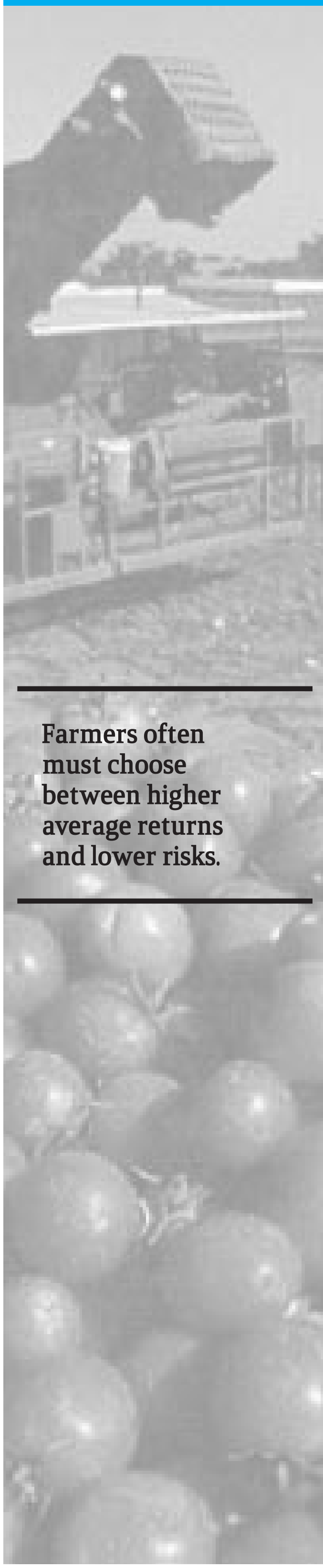
Some Practical Aspects of Farm Risk Management



Farmers often must choose between higher average returns and lower risks.

To get desirable combinations of risk and return, farmers must selectively and carefully use the various risk management tools available to them. Only tools that have good prospects for reducing income uncertainty or increasing expected income are candidates. This section considers certain practical aspects of risk management, which are easily overlooked or contrary to intuition.

Risk management implies different things for different people, depending on their attitudes toward risk, their financial situations, and the opportunities available to them. In some cases, managing risk involves minimizing risk for a given level of expected output or revenue. In other cases, it involves keeping risk within bounds while seeking higher expected returns. More generally, the goal of risk management is to obtain the best available combination of expected income and income certainty, given the individual's resources and risk preferences.

Farmers Often Are Willing To Accept Higher Risks To Obtain Higher Incomes

Farming, like any business enterprise, involves taking risks to obtain a higher income or higher satisfaction than might be obtained otherwise. Some farmers appear to virtually disregard risk. But for most, the amount of risk that can be accepted is limited. Thus, risk management is not a matter of minimizing risk, but of determining how much risk to take, given the farmer's alternatives and preference tradeoffs between risk and expected return.

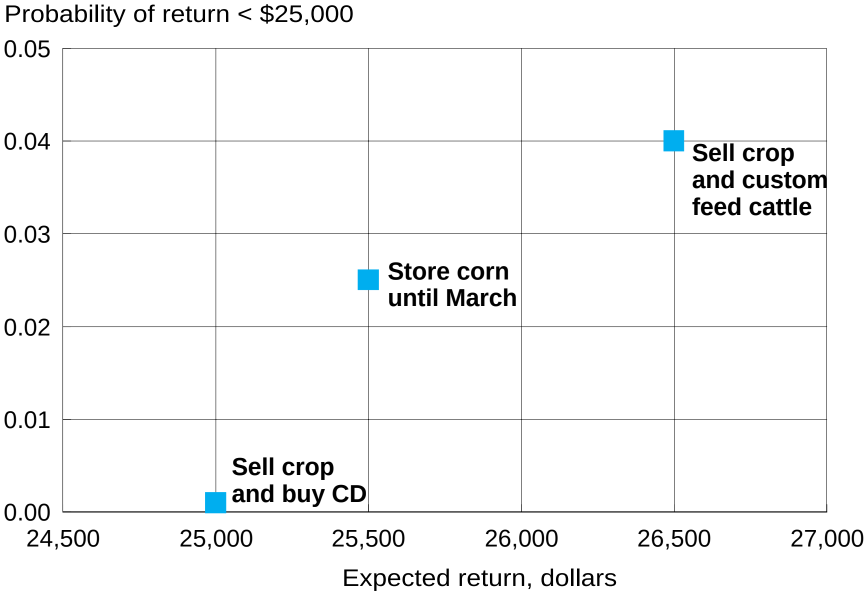
To use an example, consider a producer who has just harvested 10,000 bushels of corn and is examining three alternatives: (1) selling the crop and placing the income in a certificate of deposit (CD); (2) storing the corn until March, or (3) selling the crop and using the returns to custom feed cattle. Figure 18 shows expected outcomes for the three strategies in terms of expected profit on the horizontal axis and the probability of return less than $25,000 on the vertical axis. The CD provides zero probability of loss and the lowest expected profit, the cattle feeding alternative offers the highest risk and highest expected return, and the storage alternative is in the middle.

