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OF THE
ONTARIO WHITE BEAN SECTOR

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I. Introduction

White bean production has always provided farmers in certain parts of Ontario with a viable cropping alternative. In the three county region of Huron, Perth, and Middlesex, approximately 10 percent of available cropland is devoted to white beans. However, the actual proportion planted to this crop by this region and by the province in any given year can vary significantly as illustrated in Figure 1 for Ontario.

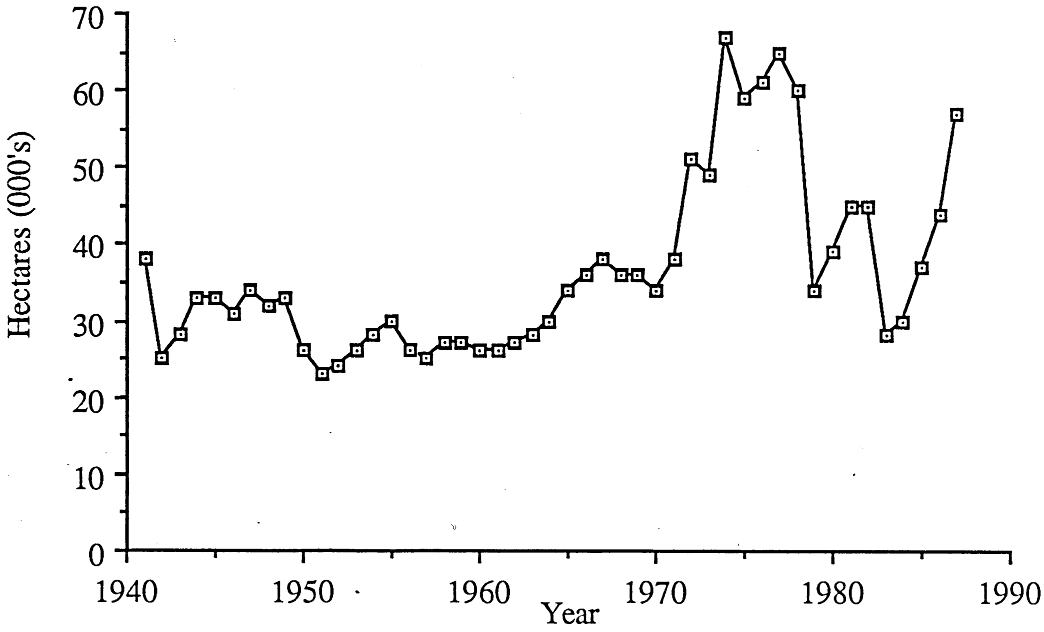

Figure 1. Hectares of White Beans Grown in Ontario 1940-1988

Changes in supply can be explained in part by changes in the prices and yields for corn, soybeans, and winter wheat relative to the price of white beans. These crops represent alternatives available in the crop rotation of farms in the producing region. In addition, risk in terms of both prices and yields is assumed to play an integral role in the management decision involving planting decisions. Research results in other crops have demonstrated that increases in income variability tend to decrease aggregate supply due to the risk averse behaviour of producers (Just (1974); Lin (1977); Adesina and Brorsen (1987); and Chavas and Holt (1989)).

Large relative uncertainties involved in white bean production implies that risk is an important element in producers' supply response.

Risk in white bean production comes from two sources. The first is yield risk as shown in Figure 2 by the fluctuations in average production per acre. Besides disease hazards such as antrachnose, white beans are a short season crop that are vulnerable to very dry weather (such as in 1986 and 1988) and to wet weather, especially during the fall harvest (as occurred in 1977 when much of the crop rotted in the field).

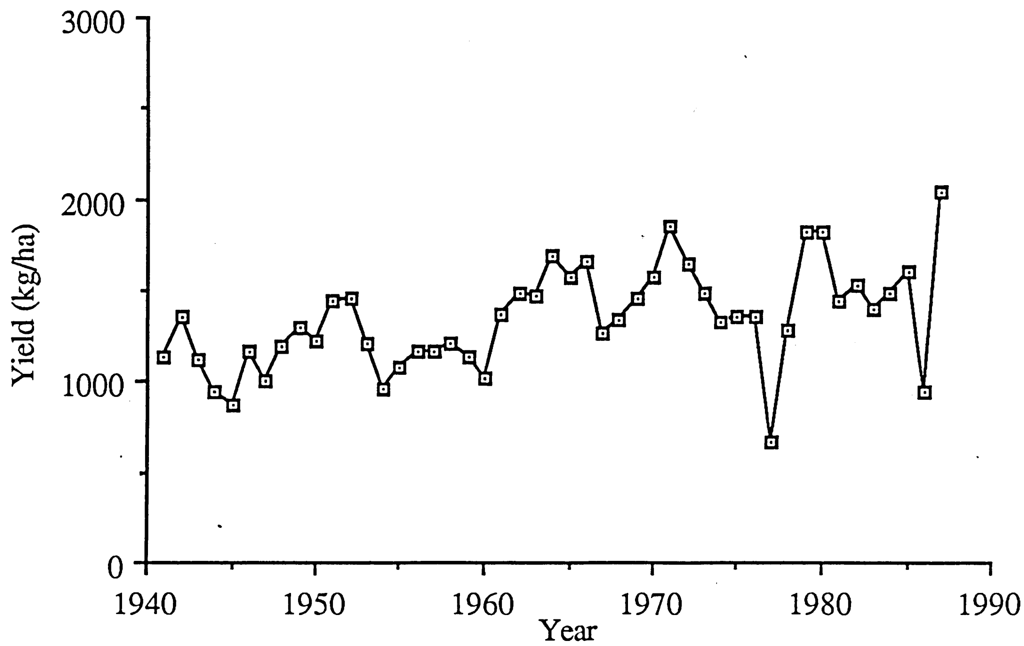

Figure 2. Ontario White Bean Yields 1940-1988

The second source of risk in white bean production arises from price variability (Figure 3). In Ontario, the white bean price is established by the Ontario Bean Producers Marketing Board (OBPMB) who pool total supply from Ontario and arrange its sale. Since approximately 80 percent of the amount produced by Ontario is sold in the export market through the OBPMB, the final price for white beans depends largely on the demand of importing countries and the supply of other exporters. The fluctuations in world demand and supply result in significant variability in the Ontario white bean price.

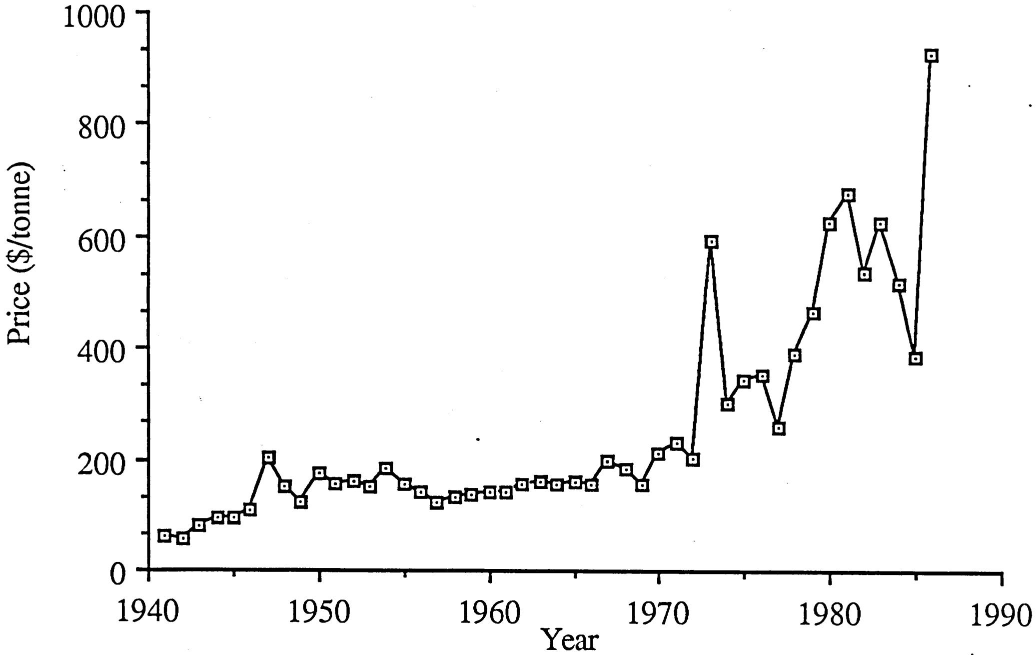

Figure 3. Nominal Price for Ontario White Beans 1940-1988

The variability in both yields and prices combine to produce uncertainties regarding revenue, which in turn affect acreage response by farmers. Consequently,the purpose of this research effort is to determine how the different sources of risk affected the planted acreage of Ontario white beans. The paper begins by analyzing changes in the variability of white bean production and revenue of white beans. Changes in production are initially examined to see if changes are determined largely by acreage or yield changes. Assuming acreage is the major determinant of variations in total supply, revenue changes are decomposed to ascertain the importance of price and yield risk. This information is then utilized in developing a risk responsive acreage supply function for white beans. The relative importance of the independent variables, including risk factors, are documented and the predictive ability of the model appraised. The paper concludes with policy implications of the tripartite stabilization and proposed changes to crop insurance levels.

