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Article *in* Canadian Journal of Agricultural Economics/Revue canadienne d agroeconomie · March 1993

DOI: 10.1111/j.1744-7976.1993.tb03729.x

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Received 11 February 1992, accepted 4 February 1993

This study assesses the impact of government support programs on acreage response in white beans, corn, soybeans and winter wheat in Ontario. The empirical model, developed from a theoretical supply response model under uncertainty from utility maximization principles, incorporates the truncation effects of government support programs on the expectation and variance of crop revenues. The findings indicate that the National Tripartite Stabilization Program dramatically boosted the level of white bean production while the Agricultural Stabilization Act *increased corn plantings at the expense of a portfolio of alternatives. The Gross Revenue Insurance Program, which provides a consistent measure of support to all crops, provided the least potential for misallocation of land among crops. The production-neutrality objectives of all programs appear to have been violated, since the measure of protection given to riskier crops is higher than that given to less risky crops, even though both groups receive the same level of support.*

L'article examine les incidences des programmes d'aide de l'Etat sur les surfaces mises en culture du haricot rond blanc, du soja, du maïs et du blé d'hiver en Ontario. Le modèle empirique utilisé est construit à partir d'un modèle théorique de réponse d'offre en régime d'incertitude basé sur les principes de maximisation de la fonction d'utilité. Il intègre les effets de troncature des programmes d'aide de l'Etat sur les attentes et sur la variance des recettes tirées de la vente des récoltes. Le programme national tripartite de stabilisation stimulait de façon spectaculaire le niveau de production des haricots, tandis que la LPSA accroissait les emblavures de maïs aux dépens de diverses autres cultures. Le RARB, qui procure une mesure d'aide pour toutes les cultures, est le régime qui comporte le moins de risque de distorsion de l'affectation des terres aux diverses cultures. L'objectif de neutralité à l'égard de la production, qui est inscrit dans tous les régimes d'aide, était violé étant donné que le degré de protection accordé pour les cultures plus à risque est supérieur à celui prévu pour les cultures moins risquées, même si les deux groupes reçoivent le même niveau d'aide.

INTRODUCTION

Governments, both federal and provincial, have attempted to stabilize prices received by agricultural producers in Canada. The primary objective of government programs has been to protect producers from the short-term lows in the market that bring returns below the costs of production. The implementation of government programs has always been accompanied by debate over the most effective method of stabilization and the inefficiency inherent in stabilization programs. Gray et al (1991), among others, argue that programs offering stabilization not only stimulate production but also favor production of some crops over others. If a program favors one crop or another, there may be an allocation of land and other resources to that particular crop that is unwarranted given market conditions. Production-neutrality of programs has become a particularly sensitive issue in light of the trade-distorting effects of support programs.

The target of various government support programs has been changing. Historically, the target for stabilization has been price. While crop insurance programs have given producers an opportunity to protect themselves from yield losses, all of the other programs have been price-based. The long-established *Agricultural Stabilization Act* (ASA) provided price support for selected major commodities. The National Tripartite Stabilization Program (NTSP) introduced for certain commodities, under an amended ASA, also was a price-based support program. These specifically designed and implemented stabilization programs have evolved to the broadly based and applied Gross Revenue Insurance Program (GRIP).

GRIP is intended to address the criticisms leveled at many previous programs. Resource allocation and trade action problems caused by industry or commodity-specific programs are addressed by the broad spectrum of products covered under GRIP. The program is also intended to be more transparent and predictable. The ability of a producer to have in advance a very clear picture of minimum returns allows for more informed production and management decisions. The program is also considered to be a more efficient method of delivery of support. Targets are farm-specific and thus payments go directly to those individuals who have not attained the support levels.

Critics argue that GRIP muzzles market signals, gluts small specialty crop markets and introduces moral hazard problems (Gray et al 1991). Supporters state that since similar protection is given to all crops, production decisions are not skewed. However, the neutrality criteria may be violated if crops with different levels of variability or risk respond differently to similar coverage. The risk reduction may well be significantly greater for risky commodities. In addition, the clear and identifiable return guarantee may increase the production of some crops at the expense of other crops. For example, in a letter to federal and provincial politicians on February 1991, the chair of the Ontario Bean Producers Marketing Board (OBPMB) warned of "the possible annihilation of the white pea bean industry" due to the changes in stabilization policies. Clearly there is a need to understand the effects of the various stabilization programs on the acreages planted to individual crops, which will aid in determining whether the programs are meeting their stated objectives. As well, identification of the specific sources of risk and their relative importance could contribute to the ongoing monitoring and evolution of support programs.

The purpose of this study is to assess the impact of government support programs, particularly the NTSP and the more general GRIP on acreage response in white beans, corn, soybeans and winter wheat in Ontario. The estimated effects are evaluated against the stated principles of the programs. The paper begins with the development of a theoretical supply-response model under uncertainty from utility maximization principles. The empirical model is then presented, including a discussion on how the truncation effects of government support programs on the expectation and variance of crop revenues are incorporated. Following the estimated model results, the simulated effects of alternative policy scenarios on crop allocations are presented.