For farmers having similar wealth and farming situations, the most risk averse would likely choose the certificate of deposit. Those who are less risk averse would be more likely to choose storage. The least risk-averse farmers would tend to choose feeding cattle, the riskiest choice among the alternatives, but also the strategy with the highest expected return. In short, optimal choices under risk for producers in similar situations can differ widely among individuals.

Crop Insurance and Forward Pricing Generally Can Reduce Income Uncertainty at Very Low Cost

Reducing risk generally involves some cost or reduction in expected

Figure 18
Risk and return for alternative uses of a 10,000-bushel corn crop



Source: Hypothetical example developed by ERS.

income. Consider Farmer Smith, for example, who is contemplating diversification, but knows that his expected net returns are maximized by planting continuous cotton. By diversifying into other crops, all of which have fairly stable (but relatively low) yields, Farmer Smith estimates that he reduces his average net return by about 15 percent. He calculates that the standard deviation in his income, however, is likely to be about 20 percent lower because the net returns to the various different crops he is considering are less than perfectly correlated. In this example, undertaking a risk-reducing strategy results in substantially lower net returns to Farmer Smith, which he must weigh relative to the benefits of lower income risk.

In contrast, strategies, such as hedging in futures, buying options, or forward contracting with a local elevator, tend to lower risk with little change in expected net returns. The low cost of forward pricing occurs because futures prices exhibit little bias, meaning that the price for each trade closely approximates the price then expected to prevail when the contract matures. Most studies have found little or no bias in futures prices for commodities, such as grains, with active trading and substantial long as well as short hedging, but not all analysts agree (see Zulauf and Irwin).

Farmers who hedge directly in futures incur costs for commissions and interest forgone on margin deposits, but these generally sum to less than 2 percent of the value of the product. When options are used, a premium must be paid but, on average, the option holder gets the premium back as gains from exercising or selling the options. Farmers' costs also typically are low when crops are forward priced through contracts with local buyers. No commissions or margins are required from the farmer, although the buyer typically incurs such costs to hedge his or her position. Many country elevators appear willing to bear these costs in order to assure a timely flow of commodities into their facilities. Some may pass along part of their hedging costs to farm-

Crop insurance and forward pricing are ways to lower risk with little sacrifice in expected returns.

ers through a wider basis and thus a slightly lower price for forward contracts than expected to prevail at harvest time.

Unlike most risk management tools, crop-yield insurance and the new crop-revenue insurance products—which are subsidized by the Government—provide a special case where income risk is reduced ***and*** expected returns are enhanced. Because the private companies delivering policies to farmers are reimbursed directly for their selling expenses (which include agent sales commissions and data processing costs), such expenses are not incorporated in the total premium. Moreover, the total premium is also subsidized by the Government, meaning that total indemnities exceed farmer-paid premiums over time. As a result, buying crop-yield or crop-revenue insurance raises average returns as well as reduces risk for most participating farmers. In short, the relationship between risk and returns depends on the given tool or strategy, and the unique situations confronted by individual producers.

Crop insurance and hedging typically can reduce probabilities of revenues less than 75 percent of average by about half, depending on yield variability and price-yield correlation.

