Impact of Risk Preferences on Crop Rotation Choice

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Stochastic dominance analysis of five crop rotations using twenty-one years of experimental yield data returned results consistent with Pennsylvania cropping practices. The analysis incorporated yield risk, output price risk, and rotational yield effects. A rotation of two years corn and three years alfalfa hay dominated for approximately risk neutral and risk averse preferences, as did participation in government programs under the 1990 Farm Bill. Crop rotation selection appeared to impact net revenues more than the decision to participate in government programs.

Before inexpensive inorganic fertilizers were widely available, farmers used crop rotation to maintain soil productivity and control insects, diseases, and weeds. The gradual replacement of crop rotation by inorganic nitrogen fertilizers and pesticides reflected the view that nitrogen could be eliminated as a growth-limiting factor (Kurtz et al. 1984). Recently, however, changes in environmental, political, and market forces have generated renewed interest in crop rotation as a yield risk management tool.

Environmental concerns and farm legislation have encouraged lower use of synthetic chemical inputs. Increased international trade of U.S. agricultural products and wider fluctuations in input prices during the last twenty years (Musser 1994) suggest that price risk may be increasing. The recent policy emphasis on market orientation indicates that farmers will receive less government protection from risk. Even prior to the 1996 Farm Bill, target prices were reduced and then frozen while market prices increased, and program payment yields were frozen while actual yields tended to rise.

To facilitate policy analysis and program design, Williams et al. (1993) suggest that additional crop rotation research is needed on different crops and in different production regions. This study uses yield data from a long-term crop rotation experiment in central Pennsylvania (Centre County), thereby capturing rotational yield effects not observable in simulated rotations. Net revenue distributions, which incorporate yield risk, output price risk, and government commodity program participation under the 1990 Farm Bill, are developed. Generalized stochastic dominance analysis is used to investigate the link between crop rotation choice and risk preferences.

Background

Generalized stochastic dominance (also known as stochastic dominance with respect to a function) is a flexible evaluative tool grounded in the expected utility hypothesis (Meyer 1977). It ranks risky alternatives for selected risk preference intervals defined by the Pratt-Arrow absolute risk aversion coefficient. An attractive feature of generalized stochastic dominance for the researcher is that it does not require specific knowledge of an individual's utility function. Another advantage is its ability to evaluate the full range of risk preferences, from risk preferring to risk averse.

Generalized stochastic dominance is implemented by selecting an interval bounded by upper and lower values of the absolute risk aversion coefficient (Meyer 1977). Within this interval, the utility function with the highest probability of not preferring action H to action G is identified. If, for this utility function, the expected utility of H is still greater than the expected utility of G, then action H is said to be preferred to action G for all decision makers in the selected class of risk preference. The flexibility to choose the intervals allows the re-

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searcher to control the trade-off between accuracy and discriminatory power (King and Robison 1981; Cochran 1986). The wider the interval, the greater the accuracy, but the lower the discriminatory power.

Cochran (1986) provides a summary of commonly used risk aversion coefficients, six of which were elicited directly and are shown in table 1. Cochran suggests that the majority of farmers' risk preferences can be represented within the interval –.0002 to .0015, measured at after-tax net farm income levels. Concerning the incidence of risk preferences among farmers, Tauer's study of seventy-two New York dairy farmers classified 26% as risk preferring, 39% as risk neutral, and 34% as risk averse. In the aggregate, the sample of farmers was decreasingly risk averse as income increased. Another study of forty-five Minnesota swine producers classified 22% as risk preferring, 36% as risk neutral, and 42% as risk averse (Wilson and Eidman 1983). The relatively high incidence of risk-preferring behavior in the two studies was a factor in the decision to use generalized stochastic dominance for this analysis.

