Evaluating Risk Management Alternatives for Indiana Crop Producers

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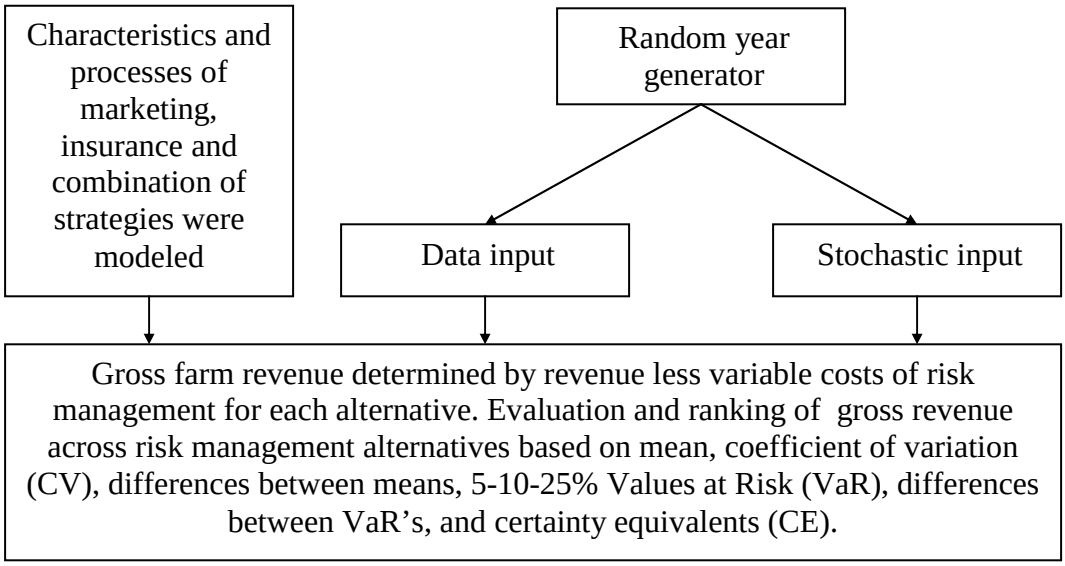
Agricultural producers face an ever-changing landscape of prices, yields, and government policies. A broad variety of risk management strategies exist which may reduce the risks associated with farming. A number of studies have determined the benefits, costs, and possible consequences associated with the implementation of a particular strategy or combination of strategies in different geographic locations and time periods. Some of these studies have reached conflicting conclusions due in part to differences in the risk environments analyzed (e.g., Clow and Flaskerud; Coble and Knight; Collins; Nydene; and Philpot and Stokes). Recently, the types of crop insurance available have expanded, premium subsidies have increased, and the 2002 Farm Bill may have affected the risk management environment faced by producers (Eidman). Given the changes which have occurred with respect to government farm policy and risk management tools, it is not fully understood how risk management strategies may affect the level and variability of net farm revenue. This study evaluates some risk management alternatives under current conditions in three areas of Indiana to develop guidelines for corn and soybean producers.

Methodology

A non-parametric simulation model (Richardson) using @Risk software (Palisade Corporation) evaluated the effect of several risk management strategies on net farm revenue for corn and soybean producers in Indiana. An overview of the model is presented in Figure 1. The analysis considered a 1,500 acre farm with 50/50 corn and soybean rotation in three geographical areas. Three counties were chosen to represent areas with differing levels of yields, yield variability, yield/price correlation or natural

hedge, and proximity to demand centers. Carroll County, in Central Indiana, was chosen to represent the typical high yield region with average variability and access to processing centers. Elkhart County, in Northern Indiana, represented an area with relatively low corn yields with low variability, average soybean yields with low variability, and limited local markets. Posey County, near the Ohio River in Southwest Indiana, is an area with average corn yields with high variability, low soybean yields with high variability, and greater access to international markets.

