UNIVERSITY OF ALBERTA

THE IMPACT OF GOVERNMENT PROGRAMS ON ALBERTA FARM REVENUE RISK

BY ©
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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled *The Impact Of Government Programs On Alberta Farm Revenue Risk* submitted by Robert E. Burden in partial fulfillment of the requirements for the degree of Master of Business Administration.

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Dedication

I would like to dedicate this thesis to the two people that I admire most in the entire world, my mother and my wife. Their spirit, courage, and determination is a source of inspiration for all who know them.

ABSTRACT

This thesis analyzes the risk effects of the Net Income Stabilization Account (NISA); Gross Revenue Insurance Program (GRIP); Revenue Insurance Program (RIP) (including Saskatchewan versions of GRIP and RIP; Crop Insurance (CI), an analog of the Special Canadian Grains Program (SCGP) and the Western Grain Stabilization Act (WGSA).

Estimated yield data is combined with prices and regional grade information by year to generate a time series of revenue on a per acre basis. Simulated estimates of annual payouts from each of the programs allow the formation of additional time series for each program, elevator point and crop. Risk comparisons are then made between the various time series, and summarized for each of 13 regions.

A root mean squared error and a coefficient of variation are used to measure the impact of programs on short-term revenue predictability and long-term revenue variability. The influence of each of the programs on a farmer's relative debt carrying capacity is also examined.

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TABLE OF CONTENTS

List Of Tables

LIST OF FIGURES

List Of Abbreviations

Alberta Hail and Crop Insurance Corporation (AHCIC)

Alberta Wheat Pool (AWP)

Canadian Wheat Board (CWB)

Census Division (CD)

Certainty Equivalent Expression (CEE)

Chicago Board of Trade (CBT)

Coefficient of Variation (CV)

Common Agricultural Policy (CAP)

Crop Insurance Act (CIA)

Crop Insurance Program (CI)

Elevator Point (EP)

Expected Utility Maximization (EUM)

Export Enhancement Program (EEP)

Farm Income Price Index (FIPI)

Farm Income Protection Act (FIPA)

Gross Revenue Insurance Program (GRIP)

Mean Absolute Difference (MAD)

Negative Root Mean Squared Error (NRMSE)

Net Income Stabilization Account (NISA)

Revenue Insurance Program (RIP)

Root Mean Squared Errors (RMSE's)

Saskatchewan Gross Revenue Insurance Program (SGRIP)

Saskatchewan Revenue Insurance Program (SRIP)

Special Canadian Grains Program (SCGP)

Western Grain Stabilization Act (WGSA)

Winnipeg Commodity Exchange (WCE)

1.0 NATURE OF THE INQUIRY

1.1 INTRODUCTION

Canadian government has a long history of involvement in the agricultural area. Many programs continue to jointly subsidize production, transfer income and reduce farm risk exposure. In the spring of 1991, the *Farm Income Protection Act* (FIPA) was passed by the federal parliament. The previous *Crop Insurance Act* and the *Western Grain Stabilization Act* (WGSA) were repealed. In their place the Federal Minister of Agriculture entered into agreements with the provinces for the establishment of the Net Income Stabilization Account (NISA); Gross Revenue Insurance Program (GRIP); Revenue Insurance Program (RIP); and Crop Insurance Program (CI).

The effect of these programs on risk in grain farming is evaluated in this analysis. In addition to the new programs mentioned above, the analysis encompasses the Saskatchewan modifications of GRIP and RIP (SGRIP and SRIP), a simulated version of a former program, the Special Canadian Grains Program (SCGP) and an historical study of WGSA.

The risk in agricultural income originates from two main sources: commodity price movements; and variance in production (yield). These sources contribute to variation in farm revenue. Farm expenses tend to be stable and predictable by comparison. The general approach of this paper is to examine the risk in revenue that would have prevailed without government programs during a recent 18 year period (1974-91), and compare this to estimates of the risk which would have been present during these periods if any one of the programs had been in effect.

The empirical base of the paper consists of yield estimates from each of about 300 country elevator points over each of these 18 years, for each of 3 crops. This yield data, combined with regional grade information by year, and annual prices, is used to generate a time series of revenue per acre for each elevator point. Simulated estimates of annual payouts from each of the programs allow the formation of additional time series for each program, elevator point and crop.

Risk comparisons are then made between the various time series, and summarized for each of 13 regions.

1.2 JUSTIFICATION AND PROBLEM STATEMENT

Much of the risk in agricultural cash receipt levels is a result of two main factors: commodity price movements; and variance in production and quality levels. Risk is exacerbated by high asset to sales ratios typically found in agricultural operations. In recent history, government response to risk has been to introduce various generalized stabilization programs at the national and provincial level.

The efficiency of these programs can be more effectively evaluated at sub-regional rather than at the provincial level of aggregation due to the fact that a considerable amount of production variability occurs at the local level and averages out at broader levels of aggregation. Finer aggregation also allows recognition of different price risk exposure arising from different localized crop production mixes.

The provincial and federal governments have spent large amounts of public funds in the delivery of these programs and while there is little doubt that they have provided an income transfer to the agricultural community, their effectiveness in reducing risk is not well understood.

1.3 OBJECTIVES

The general objective of this research is to evaluate the significance of the impact of agricultural stabilization programs on farm revenue risk at a sub-provincial level where revenue risk is defined in two alternative ways: revenue predictability, and revenue variability.

Specific objectives of the study include:

1. Synthesize a time series of contemporary farmer revenue forecasts for various crops and locations in order to generate single period errors in expected crop revenues.

2. Measure the effectiveness of specific stabilization programs by observing the statistical significance of changes in the single-period errors in crop revenue estimation. The significance tests will be conducted using a pairwise test of difference among the various error terms.

3. Perform a quantitative analysis of the secondary effects of the stabilization programs, with reference to borrowing capacity, as well as various market risk control practices.

1.4 SCOPE

Actual and expected revenue series, independent of government involvement, are calculated by elevator point using actual and expected prices and yields for various combinations of crop production. These figures are then used to generate a series of Root Mean Squared Errors (RMSE's), which may then be compared to RMSE's resulting from the implementation of various government risk reduction programs.

Numerous government programs for managing risk have been made available to agricultural producers and are evaluated by adjusting the time series of revenues and expected revenues to simulate their effect. Different models used to forecast revenue from crop production in the simulation represent the gathering of information at the individual producer level. Deviation from forecast revenue is then measured and compared using RMSE calculations.

The issue of premiums is not considered in model simulation. In most cases this does not affect the model as the actual cost of insurance is known to producers in advance of seeding, and as a result does not impact RMSE calculation. Income tax implications are not considered in the model.

2.0 GENERAL BACKGROUND

2.1 HISTORY OF RISK CONTROL PRACTICES AFFECTING ALBERTA

In the spring of 1991, the *Farm Income Protection Act* was passed by parliament. This act authorized agreements between the federal government and the provinces of Canada, and provided for protection for the income of producers of agricultural products.

Under this framework, the federal and provincial governments could negotiate bipartite or tripartite programs. The act also enabled the federal government to put into place, of its own accord, programs to protect the income of agricultural producers.

With the establishment of this Act, the *Crop Insurance Act* (CIA), and the *Western Grain Stabilization Act* were repealed. In their place the Federal Minister of Agriculture entered into an agreement for the establishment of the:

- NISA;
- GRIP[1];
- RIP; and
- CI.

In effect, established programs were replaced by a new generation of government intervention in agriculture. The background and mechanics of each program will be discussed on an individual basis and described in detail.

2.2 CROP INSURANCE (CI)

All-risk crop insurance was originally introduced in the 1964/65 crop year and had 1,312 participants. By 1992 producer involvement had increased to over 26,000 farmers, representing

[1] While GRIP is identified as a program by itself, it is important to note that it is in fact administered through the CI and the RIP.

approximately 40% of both the total production units and total improved land as identified in the 1991 census. Over half of total costs have been borne by either provincial or federal government.

The program is now administered by the Agriculture Financial Services Corporation. This corporation sells all-risk crop insurance and also offers a specialized program of hail insurance for those who want only that coverage or who wish to supplement the hail coverage contained in all-risk insurance. Specialized hail insurance is also available in the private sector and is not considered in this analysis.

Prior to the 1990/91 crop year the federal government paid 50% of the actuarial premium of the crop insurance, the producer paid the other 50%, and provincial governments paid the administrative costs. Under the new agreement the federal government reduced its share of the premium payment to 25%, the producers share remained at 50% and the provincial government was made responsible for 25%. Administrative costs are now shared between the federal and provincial governments.

CI coverage is differentiated by geographical "risk areas" and for the 1990/91 crop year the number of risk areas was increased by over 50%, to increase the homogeneity of production experience within each area. Crop insurance coverage for irrigated crops was also separated from coverage levels of non-irrigated crops. In addition, producers were given the option of insuring their yield at 80%, 70%, or 60% of individually-indexed production levels.

The 1990/91 reform also introduced individual indexing, which related the terms of insurance to individual producer production experience. This change, along with the increased number of risk areas, is intended to make CI more equitable and efficient. Eventually lower premium/ coverage ratios are expected as the tracking of individual production reduces costs of providing routine coverage to producers with chronic sub-average production.

2.3 WESTERN GRAIN STABILIZATION ACT (WGSA)

The *Western Grain Stabilization Act* was established in April, 1976 to provide prairie-wide grain income stability through a program of compensatory payments to producers in years when prairie grain cash flow, as defined by WGSA, fell below its prior 5-year mean. Participation was voluntary for producers. By the 1989/90 crop year over 129,400 producers, accounting for 90.5% of all Canadian Wheat Board permit holders, were registered as program participants.

Farmer contributions were restricted, and eventually allowed on up to a maximum of $60,000 annual sales. Farm families could establish several WGSA accounts through registration of spouses and children. Participation proved to be very remunerative for producers, since over its lifetime the program paid them an average of $5.20 for every dollar of levy contributed.

The program was to be financed from a fund built up by levies assessed against participating grain producers and by the federal government. Surplus funds in the WGSA account earned interest which was credited to the program's funding. During periods of deficits, the federal government advanced funds, repayable with interest, to make up the shortfall. By August 1989, the fund balance supporting the WGSA program was in a deficit position of $1.30 billion. By the following August, this deficit had dropped slightly to $1.09 billion. This deficit was written off by the federal government when the program ended on July 31, 1991.

2.4 Special Canadian Grains Program (SCGP)

SCGP was an ad-hoc subsidy justified by low world grain prices, which were attributed, at least in part, to the European Economic Community's Common Agricultural Policy and the 1985 Food Security Bill in the United States. SCGP was introduced in the 1986/87 crop year, and was extended for 1987/88. The program partially offset calculated price declines for specific grains and oilseeds when compared against 1985 price levels. The SCGP paid $1 billion to producers on their 1986 crop, and $1.1 billion on the 1987 crop. Alberta producers received a total of $548 million over the two year period.

Assistance was distributed on a regional basis. Farmers received payments based on their acreage but independent of their individual yield or pricing experience for the year.

2.5 National Income Stabilization Account (NISA), Gross Revenue Insurance (GRIP), and Revenue Insurance (RIP)

NISA and GRIP are different programs, but their development was closely interrelated. As a result, the evolution of the two programs are discussed together, while program mechanics and model simulation are discussed separately.

In November of 1990, federal and provincial ministers agreed in principle to the new programs, subject to the establishment of a suitable cost sharing agreement. In January 1991, the federal government announced the new generation of "safety nets". GRIP began in the 1991/92 crop year, while NISA was available retroactive to the 1990 tax year.

NISA is a subsidized savings plan where individual contributions are matched by equal government contributions. The program incorporates the principles that payment triggers should be based on overall income deficiencies and not shortfalls for specific commodities; that payments should be specific to the circumstances of the individual producer; and that there must be sufficient motives for voluntary accumulation of NISA accounts. Funds are periodically paid into individual NISA accounts. When an individual's farm income drops to a predetermined payment trigger, the account holder may make a regulated withdrawal.

GRIP supports gross farm revenue on an individual crop basis. GRIP is comprised of two separate components: the CI and the RIP. (CI has been discussed previously.) RIP offers a combination of protection against shortfalls in revenue (the product of yield and price), over and above the yield insurance offered under CI. RIP payments are net of payments receivable from potential CI participation. Enrollment in these subsidized programs in voluntary, and they may be purchased separately or in combination. A producer may opt out of GRIP or RIP by providing notice 3 years in advance of the cancellation year, upon retirement or by repaying all of the benefits received in the previous three years. GRIP premiums are shared between producers, and federal and provincial governments in the ratio of 33.3% : 41.7% : 25%.

2.6 Saskatchewan Versions Of GRIP And RIP (SGRIP And SRIP)

SGRIP and SRIP were introduced in the 1992/93 crop year. They were proposed by a Saskatchewan government advisory committee which submitted a report on February 15, 1992. The report made five specific recommendations:

1. Offer completely separate production insurance and revenue insurance;
2. Operate crop insurance with the basic features it had before GRIP;
3. Operate revenue insurance as a deficiency payment program;
4. Make allowance for offsets between price and yield;
5. Keep the program simple and keep administration costs down.

SGRIP provides production and price risk protection through CI and SRIP programs. Producers have the option of participating in either, or both, programs. Premium sharing arrangements between producers and provincial and federal governments have been the same as on GRIP. Premiums are based on seeded acres, with a rate which varies regionally. Of the actuarial total premium, farmers pay 33.3%, the province pays 25%, and the federal government pays the remaining 41.7%.

SGRIP differs from GRIP by using a "basket" of 19 eligible crops to determine coverage levels. This isolates program payments from individual producer production decisions, keeps the program from distorting production choices between crops, and pools the regional experience from a variety of crops in determining whether there is revenue shortfall. Under SGRIP, a single per-acre payout is calculated and all eligible producers are given the same level of payout on enrolled acreage, subject to adjustment by individual indexing.

3.0 THEORETICAL BACKGROUND

Risk analysis has long been applied to agriculture, e.g. Heady (1952). Examples of more recent work includes Ye and Yeh's (1995) comparative evaluation of yield risk reductions under various crop insurance schemes using a generalized stochastic dominance (GSD) methodology; Mumey, Burden, and Boyda's (1992) discussion of the use of single period forecast errors at the local level to evaluate the revenue risk reduction of specific programs and crop rotations; Novak, Mumey, and Underschultz's (1991) evaluation of risk management in finishing heavy feeder steers in a custom lot in Alberta; Turvey and Driver's (1987) beta-risk coefficients for agricultural commodity revenues; Collins and Barry's (1986) Sharpe Single Index approach; Young and Barry's (1987) evaluation of financial assets in farm portfolios; and Robinson and Barry's (1987) study of government stabilization policy and farm risk control.

With the exception of Mumey, Burden, and Boyda (1992), the articles are limited in that they do not have localized data. Furthermore, these studies rely on historic variance as a fundamental risk measure.

The literature on risk itself is very extensive but may be classified into three main categories (Young, 1984):

1. Decision rules requiring no probability information;
2. Safety first rules; and
3. Expected utility maximization (EUM).

This analysis makes use of a variance model which is an extension of the EUM model as outlined initially by Von Neumann and Morgenstern. Essentially, the expected utility of a revenue function can be expressed in terms of the utility of its certainty equivalent expression (CEF).