A number of previous studies presented stochastic dominance analyses of cropping decisions, addressed the relative influence of risk preferences, and recognized other important determinants of behavior. Zacharias and Grube (1984) used stochastic dominance techniques to study crop rotations as a weed control tool. Yield data were obtained from a ten-year experiment in Illinois, output prices were held constant, and rankings for three risk preference intervals were presented. The dominant rotation in all three intervals was a two-year corn, one-year soybeans rotation. Brown (1987) found a close correspondence between producer behavior and stochastic dominance results in a study of Saskatchewan crop farmers. A fifteen-year period was analyzed using first-, second-, and third-degree stochastic dominance. Brown also presented a mean-variance analysis with a graphical estimate of the risk efficiency frontier. An analysis of the decision to double-crop wheat and soybeans concluded that a farmer's individual situation can affect decisions (Harper et al. 1991). Analysis of variance results from a study of New York dairy farmers by Tauer (1986) yielded tentative confirmation that risk preferences determine farming decisions, but that other factors may be more important than risk preference in guiding action. Williams, Harper, and Barnaby (1990) suggest that the decision to pursue one means of risk management cannot rationally be made in isolation from issues of the cost and availability of other forms of risk protection.

Mathematical programming can be an appropriate tool for evaluating crop rotations. Novak, Mitchell, and Crews (1990) used Target-MOTAD and ten years of experimental data to determine the risk-minimizing rotation scheme for a given acceptable level of return. Quadratic programming with parameterized risk preferences was used by Musser and Stamoulis (1981) to evaluate agricultural commodity programs. Duffy and Taylor (1994) used dynamic programming to examine the effect of policy uncertainty on crop mix decisions. Musser et al. (1985) presented a generalized linear programming approach to address applications with many potential rotations. An advantage of mathematical programming approaches over stochastic dominance is the ability to examine portfolios of rotations. In this study, most of the rotations were dominated by two crops (corn and alfalfa), and high net revenue correlations across rotations were expected. Thus, the strengths of stochastic dominance were expected to outweigh the limitation of not considering optimal portfolios.

Table 1. Empirically Estimated Pratt-Arrow Risk Aversion Coefficients

Study	Almost Risk Neutral	Strongly Risk Averse	Outcome Variable
Cochran 1982	———	.0015	annual income 10-acre block
Love and Robison 1984	–.00001 to .0002	>.0025	after-tax annual income
Wilson and Eidman 1983	–.0001 to +.0001	.001 to .002	after-tax annual farm income
King and Oamek 1983	–.00001 to +.00001	.00005 to .0001	annual farm income
King and Robison 1981	–.0001 to .0001	.001	annual income
Tauer 1986	–.0001 to .001	>.001	annual farm income

SOURCE: Cochran (1986).

Data and Methods

The analysis was structured around a hypothetical cash crop farm with 400 tillable acres. The size was chosen so as to be representative of cash crop farms in central Pennsylvania and large enough to ensure that the machinery complements used in each rotation were cost effective. Acreage was distributed based on the proportion of each crop grown in a given rotation.

The yield data for this study were collected from an ongoing long-term crop rotation study conducted by Penn State agronomists since 1969. The experiment site is endowed with a highly productive soil type, Hagerstown silt loam. Major changes in the rotation study were instituted in 1990, so the analysis was limited to data from five crop rotations consistently studied during the twenty-one-year period from 1969 to 1989. Technology (e.g., seed varieties) has advanced since the study period; this technological progress could pose a limitation if it occurred unevenly among the crops since 1989. The rotations are denoted as follows:

C	Continuous corn (Rotation 1)
CS	Corn-Soybeans (Rotation 2)
CAA	Corn-Alfalfa-Alfalfa (Rotation 3)
CCAAA	Corn-Corn-Alfalfa-Alfalfa-Alfalfa (Rotation 4)
COWAA	Corn-Oats-Wheat-Alfalfa-Alfalfa (Rotation 5)

Each of the sixteen crops was replicated on four plots each year. Replications were averaged to obtain a single "whole farm" yield for each crop each year. Missing or zero yield observations were discarded because most cases resulted from bird or deer damage, which can cause total crop failure on a small experimental plot, though not on a commercial-sized field. One ton of straw per acre (valued at $65 per ton) was assumed to be harvested with each oats or wheat crop. Summary statistics of the experimental yield data are presented in table 2.