II. Analysis of Changes in Variability

This paper uses statistical identities to decompose the components of changes in the average and variance of both production and revenue of white beans between two periods. The two periods, from 1961 to 1972 and 1973 to 1985, divide the data series into approximate halves and represent changes in the extent of variability in all aspects of white bean production and revenue. The elements of production, acreage and yield, are examined first to determine which component contributes most to the changes in the variability of total supply of white beans in Ontario between the time periods. If acreage is relatively constant and the variability in supply was due largely to changing yield, an acreage forecast would be of little use to the Ontario White Bean Producers Marketing Board. Sources of variability are then examined for revenue which will determine the contributions of price and yield to the increased fluctuations in returns. Since acreage supply response depends on price and yields, the information on the sources of revenue risk will aid in the modelling of acreage decisions.

II.A. Methodology

The variance decomposition procedure is derived from a Taylor series expansion of the variance of a multiplicative identity. The mathematical development and formal definition of the various components of change are shown in Appendix A. The method of analysis presented follows that described in Hazell and Anderson.

As an analytical tool variance decomposition has several valuable properties which can contribute to the understanding of acreage response in the white bean industry. First, it does not depend on any assumptions nor does it have any critical maintained hypotheses. Second, this method provides a wealth of information across many dimensions such as time periods, crops, regions, and elements of production (area and yield) or revenue (price and yield). Moreover, once the statistical decompositions are understood, the qualitative basis of the results are quite transparent. The results do not hide behind complicated data transformations or complex algebraic manipulations. Finally, data requirements are minimal. All that is required is series of total supply, yield and acreage for production, and gross returns, yield and price for revenue. The major criticism of using variance decomposition is that it lacks the explanatory power of some econometric alternatives.

Data on white bean yield, acreage and price was collected for six individual counties and an aggregate of the remaining counties in Ontario from 1961 to 1985. The six counties are Elgin, Kent, Lambton, Middlesex, Huron, and Perth. The data for each of these counties was obtained from the Ontario Ministry of Food's Agricultural Statistics for Ontario (Publication 20) and is presented in Appendix B.

Production and revenue variability are measured and compared for two time periods; 1961-72 and 1973-85. The split was made between 1972 and 1973 partially for pragmatic reasons since this divides the data into approximately two halves. In addition, since white beans produced in Ontario are primarily for export, the advent of new agricultural programs in the United States in the early 1970s had significant impacts on the nature of agricultural trade. Besides the resulting fluctuation in prices, Figure 2 illustrates that the early 1970s also appear to represent the beginning of major fluctuations in yield.

The data for each period were detrended so that variability was measured around the trend for each period. The detrending procedure regressed a linear and quadratic time trend variable on each of the variables, acreage, yield and price. A generalized least squares estimator was used to correct for heteroscedasticity following the approach used by Hazell. The residuals represent the difference between the actual observations and a predicted value. Centered on the mean, these residual become the primary data for the variability analysis. The net result is to remove the effect of systematic changes in production and revenue such as that caused by technical improvements or demand changes. The analysis focuses on identifying and explaining the sources of year to year instability. Price data were converted into 1981 dollars.

II.B. Production

The changes in total production of white beans between the two time periods are summarized in Table 1. Average supply for the province increased in the second period by 13% from the first period average but the difference in the means is statistically insignificant. However, the small change at the provincial level hides some of the shifts occurring in supply among the counties. Table 1 indicates that total supply has dropped dramatically in the southern counties of Kent and Elgin and increased in the major production areas in Middlesex, Huron, and Perth. In addition, total supply has risen in the aggregate of the remaining counties.

Table 2 and 3 show the changes in the two components of total Ontario white bean production. With the exception of Kent county, Table 2 indicates average yield has dropped slightly in all counties and for the province as a whole. Thus, the increase in supply has resulted from an increase in acreage planted which is shown in Table 3. This table also shows the regional shifts in white bean acreage which coincide with the production trends.

Variance in the total supply of white beans for Ontario increased slightly although the coefficient of variation between the two periods actually declined. Looking at the components of variance, both yield and acreage variability increased at the provincial level at rates much higher than the total changes in production variance suggesting the covariances and interaction terms of yield and acreage have had a stabilizing effect on total supply. At the county level, yield variability as measured by the coefficient of variation increased for all counties but the difference was statistically significant in Perth only. Similarly, the dispersion in area sown generally rose for all counties and was significant for Lambton and the other counties outside of the major producing area. Variability in acreage declined for Kent county which has experienced a large drop in the number of acres planted to white beans.

Table 4 shows the results of the decomposition of the changes in average white bean production for Ontario. Changes in average production can arise from changes in average yield, average acreage planted, the interaction between the two means, and from changes in the yield-area covariances. Table 4 indicates that 157 percent of the change in average total

Table 1. Changes in the Mean and Variability of White Bean Production in Ontario: 1961-72 and 1973-85

County	Average			Coefficient of Variation			F Ratio
	First Period	Second Period	% Change	First Period	Second Period	% Change	
Elgin	134.89	74.05	-82.16	37.99	67.24	43.49	1.06
Kent	308.37	38.38	-703.47	71.14	61.07	-16.48	87.58*
Lambton	63.80	65.85	3.11	22.38	48.12	53.49	0.20*
Middlesex	158.52	268.01	40.85	48.28	27.22	-77.39	1.10
Huron	460.04	595.38	22.73	36.82	23.93	-53.82	1.41
Perth	128.38	321.63	60.08	67.74	27.49	-146.42	0.97
Other	18.75	76.89	75.61	67.47	36.70	-83.82	0.20*
Ontario	1272.85	1467.90	13.29	32.26	24.64	-30.92	1.29

Table 2. Changes in the Mean and Variability of White Bean Yield in Ontario: 1961-72 and 1973-85

County	Average			Coefficient of Variation			F Ratio
	First Period	Second Period	% Change	First Period	Second Period	% Change	
Elgin	12.88	12.12	-6.27	19.02	28.71	29.60	0.50
Kent	13.55	13.77	1.62	16.99	21.03	17.89	0.67
Lambton	13.44	12.26	-9.62	14.58	17.54	8.84	0.83
Middlesex	13.63	12.99	-4.93	14.67	20.55	25.09	0.56
Huron	13.65	13.00	-5.00	13.26	21.31	34.66	0.43
Perth	13.78	12.98	-6.16	12.99	22.80	39.53	0.36*
Other	12.17	11.57	-5.19	16.11	20.14	15.88	0.71
Ontario	13.62	13.05	-4.37	11.53	21.15	43.12	0.32*

Table 3. Changes in the Mean and Variability of White Bean Acreage in Ontario: 1961-72 and 1973-85

County	Average			Coefficient of Variation			F Ratio
	First Period	Second Period	% Change	First Period	Second Period	% Change	
Elgin	10,533	6,600	-59.59	32.40	67.30	51.86	0.59
Kent	17,550	3,200	-448.44	43.40	61.70	29.66	14.84*
Lambton	4,733	5,600	15.48	15.30	56.70	73.02	0.05*
Middlesex	11,383	21,415	46.85	40.20	32.50	-23.69	0.43
Huron	33,300	47,200	29.45	36.60	24.60	-48.78	0.77
Perth	9,083	25,553	64.45	63.00	25.90	-143.24	0.75
Other	1,539	6,915	77.74	64.10	42.50	-50.82	0.11*
Ontario	88,122	116,239	24.19	22.70	28.00	18.93	0.38

* Statistically significant at the 10% confidence level

Table 4. Components of Change in Average Production of White Beans in Ontario Between 1961-72 and 1973-85

Change in Mean Acreage %	Change in Mean Yields %	Change in Interaction Term %	Change in Area/Yield Covariances %
157.8	24.6	-27.8	-54.6

production of white beans came from an increase in the area planted which means in terms of this problem, that exclusive of changes in yields, or covariances between yield and area, the change in production would have been one and half times greater than what it was.

The change in mean yield added 25% to the increase in production which seems counter intuitive given the overall yield decrease (Table 2). In conjunction with the change in interaction term, however, the source of yield decline becomes clear. If acreage had not changed between the two periods, the county that had an increase in yields (Kent) would have outweighed those counties with yield decreases and there would have been a net increase in production. The interaction term indicates that, on average, counties with increasing acreage suffered yield decreases and counties with declining acreage had yield gains. The net result is that the increase in production is 28% less that it would have been if yield had not declined on the increased acreage. By combining the positive 24% from the changes in mean yield and the negative 28% from the interaction term, the slight net decline in yields is accounted for.

The covariance term between the two time periods has become more negative. The increase in the absolute value of the covariance term suggests that more farmers are jumping in and out of white bean production, perhaps drawn in by high relative prices, only to exit because of low yields. As a result of the covariance between are and yield becoming more negative, the increase in production is 55% less than it would have been without the change in covariance.