This version of the EUM can be used to represent risk neutral, risk adverse, or risk seeking grain producers. Neither the risk neutral, nor the risk seeking investor are intuitively appealing in this case. As a result, producers are assumed to be risk adverse for the risk efficiency criterion. For example, two strategies, X and Y, are ranked based on their ability to predict gross revenue on an annual basis over a given period of time. Choice X is preferred if prediction error X < prediction error Y. If there is no significant difference in the prediction error, the producer is indifferent between the strategies.

3.1 Two Measures Of Risk

The general objective of this research is to evaluate the impact of agricultural stabilization programs on farm revenue risk at local level. Risk control can be more effectively evaluated at local rather than provincial level of aggregation, since a considerable amount of local yield variability averages out at broader levels of aggregation.

Revenue risk is addressed by measuring or simulating the effect of programs on short-term revenue predictability, and long-term revenue variability. Revenue predictability refers to the degree to which revenues can be accurately forecast from such information as past yield history and available price forecasts. Revenue variability, in the context of this paper, refers to instability of farm income over a longer period of time.

Both risk measures have relevance. Short-term forecasts are especially important for farmers who rent land on short-term leases. If predictions for any year are unfavourable, land rents can be negotiated down or rented land can be dropped. Even farmers who have a longer-term commitment to farming may choose to defer or accelerate farm investment or consumption plans, or seek or quit off-farm employment, on the basis of short-term prospects. If these predictions are frequently wrong, planning is difficult and business loss or personal hardship may result from planning errors.

For a farmer who makes a long-term commitment to farming, owns land and does not have accessible off-farm income sources, the ability to make year-to-year adjustments in response to short-term predictions may be limited. A farmer who is firmly planted in the business may be more concerned about variability. That farmer may be satisfied that if the farm can generate "average" revenues it can survive or prosper. The farmer is likely to be concerned about the potential for revenues that depart far from long-term average, whether or not they are predictable in the short-period.

Results are not sharply different between the two methods. Farmers are likely to predict yields from long-term averages, so short-term yield surprises are usually also corresponding deviations from long-term normal yield. Short-term price predictions are based on updated price information, but in a market where prices are unstable, big fluctuations can occur during any crop year and often a farmer who experiences a price below long-term average in any year is also experiencing a short-term forecasting error. But the relationship between the two methods is not perfect (a correlation is reported later); sometimes prices which are far from the long-term norm may have been accurately forecastable a year in advance.

3.1.1 Revenue Predictability

RMSE is used to measure the extent of deviation from the short-term forecast. It is calculated from each year's differences between predicted revenue and observed revenue at each elevator point. This may be expressed as the relative deviation from forecast, ε_t.[2] Where c_t is end-of-period-cash flow for period t and where $\hat{c}_t$ is a synthesized beginning-of-period forecast of this cash flow,

$$\varepsilon_t = (c_t - \hat{c}_t) / \hat{c}_t \qquad \mathbf{1}$$

Crop investment errors are summarized, where n = number of time periods into an RMSE:

$$\text{RMSE} = (\sum_t \varepsilon_t^2 / n)^{.5} \qquad \mathbf{2}$$

---

[2] Central findings of the paper are unaffected by indexing, since investment error ε_t is defined in ratio form, $(c_t - \hat{c}_t)/\hat{c}_t$. The use of CPI is consistent with the concept of free-standing single-period investment decisions. A farmer invests cash at t in anticipation of cash back at t+1. No reinvestment is presumed. Cash is characterized as potential consumption at both t and t+1, and use of CPI enables comparison of the consumption equivalents.

The use of the RMSE as a measurement of risk associated with crop production is a better measurement of revenue risk than the use of the historical standard deviation, since historical standard deviation ignores the fact that producers can use currently available information when making investment decisions. Since rational investors are assumed to use both current and historical information when evaluating risk in capital investment decisions, the RMSE would appear to provide a more accurate depiction of the risks associated with production decisions.

Burton and Claasen (1993) argue that a measure analogous to semivariance, which considers only negative deviations below forecast would be more appropriate than would RMSE in measuring revenue predictability. They suggest the use of a Negative Root Mean Squared Error (NRMSE) which is essentially the same as a RMSE except that it ignores positive forecast errors. They argue that farmers experience disutility when actual annual incomes are below forecasts, but do not experience disutility when incomes are above forecasts.

There are two main reasons not to ignore the positive deviations in revenue errors. First, the major risk measure used in the general finance literature is the investment standard deviation, which includes positive deviations in its calculation (Mumey, 1993). Since the RMSE used in this analysis is closely linked to the investment standard deviation, it allows the analysis to be linked to external information on capital markets and other financial indicators (Mumey, Burden, and Boyda, 1992).

A second, and possibly more compelling argument is that positive errors in revenue prediction are not inconsequential in risk analysis. While positive revenue surprises are welcome ex ante, using them in forming future expectations may make the forecast dependent upon unusually good luck. Farming enterprises may be as likely to fail as a result of substandard annual results while waiting for the next outstanding year, as they are from extremely poor performance in a single year.

Another method of risk measurement used in agricultural literature is the Mean Absolute Difference (MAD). With this method the errors are not squared in an attempt to ensure that the resulting distribution is better behaved. However, the MAD assumes that producers are adverse to errors (both positive and negative) but are indifferent with respect to the scale of these differences. While useful in certain situations, this logic is not consistent with farm revenue risk analysis conducted in this project.

3.1.2 Revenue Variability

The Coefficient of Variation (CV) is used as an estimate of revenue variability in this analysis. The CV is a normalization of the revenue function which allows for the use of a common unit of investment scale. It is calculated from each year's differences between actual revenue and mean revenue, at each elevator point. This may be expressed as the relative deviation from mean revenue, ε_t^*. Where:

$$\varepsilon_t^* = (c_t - \bar{c}_t) / \bar{c}_t \qquad 3$$

Crop investment errors are summarized, where n = the number of time periods into a CV for each elevator point:

$$CV = (\sum_t \varepsilon_t^{*2} / n)^{.5} \qquad 4$$

To summarize the variability across a crop district an unweighted mean of elevator CV values is used.

3.2 Pairwise Test Of Difference Among MSE's

A great deal of research has been completed in the area of the issues involving the comparison of MSE forecast errors: Clements and Hendry, (1993); Armstrong and Fildes (1995); and Mathews and Diamantopoulos, (1994). While most agree that the MSE and its variant, RMSE, provide a useful indication of forecast accuracy for a single time series there is little agreement on the use of MSE's for assessing accuracy across many series. MSE's tend to have a highly skewed distribution. In addition, the MSE's of the different models represented in this analysis are not independent as they use much of the same information in their calculation. As a result of these two issues it is difficult to find a good measure of relative difference among various RMSE calculations.

Thompson (1990) attempted to deal with this issue by using a log mean squared error ratio in order to attempt to get the distribution to approximate normal. While this method is interesting in concept, it still does not deal with the independence issue.

Beverage and Oickle (1994) proposed the use of a pairwise test of difference between two MSE's which was fashioned after that completed by Ashley et al. (1980). Their process consists of letting s_{1t} and s_{2t} be two error series. These series are used to create two new variables Y_t and X_t where: $Y_t = (s_{1t} - s_{2t})$ and $X_t = [(s_{1t} + s_{2t}) - (\bar{s}_{1t} + \bar{s}_{2t})$, where $\bar{s}$ is the simple mean of the various revenue error series. The test itself involves estimating the equation:

$$Y_t = \alpha + \beta X_t + \varepsilon_t \qquad \textbf{5}$$

In reality, β represents the difference between the forecast error of the variance of S_1 and the forecast error of the variance of S_2. As a result, a significant positive β indicates that the model used to generate the error series S_2 is more effective at reducing prediction risk, a significant negative β indicates the opposite, and an insignificant coefficient suggests that the predictive power of the two series is not significantly different.

3.3 Other Related Risk Reduction Issues

3.3.1 Black's Option Pricing Model

Option values may be valued using an arbitrage approach as described by Black and Scholes (1973). Black and Scholes used the concept of building a riskless portfolio of options and stocks to deduct the value of the option itself. They demonstrated that the value of an option depends on five parameters:

- the current underlying stock price;
- the strike price;

- the time to expiration;
- the risk free interest rate; and
- the volatility of the stock.

The Black-Scholes model is used to calculate the value of European calls and puts on non-dividend paying stocks. However, the model may be altered to provide values for European put and call options for futures contracts - a situation more analogous to this analysis.

Black modified the Black-Schole's model in order to calculate the option value of futures prices (Black, 1976). The Black's model may be used to calculate the value of the option provided by the various programs in the simulation. The volatility for the Black model is obtained from the time series of differences between forecast prices and observed prices in the form of an RMSE. Since the Black model is based on continuous time, this RMSE is accordingly adjusted (Continuous RMSE = ln[1+RMSE]). The life of the option is 1 year, the striking price of the option is the price guarantee, and the market price for the Black formula is the price expectation for the current year. The Black model yields an estimate of the future value of the option when an interest rate of zero is used. Since the option value is being used in this context for forming an expectation of a future payout, a zero interest rate is used in this and subsequent calculations employing the Black model.

Using Black's model to estimate the put value of various government agricultural programs is common in the literature. Kang and Brorsen (1995) use a Black average pricing model to predict the implicit premium of the U.S. government deficiency payment. Witt and Reid (1987), Turvey, Brorsen, and Baker (1988), and Marcus and Modest (1986) have also used Black's model or variants of the Black -Scholes model in order to determine the value of put options provided by various government programs.

One of the main issues involved in the Black model is its assumption of a normal distribution; and constant volatility. Work completed by Johnson and Shanno (1987), Hull and White (1987), and Kang and Brorsen (1993) have used Monte Carlo studies to demonstrate that Black option pricing models underprice in- and out-of-the money put options relative to models considering nonnormality and heteroskedasticity. However, this work has been completed using price data, where fat tails, a Kurtosis issue, have been the point of contention.

The distribution of revenue data tends to be skewed rightward due to the impact of the multiplicative process (price x yield). The expected impact on put value estimation is to overprice in- and out-of-the money options, at least compared to the estimates for price distributions. Neither the existence, nor the extent of option over-valuation was examined in this analysis, as it was considered to be beyond the scope of the study.

3.3.2 Cropping Practices

Crops are usually grown in combination, and disturbances in price or yield may affect individual crops differently. Therefore, some degree of risk control through diversification is obtained. In crop districts where crop mixtures rather than monocultures are common practice, the effect of government risk control measures should be evaluated relative to prevailing practice.

For simplicity, cropping combinations in the province were characterized by three crop portfolios, which were considered representative. These were 100% wheat (W), 50% wheat and 50% barley (WB); and 33% wheat, 33% barley, and 33% canola (WBC). Historic data on cropping history for each region provided the basis for assigning a cropping pattern to each crop district. Historic crop mixtures and assignation of representative crop mixtures is shown in Table 1.

Table 1: Average Production Levels and Representative Crop Mixtures by Census Division

CD	% Wheat	% Barley	% Canola	Rotation Used
1	90.21	7.07	2.70	W
2	73.23	22.09	4.67	W
3	51.75	43.79	4.44	WB
4	88.05	6.73	5.20	W
5	66.28	22.87	10.83	W
6	29.86	52.93	17.19	WB
7	53.79	21.33	24.87	WBC
8	14.31	69.08	16.59	WBC
10	42.33	28.11	29.55	WBC
11	21.32	63.27	15.40	WBC
12	24.73	45.43	29.83	WBC
13	18.43	59.60	21.96	WBC
15	40.48	26.38	33.13	WBC

Source: Statistics Branch, Alberta Agriculture.

4.0 DATA

Data from 18 years of price and yield experience are used to investigate the risk effects of the various programs under consideration.

Historical yield and grade estimates from the country elevators operated by the Alberta Wheat Pool (AWP) are the major source of production data.

Results are summarized by crop districts which coincide with Statistics Canada census divisions.[3] These districts encompass heterogeneous production conditions in the northernmost major crop production region in North America.

4.1 DATA NOTATION

The time series for each locality is based on separate estimations of yield, grade, and price, where

$_j$ denotes elevator point (each of 311 AWP elevator locations),

$_t$ denotes year of production (each of the 18 years from 1974/75 to 1991/92),

$_r$ denotes district (each of 13 crop districts)

y_{jt} = yield in kilograms per acre at the j-th elevator at time t,

g_{rt} = a district grade factor,

$q_{jt} = y_{jt}\, g_{rt}$ = production per acre adjusted for grade,

p_t = price,

$c_{jt} = q_{jt}p_t$ = revenue,

n_j = number of observations across time at the j-th elevator point (18, unless data is missing), and

n_r = number of observations across time for all elevator points in the r-th district.

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[3] While there are now 18 crop districts in Alberta, the data from 1987-92 was sorted into the 13 districts that existed prior to 1987 in order to be consistent with the previous research by Mumey, Burden, and Boyda, 1992, and Mumey and Burden, 1993. A graphical illustration of both the current Census Divisions and the CD's used in this analysis, can be found in Appendix #1.

Bars and carats designate means and forecasts; e.g., $\bar{c}_j$ = mean revenue across time at elevator point j and $\hat{c}_{j_t}$ = expected revenue to be received at end of year t at elevator point j. To simplify notation, a subscript is not assigned to crop kind - wheat, barley or canola. Until subsequently noted, each crop is analyzed separately.

4.2 Yield Data

Annual yield estimates filed by managers of AWP country elevators provide the basic yield data. These elevators typically serve farming areas within 10 to 30 kilometers radii. With these small areas of data aggregation, data series are presumed to be representative of farm level experience. The maximum number of reporting elevator points in any year is 311 for wheat and barley, so over 18 years there are 5,598 potential data points for each of these crops. For canola, the maximum number of reporting points is 250, a potential data set of 4,500. Approximately 20% non-response occurred in wheat reporting, 19% in barley, and 24% in canola. Non-response is attributed mainly to the shut-down of elevator points, reporting omissions by managers, and sporadic canola production at some points, especially in southern Alberta.

4.3 Grade Adjustment

Crop sales are subject to price adjustment for quality through a system of official grades. Definition of price p_t is based on the major grade of the respective crop, and the factor g_{rt} is applied to recognize value adjustment for different grades, by district since data are not available by elevator point.

$$g_{rt} = \sum_k (w_{rkt} d_{kt}) \qquad 6$$

Where:

$_k$ denotes grades which are subject to price adjustment from p_t,

d_{kt} = price discount or premium of grade k in ratio to p_t,

w_{rkt} = ratio of sales of grade k to all crop sales for the respective district (Alberta Wheat Pool, 1974-1986).

4.4 PRICE DATA

Values of d_{kt} for wheat and barley are determined from annual Canadian Wheat Board (CWB) payouts for different grades. (Alberta Agriculture, 1973/74-1991/92, and Canada Grains Council, 1974/75-1991/92). Canola grade discounts are from Alberta Hail and Crop Insurance Corporation records (AHCIC, correspondence).

Wheat and barley are priced on the assumption they will be marketed through the CWB. Delivery is assumed to occur in December. Intermediate and final payments are discounted for 0.5 year and 1 year delays with contemporary 1-year Canada T-bill interest rates. CWB prices are net-to-farmer, Edmonton delivery, for 1CWRS wheat and 1 Feed barley.

Canola is priced at $December_t$ #1 Canada Canola elevator cash price, Edmonton. All prices are CPI adjusted, consistent with an assumed farm investment objective of maximizing potential consumption.

