

**Risk and Profits Insurance and Pricing Strategies for Grain
Producers in Selected Regions of the U.S., A Series of Case Studies**

by

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ABSTRACT

Pre-harvest corn and soybean options-based pricing strategies, and crop yield and revenue insurance were applied to model farms in three states. These combinations reduced income variability while increasing net incomes relative to uninsured harvest cash sales. Adding crop insurances to pre-harvest pricing reduced net incomes from those with pre-harvest pricing alone, but produced larger incomes than uninsured harvest sales. The Ohio model farm was modified to reflect (1) a debt-free operation, (2) a cash renter, and (3) a buyer-renter operation. No strategy was able to cover opportunity costs on investments for types (1) and (3). For farm type (3), mean net cash-flow returns were negative for harvest cash sales, but positive when pre-harvest pricing was added with and without insurance.

Integrated Production and Price Risk Management: Impacts on Level and Variability of Corn and Soybean Producers' Net Returns

Producer Dilemma

Analysis of harvest-delivery corn and soybean futures contracts reveals that over the 22-years ending in 1996-97, planting-time to early summer prices have exceeded harvest prices in approximately two-thirds and three fourths of the years, respectively. Pre-harvest prices for harvest-delivery new-crop corn futures often exceed harvest prices by 25 to 30 cents per bushel or more (Wisner, Blue, and Baldwin, RAE, 1998). *For a modestly leveraged cash grain farm relying largely on cash rented and/or recently purchased land, these price advantages over harvest sales are large, often equaling or exceeding the average net margin available through harvest cash sales.* This pattern gives producers incentive to take advantage of pre-harvest pricing opportunities that meet their financial needs.

However, where a high price/yield correlation exists, producers who price before harvest with fixed-price commitments may have greater exposure to production risk than with harvest sales. *Increased risk occurs because short hedges work effectively as a risk-management tool only when value changes in the short futures position are offset by approximately equal and opposite value changes in the long cash position, i.e., the grain being produced.* Equal and opposite positions are not present when low yields create a smaller physical commodity position than exists in the futures market. When minimum prices are established with options purchases, the problem is much less serious

The pre-harvest pricing objective for this type of producer is different than in much of the risk-management literature. It is not to minimize or reduce variance of gross returns over a period of years. Nor is it necessarily focused on generating a higher net price than harvest cash

sales. *It is to protect favorable net returns that are offered at a point in time and to meet cash flow needs of the farm business. Management of production risk and/or avoiding exposure to futures losses that are not offset by cash market gains are key factors in making it work effectively.*

Researchers often have dealt with the two-dimensional price/yield risk problem by using optimal hedge ratios to price a variance-minimizing percent of the crop. (Grant (1989), Plato (1989), Lapan and Moschini (1991), and Lence (1993)). If the hedging objective is solely to minimize variance of gross income, this approach is satisfactory. However, for many producers, optimal hedge ratios neglect the extremely critical risk-management problem noted above. *The crop insurance needed for maximum effectiveness in managing production risk with pre-harvest pricing would be a type valuing lost production at its replacement cost.* To meet this need, Crop Revenue Coverage (CRC) insurance containing market replacement coverage linked to futures prices was introduced in 1996.¹

Objectives and Hypotheses Tested

This paper compares historical net returns over costs and cash flow obligations from combinations of pre-harvest sales and insurance products to those from the naïve harvest cash sales on four simulated farms. The model farms were located in northern Iowa, Kansas, and Ohio. The hypotheses tested were that (1) from 1985 to 1997, selected types of insurance when combined with pre-harvest pricing strategies would have increased net returns without increasing variance of net income, as compared with the naïve strategy, and (2) as compared with those from uninsured pre-harvest pricing. It was anticipated that these hypotheses would be true only for CRC insurance.