Figure 1: Model Flowchart



Mechanical marketing strategies, crop yield and crop revenue insurance, and combinations of marketing strategies and crop insurance were risk management strategies considered. Mechanical marketing strategies involving cash sale at harvest, cash forward contracts, hedging with futures contracts, and hedging with option contracts were evaluated in this study. Marketing contracts were implemented at 33%, 66%, and 100% of the estimated ten year moving average APH yields. Alternative crop and revenue

insurances were analyzed at different coverage levels and price elections. Combinations of marketing strategies and crop insurance coverage were analyzed to determine whether it would be less expensive and/or more effective to combine strategies rather than using the crop revenue insurance packages now offered.

Due to data availability, the years considered in the analysis were from 1986 to 2001 for Carroll and Elkhart Counties and from 1987 to 2001 for Posey County. Cash prices for Posey County soybeans in 1987 were unavailable and were estimated using the average relationship of Carroll County soybean cash prices to Posey County soybean cash prices from 1988 to 2001. Wednesday corn and soybean cash prices were gathered from central, northern, and southern Indiana elevators (Hurt, Cabrini de Colonna).

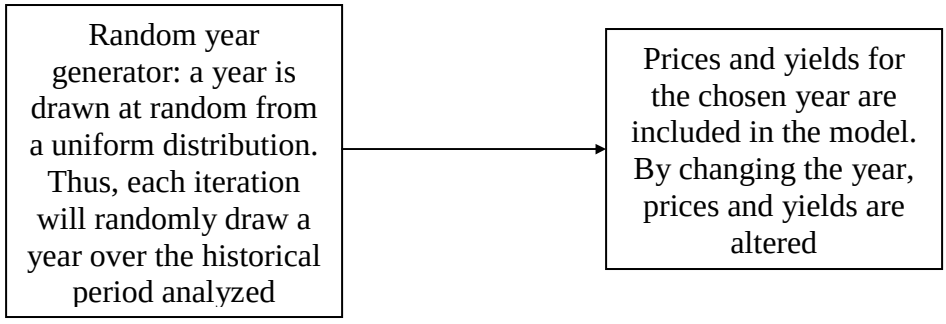
Chicago Board of Trade (CBOT) December corn and November soybean futures and options prices for Wednesdays were also used in the analysis. The study considered prices for futures contracts at three points in time: early spring (March 15), late spring (June 1), and harvest time (November 1 for corn, and October 1 for soybean). Additionally, early spring (March 15) and harvest time (November 1 for corn, and October 1 for soybean) option premiums were incorporated. A complete turn futures transaction cost was $100, which represents $50 per half turn. Options transaction costs were equal to futures transaction costs with the difference that the entire commission was paid upfront. Commissions were assumed to be paid regardless the option contract was exercised or not. For trading purposes, a non-interest bearing margin deposit of 7.5% was required. In order to capture the opportunity cost associated with entering into the transaction, a 7% interest cost was assumed in the model for the period of the futures or options contracts were held.

The springtime forward price for harvest delivery for both corn and soybean were assumed to be $0.20 under the December corn and November soybean CBOT futures contract, respectively, at the time the contract was implemented (Collins).

Marketing average prices and county level yields were gathered from the National Agricultural Statistics Service (NASS). Farm level corn yields were collected from an APH database from the Risk Management Agency (RMA).

The historical year generator and farm level yields for corn and soybeans, which are generated by a boot strapping procedure (Gray), were stochastic variables in this model (Figures 2 and 3). Prices and yields from the randomly drawn historical year are input into the model and used to calculate the net farm revenue under each of the risk management alternatives. However, because the prices and yields are historical data, the variability in the results generated by using these raw data may be over estimated due to trends in yields and prices, and to cyclical patterns of prices that may exist.

