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## IMPLICATIONS OF CROP INSURANCE FOR FARMERS AND LENDERS

David J. Leatham, Bruce A. McCarl, and James W. Richardson

### Abstract

The effect of the farmer's choice of crop insurance was evaluated on both the farmer's and lender's performance. This was done using whole-farm, Monte Carlo simulation for Texas wheat/sorghum operations. Results indicate crop insurance would be preferred by moderately risk-averse farmers when farm firm failure became an issue or the insurance loss ratio approached one. A lender always preferred the use of crop insurance, especially when the probability of firm bankruptcy was an issue.

*Key words:* crop insurance, risk management, simulation, farmers' perspective, lenders' perspective.

Many farmers have found farm income in the 1980s insufficient to service debt incurred in the 1970s. The resultant increase in loan delinquencies and problem loans has also stressed agricultural lenders. In this study, we examine some of the effects that crop insurance has in such a setting.

With the Federal Crop Insurance Act of 1980, Congress authorized an expanded insurance program wherein crop insurance became the primary form of disaster protection for farmers. Crop insurance primarily protects farmers from yield shortfalls and, theoretically, stabilizes income while protecting liquidity. Consequently, crop insurance potentially can reduce lenders' credit risk by reducing the likelihood of delinquent and defaulted loan payments. Some lenders have reacted to this by either requiring or considering requiring crop insurance of lenders. The cost of the insurance premium, however, reduces a firm's income and liquidity reserves and can increase the probability of bankruptcy.

The income protection, therefore, must be compared to the increase in cost.

Thus, both farmers and lenders need to consider the risk/return situation relative to crop insurance. At times, however, risk/return preferences may differ between farmers and lenders. In this study, we investigate the crop insurance question and the conditions under which both lenders and farmers would prefer crop insurance.

Prior studies (Gardner and Kramer; King and Oamek; Kramer and Pope; Lovell et al.; and Lee and Djogo) have focused on the farm-level effects of crop insurance but have not discussed effects on the lender. Pflueger and Barry placed lenders in a hypothetical case study and found lenders would provide additional credit to farmers using crop insurance. The effect of borrowers' use of crop insurance on lenders' income, however, has not been explored and thus this is the main question this study explored explicitly. This analysis allows one to determine the instances when it may be advantageous for lenders to require farmers' use of crop insurance and to examine when potential conflicts between farmers' and lenders' preferences may arise. The impact of lenders charging a higher rate of interest to noninsured borrowers was also examined. The study was done considering the use of wheat crop insurance by wheat/sorghum farmers in the Texas Northern High Plains.

### MODELING APPROACH

Crop insurance can affect the lender's credit risk. From the lender's standpoint, the ultimate risk is the loss associated with a defaulted loan. The default rate, in turn, is influenced by a borrower's net income, net income variability, and leverage position. Because crop insurance affects both expected returns and variability,

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crop insurance will affect the default rate. Some lenders have reacted to this by requiring crop insurance.

Lenders may also encourage crop insurance use by charging farmers who do not use it a higher interest rate. Traditionally, agricultural lenders have not charged interest rates that vary with the riskiness of the borrower. It is a viable alternative, however, that may be considered. Of course, while an interest rate premium increases lender income, it also reduces borrower profitability which, in turn, may decrease liquidity and increase the default rate. Lenders, thus, face tradeoffs.

Analysis of the insurance problem requires information on the farm income and probability distributions. Whole-farm simulation was used to generate these distributions under alternative yield variabilities using the FLIPSIM model (Richardson and Nixon; Richardson et al.; and Perry et al.). Briefly, FLIPSIM is a firm-level, recursive, simulation model which simulates the annual production, farm policy, marketing, financial management, growth, and income tax aspects of a farm over a multiple-year planning horizon. The model recursively simulates a typical farm by using the ending financial position for year 1 as the beginning position for the second year, and so on. Accounting equations and identities constitute almost all of the computational components of the model. Psuedo-random prices and yields are drawn from a multivariate empirical probability distribution. A historical correlation matrix was used to capture the correlation between the yields and prices. A six-year period was simulated.

A number of assumptions were made relative to the financial function of the firm. Existing and new long- and intermediate-term loans were amortized (using the remaining balance formula) based on their respective loan life, initial amount borrowed, and annual interest rate. Variable interest rates were used for new and old loans.