Given the typically negative correlation (*ceteris paribus*) between yield and output price, consideration of yield risk alone was expected to introduce an avoidable bias in the stochastic dominance rankings, particularly given the possibility of increasing price risk (Musser 1977). Hence, output price risk was considered as well. Average nominal crop prices received by Pennsylvania farmers from 1969 to 1989 were obtained from the USDA's *Annual Price Summary* (1970–90) and the *Keystone Ag Digest* (Pennsylvania Agricultural Statistics Service 1970–90). As Pennsylvania seasonal average alfalfa prices were not reported during most of the period, the average monthly price from June to September was used as a proxy. The four-month period was selected to encompass the harvest period for current year alfalfa marketings.

The time series of yields and output prices were detrended using ARIMA models to reflect revenue risk at a single point in time. As Ford, Musser, and Yonkers (1993) indicate, ARIMA techniques can be simpler and more accommodating of misspecification error than other detrending approaches. Two cases were analyzed in this study. The first case involved detrending the yield and nominal output price series separately. Maintaining separate

Table 2. Summary Statistics of Yield Data (in bushels/acre, except hay, tons/acre)

Rotation	Crop	Mean	Min	Max	Std. Dev.	Skewness
1	C	139.62	91.32	184.93	28.90	−0.10
2	C	145.30	86.99	198.63	32.56	−0.04
	S	33.06	18.87	52.60	8.85	0.56
3	C	154.31	95.57	210.43	30.15	0.01
	A1	2.31	0.93	3.26	0.65	−0.62
	A2	4.89	3.90	8.05	0.90	2.26
4	C	153.35	98.11	202.08	31.68	−0.20
	C2	148.54	97.57	192.08	28.03	−0.04
	A1	2.26	0.97	3.11	0.55	−0.72
	A2	4.75	3.61	6.32	0.74	0.40
	A3	5.06	4.04	7.80	0.84	1.65
5	C	152.70	94.42	208.40	31.15	0.00
	O	74.41	35.18	116.40	23.96	0.27
	W	42.68	27.08	60.80	8.95	0.53
	A1	4.04	1.47	5.86	1.17	−0.66
	A2	4.87	3.69	7.63	0.88	1.60

where C = corn, C2 = corn after corn, S = soybeans, A1 = first-year alfalfa, A2 = second-year alfalfa, A3 = third-year alfalfa, O = oats, W = wheat.

series allowed the simulation of government commodity program participation but did not account for the covariances of yields and prices. The second case involved detrending nominal gross revenue series. While government programs could not be simulated without explicit yields, this approach reflected the interaction of yields and prices. The use of two approaches also helped establish the robustness of the stochastic dominance results.

In both cases, Dickey-Fuller tests could not reject the null hypothesis of unit-root nonstationarity in almost all of the time series. After taking first differences, nonstationarity was rejected in all series. The autocorrelation, partial autocorrelation, and inverse autocorrelation functions of each series were examined to identify appropriate ARIMA processes. Processes were individually selected based on minimization of Akaike's Information Criterion (AIC), statistical significance of AR and MA parameters, and whiteness of the resulting residuals. The estimated ARIMA models for individual crop yields, nominal output prices, and rotation gross revenues are detailed in table 3.

In the case of separate yield and price detrending, residuals from one-step-ahead yield forecasts were centered around the forecasts corresponding to 1993. Output price residuals were centered around the average 1993 prices received by Pennsylvania farmers (USDA 1994). For purposes of comparison, residuals in the case of gross revenue detrending were centered around the same values.