A sub-objective was to up-date a set of pre-harvest pricing strategies reported by Wisner, Blue, and Baldwin (1997 and 1998), by (1) adding one additional year to the analysis and (2) adding Kansas locations. It was hypothesized that with these changes, net returns over total and variable cost would continue to significantly exceed those from the naive strategy, with no increase in the coefficient of variation relative to the naive strategy. A second sub-objective was to see how differences in farm financial structures would alter outcomes and the pre-harvest marketing/insurance risk choices. This second-phase analysis was conducted for three variations of the Ohio model farm: (1) an owner-operator, (2) a recent-buyer/cash renter, and (3) a cash renter.

Related Work

For a comprehensive review of relevant literature on pre-harvest pricing with futures and options, see Wisner, Blue, and Baldwin (1997 and 1998), and Zulauf and Irwin, (1997 and 1998). These papers discuss issues and previous work in market efficiency and risk premiums that pertain to pre-harvest pricing. Wisner, Blue, and Baldwin reported results from an empirical study covering 1985-1996 in which several pre-harvest marketing strategies out-performed naive harvest cash sales, in mean net income and in the coefficient of variation of net income for 1,000 acre model corn/soybean farms in Ohio and Iowa. The Wisner, et. al., study made extensive use of planting-time corn put option purchases and synthetic puts for soybeans, in years for which the previous U.S. crop did not fall below total utilization in year $t-1$. When the previous year's U.S. production was a weather-induced short crop that fell below $t-1$ utilization (i., e., induced by low yields, not government programs alone), pricing was done with hedges in late February prior to harvest using the December corn and November soybean futures prices. This work was later modified by adding call options purchases in February in years following short crops, to retain

upward price flexibility in event that two consecutive short crops would occur. This modification produced very little change in results, and the hypothesis of increased income with little or no increase in variance and CV was still accepted (Wisner, Blue, and Baldwin, 1998). The authors concluded that possible explanations for positive results from pre-harvest marketing that are contrary to those expected from the efficient market hypothesis are: (1) that a time lag is involved before the market incorporates all available information into prices, due to the costs and time required to develop the information, (2) pronounced seasonal patterns in volatility of new-crop corn and soybean futures may affect options values and hence create these results, and/or (3) global grain producers may respond to pre-planting prices by shifting resources among crops.

Since crop insurance coverage with market replacement value features is a relatively new product, little research has been done on its complementarity with pre-harvest pricing. Wisner in 1995 found that for northern Iowa locations, net returns for corn and soybean production on model farms using pre-harvest pricing (primarily with options, with a post short-crop hedging strategy) were significantly increased from harvest cash marketings over the 1979-95 period, but were less than net returns from pre-harvest pricing without insurance. Options premiums for the 1979-94 period (prior to the introduction of actual options trading) were estimated using the Black model, and actual options premiums were used for the rest of the study period. For some high yield risk farms in southern Iowa, results showed greater net returns from the pricing plus insurance strategies than for (1) the harvest cash marketings and (2) the pre-harvest pricing with no insurance. Insurance programs used by Wisner included multi-peril and multi-peril plus a market replacement value add-on feature. Addition of crop insurance prevented the extremely large negative net cash flow that otherwise occurred for the southern Iowa model farms in the severe drought years of 1980, 1983, and 1988, as well as the in the extreme flood year, 1993.

Smith and Baquet examined the demand for multiple peril crop insurance for Montana wheat farmers to explore the low participation rate and large loss ratios that have occurred since 1980. Producers were sampled to determine who bought insurance, the percent coverage selected, and significant variables influencing these choices. Age, experience, farm size, marketing choices, off-farm income, and credit situations were not statistically significant variables, although the farmers' subjective judgment of yield variability was significant.

Miranda and Glauber examined crop insurance programs in terms of reinsurance and systemic risks. They saw a risk that private programs could fail because weather conditions affect farm yields across large areas and could defeating insurers' efforts to pool risks across farms. Heifner and Coble (1997) tested combinations of futures and options hedges with 75 percent crop insurance coverage for corn in DeWitt county, Illinois. They found that crop insurance and forward pricing together were much more effective in reducing risks than was true for either tool used separately. Their research indicated that without forward pricing, revenue insurances offers slightly greater risk reduction than yield insurance. Measures of risk in their work included the standard deviation, the root mean squared negative deviation, probabilities of revenue less than 60, 70, and 80% of the expected value of gross income, as well as other measures using a joint normal distribution of income based on yields and prices. With forward pricing, Heifner and Coble found smaller differences in risk reduction between yield and revenue insurances than without forward pricing. Insurances analyzed included MPCI, Market Value Protection, Revenue Assurance, and Crop Revenue Coverage. Details on timing of hedge and options trades, and options strike prices were not given.