Table 5 summarizes the decomposition of the change in the variance of white bean production. Changes in the average yield and acreage have had a small impact on the variability of production. The result indicates that the increase in the variance of production comes from sources related to increased riskiness, not just because average yields and sown area was

Table 5. Components of Change in the Variance of White Bean Production in Ontario Between 1961-72 and 1973-85

Source of Change	%
Change in Mean Yields	-5.14
Change in Mean Acreage	13.27
Change in Yield Variance	44.86
Change in Acreage Variance	168.49
Interaction Between Change in Mean Area and Yield	-2.02
Change in Area/Yield Covariance	39.18
Interaction Between Change in Mean Area and Yield Variance	-63.55
Interaction Between Change in Mean Yield and Area Variance	-20.96
Interaction Between Mean Area, Mean Yield and Covariances	-79.27
Change in Residual	5.15

higher. Changes in yield variances have had a significant impact (45%) on the increase in variance of total white bean production confirming the hypothesis that yield risk has increased over time. However, most of the increase in production variance between the two time periods is due to an increase in the variances and covariances of acres planted (168%). Furthermore, most of this arises from increases in the variability of area sown within counties. The increase of within county acreage variability means that most of the increase in production variability can be attributed to an increase in the tendency of farmers to move in and out of white beans from one year to the next. The covariances between county acreages, however, had a small offsetting effect on total production variability (-2%). This stabilizing effect is explained by the fact that acreage is increasing in the second period in some counties while decreasing in others.

An increase in the area-yield covariance has also increased the variability of supply over time (39%). This result supports the conjecture that, in the areas of rising acreage, it is the farmer with a smaller comparative advantage who are moving in and out of white bean production. Not only are yields lower are on the new areas of production, but the yields are more unstable.

The interaction terms supply the most concrete evidence of the increasing importance of risk in the acreage allocation decision. The interaction term between the change in mean acreage and yield variability (-63%) implies that mean acreage increases when yield variability is less of a factor. This interaction has a large dampening effect on the overall increase in production variability. The interaction between the change in mean yield and acreage variability (-21%) suggests that where mean yields are consistently high, farmers do not adjust their white bean acreage to the same extent as producers in other areas. The final interaction term between the changes in average yield, average acreage and the yield-acreage covariances contributes a similar but even stronger stabilizing effect on the increase in production variability (-79%).

II.C. Revenue

The changes in real revenue per acre and the real price of Ontario white beans are summarized in Table 6 and 7 respectively. Revenue per acre is determined by yield (or production per acre) and price per unit of output. Table 2 indicated that average yield had not changed significantly over time. Table 7 shows that real price also fell by an insignificant amount. Thus, average real revenue per acre also decreased in the second time period and the difference from the first period was again not statistically significant at the ninety percent confidence level. However, the variability in revenue per acre rose significantly in all counties with the exception of Huron. Similarly, the dispersion of the annual price around its mean increased significantly in the second period.

Changes in average real revenue are decomposed in Table 8. Table 8 indicates that the small decrease in average returns per acre is due largely to the slight decrease in mean yield over time (95%). Average real prices have fallen slightly also but if all else had remained constant, average revenue would have risen by 37.6%. The apparent paradox is explained by the covariance term between prices and yield which contributed 42% to the decrease in average revenue. The covariance term became more negative over time implying high yield years are now more likely during low prices. Combining the change in average price with the change in

Table 6. Changes in the Mean and Variability of Real White Bean Revenue/Acre in Ontario: 1961-72 and 1973-85

County	Average			Coefficient of Variation			F Ratio
	First Period	Second Period	% Change	First Period	Second Period	% Change	
Elgin	111.65	104.85	-6.09	19.93	48.79	144.84	0.19*
Kent	120.03	115.12	-4.09	21.59	40.90	89.46	0.30*
Lambton	116.98	105.17	-10.10	20.49	41.08	100.46	0.31*
Middlesex	118.61	113.11	-4.64	20.33	48.75	139.82	0.19*
Huron	119.01	111.10	-6.65	22.43	39.17	74.67	0.38
Perth	120.02	112.97	-5.87	21.69	47.21	117.66	0.24*
Other	105.74	100.23	-5.21	20.22	45.24	123.73	0.22*
Ontario	118.62	111.39	-6.10	19.42	41.11	111.64	0.25*

Table 7. Changes in the Mean and Variability of Real White Bean Price in Ontario: 1961-72 and 1973-85

County	Average			Coefficient of Variation			F Ratio
	First Period	Second Period	% Change	First Period	Second Period	% Change	
Elgin	8.70	8.62	-0.93	11.38	36.89	69.15	0.10*
Kent	8.69	8.62	-0.81	11.28	36.89	69.43	0.10*
Lambton	8.69	8.62	-0.81	11.28	36.89	69.43	0.10*
Middlesex	8.68	8.62	-0.70	11.29	36.89	69.40	0.10*
Huron	8.66	8.62	-0.46	11.20	36.89	69.64	0.10*
Perth	8.66	8.62	-0.46	11.32	36.89	69.32	0.10*
Other	8.68	8.62	-0.70	11.29	36.89	69.40	0.10*
Ontario	8.68	8.62	-0.70	11.29	36.89	69.40	0.10*

* Statistically significant at the 10% confidence level

Table 8. Components of Change in Average Revenue per Acre of White Beans in Ontario Between 1961-72 and 1973-85

Change in Mean Yields %	Change in Mean Price %	Change in Price/Yield Covariances %	Change in Interaction Term %
95.02	-37.65	41.55	1.08

covariance, accounts for the small drop in real prices and the subsequent fall in average real revenue per acre.

The sources of change in the variability of revenue per acre of white bean production are summarized in Table 9. The decomposition reinforces the results presented thus far. The direct effects of changes in average yield and price are very small which is expected since the means for both variables were not statistically significant different between the two periods. The largest contribution to the increase in per acre revenue variability was from the change in price variation (105%). Table 9 also shows increased yield variation contributed to an increase in revenue variation (26%) but not to the degree that price variability did. The change in the price/yield covariance had a stabilizing effect on revenues (-23%) implying that increases in the dispersion of price and yield tended to offset one another. The interaction between changes in average price and average yield had no effect. The impact is expected since price in the current period is largely a function of world demand and supply conditions on which the supply arising from Ontario plays a minor role. In addition, as shown in the previous section, total production is largely driven by changes in acreage and not yield which is dependent on local weather conditions.

Table 9. Components of Change in the Variance of White Bean Revenue per Acre in Ontario Between 1961-72 and 1973-85

Source of Change	%
Change in Mean Yield	-0.91
Change in Mean Price	0.40
Change in Yield Variance	25.70
Change in Price Variance	104.74
Interaction Between Change in Mean Price and Yield	0.01
Change in Price/Yield Covariance	-23.14
Interaction Between Change in Mean Price and Yield Variance	-5.90
Interaction Between Change in Mean Yield and Price Variance	0.59
Interaction Between Mean Price, Mean Yield and Covariances	0.41
Change in Residual	-1.88

III. Risk Responsive Acreage Supply Function

Analyzing the changes in the variability of Ontario white bean production and revenue per acre has demonstrated two major points from which we can proceed. The first is that most of the change in both average supply and its variability are due to changes in acreage planted. Thus, a forecast of acreage supply will provide the marketing board with the largest determinant of total supply for the following year. The second point is that price risk, and to a lesser extent yield risk, has had a major effect on the variability of revenues over time and thus can influence producer planting decisions. In the following section, an acreage supply function which incorporates both price and yield uncertainty is developed.

III.A. Theory of Acreage Response under Uncertainty

The theoretical formulation of production decisions under uncertainty is developed in this section. Instead of maximizing profit as is assumed under deterministic prices and yields, the firm facing uncertainty in these variables maximizes the expected utility of profits. The incorporation of stochastic elements into the decision making theory results in the inclusion of risk into the acreage response function.

We begin by assuming an individual farm which produces n crops according to the technology

(1) $Y(X) = \{X,Y; F(X)>Q; X_1 = 1\}$

where Y is a (1xn) vector of crop yields and X is a (nxk) matrix of inputs used in crop production, and Y(X) is the restricted production possibility set from a fixed amount of cultivatable land X_1. Following Just et. al. and Adesina and Brorsen output is uniquely determined by assuming inputs are allocable among production activities and production is non-joint.

Output for an individual crop i, Q_i, is equal to

(2) $Q_i = A_i F_i(X) = A_i Y_i \quad (i=1,2,\ldots n)$

where A_i is the number of acres planted to crop i. Total revenue for the farm, R, is determined by multiplying the crop's market price P_i by output and summing over all n crops.

(3) $$R = \sum_{i=1}^{n} P_i Q_i$$

The total variable cost of production per acre of an individual crop C_i is

(4) $$C_i = \sum_{j=2}^{k} W_j X_{ji} \quad (i=1,2,\ldots,n)$$

where is the W_k price of input X_k. The total cost of production C is then

(5) $$C = \sum_{i=1}^{n} C_i A_i$$

The uncertainty for the decision maker involves crop prices and yields which are unknown when acreages are allocated. Input prices and thus costs are assumed to be known at planting time.

The farmer's decision is to maximize the expected utility of profits subject to the production technology. Formally this can be stated as

(6) Max E U(π)

subject to Y(X)

The utility function is assumed to be a concave, continuous and differentiable function of consumption with $U'(\pi)>0$ and $U''(\pi)<0$. A von Neumann-Morgenstern utility function with these properties implies the firm is risk averse. The expectation operator E indicates the uncertainty of the decision making process due to the stochastic nature of crop prices and yield.

