NCCC-134
APPLIED COMMODITY PRICE ANALYSIS, FORECASTING AND MARKET RISK MANAGEMENT

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Suggested citation format:

Wisner R. N., E. N. Blue, E. D. Baldwin, G. A. Barnaby Jr., and D. O'Brien. 1998. "Crop Insurance and Pre-Harvest Pricing of Corn and Soybeans: Case Studies for Selected States and Farms." Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. Chicago, IL. [http://www.farmdoc.uiuc.edu/nccc134].

CROP INSURANCE AND PRE-HARVEST PRICING OF CORN AND SOYBEANS: CASE STUDIES FOR SELECTED STATES AND FARMS

Robert N. Wisner, E. Neal Blue, E. Dean Baldwin, G. Art Barnaby, Jr. and Daniel O'Brien[1]

To test the effectiveness in managing net income risk and profit levels, pre-harvest corn and soybean options-based pricing strategies and crop yield and revenue insurances products were modeled for case study farms in three states. These combinations reduced income variability while increasing net incomes relative to harvest cash marketings. Adding crop insurances to pre-harvest pricing strategies 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). Both crop insurance and pre-harvest strategies are effective tools especially for highly leveraged farms.

Issues, Importance, and Producer Dilemma

An examination 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. Spring-to-fall price changes are not normally distributed, and hence create this relatively high frequency of pre-harvest pricing opportunities. Very often, pre-harvest prices for harvest-delivery new-crop corn futures have exceeded 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 rental land leases, these pre-harvest price advantages relative to harvest cash prices are large, often equaling or exceeding the net profit margin available through harvest cash marketings.*** Hence, producers appear to have considerable incentive to search for pre-harvest marketing opportunities that meet their financial needs and goals. However, if producers take advantage of pre-harvest marketing opportunities through short hedges, potential exposure to production risk is increased relative to the naive harvest sale strategy. Increased production risk is due to the fact that short hedges work effectively as a risk-management tool only when value changes in the short futures position are offset by approximately opposite value changes in the long cash position, i.e., the value of the physical grain being produced. Problems occur when adverse weather and low yields reduce the size of the cash position to less than that of the futures position so that potential financial losses on futures cannot be offset by the increased value of the physical grain.

Note that the risk-management objective in this type of hedge is different than in much of the published risk-management literature. The objective is not to minimize or reduce variance of net returns over a period of years to less than that of naive harvest cash marketings. It is not necessarily designed to generate a higher net price than would be available through harvest cash marketings. ***Instead, its focus is to lock in average returns above costs and/or net cash flow***

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obligation that are above the long-term naive harvest marketing average for producing grain. The hedge is made to protect against risks and uncertainty that could produce much smaller net returns than are currently available in the market, or even very large negative returns due to price changes. Risks are defined as those events which could adversely affect the profitability of the farm business, for which sufficient historical experience is available to calculate probability distributions of their occurrence. Uncertainty reflects circumstances for which insufficient historical experience is available to calculate probabilities of their occurrence. Examples of the first would be yield and price changes within some historical range. Examples of the latter might include external events that seriously impact U.S. agriculture such as the Southern Corn Leaf Blight epidemic of 1970, the demise of the Former Soviet Union and loss of a once large export market, the Mexican peso crisis, the export embargoes of the 1970s and 1980s, and the 1997-98 Asian economic crisis and an accompanying sharp decline in U.S. corn exports.

Pre-harvest fixed-price forward contracting controls for price risk without providing any protection for production risks. In fact, the fixed-price contracts may exacerbate the production risk problem because underlying futures prices may increase when production shortfalls occur. When minimum prices are established through options purchases, the potential problem is present to a much smaller degree. In that case, the size of the initial negative financial position in the options market does not increase with rising prices, although with severe weather, fewer bushels are available to spread options costs over than initially planned.

Traditionally, researchers have dealt with this two dimensional price and yield risk problem through the use of optimal hedge ratios with which a variance-minimizing percent of the crop is hedged (See Grant (1989), Plato (1989), Lapan and Moschini (1991), and Lence, et al., (1993)). If the objective of the hedge is solely to minimize variance of gross income over a long period of years, this approach is satisfactory. **However, for many producers, the optimal hedge ratio concept fails to focus on the most critical risk-management problem, namely that of covering the financial needs of the farm business and farm family for the current crop production year.**

This problem with pre-harvest pricing theoretically can be overcome or partially overcome through the use of certain types of crop insurance to compensate for increased exposure to production risk. ***Note that the type of crop insurance needed for maximum effectiveness with pre-harvest hedging or forward contracting is insurance that values the lost production at market replacement value.*** To meet the needs of pre-harvest hedgers, Crop Revenue Coverage insurance containing this feature was introduced in 1996.[1]

Objectives and Hypotheses

The general objective of this paper is to create and then compare recent histories of net returns over costs and cash flow obligations from combinations of pre-harvest sales and insurance products to returns from naive cash marketing sales for simulated case study farms in Iowa, Kansas, and Ohio. The hypotheses tested are that (1) over the 1985-97 time period, selected types of insurance when combined with a set of pre-harvest pricing strategies increased net returns without increasing variance of net income, for cash grain producers in the three study areas as compared with those available from naive harvest cash sales, and also as compared with those

from (2) uninsured pre-harvest pricing. It was anticipated that hypothesis (1) would be true only for crop insurance that replaced lost bushels at current market value.