Costs were held constant in this analysis because of data constraints and were expressed in 1993 prices. Enterprise budgets were developed using the Mississippi State Budget Generator (Spurlock and Laughlin 1987). Variable costs were based on field operations used in the long-term crop rotation study (where applicable) or recommended farming practices as detailed in *The Agronomy Guide, 1993–1994* (Penn State Cooperative Extension 1993). Conventional tillage was used in all crops except oats in the COWAA rotation, which used no-till. Fertilizer application rates were based on removal rates associated with experimental yield goals (when observed yields approximated yield goals) or average yield (when observed yields were consistently lower than yield goals). Corn crops following alfalfa received nitrogen credits of 110 pounds per acre for the first year and 50 pounds per acre for the second year. Corn following soybeans received a nitrogen credit of 50 pounds per acre. In the COWAA rotation, alfalfa was established by seeding it in the fall with the winter wheat crop. In the CAA and CCAAA rotations, the alfalfa was

Table 3. Estimated ARIMA Processes for Experimental Yields, Nominal Prices, and Rotation Gross Revenues

YIELD(1C)	$(1 + 1.57B^1 + 1.67B^2 + 1.82B^3 + 1.73B^4 + 1.07B^5 + 0.47B^6)\nabla y_t = 2.70 + \epsilon_t$
YIELD(2C)	$(1 + 0.70B^1)\nabla y_t = \epsilon_t$
YIELD(2S)	$(1 + 0.49B^1)\nabla y_t = \epsilon_t$
YIELD(3C)	$(1 + 0.71B^1)\nabla y_t = \epsilon_t$
YIELD(3A1)	$(1 + 0.43B^1)\nabla y_t = \epsilon_t$
YIELD(3A2)	$(1 + 0.47B^1)\nabla y_t = \epsilon_t$
YIELD(4C)	$(1 + 1.40B^1 + 1.16B^2 + 1.18B^3 + 1.01B^4 + 0.32B^5)\nabla y_t = 3.61 + \epsilon_t$
YIELD(4C2)	$(1 + 0.74B^1)\nabla y_t = \epsilon_t$
YIELD(4A1)	$(1 + 0.44B^1)\nabla y_t = \epsilon_t$
YIELD(4A2)	$(1 + 0.64B^1)\nabla y_t = \epsilon_t$
YIELD(4A3)	$\nabla y_t = \epsilon_t$
YIELD(5C)	$(1 + 1.02B^1 + 0.73B^2 + 0.67B^3 + 0.54B^4)\nabla y_t = 3.33 + \epsilon_t$
YIELD(5O)	$(1 + 0.38B^1 + 0.54B^2)\nabla y_t = \epsilon_t$
YIELD(5W)	$(1 + 0.47B^1 + 0.77B^2)\nabla y_t = \epsilon_t$
YIELD(5A1)	$(1 + 0.64B^1)\nabla y_t = \epsilon_t$
YIELD(5A2)	$\nabla y_t = \epsilon_t$
PRICE(CORN)	$\nabla y_t = \epsilon_t$
PRICE(SOYBEANS)	$\nabla y_t = \epsilon_t$
PRICE(OATS)	$(1 + 0.01B^1 + 0.53B^2)\nabla y_t = \epsilon_t$
PRICE(WHEAT)	$\nabla y_t = \epsilon_t$
PRICE(ALFALFA)	$\nabla y_t = \epsilon_t$
GROSS(1:C)	$\nabla y_t = 14.49 + (1 - 0.65B^1)\epsilon_t$
GROSS(2:CS)	$\nabla y_t = 12.03 + (1 - 0.50B^1)\epsilon_t$
GROSS(3:CAA)	$\nabla y_t = 13.62 + \epsilon_t$
GROSS(4:CCAAA)	$\nabla y_t = 15.32 + (1 - 0.61B^1)\epsilon_t$
GROSS(5:COWAA)	$\nabla y_t = 11.14 + (1 - 0.61B^1)\epsilon_t$

where y_t denotes the variable of interest, ϵ_t denotes an i.i.d. error term, $\nabla y_t = y_t - y_{t-1}$, $B^k y_t = y_{t-k}$.

spring seeded and two cuttings were taken in the establishment year. Three cuttings were taken from mature alfalfa stands in all applicable rotations.