CROP INSURANCE ALTERNATIVES

At least seven types of crop insurance are available in the U.S (Iowa State University, 1997). Rate structures vary, depending on whether individual units such as fields are insured, or whether the insurance is for the specific crop enterprise (in this case, corn or soybeans) over all fields and farms operated by the producer. Some types are available throughout the producing area. Others are limited to only a few states. Two types of insurance were analyzed here: Average Production History (traditionally called multi-peril and labeled here as MPCCI), and Crop Revenue Coverage (CRC). Both are widely available geographically. MPCCI insures yield per acre, using the farmer's actual yield history for the past three to 10 years. The producer has a choice of percentages of the historical yield to select for risk protection, ranging from 55 percent to 75 percent in five percent increments. If no farm yield history is available, an alternative history is substituted by the insurance company.

Premiums and coverage percent: Since the government subsidy does not apply to additional costs from going above the 65 percent insured level, insurance premiums generally increase sharply as one moves to 70 and 75 percent levels of coverage. Thus, most farmers select no more than 65 percent protection. For analytical purposes, the authors selected 65 percent insurance coverage for both MPCCI and CRC. Individual units were used to determine the insurance premium rates, although enterprise rates would have been lower in cost. The 1998 insurance premiums structures and subsidies were assumed to have existed over the entire study period. CRC costs and levels of insurance protection varied from year to year with the level of February average futures prices. For details on the insurance equations used in this analysis, see Wisner, et. al. (1998).

Government payments excluded: Income from marketing and crop insurance choices is independent of government payments. For simplicity, all government deficiency, storage, disaster, and payment in kind payments were excluded. Thus, net returns estimated here likely understate actual net returns.

Simulation Model

The marketing decision rules used were the top-performing ones tested in 1997 and 1998 (See Wisner, et. al., 1997, and 1998). The crops were hedged in harvest-delivery futures contracts in the fourth week in February after short crop years. In other years, 20 percent of 10-year average production was priced with a short hedge in harvest-delivery futures contracts in the first week of July, at the time of a long-term average seasonal peak in new-crop futures. In years that did not follow short crops, put (for corn) or synthetic put (for soybeans) positions were established for 80 percent of average production the third Thursday of May, the time of a long-term secondary peak in new-crop futures prices. Puts were closed in September, and calls (soybeans) were closed in July.

RESULTS WITH NON-VARYING FARM FINANCIAL CONDITIONS

Over-view of Crop Insurance Results

From the farmers' viewpoint, a major role for crop is to reduce the risk of a severe drop in net income that could occur with extremely low yields. During the study period, MPC and CRC performed this role in a few instances. Insurance benefits were insufficient to maintain a positive net income, but did modestly reduce financial stresses. Indemnity payments occurred for Ohio corn in 1988 and 1993, and for Ohio soybeans in 1981, for both kinds of insurance. A CRC indemnity payment occurred on Kansas corn farms in 1995, but the Iowa farm received no

indemnity payments. For all years, the mean net incomes with both insurances were less than mean net incomes of the naïve strategy (Table 1).

Net Corn Returns With and Without Pre-harvest Pricing

With the additional year of empirical data, results closely resembling those reported by Wisner, Blue, and Baldwin (1997 and 1998). Pre-harvest pricing strategies on model farms in widely dispersed areas continued to show economically and statistically significant positive impacts on net income. Net returns for pre-harvest pricing strategies at all locations, with the May/July 80/20 mixed hedge/put, with post short-crop pricing late February, generated returns that were well above and significantly different from those with harvest cash marketings at probabilities of five percent or less (Table 1). Gains in mean annual net corn income verses the naïve strategy were in the \$10,000 to \$11,000 range.