A sub-objective was to update a set of pre-harvest pricing strategies Wisner, Blue, and Baldwin reported at this conference in 1997, by (1) adding one additional year to the analysis, (2) comparing mean net incomes with those from the naive strategy, (3) adding additional farm locations, and (4) examining variance of income. It was hypothesized that with the additional year of data, net returns over total and variable cost for model farms in the selected geographic regions would continue to significantly exceed those from the naive strategy, with no increase in the coefficient of variation relative to the naive strategy. Significance here is used in both a statistical and an economic sense.

A second sub-objective was to examine how differences in farm financial structures would alter the outcomes and thus the pre-harvest/insurance risk choice decisions of the different managers. This analysis was conducted for three Ohio case study farms - an owner-operator, a recent-buyer/cash renter, and a cash renter. Averages, standard deviations, and coefficients of variations (CVs) were reported.

Review of Literature

For a comprehensive review of relevant literature on pre-harvest pricing with futures and options, see Wisner, Blue, and Baldwin (NCR-134 Proceedings, April 1997), and Zulauf and Irwin, (NCR-134 Proceedings, April 1997). 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 the 1985-1996 period in which several pre-harvest marketing strategies out-performed naive harvest cash sales, both 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. crop 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 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 latter 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. This work will be published in a forthcoming Review or Agricultural Economics article (Wisner, Blue, and Baldwin, 1998).

Since crop insurance coverage with market replacement value features is a new product introduced in 1991, little research has been done on its complementarity with pre-harvest pricing. Wisner 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 increased from harvest cash marketings over the 1979-95 period, but were less than net returns from pre-harvest pricing without insurance. For some high yield risk farms in southern Iowa, results showed greater net returns from the pricing plus insurance strategies than for both

(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.

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. The data were divided into two subgroups, those that expected positive returns from crop insurance and those that expected negative returns For both groups, it was determined 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 judgement of yield variability was significant.

Miranda and Glauber examine participation in insurance programs in terms of reinsurance and systemic risks. The authors report that the private insurance program could fail because weather conditions affect farm yields across large areas defeating the insurer's effort to pool risks across farms. Based on their research, the authors suggest that reinsurance contracts could be one answer to this problem. Moral hazard issues and adverse selection may impede the use of reinsurance contracts because of the high monitoring costs.

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 use of either tool separately. Their research indicated that without forward pricing, revenue insurance 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 percent 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.

Crop Insurance Alternatives

The set of crop insurance choices available to grain farmers has been enlarged substantially in recent years.[2] It includes at least seven different types of insurance, excluding private add-on features on some types. To reduce the analysis to a manageable size, two types of insurance were selected for this research: Average Production History (formerly called multi-peril and referred to here as MPCI), and Crop Revenue Coverage (CRC). These insurances are widely available in major grain producing areas. MPCI has been available for many years, and insures yield per acre. To do this, it uses the farmer's actual yield history for the past three to 10 years as a base. The producer is given a choice of alternative percentages of the historical yield to select for risk protection, ranging from 55 percent to 75 percent in five percent increments. If the producer does not have the required yield history, an alternative history is substituted by the insurance company. This and other insurances analyzed here are government subsidized. However, the subsidy does not apply to additional costs from going above the 65 percent insured level. Insurance costs generally increase sharply as one moves to the 70 and 75 percent levels of coverage, so most farmers tend to select no more than 65 percent protection. For analytical purposes, the authors

selected 65 percent insurance coverage for CRC and MPCI. CRC insurance analysis was based on 100 percent of the futures price. Individual units were used to determine the insurance premium rates, although enterprise rates would have been slightly lower in cost. The analysis assumed the 1998 insurance rate structures and subsidies had existed over the entire study period. Costs and levels of insurance protection for CRC varied from year to year with the level of February average futures prices.

