The 2002 Farm Bill Commodity Programs: A Tool for Improving Rotation Crop Profitability and Reducing Risk in Potato Cropping Systems

ABSTRACT

The Farm Security and Rural Investment Act (“Farm Bill”) of 2002 has modified the provisions under Title 1 (Commodity Programs) regarding commodity eligibility. Concurrently, potato producers in Maine have expanded their use of program crops as rotations in potato cropping systems. These changes could affect the economic viability of the potato cropping system. An economic simulation model using budgeting techniques that incorporate stochastic elements to measure risk was developed to evaluate profitability and income risk of four cropping systems with and without participation in the 2002 Farm Bill. The four systems modeled were barley-potato, canola-potato, corn-potato, and soybean-potato. Participation in the 2002 Farm Act’s commodity support programs increases the profitability of each cropping system, ranging from $26.00/acre for canola-potato to $122.00/acre for corn-potato. The use of stochastic dominance criteria shows that participation is more risk-efficient than non-participation. Furthermore, two measures of income risk—coefficient of variation and probability of loss—are also reduced with participation. For those growers using program crops in rotation with potatoes, participation in the commodity programs is a valuable tool to improve economic viability and reduce risk.
INTRODUCTION

Potato producers in Maine have identified the lack of profitable rotation crops as one of the industry’s primary constraints. An examination of state yields over the last five decades shows that per-acre yields in Maine have been virtually stagnant. One hypothesis regarding the lack of yield gains in Maine is the long reliance on short-term (two-year) rotation sequences with limited rotation crop diversity. Although, the industry recognizes the need for longer and more varied rotation sequences, economic considerations dominate their decision-making.

Research at the United States Department of Agriculture-Agricultural Research Service Laboratory in Orono, Maine is evaluating several rotation crops to determine their suitability in Maine’s potato cropping systems with respect to increased productivity and economic viability. While initial results show economic benefit in all rotations, the reduction in income risk for lower-valued commodities may not be a sufficient incentive for producers to alter their current rotation practices. However, changes embodied in the 2002 Farm Security and Rural Investment Act (Farm Bill), and recent changes in Maine’s potato cropping system could expand the possibilities for potato producers to use the bill’s provisions to reduce income risk and increase the profitability of rotation sequences.

Maine growers have already expanded the use of alternative rotation crops. Barley production has grown significantly in the last few years. In addition, a small but significant amount of acreage has been cropped to canola, soybeans, and field corn. Under the 2002 Farm Bill all of these crops are covered under the support provisions. This larger array of rotation crops and the more inclusive Farm Bill provisions may provide potato producers new opportunities to increase the economic viability of the potato cropping system. The two primary provisions studied here are: 1)
direct payment; and 2) counter-cyclical payment. This analysis evaluates the impacts of these two provisions on the entire rotation sequence’s profitability and income risk.

**Crop Diversification, Risk, and the Farm Bill**

A significant amount of research has been devoted to analyzing the support programs of the various Farm Bills. Much of these analyses have examined whether the programs distorted market signals or fostered inequities in the distribution of benefits. Other analyses have examined the impact of legislation on farm-level decisions, particularly with regard to 1) determining what crops are favored in the Farm Bill, 2) identifying strategies to maximize farm benefits, and 3) assessing which strategies are risk-efficient under the program. Little attention has been paid to studying the impacts on other cropping systems, centered on non-program commodities, such as potato, that may include program crops as part of the system.

The impact of farm bills on crop diversification has not been heavily studied. Just and Schmitz (1989) noted that economists have failed to look meaningfully at, the effects of U.S. farm programs on diversification versus specialization. In their model of farm programs, the effects on diversification are ambiguous, depending on local conditions and crops. Smith and Young (2003) found the price-support mechanisms tended to bias production toward those commodities with the highest net return after inclusion of program benefits, which promoted monoculture in some regions.

Some consideration has been given to role of farm bill participation as a risk management tool. Maynard et al. (1997) examined the impact of producers’ risk preferences on crop rotation choice. They found that as growers’ risk aversion increased, a continuous rotation became less desirable.
They also concluded that rotations incorporating program crops ranked higher for all risk-averse and approximately risk-neutral producers.