Pre-harvest Corn Pricing With Crop Insurance

Table 1 shows mean income gains and net corn incomes when pre-harvest pricing with the mixed hedge/put strategy is combined with crop insurance. For MPCl, mean annual net returns were significantly higher than for harvest cash sales only for Ohio, based on t tests at five percent probability, but were less than those from pre-harvest pricing without crop insurance. Over the study period, net returns from with MPCl slightly exceeded those from CRC, because of a lower premium cost. With greater yield extremes, CRC might have outperformed MPCl. For Iowa and Kansas, adding crop insurance to the naïve strategy increased the CV of net income, as compared with pre-harvest pricing alone. However, CV's for the pre-harvest pricing plus insurance were consistently less than those from the naïve strategy of harvest cash sales, a finding, which is consistent with Heifner and Coble (1997).

For Ohio, with pre-harvest pricing and no insurance, the standard deviation of net income was \$46,640 on a mean annual net income that was \$10,266 greater than for the naïve strategy. By adding MPCl, the standard deviation fell to a still large \$44,676. CRC reduced it to \$44,125. For the naïve strategy, the standard deviation was \$45,304.

Soybean Returns

One extra year of data produced results similar to earlier work. Pre-harvest soybean pricing significantly increased net income, with and without MPCl, at both locations (Table 4). The Kansas farms had no soybeans.

Pre-harvest Soybean Pricing with Crop Insurance

Table 2 shows the soybean returns over variable cost when pre-harvest pricing is combined with crop insurance. In both states, mean annual net returns for MPCl plus pre-harvest pricing were significantly higher than for harvest cash marketings at the five percent level of probability, based on t tests. Over the 1985-97 period, mean annual net returns from MPCl slightly exceeded those from CRC, because of lower premium costs. Net soybean income with pre-harvest pricing and CRC was not significantly different the naïve strategy at the five percent level of probability. The CV's for pre-harvest pricing plus insurance in Iowa were slightly higher than those from the naïve strategy. Ohio's were marginally lower, although it is highly doubtful that the slight reductions in CVs would be a significant factor in farmers' decisions to purchase crop insurance.

Results With Varying Financial Conditions

To analyze risk with varying farm financial structures, net returns from the Ohio model farm were adjusted to reflect (1) total economic and (2) cash-flow costs for three different financial structures. All aspects of the farms were identical except net worth, debt, and land tenure. The three types were (1) a debt-free (owner), (2) a cash renter, and (3) a recent buyer/cash renter. The

recent buyer/renter purchased 500 acres in 1982², and cash rents another 500 acres. In this analysis, the Managing Risks and Profits (MRP) software program was solved annually from 1985 to 1997 for each farm. For more detail on the MRP model, see Baldwin (1998). To show effects of a major crop failure, a 1993 corn yield 15 bushels per acre was used. Yields were near this level twice in the 15 years prior to the study period.

Net Returns Over Total Economic Costs

When opportunity costs for land were included, neither the owner nor buyer/renter could cover total costs (Table 5). While pre-harvest pricing and crop insurance reduced the losses, these tools separately and together could not produce positive returns. For the cash renter, pre-harvest pricing with MPCI returned a mean total annual farm net return of \$61,653 over all economic costs. This combination gave the renter positive net returns for each year except 1987, 1991, and 1993. With harvest cash sales and no insurance, losses occurred only in 1987 and 1993. The 1993 loss was \$171,000. Insurance reduced each net income CV as compared with no insurance. The CVs for pre-harvest pricing and no insurance were less than those from harvest sales.