Model Farms

To test performance of alternative pricing and insurance strategies, actual cash, futures, options premiums, and historical corn and soybean yields from actual farms were applied to model farms in northwest Iowa, northwest Ohio, and northwest Kansas. Each farm was 1,000 acres in size. In Iowa and Ohio, 50% of the acreage were allocated to corn and to soybeans, respectively. Kansas farms were entirely corn, and were irrigated. In Iowa and Ohio, all yield data were from experimental farm publications (Ohio State University Extension). Kansas yield data were acquired from personal farm records. Costs were taken from extension budgets (Costs of Crop Production, FM-1712, various issues, Iowa State University; Ohio Enterprise Budgets, Ohio State University, and extension budgets from Kansas State University). Basis and cash price data were obtained from extension service publications and data files. Because pre-harvest pricing strategies involved extensive use of options markets, the time period for analysis was 1985-1997 (options trading began in late 1984). Earlier years were not used for options analysis, to avoid problems in estimating options premiums before options trading was allowed by law. For all farms, insurance costs and indemnity payments were calculated, assuming the 1998 rate structures and choices were available for all years of the study period.

The Iowa and Ohio farms were located in areas where historical production risk has been relatively low. For the Iowa farm, no insurance indemnity payments occurred. For the Ohio and Kansas farms, indemnity payments occurred twice.[3] From the producer's standpoint, the decision of whether to buy crop insurance would depend partly on (1) his/her assessment of the probability of yields dropping below 65 percent of the long-term historical average yield, (2) ability to self insure, and (3) whether a major part of the crop will be forward priced.

Exclusion of government payments— Income from marketing and crop insurance is independent of government payments, so that these sources of income can be excluded when analyzing impacts from strategies to manage price and production risks. Thus, to simplify the analysis, all income from government deficiency, disaster, and payment-in-kind payments was excluded. Since no post-harvest pricing alternatives were included, government payments for storage under the Farmer Owned Grain Reserve also were excluded.

The Simulation Model and Data [4]

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.

Marketing levels were percentages of the prior 10-year rolling yield averages. Hedges and options positions were executed up to the highest integer level not exceeding this production, using 5,000 bushel contracts. In most cases, this procedure and the 5,000 bushel futures contracts prevented the additional 20 percent of soybean production from bing hedged in July. With upward trending yields, pricing for marketing purposes was conservative relative to current potential production, and provided a cushion to help avoid being oversold in years of short crops. When an oversold position occurred, the excess was bought back at the harvest futures price (the second week of October for soybeans and for the fourth week of October for corn). All cash transactions were made at these same times.

For the pre-harvest marketing strategies, closing Thursday cash, futures prices and options premiums were used. Cash prices and local basis data were based on average prices paid to farmers in northwest Iowa, to farmers in northwest Ohio, and to farmers in northwest Kansas (Wisner and Klaus; and Baldwin and Dayton, O'Brien). If the markets were closed on Thursday, the preceding Wednesday's prices were used. Round-turn brokerage fees of $40 and $60 were charged to the futures and options accounts, respectively, and a 7% initial margin was used on futures accounts. Interest rates for investments in hedge-related costs and option premia were charged at the annual prime rate plus 1 percent. When futures profits were generated, the prevailing three month U.S Treasury bill rate was credited to the account. Futures were marked to market each week, and maximum account draw-downs were recorded. Total revenues from each of the marketing strategies were adjusted for insurance indemnity payments and premiums.

Results With No Variation in Financial Conditions

General Results for Crop Insurances

From the farmers' viewpoint, an alternative role for crop insurance (rather than reducing income variance as is reported in much of the literature), was to reduce the risk of a severe drop in net income that could occur with extremely adverse weather and low yields. [5] During the study period, crop insurance performed this role by providing indemnity payments for Ohio and Kansas farms.[6] Indemnity payments occurred in Ohio for corn in 1988 and 1993, and in 1981 for Ohio soybeans, for both MPCI and CRC insurances. In 1995, a CRC indemnity payment was made to the Kansas corn farm. There were no indemnity payments for the Iowa farm. When all years were combined, the mean net income with both types of crop insurance was less than mean net income of harvest sales without crop insurance (Table 1).

Table 1. Net Income Over Variable Costs from Selected Risk Management Strategies and Insurance Products, 1000 Acres on Model Farms

Risk Strategy	Iowa	Ohio	Kansas farm 1	Kansas farm 2
	Corn and Soybean Farms		Corn Farms	
Uninsured Harvest Cash Sales	$150,989	$162,454	$121,418	$105,096
Harv. Sale & MPCI	$147,662	$159,489	$117,724	$102,522
Harv. Sale & CRC	$144,955	$155,759	$115,266	$100,404

Net Corn Returns With and Without Pre-harvest Pricing for Iowa, Ohio, and Kansas

With one more year of empirical data, results from the same strategies reported by Wisner, Blue, and Baldwin in 1997 closely resembled that from earlier work. Pre-harvest pricing strategies consisting of May/July 80/20 mixed hedge/put, with post short-crop pricing late in February generated returns that were significantly different from those with harvest cash marketings at probabilities of 3.5 percent or less for Iowa and Ohio Farms. For the irrigated Kansas corn farms, the statistical differences were in the five percent range (Table 2). Gains in mean annual net income for pre-harvest pricing without insurances verses the naive no insurance strategy were in the $10,000 to $11,000 range for all four farms, for 500 acres of corn (Table 3).