THEORETICAL MODEL

The producer is assumed to be a competitive price taker. Following Chavas and Holt (1990), the farm firm is assumed to produce n crops, with acreage A_i being assigned to the ith crop, which has a yield of y_i. The producer receives price p_i for crop i and faces per-acre production costs c_i. Thus the net revenue generated from crop revenue, R, is:

$$R = \sum_{i=1}^{n} (p_i \, y_i - c_i)A_i \qquad (1)$$

At the time of the production decision, acreage is allocated based on known costs of production and subjective expectations of relative prices and yields based on the information available at that time. Price and yield are uncertain and represent the risk in the decision process.

The production decision is constrained by total acreage such that:

$$A_T \geq \sum_{i=1}^{n} A_i \tag{2}$$

where A_T is the total land base available.

The farm household also faces a budget constraint:

$$W + \sum_{i=1}^{n} (p_i y_i - c_i)A_i = PG \tag{3}$$

where

W = the initial wealth and

P = an index of prices for the consumption goods, G.

Thus, the amount spent on consumption is equal to farm revenue and initial wealth.

The producer is assumed to maximize a von Newmann–Morgenstern utility function, which is a function of the bundle of goods consumed by the producer, $U(G)$, subject to the acreage constraint Eq. 2 and budget constraint Eq. 3. Substituting the budget constraint directly into the utility function, the optimization problem can be expressed formally as:

$$\underset{A}{\text{Max}}\ EU \left(I + \sum_{i=1}^{n} \pi_i A_i \right) \tag{4}$$

such that:

$$\sum_{i=1}^{n} \mathrm{A_i} \leq A_T$$

where I is the normalized initial wealth and π_i is the normalized profit per acre for the ith crop. Initial wealth and revenue per acre are both normalized by the price index of consumption goods.

The optimal acreage allocated to each crop is thus a function of initial wealth and costs as well as the unknown prices and yields. The uncertain nature of price and production means that the acreage decisions are based on the expected normalized profits per acre formed from the information available at the time of planting. Given the nature of the assumed utility function, the subjective expectations of the higher moments of the net return distributions, Ω, are also expected to have an impact on expected utility. The optimal acreage response function for crop i, A_i^*, can then be expressed as:

$$A_i^* = f(I, \pi_1, \pi_2, \ldots, \pi_n; \Omega) \tag{5}$$

The acreage response function is homogeneous of degree zero in prices (output p, input c, and consumer goods P) and initial wealth, regardless of risk preferences. However, the inclusion of risk means that the production decision does not depend on input–output price ratios only, as it does in the case of certainty (Pope 1988).

The nature of risk preferences can be tested within the above model. Risk neutrality would be indicated if the derivative of the acreage response function with respect to wealth and the higher-order moments of the random variables were equal to zero:

$$\frac{\partial A_i}{\partial I} = 0 \text{ and } \frac{\partial A_i}{\partial \Omega} = 0 \tag{6}$$

Risk neutrality would be rejected if either of these derivatives were nonzero. If the derivative of the acreage response function for a specific crop with respect to initial wealth is zero and if the producer is risk-averse, the common assumption under mean-variance analysis of constant absolute risk aversion is implied. If the first term in the above equation is nonzero, the producer is exhibiting a risk response to acreage allocation due to a change in the wealth endowment, implying nonconstant absolute risk aversion. Sandmo (1971) shows for a single product that a positive wealth effect implies decreasing absolute risk aversion.

EMPIRICAL MODEL

The model to be estimated is a linear system of equations that incorporates risk. The development is similar to that in Chavas and Holt (1990). The model is:

$$A_{it} = \alpha_i + \beta_i I_{t-1} + \sum_{j=1}^{4} \gamma_{ij} \pi_{jt} + \sum_{k \geq j}^{4} \sum_{j=1}^{4} \delta_{ijk} \sigma_{jkt} + \theta_i T + u_{it} \quad i = 1 \text{ to } 4 \tag{7}$$

where

A_{it} = the acreage planted to crop i in time t,

I_{t-1} = the initial wealth,

π_{jt} = the subjective expectation of per-acre net revenues for crop j,

σ_{jkt} = the subjective variance ($j = k$) or covariance ($j \neq k$) in period t,

T = a trend variable and

u_{it} = an error term.