Cash flow deficits were allowed to be covered several ways, such as: (a) a loan could be taken out secured by crops held for sale in the next tax year, (b) a mortgage could be obtained on equity in farmland and intermediate-term assets, or (c) farmland could be sold. The operator could borrow up to a prespecified level of debt-to-assets. Cropland sold to meet cash flow deficits could be leased back in subsequent years to avoid having more machinery than necessary to farm the remaining acreage. If the combination of all of these

options could not remove the deficit, the farm would be declared insolvent and foreclosure initiated.

Cumulative net present value (NPV) distributions for the farmer and lender were developed under alternative scenarios regarding variability and crop insurance purchase. The NPV distributions were incorporated within an expected utility framework to determine the level of risk aversion where decision makers were indifferent between farming situation that used crop insurance and those that did not. Comparisons were then drawn between the preferences of the farm operator and the farm lender.

A farmer's NPV represents the present value of ending farm net worth, plus yearly family withdrawals minus off-farm income discounted to the present, minus beginning net worth. All cash flows were adjusted for taxes. An 8 percent after-tax discount rate was used. The lender's NPV was the discounted debt repayment (principal and interest) based on operating and term loans provided to the farming operation, minus the funds loaned to the farm operator. The lender's cash flows were not adjusted for taxes. The interest rate charged on operating loans was used as the discount rate for the bank.

### Farm Situation

A representative North Texas High Plains wheat/sorghum farm was analyzed. Information used to define a representative farm was obtained from 1980 and 1983 surveys. It was assumed that the representative farm controlled 1,400 acres. Six hundred and forty acres of cropland were owned and the same amount leased on a  $\frac{1}{4}$ -share basis. One-half of the cropland was irrigated and planted equally to wheat and sorghum. The other half was planted to dryland wheat. The remaining land was in pasture and leased out at \$5 per acre. The representative farm had an initial asset position valued at \$580,150, with \$338,200 in real estate and the rest in farm machinery. The definition of the representative farm was consistent with 1980 and 1983 surveys of farmers in the region.

The initial debt-to-asset ratio for the representative farm was assumed to be 0.6 and to be the same for intermediate- and long-term assets. The farmer was allowed to sell cropland to avoid insolvency but was not allowed to purchase or lease additional cropland. It was assumed the farmer received \$6,000 in off-farm income annually. The

minimum and maximum family living expense was assumed to be \$18,000 and \$40,000, respectively. Marginal consumption was 25 percent of disposable income over the minimum amount.

The six-year simulation was replicated 50 times over a planning horizon beginning in 1985. It was assumed that the 1985 crop year farm program provisions were in place for an entire planning horizon. The annual mean prices of wheat and sorghum were assumed to be \$3.20 and \$4.10 per bushel, respectively. Per acre mean yield for irrigated wheat, dryland wheat, and sorghum was assumed to be 60, 18, and 60 bushels, respectively. Probability distributions of yield and price were based on historical observations for a farm in the area. Expenses, inputs, labor requirements, and other necessary information were obtained from the Texas Agricultural Extension Service crop enterprise budgets and extension specialists in the region.

### Farm Lender Situation

The farm lender was not extensively modeled in this study. The costs and repayments of loans made to the representative farm, however, were treated in a partial budgeting framework considering this loan only. The probability distribution of returns to loans was estimated using loan payment results from the farm simulation.

The farm lender was assumed to be the farmer's sole source of borrowed funds other than through CCC loans. This simplification is consistent with current trends and allowed the study to focus on the effects of crop insurance with loan arrangements held constant.

It was assumed that the lender initiated foreclosure whenever the firm could not meet current debt obligations after exhausting all alternatives of obtaining cash and the farmer's debt-to-asset ratio increased above a prespecified level, 0.67. This was consistent with a 1986 survey of major Texas agricultural lenders (Leatham). The farm debt-to-asset ratio at which lenders considered foreclosure ranged from 64 to 73 percent. It was also assumed in this study that repaid principal after foreclosure costs could be reinvested at the discount rate.