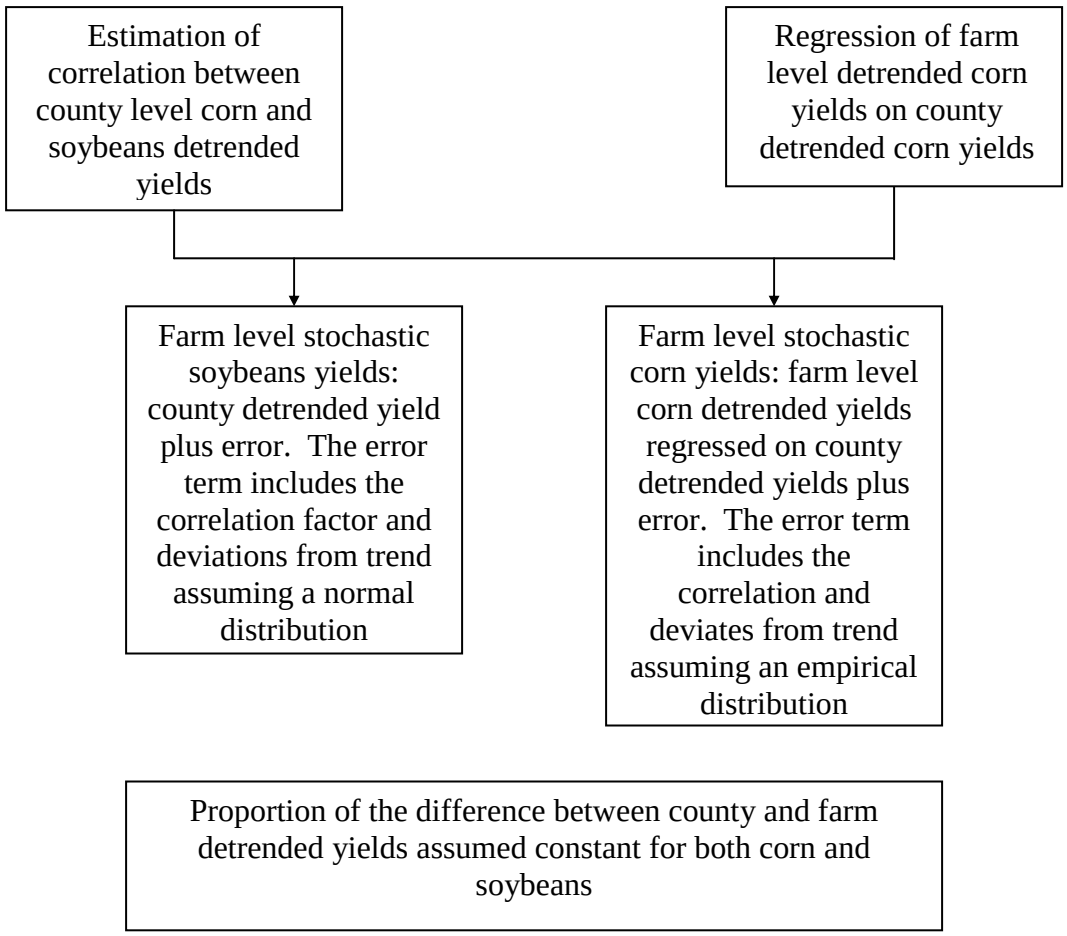
Figure 2: Random Process Flowchart



Detrending the data or employing an Autoregressive Moving-Average (ARMA) process are procedures that can be used to remove trends and cycles from historical prices and yields. These methods allow for prices to be measured in current dollars and yields to be measured in terms of today's technology. By using the transformed prices and