Implicit in the optimization of Eq. 4 is the following symmetry restriction:

$$\frac{\partial A^c}{\partial \pi} = \frac{\partial A^*}{\partial \pi} - \frac{\partial A^*}{\partial I} \cdot A^{*\prime} \tag{8}$$

where A^c is the wealth-compensated acreage response. The n × n symmetric positive semi-definite matrix above splits the two components of the uncompensated acreage response to subjective net revenue expectations (the second term in Eq. 8) into an income effect and a substitution effect. The symmetry constraint from Eq. 8 can be incorporated by manipulating Eq. 7. The γ parameter can be decomposed into the substitution effect and wealth effect components, and the resulting model is expressed as:

$$A_{it} = \alpha_i + \beta_i \left(I_{t-1} + \sum_{j=1}^{4} A_j \pi_{jt} \right) + \sum_{j=1}^{4} \rho_{ij} \pi_{ij} + \sum_{k \geq j}^{4} \sum_{j=1}^{4} \delta_{ij} k \, \sigma_{jkt} + \theta_i T + u_{it} \quad i = 1 \text{ to } 4 \tag{9}$$

where ρ_{ij} is now the derivative of the wealth-compensated acreage decision with respect to the expected profit.

Expectations Incorporating Government Policy

The model requires a measure of the producer's expectations of revenues and risk. These expectations must also incorporate the effect of the support level provided by a stabilization scheme or crop insurance program. These support programs effectively truncate the subjective net return distributions. In order to determine the effects, assumptions must be first made as to producer's expectation of both price and yield in the absence of government support.

The price expectation mechanism chosen for this study is the weighted geometric lag given as:

$$E(P_t) = 0.5\, P_{t-1} + 0.33\, P_{t-2} + 0.17\, P_{t-3} \tag{10}$$

The measure of uncertainty is also a weighted moving average measure:

$$\sigma_t^2 = 0.5\{P_{t-1} \sim E_{t-2}(P_{t-1})\}^2 + 0.33\{P_{t-2} \sim E_{t-3}(P_{t-2})\}^2 + 0.17\{P_{t-3} \sim E_{t-4}(P_{t-3})\}^2 \tag{11}$$

Calculation of risk in this manner implicitly assumes that government policies do not affect the distribution of market prices, which is reasonable for most crops in Ontario. The price expectation and uncertainty measures are consistent with a large body of the supply response literature (Adesina and Brorsen 1987; Chavas and Holt 1990; Lin 1977; Nieuwoudt et al 1988), although Clark, Taylor and Spriggs (1992) use statistical theory to justify the price prediction equation used.

The yield expectation is developed differently. The variation in yield is due in large part to uncontrollable and unforeseen environmental factors. The producer is assumed to have knowledge of the expected yield for each crop, taking into account the technological advances that tend to trend yields upward. The past yields are regressed on a trend variable, and the predicted value is used as the subjective expectation. The subjective variance measure of yield is calculated using the same moving weighted measure as with price.

The subjective distributions for both price and yield are then truncated at the appropriate support level. For example, given the expected price, $E(P_t)$, and the expected variance, σ_t^2, the truncated mean price is:

$$E(P_t)^{tr} = \bar{p}_t = \int_{-\infty}^{T} T f(P) dP + \int_{T}^{\infty} P f(P) dP \quad (12)$$

where
T = the truncation point and
$f(P)$ = the standard normal density function for the random variable P.[1]

This can be simplified using θ to represent the standard normal cumulative distribution function, which then gives:

$$\bar{p}_t = \theta\, T + \int_{T}^{\infty} P f(P) dP \quad (13)$$

The truncated price variance is then:

$$\sigma_{P_t}^2 = \theta\, T^2 + \int_{T}^{\infty} P^2 f(P)\, d(P) - E(P)^2 \quad (14)$$

Eqs. 13 and 14 are also used to calculate the truncated mean and variance of yield, respectively. However, since crop insurance is not universally used by Ontario producers, in order to arrive at an effective aggregated measure of response, a pooled measure of mean and variance is used for yield. For example, the pooled truncated mean yield, $\bar{y}_t$, is:

$$\bar{y}_t = \beta\, y_t^{tr} + (1 - \beta) y_t^{utr} \quad (15)$$

where
β = the proportion of producers participating in the crop insurance program for the particular crop,
y^{tr} = the expected truncated yield and
y^{utr} = is the expected untruncated yield for producers not in the crop insurance program.

The effective truncated yield variance, σ_y^2, is calculated using a similar pooling mechanism.

The truncated price and yield distributions are then used to obtain mean and variance measures for net revenue. Costs are assumed known at planting and thus do not affect the variation of profit. The expected value for the mean of net revenue ($\bar{\pi}$) is given as:

$$\bar{\pi}_t = \bar{p}_t\, \bar{y}_t + \sigma_{p_t y_t} - c \quad (16)$$

where
$\bar{p}_t$ = the truncated expected price,
$\bar{y}_t$ = the pooled yield expectation,
σ_{py} = the price yield covariance and
c = the per-acre costs associated with a particular crop.