Substituting the production technology constraint into the objective function results in the following unconstrained maximization problem

(7) $$\text{Max } E\,U\left[\sum_{i=1}^{n}\{P_i Y_i - C_i\}\,A_i\right]$$

Utility, which is measured in terms farm profits, is optimized through the appropriate input and crop allocations. The risk responsive acreage supply A* and input demand functions X* determined from maximization of (7) under the appropriate regularity conditions will be

(8) $A^* = A(E(Pi), E(Yi), \Omega_P, \Omega_Y)$

(9) $X^* = X(E(Pi), E(Yi), \Omega_P, \Omega_Y)$

where E(Pi) and E(Yi) are the expected price and yield respectively of crop i and Ω_P and Ω_Y are the second order and possibly higher order moments of the probability distribution of prices and yields.

III.B. Literature Review of Empirical Studies Estimating Risk Response

The survey by Askari and Cummings cited above lists the many studies which have attempted to measure the supply of agricultural commodities. However, only recently has risk been explicitly introduced into supply models. Most of these studies have found that risk is inversely related to supply confirming the theoretical results of Sandmo for risk averse producers. The articles incorporating risk into supply estimates are reviewed below with special focus paid to the definition of risk.

Behrman was the first to explicitly account for risk in an econometric acreage response model. He defined a price risk variable as the standard deviation of crop price over the preceding three years relative to the standard deviation of an alternative crop for the same period. He also specified a yield risk variable as a simple standard deviation of crop yield. In both cases, risk is measured in terms of a moving standard deviation of past values for a given period which implies risk is defined in terms of the variable's instability (Traill).

Traill distinguishes between uncertainty and instability for the latter does not induce any risk averse reaction by the producer provided it is known in advance. A reduction in acreage from an increase in risk results from uncertainty which is defined as the difference between the expected and actual values of a variable. Formally, risk in period t, R_t, can be expressed as

(10) $R_t = P_{t-1} - E_{t-2}(P_{t-1})$

where P_{t-1} is the actual price last period and $E_{t-2}(P_{t-1})$ is the expectation of that price two periods ago.

Traill, and Tronstad and McNeill have squared the risk term given by equation (10) and estimated the appropriate lag length for the resulting risk variables using alternative lag structures. However, most studies have combined lagged risk variables into a single measure of risk. Risk is then defined as an average of the squared deviations of actual and expected price (yield) for the past 3 periods.

(11) $R_t = [\beta_1\{P_{t-1} - E_{t-2}(P_{t-1})\}^2 + \beta_2\{P_{t-2} - E_{t-3}(P_{t-2})\}^2 + \beta_3\{P_{t-4} - E_{t-3}(P_{t-4})\}^2]$

Lin used equal weights on the individual risk variables as did Wilson, Arthur and Whitaker but they estimated the appropriate lag length of this average risk variable. Other researchers have imposed a weighted moving average. Adesina and Brorsen let $\beta_1=0.6$, $\beta_2=0.3$, $\beta_3=0.1$ while Nieuwoudt, Womak and Johnson and Chavas and Holt used weights of 0.50, 0.33, 0.17 based on a Fisher lag. Sometimes the deviations are expressed in percentage terms (Adesina and Brorsen) or the risk variable is divided by price (Wilson, Arthur and Whitaker).

The resulting measure of risk depends on the definition of expected prices or returns. Lin , Wilson, Arthur and Whitaker and Nieuwoudt, Womak and Johnson specify this expected value as a simple moving average. This is essentially the approach of Behrman . Thus, these studies assume that all the variation in the stochastic variable is unexpected. Adesina and Brorsen and Chavas and Holt assume that expected prices are equal to the price in the previous period. Traill assumes that it is a function of lagged prices and estimates the relationship using a second degree polynomial Almon lag.

Whatever the definition of risk, the measure appears to have some effect on acreage in these studies. Traill found that the fit of the model used to explain U.S. onion acreage was only slightly improved with the addition of risk variables which were found to have a small but theoretically consistent inverse effect on acres planted. Lin estimated similar results for a model of wheat acreage planted in Kansas. In addition, Lin found that decreasing the risk associated with gross returns by 1% would lead to a 0.06% increase in wheat acres. Wilson, Arthur, and

Whitaker examined different lag lengths of a gross return risk variable for an aggregate wheat acreage response model for the Northwestern U.S.. They found only the 3 year positive revenue variance was significant and had the expected negative sign out of the 4 risk coefficients estimated.

Hall and Brorsen obtained similar risk elasticity measures in absolute terms to Lin for U.S. corn and soybeans. As with Lin, the elasticities with respect to risk are considerably than those found for expected price. Chavas and Holt also determined that U.S. producers of corn and soybeans are not risk neutral. They found these farmers are decreasingly absolute risk averse and are not characterized by the common assumption of constant absolute risk aversion. Their empirical results indicate that risk is important and a reduction in own price variability will increase acreage planted. Risk reduction in corn was found to generally have a negative effect on soybean acreage. However, for low price support levels, the effect was found to be positive suggesting cross commodity risk reduction is potentially important.

Adesina and Brorsen found for millet acreage in Niger the model including price risk variables out performed the non risk model in terms of expected signs, statistical significance, and explanatory power. Millet price risk was estimated to have an inverse effect on the number of acres of millet while the price risk of a competing crop had a positive impact on millet acres.

In summary, the empirical studies on acreage response which have included variables to account for risk have found these variables to be statistically significant and have added to the explanatory power of the model. Increases in risk were generally found to have an inverse effect on acreage planted implying farmers are risk averse. In addition, studies which have included additional crops have also found the cross commodity effects to be important. Thus, given the importance of price and yield risk in the white bean sector suggested by the initial analysis, an acreage response model for white beans should also include measures for risk similar to the variables employed in these previous studies.

III.C. Data

The theoretical model developed thus far assumes white bean acreage is a function of expected prices and yields for itself and substitute or complementary crops plus the expected riskiness of these crops in terms of both prices and yields. The data on these variables are listed in Appendix C for the years 1961 through 1989 along with preliminary estimates for 1990.

Acreages planted, average annual price and yield for white beans, corn, soybeans and winter wheat in the province of Ontario were obtained from OMAF's Agricultural Statisitics for Ontario (Publication 20). The total cost per acre of growing each of these crops was from a variety of sources. The years from 1981 until 1989 were obtained in OMAF's annual Crop Budgets (Publication 60). Some of the earlier years were filled in from various cost of production studies which are listed in the references while the remainder of the data series was estimated through the relationship between the gathered cost per acre for each crop and the index of prices paid for crop production by farmers in eastern Canada. The index was from Statistics Canada's Farm Input Price Index.

Data was also collected on the forward contracting price of corn and soybeans in January, February, March and April for fall delivery. The quoted price is the mean for the Chatam area and was obtained from Brian Doidge of the Ridgetown College of Agriculture. The data series on forward contract prices by Mr. Doidge began in 1981. To fill in the remaining years, the average contract price in each of the first four months of the year was regressed against the average December future price for corn and the average November future price for soybeans during the corresponding time period. The four resulting regression equations for January, February, March and April, which are reported in Appendix C, were then used in combination with the future prices for those months to predict monthly contract prices for the years 1961 through 1980. The average future prices were obtained from the Statistical Annual of Cash and Futures Data of the Chicago Board of Trade and the monthly exchange rates used to convert Chicago futures into Canadian dollars was obtained from The Bank of Canada Review.

III.D. Empirical Model

The first step in defining the empirical model is to make assumptions regarding the nature of expectations surrounding prices and yields. Most of the previous studies reviewed above have assumed naive expectations so that the expected price or yield is simply the appropriate variable lagged one period. An exception is Traill who estimated an Almon distributed lag for expected price. In this study, both expected prices and yields for white beans, corn, soybeans, and winter wheat were assumed to be a weighted average of the actual values of these variables in the previous four periods. A geometric lag of the following form is imposed for prices

(12) $E_{t-1}(P_t) = 0.4(P_{t-1}) + 0.3(P_{t-2}) + 0.2(P_{t-3}) + 0.1(P_{t-4})$

A similar distributed lag is imposed to determine expected yields. No other weights were considered to avoid any biases from pre-testing. The forward contracting price of corn and soybeans were tried as proxies for expected price of these crops. However, the results were unsatisfactory.

Price and yield risk for each of the four crops were measured as the square root of a weighted moving average of squared deviations of the expected and actual values for each variable. As noted previously, this is a common form of measuring risk in the literature. Following Adesina and Brorsen, and Hall and Brorsen, the deviations between expected and actual prices or yields are expressed in relative terms. A three year weighted average is used with weights of 0.5, 0.33, 0.17 imposed which are the same as those used by Nieuwoudt, Womak and Johnson, and Chavas and Holt. The risk parameter is thus;

(13) $$R_t(P) = \left\{ 0.5\left(\frac{P_{t-1} - E_{t-1}(P_t)}{E_{t-1}(P_t)}\right)^2 + 0.33\left(\frac{P_{t-2} - E_{t-2}(P_{t-1})}{E_{t-2}(P_{t-1})}\right)^2 + 0.17\left(\frac{P_{t-3} - E_{t-3}(P_{t-2})}{E_{t-3}(P_{t-2})}\right)^2 \right\}^{0.5}$$

The above expression is the price risk variable but a similar definition is used for yield risk. Covariance terms between commodity price and yield risk measures were assumed equal to zero.