Risk affects agricultural producers in several ways. In general, for risk-averse decision-makers, risk will tend to lower inputs levels than would be employed in a risk-free environment (Hardaker et al., 1997). Production and marketing strategies can be divided into risk-efficient or risk-inefficient sets depending on the decision-maker’s risk preference. Several criteria exist to rank strategies based on the decision-maker’s utility function. Using the decision-maker’s risk preference, strategies A and B can be ranked by outcomes, X (e.g., net income), defined by the cumulative distribution functions (CDF), \( F_A(X) \), and \( F_B(X) \), respectively. Strategy A is said to dominate (be risk efficient) strategy B in the first degree if \( F_A(X) \leq F_B(X) \) for all X with at least one strong inequality. This criterion is called first-degree stochastic dominance (FSD). It holds when the decision-maker prefers to have more of the performance variable (e.g., net income) than less. A more discriminating criterion is second-degree stochastic dominance (SSD). It imposes an additional restriction on the individual’s utility function: the decision-maker must be risk-averse, which most farmers probably are. Under SSD, strategy A is preferred to strategy B if:

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-\int_{-\infty}^{X^*} F_A(X) \, dx \leq -\int_{-\infty}^{X^*} F_B(X) \, dx \quad \text{for all } X \text{ with at least one strong inequality.}
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These two criteria are used in this analysis to analyze the risk efficiency of participation.

This research extends previous work to the potato cropping system and has two objectives: 1) to evaluate profitability and income risk associated with alternative potato cropping systems; and 2) to determine how participation in the 2002 Farm Bill may impact profitability and risk within these cropping systems.
METHODS

Four different rotation sequences were modeled; including barley-potato, field corn-potato, canola-potato, and soybean-potato. Enterprise budgets were developed for each crop. Historical yields and market prices were used to derive probability distributions for these variables for all crops (USDA-NASS). Stochastic budgeting techniques were used to simulate the crop rotation sequences under two scenarios: with and without program participation. Stochastic budgeting is conducted by specifying probability distributions for key variables: in this case, price and yield. Repetitive sampling (Monte Carlo) is used to simulate and generate values from the distributions to evaluate performance measures. The iterations are carried out until the output variables converge to a stable distribution (Hardaker et al., 1997). Mean net income, income variability, and probability of a loss were calculated from the probability distribution of net income. This analysis employed “@Risk” (Palisade, 2002) to carry out the simulation.

Crop yields can often be correlated with each other because of similar growing conditions. Crop prices may also be correlated due to prevailing market conditions or similar end uses. A correlation matrix between crop yields and crop prices was estimated. However, the correlation between a crop and its own price was assumed to be zero. This is based on the assumption of a competitive market where no individual producer’s production has an influence on market price.

In this analysis two scenarios were evaluated for each rotation sequence: no participation in the income support programs and participation in the income support programs. Within the income support programs two provisions are modeled: direct payments and counter-cyclical payments. Both payments are made on a per unit basis. Under the direct payment provision, producers receive an annual payment based on the direct payment rate and their historical acre and yield bases.
The total direct payment is calculated as follows:

Direct Payment = (Direct Payment Rate)x(Base Acres)x(Program Yields)x85%

Counter-cyclical payments are designed to be awarded in years when prices are depressed. Unlike direct payments they are not made every year. The Farm Bill legislated target prices as the mechanism to determine whether counter-cyclical payments become effective. The size of the counter-cyclical payment also depends on market price and the market loan rate.

The counter-cyclical payment rate formula is:

Counter Cyclical Payment Rate = (Target Price) – (Direct Payment Rate) –
(Higher of Commodity Market Price or Loan Rate)

This formula ensures that when market prices are high no counter-cyclical payments are made. On the other hand, if market prices are lower than the loan rate, it also ensures a cap on the counter-cyclical payment.