### Cost of Foreclosure

The total accounting of farm and lender NPV requires treatment of the costs of foreclosure. Estimates of foreclosure cost components were obtained through telephone

interviews with lenders, attorneys, and auctioneers. Based on these interviews, the cost of foreclosure,  $C_f$ , was approximated by

$$(1) C_f = \$14,000 + i(t/12)D + 0.4A,$$

where the first component, \$14,000, is the associated fixed costs (i.e., legal expenses and opportunity cost of lenders' time). The second component is the opportunity cost of nonaccrual outstanding debt. This is calculated by multiplying outstanding debt,  $D$ , by the interest rate,  $i$ , and the time the foreclosure requires. Lenders interviewed indicated that the mean length of foreclosure, measured in months,  $t$ , was 4. The third component is the reduction in the value of farm asset due to foreclosure. This is the market value of assets,  $A$ , multiplied by the percent loss in asset value, 0.4, due to foreclosure.

By convention, the loan note would include a clause which requires the borrower to compensate the lender for costs and expenses incurred by the lender in collecting any past-due payments. This implies that all costs of foreclosure would be borne by the borrower. In this study, however, we assumed all foreclosure cost in excess of the borrower's ending equity,  $E$ , would be borne by the lender. This would occur due to farm bankruptcy or "goodwill" considerations by the lender. The foreclosure cost to the borrower,  $C_{f,b}$  is, thus,

$$(2) C_{f,b} = \text{Min}(E, C_f),$$

and the foreclosure cost to the lender,  $C_{f,l}$ , is

$$(3) C_{f,l} = \text{Max}(0, C_f - E).$$

The costs of foreclosure were included when calculating the NPVs.

## SIMULATION RESULTS

The representative farm was simulated assuming that wheat crop insurance was used and assuming that it was not used. When crop insurance was purchased, the highest yield protection and the medium price option were used (i.e., 75 percent of the actual production history [APH] yield was assumed to be insured at an insured price of \$2.80). This level of insurance was consistent with a study by Lovell et al. They found that the after-tax NPV for a representative wheat farm in Ochiltree County, Texas, was highest when the highest yield protection and the medium price option were chosen. The insurance

premium, obtained from the regional field office, Federal Crop Insurance Corporation (FCIC) and based on APH yield, was 6.1 percent (\$10.25 per acre) on irrigated wheat and 18.4 percent (\$9.27 per acre) on dryland wheat.

The representative farm was also simulated using alternative insurance loss ratios. The base insurance loss ratio was 0.36.<sup>1</sup> Loss ratios of 0.47, 0.58, 0.70, 0.81, 0.92, and 1.04 were also simulated by parametrically increasing the variability of wheat yields by 10, 20, 30, 40, 50, and 60 percent, respectively.

Results showed, from the lender's perspective, that farmers' use of crop insurance dominated not using crop insurance at all loss

ratios. In Table 1, we show that the mean NPV was greater and the standard deviation (SD) of NPV was lower when crop insurance was used at all loss ratios. Only modest differences in the mean, SD, and coefficient of variation (CV) of lender's NPV, were observed, however, when loan default due to farm failure was not a factor (Tables 1 and 2).

The representative farm with an insurance loss ratio of 0.36 or 0.47 did not fail, with or without crop insurance, over the six-year planning horizon (Table 2). Thus, loan default was not an issue and only minor changes were observed in the lender's performance measures when no crop insurance was used. These changes were due to different levels and pat-

TABLE 1. PERFORMANCE MEASURES FOR LENDERS UNDER INSURANCE ALTERNATIVES AND SELECTED LEVELS OF INSURANCE LOSS RATIOS

Insurance Loss Ratio <sup>a</sup>	Net Present Value of Lender Income					
	Crop Insurance			No Crop Insurance		
	Mean	Standard Deviation	Coef. of Variation	Mean	Standard Deviation	Coef. of Variation
	(\$1,000)	(\$1,000)	(%)	(\$1,000)	(\$1,000)	(%)
0.36	4.72	0.24	5.0	4.61	0.28	6.0
0.47	4.70	0.25	5.0	4.61	0.30	6.5
0.58	4.68	0.26	5.6	4.34	1.19	27.4
0.70	4.67	0.28	6.0	3.80	3.96	104.2
0.81	4.64	0.29	6.2	3.65	4.76	130.4
0.92	4.60	0.31	6.6	2.29	10.52	459.4
1.04	4.61	0.32	6.9	2.37	11.10	488.4

<sup>a</sup>Loss ratios are consistent with 0, 10, 20, 30, 40, 50, and 60% increases in wheat yield deviations.