Risk Reduction From Forward Pricing Can Be Quite Small for Farms With High Yield Variability or Strongly Negative Yield-Price Correlations

Farmers can reduce their price uncertainty through several mechanisms, including hedging in futures or options or entering into cash forward contracts. The effectiveness of these forward pricing tools, however, can vary greatly, depending on the yield risks faced by the given farmer, the interactions between price and yield, and the other risk management tools that are used on the operation. Table 21 illustrates the effectiveness of hedging and crop insurance on farms that have different price-yield correlations and yield variabilities. Although futures hedging is used as a proxy in the table for all types of forward pricing strategies, results for hedging with commodity options, or forward contracting, would be similar.

More specifically, the table illustrates how crop insurance and futures hedging work together to reduce risks for farmers in differ-

Table 21—Effect of futures hedges and crop insurance on the probability of returns less than 75 percent of expectations

Price-yield correlation	Risk strategy	Yield coefficient of variation (standard deviation/mean) 0.1	0.2	0.3	0.4	0.5
0	None	0.14	0.19	0.21	0.24	0.25
	MPCI	.12	.15	.18	.18	.20
	MPCI+hedge	.06	.08	.12	.14	.18
-0.1	None	.14	.17	.20	.22	.25
	MPCI	.12	.14	.15	.17	.18
	MPCI+hedge	.06	.06	.11	.15	.17
-0.2	None	.13	.17	.20	.21	.24
	MPCI	.11	.13	.14	.16	.17
	MPCI+hedge	.06	.06	.10	.14	.16
-0.3	None	.13	.15	.19	.20	.23
	MPC	.11	.12	.13	.14	.16
	MPCI+hedge	.06	.06	.10	.13	.14
-0.4	None	.12	.15	.18	.19	.22
	MPCI	.10	.11	.10	.13	.14
	MPCI+hedge	.06	.07	.10	.11	.13
-0.5	None	.11	.14	.17	.19	.20
	MPCI	.10	.10	.09	.12	.13
	MPCI+hedge	.06	.07	.08	.10	.11

Source: Estimated by ERS.

ent risk situations. Yield risk increases from left to right across the table, while negative yield-price correlations increase down the left column. The entries in the cells reflect the probabilities of revenues falling below 75 percent of expectations. Price volatility is assumed to be 20 percent, regardless of yield variability or the price-yield correlation.

Because the table is constructed using a wide range of parameters, it applies to many different farming situations. Corn producers in the Corn Belt, who confront fairly low yield variability and a strongly negative price-yield correlation, tend to lie near the lower left corner of the table. Dryland wheat growers and corn growers in areas distant from the Corn Belt tend to lie near the upper right corner. Producers who irrigate tend to lie near the upper left corner, as they experience low yield variability and tend to be outside major producing areas. The lower right corner, in contrast, is of minor interest because yield-price correlations are generally not strong where yield variability is highest.

Three risk management strategies are shown: no insurance or hedging (denoted by "none" in the table), crop insurance at the 75-percent yield coverage level ("MPCI"), and crop insurance combined with a minimum-risk futures hedge ("MPCI + hedge"). Risk-reducing effectiveness can be gauged by comparing the probabilities of low revenues across the different strategies. As expected, the risk-reducing effectiveness of crop insurance increases as yields become more variable. In contrast, the added risk reduction obtained by hedging an insured crop diminishes as the yield coefficient of variation increases. Thus, the effects of changes in yield variability or price-yield correlation on the total risk reduction obtained from insurance and hedging can differ substantially for farmers in different situations.

Elimination of Deficiency Payments Increases Risks for Many, But Not Necessarily All, Producers of Program Crops

Replacing commodity programs (deficiency payments and supply management programs) with fixed Agricultural Market Transition Act (AMTA or contract) payments and planting flexibility in the 1996 Farm Act dramatically altered decades of significant government intervention in the markets for program crops.[29] Deficiency payments were in effect between 1973 and 1995, and provided compensation in years of low prices by paying farmers the difference, if positive, between a pre-established target price, and the higher of the average market price for the crop over a specified period or the loan rate. These payments averaged over $5 billion annually between 1990 and 1995, and accounted for more than one-half of total farm program outlays over that period (USDA, 1998). Their elimination has raised concerns about greater risk in farming, with some observers arguing that the elimination of deficiency payments—and their replacement with "contract payments"—removes the safety net in low-price years (Conrad).