5.0 METHODOLOGY

Following the method used by Mumey, Burden and Boyda (1992), and Mumey and Burden (1993), information available to producers prior to crop planting is used to generate time series of contemporary farmer revenue forecasts. These forecasts are synthesized for each crop and location to generate single period errors in expected crop revenues.

Each of the nine stabilization programs under study is modeled. This modeling consists of simulating the payouts which would have occurred in each year from each of the programs at each elevator point. Corresponding year-in-advance estimates of each of these payouts are also simulated. For each year, program and elevator point these simulated payments are added to the observed payments to produce new local revenue time series for each program, and new local time series of predicted revenue for each program.

Improvement in prediction on each program is measured by observing the change in the single-period errors in crop revenue estimation when stabilization programs are introduced. These errors are summarized in the error statistic, RMSE, which is first calculated at each elevator point for each program, and then merged into 13 regional means of RMSE for each program.

Reduction in variability from each program is measured by calculating deviations from mean by program, year and elevator point, and identifying a deviation statistic, CV, for each elevator point.

Again, the elevator point CV's are then reported as regional means, for each program.

The analysis also briefly considers impact of the programs on farm borrowing capacity. This results from this exercise having two possible interpretations. They illustrate how much extra borrowing is enabled by a government program if risk on farm equity is left at its pre-program level. They also may predict how much extra borrowing farmers are likely to do in response to government programs, if one makes the assumption that farmers will respond to programs by borrowing to reestablish the degree of equity risk which they had previously decided to tolerate.

5.1 QUANTITY FORECAST

Prior to planting (by December$_{(t-1)}$) producers have access to data which may be used in predicting revenue for the coming crop year:

- historical production, yield and grade;
- planned input use;
- futures market price; and
- historical covariance between production and price.

Data available to producers prior to seeding is used to synthesize revenue forecast errors which could have been made by producers in various localities. Local production depends on physical conditions such as soil and climate, available technology, and the amount and kind of discretionary inputs. Physical conditions are presumed to be stationary, technology to change gradually over time, and discretionary inputs to vary year-by-year in response to price signals. With these assumptions, a series of forecast yields are simulated, using the following formula:

$$\hat{y}_{jt} = \bar{y}'_j + \beta(t - \bar{t}) \qquad 7$$

where:

$\bar{y}_j$ = composite local mean yield.

ß = straight-line time slope of y_{rt}.

Local and regional yield data for the period under study are used as a proxy for historic yield; e.g., the yield forecast simulated for 1974 is based on yield data from 1974/75 through 1991/92 crop years. Stability of basic physical conditions allows subsequent data to represent previous data, so long as appropriate compensation is made for technology improvements. The broad time span minimizes the feedback of data from the year being forecasted.

In simulating local yield estimates, $\hat{y}_{jt}$ regional data is used to temper the effect of local yield outliers, following the James-Stein method. (James and Stein, 1961; Efron and Morris, 1975, 1977). This method has been applied in an agricultural context by Mumey, Burden, and Boyda (1992); Mumey and Burden (1993); Berger (1985); and Fay and Heriot (1979). The method also seems, intuitively, to form judgments about yield potential in the way a thoughtful farmer would.

Basically, as historical yield variability in local data exceeds the variability of the surrounding region, a farmer is assumed to place more emphasis on regional rather than local historic yield information in forming an expectation of future local yield.[4]

Technology change is identified as the time trend in yield data. Positive time trend is expected in barley because cross-sectional barley yield trial data show improvement from varieties introduced during 1974-92.[d] Canola yield increases are expected from learning of new cultural practices, since this crop had only been produced on a large scale in Alberta since about 1960. In contrast, wheat cultural practices are long-established and its cross-sectional data do not indicate genetic yield improvement

Regression results are expressed in terms of kg/acre/year and are as follows:

Crop	Beta	t-statistic
Wheat	6.73	1.42
Barley	18.01	4.08
Canola	6.55	3.88

Only the trends in barley and canola are significant. Both the barley and canola trends are quantitatively consistent with genetic improvement manifest in cross-sectional data.

[4] The James-Stein statistic: The use of S_j requires normally distributed values of Y_j within districts (Efron and Morris, 1975,1977). Y_j was tested for normality with a Shapiro-Wilk w statistic, and the normality condition is generally satisfied.

The weight placed on local historical data in forming the expectation of future yield ranged from .02 to .86. A summary of weights by district indicates wide interregional difference. In high risk districts, where broad weather patterns create variance across time rather than across elevator points, local weight below .10 are typical.

With the assumptions of stationary historic grades and with approximate statistical independence between grade and yield, q is forecasted as:

$$\hat{q}_{jt} = \hat{y}_{jt} \bar{g}_r \qquad \textbf{8}$$

5.2 PRICE FORECASTS

Price forecasting in this analysis rests on the assumption that a current futures contract price forecasts a future cash price after adjusting for basis.

Essentially, the producers anticipated price for a given year and crop is the current futures price for that crop for a contract maturing after the crop season, less the anticipated basis, or difference in location, timing issues, and quality levels.

Basis for barley and canola (cleaning, transporting and handling) is obtained from trade information. Wheat basis, more complex because of quality difference and exchange rate difference, is estimated as CPI-indexed historic mean difference between p_t and November$_t$ price of December$_t$ CBT contracts.

$$\hat{p}_t = p^t_{(t-1)} + Basis \qquad \textbf{9}$$

where $p^t_{(t-1)}$ is the price in December$_{(t-1)}$ of a futures market contract for commodity deliverable after harvest in year t. Prices are from the Winnipeg Commodity Exchange (WCE) and the Chicago Board of Trade (CBT) and Agriculture Canada:

$p^t_{(t-1)}$ = December$_{(t-1)}$ prices of the following contracts:

- Barley WCE October$_t$ (WCE, 1974-92)
- Canola, WCE November$_t$ (WCE, Ibid.)
- Wheat CBT December$_t$ (CBT Annual Report, 1974-92).[5]

[5] In an attempt to account for the Export Enhancement Program (EEP), expected prices from 1987-1991 are reduced by $30/tonne. This represents the St. Lawrence wheat price used by Agriculture Canada in their medium term price forecasting models.

U.S. futures prices are converted to Canadian dollars at forward exchange rate for t, quoted at t-1 (Bank of Canada Review, 1974-92).

Some weak and rather broadly distributed negative correlation between p_{jt} and y_{jt} is observed in barley and canola. However, because the coefficients are either small or isolated, the assumption of zero covariance is used, and as a result

$$\hat{c}_{jt} = \hat{q}_{jt} \hat{p}_t \qquad 10$$

5.3 Actual And Predicted Revenue Simulation For Individual Programs

5.3.1 Crop Insurance

Producers may purchase crop insurance from Alberta Hail and Crop Insurance Corporation (AHCIC) which compensates for yield differences from a historic norm. This analysis models the all-risk insurance policy by revising the previously established c_{jt} and $\hat{c}_{jt}$ series to reflect program payouts, and expectations of revenue consistent with the subsidized program.

As previously discussed, current coverage levels available under the program include 60%, 70%, or 80% of individual average yield. This analysis simulates coverage at the 70% level so as to be consistent with the subsequent analysis of alternative programs.

As noted, CI offers two price options. However, a lack of accurate data prevents this analysis from using either of these two options in the analysis. As a result, 75% of the expected price is used as the CI price. In this manner, the CI analysis provides insight into the potential upper boundary of expected and actual risk reduction using the program.

5.3.1.1 Actual Crop Insurance Revenue Series

This research simulates protection at 70% of mean historic yield by replacing the actual revenue time series, c_{jt} with the generated series c_{CIjt}.

Where:

- $\bar{y}_j$ is historic mean yield;
- y_{CIj} is $.7\,\bar{y}_j$; the yield guaranteed under CI;
- p_{CIt} is $.75\,\hat{p}_t$; 75% of the anticipated price prior to seeding, which is an estimate of the price at which yield deficiencies are settled under CI;
- c_{CIjt} is the simulated actual revenue given CI participation; and
- $\hat{c}_{CIjt}$ is the expected revenue given CI participation.

If: $y_{jt} \leq (y_{CIj})$,

Then:

$$c_{CIjt} = (y_{CIj} - y_{jt})\, p_{CIt} \quad g_{rt} + y_{jt}\, p_t\, g_{rt} \qquad \textbf{11}$$

If $y_{jt} > (y_{CIj})$,

Then:

$$c_{CIjt} = c_{jt} \qquad \textbf{12}$$

5.3.1.2 Predicted Revenue Series

The predicted revenue series are correspondingly modified to recognize that producers expect insurance protection and payouts. This anticipation is modelled on the assumption that a farmer will correctly anticipate the 18 year mean yield deficiency for the locale, multiply this long term mean deficiency by the contemporary crop insurance settlement price, and add this product to each year's revenue expectation.

Predicted revenue is correspondingly modified to:

$$\hat{C}_{CIjt} = \hat{C}_{jt} + P_{CIt} \sum_{t=1}^{n} Max(y_{CIj} - y_{jt}, 0) / n \qquad \textbf{13}$$

In other words, under the CI program, expected revenue is expanded by an expectation of an insurance payout.

There has been no attempt to refine $\hat{c}_{cljt}$ further by recognizing that a high value of p_t may induce extra input use and thereby reduce the probability of yield deficiency. Analysis of the data has shown little relationship between $\hat{p}_t$ and y_t.

5.3.2 The Western Grain Stabilization Act

5.3.2.1 Program Mechanics

The program was based on an arrangement between participating grain producers and the federal government. Both parties made levy payments into a general account used solely to fund stabilization payments. Producers contributed levy payments at varying rates of their grain receipts to a maximum amount as set in the program (see Tables 2 and 3).

Table 2: Allowable Annual Levy and Payouts per $ of Levy

Year(s)	Eligible Grain Receipts	% of Producer Contribution	Maximum Total Levy	Payout per $ of Levy[a]
1976/77/78	$25,000	2%	$500	1977 = $2.19 1978 = $3.13
1979/80/81/82	$45,000	2%	$900	
1983	$60,000	2%	$1,200	1983/84 = $1.09[6]
1984 (Jan-July)[7]	$35,000	1.5%	$525	
1984/85	$60,000	1.5%	$900	1984/85 = $2.70
1985/86/87	$60,000	1%	$1,200	1985/86 = $5.12 1986/87 = $13.60
1987/88/89/90/91	$60,000	4%	$2,400	1987/88 = $10.29 1990/91 = $ .27

Source: Western Grain Stabilization Annual Report 1990/91
a: This payment level is related to the levy contributions in both the payout year and the preceding two years.

Surplus funds in the WGSA account earned interest and were credited to the account. During periods of deficits, the federal government advanced funds, repayable with interest, to make up the shortfall.

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[6] While the 1983 levy was based on the calendar year, the payout was based on the 1983/84 crop year.

[7] As of July 31, 1984 WGSA calculations were made on a crop year basis (Aug1 - July31).

Two methods of measuring cash flow, using a Prairie-wide formula, were employed in determining payout calculations. The calculation of WGSA payouts were independent of individual producer production. Each participant received a payout based on his or her contributions to the program, irrespective of individual revenue experience in the year of payout.

In the early years of the program, the aggregate payments to all participants were determined by subtracting prairie wide gross grain expenses from gross cash receipts to estimate net proceeds for marketed grain. This amount, subject to some technical adjustments, was compared to the previous 5 year average net cash flow to set the total payout.

However, early in the 1980's, complaints concerning the lack of payouts resulted in adjustments to the program. The per tonne method of determining cash flow was introduced for the 1983/84 crop year. The result of this change was to make the program more generous to its participants. A cost/benefit comparison for a permit holder participating at the allowable individual yearly maximum levy limit from the programs inception to July 1990, shows a realized producer benefit of $5.20/levy dollar paid.

An individual's share of any payment was based on the amount of levy contributed by the permit holder in the payout year plus the preceding two crop years.

It should be noted that the maximum levy contribution was not very restrictive. Farm families could use several WGSA accounts if needed, by having both spouses and eligible dependents registered as producers. A family of four would have been eligible for a $240,000 participation base. Corporate farms could have had accounts for each preferred and common shareholder if necessary.

The payout process may be represented algebraically as:

$$WGSA_t = [Levy_{t-2} + Levy_{t-1} + Levy_t]Payout_t \qquad \textbf{14}$$

Where:

- $WGSA_t$ is the total payout in year t ($);

- $Levy_t$ is the levy contribution in year t ($);
- and $Payout_t$ is the payout per unit of eligible levy in year t ($).

Table 3: WGSA Payout Calculations

Year	Maximum Levy Contribution	Three Year Levy Total	Payout per Unit of Eligible Levy (nominal $)	Total Payout
1975/76	500	500		
1976/77	500	1000	2.19	2,190
1977/78	500	1500	3.13	4,695
1978/79	500	1500		
1979/80	900	1900		
1980/81	900	2300		
1981/82	900	2700		
1982/83	900	2700		
1983/84	1200	3000	1.09	3,270
1984/85	900	3000	2.70	8,100
1985/86	600	2700	5.12	13,824
1986/87	600	2100	13.60	28,560
1987/88	2400	3600	10.29	37,044
1988/89	2400	5400		
1989/90	2400	7200		
1990/91	2400	7200	.27	1,944

WGSA was established to ensure income stability for grain farmers in Western Canada. This method of income stabilization consisted of a process that paid out based on the sum of farmer contributions in the payout year and those in the previous two years. The WGSA program is modeled for the period of time that it was in effect (1975-90). As a result, the RMSE calculated contains 16 years of data.

5.3.2.2 Actual Revenue Series

WGSA alters the revenue stream and may be represented as:

$$C_{WGSAjt} = [\sum_{t=-2}^{0}(rate_t \; C_{jt})Payout_t] + C_{jt} \qquad \mathbf{15}$$

where:

- rate$_t$ is the % of allowable producer contribution in year t; and
- Payout$_t$ is the per dollar payout for every dollar of eligible levy in year t which are CPI indexed in order to be consistent with the other calculations in the report.

5.3.2.3 Predicted Revenue Series

Predicted revenue is also adjusted in the simulation of the WGSA. Since price and quantity are random independent normally distributed variables, expected revenue under the WGSA simulation is expressed as:

$$\hat{c}_{WGSAjt} = (rate_t \ \hat{c}_{jt} \ Mean \ Payouts) + \hat{c}_{jt} \quad \textbf{16}$$

Where:

- Mean payout is the average per dollar payout for every dollar of eligible levy, CPI indexed to the appropriate year.

In effect, the expected payout from WGSA is assumed to be the same each year, the mean payout per dollar of levy over the program lifetime. This expectation of WGSA payout is added to the raw expected revenue series to produce the expected revenue time series under WGSA. While admittedly over-simplified, the estimate is likely a reasonable compromise. It may overstate how much farmers could know about the ultimate extent of WGSA subsidy, but it would also understate the potential for year-by-year forecasts using futures market price information.

5.3.3 The Special Canadian Grains Program (SCGP)

5.3.3.1 Program Mechanics

Assistance was distributed on a regional basis and was affected by historic yields, acreage in eligible crops, and the extent of summer fallow and irrigation.