TABLE 2. PERFORMANCE MEASURES FOR FARMERS UNDER INSURANCE ALTERNATIVES AND SELECTED LEVELS OF INSURANCE LOSS RATIOS

Insurance Loss Ratio <sup>a</sup>	Net Present Value of Farmer Income									
	Crop Insurance					No Crop Insurance				
	Mean	Standard Deviation	Coef. of Variation	Probability of Survival <sup>b</sup>	Mean	Standard Deviation	Coef. of Variation	Probability of Survival <sup>b</sup>	Pratt Risk Coef.	Implied Confidence Interval
	(\$1,000)	(\$1,000)	(%)	(%)	(\$1,000)	(\$1,000)	(%)	(%)		(%)
0.36	17.9	27.2	150	100	30.7	29.7	96	100	c	—
0.47	20.2	28.5	140	100	31.3	31.1	100	100	c	—
0.58	22.9	30.1	130	100	27.8	47.5	170	98	5.20E-6	54.78
0.70	25.6	31.8	124	100	25.3	58.5	230	96	d	—
0.81	28.0	32.8	117	100	26.0	59.7	229	96	d	—
0.92	30.7	33.8	110	100	19.1	77.0	400	92	d	—
1.04	33.8	35.5	100	100	19.3	79.3	410	92	d	—

<sup>a</sup>Loss ratios are consistent with 0, 10, 20, 30, 40, 50, and 60% increases in wheat yield deviations.

<sup>b</sup>Probability of survival is the probability that the farm will maintain its equity-to-asset ratio at or greater than minimum levels established by local financial institutions.

<sup>c</sup>The strategy of farmers' nonuse of crop insurance dominated using crop insurance for all levels of farmers' risk aversion.

<sup>d</sup>The strategy of farmers' use of crop insurance dominated not using crop insurance for all levels of farmers' risk aversion.

<sup>1</sup>Loss ratio is the ratio of expected insurance indemnity payments to the expected cost of crop insurance. Expected insurance indemnity was the mean indemnity based on a representative farm's yields over the past 10 years and the insured price of \$2.80. The expected cost of the crop insurance was the current cost of crop insurance. The insurance loss ratio for irrigated and dryland wheat were weighted by  $\frac{1}{3}$  and  $\frac{2}{3}$ , respectively, to obtain a combined loss ratio.

terms of borrowing under the stochastic simulation (Table 1).<sup>2</sup>

The probability of foreclosure was nonzero at insurance loss ratios of 0.58 and above (Table 2). When crop insurance was not used (loss ratio = 0.58), the lender's average NPV decreased by \$340 (Table 1). The SD of the lender's NPV and CV of NPV increased by \$930 and 21 percentage points, respectively. The lender's performance measures worsened as the insurance loss ratio was increased. At an insurance loss ratio of 1.04, for example, the lender's NPV decreased by \$2,240, and the CV increased by 459 percentage points. In these situations, lenders would clearly prefer a borrower's use of crop insurance.

Simulation results showed that crop insurance always decreased the farmer's SD of NPV but its effect on income depended on the loss ratio: at low loss ratios income was reduced as premium payments exceeded average insurance paybacks (Table 2). The strategy of a farmer's nonuse of crop insurance dominated using crop insurance for all levels of farmers' risk aversion when the loss ratio was 0.36 or 0.47. When the loss ratios were at or about 0.58, however, the farmer's mean NPV decreased sharply and the SD and DV increased sharply.<sup>3</sup> The crop insurance alternative dominated the alternative of not using crop insurance whenever the loss ratio was 0.70 or higher. A farmer's decision of using crop insurance depended on his risk/return preference when the loss ratio was 0.58.

Assuming constant absolute risk aversion, the Pratt risk-aversion parameter,  $\phi$ , was calculated such that decision makers were indifferent between farming situations that used crop insurance and those that did not (as suggested by Hammond or as implemented in the risk root procedure by McCarl). Values of the Pratt coefficient  $\phi$  were interpreted probabilistically following the arguments of McCarl and Bessler and assuming normality. Namely, given a Pratt coefficient of  $\phi$  and assuming the risk premium ( $1/2\phi\sigma^2$ ) is a multiple  $Z$  times the standard error implies that  $Z$  equals  $(\phi\sigma)/2$ .