Table 2. Probabilities of Significant Difference From Harvest Cash Corn Sales, Based on t Tests

Risk Strategy	Iowa	Ohio	Kansas Farm 1	Kansas Farm 2
Harv. Sale & MPCI	0	14.59	0.02	9.70
Harv. Sale & CRC	0	1.33	0.02	3.28
Pricing w/o Insurance	**3.52**	**3.50**	**5.01**	**5.44**
Pricing & MPCI	8.05	5.21	9.42	9.97
Pricing & CRC	14.82	10.50	14.03	14.36

Table 3. Gains in Corn Mean Net Income Vs. Uninsured Harvest Cash Sales, When Pre-harvest Pricing is Combined With and Without Crop Insurance

Insurance Type	Iowa	Ohio	Kansas Farm 1	Kansas Farm 2
Pricing & No Insurance	**$10,143**	**$10,266**	**$11,023**	**$11,038**
Pricing & MPCI	$ 8,177	$ 8,881	$ 9,176	$ 9,751
Pricing & CRC	$ 6,602	$ 7,165	$ 7,947	$ 8,691

Pre-harvest Corn Pricing With Crop Insurance

Tables 3 and 4 show the mean income gains and corn net incomes when pre-harvest pricing

with the mixed hedge/put strategy is combined with crop insurance. In all cases, mean annual net returns from these combinations were higher than for harvest cash marketings without insurance (Table 3). However, based on t-tests, only the mean net return from pre-harvest pricing and MPCI insurance was significantly different from the naive strategy at the five percent range for the Ohio corn farm (Table 2). This finding is not surprising for the period under study since crop failures appeared in Ohio more frequently than was the case for Iowa or Kansas. Furthermore, these results do not allow for the analysis of a major crop failure. Such an outcome, even if it happened only once in 100 years, may cause financial ruin for some individuals. If anticipated production risk prevent farmers from taking advantage of pre-harvest pricing opportunities, these risk averse individuals may want to consider using crop insurance to bolster their confidence to enter into pre-pricing marketing strategies.

Over the time period studied here, net returns from using multi peril insurance slightly exceeded those from Crop Revenue Coverage. This outcome was due entirely to the lower premium cost for MPCI than for CRC. In an area or time period of greater yield variability, CRC might have exhibited greater positive effect on income than MPCI.

Table 4. Corn Mean Net Income Over Variable Costs from Selected Risk Management Strategies and Insurance Products, 500 Acres on Model Farms

Risk Strategy	Iowa	Ohio	Kansas farm 1	Kansas farm 2
Uninsured Harvest Cash Sales	**$65,019**	**$81,293**	**$60,709**	**$52,548**
Harv. Sale & MPCI	$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 &MPCI	$73,196	$90,174	$69,885	$62,299
Pricing & CRC	$71,621	$88,458	$68,656	$61,239

For Iowa and Kansas, adding crop insurance to cash marketing strategies increased the coefficient of variation (CV) of net income, as compared with pre-harvest pricing alone. However, CVs for the pre-harvest pricing plus insurance were consistently less than those from the naive strategy of harvest cash sales (Table 5). Although these results are consistent with findings of Heifner and Coble (1997), whether insurance is purchased and the level of protection purchased may depend on the producers' perceived negative or positive return estimates (Smith and Baquet). Thus, the total effect of these findings on demand for crop insurance cannot be determined with certainty.

In contrast for Ohio, adding insurances to both pre-harvest pricing and naive harvest sales reduced the standard deviations and the CVs. These differences relative to the observations for Iowa and Kansas reflects the benefits of the indemnity payment to the Ohio farm. Thus, farms that experience crop failure, as was the case in Ohio, may find that risk as measured by standard deviations and CVs may be reduced by adding insurances. For the Ohio farm pre-harvest pricing and no insurance resulted in a $46,640 standard deviation on a mean annual net income that was $10,266 greater than for harvest cash sales. When MPCI was added, the standard deviation fell to a still large $44,676. CRC reduced the standard deviation to $44,125. The CVs for each

strategy and insurance combinations are shown in Table 5

Table 5. Coefficient of Variation of Corn Net Income With Pre-harvest Pricing, Uninsured Harvest Cash Sales, and Pre-harvest Pricing Combined With Crop Insurance

Risk Strategy	Iowa	Ohio	Kansas farm 1	Kansas farm 2
Uninsured Harv. Cash Sales	**0.594**	**0.557**	**0.740**	**0.856**
Harv. Sale & MPCI	0.612	0.546	0.752	0.847
Harv. Sale & CRC	0.623	0.553	0.757	0.854
Pricing w/o Insurance	**0.537**	**0.509**	**0.680**	**0.769**
Pricing &MPCI	0.551	0.495	0.688	0.768
Pricing & CRC	0.559	0.499	0.691	0.774

