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Provision of a Safety Net for U.S. Agriculture

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Abstract
Provides insight into three current agricultural risk management policy issues: (1) What are the benefits to farmers of utilizing agricultural insurance products? (2) How do commodity loan rates complement or not the benefits of insurance coverage? (3) What are the incentives for producers to include insurance products in their risk management strategies?

Disciplines
Agricultural and Resource Economics | Agricultural Economics | Economic Policy | Public Economics

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PROVISION OF A SAFETY NET FOR U.S. AGRICULTURE

This briefing paper provides insight into three current policy issues:

- What types of agricultural insurance products provide the most insurance benefits to farmers?
- How are insurance benefits affected by the loan rate provisions of agricultural commodity policy?
- How can insurance products be designed to meet farmers' demands for more coverage at an affordable price?

Numerical simulations of representative farms in Iowa and North Dakota are used to gain insight into these questions.

THE SHARP DECLINE in commodity prices in 1998 stepped up momentum for development of an improved U.S. agricultural safety net. There is no consensus, however, about which policy path to follow, although a disaster assistance package passed by Congress before adjournment for the 1998 elections provides clues about the direction policy will travel.

Congressional democrats proposed to raise floor prices by unfreezing commodity loan rates. Republicans proposed and passed additional transition payments to be paid in 1998. These additional transition payments were made to all eligible farmers, presumably to compensate them for low prices. In addition, those farmers who experienced crop losses received double insurance indemnities if they had purchased crop insurance, and single indemnities if they had not.

There are two lessons to be learned from passage of the 1998 assistance package. First, political support for agricultural subsidies remains strong. Second, there seems to be a need to justify these subsidies as compensation for hard times. The additional transition payments compensated producers for low prices and the disaster payments compensated producers for crop losses. Thus, given the current political and economic environment, Congress seems poised to expand federal involvement in agriculture, and that involvement is likely to take the form of a safety net.

The phrase "safety net" conjures an image of a trapeze artist who, through no fault of his own, finds himself falling to earth only to be saved by a net. The net for the trapeze artist is analogous to an insurance policy. The insurance premium is the cost of acquiring the net, setting it up and taking it down for each performance.

An indemnity is collected only if the artist falls. If the expected, or long-run average value to the artist of the indemnity is greater than the cost of the premium, the insurance policy is purchased (a net is used). This analogy suggests that estimation of the benefits, or value, of alternative agricultural insurance schemes will provide insight into determining how a safety net for agriculture should be developed.

What Is Agricultural Insurance?

An insurance policy is a contract that pays an indemnity to the insured when a covered peril occurs. In agriculture, perils abound. Crops can be damaged from disease, drought, flood, insects, weeds, hail, wind, loss of irrigation water, freezes, temperature and excess heat. And livestock can be lost due to hazardous weather. Other perils include low prices for crops due to unexpected shifts in demand, or bumper crops and high prices for inputs, such as feed, fuel, fertilizer, and capital.

These perils create a demand for an insurance contract that compensates the contract owner for damage caused by the peril. For many perils, the willingness to pay for such a contract exceeds the actual expected monetary loss.[1] This enhanced willingness to pay can occur because of the realization that the impact of some losses can be devastating. For example, a crop loss may lead to a loss of financing, which could lead to the loss of the farm. A producer's willingness to pay to remain on his or her farm may be greater than the expected loss on a policy that covers the crop loss.

An enhanced willingness to pay creates the possibility that an insurance company will be there to cover the peril. The insurance company will require a premium that covers

- the expected loss from the peril;
- the cost of writing and adjusting the policy; and
- the opportunity cost of investment.