Given the breakeven  $\phi$  value and the  $\sigma$  pertinent to the alternative allows  $Z$  to be calculated. In turn, the probability of that  $Z$  value was looked up in the standard normal table. A Pratt risk-aversion coefficient of 0.0000052 was required for the farm operator to be indifferent between purchasing crop insurance or not when the loss ratio was 0.58. Given a \$58,500 standard deviation of NPV under the above assumptions, the farm operator must discount risky alternatives by 0.124 standard deviations or more (54.8% confidence interval) in order to justify not buying crop insurance. This means that the farmer allows the outcomes in the 45.2% tail to cause the insurance option to be chosen. Results indicate, thus, that farm operators who conform to the farming situation with an insurance loss ratio of 0.58 or larger and are modestly risk averse (discount risky alternatives by 0.124 standard deviations or more) will choose crop insurance.

A potential conflict in the preference of a farmer's choice of crop insurance between a risk-averse farm operator and his lender was found for the farming situation with an insurance loss ratio of 0.58 or less. As previously noted, the crop insurance alternative dominated nonuse of crop insurance from the lender's perspective. Results showed, however, that risk-averse farmers would prefer not using crop insurance when insurance loss ratios were 0.48 or less and that some would prefer not using it when insurance loss ratios were 0.58 (Table 2). Potential conflicts were not found in the other farming situations modeled.

The lender's response of adding a premium to the interest rate was investigated. The difference in a farmer's average NPV and SD of NPV between nonuse and use of crop insurance decreased and increased, respectively, as a result of increases in interest rates (Table 3). The implied confidence interval required before a farmer would choose crop insurance decreased as the interest rate premium increased. This implies that fewer farmers would choose the no-insurance alter-

<sup>2</sup>The mean and standard deviation of the lender's NPV did not change significantly when crop insurance was not used and the probability of firm survival was 100 percent. Small increases in NPV occurred when more debt was used since the discount rate used was slightly smaller than the interest rate on intermediate- and long-term loans. The lender's average NPV, thus, was slightly larger when the borrower purchased crop insurance due to increased debt requirements. The lender's standard deviation of NPV also increased slightly when no crop insurance was purchased because the fluctuations in debt requirements increased as a result of financing yield losses.

<sup>3</sup>Crop insurance under the 1980 program revision is more attractive to farmers with greater yield variability, holding the mean yield constant. Under such a condition, the expected indemnities increase but the insurance premium does not. This contrasts with the previous crop insurance program. Premiums were based on district averages; thus, the less efficient farmers in terms of lower crop yields were favored. Our results show the shift to crop insurance premiums based on APH yields to correct this inequity has shifted the advantage to farmers who have more variable crop yields.

native in response to higher interest rate premiums. At one extreme, an interest premium of 0.2 percent or less, the strategy of a farmer's nonuse of crop insurance still dominated using crop insurance for all levels of the farmer's risk aversion, given an insurance loss ratio of 0.36. The combined effect of increased interest payments and increased likelihood of failure, on the other hand, resulted in the farmer's preference for crop insurance except for the less risk-averse and risk-loving farmers at interest premiums of 0.3 percent–0.4 percent (insurance loss ratio =

0.36) and 0.1 percent–0.2 percent (insurance loss ratio = 0.47). At the other extreme, the strategy of a farmer's use of crop insurance dominated not using crop insurance for all risk-averse farmers when interest premiums were 0.5 percent, 0.3 percent, and 0.1 percent under conditions of insurance loss ratios of 0.36, 0.47, and 0.58, respectively.

The results showed that crop insurance conflicts between the lender and farmer could be resolved by adding an interest rate premium in response to a farmer's nonuse of crop insurance. Both the farmer and the lender pre-

TABLE 3. DIFFERENCE IN FARMERS' PERFORMANCE MEASURES BETWEEN FARMERS' NONUSE OF CROP INSURANCE UNDER ALTERNATIVE LENDERS' INTERESTS RATE RESPONSE AND FARMERS' USE OF CROP INSURANCE