Net Soybean Returns With and Without Pre-harvest Pricing for Iowa and Ohio

As with corn, results from the strategies reported by Wisner, Blue, and Baldwin in 1997, with one more year of empirical data, closely resembled that from earlier work. Pre-harvest pricing of soybeans on the model farms generated both economically and statistically significant increases in net income. Net returns at all locations for pre-harvest pricing strategies) consisting of May/July 80/20 mixed synthetic put/hedge, with post short-crop pricing in late February, generated returns that were significantly different from those with harvest cash marketings at probabilities of less than two percent at both the Iowa and the Ohio locations (Table 6).[7] Gains in mean annual net income versus the naive strategy are shown in Table 7.

Table 6. Significance Probabilities Indicating Difference From Harvest Cash Soybean Sales, Based on t Tests.

Risk Strategy	Iowa	Ohio
Harv. Sale & MPCI	0	0
Harv. Sale & CRC	0	0
Pricing w/o Insurance	1.96	1.96
Pricing &MPCI	4.22	4.71
Pricing &CRC	7.69	15.00

Table 7. Gains in Soybean Net Income Over Variable Cost vs. Uninsured Harvest Cash Sales, When Pre-harvest Pricing is Combined With Crop Insurance

Insurance Type	Iowa	Ohio
Pre-harvest Pricing & No Insurance	$8,798	$8,798
MPCI	$7,436	$7,217
CRC	$6,305	$5,023

Pre-harvest Soybean Pricing With Crop Insurance

Table 8 shows the net soybean incomes over variable cost when pre-harvest pricing with the

mixed hedge/put strategy is combined with crop insurance. In both states, mean annual net returns for MPCI plus pre-harvest pricing were significantly higher than for harvest cash marketings at the five percent level of probability, based on t tests, but were less than those from pre-harvest pricing without crop insurance (Tables 8 and 9). Over the time period studied here, mean annual net returns from using multiperil insurance slightly exceeded those from Crop Revenue Coverage. That was due entirely to the lower premium cost for MPCI than for CRC. Net soybean income generated by pre-harvest pricing and CRC was not significantly different from that of harvest cash sales without insurance, based on a five percent level of probability.

Table 8. Soybean Net Income Over Variable Costs from Selected Risk Management Strategies and Insurance Products, 500 Acres on Model Farms

Risk Strategy	Iowa	Ohio
Uninsured Harvest Cash Sales	$85,970	$81,161
Harv. Sale & MPCI	$84,608	$79,580
Harv. Sale & CRC	$83,477	$77,387
Pricing w/o Insurance	$94,768	$89,959
Pricing &MPCI	$93,406	$88,378
Pricing &CRC	$92,275	$86,184

As with corn, one implication from these findings is that if production risk holds farmers back from taking advantage of pre-harvest pricing opportunities, producers may want to consider using crop insurance to bolster their confidence to take steps to reduce price risk. However, it may be surprising that over the study period, this role was performed more satisfactorily by MPCI than by CRC, based on average income, income variability, and t tests. In a period of greater yield variability in the study areas, CRC might have had a greater positive effect on income than MPCI. For both states however, cash marketings and insurances increased the CVs.

The CVs for pre-harvest pricing plus insurance in Iowa were very slightly higher than those from the naive strategy, while Ohio's were marginally lower (see Table 9). The Ohio result, like corn, supports findings of Heifner and Coble (1997). However, it is highly doubtful that the very slight reductions in the coefficient of variation of the observed magnitude would be a significant factor in farmers' decisions to purchase crop insurance.

Table 9. Coefficient of Variation of Soybean Net Income with Pre-harvest pricing, Uninsured Harvest Cash Sales With and Without Insurance, and Pre-harvest Pricing Combined With Crop Insurance

Risk Strategy	Iowa	Ohio
Uninsured Harvest Cash Sales	0.352	0.304
Harv. Sale & MPCI	0.357	0.310
Harv. Sale & CRC	0.360	0.317
Pricing w/o Insurance	0.349	0.292
Pricing &MPCI	0.354	0.297
Pricing &CRC	0.356	0.303

Net Cash Flow Results for Ohio Farms With Different Financial Structures

To analyze risk in terms of different financial structures, results from the Ohio model farm were adjusted to reflect total cash flow costs for three different types of financial structures. These were (1) a debt-free farm (owner) , (2) a cash-renter, and (3) a recent buyer/cash renter who bought 500 acres and cash rented 500 acres. The land area and quality, and machinery line for the three farms are identical, as well as the yields. The only variations from one farm to another are in the financial structures. The recent buyer/renter is assumed to have purchased his/her land in 1982.[8] Variable costs of production for the three farms are taken from extension budgets, and are the same as used in the previous analysis. The debt-free farmer is capable of self insuring, and can absorb a great deal of price and yield risk. The other two types of farms have much less risk absorbing capability.