The variance of net revenue is:

$$\sigma_\pi^2 = (\bar{p}_t)^2\, \sigma_{y_t}^2 + (\bar{y}_t)^2\, \sigma_{p_t}^2 + 2\, \bar{p}_t\, \bar{y}_t\, \sigma_{p_t y_t} - (\sigma_{p_t y_t})^2\, e\,[(p_t - \bar{p}_t)^2 (y_t - \bar{y}_t)^2] + 2\bar{p}_t\, E\,[(p_t - \bar{p}_t)\,(y_t - \bar{y}_t)^2] + 2\bar{y}_t\, E\,[(p_t - \bar{p}_t)^2\,(y_t - \bar{y}_t)] \quad (17)$$

Costs are not included in the variance calculation, as they are assumed known and thus do not contribute to the variability. Since Ontario can be considered to be a price taker for the crops under study, the assumption of price and yield independence simplifies Eq. 17 to:

$$\sigma_\pi^2 = \bar{p}_t\, \sigma_{y_t}^2 + \bar{y}_t\, \sigma_{p_t}^2 + \sigma_{p_t}^2\, \sigma_{y_t}^2 \quad (18)$$

The covariances of net returns between crops are calculated using an untruncated correlation coefficient, which is assumed to be constant over the period estimated. Given the constant correlation coefficient and the variances calculated above, the covariances between profits of two crops are:

$$\sigma_{\pi_1 \pi_2} = \sigma_{\pi_1}\, \sigma_{\pi_2}\, \rho_{\pi_1 \pi_2} \quad (19)$$

where ρ is the correlation coefficient (Mood et al 1974). The use of an untruncated correlation coefficient will tend to overestimate the covariance term in absolute terms. Thus, the risk impacts of a change in policy between crop may be overestimated.

Estimation Procedure

The empirical model using truncated distributions to incorporate the effects of government programs on the acreage of white beans, corn, soybeans and winter wheat is estimated with symmetry imposed. This restriction requires the cross revenue effects to be symmetrical for all the crops. The model is estimated using seemingly unrelated regression, which allows for correction of contemporaneous correlation in the estimation of a system of equations.

The inclusion of four crops generates 16 separate variance and covariance terms for each equation, resulting in a degrees of freedom problem. To incorporate a measure of marginal risk, only the covariances relating directly to the crop whose acreage is being estimated are included. The marginal risk specification is based on the specification of a total variance of a portfolio of crops, which is:

$$X'QX \tag{20}$$

where

X = a vector of activities (in this case acreages) and

Q = the variance covariance matrix.

The marginal risk or gradient vector is:

$$\nabla_x \sigma^2 = QX \tag{21}$$

Each element in the first vector is the sum of the ith crop's variance and covariance, which is in fact the marginal risk associated with that crop. An increase in the marginal risk would be expected to decrease the acreage of that particular crop. The assumption that the coefficient of correlation is constant across the entire period also allows the use of the covariance as a measure of variance relative to the base crop being estimated. The only variance included in each equation is therefore the crop's own. The variance of the other crops is captured on a relative basis in the covariance terms.

DATA

The system to be modeled consists of four crops: white beans, corn, soybeans and winter wheat. Data on Ontario acreages, average annual yields and prices for the four crops are collected for 1965 to 1990 from the Ontario Ministry of Agriculture and Food (OMAF various). Provincial farm equity numbers are used as the variable for wealth. While these equity numbers encompass all producers, including some who are not involved in crop production, the aggregate number is used as a proxy for the initial wealth of the crop producers. The equity values are received from Statistics Canada, Agricultural Economics Statistics Branch. Since cost data for all crops are incomplete, gross revenues are used in the estimation rather than net revenue. The assumption that gross revenue gives an indication of the relative profitability of each specific crop may inflate the response of high-cost crops such as corn and white beans relative to lower-cost crops such as soybeans and winter wheat. The deflator used is the prices paid index for crop production in eastern Canada (Statistics Canada, various).

Data on the level of government support are also needed in order to determine the truncation points of the revenue distribution. Winter wheat is covered by the ASA for the entire period of estimation. The program was changed in 1976 to broaden its scope and to change the method of calculating support. The initial level of coverage was a minimum price of 80% of the 10-year average price. After 1976, the period over which a price average was taken was shortened to five years, and the coverage level was increased to 90% of that average. A producer is automatically eligible, and all receive payments in years that the market price falls below the stabilization price. An additional consideration is made for winter wheat in order to account for winterkill. The acreage may be reseeded if the crop is severely damaged over the winter and this will affect the harvested acres. A dummy variable is used in those years that winterkill was a significant factor.[2]

The ASA was amended in 1976 to include corn and soybeans on the list of those crops covered. The coverage level, and thus the truncation point, is calculated in the same manner as post-1976 winter wheat. There is also an allowance for cost-of-production adjustment to the coverage level. As this is not done using a fixed adjustment rule, the 90% of a five-year average price is used as an approximation of the actual expected coverage level.

The NTSP for white beans was implemented in 1987. As white beans were not covered under the ASA, there is no price truncation before this point. The support price is calculated based on cash costs of production plus 90% of a seven-year average margin. The margin is calculated based on average market price minus the average cash costs for a given year. While this program is voluntary, there are few if any white bean producers who choose not to enroll. The price is assumed to be truncated for all producers.