With the exception of irrigated crop area, the formula is specified as:

Where:

- EA_{ij} is the eligible acres of each crop for producer j;
- EA_{ia} is the eligible acres of each crop in region a;
- Y_{ia} is the average yield for crop i in region a;
- AR_i is the stated assistance rate for each crop;
- SF is the total summer fallow acres on the individual production unit;
- and $\$Payment_{SCGPj}$ is the per acre payout received by producer j.[8]

Irrigated land was eligible for higher payments reflecting the higher yield potential in those areas, this is not included in the formula or in subsequent analysis.

For the purpose of this analysis summer fallow and irrigation acres are not considered in the SCGP simulation. The exclusion of summer fallow is not of significance as it may be assumed that elevator point yield estimates are net of summer fallow acres. However, since irrigated regions are eligible for higher payments, the estimated impact of SCGP on revenue risk reduction in southern Alberta may be downwards biased.

The SCGP was initiated in order to protect Canadian producers from falling world grain and oilseed prices as an effect of the European Common Agricultural Policy (CAP) and the American Export Enhancement Program (EEP). In effect the SCGP was a naive form of price insurance. While the SCGP was only in effect for two crop years, a price insurance program similar in theory to the SCGP can be simulated in order to look at the impacts on revenue protection.

Modelling restrictions change the nature of the program from an ad-hoc price protection program to a more systematic one. While hedging on the futures markets is another source of price risk

[8] There were 20 eligible crops under the SCGP in the Canadian Wheat Board area.

protection, the simulation of SCGP is different in that it provides protection based on historical prices rather than expected future prices.

SCGP payments from this model are made in the year following crop production. As a result, the payments must be discounted in the analysis when calculating actual revenue. In addition, while actual SCGP payouts are independent of crop grades, payments in this analysis are adjusted by grade factor calculations. Thus, the yield used in the estimation is multiplied by the grade factor.

5.3.3.2 Actual Revenue Series

This analysis simulates price protection at the moving average of market price as used in generating the GRIP IMAP prices (Economic Services Division, Alberta Agriculture). The actual revenue time series (c_{jt}) is replaced with the generated series c_{SCGPjt}. Where P is the price used in calculating the GRIP price guarantee. A payout is simulated in years when the observed price (P_t drops below the guaranteed price (P):

if: $p_t \leq P$,

then: $$c_{SCGPjt} = P \; q_{jt} \quad (17)$$

if: $p_t > P$,

then: $$c_{SCGPjt} = c_{jt} \quad (18)$$

5.3.3.3 Predicted Revenue Series

This program is modelled as a government provided minimum price set at 70% of the five year average price series. In effect, the farmer is provided with a put option. The producer must consider the value of this option in addition to other pricing considerations when forming expectations of revenue to be received in a given year.

The farmer's forecast of revenue from SCGP will depend on the relationship with the expected price for next year (from the futures market) and the SCGP guarantee. If current prospects are low relative to historic prices, the expectation of SCGP payout will be high. In effect, the farmer has been provided with a 1-year-in-advance futures contract. The producer's estimate of revenue for the year may be simulated by adding the value of this option to the raw revenue estimate.

If we assume that the crop prices are lognormally distributed, the value of the option provided by SCGP may be provided in the following equations:

$$Put_{SCGP} = (.7P\ N(-d2)) - (\hat{p}_t\ N(-d1)) \qquad \mathbf{19}$$

Where:

- $d1 = (In(\hat{p}_t / .7P) + (\sigma^2 2)T) / \sigma\ T^{.5}$
- $d2 = d1 - \sigma\ T^{.5}$;
- $\sigma = \Sigma[((p_t - \hat{p}_t) / \hat{p}_t)^2] / n$;
- $N(d_x)$ is the cumulative probability function for a standardized normal variable (d_x); and
- T = the amount of time until option expiry (7 months).

As a result, the expected revenue given the existence of the SCGP as modelled may be represented as:

$$\hat{c}_{SCGPjt} = \hat{q}_{jt}\ Put_{SCGP} + \hat{c}_t \qquad \mathbf{20}$$

5.3.4 NISA

NISA enables farmers to make contributions to individual accounts, which are then matched by federal and provincial governments. Farmer contributions are based on net sales of eligible commodities (adjusted to remove costs of production).

The contribution rate is currently set at 2% of eligible net sales. This rate is matched by an equivalent government contribution. Individual contributions in any single year by an individual can be made on a maximum of $250,000 of eligible net sales. Producers may contribute up to an additional 20% of their net sales into the account, but this amount is not matched.

Producer accounts are separated into a "government side" and a "producer side" based on the source of contribution. Contributions by governments earn interest at a competitive rate, while all farmer contributions earn 3% above 90% of the 90 day T-Bill rate for the prior month. This subsidized interest rate provides an incentive for voluntary contributions, which might otherwise be unattractive because of the controls on withdrawals from the NISA account. No contributions are allowed during years that an individual account exceeds one and a half times the account holder's five year average eligible net sales.

Withdrawals are triggered in two ways: if the eligible net sales of the individual farm falls below the previous five year average; or if taxable income falls below a legislated minimum level. Farmers may withdraw the larger of the two amounts triggered; however, the account is not allowed to go into deficit. Withdrawals are taken from the government side first. Only when this side is empty do producers remove funds from the personal side of the account. Withdrawals from the government side of the account are taxed as income, while those from the producers side are not taxed.

A producer must accept a triggered withdrawal except under two conditions: if the funds in the account are less than the year's eligible net sales; and a refusal is allowed unconditionally once every five years. When the individual quits farming, the entire account balance, including the government contributions and interest accrued, is paid to the individual producer.

Example #1:

Qualifying Sales[9]	*$108,000*
Eligible Cash Costs[10]	*$8,000*
Eligible Net Sales	*$100,000*

[9] Qualifying sales refers to the revenue generated from the sale of grains, oilseeds, special crops including farm-fed grain, and to edible horticulture crops not included under the National Tripartite Stabilization Program.

[10] Eligible cash costs refers to all costs incurred in producing the crops eligible under the program.

Based on a 2% contribution rate, a farmer in this scenario can contribute up to $2,000 (2% of qualifying sales) to the NISA account. A matching government contribution of $2,000 shared equally by federal and provincial governments would also be placed in the account[11]. The account is not allowed to increase above $150,000 (1.5 x the average eligible net sales) in this example. The producer may also contribute an extra $20,000 (20% of eligible net sales) if desired.

In example #1 a withdrawal could be made if eligible sales fell below $100,000. A withdrawal could also be made if taxable income falls below a minimum level, presently set at $10,000.

The simulation model for the NISA program requires numerous assumptions. These assumptions are reasonable, and do not significantly impact the assessment of revenue risk reduction protection under the program.

Based on information supplied by the Farm Income Analysis Division of Agriculture Canada, Eligible Net Sales (ENS) are assumed to be 90% of total revenue on a per acre basis, and there is no distinction made between the government and personal contributions. Two different contribution levels are used in the analysis (4%, and 10%), and these contribution levels are maintained across all years. NISA contributions are assumed to be made even in withdrawal years. The total maximum contribution level is ignored and it is assumed that triggered withdrawals are based on eligible net sales levels and are always taken in the year that they are triggered.

5.3.4.1 Actual Revenue Series (NISA)

Where

- C_j is the five year moving average net eligible sales level[12];
- $NISA_{jt-1}$ is the level of funds in the NISA account in year t-1;
- c_{Ejt} is $.90c_{jt}$, or the net eligible sales in year t.

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[11] For the 1990 taxation year, the federal government paid the provinces share of the program, as well as providing an additional 1.5% of eligible sales into the producer's account.

[12] Since the yield series starts as of 1974, the initial five years of revenue calculations will not accurately represent five year moving averages.

The actual revenue from NISA involvement (c_{NISAjt}) may be simulated mathematically as:

if: $c_{Ejt} \leq C_j$ and $(C_j - c_{Ejt}) \leq NISA_{jt-1}$;

then: $$c_{NISAjt} = c_{jt} + (C_j - c_{Ejt}) \qquad 21$$

if: $c_{Ejt} \leq C_j$ and $(C_j - c_{Ejt}) > NISA_{jt-1}$;

then: $$c_{NISAjt} = c_{jt} + NISA_{jt-1} \qquad 22$$

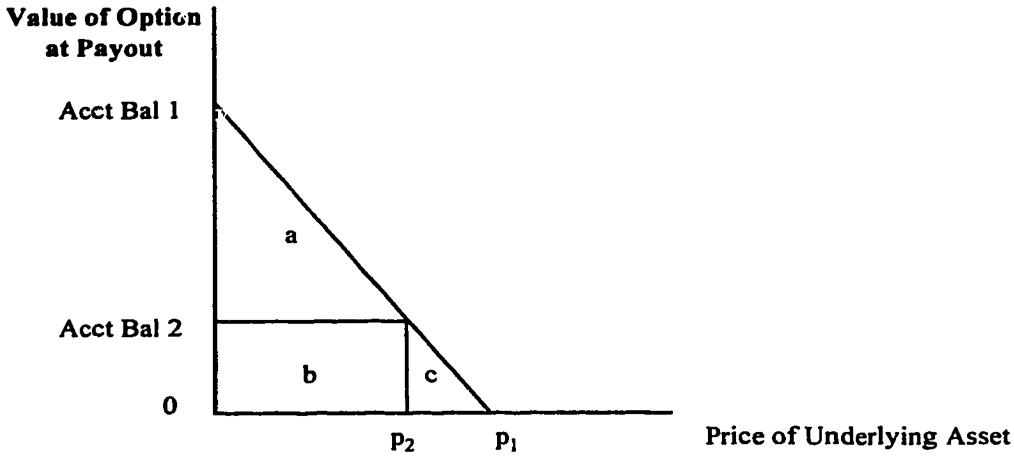
if: $c_{Ejt} > C_j$;

then: $$c_{NISAjt} = c_{jt} \qquad 23$$

5.3.4.2 Predicted Revenue Series (NISA)

The prospect for a NISA payout will be greater to the extent that the current raw expectation of revenue is lower than historic revenue. In effect, the existence of a NISA account provides the producer with a type of de facto put option for a given floor revenue with the striking price set at the floor revenue below which a withdrawal will be triggered. Expected ENS, 90% of raw expected revenue is used as the equivalent of market price in the Black model. 90% of RMSE on historic revenue, adjusted to continuous time, is used to estimate volatility. A time of 1 year and an interest rate of zero are used, as discussed under SCGP. This option may be called a full-account put. However, the revenue guarantee is limited by the amount of funds in the producer's NISA account, since negative balances are prohibited. When this occurs, a more complex calculation is required, in which the value of a second put is subtracted from value of a full-account put. The striking price on the second put is based on the difference between floor revenue and the amount of funds in the NISA account, and can be illustrated in the following Bachelier's diagram.

Figure 1: NISA Put Value Estimation



If the account balance at the beginning of a year is greater than the revenue guaranteed, then the value of the put is the area a + b + c. However, if the NISA account balance is less than the guaranteed revenue (Acct Bal 2), then the value of the put is defined as the value of the fully guaranteed put (a + b + c) less the value of the put at the actual balance level (a). In order to simulate the actual value defined by b + c, the price of issuing a put at price P_2 (a) was removed from the full-account put value (a + b + c).

The error used in calculating the BS put value estimate is the continuous RMSE of the unprotected revenue adjusted for the fact that only 90% of the revenue is used in calculating the 5 year moving average. As a result, the error term may be described algebraically as:

$$e = ln(1+.9\ (RMSE_{cj}) \qquad \mathbf{24}$$

For the purposes of this analysis:

- PNISA is the net value of the actual NISA put option taking the NISA account level into consideration; and
- $\hat{C}_{NISAjt}$ is the expected revenue under NISA.

then:

$$\hat{C}_{NISAjt} = \hat{C}_{jt} + PNISA_{jt} \qquad 25$$

It should be noted that the nature of risk control under the NISA program is not the same as risk control under the other programs. NISA pays out from the farmers own accumulated wealth rather than as an insurance program with a cross-sectional transfer of wealth. As a result, it acts as a type of self-insurance, which makes it more difficult to come to conclusions regarding its relative effectiveness in revenue risk reduction.

5.3.5 Gross Revenue Insurance Plan (GRIP)

GRIP was designed to provide revenue protection in the form of income stability against fluctuations in price and/or production level. The program is administered through two separate components: the CI, and the RIP.

Crop insurance compensates producers for production shortages due to natural perils. Coverage levels are based on location, soil type (productivity index) and crop selection. A detailed discussion of the CI is found in the section on the Canada-Alberta Hail and Crop Insurance Program. It is important to note that indexed coverage adjustments from the CI apply to the RIP. Yield measurements taken for either program can influence coverage adjustments for both programs.

The RIP guarantees revenues based on a "Target Revenue" as calculated under the plan. Target revenue is calculated as the product of indexed yield, as defined in the CI section (Y_i), and a provincially-set support price (p_{GRIPt}). Support Prices are calculated as 70% of historical prices for each crop, indexed for inflation using the Farm Income Price Index (FIPI) to 1991 dollars. This time series of prices is lagged 2 years for the calculation.

Program payouts are calculated as the difference between the sum of crop insurance payments and market revenue, and the guaranteed revenue protection level[13]. Market revenue is defined to

[13] It is important to stress here that although participation in the CI is not required by the GRIP, payouts available from CI participation are deducted from GRIP settlement, whether or not there is actual CI participation.

be the dollar value of harvested grain. Values are calculated using prairie average prices for individual crops by designated grade. Prairie average prices are established on an annual basis, and revenue protection payouts are distributed regardless of whether or not the farmer actually sells his crop.

GRIP provides a protection guarantee for crop i as represented by:

$$\$Payment_{GRIPi} = \max[(Yi \;\; p_{GRIPti}) - ((\$Payment_{CIia}) + (Y_{jt} \;\; p_{jt})),0] \qquad \textbf{26}$$

where:

- $\$Payment_{GRIPi}$ is the per acre program payment generated by GRIP for crop i.
- $Y_i \;\; p_{GRIPti}$ is the revenue protection support component of the formula. Y_i represents the individual indexed yield and P_{GRIPi} is the support price for the individual crop being insured.
- $\$Payment_{CIi}$ is the CI payout that would be received for crop i calculated at a 70% level of coverage, regardless of individual producer participation in the program.
- $Y_{it} \;\; P_{it}$ represents the dollar value of the specific crop a farmer harvests and is calculated using the final average prairie price (P_{it}) and the individual's yield (Y_{it}).[14]

Example 1: An Example of the GRIP Calculation Process

If:

P_{CIti}	= \$2.50/bu	: *Crop Insurance Protected Price*
p_{GRIPti}	= \$4.15/bu	: *GRIP SupportPrice*
Y_i	= 30bu/acre	: *Indexed Yield*
CL_{CIi}	=70%	: *Crop Insurance Coverage Level*
P_{it}	= \$2.85/bu	: *Final Average Prairie Price*
Y_{it}	= 10bu/acre	: *Actual Yield*

[14] This price may not be what the farmer actually receives and is calculated regardless of whether or not the farmer actually sells the grain.

Then:

$\$Payment_{GRIPi} = [30bu/acre \times \$4.15/bu] - [((30bu/acre \times .70) - (10bu/acre)) \times \$2.50/bu] - [10bu/acre \times \$2.85/bu]$

The total GRIP payment would be $96.00/acre which is composed of $27.50/acre from the CI and $68.50/acre from the revenue protection component of the program.