Difference in Net Present Value of Farmer's Income						
Interest Rate Premium (%)	Mean (\$1000)	Standard Deviation (\$1000)	Coef. of Variation (%)	Change in Probability of Survival <sup>a</sup> (%)	Pratt Risk Coef.	Implied Confidence Interval (%)
Insurance Loss Ratio = 0.36 <sup>b</sup>						
0.1	10.704	2.505	-45.52	0	c	—
0.2	9.056	2.698	-40.52	0	c	—
0.3	3.119	16.873	57.87	2.0	3.96E-6	53.59
0.4	0.987	16.672	80.30	2.0	1.52E-6	51.20
0.5	-8.036	33.275	458.81	6.0	d	—
Insurance Loss Ratio = 0.47 <sup>b</sup>						
0.1	5.007	17.428	39.45	2.0	5.55E-6	54.78
0.2	3.423	17.402	53.35	2.0	4.06E-6	53.59
0.3	-1.954	26.228	158.32	4.0	d	—
Insurance Loss Ratio = 0.58 <sup>b</sup>						
0.1	-0.500	26.10	120.40	4.0	d	—

<sup>a</sup>Probability of survival is the probability that the farm will maintain its equity-to-asset ratio at or greater than minimum levels established by local financial institutions.

<sup>b</sup>Loss ratios 0.36, 0.47, and 0.58 are consistent with 0%, 10%, and 20% increases in wheat yield deviations.

<sup>c</sup>The strategy of farmers' nonuse of crop insurance dominated using crop insurance for all levels of farmers' risk aversion.

<sup>d</sup>The strategy of farmers' use of crop insurance dominated not using crop insurance for all levels of farmers' risk aversion.

TABLE 4. DIFFERENCE IN LENDERS' PERFORMANCE MEASURES BETWEEN FARMERS' NONUSE OF CROP INSURANCE UNDER ALTERNATIVE LENDERS' INTERESTS RATE RESPONSE AND FARMERS' USE OF CROP INSURANCE

Difference in Net Present Value of Lenders' Income					
Interest Rate Premium (%)	Mean (\$1000)	Standard Deviation (\$1000)	Coef. of Variation (%)	Pratt Risk Coef.	Implied Confidence Interval (%)
Insurance Loss Ratio = 0.36 <sup>a</sup>					
0.1	1.633	0.091	0.15	b	—
0.2	3.378	0.141	− 0.34	b	—
0.3	4.856	1.580	13.97	5.09E-4	67.72
0.4	6.582	1.842	13.40	5.10E-4	69.85
0.5	7.761	3.146	13.40	4.41E-4	77.34
Insurance Loss Ratio = 0.47 <sup>a</sup>					
0.1	1.392	1.476	23.03	2.82E-4	59.48
0.2	3.097	1.748	20.16	3.36E-4	62.93
0.3	4.495	2.754	27.37	2.95E-4	67.00
Insurance Loss Ratio = 0.58 <sup>a</sup>					
0.1	1.042	2.640	45.08	1.33E-4	67.53

<sup>a</sup>Loss ratios 0.36, 0.47, and 0.58 are consistent with 0%, 10%, and 20% increases in wheat yield deviations.

<sup>b</sup>The strategy of farmers' nonuse of crop insurance dominated using crop insurance for all levels of lenders' risk aversion.

ferred that the farmer did not use crop insurance when the insurance loss ratio was 0.36 and the interest rate premium was less than 0.2 (Tables 3 and 4). Under these conditions the interest premium was sufficiently high to make the loan attractive to the lender but not so high that the likelihood of farm failure increased or discouraged farmers from choosing the no-insurance option. The conflict was also resolved by lenders charging an interest rate premium sufficient to encourage all risk-averse farmers to buy crop insurance: 0.5 percent (insurance loss ratio = 0.36), 0.3 percent (insurance loss ratio = 0.47), and 0.1 percent (insurance loss ratio = 0.58).

Potential conflict still existed when the interest rate premiums were 0.3 percent–0.4 percent (insurance loss ratio = 0.36) and 0.1 percent–0.2 percent (insurance loss ratio = 0.47). The increase in profits from interest payments was dampened somewhat by the increased likelihood of loan default. Under these conditions the lender's preference for farmer's use of crop insurance was dependent on lender's level of risk aversion. A highly risk averse lender may prefer that the farmer use crop insurance but a farmer that is not very risk averse may prefer the option of not using crop insurance. Thus the potential conflict remained.