There is also a truncation point caused by the purchase of yield insurance coverage. The program in Ontario is based on 80% of a five-year average farm yield. Although coverage begins at the 75% level initially and climbs by 1 percentage point per nonclaim year to 80%, the final 80% level is used as the crop insurance truncation point. The provincial five-year average yield is used. The percentage of producers who purchased crop insurance coverage is used to pool the expectation and variance of yield (see Eq. 15).

The new GRIP, as it has been implemented in Ontario, effectively truncates the price distribution similarly to the previous price stabilization programs. The yield expectation continues to be pooled, as crop insurance is considered a complementary program to GRIP. The price support level is based on a level of 85% of a 15-year moving average price. This is the trigger level for the price support component of the GRIP.

RESULTS

The results of the acreage response model incorporating risk and wealth effects are given in Table 1. The null hypothesis that producers of these crops are risk-neutral or that the coefficients on the wealth, variance and covariance effects are jointly zero in all the equations is tested on the basis of the Gallant and Jorgenson (1979) test, which involves testing the nested hypothesis by using changes in the least squares criterion function. This generates an asymptotically valid chi-square test. The test statistic value of 101.9 indicates the rejection of risk neutrality. If the variance coefficients are nonzero and if the coefficients on the wealth terms are jointly zero in all the equations, then constant absolute risk aversion (CARA) behavior is implied. As Chavas and Holt (1990) argue, if one rejects CARA, the exclusion of a wealth term, as is usually the case in such acreage response estimations, is a misspecification and brings the results from such estimations into question. The CARA, or zero wealth effect, is also rejected, given the test statistic value of 17.4.

The overall fit of the resulting model explicitly incorporating risk measures is relatively good, as indicated by the high adjusted R^2 values and the low Thiel forecast error inequality coefficient. In addition, the signs on the various variables are generally consistent with theory. Own revenue has a significant positive impact for all four crops. Corn is a substitute for the other three crops in the model, but a significant relationship is found only between corn and soybeans. White beans, soybean and winter wheat revenue terms are all positive in their respective equations, suggesting a complementary relationship. This estimated relationship between the two bean crops and winter wheat is expected, since these crops are often grown together in rotation. Although the estimated effect between white beans and soybeans is not entirely what one would expect, it is not completely unreasonable. Over the period of estimation, crop rotation and herbicide constraints made it more difficult to switch freely between corn and other crops. In reality, the scenario is that corn was grown along with a portfolio of other crops. The other crops were much easier to exchange and work into a joint crop rotation. Since winter wheat must

Table 1. Estimated acreage response equations for Ontario, 1965 to 1990[a]

Independent variable	Crop			
	White beans	Corn	Soybeans	Winter wheat
Intercept	10.8033	−195.5696	232.7264*	138.7780
	(0.24)	(−0.92)	(1.82)	(1.29)
Wealth	−0.0018	0.0283*	−0.0157*	−0.0118*
	(−0.90)	(3.96)	(−3.13)	(−3.03)
Revenues				
White beans	0.3757*	−0.4104	0.3053	0.2227
	(2.47)	(−1.36)	(1.31)	(1.18)
Corn	−0.4104	5.8553*	−2.5847*	−1.2060
	(−1.36)	(4.18)	(−2.91)	(−1.50)
Soybeans	0.3053	−2.5847*	2.4235*	0.6819
	(1.31)	(−2.91)	(2.70)	(1.19)
Winter wheat	0.2227	−1.0261	0.6819	1.7846*
	(1.18)	(−1.50)	(1.19)	(1.94)
Variances				
Crop/white beans	−0.0031	0.0614	−0.0004	−0.0212*
	(−1.45)	(1.60)	(−0.12)	(−2.35)
Crop/corn	−0.0329*	−0.0216	0.0078	−0.0041
	(−1.85)	(−0.83)	(0.67)	(−0.69)
Crop/soybeans	0.0139*	0.0012	0.0059	0.0016
	(1.97)	(0.03)	(0.22)	(0.09)
Crop/winter wheat	−0.0161	−0.0310	−0.0139	0.0137
	(−0.85)	(−1.20)	(−0.82)	(0.62)
Trend	1.2988	42.5299*	47.2318*	17.0529*
	(1.34)	(11.20)	(19.36)	(8.07)
Winterkill	14.6379	−24.9948	39.4269	−233.0704*
	(0.74)	(−0.34)	(0.92)	(−9.09)
Adj. R^2	0.371	0.950	0.964	0.912
Thiel inequality coefficient	0.152	0.049	0.065	0.056

[a] *t*-statistics in parentheses.
* indicates coefficient significant at the 10% significant level.

be planted before the corn crop is harvested, these crops cannot be the only two in a rotation. Thus, the revenue for crops in a non-corn portfolio may in fact have a positive effect on the acreage of other crops in that portfolio.