Only when the willingness to pay to cover the peril is equal to or greater than the total premium required for an insurer to cover the peril, will private insurance markets emerge.[2]

Thus, an assessment of producers' willingness to pay for coverage of loss due to peril will determine whether a program or product has safety net characteristics. An equivalent assessment is to calculate how much the safety net program or product increases the benefit from farming as measured by certainty equivalent returns.[3]

The insurance products that increase the benefit from farming by little more than the expected loss (which equals the average insurance indemnity) from insuring a peril are not consistent with a safety net policy objective. Those that greatly exceed the expected loss are the programs that will give the greatest return to government investment in agriculture. Not surprisingly, the products where the expected loss is small relative to the change in farming benefit are those that would most likely be provided by the private insurance market.

Willingness to Pay to Avoid Risk

A representative 500-acre farm in Black Hawk County, Iowa, is used in our examination of willingness to avoid risk. This farm has 250 acres of corn and 250 acres of soybeans. The operation faces two primary sources of risk: price and yield. Expected price at harvest is $2.15/bu for corn and $4.81/bu for soybeans. Expected yield is 130 bu/ac for corn and 40 bu/ac for soybeans.

The amount of price risk can be estimated from the Chicago Board of Trade implied volatility report. For this farm, price volatilities are 0.20 for corn and 0.18 for soybeans. The amount of yield risk that this farm faces can be inferred from the premium charged for federal crop insurance. For this farm, the base premium rate for crop insurance is 3.6 percent for corn and 2.6 percent for soybean at the 65 percent coverage level.

This farmer cares about the amount of net revenue his 500 acres will generate in a year. But, given the large amount of yield and price risk, he cannot be certain what the revenue will be. Figure 1 shows two characterizations of the revenue risk faced by this farmer as of March 15, 1999. The bar chart is a histogram. The horizontal axis shows the revenue outcomes that are possible. As shown, per-acre revenue can range from about $50/ac to over $500/ac for this farmer. The height of the bar equals the probability that actual revenue outcome will fall in a given revenue "bin." Because the histogram shows all possible outcomes, the height of all bars added together equals 1.0.[4]

The line chart in Figure 1 is the cumulative distribution function of revenue risk. It shows the same risk as the histogram but now the vertical axis measures the probability that gross revenue will be less than or equal to a given value. As shown, there is about a 35 percent chance that gross revenue will be less than $200/acre.[5] And, there is an 80 percent chance that revenue will be less than $300. Thus, there is a 45 percent chance that revenue will be between $200 and $300 per acre.

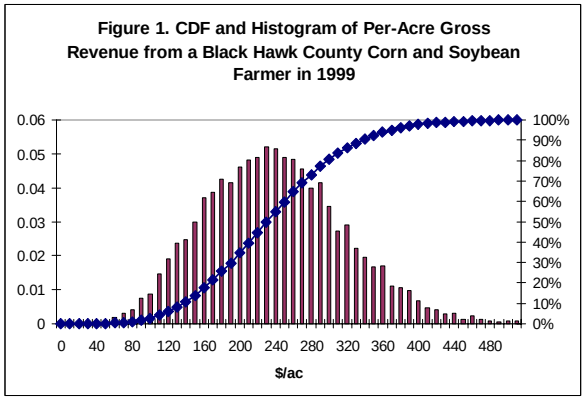


Figure 1. CDF and Histogram of Per-Acre Gross Revenue from a Black Hawk County Corn and Soybean Farmer in 1999

Most agricultural producers would prefer to avoid the type of risk shown in Figure 1. This risk makes planning difficult and raises the possibility of bankruptcy. The expected value of revenue is about $234/ac. If offered a choice between a certain $234 and the risk shown in Figure 1, most producers would choose the certain $234.