Once the producer is in the program, he may opt out by providing an official written notice three years in advance of the cancellation year. A producer may also opt out of the program without written notice upon retirement or by paying back all of the benefits received in the previous three years.[15]

Producers not having an individual index may purchase additional revenue protection in the form of the offset adjustment option. The Offset Adjustment Option is offered to make RIP more attractive to producers who do not wish to have RIP benefits reduced by high yields. However, this issue is not of importance in this analysis, since individual indexing is used in establishing expected RIP protection.

In reality, the GRIP model is very similar in nature to the CI model. In both cases the revenue expectation is enhanced by a conditional payout, which must be estimated and added to the expected revenue without the conditional payout. Both RIP and GRIP are modelled in order to identify the benefits associated with the addition of crop insurance to the RIP program in terms of risk reduction.

Where:

- C_{Rjt} is the actual revenue under the RIP program;
- c_{CIjt} is the actual revenue from involvement in the CI;
- P_{GRIP} is the GRIP price guarantee;

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[15] Further information concerning specific aspects of the program are available through the Alberta Hail and Crop Insurance Association.

- $\bar{q}$ is the mean elevator point yield adjusted for grade; and
- C_{Gjt} is the actual revenue under the GRIP program.

5.3.5.1 Actual Revenue Series (RIP)

if: $C_{CIjt} \geq \bar{q}_j \; P_{GRIP}$

then: $$C_{Rjt} = C_{jt} \tag{27}$$

if: $C_{CIjt} < \bar{q}_j \; P_{GRIP}$

then: $$C_{Rjt} = (\bar{q}_j \; P_{GRIP}) - C_{CIjt} + C_{jt} \tag{28}$$

5.3.5.2 Actual Revenue Series (GRIP)

if: $C_{CIjt} \geq \bar{q}_j \; P_{GRIP}$

then: $$C_{Gjt} = C_{CIjt} \tag{29}$$

if: $C_{CIjt} < \bar{q}_j \; P_{GRIP}$

then: $$C_{Gjt} = (\bar{q}_j \; P_{GRIP}) \tag{30}$$

5.3.5.3 Predicted Revenue Series

Expected revenue simulation with GRIP and RIP involvement is similar to that of the NISA program. However, GRIP and RIP guarantee a specific revenue without the constraint imposed by funding from an individual account.

The Black model is used each year at each elevator point to calculate the expected value of the GRIP guarantees, which are analogous to put options. The GRIP guaranteed revenue replaces the strike price in the model, expected revenue in absence of programs replaces market price, and the continuously compounded RMSE without protective programs is used as the measure of volatility. These calculated put values are added to raw revenue expectations to generate GRIP expectations.

Expected revenues from RIP are obtained by subtracting expected CI payments from expected GRIP revenues.

Given the above considerations, the predicted revenue series are generated as follows.
Where:

- $\hat{C}_{Rjt}$ is expected revenue from RIP involvement;
- $\hat{C}_{Gjt}$ is expected revenue from GRIP involvement;
- $\hat{\hat{C}}_{CIdjt}$ is the expected addition to actual unprotected revenue from CI involvement; and
- Put_{GRIPjt} is the value of the put option described above.

5.3.5.4 Predicted Revenue Series (RIP)

$$\hat{C}_{Rjt} = \hat{c}_{jt} + (Put_{GRIPjt} - \hat{C}_{CIdjt})^{16} \qquad 31$$

5.3.5.5 Predicted Revenue Series (GRIP)

$$\hat{C}_{Gjt} = \hat{c}_{jt} + Put_{GRIPjt} \qquad 32$$

5.3.6 Saskatchewan's Gross Revenue Insurance Plan (SGRIP)

Revenue insurance is available to farmers with the coverage based on 19 eligible crops. Support levels for each provincial risk area is calculated at 70% of the indexed moving average price

[16] It should be noted that $(Put_{GRIPjt} - \hat{C}_{CIdjt})$ is not allowed to reduce the expected revenue below c'_{jt}. This is consistent with reality, as program involvement should not reduce revenue expectations.

(IMAP) for the 19 commodities. Individual payouts are based on: the total seeded acres of all eligible crops; the per-acre payment in the risk area and; an index for historical production which considers land quality, summer fallow stubble crop mix, and management, and reflects the long-term individual farmer yield experience relative to regional yield experience.

To obtain the land quality index, the long-term individual farmer yield $(\bar{y}_j)$ is divided by the long-term area yield $(\bar{y}_j)$.This index reflects each farmer's land quality, mix of summer fallow and stubble crop, and management as compared to the average of all farmers for the risk area. The producer is given this index on any land used within the risk area, regardless of the quality of the specific piece of land.

Risk area payouts are calculated on an per acre basis by calculating the projected income shortfall for each of the 19 crops and dividing this by total seeded acres in the area. Projected income shortfall on an individual crop basis is calculated as the product of risk area seeded acres, A_{ir}, and 70% of the IMAP minus projected market price.

The total projected payment for a risk area is calculated as:

$$PSRIP_r = (\sum_{i=1}^{19}(A_{ir}\ \bar{y}_{ir}\ .7\ IMAP_i)) - (\sum_{i=1}^{19}(A_{ir}\ \bar{y}_{ir}\ P_{it})) \qquad 33$$

Where:

- A_{ir} is the historic seeded acres of crop i in region r;
- Y_{ir} is the historic yield for crop i in region r;
- p_{it} is the projected market price of each crop;
- and PSRIPr is the expected total payout per risk area r in the province, and is divided by projected seeded acres to calculate the SRIP payment on a per acre basis (PAP_{SRIPr}).

Individual producer payments are calculated as:

$$\$Payout_{SRIPr} = \sum_{i=1}^{19}(A_{it}\ PAP_{SRIPr}(\bar{y}_{it} / \bar{y}_{r})) \qquad 34$$

Where:

- A_{it} is the individual seeded acres of each crop in year t;
- and $\$Payout_{SRIPr}$ is the total individual SRIP payout in region r.

As a result, the total producer payment under the SGRIP is the sum of SCIP payments as defined under the CI and SRIP payments as defined above. While SCIP payments directly relate to a given crop's production in the given year, SRIP payments are only indirectly related to a given years production level through a farmer performance index. This index is calculated for each producer on an individual crop basis.

Premiums are determined by an actuary on an individual crop basis and are divided by total seeded acres to establish the per acre premium. Farmers pay premiums based on their seeded acres at the rate for that specific risk area. Of the total premium, farmers pay 33.3%, the province pays 25%, and the federal government pays the remaining 41.7%.

As with the GRIP program, SGRIP simulation is broken into two components based on a producer's involvement in CI. For the purpose of this analysis, SGRIP denotes the producers involvement in both SGRIP and CI. SRIP denotes producers involvement in only revenue protection and not CI.

SRIP payments are simulated using the following information:

- proportion of each crop grown in region;
- guaranteed price for each crop offered by the SRIP program x long-term regional yield for that crop;
- current year mean regional yield for each crop x current price; and
- farmer production index, the ratio between local historic mean production and regional historic mean production.

SRIP payments are simulated in Alberta by approximating the most common crop combination in a region (e.g., equal areas of wheat and barley), GRIP guaranteed prices for each, regional yields for each, and elevator point production indexes. SGRIP payments are simulated by adding CI payments to SRIP payments.

5.3.6.1 Actual Revenue Series (SGRIP)

Actual revenue under the SGRIP program (c_{SGjt}) may be represented by the following algorithm, where:

- $\%_{ir}$ is the percent of crop i traditionally grown in region r;
- $IMAP_{it}$ is the guaranteed price for crop i, offered by the SGRIP program;
- $\bar{q}_{ri}$ is the average adjusted yield of crop i in region r for year t;
- $\bar{q}_{ij}$ is the average adjusted quantity of crop i by ep over time; and
- $\bar{q}_{ir}$ is the average regional adjusted quantity of crop i over time.

$$c_{SGjt} = c_{CIjt} + \sum_{i=1}^{3} [((\bar{q}_{ri} .7\ IMAP_{it}) - (\bar{q}_{ri}\ p_{it}))\ \%_{ir}\ \bar{q}_{ij} / \bar{q}_{ir}] \quad 35$$

5.3.6.2 Actual Revenue Series (SRIP)

Actual revenue under the SGRIP program (c_{SRjt}) may then be represented as:

$$c_{SGjt} = c_{jt} + \sum_{i=1}^{3} [((\bar{q}_{ir} .7\ IMAP_{it}) - (\bar{q}_{ri}\ p_{it}))\ \%_{ir}\ \bar{q}_{ij} / \bar{q}_{ir}] \quad 36$$

5.3.6.3 Predicted Revenue Series

Although the SGRIP and SRIP programs do not guarantee a specific level of revenue adjusted by EP or crop, they do protect revenue at a specific level by CD and cropping combination. As a result, the expected revenue calculation must include the value of a put at the guaranteed level. The strike revenue of the put may be expressed as:

$$Strike = \sum_{i=1}^{3} [\bar{q}_{ir} \; .7 \; IMAP_{it} \; \%_i] \qquad 37$$

while the expected revenue is:

$$ExpRev = \sum_{i=1}^{3} [\bar{q}_{ir} \; \hat{P}_{it} \; \%_i] \qquad 38$$

and the error used in generating the standard deviation in Black's calculation is:

$$\varepsilon = ((\sum_{i=1}^{3} [\bar{q}_{rti} P_{it} \; \%_i]) - (\sum_{i=1}^{3} [\bar{q}_{ir} \; \hat{P}_{it} \; \%_i])) / (\sum_{i=1}^{3} [\bar{q}_{ir} \; \hat{P}_{it} \; \%_i]) \qquad 39$$

The SGRIP and SRIP programs protect revenue at regional level, subject to individual indexing. The expected payment from SRIP is the value of the individual index multiplied by the value of a put under the Black model with striking price at the SRIP guarantee level, using expected revenue and revenue RMSE calculated at the regional level and with other parameters as discussed previously. SGRIP expectation is formed by adding expected SRIP and CI payments to raw expectations.

The actual algebraic representation of predicted revenue with the SRIP ($\hat{c}_{SRjt}$) and SGRIP ($\hat{c}_{SGjt}$) programs are listed below, where:

- Put$_{SG}$ is the value of the put option described above.

5.3.6.4 Predicted Revenue Series (SGRIP)

$$\hat{c}_{SGjt} = \hat{c}_{CIjt} + (Put_{SGi} \; \bar{q}_j / \bar{q}_{ir}) \qquad 40$$

5.3.6.5 Predicted Revenue Series (SRIP)

$$\hat{c}_{SRjt} = \hat{c}_{jt} + (Put_{SGi}\ \bar{q}_j / \bar{q}_{ir}) \qquad \textbf{41}$$

6.0 RESULTS

6.1 RISK CONTROL PRACTICES

A separate calculation was made for each of wheat, barley, and canola, and also for two cropping combinations: 50% wheat and 50% barley (WB); and 33% wheat, 33% barley, and 33% canola (WBC) for each of the nine programs. While RMSE's were calculated for each cropping combination at each elevator point (EP), not all combinations constituted usual or agronomically suitable practices in all areas. As a result, the data for only the most commonly used rotations within a CD were reported. Rotations used for reporting purposes are based on the information provided in Table 1.[17]

To illustrate the results at the disaggregate level, experience at one elevator point for one crop is shown under conditions of various programs. The following four figures show, year by year, the prediction errors which would have occurred without government programs, as well as the prediction errors which are simulated under each of the nine programs. A canola revenue series is used from elevator point (EP) 327 from CD 15 in the example. EP 327 is used for two main reasons: it is one of only seven CD's which has 13 years of data for wheat, barley and canola; and canola revenue has the highest RMSE of all of the 21 possible combinations. This allows the effects of risk control programs to be clearly illustrated. The relative deviation from mean revenue for the same elevator point may be seen in the figures presented in Appendix 2.

Except in 1979, CI does not reduce revenue error. For this EP, price risk is more significant in establishing overall revenue risk. This is reinforced in Figures 4 and 5, where GRIP and SGRIP are only superior to RIP and SRIP in 1974.

[17] Where there is more than one logical rotational practice, the risk maximizing rotational practice is used. For example, in CD #2 there are two possible rotations that could be used (W or WB). However, the RMSE for the W combination is greater than that of WB and is used for reporting purposes. Reporting the higher risk option provides a more effective demonstration of the results of risk control measures.

WGSA is only modelled for 1975 to 1990. Problems with the payout mechanism are obvious in Figure 2. WGSA increased the upside errors in 1977, 1986, and 1987, while not doing anything for downside risk.

The price protection from SCGP was effective at reducing revenue errors in this EP. While the guaranteed price was not high enough to offset the negative revenue error in 1979, SCGP protected against downside errors in 1985, 1989, 1990, and 1991.

NISA provided minimal protection to EP 327 and reduced upside errors as well as downside errors. NISA at 10% offered more protection to the large downside error of 1979 than any program other than GRIP and SGRIP.