The resulting empirical model of acreage response for Ontario white beans to be estimated is

(14) $WBACR_t = \beta_0 + \beta_{1i}\{E_{t-1}(P_{i,t})\} + \beta_{2i}\{E_{t-1}(Y_{i,t})\} + \beta_{3i}\{R_t(Y_{i,t})\} + \beta_{4i}\{R_t(P_{i,t})\} + \varepsilon_t$

where $WBACR_t$ is the number of acres planted to white beans in Ontario in year t, $E_{t-1}(P_{i,t})$ and $E_{t-1}(Y_{i,t})$ are the expected price and yield respectively of crop i in period t, and $R_t(P_{i,t})$ and $R_t(Y_{i,t})$ are the risk measures of price and yield for crop i in period t. The error term, ε_t, is assumed to be normally distributed with a mean of zero and a constant covariance.

III.E. Model Results

The ordinary least squares (OLS) estimates of the coefficients in the acreage response equation are summarized in Table 10. The first column of Table 10 gives the parameter estimates for the non risk model which only includes the expected values of prices and yields and not any higher order terms. The coefficients of the non-risk model are generally statistically significant at the ninety percent confidence level and their signs also conform with *a priori* expectations. Expected price of white beans and the price and yield of winter wheat which represents a complimentary crop in a typical rotation have a positive effect on white bean acreage. An inverse effect on white bean acreage results from changes in expected price and yield of the substitute crops, corn and soybeans. However, the negative but insignificant sign on the coefficient for expected white bean yield does not conform to expectations.

The second column of Table 10 gives the parameter estimates for the risk model. The coefficient signs of expected prices and yields remains the same for both models with the exception of expected soybean yield. However, only the price of white beans and winter wheat yield are statistically significant at the ninety percent confidence level. The coefficient on the price and yield risk variables generally conform to expectations in that the risk associated with white bean and winter wheat production has an inverse effect on white bean acreage while the risk associated with the production of substitute crops, corn and soybeans, has a positive effect

Table 10. Estimated Non-Risk and Risk Acreage Response Equations for Ontario White Beans

Independent	Variable	Non-Risk Model	Risk Model
Intercept		313.401	-40.015
		(160.259)*	(265.455
White Beans	E(Price)	4.357**	9.595*
		(1.223)	(5.087)
	R(Price)		-79.975
			(189.122)
	E(Yield)	-4.306	-6.000
		(4.296)	(8.942)
	R(Yield)		-100.776
			(112.348)
Corn	E(Price)	-46.731*	-42.122
		(26.321)	(64.492)
	R(Price)		66.194
			(248.211)
	E(Yield)	-5.864**	-7.284
		(2.082)	(4.999)
	R(Yield)		-245.274
			(183.388)
Soybeans	E(Price)	-0.184	-12.034
		(5.951)	(19.894)
	R(Price)		-261.711
			(232.594)
	E(Yield)	-0.198	13.743
		(3.934)	(12.616)
	R(Yield)		452.323
			(307.085)
Winter Wheat	E(Price)	20.009	36.923
		(15.942)	(33.834)
	R(Price)		-11.886
			(231.625)
	E(Yield)	7.128**	6.514*
		(1.759)	(4.089)
	R(Yield)		-78.448
			(295.896)
Adj R^2		0.650	0.563
D.W.		1.875	2.603
Root MSE		17.576	19.633
Theil's U		0.115	0.079

Standard errors in parentheses

*, ** Significant at the ninety and ninety five percent confidence levels respectively

on acres planted to white beans. The exceptions are the risk of corn yield and soybean price which are estimated to have a negative relationship with white bean acreage. However, none of the risk parameters are statistically significant. The net result is that the non-risk model out performs the risk model in terms of explanatory power, consistent signs of the estimates, and statistical significance of the parameters.

The non risk and risk acreage response models are also appraised in terms of their predictive ability. Figure 4 plots the predicted acreage for Ontario White beans for the non risk and risk model against actual acreage. Both models track actual acreage reasonably well but the risk model appears to better capture the turning points. This is confirmed through Theil's U given in Table 10. The lower Theil's inequality coefficient of 0.079 for the risk model versus 0.115 for the non risk model indicates the forecasts produced by the former model are slightly more accurate. Forecasts for the 1990 white bean acreage are also very similar for both models. Using preliminary estimates of annual prices and yields for the four crops used as parameters, estimated 1990 acreage is 129,000 for the non-risk model and 131,000 for the risk model.

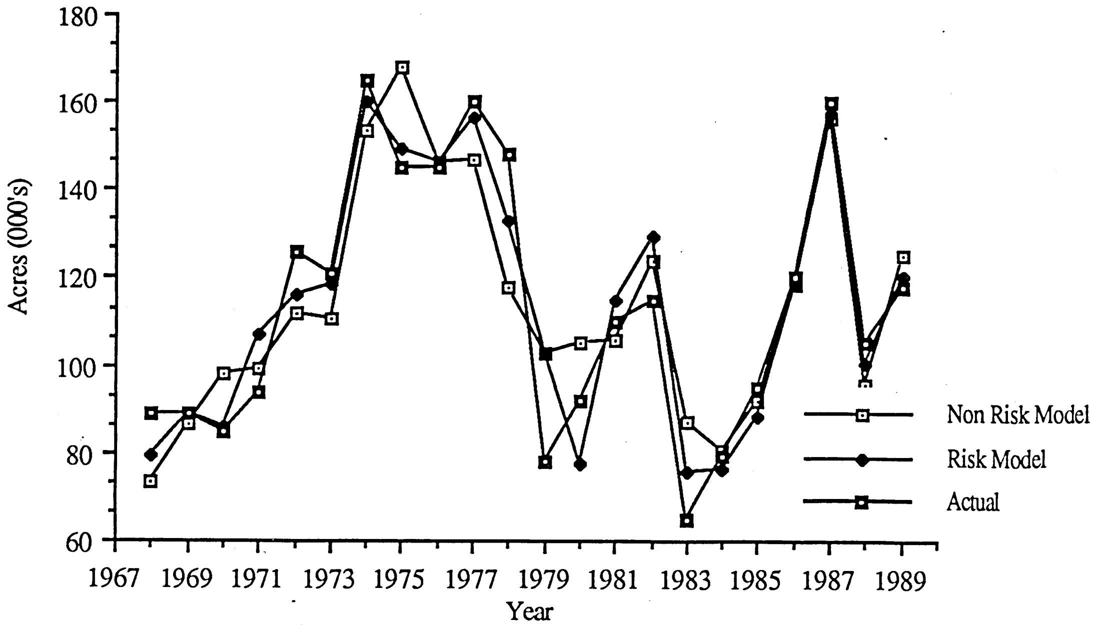

Figure 4. Non Risk and Risk Model of White Bean Acreage vs Actual, 1968-89

The elasticities of white bean acreage are computed at the mean values in Table 11. The results indicate that expected values of the independent variables have a much larger impact on planting decisions than the risk parameters. This result and the absolute values of the risk elasticity measures are consistent with the findings of previous studies such as Lin, and Hall and Brorsen. A 1% increase in own price increases white bean acreage by 2.29% while a 1% increase in the instability of own price is calculated to decrease acres of white beans by 0.23%. The largest impact from other crops is in terms of yields rather than prices. For example, a 1% increase in winter wheat yields leads to a 2.73% increase in white bean acres versus a 1.46% increase from an increase in winter wheat price. The elasticity values are generally higher under the risk model than for the non risk model. Only elasticity measures for soybeans appear biased with the omission of the risk parameters. However, this may be a result that these variables were statistically significant in the risk model rather than from any bias created through missing variables.

Table 11. Estimated Mean Acreage Response Elasticities for Ontario White Beans, 1968-1989

Independent	Variable	Non-Risk Model	Risk Model
White Beans	E(Price)	1.04	2.29
	R(Price)		-0.23
	E(Yield)	-0.46	-0.68
	R(Yield)		-0.18
Corn	E(Price)	-1.55	-1.40
	R(Price)		0.11
	E(Yield)	-4.57	-5.68
	R(Yield)		-0.31
Soybeans	E(Price)	-0.01	-0.93
	R(Price)		-0.37
	E(Yield)	-0.06	3.87
	R(Yield)		0.56
Winter Wheat	E(Price)	0.79	1.46
	R(Price)		-0.02
	E(Yield)	2.98	2.73
	R(Yield)		-0.07

IV. Summary and Conclusions

This paper has examined the role of risk in Ontario white bean production. Utilizing variance decomposition procedures, it was shown that the changes over time in the average and variance of production was due largely to changes in the corresponding measures for acreage rather than yield. Thus, forecasts of Ontario white bean supply can best be predicted through a model explaining white bean acreage. The increase in the variance of real revenue per acre over time was also decomposed to reveal that the increase in price dispersion was the largest contributer to the increase in revenue variance. An increase in yield variability was also found to significantly add to the rise in the variation of producer returns. Given the influence of relative returns on acreage decisions and the importance of price and yield risk in the levels of returns, risk elements were incorporated into the acreage response model. However, the results indicated that white bean acreage is affected more by the expected values of prices and yields rather than its associated risk parameters. Expected own price has a larger impact than expected white bean yield on whtie bean acreage but yield was found to be more influential than price for the other crops in the model.