To analyze risks for different types of farms, the Managing Risks and Profits (MRP) data based software program is solved for each of the farms for the 1985 to 1997 time period. The software was designed so that a producer could create a marketing and production plan for his/her farm, evaluate and understand contemporary risks associated with crop yields and prices, and could make informed insurance and marketing decisions. For more details on this model and to understand the underlying assumptions, read Managing Risk and Profits (MRP) Software Manual (Baldwin).

The input and output data from the prior analysis were used to solve the MRP model. To analyze the effects of a major crop failure, the 1993 corn yield was lowered to 15 bushels per acre. Similar yield outcomes occurred on this experiential farm in 1970s and again in the early 1980s (Ohio State University Extension). Lowering the yield to this level illustrates the potential benefits of the crop insurance products.

Results with VARIATION IN FINANCIAL CONDITIONS

Net Returns Over Total Economic Costs

When opportunity costs of land were included as one facet of fixed costs, neither the owner or buyer/renter could earn average returns that would cover total costs (Table 10). The average losses reported here were consistent from year to year and do not represent an anomaly. Although both pre-harvest pricing and the use of insurance products reduced the financial losses, neither used separately or together could overcome these negative averages. These results suggest that land buyers must expect to achieve returns on farmland investment by speculating on land prices. Alternatively, the land buyer is averaging out the cost of new purchases by undervaluing the opportunity cost of prior owned land.

In contrast, the cash renter did earn average returns that covered all opportunity costs. The combination of pre-harvest pricing and the use of MPCI product returned on average $61,653, annually. Profits were earned in every year except for 1987, 1991, and 1993. When grain was priced at harvest time and insurance was not used, losses occurred in only two years, 1987 and 1993. However, the losses were large equaling $131,957 in 1993.

Table 10. Mean Net Income Over Total Economic Costs for Harvest and Pre-harvest Sales and Crop Insurances for Different Financially Structured Corn and Soybean Farms, Ohio 1985-1997.

Farms	Cash Renter		Buyer-Renter		Owner	
Insurance	*Harvest Sales*	*Pre-Harvest Sales*	*Harvest Sales*	*Pre-Harvest Sales*	*Harvest Sales*	*Pre-Harvest Sales*
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

Because the insurance indemnity payments partially offset the large losses that occur from a near crop failure, the insurance products reduce the variance about the mean net incomes (Table 11). This finding is consistent with that reported in the prior simulation analysis for Ohio. For pre-harvest sales, the standard deviations for the farm as a whole are increased relative to those for harvest sales. This finding reflects the impact of the assumed corn crop failure in 1993 and the realization that corn and soybean prices and yields are not always moving in tandem.

Table 11. Standard Deviation About Mean Net Economic Income for Harvest and Pre-harvest Sales and Crop Insurances for Different Financially Structured Corn and Soybean Farms, Ohio 1985-1997.

Farms	Cash Renter		Buyer-Renter		Owner	
	Harvest	Pre-Harvest	Harvest	Pre-Harvest	Harvest	Pre-Harvest
No Insurance	71,428	77,745	102,848	108,451	60,352	67,469
MPCI	57,858	59,986	81,481	87,726	49,468	55,386
CRC	55,300	57,159	77,476	83,695	47,926	53,720

Net Returns Over Cash Flow

Analyzing risks in terms of cash flow for the three farms leads to quite different conclusions compared to the risk analysis using opportunity cost. The owner has the highest average annual positive returns throughout the entire period relative to the other two farms (Table 12). Negative returns occurred only during the 1993 near corn crop failure. Both the insurance products and pre-harvest sales increased the positive returns relative to marketings at harvest time. This is an important finding for the pre-harvest pricing strategies, given that a near total corn crop failure was imposed in 1993 and nearly 50 percent of the crop was lost in 1987. Thus, extensive use of synthetic puts, puts, and hedges captured some of the return effects produced by the yield and price correlations. For the MPCI product, mean net returns were positive. That is, the mean indemnity payments were greater than the mean premium for the 13 year period.

Table 12. Mean Net Cash Flow for Harvest and Pre-harvest and Crop Insurances for Different Financially Structured Corn and Soybean Farms, Ohio 1985-1997.