Net Returns Over Cash Flow

Cash-flow shows a much different view of risk exposure than economic cost analysis. The owner has higher mean annual net cash-flow returns than the other two farms (Table 3). Negative returns occurred for this farm only with the 1993 corn crop failure. Insurance and pre-harvest sales (individually and in combination) increased the mean returns relative to selling at harvest. Despite the 1993 crop failure and a nearly 50 percent crop failure in 1987, the options-based pre-harvest pricing strategies produced mean net returns well above the naïve strategy. The owner's weighted cash flow risk ratio equaled 0.69 and indicates 69% of the crops had to be sold at average harvest cash prices to cover cash flow costs. For the 13-year period, the renter's total net

cash-flow was at least \$770,000, about half as large as the owner's. Lack of a risk-management strategy would have produced a negative net cash flow of more than \$40,000 in 1987 and \$150,000 in 1993, versus a \$100,000 negative result for the owner in 1993. The renter's weighted cash flow risk ratio approached 0.8.

For the study period, the buyer-renter's mean net returns without insurance was less than \$2,000. Using MPCl increased the mean net return to just under \$5,000 for the 13-year period. Total net returns with the latter strategies were only \$5,000 for the 13-year period. His/her risk ratio exceeded 1.2. Without insurance and pre-harvest pricing, this buyer-renter earned on average \$1,798 of net cash flow, and sustained negative net cash-flow returns of \$171,000 in the 1993 crop failure.

CONCLUDING COMMENTS

Over the 1985-97 period, results show that a potential existed for decreasing corn and soybean income variability, while increasing mean net incomes through pricing strategies. This result held true when MPCl was added to soybean pricing strategies, and also to corn in Ohio. The base measurement for comparison was naïve harvest cash sales. Crop insurance products alone over this time period offered limited potential for enhancing risk management as traditionally considered in the literature, i.e. through reduced variability of income relative to harvest sales. The CVs of net returns over variable cost for the four model farms, and with the varying financial structures in the Ohio farm, with both MPCl and CRC plus pre harvest pricing were lower than with crop insurance alone. Significant differences in net returns for pricing plus MPCl vs. the naïve strategy occurred for soybeans in both Iowa and Ohio, but only in Ohio for corn. CRC plus pricing did not generate significantly different net returns than the naïve strategy, as hypothesized. While CRC should insure a long cash position to offset the short futures in

hedging situations in times of severely adverse weather, yields were not variable enough over the study period to make this effect operational.

These findings offer some (but not unanimous) support that crop insurance may have a role in boosting the confidence level for farmers who, because of production risk, are reluctant to price grain before harvest even when prices are well above historical average harvest prices. Over the study period, MPCl was more effective in performing this role than CRC as measured by mean net incomes and *t* values. In areas with greater yield variability, CRC's role may have been more positive. Crop insurance offered protection against the occasional situation of extremely low yields and a large financially destabilizing negative net income. Its performance in this area was in Ohio, where yields were arbitrarily lowered to test their effects on varying financial structures.

Net returns, statistical significance, and variance of returns from pre-harvest marketing strategies produced results similar to those reported in 1997. Gains in mean annual net returns without crop insurance versus harvest cash marketings for 1,000 acre farms (all in corn in Kansas, half soybeans and half corn in Iowa and Ohio) ranged from a low of \$18,941 in Iowa to a high of \$22,076 in the Kansas irrigated farm number 2. While past performance of the pre-harvest pricing strategies was impressive, the authors caution that past results do not guarantee future performance. These results also suggest that opportunities exist for additional empirical work on the behavior of forward pricing tools and options markets.

When the cash flow risk ratio approaches or exceeds 1.0, the producer faces large exposure to cash flow risk. Recent buyers and cash renters often are in this situation. If a crop failure occurs, the financial burden on both types would be severe. The cash flow analysis illustrates that minimizing variance on income is not necessarily an effective risk-management strategy for producers who face high cash-flow risk ratios.