Figure 2: Revenue Risk Protection (CI, WGSA, SCGP), EP #327 Canola

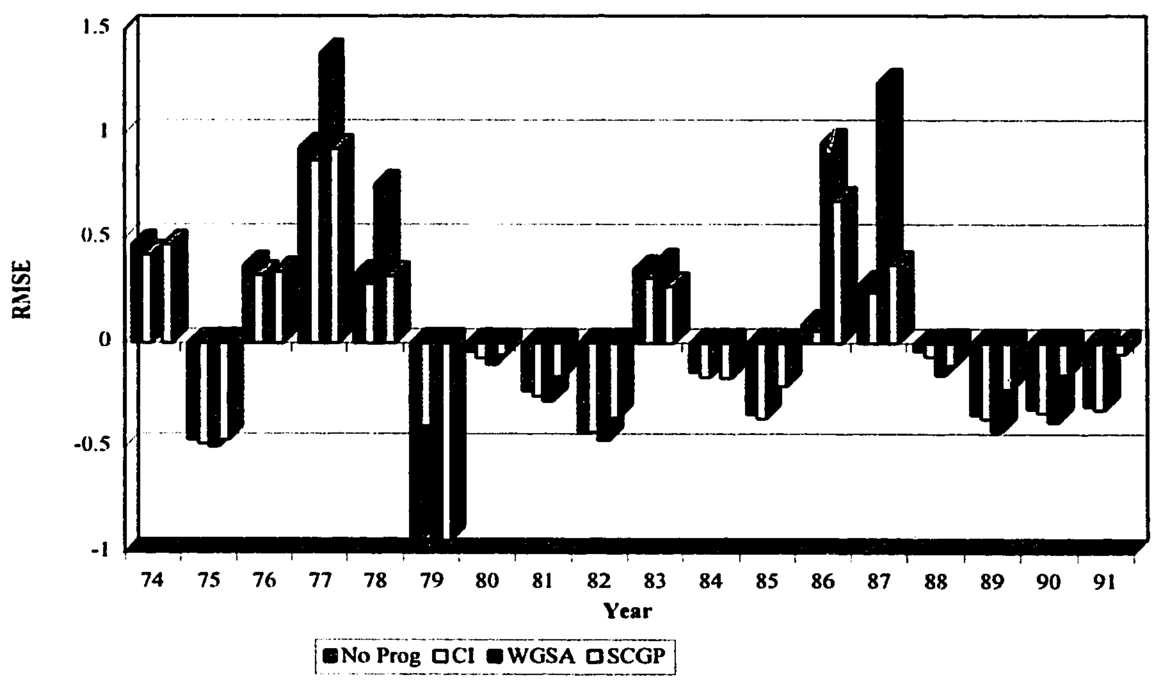


Figure 3: Revenue Risk Protection (NISA 4%, NISA 10%), EP #327 Canola

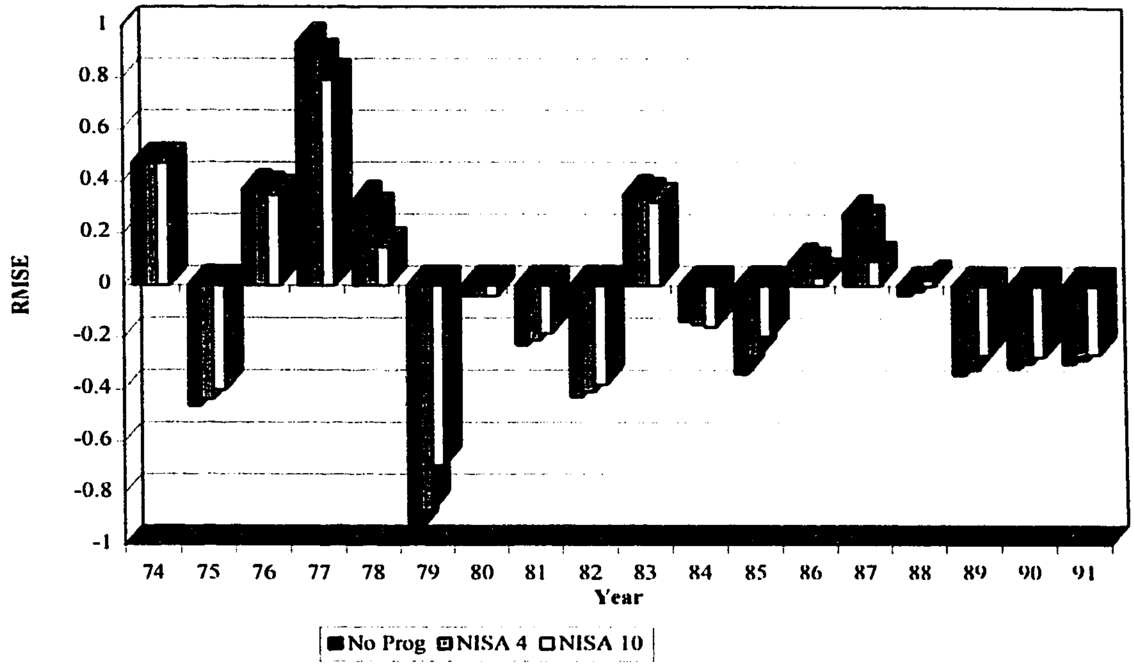


Figure 4: Revenue Risk Protection (GRIP, RIP), EP #327 Canola

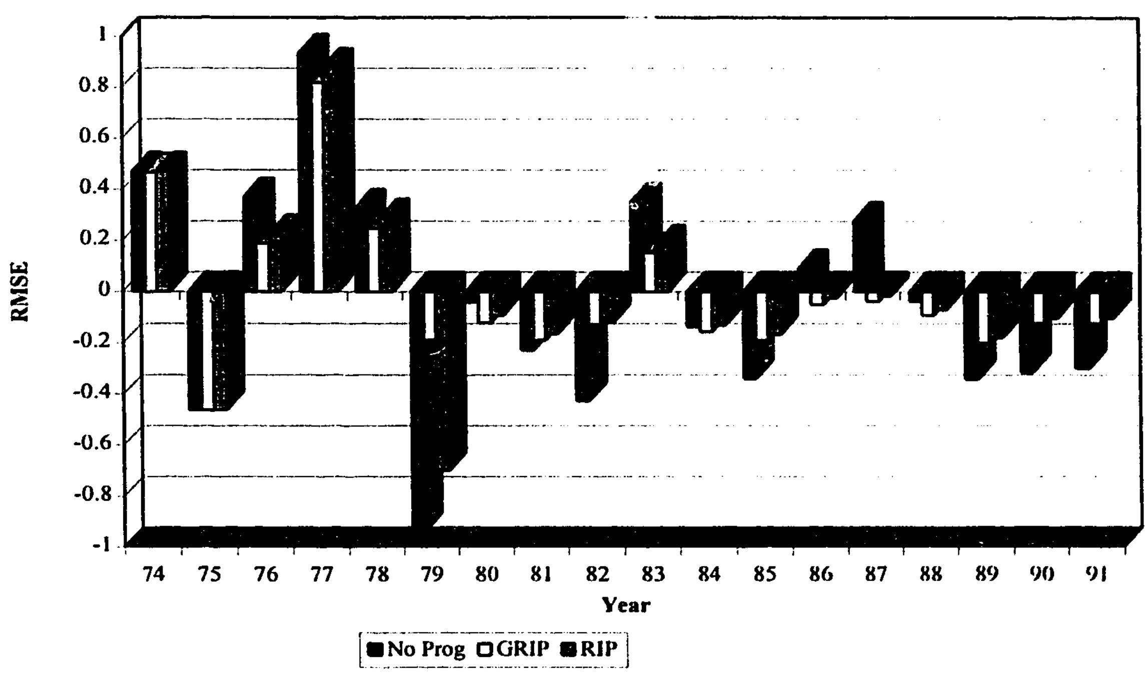
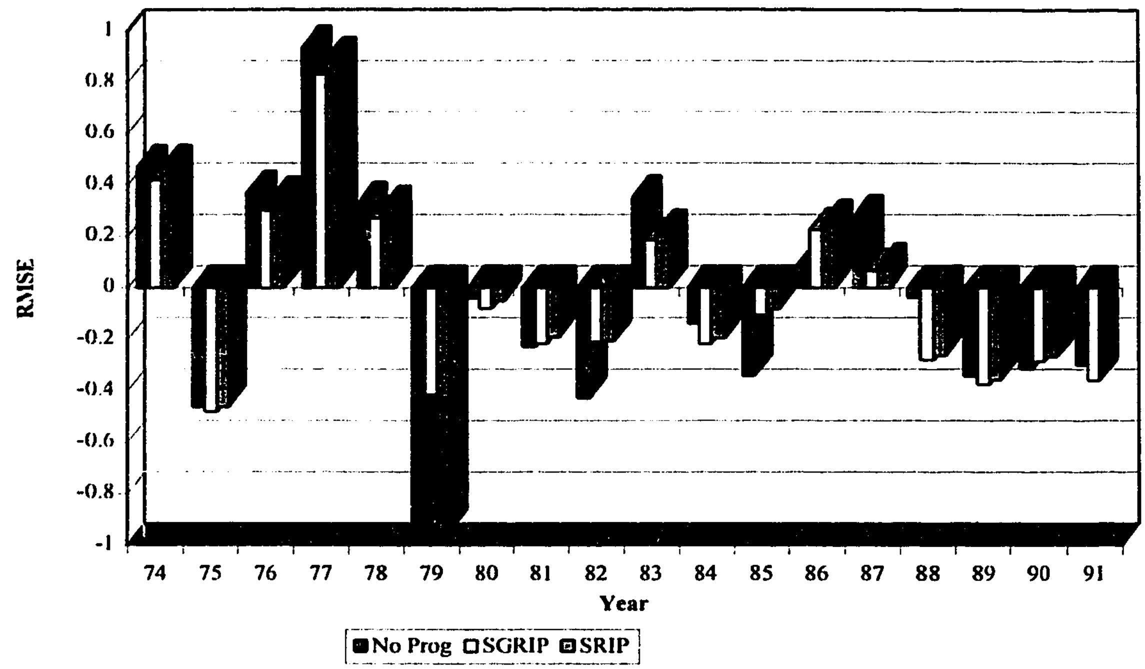


Figure #5: Revenue Risk Protection (SGRIP, SRIP), EP #327 Canola



With the exception of 1988-1991, there is little difference between the protection offered under GRIP and SGRIP, or, RIP and SRIP. SGRIP and SRIP did not provide the same level of revenue protection as GRIP and RIP in the last four years. Since these two programs are based on the individual EP's revenue rather than the CD's performance, the observation suggests that EP 327 had more variable yield in those years than other EP's in CD 15.

6.2 INCOME PREDICTABILITY

Difficulties in income predictability are measured as the difference between actual and expected revenue and are quantified by RMSE.

Conclusions about income predictability are reported by location and program and are drawn for the most common crop rotation as previously defined. These results, and the corresponding significance or lack thereof, are reported in Table 4. Table 5 illustrates revenue risk reduction program comparisons between CI and SCGP, and GRIP and SGRIP by CD.

Table 4. RMSE By CD For the Most Common Rotation

CD	No Prog	CI	WGSA	SCGP	NISA 4	NISA 10	GRIP	RIP	SGRIP	SRIP
1	0.36801	0.32834	0.41015[1]	0.31195	0.33018	0.27461	0.18402	0.21650	0.18882	0.22133
2	0.37871	0.34348	0.40847[1]	0.33573	0.34711	0.30095	0.22057	0.24600	0.24992	0.27881
3	0.39451	0.32826	0.49183[1]	0.36752[1]	0.37739[1]	0.35144	0.23455	0.27162	0.24570	0.27331
4	0.36671	0.33311	0.37627[1]	0.34266[1]	0.33435	0.29480	0.23477	0.25686	0.23601	0.26015
5	0.31583	0.29678	0.36446[1]	0.24962	0.29122	0.25219	0.17236	0.18629	0.18746	0.20338
6	0.28752	0.27342	0.37289[1]	0.22942	0.26739	0.23375	0.15685	0.16743	0.18521	0.19567
7	0.25027	0.23879[1]	0.31727[1]	0.22325[1]	0.23083[1]	0.20334	0.16439	0.17377	0.20140	0.21170
8	0.23631	0.22998[1]	0.32703[1]	0.18909	0.22031[1]	0.19224	0.14898	0.15126	0.16228	0.16846
10	0.24897	0.23620[1]	0.32774[1]	0.20598	0.22692	0.20021	0.15734	0.16707	0.18559	0.19935
11	0.25760	0.24456[1]	0.34100[1]	0.20316	0.24041[1]	0.21400	0.15131	0.16200	0.17311	0.18421
12	0.26039	0.25270[1]	0.35842[1]	0.18281	0.24107	0.21075	0.15082	0.15945	0.16960	0.17834
13	0.27081	0.26116[1]	0.33397[1]	0.19429	0.25374	0.22899	0.16309	0.17288	0.17076	0.18102
15	0.31562	0.29747[1]	0.38271[1]	0.24462	0.29263[1]	0.25858	0.17799	0.19224	0.20274	0.21913

[1] Indicates the lack of a significant downward difference from the No Program scenario using a 95% level of confidence.

Table 5. Revenue Risk Reduction Program Comparisons (at a 95% Level of Confidence)

CD	CI vs SCGP	GRIP vs SGRIP
1	No Difference	No Difference
2	No Difference	GRIP
3	CI	No Difference
4	CI	No Difference
5	SCGP	GRIP
6	SCGP	GRIP
7	No Difference	GRIP
8	SCGP	GRIP
10	SCGP	GRIP
11	SCGP	GRIP
12	SCGP	GRIP
13	SCGP	GRIP
15	SCGP	GRIP

Crop insurance exerts little control over predictability, on balance. Yield disturbances below 70% of individualized mean are apparently quite uncommon. Crop insurance effects are small but statistically significant in Regions 1 through 6, and are insignificant in the remaining regions.

Western Grain Stabilization actually amplified prediction problems in the analysis. While the forecasting method used in this simulation was relatively naive and may explain some of this problem, it is still quite clear that this income support program did not contribute to short-term predictability of revenues. Part of this ineffectiveness is undoubtedly explained by the fact that the program was driven by prairie-wide variables which may have been of little relevance in much of Alberta. However, the program should not be discredited solely on the basis of its effect on predictability. It shows some merit, subsequently, when effect on variability is considered.

While having no significant impact on Regions 3, 4, and 7, the simulated version of price protection, as exemplified by Special Canadian Grains, had some general effect on revenue predictability, removing about one-sixth of RMSE when compared to having no program. Since this program offers no yield protection, its effect illustrates the importance of a program's offsetting price volatility.

The two versions of NISA had surprisingly small effects on predictability. At the 4% level its consequences were very small, and were insignificant in Regions 3, 7, 8, 11, and 15. Even at the 10% level, which is much higher than the present scale of the program, NISA had an effect only comparable to the SCGP simulation.

All versions of GRIP, RIP, SGRIP, and SRIP had important and similar effects on predictability. This was general across crop districts and applied to monocultures as well as crop mixtures. The interesting aspect of this result is the small differences between the versions. SRIP, without crop insurance and without crop-specific price coverage or local-yield sensitivity, approached the performance of GRIP. Some of this similarity may be created by the simplified "basket" used in this simulation, but the merit of SRIP and SGRIP still appears to be considerable, when their advantages over GRIP and RIP in other respects are considered.

When the differences between the revenue predictability of CI and the SCGP were tested, a specific pattern became evident. While not significantly different in Regions 1, 2, and 7, CI was better protection in Regions 3 and 4, while the SCGP was better in Regions 5, 6, 8, 10, 11, 12, 13, and 15. This is not surprising since the latter regions have lower yield risk.

The differences between GRIP and SGRIP were somewhat more interesting. GRIP proved to be a superior method of reducing revenue risk in all but Regions 1, 3, and 4. These Regions also happen to be the locations with more regional yield variation, indicating lower individual EP yield variability in comparison to regional variability. As the individual EP yield variability decreases in ratio to the regional variation, the ability of a program like SGRIP, which is more related to the area yield, improves. In the more northern regions, where relative individual yield variability is higher, the importance of GRIP's individual yield index is increased.

6.3 INCOME VARIABILITY

Information on variability is contained in the coefficient of variation results reported in Table 6. CV's were calculated only for the most common rotations, and correlate rather closely with RMSE results.

In general, CD's 1-4 experience the most serious revenue fluctuations in the province. Region #3 has a No Program CV of .57 suggesting that the standard deviation of revenue in this region is approximately 57% of average revenue. In fact, all regions in the south-east part of the province have a raw CV of greater than .44. In contrast, central and northern Alberta are more stable, and have No Program CV's between .30 and .38.

Table 6. Coefficient of Variation For Actual Revenue Series

(Most Common Rotation)

CD	No Prog	CI	WGSA	SCGP	NISA 4	NISA 10	GRIP	RIP	SGRIP	SRIP
1	0.44061	0.41294	0.40659	0.39951	0.41904	0.37867	0.31777	0.34058	0.31091	0.33281
2	0.54183	0.51887	0.48364	0.50362	0.52352	0.49954	0.43057	0.44830	0.43712	0.45495
3	0.56909	0.52138	0.52060	0.51435	0.54865	0.52159	0.40961	0.44388	0.39580	0.42115
4	0.53088	0.50973	0.42426	0.49092	0.50641	0.47283	0.40012	0.41894	0.38991	0.40674
5	0.44061	0.42660	0.36885	0.39913	0.42060	0.39050	0.34783	0.35798	0.34727	0.35860
6	0.39630	0.38565	0.32783	0.33771	0.37755	0.35073	0.30871	0.31597	0.31478	0.32269
7	0.38582	0.37739	0.30203	0.31956	0.37336	0.35175	0.29196	0.30116	0.31446	0.32237
8	0.36075	0.35631	0.29146	0.29396	0.34541	0.32401	0.27350	0.27708	0.28356	0.28738
10	0.34860	0.34205	0.28706	0.28198	0.33084	0.30822	0.26897	0.27391	0.28518	0.29195
11	0.33906	0.33129	0.29145	0.26597	0.32490	0.30266	0.25151	0.25669	0.26225	0.26863
12	0.34757	0.34727	0.27377	0.26417	0.32936	0.30189	0.26461	0.26409	0.27463	0.27555
13	0.30117	0.30165	0.24021	0.22519	0.28367	0.25888	0.23164	0.23146	0.23997	0.23978
15	0.37860	0.36491	0.30362	0.31619	0.36562	0.33808	0.27975	0.29062	0.29569	0.30737

Crop insurance is ineffective in reducing variability, just as it was for unpredictability. Under an individually indexed system, crop production variability is just not high enough to allow a program with 70% coverage to be of much relevance. It is quite possible that crop insurance in the past, without indexing, has served more as a means of providing transfer payments to sub-normal producers than as a risk control system.