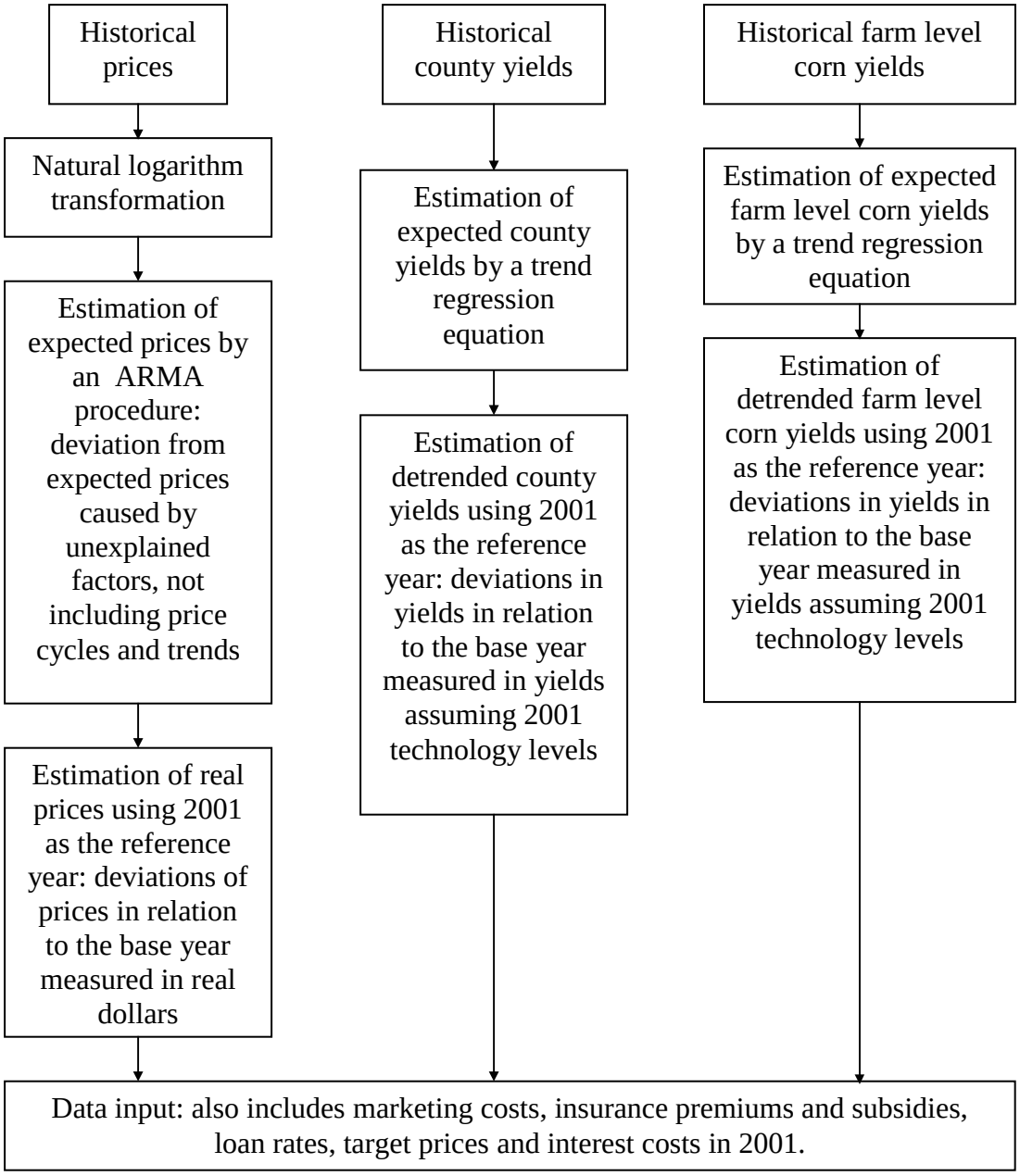
yields, the variability of the distribution of net farm revenue used to determine the effectiveness of alternative risk management strategies will not be overestimated. Because prices are positive dollar amounts, the natural logarithm of historical prices was incorporated in an ARMA procedure where the expected prices were estimated while maintaining the cycles and behaviors of prices. Expected yields were calculated by a trend equation of the historical data. In order to eliminate the systematic pattern of prices and yields, time series were adjusted by an index using 2001 as the base period. Although specific conditions of 2001 are not simulated, the 1,000 iterations used reflect prices measured in real dollars and yields assuming 2001 technology levels (Figure 3).

Figure 3: Stochastic Input Flowchart



The flow of data into the model is summarized in Figure 4.

Figure 4: Data Input Flowchart



All of the available crop yield and crop revenue insurance products were included in the analysis. These included the individual farm-based Actual Production History (AHP) and the county-based Group Risk Plan (GRP) types of yield insurance. Crop

Revenue Coverage (CRC), Income Protection Plan (IP), Revenue Assurance (RA) with both the base and harvest price options, and Group Risk Income Plan (GRIP) were also included. In all cases, the premium rates and coverage levels reflected those available in 2002. It was assumed that all of the corn and soybeans would each be treated as a unit for insurance purposes. For a further discussion of insurance product specifics, see Collins or www.farmdoc.uiuc.edu/cropins.