Table 1. Corn Mean Net Return over Variable Cost, Coefficient of Variation of Corn Net Income and t tests with Selected Risk Management Strategies

Risk Strategy	Iowa	Ohio	Kansas Farm 1	Kansas Farm 2
Net Return over Variable Costs				
Uninsured Harvest Cash Sale	\$65,019	\$81,293	\$60,709	\$52,548
Harv. Sale & MPCl	63,053	79,909	58,862	51,261
Harv. Sale & CRC	61,478	78,192	57,633	50,202
Pricing w/o Insurance	75,162	91,599	71,732	63,586
Pricing & MPCl	73,196	90,174	69,885	62,299
Pricing & CRC	71,621	88,458	68,656	61,239
CV of Net Return				
Uninsured Harvest Cash Sales	.594	.557	.740	.856
Harv. Sale & MPCl	.612	.546	.752	.847
Harv. Sale & CRC	.623	.553	.757	.854
Pricing w/o Insurance	.537	.509	.680	.769
Pricing & MPCl	.551	.495	.688	.768
Pricing & CRC	.559	.499	.691	.774
Probability From t tests vs. Uninsured Harvest Sales				
Harv. Sale & MPCl	0	14.59	.02	9.70
Harv. Sale & CRC	0	1.33	.02	3.28
Pricing w/o Insurance	3.52	3.50	5.01	5.44
Pricing & MPCl	8.05	5.21	9.42	9.97
Pricing & CRC	14.82	10.50	14.03	14.36

Table 2. Soybean Mean Net Return Over Variable Costs, CVs and t test Results from Selected Risk Management Strategies with 500 Acres.

Risk Strategy	Iowa	Ohio
Net Return over Variable Costs		
Uninsured Harvest Cash Sales	\$85,970	\$81,161
Harv. Sale & MPCl	84,608	79,580
Harv. Sale & CRC	83,477	77,387
Pricing w/o Insurance	94,768	89,959
Pricing & MPCl	93,406	88,378
Pricing & CRC	92,275	86,184
Probability from t tests vs. Increased Harvest Sales		
Harv. Sale & MPCl	0	0
Harv. Sale & CRC	0	0
Pricing w/o Insurance	1.96	1.96
Pricing & MPCl	4.22	4.71
Pricing & CRC	7.69	15.00
Coefficient of Variation of Net Income Returns		
Uninsured Harvest Cash Sales	.352	.304
Harv. Sale & MPCl	.357	.310
Harv. Sale & CRC	.360	.317
Pricing w/o Insurance	.349	.292
Pricing & MPCl	.354	.297
Pricing & CRC	.356	.303

Table 3. Mean Net Return over Total Economic Costs, Mean Net Cash Flow, and CVs of Net Cash Flow for Alternative Risk Management Strategies for Different Financially Structured Corn and Soybean Farms, Ohio 1985-1997.

Risk Strategy	Cash Renter		Buyer-Renter		Owner	
	<i>Harvest</i>	<i>Pre-Harvest</i>	<i>Harvest</i>	<i>Pre-Harvest</i>	<i>Harvest</i>	<i>Pre-Harvest</i>
Mean Net Return over Total Economic Cost						
No Insurance	\$40,905	\$60,306	-\$36,275	-\$18,375	-\$110,178	-\$90,798
MPCI	45,463	61,653	-34,811	-15,423	-107,185	-87,837
CRC	42,686	58,875	-37,589	-18,201	-110,004	-90,401
Mean Net Cash Flow						
No Insurance	\$42,770	\$78,624	\$1,798	\$21,186	\$118,010	\$137,339
MPCI	64,089	77,464	4,750	24,139	120,963	140,355
CRC	61,003	77,192	2,007	21,361	118,185	137,534
Coefficient of Variation of Net Cash Flow						
No Insurance	1.211	0.990	40.326	3.716	0.620	0.577
MPCI	0.910	0.743	12.041	2.596	0.478	0.450
CRC	0.906	0.731	27.225	2.802	0.467	0.438

ENDNOTES

¹ A forerunner of CRC was introduced in 1994 by adding a replacement cost feature to multiple peril yield insurance. Indemnity payments with this product are triggered by low yields in contrast to payments from CRC that are triggered by low total income per acre.

² Land prices in 1982 were declining from earlier highs and are about equal to prices reported for 1996 and 1997. If price extremes were selected as the base or nor, the outcomes would be different from those reported here.