The reader should note these results understate the impact of crop insurance, because data are at elevator point level and this is not sufficiently localized to show the effect of pinpoint calamities, such as hailstorms. However, since hail insurance is readily available without government programs, at least the omission of some hail effects does not seem serious in a policy context.

WGSA was not an outstanding performer on variability, but its results are much better than when predictability is being examined. This result is probably explained by the fact that some of the large WGSA payment came as short-run surprises, but they still arrived during years when revenues were historically low.

SCGP's performance, while not among the best, was non-trivial, and was comparable to its effect on predictability.

NISA in both versions offered little control over revenue variability. This performance was weaker than the performance on predictability, which itself was not outstanding.

The GRIP, RIP, SGRIP, and SRIP programs were the stronger performers on variability control, just as they were on predictability. Again, the more production-neutral programs of Saskatchewan were nearly as effective as the crop and local yield-specific versions used outside that province.

6.4 Economic Effects Of Risk Reduction

One of the interesting aspects of risk reduction to farm management, is the corresponding change in debt carrying capacity. The individual farmer's ability to carry debt increases as revenue risk is reduced, as producers require higher rates of return on crop investments which have a higher risk.

D values (as defined by Mumey, Burden and Boyda, 1991), may be used to evaluate the impacts of various programs on farmers ability to handle debt. These values are calculated by program for the most common rotation. Since these calculations are made from RMSE values which measure short-term variability, they should be thought of as measures of proportional short-term borrowing capacity. However, since CV values do not measure sharply different risk control effects for most programs, D values may also be regarded as indicative of general borrowing power. The actual value of D may be calculated by identifying the debt ratio which satisfies:

$$\text{RMSE With Program} = \text{RMSE Without Program}/(1\text{-D}) \qquad \textbf{42}$$

The D value as calculated in this analysis is an indication of the increase or decrease in the proportional amount of total anticipated income that could be pledged as a result of participating in the various revenue risk reduction programs.

For example, a producer involved in GRIP in CD 1 could pledge 50% of anticipated revenue to creditors and still bear no more risk than other producers in that region who were not in the program and who were debt free.

Table 7. Debt Use Issues With Various Programs

(D values, indicating additional ability to borrow)

CD	CI	WGSA*	SCGP	NISA 4	NISA 10	GRIP	RIP	SGRIP	SRIP
1	10.78	10.27	15.23	10.28	25.38	50.00	41.17	48.69	39.86
2	9.30	7.29	11.35	8.35	20.53	41.76	35.04	34.01	26.38
3	16.79	19.79	6.84	4.34	10.92	40.55	31.15	37.72	30.72
4	9.16	2.54	6.56	8.82	19.61	35.98	29.95	35.64	29.06
5	6.03	13.34	20.96	7.79	20.15	45.43	41.02	40.65	35.60
6	4.90	22.89	20.21	7.00	18.70	45.45	41.77	35.58	31.94
7	4.59	21.12	10.80	7.77	18.75	34.32	30.57	19.53	15.41
8	2.68	27.74	19.98	6.77	18.65	36.95	35.99	31.33	28.71
10	5.13	24.03	17.27	8.86	19.58	36.80	32.89	25.46	19.93
11	5.06	24.46	21.13	6.67	16.92	41.26	37.11	32.80	28.49
12	2.95	27.35	29.79	7.42	19.06	42.08	38.77	34.87	31.51
13	3.56	18.91	28.26	6.30	15.44	39.78	36.16	36.94	33.16
15	5.75	17.53	22.49	7.28	18.07	43.61	39.09	35.77	30.57

* Actually reduces the level of borrowing capacity by this percent.

NISA at the 10% level, GRIP, RIP, SGRIP, and SRIP all provide individual producers the opportunity to borrow between 18-50% more funds without changing risk level. In addition, the SCGP also provides a great deal of assistance, with the exception of CD's 3, 4, and 7. As noted previously, D values indicate the amount of borrowing enabled by the program, and also indicate the amount of borrowing which will neutralize the effect of the program. The reader is left to decide whether the programs should be viewed in a positive light in that they permit more borrowing, if necessary, or in the negative light that program effects can be fully offset if they result in increased borrowing of the magnitude of the D values.

6.5 SUMMARY AND CONCLUSIONS

This analysis has evaluated the ability of nine different government programs to reduce farm revenue risk. The information has been calculated at the EP level but grouped at the CD level for presentation purposes.

The two past programs, Western Grain Stabilization and Special Canadian Grains, display somewhat different effects. WGSA's sporadic large payments actually aggravated short-term predictability problems; on the other hand, WGSA had some stabilizing influence on revenue variability. SCGP, a simple program which was simulated to pay out only on market price behaviour, had substantial effect. Its effect was not as strong as some other programs, but on the other hand it is simple and easy to administer. A variant of the program is probably worth additional study.

The Net Income Stabilization programs, which were simulated at a 4% and 10% joint contribution, were relatively weak performers. Separate analysis suggests that increasing these programs to the 15% to 20% level would improve their performance substantially. However, at level close to the present NISA program they do not even match SCGP's pure price protection program in some CD's. Furthermore, NISA has the undesirable property of not being an insurance program.

Crop insurance displayed very modest performance, with no significant effect on risk in crop districts 7 through 15.

The Gross Revenue and Revenue Stabilization programs exercised the most control over predictability and variability. They were able to remove about one-third of risk, by either measure. An interesting result of examining these programs was the relative effectiveness of RIP, which excludes crop insurance coverage, and the relative effectiveness of the Saskatchewan modifications of the programs, which provide general cropping subsidies but do not distort producers' choices of crop mixture.

The study has been done without considering other important aspects of the programs. How efficient are they to administer? For example, SCGP and NISA require little administrative cost, since they do not require production measurement or monitoring. In contrast, GRIP and CI require expensive administrative establishments. How effective are they in accomplishing other objectives? CI, if it were non-indexed, could comprise a subsidy program for less successful farmers, and this could be in conformance with social welfare objectives. GRIP, while controlling risk, may require more massive total government payments to agriculture than, say, NISA.

The study has also not examined risk in the context of multi-enterprise farms, since it only showed risk being reduced by multi-crop portfolios. If farmers combine crop production with livestock enterprises or off-farm activity, it is possible the differential effect of programs on risk could be different. NISA, for example, seems readily adaptable to the multi-enterprise firm, and may stabilize year-to-year cash flow better in that context than in the present one.

Likewise, the study has not considered disturbances in asset values, which may have an important impact on the well-being of the farm business. For example, many grain farms have invested heavily in land, and changes in the price of land have a separate impact on the well-being of the farm business, in addition to farm revenues. Simulation of this aspect of programs is potentially difficult because the price of land cannot plausibly be considered independent of the programs. It is possible that the programs which stabilize revenues most would also stabilize land prices most, but that is only a conjecture.

Overall, the study shows that government programs vary considerably in their ability to remove risk in grain production, and none of them turn farms into riskless enterprises. The best of the programs appear to remove about one-third of the risk in farming, providing they do not induce increased borrowing in amounts which offset the risk reduction. Some of the programs have little effect on farm risk. With the most forceful of the risk reduction programs, the short-term risk exposure in grain enterprises still exceeds the short-term exposure on a mutual fund holding a broad collection of Toronto Stock Exchange common shares.

7.0 BIBLIOGRAPHY

Alberta Agriculture. 1973/74-91/92. *Alberta Agricultural Statistics Yearbook.* Agdex 853-10. Edmonton: Alberta Agriculture.

Alberta Agriculture. 1992. *Varieties of Cereal and Oilseed Crops for Alberta, 1992.* Agdex 100/32. Edmonton: Alberta Agriculture.

Alberta Hail and Crop Insurance Corporation. 1987. *Canada - Alberta Crop Insurance Annual Report.* Lacombe: Alberta Agriculture.

Alberta Wheat Pool. 1974-92. *Series C Crop Report Estimate of Quality by District.* Calgary: Alberta Wheat Pool.

Armstrong, J.S. and R. Fildes. 1995. Correspondence on the Selection of Error Measures for Comparison Among Forecasting Methods. Journal of Forecasting. Vol 14: 67-71.

Ashley, R., C.W.J. Granger, and R. Schmalensee. 1980. *Advertising and Aggregate Consumption: An Analysis of Causality.* Econometrica, Vol 48: 1149-67.

Bank of Canada. *Bank of Canada Review.* Ottawa: Bank of Canada, various issues.

Berger, J.D. 1985. *Statistical Decision Theory and Baysian Analysis. 2nd ed.* New York: Springer-Verlag

Beveridge S., and C. Oickle. 1994. *A Comparison of Box-Jenkins and Objective Methods for Determining the Order of a Non-Seasonal ARMA Model.* Journal of Forecasting, Vol 13: 419-434.

Black, F. 1976. The Pricing of Futures Contracts. *Journal of Financial Economics* 3: 161-179.

Black, F., and M. Scholes. 1973. *The Pricing of Options and Corporate Liabilities.* Journal of Political Economy, Vol 81: 637-54.

Bodie, Z. and V.I. Rosansky. 1980. Risk and Return in Commodity Futures. *Financial Analyst's Journal* (May-June): 27-39.

Bohrnstedt, G.W. and A.S. Goldberger. 1969. On the Exact Covariance of Products of Random Variables. *Journal of the American Statistical Association* 64: 1439-42.

Boyda, Ann. 1988. Risk and Return on Alberta Grain Farms. Unpublished thesis, Department of Rural Economy, University of Alberta.

Boyle, Phelim, Harry H. Panjer and Keith P. Sharp. 1987. *Report on C adian Economic Statistics*. Canadian Institute of Actuaries, Ottawa.

Brown, W.J. 1987. A Risk Efficiency Analysis of Crop Rotations in Saskatchewan. *Canadian Journal of Agricultural Economics* 35 (July): 333-355.

Canada Grains Council. 1974/75-1991/92. *Canadian Grains Industry Statistical Handbook*. Winnipeg: Canada Grains Council.

Chicago Board of Trade. 1974/75-1991/92. *Chicago Board of Trade Statistical Annual, Grains-Options on Agricultural Futures*. Chicago: Chicago Board of Trade.

Clements, M.P. and D.F. Hendry. 1993. *On the Limitations of Comparing Mean Square Forecast Errors*. Journal of Forecasting, Vol 12: 617-637.

Collins, R.A. and P.J. Barry. 1986. Risk Analysis With Single-Index Portfolio Models: An Application to Farm Planning. *American Journal of Agricultural Economics* 68: 152-161.

Efron, B. and C. Morris. 1975. Data Analysis Using Stein's Estimator and Its Generalizations. *Journal of the American Statistical Association* 70: 311-319.

Efron, B. and C. Morris. 1977. Stein's Paradox in Statistics. *Scientific American* 236 (May):119-127.

Fay, R.E., III, and R.A. Heriot. 1979. James-Stein Estimation of Incomes of Small Places. *Journal of the American Statistical Association* 74: 264-77.

Goodman, L.A. 1960. On the Exact Variance of Products. *Journal of the American Statistical Association* 55 (May): 708-713.

Grant, D. 1985. Theory of the Firm with Joint Pricing and Quantity Uncertainty and a Forward Market. *American Journal of Agricultural Economics* 67: 630-635.

Heady, E.O. 1952. Diversification in Resource Allocation and Minimization of Income Variability. *Journal of Farm Economics* 34: 482-496.

Hull, J. and A. White. 1987. *The Pricing of Options on Assets With Stochastin Volatilities.* Journal of Finance, Vol 62 (June): 281-300.

Ibbotson and Associates. 1987. *Stocks, Bonds, Bills and Inflation Yearbook.* Chicago: Ibbotson and Associates.

James, W. and C. Stein. 1961. Estimation with Quadratic Loss. *Proceedings of the Fourth Berkeley Symposium on Mathematical Statistics and Probability, Volume 1.* Berkeley:Berkeley Press, 361-379.

Johnson, A. and D. Shanno. 1987. *Option Pricing When the Variance is Changing.* Journal of Finance and Quantitative Analysis, (June): 143-151.

Kang, T. and B.W. Brorsen. 1995. *Valuing Target Price Support Programs With Average Option Pricing.* American Journal of Agricultural Economics, Vol 77, No. 1: 106-118.

Kang, T. and B.W. Brorsen. 1993. *GARCH Option Procing With Asymmetry.* Proceedings of the NCR 134 Conference on Applied Commodity, Forecasting, and Market Risk Management. Marvin Hayenga, ed., Iowa State University Department of Agricultural Economics: 298-314.

Marcus, A.J. and D.M. Modest. 1986. *The Valuation of a Random Number of Put Options: An Application to Agricultural Price Supports.* Journal of Finance and Quantitative Analysis (March): 73-86.

Mathews, B.P. and A. Diamantopoulos. 1994. *Towards a Taxonony of Forecast Error Measures: A Factor-Comparative Investigation of Forecast Error Dimensions.* Journal of Forecasting, Vol. 13: 409-416.

Mumey, G. 1993. *Measurement of Farm Risk: Alberta Crop Production: Reply.* Canadian Journal of Agricultural Economics (November): 363-364.

Mumey G., and R. Burden. 1993. *The Effectiveness of Farm Subsidy Programs on Farming Risk in Alberta.* Farming For The Future Project No. 92-0171. Faculty of Business, University of Alberta.

Mumey, G., R. Burden, and A. Boyda. 1992. Measurement of Farm Risk: Alberta Crop Production. *Canadian Journal of Agricultural Economics* 40: 71-91.

Novak, F.S., G.A. Mumey, and J. Underschultz. 1991. *An Economic Analysis of Risk Management Strategies for Alberta Beef Feeders.* Farming For The Future Project No. 90-0723. Department of Rural Economy, University of Alberta.

Peck, A. 1975. Hedging and Income Stability: Concepts, Implications, and an Example. *American Journal of Agricultural Economics* 57: 1210-1219.

Robinson, L. and P. Barry. 1987. *The Competitive Firm's Response to Risk,* New York:Macmillan.

Rolfo, J. 1980. Optimal Hedging Under Price and Quantity Uncertainty. *Journal of Political Economy* 88: 100-116.

Schlosser, M. 1989. *Corporate Finance, A model Building Approach.* Great Britain: Prentice Hall International (UK) Ltd.

Statistics Canada. 1991. *Agricultural Economics Statistics.* Ottawa: Cat. 21-603E, Minister of Supply and Services.