Farms	Cash Renter		Buyer-Renter		Owner	
	Harvest	*Pre-Harvest*	*Harvest*	*Pre-Harvest*	*Harvest*	*Pre-Harvest*
No Insurance	$59,301	$78,690	$1,798	$21,186	$118,010	$137,399
MPCI	$62,228	$81,620	$4,750	$24,122	$120,963	$140,355
CRC	$59,510	$78,864	$2,007	$21,361	$118,185	$137,539

For both harvest sales and pre-harvest pricing, the insurance products reduced the standard deviations about the means for the cash flow analysis (Table 13). For the highly leveraged owner-renter, the standard deviation is reduced from $72,506 for harvest sales with no insurance to $57,195 for harvest sales and MPCI insurance. Based on CVs, the risk is reduced from 40.33 to 12.04. Although not as pronounced, similar findings were observed for the cash renter and the owner-operator. These findings suggest that crop insurances do reduce risk for farms with different financial structures. Farms that are highly leveraged receive the most reduction in risk. The pre-harvest pricing strategies increased the standard deviations as compared to selling at harvest time. However the CVs were lower for all farms.

Table 13. Coefficient of Variation of Net Cash Flow for Harvest and Pre-harvest and Crop Insurances for Different Financially Structured Corn and Soybean Farms, Ohio 1985-1997.

Farms	Cash Renter		Buyer-Renter		Owner	
Insurance	*Harvest Sales*	*Pre-Harvest Sales*	*Harvest Sales*	*Pre-Harvest Sales*	*Harvest Sales*	*Pre-Harvest Sales*
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

For the entire study period, the owner earned at least $1.5 million of positive returns over cash flow obligations. Using insurance products and pre-harvest pricing strategies increased returns (Table 14). However, this individual could chose to self insure and/or could forgo pre-harvest pricing strategies. If the latter choices were exercised, net cash flow would have been negative in only one year, 1993. During this near crop failure, the owner would need to borrow or reduce assets by $56,000 to cover the short fall. Throughout this period, the owner weighted cash flow risk ratio equaled 0.64. This means that the owner had to sell about 64% of the crops at harvest cash prices to cover the cash flow risks. The weighted cash flow risk ratio measures risk by identifying the percent of the crop that must be sold at the expected market price to meet all cash obligations.

Table 14. Total Net Cash Flow for Harvest and Pre-harvest and Crop Insurances for Different Financially Structured Corn and Soybean Farms, Ohio 1985-1997.

Farms	Cash Renter		Buyer-Renter		Owner	
Insurance	*Harvest Sales*	*Pre-Harvest Sales*	*Harvest Sales*	*Pre-Harvest Sales*	*Harvest Sales*	*Pre-Harvest Sales*
No Insurance	$770,917	$1,022,965	$23,370	$275,418	$1,534,136	$1,786,185
MPCI	$808,972	$1,061,071	$61,754	$313,853	$1,572,520	$1,824,619
CRC	$773,639	$1,025,238	$26,092	$277,691	$1,536,408	$1,788,007

The cash renter also earned positive mean net returns from harvest sales but they were less than one-half of those earned by the owner (Table 14). For the entire study period, the cash renter realized positive returns equaling at least $770,000. Like the owner, this individual could also partially self insure and/or could forgo using pre-harvest pricing strategies. Such a strategy would have resulted in negative returns of more than $25,000 in 1987 and $112,000 in 1993. If a non-insurance naive marketing strategy was followed and these short falls appeared early in the cash-renters career, a major financial burden would have existed. The cash renter's weighted cash flow risk ratio approach 1.0 meaning that 100% of the crops had to be sold at average harvest prices to cover cash flow obligations.

The buyer-renter earned mean net returns that just covered cash flow obligations including living expenses by selling at harvest without any crop insurance (Table 14). In six of the 13 years, net cash flow was negative and in 1993 exceeded $170,000. Using MPCI insurance in conjunction with harvest sales nearly tripled the mean net return over cash flow obligations, and reduced negative cash flow to $86,500 in 1993. Pre-harvest pricing was a major benefit for the buyer-renter increasing the mean net cash flow returns by more than 10 times relative to harvest sales without insurance. When MPCI insurance was included with the pre-harvest pricing strategy, mean net cash flow returns increased by more than five times relative to cash sales with MPCI insurance. The number of years in which losses occurred and the size of the loss were also reduced.

Based upon average prices at harvest time, the weighted risk ratio approached 1.26. This means that the buyer-renter would have to sell more than 100% of his/her corn and bean crop to cover his/her cash flow obligations. This ratio indicates to the buyer-renter that he/she is confronting serious cash-flow risks. These findings suggest that the buyer-renter should consider using insurance products to protect against yield risks and should consider pre-harvest pricing when pricing opportunities allow cash flow obligations to be covered.