Despite the insignificance of the risk parameters, the estimated measures of the relative contribution of price and yield variability can be helpful for the producer or policy maker in choosing separate risk responses such as tripartite stabilization versus crop insurance programs. Accurate measurements of the sources of increased variability can help target policies to reduce or offset the effects of instability. In the case of white beans, the expected price and it associated risk are more important than the yield measures. Thus, price stabilization is more important to an individual white bean producer. The present tripartite price stabilization program, which applies only to white beans and not corn, soybeans, nor winter wheat wheat, increases acreage by 0.23% for every 1% reduction in price variabiliy. However, reforms to the crop insurance program which would raise the average level of support to 90% of the average crop yield, with the exception of white beans, would decrease white bean acres by 1.2%.

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Appendix A
Mathematical Development of Variance Decomposition

The method of decomposing the changes in the average and the variance of revenue and production of Ontario white beans is based on the work by Hazell (1982, 1984) and Bohrnstedt and Goldberger. The following development of the approach examines the components of change in production, Q, which is determined from the multiplication of acreage sown, A, and yield, Y. However, the methodology can be used to decompose the changes in any multiplicative identity such as revenue per acre. The presentation of the decompostiton procedure is similar to the description of Stone and Rozelle who examine total production of a number of crops and a number of provinces. This study only examined one crop, white beans, for a number of counties within Ontario. Thus, the following description is more extensive than that used in this report.

Letting the subscripts *i* and *j* denote crops and *h* and *k* denote regions, total production for the province is

(1) $$Q = \sum_{h} \sum_{j} A_{hj} Y_{hj}$$

Average production is

(2) $$E(Q) = \sum_{h} \sum_{j} E(A_{hj} Y_{hj})$$

and the variance of production is

(3) $$V(Q) = \sum_{h} \sum_{k} \sum_{i} \sum_{j} \mathrm{cov}(A_{hi} Y_{hi}, A_{kj} Y_{kj})$$

The variance can be expanded as

$$(4)\quad V(Q) = \sum_h \sum_j V(A_{hj}\, Y_{hj}) \quad \text{(Sum of individual crop variances within regions)}$$

$$+ \sum_h \sum_{i \neq j} \sum_j \mathrm{cov}(A_{hi}\, Y_{hi},\, A_{hj}\, Y_{hj}) \quad \text{(Sum of intercrop covariances within regions)}$$

$$+ \sum_j \sum_{h \neq k} \sum_k \mathrm{cov}(A_{hj}\, Y_{hj},\, A_{kj}\, Y_{kj}) \quad \text{(Sum of interregion covariances within crops)}$$

$$+ \sum_{h \neq k} \sum_k \sum_{i \neq j} \sum_j \mathrm{cov}(A_{hi}\, Y_{hi},\, A_{kj}\, Y_{kj}) \quad \text{(Sum of covariances between different crop in different regions)}$$

In our example with a single crop and a number of regions, then only the first and third blocks of equation 4 are relevant.

Each of the components of the variance expression in equation (4) can be expanded by

$$(5)\quad E(A_{hj}Y_{hj}) = \bar{A}_{hj}\bar{Y}_{hj} + \mathrm{cov}(A_{hj}Y_{hj})$$

and, due to Bohrnstedt and Goldberger, by

$$(6)\quad \mathrm{cov}\,(A_{hi}Y_{hi},\, A_{kj}Y_{kj}) = \bar{A}_{hi}\,\bar{A}_{kj}\,\mathrm{cov}(Y_{hi},Y_{kj}) + \bar{A}_{hi}\,\bar{Y}_{kj}\,\mathrm{cov}(Y_{hi},A_{kj})$$

$$+ \bar{Y}_{hi}\bar{A}_{kj}\mathrm{cov}(A_{hi},Y_{kj}) + \bar{Y}_{hi}\bar{Y}_{kj}\mathrm{cov}(A_{hi},A_{kj}) - \mathrm{cov}(A_{hi},Y_{hi})\mathrm{cov}(A_{kj},Y_{kj}) + R$$

where A andY denote average acreage and yields and R is a residual term consisting of higher order cross moments.

The objective of the decomposition analysis is to partition the changes in the average and variance of production between the first and second period into its constituent parts which can be attributed separately to changes in the means, variances, and covariances of acreages and yields. The process involves decomposing the changes in each of the terms in the equations describing average production (equation 2) and its variance (equation 4) with the aid of the expansion terms in equations 5 and 6. The change in the different components are then summed up.

The changes in average production can be shown by first examining average production in each time period separately. Ignoring crop and region subscripts for simplicity and using equation 5, average production is period 2 can be expressed as

(7) $E(Q_2) = \bar{A}_2\bar{Y}_2 + \text{cov}(A_2,Y_2)$

Each variable in period 2 can be expressed as its counterpart in the first period plus the change in the variable between the two periods. Average production in period 2 can therefore be written as

(8) $E(Q_2) = (\bar{A}_1 + \Delta\bar{A})(\bar{Y}_1 + \Delta\bar{Y}) + \text{cov}(A_1,Y_1) + \Delta\text{cov}(A,Y)$

where $\Delta A = A_2 - A_1$.

The change in average production is then obtained by subtracting average production in period 1 from average peroduction in period 2 as given by equation 9.

(10) $E(Q) = E(Q_2) - E(Q_1) = \bar{A}_1 \Delta\bar{Y}$ (change in mean yields)

$+ \bar{Y}_1 \Delta\bar{A}$ (change in mean acreage)

$+ \Delta\bar{A}\,\Delta\bar{Y}$ (interaction effect)

$+ \Delta\text{cov}(A,Y)$ (change in covariability of acreages and yields)

As shown in equation 10, there are four sources of change in average production, The changes in mean yields and mean acreages are termed pure effects for they arise even if there are no other sources of change. The interaction effect arises from the simultaneous occurence of changes in average yield and acreage. Since the differences in yield and price averages were insignificant between the two periods, this interaction term was small for chagnes in average production and revenue. The last term arises form the changes in the variances of acreages and yields and from changes in the correlation between the two variables.

The change in the variance of production can be decomposed in a similar manner. Using equation 4 and the expansion equation 6, the change in each of the production variance and covariance terms can be decomposed. The sources of change and their mathematical derivation are summarized in Table A.

Table A. Components of Change in Production Covariances

Source of Change	Components of Change
Change in Mean Yields	$2\bar{A}_i\Delta\bar{Y}cov(Y_i,A_i) + [2Y_i\Delta\bar{Y} + (\Delta\bar{Y})^2]V(A_i)$
Change in Mean Areas	$2\bar{Y}_i\Delta\bar{A}cov(Y_i,A_i) + [2A_i\Delta\bar{A} + (\Delta\bar{A})^2]V(Y_i)$
Change in Yield Variance	$(\Delta\bar{A}_i)^2\Delta V(Y)$
Change in Area Variance	$(\Delta\bar{Y}_i)^2\Delta V(A)$
Interaction Between Changes in Mean Yield and Mean Area	$2\Delta\bar{Y}\Delta\bar{A}cov(Y_i,A_i)$
Change in Area-Yield Covariance	$[2\bar{A}_i\bar{Y}_i - 2cov(Y_i,A_i)]\Delta cov(Y,A) - [\Delta cov(Y,A)]^2$
Interaction Between Changes in Mean Area and Yield Variance	$[2\bar{A}_i\Delta\bar{A} + (\Delta\bar{A})^2]\Delta V(Y)$
Interaction Between Changes in Mean Yield and Area Variance	$[2\bar{Y}_i\Delta\bar{Y} + (\Delta\bar{Y})^2]\Delta V(A)$
Interactions Between Changes in Mean Area and Yield and Changes in Area-Yield Covariance	$[2\bar{Y}_i\Delta\bar{A} + 2\bar{A}_i\Delta\bar{Y} + 2\Delta\bar{A}\Delta\bar{Y}]\Delta cov(Y,A)$
Change in Residual	$\Delta V(A,Y)$ - sum of the other components
Note: A denotes area sown Y yield, and V variance	