Regardless of the interest rate premium a lender charges in response to a farmer's nonuse of crop insurance, some farmers who

are not risk averse may choose to pay the premium to avoid purchasing crop insurance. Results showed that adding a premium to interest rates increased the lender's average NPV when farmers chose nonuse of crop insurance; however, the SD of NPV also increased (Table 5). The lender's strategy of charging an interest rate premium of 0.2 percent or less was preferred to the nonresponse strategy when farmers opted to not use crop insurance (insurance loss ratio = 0.36). This was true for all levels of lender's risk aversion. For other levels of interest rate premiums and insurance loss ratios, results showed that the lender's response would depend on the level of lender's risk aversion in situations where the lender was sure that crop insurance would not be used even if an interest rate premium was charged.

We conclude from these results that in this case lenders should encourage their borrowers to buy crop insurance by adding a premium to the interest rate charged to borrowers who choose nonuse of crop insurance. The premium amount would depend on the lender's risk-aversion level. Only the less risk-averse lenders, however, should use this strategy on borrowers who are not likely to use crop insurance when an interest premium is charged. Only in those situations where the insurance loss ratio was 0.36 would it be preferred by all risk-averse lenders to charge an interest rate premium of 0.2 percent.

TABLE 5. DIFFERENCE IN LENDERS' PERFORMANCE MEASURE BETWEEN FARMERS' NONUSE OF CROP INSURANCES UNDER ALTERNATIVE LENDERS' INTEREST RATE RESPONSE AND FARMERS' NONUSE OF CROP INSURANCE WITH NO PENALTY

Difference in Net Present ----- Value of Lenders' Income -----						
Interest Rate Premium (%)	Mean (\$1000)	Standard Deviation (\$1000)	Coef. of Variation (%)	Change in Probability of Survival <sup>a</sup> (%)	Pratt Risk Coef.	Implied Confidence Interval (%)
Insurance Loss Ratio = 0.36 <sup>b</sup>						
0.1	1.737	0.050	-0.8543	0	c	—
0.2	3.483	0.100	-1.3502	0	c	—
0.3	4.961	1.539	12.967	2.0	5.18E-4	68.74
0.4	6.686	1.801	12.391	2.0	5.18E-4	70.54
0.5	7.865	3.105	21.104	6.0	4.45E-4	77.34
Insurance Loss Ratio = 0.47 <sup>b</sup>						
0.1	1.476	1.423	21.783	2.0	2.90E-4	59.87
0.2	3.182	1.683	18.923	2.0	3.40E-4	63.31
0.3	4.579	2.702	26.136	4.0	2.98E-4	67.36
Insurance Loss Ratio = 0.58 <sup>b</sup>						
0.1	1.391	1.005	6.923	2.0	2.20E-4	62.55

<sup>a</sup>Probability of survival is the probability that the farm will maintain its equity-to-asset ratio at or greater than minimum levels established by local financial institutions.

<sup>b</sup>Loss ratios 0.36, 0.47, and 0.58 are consistent with 0%, 10%, and 20% increases in wheat yield deviations.

<sup>c</sup>The lenders' strategy of charging a higher interest rate to uninsured borrowers dominated the nonresponse strategy for all levels of lenders' risk aversion.



## SUMMARY AND CONCLUSIONS

In this paper, we evaluate the effects of a farmer's choice of crop insurance on the farmer's and his lender's performance. The results show that crop insurance uniformly decreases farmer income variability but that the effect on income level depends on the variability of yields. In an area situation where the premium depends on average yield rather than yield variability, the results show that increases in variability increase the incentive for farmers to adopt crop insurance. Simultaneously, the results show the lender to always prefer crop insurance. This was especially true when yield variability led to farm failure. This revealed a conflict in that crop insurance may be preferred by lenders but not by farmers. A small risk premium

charged by the lender proved to be sufficient incentive to cause risk-averse farmers to adopt crop insurance.

There are two implications of this research. First, it appears that the current design of crop insurance programs favors farmers who have higher variability relative to other farmers in their area. Second, it appears that in this case lenders should prefer their clients to use crop insurance, especially whenever farm failure is an issue, and that a small interest rate premium is sufficient to cause this shift. If a farmer chooses not to use crop insurance for whatever reason, however, a higher average return to the lender would be accompanied by an increase in the likelihood of loan default.

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