The revenue elasticities, given in Table 2, are generally of a magnitude consistent with other studies (Krakar 1985; Meilke and Weersink 1990). The corn and white bean own-revenue elasticities are slightly elastic in this model. The expected revenue of corn is

Table 2. Revenue and variance crop elasticities for Ontario

Area	Elasticity with respect to revenue of: White beans	Corn	Soybeans	Winter wheat	Wealth
White beans	1.090	−1.169	0.720	0.464	−0.284
Corn	−0.087	1.213	−0.443	−0.156	0.320
Soybeans	0.154	−1.280	0.993	0.247	−0.426
Winter wheat	0.158	−0.716	0.394	0.911	−0.448

Area	Elasticity with respect to variance of: White beans	Corn	Soybeans	Winter wheat
White beans	−0.220	−0.177	0.465	−0.056
Corn	0.024	−0.073	0.002	−0.042
Soybeans	−0.002	−0.001	0.014	−0.032
Winter wheat	−0.018	−0.019	0.005	0.032

the most important in determining overall acreage response, which is not surprising given the dominance of corn in acreage allocation.

Few of the variance variables are significant. Those that are tend to involve white beans, which may be a result of the higher price and yield variability of this crop relative to the other three (Weersink et al 1991). White bean acreage is found to increase with an increase in the white bean/corn covariance and with a decrease in the white bean/soybean covariance. Similarly, a decrease in the wheat/white bean covariance is found to increase the acreage of winter wheat planted. These results conform to the substitute and complement relationships found earlier. The own-variance terms for white beans and corn are negative, suggesting that when the covariance increases, these two crops offer less of an opportunity to diversify the risk associated with the entire crop portfolio and thus are a less desirable option. The marginal-risk effect for these two crops evaluated at the mean values of variance and covariance weighted by the parameters in the equation is negative, as theory would suggest.

Positive signs on the own-variance terms in the soybean and winter wheat equation, albeit insignificant, may be the effect of the truncation caused by government programs. When revenue is truncated from below, reducing the risk of loss, a larger positive variance increases the chance for a large return while downside protection is maintained; that is, in a truncated distribution, a large variance offers more upside advantage while minimizing the potential for extremely low outcomes. The positive sign may indicate that the producer will adjust to a degree for the potential for higher returns, given the degree of protection against loss.

Elasticities of area planted in response to changes in revenue variance and covariances are also given in Table 2. Variance elasticities are calculated based on the constant coefficient of variation, thus giving a measure of response to the variance of an individual crop. Own-variance effects also include the results from the covariance terms to have a measure of the total effect of a change in the own variance. White bean acreage seems generally to be the most susceptible to changes in variability. This is not surprising given that it is a relatively small crop in terms of the allocation of crop land and has the highest degree of price and yield variability among the four. The change in acreage of all four crops due to changes in the expected variability of the revenues is less than that attributable to changes in levels of expected revenues. The result is consistent with the findings of other studies on the impact of risk relative to expected returns (Adesina and Brorsen 1987; Lin 1977; Traill 1978; Wilson et al 1984). The result that the acreage response is more significant if the program affects the expected returns from individual crops than if it affects only the perceived variance of that revenue is an important consideration in the policy determination.

The wealth term is negative for white beans, soybean and winter wheat. While the limited information available suggest that the producer is diversifying less as the value of equity increases in violation of the axions of the von Newmann-Morgenstern utility function, the crops cannot be considered on their own. In addition, the producer may be shifting production to other specialty crops or to alternative options. The absolute direction of risk aversion, which is constant, decreasing or increasing, cannot be determined from a model including only a subset of the options available to the producer. The absolute effect of an increase in wealth is small and slightly negative, suggesting that other low-acreage specialty crops or the spring grains, in addition to corn, have positive wealth effects.

The inelasticity of acreage response to changes in the level of wealth, as shown in Table 2, coupled with the small size of payments relative to aggregate farm equity, seem to indicate that this is the smallest contributor to acreage response. The effect of programs on the relative acreage of crops is more significant directly on the perceived returns than through a change in financial position. The acreage allocations change by only small increments as the financial position changes.

Signs on the final two variables are consistent with *a priori* hypotheses. There is a strong positive trend for all crops except white beans, which is likely a reflection of increased improvement in the available hybrids, which has increased the potential for crops beyond historical frontiers. In contrast, average yield for white beans has not improved significantly over time (Weersink et al 1991). The winterkill dummy also has a positive coefficient, as would be expected for the spring-planted crops. The negative response to the winterkill variable in the winter wheat equation is not offset by increases in acreage of the other-crop acreage-response equations estimated. There may be other crops, for example, spring grains, that make up the replanted acreage.