The model did not explicitly consider costs of production and direct government payments in the calculation of net farm revenue under the assumption that these payments were constant across strategies. Therefore, net farm revenue was determined by gross revenue less variable costs of risk management for each strategy. Revenue was based on farm level production and harvest prices, gains or losses from marketing strategies, insurance indemnity payments. In order to reflect the current farm legislation, farm revenue also included any LDP and CCP payments for corn and soybeans under the 2002-2003 loan rates and target prices, respectively. The marketing contract commission fees, interest costs on futures and options margin accounts, and insurance administrative fees and premiums were considered as variable costs of risk management.

Results

A total of 74 risk management strategies were considered in this analysis for each of the three counties. Comparisons were made to a benchmark strategy of no insurance with cash sale at harvest as well as other management strategies. Net farm revenue across strategies were ranked using mean, coefficient of variation (CV), differences between means, 5-10-25% Values at Risk (VaR), differences between VaR's, and certainty equivalents (CE's). Appropriate statistical tests were performed at the 5%

significance level. CE's were determined using the power utility function that assumes constant relative risk aversion and decreasing absolute risk aversion (Richardson et al.). Initially, the marketing strategies, crop insurance, and crop revenue strategies were analyzed independently and these results are discussed briefly. Discussion in this paper emphasizes the strategies with the highest CE's in each of the counties.

Results indicate that mechanical marketing strategies tend to provide significantly higher net farm revenue than the cash sale at harvest in all three counties. However, cash forward contracts established on June 1 in Carroll and Posey Counties had lower returns than the benchmark strategy. Higher levels of hedging and forward contracting resulted in higher mean returns for Carroll and Elkhart Counties. Most of the crop yield insurance (APH and GRP) strategies resulted in significantly lower net farm revenue than the benchmark strategy in all three counties. Yield insurance resulted in higher 5% and10% VaR values for Elkhart County, but lower values for Posey County. In contrast to yield insurance, crop revenue insurances (CRC, RA, IP and GRIP) often had mean returns that exceeded the benchmark strategy. Furthermore, the higher levels of coverage of CRC and RA-BP typically also provided higher 5% and 10% VaRs than the no insurance, cash sale at harvest strategy. GRIP in Carroll and Posey Counties generally had mean returns and 5% and 10% VaR values which exceeded the benchmark strategy, while this was not the case in Elkhart County. For a more in-depth analysis of these strategies, see Rios.

Certainty Equivalents Results - Carroll County

The benchmark strategy of no insurance with cash sale at harvest resulted in CE's which ranged between $352 per acre for a risk neutral individual to $316 per acre for a

highly risk averse individual. Marketing strategies involving futures contracts alone or futures contracts in combination with APH or GRP insurance provided the highest CE's at all risk aversion levels in Carroll County (Table 1). Hedging using futures contract positions established in March for 100% of expected production resulted in the highest CE for risk neutral to moderately risk averse individuals. This represented an increase in CE of about $40 per acre relative to the benchmark strategy. At the higher risk aversion levels, the highest CE values were associated with futures contracts for 66% of the expected production level were combined with APH at 85% coverage level.

Table 1: Carroll County Top Risk Management Strategies Ranked by Certainty Equivalents ($/acre).

Strategy /CE	Relative Risk Aversion Coefficient					
Rank	0	1	2	3	4	5
1	Futures (M15) 100% 392.47	Futures (M15) 100% 385.14	Futures (M15) 100% 377.12	Futures (M15) 100% 368.17	APH (100%PE) 85% Futures (M15) 66% 363.27	APH (100%PE) 85% Futures (M15) 66% 359.71
2	GRP (70%MP) 90% Futures (M15) 66% 382.87	GRP (70%MP) 90% Futures (M15) 66% 377.36	GRP (70%MP) 90% Futures (M15) 66% 371.58	APH (100%PE) 85% Futures (M15) 66% 366.95	APH (100%PE) 75% Futures (M15) 66% 360.46	APH (100%PE) 75% Futures (M15) 66% 355.83
3	GRP (70%MP) 80% Futures (M15) 66% 381.22	GRP (70%MP) 80% Futures (M15) 66% 375.40	APH (100%PE) 85% Futures (M15) 66% 370.77	GRP (70%MP) 90% Futures (M15) 66% 365.48	APH (100%PE) 85%C Futures (M15) 66% 359.10	APH (100%PE) 85%C Futures (M15) 66% 354.34

The second and third highest CE's were associated with GRP and hedging with futures for the risk neutral and slightly risk averse individuals, and the CE's were about $10 per acre below the top-rated strategies. In general, there tended to be a shift away from the county-based GRP insurance toward the individual farm-based APH insurance as the level of risk aversion increased.