If counter-cyclical payments are made, the payment is calculated as;

Counter-cyclical payment = (Counter Cyclical Payment Rate)x(Base Acres)x(Program Yield)x85%

In both scenarios, with and without participation, yield and price are multiplied to determine gross revenue on a per-acre basis. In the no-participation scenario, per-acre production costs are subtracted to obtain net income per acre. In the participation scenario, three additional steps are required to obtain net income. The first is to add in the direct payment (per-acre basis). The second step is to determine whether a counter-cyclical payment is made. If it is not, only the direct payment is included. If a counter-cyclical payment is made, the size of the payment is calculated and this amount is also added to gross income so that net income reflects the direct payment and the counter-cyclical payment.
RESULTS

Figures 1–4 show the cumulative density functions (CDFs) for each rotation sequence under the two scenarios. It is clear that mean income for each rotation is higher with participation in the income support programs than without participation. Given the design of the programs, this result is expected.

Under FSD the decision-maker is assumed to prefer more of the performance measure, (i.e. net income) rather than less. Graphically, this means that for one strategy to dominate another, its CDF must lie to the right of and below the CDF of the alternative strategy. As shown in Figures 1-4, for every probability level on the y-axis, the participation strategy returns a higher net income than the non-participation strategy.

As mentioned earlier, FSD is less discriminating than SSD with respect to eliminating strategies from the risk-efficient set. SSD also assumes that the decision-maker is risk-averse. Under SSD, for a strategy to dominate the other and be considered risk-efficient, the area under its CDF must be less than the area under the dominated strategy’s CDF. Although less clear graphically, in all four cases the participation strategy is more risk-efficient than the non-participation strategy. Thus, participation in the income support programs dominates the non-participation strategy under the SSD criterion. Based on these criteria we can say that for all risk-averse decision-makers, participation in the income support programs is the risk-efficient strategy and dominates the non-participation strategy.

Another measure of income risk is the variability of returns. Highly variable returns can make planning difficult and often puts operators in a situation where liquidity or solvency issues create problems. The coefficient of variation in net income is a measure of income variability that is
easy for decision-makers to understand, because it is scale-less. Figure 5 gives the coefficient of variation for all rotations under each scenario. In all cases the coefficient of variation was significantly reduced through participation in the income support programs.

A third measure of risk is the probability of loss. Some decision-makers are willing to accept higher levels of risk if the rewards are commensurate. But they are also often interested in the probability of incurring a loss. Figure 6 shows the probability of loss – what percentage of times during the simulation a net income of less than zero occurred - for each rotation sequence under each scenario. Again, the participation strategy reduces the probability of a loss for each rotation sequence.

DISCUSSION

The objective of this research was to determine the efficacy of participation in the 2002 Farm Bill’s income support provisions on Maine potato producers’ net income and risk exposure. The results show that participation increases net income for all rotation sequences and reduces the risk associated with all rotation sequences. Furthermore, the CDFs indicate that participation in the income support programs is more risk-efficient than non-participation based on the two efficiency criteria, first-degree stochastic dominance (FSD) and second-degree stochastic dominance (SSD).

This research was motivated to address the concerns of the industry to find profitable rotation crops. Most industry participants recognize that continuous potato production is not a viable option. The findings demonstrate that participation in the income support programs can be a valuable tool in increasing profitability over the life of a rotation sequence and can lead to a reduction in income risk as well.
Further research can expand the applicability of this model. Ongoing research is expected to generate findings regarding the rotation effects of these crops. Furthermore, longer rotation sequences are being used to evaluate longer-term effects on potato productivity and the impact of crop position in the rotation sequence. The results of this research can be easily incorporated into the model to determine the impact on profitability and income risk.

Techniques also exist to expand the discriminatory power of the risk efficiency criteria. Stochastic dominance with respect to a function allows strategies to be ranked in small increments over the risk-averse range (e.g., high aversion, moderate, low, etc.). This criterion will allow individual rotation sequences of various lengths and crops to be compared against each other in order to determine a risk-efficient or dominant set.
Literature Cited


Figure 1. Net Income Cumulative Probability for Barley-Potato with and without Price Support Program Participation

Figure 2. Net Income Cumulative Probability for Canola-Potato with and without Price Support Program Participation
Figure 3. Net Income Cumulative Probability for Corn-Potato with and without Price Support Program Participation

Figure 4. Net Income Cumulative Probability for Soy Bean-Potato with and without Price Support Program Participation
Figure 5. Coefficient of Variation in Net Income with and without Price Support Program Participation
Figure 6. Probability of a Loss with and without Program Participation