Policy Simulations

Various policy scenarios are dynamically simulated using the truncated expectations model presented above over the 10 years 1980 to 1989 to measure how any scenario would have affected the acreages of each of the crops considered. The scenarios are: actual; no crop insurance; no ASA; no NTSP for white beans; 10 years of NTSP for white beans; 10 years of GRIP for corn, soybeans and winter wheat and NTSP for white beans; and 10 years of GRIP with white beans included. Table 3 shows the summary results. Truncated mean and variances for both price and yield are calculated for each scenario on the basis of policy rules in place. Payouts calculated based on the policy rule for each individual program are cumulatively subtracted from the wealth variable in the case where a scenario simulates conditions after removal of a program. In the case of the 10-year NTSP scenario, payouts are added to the equity figures in the simulation. The GRIP scenario adds the calculated cumulative GRIP payments while subtracting calculated payouts under the ASA.

No Crop Insurance

The response to removal of crop insurance is not substantial. Expected revenues average 4.0%, 0%, 0.2% and 0.3% lower for white beans, corn, soybeans and winter wheat, respectively, over the 10-year simulation. The subsequent result is that the response for white beans, in terms of acreage, is tenfold greater than for the other crops when averaged over the entire simulation period. Among the four crops in the model, white beans exhibit the greatest degree of variability in yields.

Table 3. Average percentage change (1980–89) from actual acreage in Ontario for alternative policy simulations

	Percentage change in area planted to:				
Policy simulation	White beans	Corn	Soybeans	Winter wheat	Total
No crop insurance	−4.6	0.0	−0.4	−0.04	−0.01
No price support	−4.9	−8.5	2.9	−1.0	−4.1
No NTSP in 1987–89[a]	−34.0	2.9	−2.0	−7.0	−1.5
NTSP in 1980–86[b]	24.3	−1.4	2.3	2.9	1.0
GRIP and NTSP for white beans[c]	20.5	2.7	2.7	9.1	4.2
GRIP on all crops	14.3	3.3	1.4	7.4	3.6

[a]NTSP in fact was in place during these years.
[b]NTSP was not in place during these years.
[c]Support level on NTSP for white beans was lowered.

Therefore, crop insurance provides the greatest measure of relative protection to the white bean sector, as evidenced by the simulation result without crop insurance. Although the overall effect of crop insurance on acreage may be small, it may be underestimated through the use of aggregate measures of yield risk instead of farm-level yield risk.

No ASA or NTSP

The second scenario removes the price supports provided by the ASA for corn, soybeans and winter wheat over the whole simulation period, as well as the support given the white bean price through NTSP since 1987. The NTSP instituted in 1987 as an amendment to the ASA is considered part of the ASA and is removed when the ASA is removed for the simulation.

The overall average level of response of white bean acreage to the removal of the ASA is a decrease of 4.9%. However, the response is significantly different if one considers the pre- and post-NTSP periods separately. Acreage over the first seven years of the simulation is 2.3% higher without price supports. After 1987, when NTSP was implemented for white beans, its removal decreases white bean area by 24.5% over those three years. Expected revenues for corn, soybeans and winter wheat decrease by 8.4%, 5.4% and 5.8%, respectively. The decrease in revenue without the support of price through the ASA leads to an average 8.5% reduction in corn area planted. Winter wheat has an average acreage decrease of 1.0% while soybeans actually average 2.9% higher over the 1980s with the removal of the price supports. The measure of support lost by removal of the price truncation for soybean and its complementary crops is more than offset by the benefit of the removal of the truncation of corn price. The average overall acreage level decreases by 4.1% over the 1980–89 simulation period.

No NTSP for White Beans

The third scenario removes the NTSP while maintaining the ASA for the other crops in order to determine the response to the specific program in isolation. This simulation is run over the three years the NTSP has been in place in order to develop a picture of predicted acreage without the program. This is similar to the previous simulation in that the support price is removed for the white beans with the attendant decrease in average expected revenue but differs in that the ASA support for the other three crops is not removed. The average level of white bean acreage is lowered by 34% over the three-year period by removing the support price from the expectations, while average corn acreage is boosted by 2.9%. Area planted to soybeans and winter wheat decreases by 2.0% and 7.0%, respectively. The risk of the noncorn portfolio is increased and thus shifts production away from these crops to corn. Overall acreage planted to the four crops in the model decreases by 1.5% over the three-year period, as not all crop land is shifted to corn production.

Ten Years of NTSP for White Beans

A fourth scenario assumes that NTSP was available to white bean producers for the whole period of 1980–89 rather than just the last three years. Average expected revenue for white beans increases by 21.3% over the 1980–86 period in which there was no prior NTSP. The imposition of NTSP over these six years increases average white bean acreage by 24.3%. The specific level of price support offered for the other three crops in the model remains unchanged but they are still affected indirectly through the revenue and covariance terms. The NTSP for white beans has a marginal dampening effect on corn acreage over the seven years at the beginning of the 1980s while soybean and winter wheat acreages are stimulated; the net effect is an increase of 2.3% for soybeans and an increase of 2.9% for winter wheat. Overall acreage of the four crops is boosted by 1.0% in the first seven years of the simulation. These results show that the NTSP has had a significant effect on the acreage of white beans while producing some other small distortions in the allocation of crop land.