Prices of seed and chemical inputs such as fertilizer, herbicides, and pesticides were obtained from two local input suppliers. Variable costs dependent on yield (hauling and drying) totalled $0.20 per bushel for corn, $0.07 per bushel for wheat and oats, $0.02 per bushel for soybeans, and $1.80 per ton for alfalfa hay. Fixed costs per acre were calculated for each of the five rotations by averaging fixed costs computed for each crop in the rotation. A land charge of $50 per acre was added for all rotations. Budgeted fixed costs per acre ranged from $105.91 for continuous corn to $115.56 for the COWAA rotation. As expected, fixed costs were lowest for the rotation requiring the least equipment. In rotations requiring more equipment, however, higher ownership costs were partially offset by longer useful life of machinery. Consequently, estimated fixed costs did not vary substantially among rotations.

For the scenario using separate yield and price detrending, net revenue distributions for each of the five crop rotations were computed with and without participation in government commodity programs for corn, wheat, and oats. The effect of participation was based on legislation enacted with titles III (wheat), IV (feedgrains), and XI (general commodity programs) of the 1990 Farm Bill (USDA 1990). Variable costs were reduced proportionally with the required acreage reduction. Basic loan rates were estimated as the average of deflated basic loan rates for years 1988/89 through 1992/93 (USDA 1994), and national average market prices were estimated as the average of deflated national average crop prices from 1988 to 1992 (Pennsylvania Agricultural Statistics Service 1993; USDA 1991–92). Set-asides for the acreage reduction program (ARP) were assumed to be 7.5% for corn, 10% for wheat, and 0% for oats, based on historical data published by the USDA (1994). Program yields were calculated as the simple average of experimental yields from 1980 to 1984, and announced loan rates were based on Centre County figures (ASCS, personal communication, 1994). Deficiency payments were not calculated on acreage allocated to ARP or normal flex acres (15% of base acreage). ARP set-aside was assumed to be seeded with annual ryegrass. Soybeans were treated under the mandatory marketing loan provisions of the 1990 Farm Bill (USDA 1990), with an announced loan rate of $5.02 (USDA 1994), which effectively imposed a price floor.

Summary statistics of the resulting net revenue distributions for both detrending approaches are presented in table 4. Recognizing the interaction of prices and yields by detrending gross revenues resulted in both lower mean values and lower variances in rotation returns. The CCAAA rotation had the highest mean and minimum values, the continuous corn rotation (C) had the highest maximum value, and the COWAA rotation had the lowest standard deviation. All of the rotations yielded higher mean net revenue and lower standard deviation with participation in government programs. Correlation coefficients among net revenue distributions are shown in table 5. Values substantially lower than one suggest that portfolios of rotations might be desirable over some ranges of risk preference.

A computer program developed by Raskin and Cochran (1986b) was used to perform the stochastic dominance analysis. McCarl (1990) suggests that when risk aversion coefficient information is unavailable, a useful procedure is to find breakeven coefficients defining where preferences between options shift. This method, developed earlier by Hammond (1974) in a different context, allows the researcher to iteratively determine the largest possible interval within which dominance prevails. As this study did not involve elicitation of risk preferences from individuals, the breakeven coefficient method was used to identify risk preference intervals reflecting unique preference rankings. The resulting intervals can be compared to empirically estimated risk aversion coefficients from previous studies (e.g., Love and Robison 1984; Wilson and Eidman 1983; Tauer 1986). Scaling of the outcome variable must be accounted for in drawing inter-

Table 4. Summary Statistics of Net Revenue Distributions ($/farm)

	Scenario 1 Yield, Price Detrended		Scenario 2 Gross Revenue Detrended	
	Mean	Std. Dev.	Mean	Std. Dev.
C	65,333	44,334	62,926	37,463
C-G	68,419	41,009		
CS	32,804	30,389	28,104	23,245
CS-G	33,409	28,830		
CAA	69,323	26,585	66,129	20,200
CAA-G	69,324	26,169		
CCAAA	73,661	24,881	67,988	20,244
CCAAA-G	74,174	24,111		
COWAA	19,131	20,838	15,769	16,207
COWAA-G	22,670	20,657		

where C = corn, S = soybeans, A = alfalfa, O = oats, W = wheat.
(G following rotation name denotes participation in government programs.)