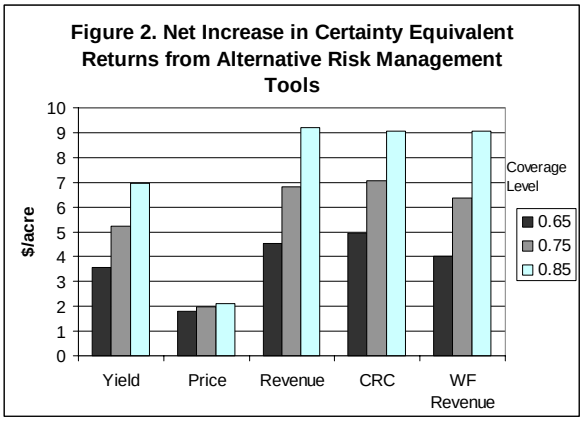
This preference suggests that many producers would also be willing to pay something for certainty. That is, they would be willing to pay an insurance premium in order to receive the $234 and not face the risk. Their net position after paying the premium is $234 less the premium. We can judge a producer's aversion to risk by estimating the maximum the producer would be willing to pay to avoid the risk and obtain the $234. In the calculations that follow, our representative producer would be willing to pay a maximum of $18/ac ($9000 for the 500-acre farm) to avoid the risk. This willingness to avoid risk creates an opportunity for development of insurance markets.

Insurance Benefits of Alternative Products

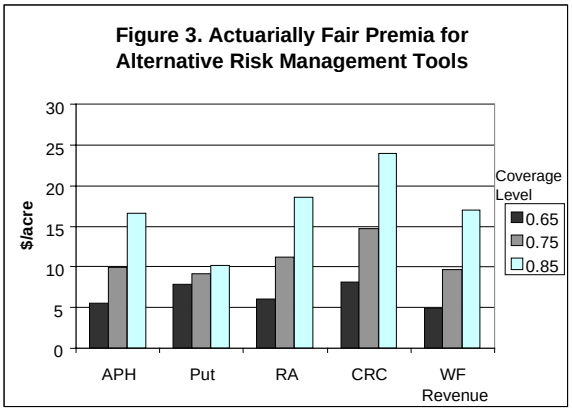
A variety of insurance products is currently available to our Iowa corn-soybean farmer. These include yield insurance, which pays an indemnity when yield is low; price insurance, which covers low prices; and revenue insurance, which covers low gross revenue (price $\times$ yield). In addition, there exists "combined crop" revenue insurance, which pays when corn revenue plus soybean revenue is low.[6]

Figure 2 shows the per-acre net producer benefits from these products for three coverage levels. Net producer benefit equals the change in the certainty equivalent returns from farming this land with the producer paying the actuarially fair value of the insurance product.[7] The yield insurance covers 65 percent, 75 percent, and 85 percent of expected yield of corn and soybeans separately. The revenue insurance product and CRC[8] covers 65 percent, 75 percent, and 85 percent of expected price times expected yield for each crop separately. The price insurance offers put options with a strike price, 3 percent out of the money on 65 percent, 75 percent, and 85 percent of expected production. And the combined crop revenue insurance (WF Revenue in Figure 2) covers 65 percent, 75 percent, and 85 percent of the acreage-weighted average of expected price × expected yield for each crop.

As shown in Figure 2, the net benefit to the three revenue insurance products is greater than the net benefit to the yield product or the two price products. This should not be too surprising because utility is defined on revenue. What may be



surprising is the low insurance benefit of price insurance tools relative to the yield insurance. The reason for this is that the main source of risk within a growing season is yield, not price. Hence, even after a put option on price is purchased, the farmer still faces significant revenue risk because of yield variability.



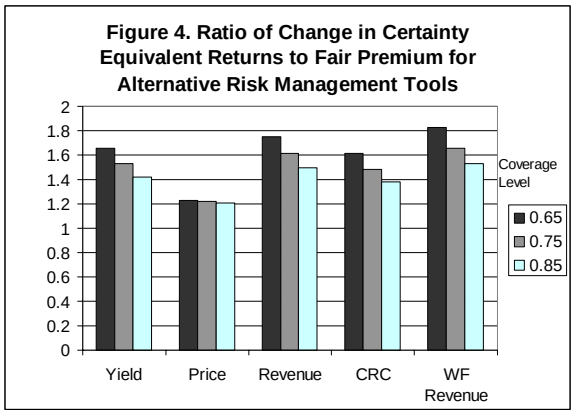
Of course, a positive net benefit is not the only determinant in whether farmers will actually purchase an insurance product. A positive net benefit simply suggests that a market might emerge. A practical factor influencing producers' purchase decisions is the magnitude of the insurance premium. The fair premiums for the products illustrated in Figure 2 are shown in Figure 3. A comparison of Figures 2 and 3 show that there is not a one-to-one correspondence between net benefit and premium. That is, those products that cost more do not necessarily return the most in insurance benefit. For example, CRC costs significantly more than the combined crop revenue insurance product but it does not yield significantly more insurance benefits. And the price insurance at a 65 percent coverage level costs more than the other products but returns far less in net benefits. An alternative measure of benefit is shown in Figure 4 where the ratio of benefits to cost is graphed. If the ratio equals 1.0, then a private market for insurance will not emerge.