Although not shown in Table 1, differences in CE's between the top and fifth ranked crop yield insurance strategies tended to be about $5 per acre with some tendency toward an increase as risk aversion increased. In contrast, differences in CE's values between crop revenue insurance strategies tended to be larger for the risk neutral individuals than for the more risk averse individuals.

Certainty Equivalents - Elkhart County

CE's for the no insurance, cash sale at harvest strategy ranged from $281 per acre for the risk neutral individual to $233 per acre for the highly risk averse individual, reflecting the lower levels of yields and prices in Elkhart County. However, similar to Carroll County, futures contracts alone or in combination with a yield insurance product resulted in the highest CE's among the risk management strategies evaluated in Elkhart County (Table 2). Hedging 100% of expected production using futures positions implemented on March 15 had the highest CE's for risk neutral to somewhat risk averse producers. At higher risk aversion levels, combinations of APH insurance with futures contracts at 66% level of expected production established in March provided the highest CE's.

Table 2: Elkhart County Top Risk Management Strategies Ranked by Certainty Equivalents ($/acre).

Strategy /CE	Relative Risk Aversion Coefficient					
Rank	0	1	2	3	4	5
1	Futures (M15) 100% 311.70	Futures (M15) 100% 302.74	Futures (M15) 100% 292.52	APH (100%PE) 85% Futures (M15) 66% 285.82	APH (100%PE) 85% Futures (M15) 66% 281.49	APH (100%PE) 85% Futures (M15) 66% 277.36
2	Forward (M15) 100% 304.42	APH (100%PE) 75% Futures (M15) 66% 296.72	APH (100%PE) 75% Futures (M15) 66% 290.96	APH (100%PE) 75% Futures (M15) 66% 285.28	APH (100%PE) 75% Futures (M15) 66% 279.72	APH (100%PE) 75% Futures (M15) 66% 274.35
3	APH (100%PE) 75% Futures (M15) 66% 302.49	APH (100%PE) 75%C Futures (M15) 66% 295.52	APH (100%PE) 85% Futures (M15) 66% 290.33	APH (100%PE) 85%C Futures (M15) 66% 282.21	APH (100%PE) 85%C Futures (M15) 66% 275.77	RA-BP 75% 271.77

APH at the 75% and 85% coverage levels were the highest ranked crop yield insurance strategies in terms of CE's. In contrast to Carroll County, in Elkhart County the GRIP products were not included in the top five revenue insurance strategies in terms of CE's. RA-BP at 75% coverage level produced the highest CE's among the revenue insurance alternatives considered for the slightly to the extremely risk averse producers.

Certainty Equivalents - Posey County

CE's for the benchmark strategy ranged from $274 per acre for a risk neutral individual to $255 per acre for a highly risk averse individual, a narrower range than in the other counties. Futures hedges initiated on March 15 at 100% of the expected

production level provided the highest CE's of the risk management alternatives evaluated for most risk aversion levels in Posey County (Table 3). The exception was for a risk neutral individual where a put option strategy for 100% of expected production implemented on March 15 was the top ranked strategy. GRP insurance combined with futures contracts were among the top three ranked alternatives in terms of CE's, and the rank of this strategy increased at higher risk aversion levels. There was about a $10 per acre difference in the CE's between the top and third ranked alternatives.

Table 3: Posey County Top Risk Management Strategies Ranked by Certainty Equivalents ($/acre).