Table 5. Correlation Coefficients of Net Revenue Distributions

	C	CS	CAA	CCAAA	COWAA
C	1.00	0.77	0.39	0.58	0.34
CS		1.00	0.62	0.70	0.67
CAA			1.00	0.83	0.77
CCAAA				1.00	0.84
COWAA					1.00

pretations from previous studies (Raskin and Cochran 1986a).

Results

In general, the two detrending approaches yielded similar stochastic dominance results. The efficient set under first-degree stochastic dominance included the continuous corn (C), CAA, and CCAAA rotations. The efficient set under second-degree stochastic dominance included only the CCAAA rotation in the case of separate price and yield detrending, and both the CAA and CCAAA rotations in the case of gross revenue detrending. Preference rankings under generalized stochastic dominance are shown in table 6 for the case of separate yield and price detrending, and in table 7 for the case of gross revenue detrending.

The continuous corn rotation (C) ranked first in risk-preferring intervals characterized by Pratt-Arrow coefficients as high as −0.000011. The continuous corn rotation dropped rapidly in the rankings as risk aversion increased, suggesting that a rough knowledge of risk preferences may be of considerable importance in identifying a preferred rotation. The magnitude of this importance can be quantified in terms of estimated willingness-to-pay. Relative to a given rotation, willingness-to-pay for another rotation can be estimated by iteratively shifting the rotation's cumulative distribution of returns until neither rotation dominates. Willingness-to-pay for the CCAAA rotation over the continuous corn rotation was estimated as −$54 per acre at a risk aversion coefficient of −0.0001, $13 per acre given risk neutrality, and $56 per acre at a risk aversion coefficient of 0.0001.

Table 6. Preference Rankings of Crop Rotations with and without Government Program Participation

	Absolute Risk Aversion Coefficient					
Lower	−.005000	−.000022	−.000021	−.000013	−.000011	−.000010
Upper	−.000023	−.000022	−.000014	−.000012	−.000011	−.000007
	Ranking					
C	1	1	2	4	4	4
C-G	2	2	1	1	2	3
CS	7	7	7	7	8	8
CS-G	8	8	8	8	7	7
CAA	5	5	5	5	5	5
CAA-G	6	6	6	6	6	6
CCAAA	3	4	4	3	3	2
CCAAA-G	4	3	3	2	1	1
COWAA	10	10	10	10	10	10
COWAA-G	9	9	9	9	9	9
	Absolute Risk Aversion Coefficient					
Lower	−.000006	−.000001	0	.000065	.000075	.000094
Upper	−.000002	−.000001	.000064	.000074	.000093	.005000
	Ranking					
C	6	6	6	7	8	9
C-G	5	5	5	5	5	5
CS	8	8	8	8	7	7
CS-G	7	7	7	6	6	6
CAA	3	3	4	4	4	4
CAA-G	4	4	3	3	3	3
CCAAA	2	2	2	2	2	2
CCAAA-G	1	1	1	1	1	1
COWAA	10	10	10	10	10	10
COWAA-G	9	9	9	9	9	8

Table 7. Preference Rankings of Crop Rotations Incorporating Price-Yield Interactions

	Absolute Risk Aversion Coefficient				
Lower	−.005000	−.000081	−.000010	−.000006	.000098
Upper	−.000082	−.000011	−.000007	.000097	.005000
	Ranking				
C	1	1	2	3	3
CS	4	4	4	4	5
CAA	2	3	3	2	2
CCAAA	3	2	1	1	1
COWAA	5	5	5	5	4

The CCAAA rotation dominated for risk aversion coefficients greater than −0.00001, which are expected to encompass the majority of farmers' risk preferences. The CS rotation ranked low in all intervals. Rotations incorporating government programs ranked higher than their counterparts without participation for all risk averse and approximately risk neutral intervals. Table 8 shows estimated willingness-to-pay per acre for participation in government commodity programs under the 1990 Farm Bill at selected levels of risk preference. As expected, willingness-to-pay increased for all rotations as risk aversion increased. Continuous corn had the widest range in willingness-to-pay, ranging from a low of $4.31 per acre at a risk aversion coefficient of −0.00001 to a high of $23.67 per acre at a risk aversion coefficient of 0.0001.