As shown in Figure 4, yield and revenue insurance all have benefit-cost ratios

between 1.4 and 1.8, which correspond closely with published ratios.[9]

Effect of Loan Deficiency Payments on Insurance Benefits

The high benefit-to-cost ratios of the revenue products are not surprising because revenue risk is the risk that affects utility. But are these high ratios maintained when the price protection from loan deficiency payments (LDP) are available to farmers? Farmers are eligible to receive an LDP when the posted county price falls below the county loan rate. The size of the LDP



equals the difference between the loan rate and the posted county price multiplied by harvested production. The loan rates for the example farm in Black Hawk County are $5.10/bu for soybeans and $1.80/bu for corn. The expected local price (a proxy for the posted county price) for this example farm is $4.81/bu for soybeans and $2.14/bu for corn. The per-bushel expected value of the LDP is $.497 for soybeans and $.054 for corn.

Some have called the LDP a put option on price with the loan rate being the strike price. But a significant difference between a put option and an LDP is that the LDP pays off on harvested bushels whereas the put option pays off on a fixed number of bushels specified in the contract.

Table 1 shows the effect on the net insurance benefit from the LDP. The entries are the percentage change in the change in certainty equivalent returns due to the insurance product. As shown, the LDP actually increases the insurance benefit of yield insurance by between 15 percent and 16 percent. The LDP has little effect on the single crop and combined crop revenue insurance. The net benefit of CRC increases by a small amount. Not surprisingly, the largest change in insurance benefit is with price insurance, where nearly all the benefits are replaced by the LDP. This suggests that the demand for put options on the Chicago Board of Trade is quite strongly affected by the LDP in 1999.

It seems surprising that the insurance benefits of the revenue insurance products are not adversely affected by LDPs. After all, revenue insurance is valuable because it protects a producer against declines in either price or yield. The LDP should substitute for the price component of revenue

Table 1. Percentage change in insurance benefit due to LDP

	Coverage Level		
	65%	75%	85%
Yield Insurance	15.0%	15.6%	16.2%
Price Insurance	-81.5%	-84.9%	-88.7%
Revenue Insurance	1.9%	0.5%	-1.0%
CRC	6.7%	5.7%	4.9%
Combined Crop Revenue Insurance	1.2%	0.2%	-3.2%

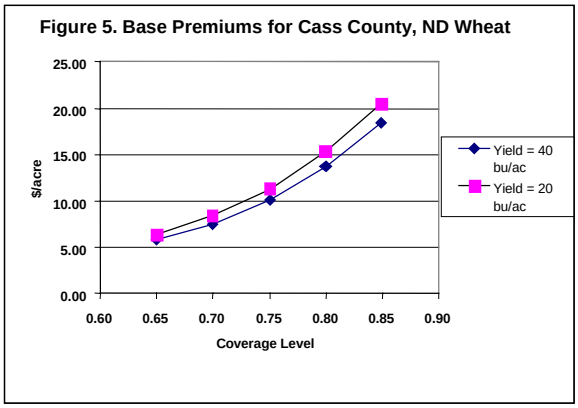
insurance. But what must be remembered is that, for this example farmer, yield risk is the single most important source of revenue variability. The LDP option does nothing about this source of risk, so revenue insurance still provides a significant amount of coverage. Also, the amount of price protection offered by LDPs depends on harvested production, not actual production. So, when both price and yield are low, the LDP does not offer much insurance benefit. The LDPs pay off the most when price is low and yield high (as occurred in Iowa in 1998). For many farmers a low price and a high yield imply a high gross revenue, and price protection does not offer significant insurance benefits.