GRIP and New NTSP Coverage Level

This policy scenario simulates the program actually in place for the 1991 growing season. It assumes that GRIP has been established for the major crops of corn, soybeans and winter wheat, and that the white bean producers along with both levels of government have negotiated a new support level. Rather than adding 90% of the seven-year average gross margin to the calculated cost of production, 85% of that gross margin is used. As a result, average expected revenue is 0.2% lower over the three years in which the NTSP was in place. Average expected white bean revenue over the first seven years of the simulation, during which there was in fact no NTSP, is higher by 20.8% with NTSP in place along with GRIP for the other three crops. This is only marginally lower than the boost predicted by the simulation with NTSP over the first seven years of the decade and ASA for the other crops. For the other three crops, GRIP raises average expected revenues by 6.3%, 7.7% and 13.1% for corn, soybeans and winter wheat, respectively, over the 10-year period. There is apparently a greater measure of support from GRIP than from the original ASA.

The effect on white beans when faced with the introduction of GRIP for the other three crops is significant. Average acreage over the entire 10-year simulation period with the inclusion of NTSP support is 20.5% higher than the actual. White bean acreage increases by 3.8% even during the last three years of the simulation, which was covered by NTSP, despite the introduction of GRIP for the other three crops. Although the level of price support is slightly lower for white beans, the support given soybean and winter wheat prices offsets that lower level of support and the higher corn support. Thus, GRIP may in fact boost white bean acreages by reducing overall risk. All of the other crop acreages are boosted by the implementation of GRIP. Corn acreages increase by an average of 2.7% over the period of simulation, while soybeans and winter wheat acreages increase by 2.7% and 9.1%, respectively. Overall acres average 4.2% higher over the period of the simulation, which is consistent with what one would expect given the higher degree of price support.

GRIP for All Crops

The final scenario includes white beans in the GRIP program and removes the NTSP, which is the proposed policy for 1993. Average expected white bean revenue is raised by 4.7% over the first seven years of the simulation, when producers received no price support. In contrast, average expected revenue is 7.7% lower with GRIP than with NTSP over the last three tripartite years. Thus, the degree of price support under GRIP is not nearly as significant for white bean producers as under the NTSP. Acreages are affected similarly. Average white bean acreage during the first seven years of the simulation with all crops covered by GRIP is 14.3% higher than the actual level, which is not as large as in the case where white bean producers retain NTSP and the other crops are given GRIP price supports. White bean acreage over the final three years of the simulation is 5.4% lower than the actual, despite of the additional support given the complements. GRIP does provide a measure of support to white bean producers but it is not as significant as the NTSP currently in place. The relative decrease in support for white beans under GRIP compared with NTSP also lowers the relative increase in the acreage of its complements in diversification. However, corn acreage is 3.3% higher on average. The net result is that overall acreage averages 3.6% higher than the actual scenario, which is lower than the previous scenario in which white beans kept the NTSP rather than adopt the GRIP.

SUMMARY

This study determines the effect of a number of different policy scenarios on crop allocation decisions in Ontario. The government policy effects are directly incorporated into the expectation and variances of prices, yields and revenues through a truncation of the distribution at the support level for a specific program. Estimation of the system of acreage response functions generates theoretically valid results. Rejection of the risk-neutrality hypothesis affirms the results of the majority of the recent results of research and indicates the need to include some measure of risk into any supply response specification. Inclusion of a wealth term in the estimation of a supply response function is also supported by the rejection of the constant absolute risk aversion hypothesis.

The policy simulations lead to a number of conclusions. The program that has the most potential to affect acreage is the NTSP, dramatically boosting the level of white bean production. The ASA boosts corn plantings at the expense of the portfolio of alternatives. GRIP, which provides a consistent measure of support to all of the crops, provides the least potential for misallocation of land among crops. That is not to say, however, that the program does not produce an acreage response; its objective of production neutrality appears to have been violated.

White beans are accorded the most support by each of the broadly based programs. The higher degree of variability for this crop means that a given calculated support price, yield or revenue eliminates a larger portion of possible outcomes. The measure of protection is higher despite the fact that support is given at the same level. This would seem to run counter to the objectives of the programs. The determination of support levels that offer a consistent measure of risk reduction may eliminate a degree of the inequity. The level of support required to give all crops the same measure of stability relative to the others could be derived. The political question arises, however, as to whether this trade-off can be made.

NOTES

[1]It is assumed that the truncation point for price and yield is known with certainty by farm operators under all policies. Without this assumption, the following formulae are not correct. However, Clark, Siemens and Fleming (1990) find that price distortions are minimal if the truncation point is not known with certainty.

[2]Years during the period in question in which significant winterkill occurred are 1978, 1982 and 1987.

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