In general, the selection of a crop rotation appeared to have more impact on net revenues than the decision to participate in the now-defunct government commodity programs. For example, at a risk aversion coefficient of 0.0001, estimated willingness-to-pay for rotation C with government programs versus without government programs was $24 per acre, while estimated willingness-to-pay for the CCAAA rotation versus rotation C was $56 per acre. Interpretation of table 8 should be made with the recognition that it does not reflect the possible incorporation of other risk management alternatives (e.g., crop insurance or futures markets).

Table 8. Estimated Willingness-to-Pay for Government Commodity Programs ($/Acre)

	Absolute Risk Aversion Coefficient			
	−.00001	0	.00001	.0001
C	$4.31	$7.72	$11.08	$23.67
CS	$0.18	$1.52	$2.45	$6.22
CAA	−$0.30	$0.00	$0.25	$3.27
CCAAA	$0.78	$1.29	$1.68	$2.95
COWAA	$8.73	$8.82	$8.98	$10.39

While data obtained from experimental plots promise greater reliability, internal validity, and cost savings compared with actual farm data, questions of external validity might still be raised. Average corn, alfalfa, and oats yields from the crop rotation study exceeded Pennsylvania average yields by a wide margin (Pennsylvania Agricultural Statistics Service 1993). Also, when a crop failure occurred on a small experimental plot, it was difficult to identify how yield would have responded over a large field.

Summary and Conclusions

This study used 1969–89 yield data from a long-term crop rotation experiment conducted in central Pennsylvania to analyze the effects of risk preferences on crop rotation decisions. Net revenue distributions for a 400-acre cash crop farm were developed for each of the five crop rotations studied, with and without participation in government commodity programs under the 1990 Farm Bill. Both yield risk and output price risk were introduced.

The resulting net revenue distributions were subjected to generalized stochastic dominance analysis. Breakeven risk aversion coefficients, which defined risk preference intervals characterized by unique, complete preference rankings, were determined. Continuous corn dominated over most of the risk-preferring range, and a two-year corn, three-year alfalfa rotation (CCAAA) dominated over intervals with risk aversion coefficients greater than −.00001.

In this particular application the expected profit-maximizing rotation dominated over a wide range of risk preferences. Zacharias and Grube (1984) obtained a similar result. For prescriptive purposes, it is convenient that the optimal solution under risk neutrality was fairly robust. Caution is advised in anticipating such a relationship a priori, however. As Raskin and Cochran (1986a) illustrated, decision makers with apparently similar risk aversion coefficients of 0.0002 and 0.0003 would differ in the valuation of their 50,001st dollar by a factor of 160.

Participation in government programs was preferred for all rotations in the approximately risk neutral and risk averse intervals, but was generally not preferred in strongly risk-preferring intervals. Estimated willingness-to-pay for participation in government commodity programs ranged from –$0.30 to $23.67 per acre over the selected range of risk preferences. For most levels of risk preference, crop rotation selection appeared to have more impact than the decision to participate in the now-obsolete government commodity programs.

During the period 1990–92, harvested field crop acreage in Pennsylvania averaged 940,000 acres in corn for grain, 797,000 acres in alfalfa hay, 287,000 acres in soybeans, 190,000 acres in winter wheat, and 218,000 acres in oats (Pennsylvania Agricultural Statistics Service 1993). The stochastic dominance results are roughly consistent with these values, providing a degree of confidence in the use of experimental yield data, stochastic dominance analysis, and the simplifying assumption of a cash crop farm. The existence of unidentified optimal portfolios of rotations, variation in net revenue relationships, and divergence between cash values and feed values may partially explain the relatively high acreage in corn and the substantial acreage in soybeans, oats, and wheat.

The data set used in this study provided a rare opportunity to study the economic effects of cropping systems. It covered a substantially longer period than most agronomic studies, and it allowed consideration of rotational yield effects. The location of the study helps fill a need for site-specific risk management research on Northeastern crop rotations.

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