Increased Coverage Levels

One of the complaints heard from farmers is that they need greater insurance coverage at affordable prices. As shown in Figure 2, the net insurance benefit increases as coverage level increases. But Figure 4 shows that the benefit-to-cost ratio declines as coverage level increases, which means that the actuarially fair premiums rise faster than the insurance benefit as coverage increases. Figure 4 results indicate that as measured by a benefit-to-cost ratio, increased coverage increases total benefits, but at a declining rate. This suggests that farmers may benefit from coverage levels in excess of 75 percent, which is the maximum coverage level available on a widespread basis under USDA crop insurance programs.

In response to perceived demand, USDA's Risk Management Agency (RMA) is offering 80 percent and 85 percent coverage in selected counties and for selected crops under the APH (yield insurance) program. One of these counties is Cass County, North Dakota, for wheat.

Figure 5 shows the base (unsubsidized) premium for two farms in Cass County. One farmer has an expected yield of 40 bu/ac, the other has an expected yield of 22 bu/ac. As shown, the per-acre premiums are not that far apart. This implies that the premium rate ($ of premium per $ of liability) for the low-yield farmer is much higher than for the high-yield farmer.



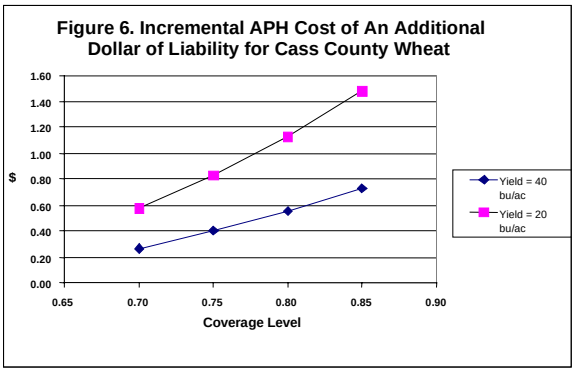
The most popular level of coverage available across most areas of the United States is 65 percent even though 75 percent coverage has always been available. How likely is it that producers will opt for more than 75 percent coverage when they believe the level of coverage is too expensive? One cannot answer this question merely by looking at the level of premium shown in Figure 5. Premium is calculated by applying a premium rate to an amount of liability. The premium rate is an average rate because it applies to all dollars of liability.

To determine if a producer will find it beneficial to purchase additional coverage (liability), it is more instructive to consider the additional premium per additional dollar of liability. If the additional or marginal cost is excessively high, then producers won't buy the additional coverage.

There is a logical maximum limit above which marginal cost should not rise. Consider the cost of the dollar of liability that results in a 100 percent coverage level.

With a symmetric yield distribution, there is a 50 percent chance that an indemnity will be paid on this dollar. There is also a 50 percent chance that it won't be paid. Thus, the expected indemnity on this last dollar is $0.50. So, the marginal premium rate is 50 percent. This is the maximum marginal premium rate because the probability of a loss on the dollar of liability typically declines as coverage level decreases.

Figure 6 shows the marginal cost of additional liability to our Cass County wheat farmer. As shown, the marginal cost exceeds $0.50 for the 40 bu/ac farm as coverage goes from 75 to 80 percent and from 80 to 85 percent. The marginal cost exceeds $0.50 for the 22 bu/ac farmer even as coverage goes from 65 to 70 percent. It actually exceeds $1.00 as coverage goes



from 75 to 80 percent and from 80 to 85 percent. That is, this producer would be paying more premium than he receives in increased liability.

Clearly, this producer, if he buys crop insurance, would purchase only the 65 percent level. All other levels of insurance are simply worth more than he could ever find valuable.