Appendix B

White Bean Yield, Acres, and Price by County, 1961 to 1985

Year	Elgin			Kent			Lambton			Middlesex		
	Yield	Acres	Price	Yield	Acres	Price	Yield	Acres	Price	Yield	Acres	Price
1961	10.8	6,100	6.44	12.6	23,500	6.44	12.3	4,000	6.42	12.0	6,500	6.40
1962	13.4	5,900	6.79	13.8	22,900	6.80	12.3	3,900	6.83	13.1	7,000	6.79
1963	12.7	6,300	7.37	13.1	23,500	7.27	12.7	4,100	7.32	13.5	7,400	7.27
1964	15.0	7,800	7.05	15.2	24,000	7.05	15.4	4,500	7.03	14.4	8,400	7.04
1965	14.7	9,000	7.32	15.4	25,000	7.32	14.7	5,400	7.33	15.5	8,100	7.32
1966	16.0	14,100	6.81	16.9	20,100	6.82	14.5	5,500	6.83	14.9	15,300	6.81
1967	12.7	13,000	9.04	13.1	18,700	9.00	12.7	5,000	9.02	12.9	13,000	9.01
1968	7.0	14,700	8.50	9.1	22,300	8.50	9.5	4,600	8.50	8.5	9,500	8.50
1969	11.8	13,500	7.07	10.0	11,100	7.07	14.4	4,800	7.07	13.0	11,600	7.07
1970	14.1	11,000	9.50	15.7	5,900	9.50	11.8	4,700	9.50	15.2	12,000	9.50
1971	11.4	10,700	10.53	15.3	5,800	10.53	17.0	4,000	10.53	15.6	16,000	10.53
1972	15.0	14,300	9.05	15.0	7,800	9.05	14.0	6,300	9.05	15.0	21,800	9.05
1973	13.1	12,300	26.00	13.9	5,800	26.00	12.8	5,600	26.00	15.3	22,400	26.00
1974	12.0	13,000	13.00	11.8	7,000	13.00	12.7	6,500	13.00	12.6	29,000	13.00
1975	7.0	11,500	16.50	6.7	5,000	16.50	8.5	10,000	16.50	13.1	30,000	16.50
1976	10.7	11,600	16.50	12.2	3,700	16.50	9.5	11,900	16.50	10.8	30,000	15.00
1977	5.5	8,800	15.00	12.4	3,900	15.00	12.7	8,000	15.00	7.1	30,000	11.31
1978	13.0	8,500	11.31	15.0	3,300	11.31	10.0	6,800	11.31	11.0	27,000	16.21
1979	18.0	2,600	16.21	18.0	1,700	16.21	16.0	5,500	16.21	17.0	14,000	23.81
1980	17.3	5,000	23.81	15.2	3,000	23.81	14.7	6,000	23.81	16.8	15,000	25.67
1981	12.0	2,000	25.67	13.5	1,000	25.67	12.5	4,000	25.67	12.0	20,000	11.96
1982	10.0	4,000	11.96	14.5	500	11.96	13.5	3,500	11.96	14.5	19,000	23.08
1983	11.5	2,000	23.08	11.0	1,500	23.08	12.0	2,000	23.08	12.5	13,000	25.00
1984	14.0	2,000	25.00	16.0	1,000	25.00	10.5	1,500	25.00	12.0	14,000	16.60
1985	13.5	2,500	16.60	16.0	1,500	16.60	14.0	1,500	16.60	14.2	15,000	36.06

Appendix B
White Bean Yield, Acres, and Price by County, 1961 to 1985

Year	Huron			Perth			All Other		
	Yield	Acres	Price	Yield	Acres	Price	Yield	Acres	Price
1961	12.0	21,400	6.42	12.0	2,600	6.41	11.3	870	6.43
1962	12.7	21,500	6.80	11.1	2,600	6.78	12.7	150	6.79
1963	12.7	21,600	7.07	14.4	2,700	7.07	12.6	400	7.20
1964	14.5	25,800	7.05	16.0	3,500	7.08	15.2	1,000	7.05
1965	12.0	31,100	7.27	13.2	5,000	7.26	14.3	1,400	7.30
1966	13.0	42,900	6.84	14.8	15,300	6.81	13.2	3,300	6.81
1967	11.4	39,900	9.00	12.2	12,700	9.00	11.1	2,700	9.00
1968	14.1	29,800	8.50	13.0	8,000	8.50	7.8	1,100	8.50
1969	14.4	35,000	7.07	13.0	11,900	7.07	10.0	1,150	7.07
1970	15.0	35,000	9.50	14.1	11,500	9.50	13.3	1,800	9.50
1971	18.1	41,200	10.53	17.6	14,600	10.53	11.8	1,700	10.53
1972	14.0	54,400	9.05	14.0	18,600	9.05	12.5	2,900	9.05
1973	11.8	54,000	26.00	14.2	18,600	26.00	12.3	3,300	26.00
1974	12.4	62,000	13.00	12.9	30,000	13.00	11.5	8,500	13.00
1975	13.8	55,000	16.50	13.5	25,000	16.50	9.9	7,500	16.50
1976	13.1	58,600	16.50	13.3	25,600	16.50	12.1	8,600	16.50
1977	5.3	62,000	15.00	4.1	35,000	15.00	5.9	12,300	15.00
1978	11.0	54,000	11.31	12.0	36,000	11.31	11.0	12,400	11.31
1979	16.0	33,000	16.21	16.0	20,000	16.21	14.8	7,200	16.21
1980	16.4	35,000	23.81	16.3	26,000	23.81	15.6	5,000	23.81
1981	13.5	48,000	25.67	13.0	31,000	25.67	11.5	4,000	25.67
1982	14.5	48,000	11.96	12.5	30,000	11.96	10.9	4,600	11.96
1983	13.0	29,000	23.08	12.5	16,000	23.08	10.5	4,500	23.08
1984	13.5	34,000	25.00	14.0	17,000	25.00	12.5	5,500	25.00
1985	14.7	41,000	16.60	14.4	22,000	16.60	11.9	6,500	16.60

Appendix C
Ontario White Bean Data, 1960 to 1989

Year	WHITE BEANS						
	Acres (000's)	Yield (cwt/acre)	Total Payment ($/cwt)	Initial Payment ($/cwt)	Interim Payment ($/cwt)	Budget Cost ($/acre)	% Exported (percent)
1960	65	9.0	6.40	.	.	73.57	.
1961	65	12.1	6.50	.	.	75.45	.
1962	67	13.1	7.00	.	.	78.02	.
1963	70	13.0	7.20	.	.	79.76	.
1964	75	14.9	7.05	.	.	80.79	.
1965	85	13.9	7.30	.	.	83.15	.
1966	90	14.6	7.05	.	.	88.18	.
1967	95	11.1	9.00	.	.	91.57	.
1968	89	11.7	8.30	5.50	2.00	93.82	53
1969	89	13.0	6.99	5.76	0.80	96.70	56
1970	85	14.1	9.52	5.76	2.25	99.16	60
1971	94	16.4	10.53	5.76	3.10	102.65	63
1972	126	14.6	9.15	5.76	1.25	107.79	70
1973	121	13.2	27.02	5.76	15.00	131.50	68
1974	165	12.0	13.42	7.06	2.00	154.39	75
1975	145	12.3	15.55	7.06	2.00	165.17	83
1976	145	12.7	16.05	8.00	6.00	159.30	77
1977	160	6.0	8.16	8.16	.	167.50	75
1978	148	10.8	14.55	8.36	2.95	179.94	67
1979	78	16.8	21.10	9.27	6.94	204.92	75
1980	92	16.3	28.50	11.34	12.47	228.18	80
1981	110	13.0	30.70	15.14	10.43	290.80	75
1982	115	13.0	24.44	11.96	.	312.73	82
1983	65	12.9	28.41	11.96	11.11	288.39	67
1984	79	12.4	24.70	11.96	9.55	267.40	76
1985	95	13.7	21.33	13.61	2.99	345.97	82
1986	120	7.6	42.20	20.22	19.73	328.03	76
1987	160	15.0	21.99	11.02	.	292.64	85
1988	105	12.2	32.54	15.00	13.61	271.22	77.5
1989	118	12.0	.	.	.	286.43	.

Appendix C
Ontario Corn Data, 1960 to 1989

Year	CORN											
	Acres (000's)	Yield (bu/Acre)	Avg Year Price ($/bu)	Budget Cost ($/Acre)	Forward Price*				Futures Price			
					January	February	March	April	January	February	March	April
1960	450	57.6	1.23	84.76	.	.	.	.	.	.	.	.
1961	396	73.4	1.21	86.93	.	.	.	.	.	.	.	.
1962	436	76.3	1.28	89.88	.	.	.	.	.	.	.	.
1963	548	65.7	1.37	91.89	.	.	.	.	.	.	.	.
1964	650	81.1	1.30	93.07	.	.	.	.	.	.	.	.
1965	740	80.2	1.30	95.80	.	.	.	.	.	.	.	.
1966	786	82.4	1.47	101.59	.	.	.	.	.	.	.	.
1967	850	85.0	1.25	105.49	.	.	.	.	.	.	.	.
1968	925	84.9	1.24	108.09	1.30	1.34	1.36	1.33	1.258	1.283	1.276	1.233
1969	930	75.1	1.31	111.41	1.22	1.22	1.25	1.29	1.175	1.156	1.146	1.188
1970	1100	85.0	1.36	114.24	1.23	1.24	1.27	1.30	1.189	1.178	1.173	1.209
1971	1263	80.9	1.15	118.27	1.47	1.45	1.44	1.41	1.558	1.533	1.484	1.423
1972	1220	76.0	1.63	124.18	1.22	1.23	1.27	1.29	1.259	1.248	1.267	1.289
1973	1210	86.0	2.53	146.39	1.32	1.34	1.42	1.51	1.390	1.401	1.470	1.564
1974	1340	70.0	3.03	199.77	2.29	2.49	2.39	2.18	2.646	2.970	2.826	2.534
1975	1420	92.0	2.52	190.29	2.43	2.30	2.25	2.35	2.815	2.635	2.553	2.644
1976	1580	85.0	2.12	215.00	2.33	2.34	2.32	2.30	2.653	2.719	2.688	2.646
1977	1610	95.0	2.15	199.20	2.36	2.42	2.45	2.43	2.681	2.730	2.690	2.648
1978	1680	82.0	2.79	257.07	2.21	2.21	2.64	2.51	2.288	2.274	2.445	2.523
1979	1870	90.0	3.03	264.67	2.59	2.65	2.61	2.65	2.519	2.593	2.589	2.673
1980	2000	93.0	3.84	325.40	3.10	3.13	3.02	2.92	3.066	3.111	2.981	2.946
1981	2171	95.0	2.92	321.25	3.75	3.87	3.79	3.91	3.680	3.750	3.679	3.831
1982	2080	98.0	2.84	389.71	2.94	2.95	2.84	2.92	2.956	2.996	2.880	2.970
1983	2000	92.0	4.03	334.90	2.89	2.92	2.91	3.15	2.811	2.869	2.971	3.035
1984	2120	97.0	3.41	348.40	3.07	3.03	3.11	3.25	2.859	2.940	3.019	3.019
1985	2100	102.0	2.87	355.80	2.92	2.91	3.17	3.07	2.680	2.666	2.631	2.665
1986	1829	101.0	2.28	339.75	2.62	2.49	2.47	2.40	2.213	2.106	2.068	1.995
1987	1840	117.0	2.57	333.41	2.17	2.10	2.11	2.22	1.758	1.691	1.734	1.818
1988	1740	84.0	3.68	318.83	2.39	2.41	2.43	2.48	2.099	2.167	2.187	2.251
1989	.	.	.	330.67	3.08	3.06	3.05	2.96	2.742	2.709	2.703	2.625