One recent study, however, indicates that the effectiveness of deficiency payments in stabilizing income risk varied, depending on the correlation between individual and aggregate yields and the relationship between aggregate yields and prices (Glauber and Miranda). The study suggests that deficiency payments were least effective in stabilizing farmers' incomes in

[29]Program crops eligible for deficiency payments between 1973 (the start of the program) and 1995 included corn, sorghum, barley, oats, wheat, cotton, and rice.

Negative price-yield correlations reduce the effectiveness of deficiency payments in stabilizing farmers' incomes.

areas where farm-level yields and prices are strongly negatively correlated. In the study, about 29 percent of corn acreage and 26 percent of wheat acreage was found to be located in counties where revenues were destabilized by deficiency payments. In several situations—such as that for Illinois corn and North Dakota wheat—the proportion of output in counties where income was destabilized was greater than 50 percent (table 22).

The relationship between local yields and prices is significantly related to the effectiveness of deficiency payments. In major producing areas, high prices tend to offset low yields (which can be strongly correlated with national yields), and vice versa. In the absence of deficiency payments, this relationship tends to stabilize revenues and is termed the “natural hedge.” In major producing areas where the natural hedge is strong, deficiency payments may actually increase income variability by providing producers higher-than-average incomes in high-yield (low-price) years, while having only a small effect in low-yield (high-price) years. Outside major growing areas, the natural hedge is weaker, and deficiency payments tend to stabilize incomes compared with situations where producers depend only on the market. Thus, in markets where incomes are inherently most variable, deficiency payments, by stabilizing price, work to reduce revenue risk.

Demand considerations are also important in judging the risk-reducing effectiveness of deficiency payments. Such payments may provide even producers in major growing areas some protection against prolonged slumps in demand, such as might accompany a worldwide downturn in economic conditions. Thus, deficiency payments would likely be relatively more effective in protecting producer incomes in years like 1998, when large worldwide supplies and low prices resulted in weak demand for several U.S. crops.

Research has found that deficiency payments reduced farm revenue variability on less than one-third of U.S. corn and wheat farms.

Table 22—Effects of deficiency payments on farm revenue variability

Crop	State	Average percentage of production destabilized
		Percent
Corn	Iowa	33.1
	Illinois	50.7
	Nebraska	25.1
	Minnesota	35.9
	Indiana	23.1
	Ohio	4.0
	South Dakota	52.3
	Wisconsin	19.4
	Missouri	53.8
	Michigan	0.0
	United States	28.9
Wheat	Kansas	37.4
	North Dakota	74.6
	Montana	1.4
	Oklahoma	3.6
	South Dakota	46.9
	Texas	15.7
	Colorado	6.5
	Minnesota	74.9
	Washington	0.0
	Nebraska	9.4
	United States	25.5

Source: Excerpted by ERS from Glauber, Joseph W., and Mario J. Miranda, “Price Stabilization, Revenue Stabilization, and the Natural Hedge,” Working Paper, U.S. Dept. Agr., Office of the Chief Economist, and Ohio State University, October 30, 1996.

Spreading Sales Before Harvest Tends To Reduce Risk, While Spreading Sales After Harvest Tends To Increase Risk

Spreading sales over time appears, on the surface, to be a form of diversification, which is a sound means for reducing risk. Indeed, spreading pre-harvest sales of a crop over time to increase the amount forward priced as yield or output becomes more certain can reduce risk for producers in many cases. The risk-reducing effectiveness of such forward pricing actions depends on the degree of price-yield correlation and the yield variability confronted by the farmer. For most farmers, the minimum-risk forward sale at the time of planting is no more than 70 percent of the expected crop, and it may approach zero for farmers with a strong "natural hedge" or very high yield variability (Grant; Miller and Kahl; Lapan and Moschini; Coble and Heifner). It is higher for farmers with low yield variability or who carry crop insurance.