Strategy /CE	Relative Risk Aversion Coefficient					
Rank	0	1	2	3	4	5
1	Put (M15) 100% 312.16	Futures (M15) 100% 304.32	Futures (M15) 100% 299.34	Futures (M15) 100% 294.45	Futures (M15) 100% 289.69	Futures (M15) 100% 285.05
2	Futures (M15) 100% 309.39	Put (M15) 100% 302.24	GRP (70%MP) 90% Futures (M15) 66% 290.84	GRP (70%MP) 90% Futures (M15) 66% 286.81	GRP (70%MP) 90% Futures (M15) 66% 282.88	GRP (70%MP) 90% Futures (M15) 66% 279.07
3	GRP (70%MP) 90% Put (M15) 66% 302.72	GRP (70%MP) 90% Futures (M15) 66% 294.99	Futures (M15) 66% 288.89	Futures (M15) 66% 284.32	Futures (M15) 66% 279.88	Futures (M15) 66% 275.57

Similar to the results for Carroll County, in Posey County, GRIP resulted in the highest CE's among the revenue insurance strategies evaluated. Although not indicated in Table 3, in Posey County, CAT insurance was one of the highest ranked yield

insurance strategies in terms of CE's. CAT coverage did not appear among the strategies with higher CE's in either Carroll or Elkhart County.

Conclusions

There are many risk management strategies that have higher CE's than the benchmark strategy of no insurance with cash sale at harvest in all three counties. Furthermore, the magnitude of the potential increase, about $40 per acre, is similar for all of the levels of relative risk aversion analyzed. Although not emphasized in this discussion, there are some strategies, such as forward contracting in June, in Carroll and Posey Counties which reduce net returns. Crop yield insurance, when not used with other risk management strategies, also generally reduces net farm revenue. Although crop revenue insurances generally increase net farm revenue relative to the benchmark strategy, their CE's are lower than the CE's of combinations of crop yield insurance and marketing strategies. Implementing a risk management strategy involving both yield insurance and a marketing position is likely to require a larger management input than purchasing revenue insurance, but does have additional returns for producers.

In all three of the counties analyzed, futures hedges established in March alone or in combination with a yield insurance product provided the highest CE's among the risk management strategies evaluated for the 1986 to 2001 period. Results also indicated that establishment of positions in March provided higher returns and CE's than positions established in June. Hedging 100% of expected production generally also provided higher CE's than hedging lower percentages of expected production. These results provide support for the Wisner et al. hypothesis of pre-harvest marketing of grains increasing returns for producers. However, the time period analyzed included a number

of years following short crop years and may not be inconsistent with the efficient market hypothesis (Brorsen; Zulauf and Irwin). Collins found that restricting analysis to years not following short crop years substantially reduced the returns associated with early marketing of corn and soybeans. Additional research could consider the effects of the prior crop year on risk management strategies.

In Carroll and Elkhart Counties, there tended to be a shift away from futures contracts alone toward APH insurance in combination with futures hedges as risk aversion increased. In Carroll County, there was also a shift from the county-based GRP coverage to individual farm-based APH insurance coverage as the level of risk aversion increased. Both of these tendencies were also observed in the more detailed analysis of the strategies which was not presented in this paper. Risk management strategies do change with the level of risk aversion of a producer.

Differences in the effectiveness of risk management alternatives among geographical areas in Indiana may be produced by differences in commodity prices, farm level yields, county yields, yield variability, and/or insurance premiums. Low variability of cash and strike prices, low options premiums, high strike prices, low farm level yield variability are factors that can explain why the CE's of marketing alternatives were dominant in Posey County. In contrast to the other counties, the CE's of GRP insurance strategies were high in Posey County. A possible explanation may be that the per bushel premiums of farm-based insurance coverages in Posey County were nearly double those of Carroll and Elkhart Counties, while GRP premiums were only about 10% higher in Posey County.

This study determined that effectiveness of risk management strategies do differ among geographical areas in Indiana. However, futures positions established in March dominated the risk management alternatives in terms of CE in all three counties. Farm-based insurance products were beneficial at higher risk aversion levels in Carroll and Elkhart Counties, while GRP was effective in Posey County. The variability of farm yields and the correlation between farm and county yields are critical in the evaluation of alternative insurance products and risk management strategies. Further research should improve modeling of farm level yields and should include a broader array of production areas. Finally, development of risk management guidelines appears sensitive to both geographical location and a producer's level of risk aversion.

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