How can RMA justify such high marginal rates? There are two possible justifications. The first is that such high rates are justified if insurance fraud is increasingly likely at high coverage levels. This fraud could result in, at the limit, a 100 percent chance of paying out an indemnity, thus justifying a high rate. The implication is that any producer who purchases 80 to 85 percent wheat coverage in Cass County should be the target of a fraud investigation.[10]

The second justification is that RMA has no freedom to set lower marginal rates because of restrictions on its rate-making procedures. RMA attempts to set actuarially fair rates at the 65 percent coverage level based on historic loss data. The 65 percent rates are subsidized by a factor of 41.7 percent. RMA is forced to hold the per-acre subsidy constant and use subsidy factors of 31.9 percent for 70 percent coverage and 23.5 percent for 75 percent coverage. Thus the 70 percent and 75 percent premiums are determined solely by these subsidy factors.

To illustrate, the per-acre premium subsidy for our North Dakota wheat farmer is $2.39/ac for the 40 bu/ac farm. This implies that the 70 percent premium must equal $7.49/ac (7.49 = 2.39/.319) and the 75 percent premium must $10.17/ac (10.17 = 2.39/.235). The relationship between the subsidy factors determine the rates as coverage levels increase. The "rate relativity" between 70 percent and 65 percent coverage is 1.31. That is, 70 percent premiums equal 65 percent premiums multiplied by 1.31. The 70 to 75 percent rate relativity equals 1.35.

The rate relativities between 75 percent and 80 percent coverage and between 80 percent and 85 percent coverage are also 1.35 in Cass County. It seems that RMA simply applied the 70 to 75 percent rate relativity to the higher coverage levels. The results are the high marginal rates shown in

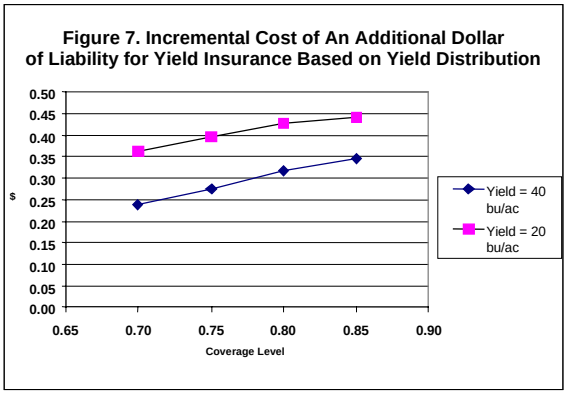
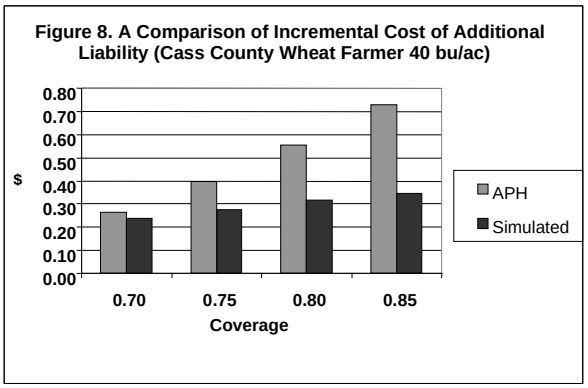


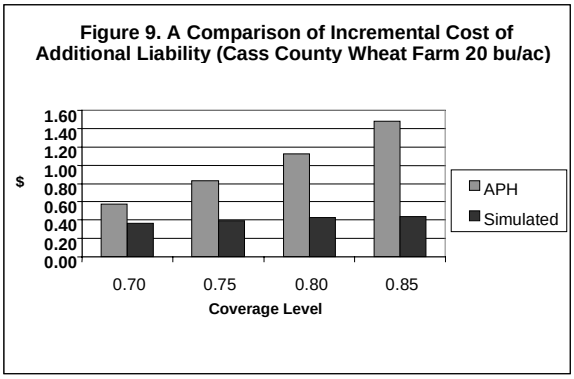
Figure 5. Clearly these high marginal rates do not meet the request by farmers for higher coverage levels at affordable prices.