In contrast, once production is known with certainty, risk is minimized by fixing the price regardless of the time of delivery, if a competitive forward market is available. This is because forward prices tend to follow "random walks," meaning that successive changes are determined by chance and independent of one another. When producers postpone establishing the price for such activities as grain storage or livestock feeding, where output is known, risk actually is increased because the final price realized equals the current price, plus a series of unknown random price changes. Postponing the pricing of all or part of an assured output makes sense only for producers who confidently expect that prices will rise in the future. In such cases, the farmer takes greater risk in the hope of obtaining a higher expected return.

Forward Pricing May Help Reduce Price Uncertainty Not Only in the Current Year, but Also in Future Years

Forward pricing with futures, options, or cash forward contracts reduces or eliminates price uncertainty between the time the forward sale is made and delivery time. It serves farmers mainly as a tool for reducing uncertainty about prices for commodities to be sold, or bought, within the year. However, forward pricing offers some opportunities to reduce price uncertainty over a longer horizon. Futures for corn and soybeans are now traded up to 2 or more years ahead of maturity, allowing farmers to forward price more than 1 year's crop. However, low trading volume in the later maturing contracts means that hedgers must be more concerned about liquidity and possible price bias.

Another possibility is to hedge future years' anticipated production in contracts that mature this year or next, and then roll over the positions to contracts that mature in successive years as they become available for trading. For example, a farmer might sell contracts in this year's harvest time futures to cover parts of several future years' expected crops, and then successively roll over the contracts to later maturing contracts that would be bought back as each future year's crop is marketed. Although superficially appealing, this strategy holds little promise either for increasing average returns or decreasing risk. It is ineffective in projecting a high price for the current year's crop into future years because rolling over the contract generally would involve buying the old crop future at a high price and selling the new crop future at a lower price. Moreover, such interyear rollover strategies hold little promise for reducing risk due to the variability

> "Rolling over" futures positions to cover parts of several futures years' expected crops holds little promise either for increasing average returns or reducing risk.

of interyear spreads (price differences between contracts maturing in different years) (see Gardner, 1989). In addition, trading costs would be substantial.

Simply forward pricing each year's expected output before planting reduces uncertainty about returns in future years, to the extent that planting time forward prices diverge less from longrun equilibrium prices than do harvest time prices. Tomek and Gray showed that such forward selling was more effective in stabilizing returns for nonstorable commodities, such as potatoes, than for storable commodities, such as grains and oilseeds. For storables, a large or small crop tends to affect prices for more than 1 year because stocks are carried from one year to the next. The current year's price is affected to the greatest extent by a very large or very small crop, but the impacts can resonate over a period of years. Table 23 shows that corn and soybean futures prices for harvest delivery have been slightly less variable from year to year in March than at harvest.

Forward pricing is more effective in stabilizing returns from nonstorable than from storable crops.

The effectiveness of forward pricing in reducing uncertainty about returns in future years depends on yield variability and the yield-price correlation, as previously shown for current-year risks. Finally, forward pricing cannot protect against longer term variations in demand, such as might arise from business cycles.

Futures Prices Provide Information Useful in Making Production and Storage Decisions

Futures prices, which represent the best estimates of well-informed traders at a given point in time, reflect the foreseeable effects of potential production adjustments. Thus, no forward pricing rule based on price levels, or price levels relative to costs, is likely to be consistently profitable for either hedgers or speculators (see Zulauf and Irwin). In other words, the farmer who bases forward pricing decisions on future price levels generally takes on more price uncertainty than necessary with little assurance of a higher average return.

Although the level of futures prices relative to costs provides little guidance about whether to price forward, it does provide information useful in deciding whether to produce or store. The appropriate rule is “produce (or store) when variable costs can be covered,” not “price forward only when costs can be covered.” Variable production costs are those costs, such as for seed, fertilizer, custom work, and rent for land or storage space, that vary with the level of output. This contrasts with fixed costs, such as interest and depreciation on buildings and equipment, which must be met regardless of the level of output. If the price covers both fixed and variable costs, production likely will be profitable. If it covers variable costs, but not fixed costs, loss is minimized by producing. If it

Table 23—Standard deviations of first-of-month prices for harvest-time futures in March and at harvest-time, 1977-96[1]

Month	December corn contract	November soybean contract
	Dollars per bushel	
March	0.41	0.77
Last full month of trading	.51	1.11

[1]Calculations are based on annual observations.