Concluding Comments

This study simulated the performance of pre-harvest pricing with extensive use of the options markets and modest use of short futures hedges during the past 13 years, separately and in combination with crop yield and revenue insurance. Results reveal a potential existed for decreasing income variability, while increasing mean net incomes. The base measurement for mean income and income variability was the naive harvest cash sales. Crop insurance products alone over this time

period offered very limited potential for enhancing risk management as traditionally considered in the literature, ie. through reduced variability of income over time relative to harvest cash marketings. The coefficient of variation of net returns over variable cost for the four model farms and both types of crop insurance was smaller with crop insurance combined with pre-harvest pricing than with crop insurance alone. Further, the CVs of net returns over cash flow were large, particularly for the highly leveraged Ohio farm (owner-renter). These findings suggest crop insurance may offer a potentially important role for farmers who, because of production risk, are reluctant to price grain before harvest even when prices are well above the historical average harvest time prices. Crop insurance also continued to offer risk management potential from the perspective typically used by the industry, ie., to protect against the risk that extremely low yields will produce a major short-fall in gross income and a large negative net cash flow In two of the three states included in this analysis, crop insurance performed this function in a modest way in a few instances. When yield were arbitrarily reduce to near-failure levels for the Ohio farms, insurance played a much more important role in managing cash flow risks.

Net returns, statistical significance, and variance of returns from pre-harvest marketing strategies produced results very 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. These gains were based on actual cash, futures, basis, and individual farm yields, with costs taken from historical extension budgets in their respective states. All brokerage and interest costs associated with futures and options positions were deducted to arrive at the net returns. Conclusions about futures margin account activity reported by Wisner et al. in 1997 held for this analysis. Mean interest costs were minor, although adequate financing would be needed to maintain the futures positions. While past performance of the pre-harvest pricing strategies was impressive, the authors caution that past performance does not guarantee future performance.

Results from the cash flow analysis suggests that a single risk management strategy cannot be expected to fit all types of farms. When cash flow risk ratios are relatively low (less than 0.7), these producers may chose to self-insure and/or to forgo pre-harvest pricing strategies. If these choices are selected, the producer must recognize that there will be years in which borrowing must occur and/or assets will be reduced. In this study, a near corn crop failure resulted in a negative cash flow that ranged from $56,000 for the owner to $170,000 for the owner-renter. If a soybean crop failure had occurred simultaneously, losses may have exceeded $100,000 for the owner and more than $300,000 for the owner-renter. The question for this producer is , "am I willing to accept that cash flow risk even if it is highly improbable?" Research that focuses on net cash flow probability distributions would be most helpful for this producer.

When the cash flow risk ratio approaches or exceeds 1.0, the producer is facing substantial cash flow risk. Most recent buyers and cash renters are in this situation. If a major crop failure occurs, the financial burden on both groups would be severe. Both should consider using some combination of insurances and pre-harvest pricing.

The cash flow analysis illustrates that there is a need to carefully analyze how to measure risk and how to develop risk management strategies. Minimizing variances about a mean does not necessarily guarantee success for those producers who face relatively high cash flow risk ratios. To solve this problem, one suggestion is that the risk management research should focus on the whole farm net

cash approach. Examining risks by enterprise may shed some light on how to manage the micro parts, but may miss broader and more important macro consequences.

These results suggest that there is major opportunity to use crop insurances and pre-harvest pricing strategies to control risk and manage profits. Like all insurances, MPCI and CRC are designed to offset major disasters. If small yield losses occur, there will be no indemnity payment. In this work, there was some evidence that indemnity payments may partially offset the price effects that occur when forward price contracts are placed, crop yields decline, and prices rise. However, extensive use of option markets in this study did not provide a complete test of the effectiveness of insurance in this role since financial exposure in options did not increase with rising prices.

These results suggest that opportunities exist for additional work on the behavior of forward pricing, options markets, and insurances as well as for possible re-examination of risk management needs of individual farmers when the focus is on net returns and variations in individual farm financial structures. Farms analyzed here are located in areas of relatively low yield risk. Extending the research to other areas with more variable yields and to other crops also would be useful.

Endnotes

A forerunner of CRC was introduced in 1991, by adding a replacement cost feature to multiple peril yield insurance. As will be noted later, 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. For an overview of the different insurance products and associate risks and benefits, read Managing Change-Managing Risk: A Primer for Agriculture, Iowa State University.

3. For the net cash flow analysis for the three Ohio farms, cash renter, buyer/renter, and owner, it was assumed that a major corn crop failure occurred in 1993 (yields for corn were reduced in 1993). This simulates a crop loss failure that occurred in the early 1980s on this Ohio experiential farm and allows for a more diversified analysis.

4. For the specific details on the simulation model, see Wisner, Blue, and Baldwin.

5. Over the study period, a major part of the Corn Belt was affected by severely adverse weather three times (1988 and 1993 in the western Corn Belt and 1988 and 1991 in the eastern Corn Belt.

6. However, the insurance benefits were insufficient to maintain a positive net income, but did modestly lessen the financial stress from low yields.

7. As noted earlier, the Kansas farms raised no soybeans.

8. Land prices in 1982 were declining from earlier highs and are about equals to prices reported for 1996 and 1997. If price extremes were selected as the base or norm, the outcomes would be different from those reported here.

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