* Monthly Forward Price for 1968-80 estimated through the following regressions; FutPr is the Avg Monthly Price for Dec Corn Futures In Cdn $

January =	0.224 + 0.788*FutPr	Adj R Sq = 0.976
February =	0.268 + 0.767*FutPr	Adj R Sq = 0.956
March =	0.313 + 0.757*FutPr	Adj R Sq = 0.939
April =	0.318 + 0.760*FutPr	Adj R Sq = 0.970

Appendix C
Ontario Soybean Data, 1960 to 1989

Year	SOYBEANS											
	Acres (000's)	Yield (bu/Acre)	Avg Year Price ($/bu)	Budget Cost ($/Acre)	Forward Price*				Futures Price			
					January	February	March	April	January	February	March	April
1960	256	22.1	2.03	58.92	.	.	.	.	.	.	.	.
1961	212	31.3	2.25	70.89	.	.	.	.	.	.	.	.
1962	221	29.9	2.48	65.55	.	.	.	.	.	.	.	.
1963	228	21.9	2.80	55.87	.	.	.	.	.	.	.	.
1964	231	30.2	2.87	71.45	.	.	.	.	.	.	.	.
1965	265	30.3	2.65	66.59	.	.	.	.	.	.	.	.
1966	279	32.0	3.00	70.61	.	.	.	.	.	.	.	.
1967	290	27.9	2.67	73.33	.	.	.	.	.	.	.	.
1968	295	30.6	2.44	75.13	2.85	2.91	2.74	2.56	2.703	2.714	2.699	2.645
1969	322	23.8	2.43	77.44	2.58	2.60	2.41	2.27	2.435	2.404	2.365	2.354
1970	335	31.0	2.78	79.41	2.61	2.68	2.55	2.55	2.466	2.499	2.526	2.653
1971	367	28.0	2.94	82.20	2.83	2.87	2.70	2.56	2.869	2.876	2.868	2.844
1972	405	34.0	3.90	86.31	2.94	3.74	3.73	3.84	3.014	3.918	4.066	4.302
1973	470	31.0	5.45	99.18	3.44	3.71	3.72	3.86	3.614	3.918	4.066	4.302
1974	415	27.0	6.34	131.37	5.53	5.69	5.34	4.71	6.118	6.395	6.070	5.425
1975	390	35.0	4.92	150.44	5.73	5.19	5.00	5.04	6.330	5.628	5.498	5.555
1976	378	24.0	7.05	139.58	4.69	4.67	4.51	4.44	5.043	5.073	5.021	5.035
1977	550	39.0	6.54	147.31	6.08	6.49	6.80	6.90	6.635	6.998	7.198	7.310
1978	705	27.0	7.64	190.97	5.76	5.74	6.89	6.33	5.750	5.670	6.106	6.183
1979	690	35.0	7.12	190.60	7.20	7.48	7.44	7.26	6.733	6.998	7.071	7.054
1980	685	37.0	8.53	235.12	7.59	7.59	7.17	6.86	7.245	7.323	6.853	6.503
1981	689	32.0	7.19	219.74	8.73	8.74	8.59	8.90	8.276	8.240	8.070	8.438
1982	900	35.0	6.80	247.93	7.23	7.26	6.97	7.29	6.804	6.780	6.488	6.756
1983	900	30.0	9.33	237.71	6.69	6.86	7.00	7.34	6.146	6.260	6.458	6.783
1984	1000	34.0	7.55	242.91	8.00	7.92	8.33	8.52	7.150	7.108	7.324	7.245
1985	1000	37.0	6.71	247.31	7.33	7.34	7.47	7.60	6.115	6.061	6.014	6.104
1986	940	37.0	6.30	237.68	6.65	6.55	6.56	6.44	5.395	5.154	5.177	5.115
1987	1120	41.0	7.19	222.70	6.05	5.72	5.71	6.01	4.851	4.715	4.777	5.099
1988	1280	32.0	8.57	224.76	7.32	7.34	7.39	7.76	6.179	6.360	6.448	6.869
1989	.	.	.	236.09	8.10	7.94	8.15	7.95	7.923	7.241	7.414	7.197

* Monthly Forward Price for 1968-80 estimated through the following regressions; FutPr is the Avg Montlhy Price for Nov Soybean Futures In Cdn $

January =	0.348 + 0.855*FutPr	Adj R Sq = 0.981
February =	0.424 + 0.843*FutPr	Adj R Sq = 0.994
March =	0.183 + 0.874*FutPr	Adj R Sq = 0.988
April =	-0.011 + 0.899*FutPr	Adj R Sq = 0.977

Appendix C
Ontario Winter Wheat Data 1960 to 1989

Year	WINTER WHEAT				CROP PRODN	EXCHANGE RATE			
	Acres (000's)	Yield (bu/Acre)	Avg Year Price ($/bu)	Budget Cost ($/Acre)	Prices Paid Index 81=100	January	February	March	April
1960	525	33.5	1.44	56.72	25.3	0.9531	0.9517	0.9509	0.9629
1961	561	35.6	1.44	58.17	25.9	0.9929	0.9896	0.9873	0.9889
1962	448	35.1	1.70	60.15	26.8	1.0450	1.0488	1.0494	1.0498
1963	438	40.2	1.70	61.49	27.4	1.0771	1.0776	1.0780	1.0768
1964	451	40.1	1.68	62.29	27.8	1.0802	1:0800	1.0805	1.0809
1965	354	36.9	1.65	64.11	28.6	1.0738	1.0758	1.0811	1.0792
1966	341	44.0	1.81	67.98	30.3	1.0746	1.0763	1.0762	1.0770
1967	400	38.7	1.81	70.60	31.5	1.0795	1.0806	1.0820	1.0824
1968	355	42.0	1.81	72.34	32.3	1.0847	1.0873	1.0849	1.0801
1969	360	39.8	1.73	74.55	33.3	1.0727	1.0744	1.0767	1.0762
1970	355	43.9	1.70	76.45	34.1	1.0728	1.0731	1.0727	1.0728
1971	341	41.3	1.72	79.14	35.3	1.0116	1.0075	1.0063	1.0076
1972	365	44.0	1.72	83.10	37.1	1.0059	1.0046	0.9984	0.9956
1973	375	40.0	4.26	101.38	45.2	0.9991	0.9955	0.9966	1.0008
1974	420	45.0	4.35	119.03	53.1	0.9914	0.9767	0.9720	0.9673
1975	455	49.0	3.64	127.34	56.8	0.9948	1.0050	1.0030	1.0111
1976	516	48.0	3.11	134.38	59.9	1.0064	0.9937	0.9858	0.9833
1977	590	52.0	3.14	143.08	63.3	1.0109	1.0279	1.0511	1.0511
1978	335	41.0	4.01	154.25	68.8	1.1011	1.1132	1.2560	1.1416
1979	490	52.0	4.02	194.91	80.3	1.1898	1.1955	1.1739	1.1463
1980	480	54.0	4.47	249.83	89.5	1.1639	1.1560	1.1731	1.1856
1981	504	52.0	4.27	198.42	100.0	1.1907	1.1988	1.1912	1.1908
1982	300	43.0	3.55	235.85	102.8	1.1924	1.2140	1.2204	1.2248
1983	565	50.0	3.99	229.60	104.3	1.2284	1.2273	1.2262	1.2322
1984	510	57.0	4.20	227.75	107.1	1.2483	1.2480	1.2700	1.2794
1985	525	67.0	3.89	238.10	106.2	1.3238	1.3530	1.3834	1.3694
1986	641	54.0	3.00	209.00	108.7	1.4066	1.4035	1.4009	1.3875
1987	370	52.0	4.62	206.57	110.9	1.3603	1.3339	1.3192	1.3189
1988	690	55.0	3.54	194.98	115.7	1.2853	1.2679	1.2491	1.2351
1989	.	.	.	205.92	.	1.1914	1.1890	1.2491	1.1886