If increased coverage is a policy objective, how can APH rates be set to make higher coverage levels affordable? The preferred approach is to set base premium rates so that they reflect actual risk as shown in Figure 1. That is, the rates should be based on a well-defined distribution. When this is done, the marginal cost of additional liability is much lower as shown in Figure 7. Figures 8 and 9 show a comparison RMA yield insurance rate and distribution-based insurance rates.



But simply basing rates on a well-defined distribution does nothing about an increased propensity to commit fraud as coverage increases. Evidence for insurance fraud is that the loss ratios at 75 percent coverage are generally higher than at 65 percent coverage even though as one goes from 65 percent to 75 percent coverage the rate increase is greater than the expected increase in losses based solely on a well-defined yield distribution.

There are two approaches that can account for fraud. The first is to explicitly load rates for fraud. If this results in rates that are too high, then so be it—and nobody will purchase the insurance. The disadvantage of this approach is, as mentioned above, the farmers who purchase fraud-loaded insurance will be those who expect to benefit from it. This will be either extremely risk averse individuals or those who will commit greater fraud than the load assumes.



An alternative approach is to offer insurance products that reduce the incentive to commit fraud. Fraud reduction can be obtained by insuring multiple enterprises on a single insurance contract. These enterprises can be multiple locations where the same crop is grown, or multiple crops, or both. The incentive to commit fraud is lowered for multiple locations because it makes it more difficult to move production from unit to unit. One possible means of making a fraudulent insurance claim is to take production from one location to another and make a claim on one of the locations. Such movement would be pointless if both locations were insured together.

The incentive to commit fraud is also lower when multiple crops are combined. Consider the Webster County corn and soybean farmer. Suppose the soybean crop didn't look like it was going to yield well, and the farmer was considering reducing its care in the hope of collecting an insurance indemnity. The problem with this course of action is that the farmer runs the risk of the corn revenue coming in at a high level and more than compensating for the lost soybean revenue. Thus, the actions taken would end up hurting the farmer.

Thus, enterprise coverage and combined-crop or whole-farm insurance policies can lower the incentives to commit fraud thus allowing actuarially fair rates to be implemented. In addition, enterprise and combined crop policies offer the benefit that the actuarially fair insurance premium rates decline, thus allowing producers to purchase more coverage without increasing premiums. This decline in premium is due to spatial diversification and/or crop diversification.

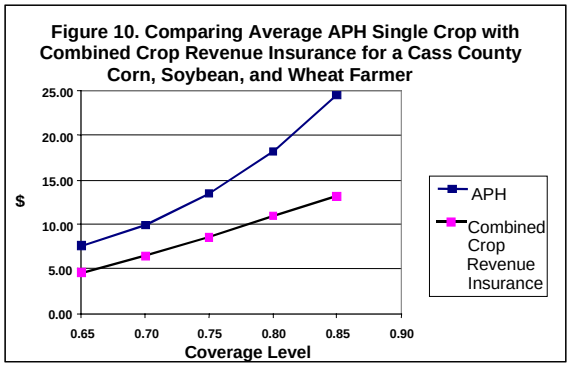
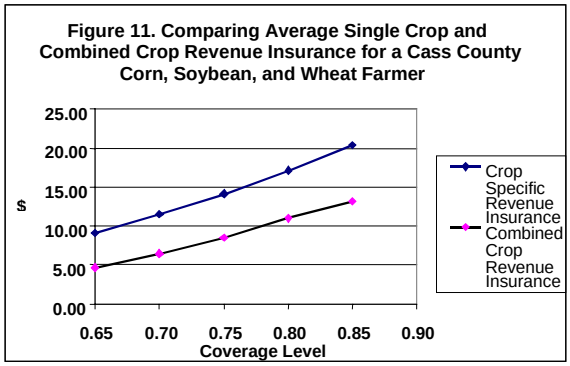


Figure 10 shows how combined crop revenue insurance premiums compare to the average single crop premium for a corn-soybean-wheat farmer in Cass County, North Dakota. This farmer is assumed to plant equal acres of each crop. As is readily apparent, one option for meeting the farmer request for additional coverage at affordable prices is to offer whole-farm policies. The premium for 85 percent combined crop coverage is about equal to the premium for 75 percent single crop yield insurance, and about half the premium for single crop yield insurance at 85 percent coverage. Thus, whole-farm coverage allows a producer to pay significantly less for the same coverage level or to pay the same premium but obtain a significantly greater coverage level.