Thompson, P.A. 1990. *An MSE Statistic for Comparing Forecast Accuracy Across Series.* International Journal of Forecasting, Vol 6: 219-227.

Turvey, C.G., B.W. Brorsen, and T.G. Baker. 1988. *A Contingent Claim Pricing Model of Valuing Non-Recourse Loan Program and Target Prices.* Paper presented at the AAEA annual meeting, Knoxville, TN.

Turvey, C.G. and H.C. Driver. 1987. Systematic Risks and Nonsystematic Risks in Agriculture. *Canadian Journal of Agricultural Economics* 35 (July):387-401.

Winnipeg Commodity Exchange. 1974/75-1991/92. *Winnipeg Commodity Exchange Statistical Annuals*. Winnipeg: Winnipeg Commodity Exchange.

Witt, C.A. and D.W. Reid. 1987. *U.S. Farm Price Support Programs Analyzed as Put Options.* Paper presented at the AAEA annual meeting, East Lansing, MI.

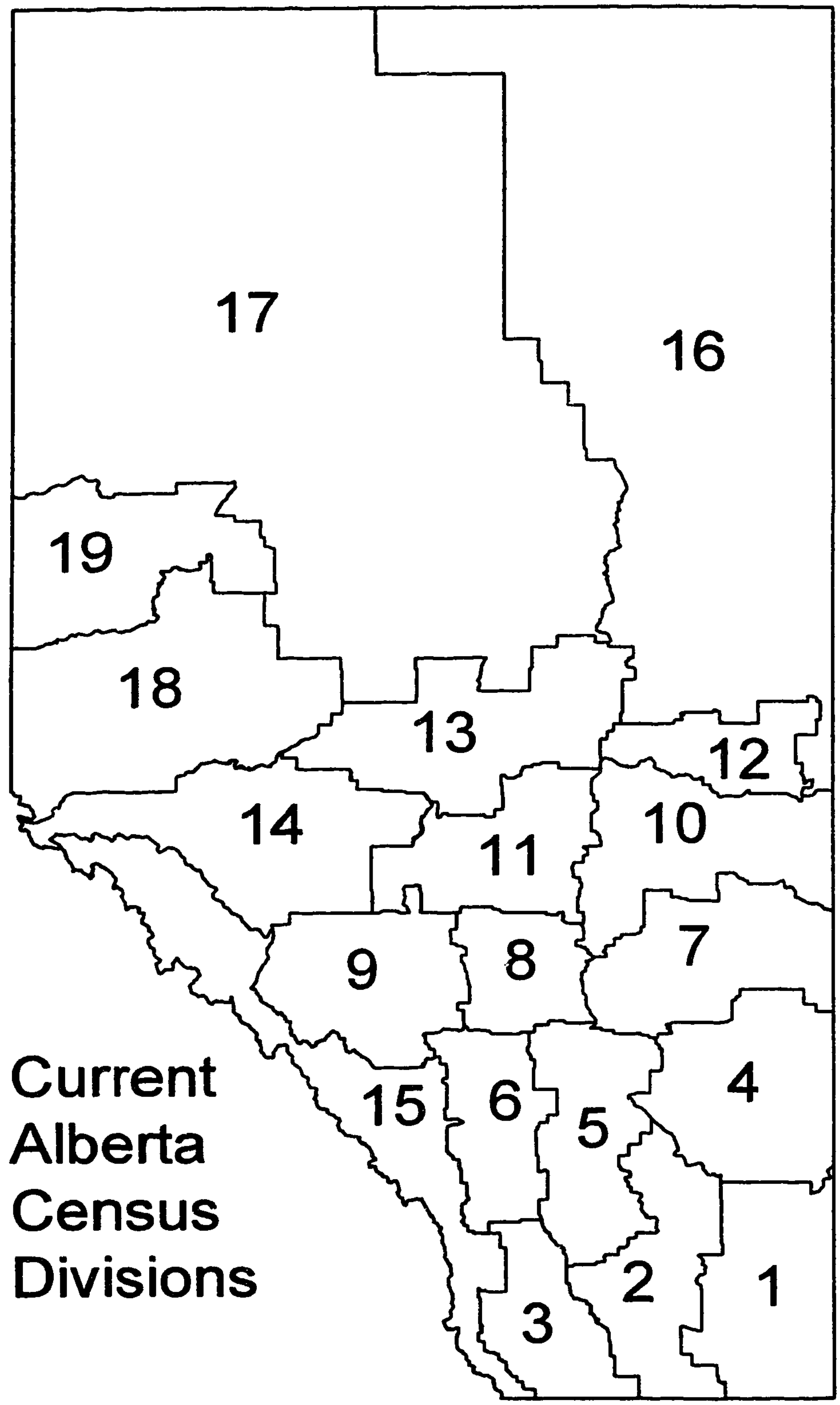
Ye, Y. and M.H. Yeh. 1995. *A Comparative Evaluation of Yield Risk Reductions With Alternative Crop Insurance Programs in Manitoba.* Canadian Journal of Agricultural Economics (March): 57-71.

Young, D.L. 1984. *Risk Concepts and Measures for Decision Analysis.* Risk Management in Agriculture. Iowa State University Press, Iowa.

Young, R.P. and P.J. Barry. 1987. Holding Financial Assets as a Risk Response: A Portfolio Analysis of Illinois Grain Farms. *North Central Journal of Agricultural Economics* 9 (January): 77-84.

APPENDIX 1: CURRENT AND ADJUSTED CENSUS DIVISIONS

APPENDIX 2: SPECIAL EXAMPLE OF THE RELATIVE DEVIATION FROM MEAN REVENUE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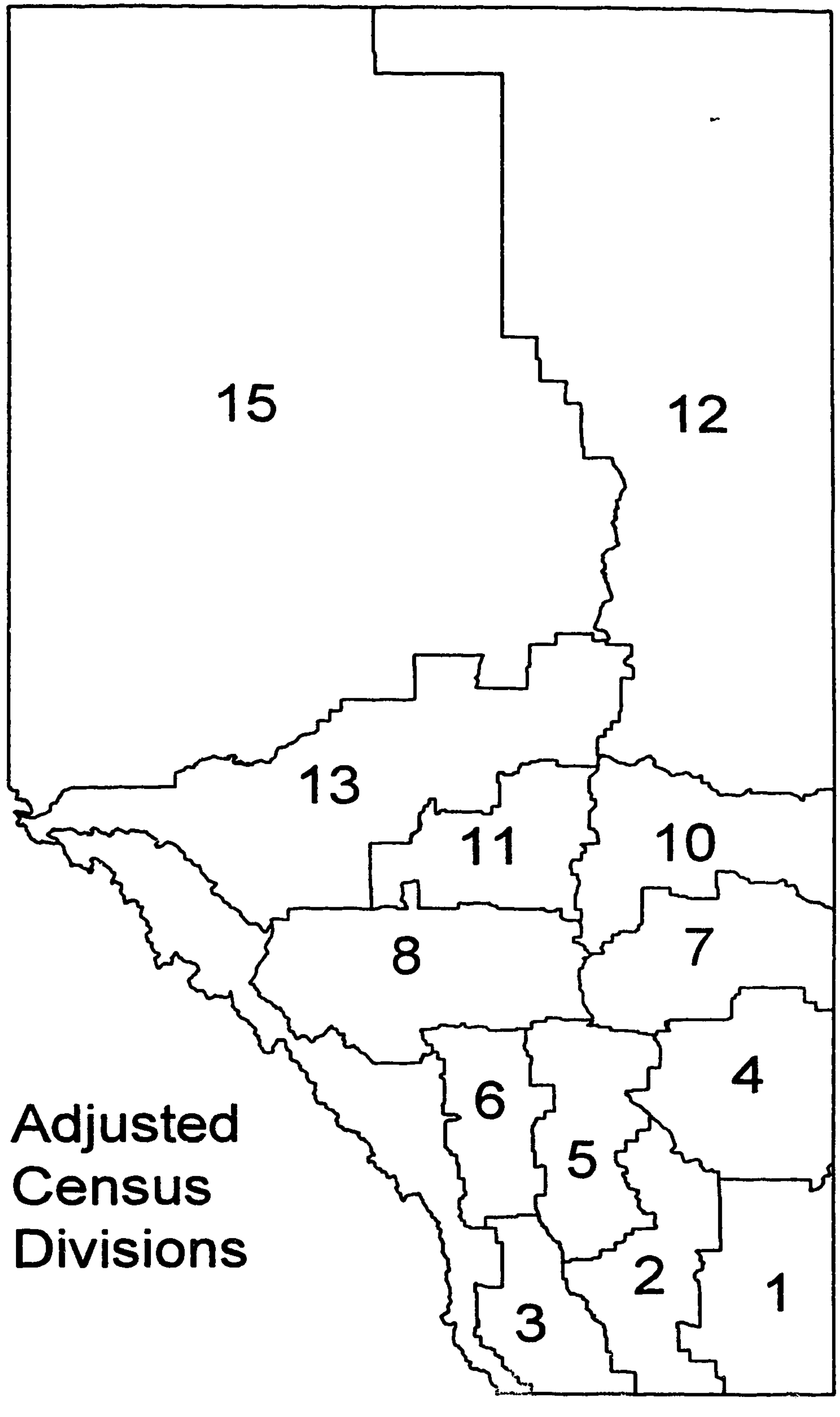
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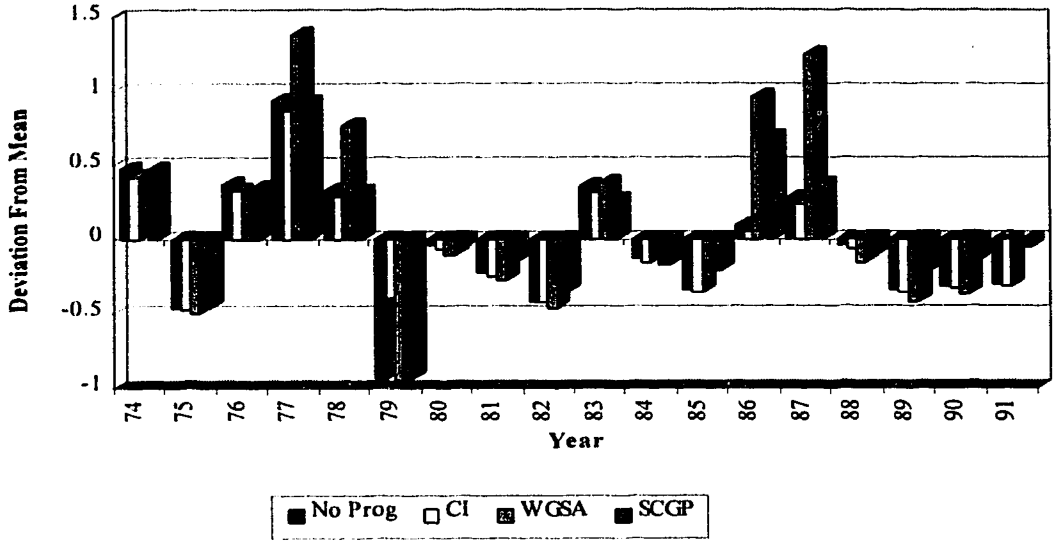
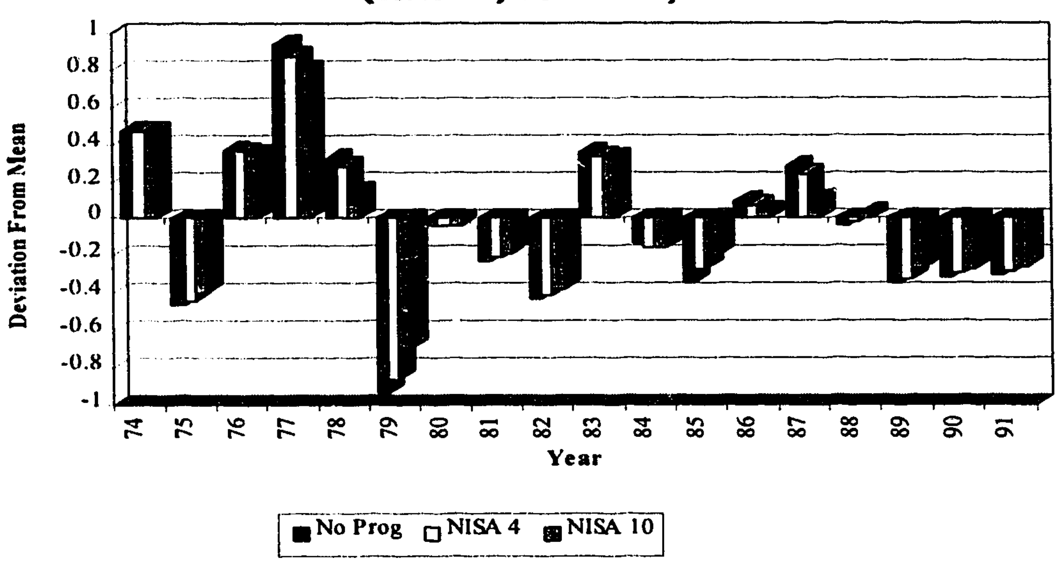
Divisions

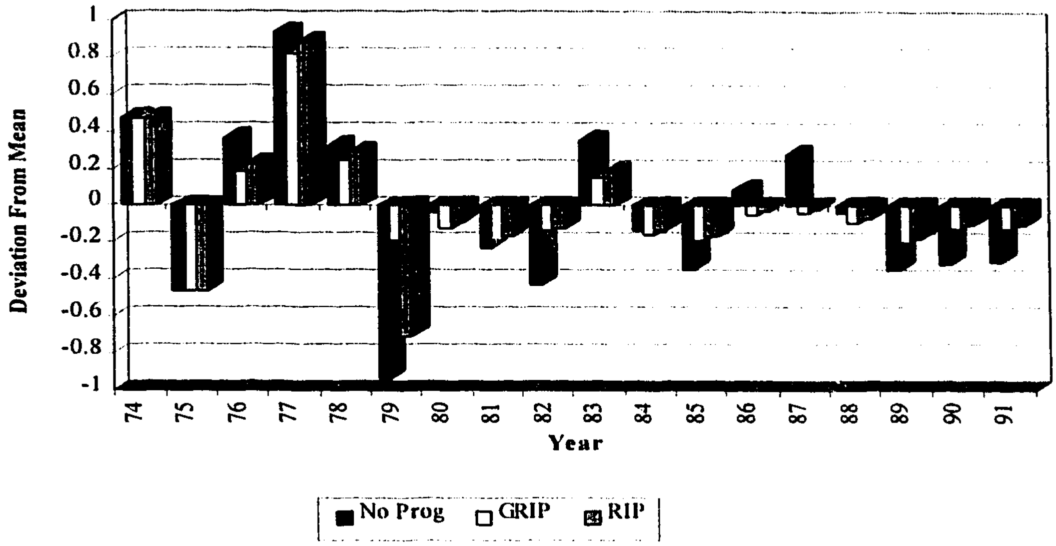
Relative Deviation From Mean Revenue (EP #327 Canola)
(CI, WGSA, SCGP)



Relative Deviation From Mean Revenue (EP #327 Canola)
(NISA 4, NISA 10)



Relative Deviation From Mean Revenue (EP #327 Canola) (GRIP, RIP)



Relative Deviation From Mean Revenue (EP #327 Canola) (SGRIP, SRIP)