Of course, one objection to the comparison in Figure 10 is to point to the results in Figure 7 that show the premiums for yield insurance are loaded for fraud



whereas the premiums shown in Figure 10 for combined crop revenue insurance are not. Thus, to show the effects on premium from combining units, Figure 11 compares the average premium for single crop revenue insurance for the Cass County corn-soybean-wheat farmer to the premium for a whole-farm revenue insurance. The premium for 85 percent coverage is below the average single-crop premium at 75 percent coverage. And the 85 percent premium for whole-farm coverage is 35 percent below the average single-crop premium at 85 percent.

Concluding Remarks

Routing government subsidies to agriculture through provision of an improved safety net for farmers seems inevitable in 1999. But disagreement about what constitutes a safety net and how to

improve the existing crop insurance policy is a source of contention. Some argue that a safety net is provided with higher guaranteed prices. Others argue that crop insurance should be expanded in terms of available coverage levels and the number of crops covered. And some argue for whole-farm revenue insurance policies that cover crops as well as livestock.

This briefing paper shows that for Midwestern crop production, yield or revenue insurance policies provide the greatest level of insurance benefits, with revenue insurance providing the greatest benefits, both in levels and benefits per dollar of insurance premium. Price insurance provides relatively few insurance benefits to Midwestern crop producers.

Simulation results also show that LDPs complement yield insurance in the sense that the existence of LDPs increases the insurance benefits of yield insurance. LDPs have little effect on the insurance benefits from revenue insurance, whereas they are nearly perfect substitutes for price insurance. And finally, current rates for yield insurance at the high coverage levels available in 1999 on a pilot basis are so high that they do not provide a basis for a better safety net. Combining insurance units of the same crop or combining crops into a whole-farm revenue insurance policy is a viable option to provide increased coverage level at a reasonable premium without encouraging insurance fraud.

Endnotes

1. The expected monetary loss is the average indemnity paid over many insurance policies in a given year or paid on a single policy over many years.
2. Of course, premium subsidies can increase the demand for insurance sufficiently to create a market.
3. Certainty equivalent returns from farming is the maximum amount of money that an individual would pay to take a farming risk.
4. Prices are assumed to be log normally distributed and yields follow a beta distribution. Corn and soybean yields are correlated at +0.7 corn and soybean prices are correlated at 0.8. Price-yield correlations are -0.4 for corn and -0.2 for soybeans. These correlations are consistent with those used to rate Revenue Assurance.
5. The same 35 percent can also be found in Figure 1 by adding the height of all bars that are to the left of 200.
6. Revenue Assurance offers a combined crop revenue insurance policy to corn and soybean growers in Iowa, Minnesota, South Dakota, North Dakota and Illinois. In addition, corn-soybean-wheat insurance is offered to North Dakota producers.
7. A negative exponential utility function was used with a risk aversion coefficient set so the risk premium without insurance equals 20 percent of the standard deviation of gross revenue without insurance.
8. The product labeled CRC performs the same as the commercial product of the same name in that the revenue guarantee increases if the harvest price is greater than the springtime price.
9. See Hennessy, D., B. A. Babcock, and D. Hayes. "The Budgetary and Producer Welfare Effects of Revenue Assurance," *American Journal of Agricultural Economics*, 79(August 1997):1024-34.
10. An important caveat to this statement is that the presence on available premium subsidy may make 80 percent corn attractive to some wheat farmers in Cass County