Source: Calculated by ERS from Chicago Board of Trade data.

does not cover variable cost, loss is minimized by not producing.

Forward markets allow price setting and delivery at different times. Being able to price forward gives farmers opportunities to lock in returns when storage is profitable. Indeed, farmers can use market signals, *together with forward pricing*, to both increase their profits and reduce the risks associated with crop storage. For example, farmers can profitably store crops after harvest if their own storage costs are lower than the "market price of storage." The price of storage offered by the market is indicated by spreads between futures prices for successive months.

To illustrate, suppose that it is November and a farmer with new crop corn in a local elevator is deciding whether to store the corn until March. The local price for corn is $2.40 a bushel, the March futures contract is trading for $2.75, and the expected basis in March is $0.20 under. The elevator storage charge is $0.025 per bushel per month, all of which is variable cost since it can be avoided by not storing. Should the farmer store or sell the corn? The expected return from storage is $2.75 - $0.20 - $2.40, or $0.15 per bushel. The cost of bin space for 4 months is 4 * $0.025, or $0.10 per bushel. In addition, the farmer must cover the cost of interest on the grain. If the farmer's interest rate is 6 percent, the interest cost per bushel is 0.06 * 1/3 year * $2.40 = $0.05 per bushel. Thus, storage is a break-even operation at current prices. This is because the cost of bin space plus interest ($0.10 + $0.05 = $0.15) equals the expected return from storage. If the local cash price should fall relative to the March future, then storage would be profitable; otherwise, it is not profitable. The producer can minimize the risk of storage by entering a fixed price forward sale for delivery in March, or by selling March futures contracts in an amount equal to the quantity in storage.

The importance of variable costs can also be illustrated by considering a second producer, who is holding corn in his own bins, which otherwise would be empty. The costs for the bin, including interest, depreciation, and insurance, are fixed and cannot be avoided by not storing. This farmer's variable (or added) cost for storing an additional 4 months is $0.02 per bushel for insurance on the grain and insect control plus $0.05 per bushel for interest, equaling $0.07 per bushel. The expected return above variable cost for storage is $0.15 - $0.07, or $0.08 per bushel. If the $0.08 more than covers the total cost of the bin, the farmer would make a profit. If the total cost associated with the bin exceeds $0.08 per bushel, the producer would be sustaining a loss over the long run. The farmer is, however, still better off to store than to leave the bin empty because he can cover his variable costs, plus a portion of his fixed costs that would be incurred anyway.

The return per month from corn storage declines after harvest as month-to-month storage charges accumulate (see table 24 for an example). In the example, a producer with storage costs of 2-1/2 cents per bushel per month, for example, might expect to store his crop until May. At this point in time, the per month expected return to storage is $0.05 3/4 divided by 2 months, or $0.0288, while the variable cost of storage is nearly equal, at $0.025. A prudent policy for this farmer involves selling the May or July futures contract when the corn was put in storage in October, and holding it until the expected return from storage no longer covers storage costs. At that time, the producer would sell the corn crop in the cash market and buy back the

Production or storage is advisable only when the forward price covers variable costs.

Table 24—Expected return from storing corn between futures delivery months, 1997 crop[1]

Futures contract month	Futures price, 10/31/97	Difference from previous delivery month	Storage interval	Expected return to storage
	$ per bushel		Months	$ per bushel per month
December 1997	2.79 ¾	--	--	--
March 1998	2.89 ¼	0.09 ½	3	0.0317
May 1998	2.95	0.05 ¾	2	0.0288
July 1998	2.99 ¼	0.04 ¼	2	0.0212
September 1998	2.91	-0.08 ¼	2	-0.0412

-- = Not applicable.
[1]Estimates based on October 31, 1997, futures prices.
Source: Calculated by ERS from Chicago Board of Trade data.

futures contract. On average, those farmers with the lowest costs of storage would want to store for a longer period of time. Unlike decisions about crop production or livestock feeding, decisions regarding storage can be reversed at any time when the forward price no longer covers costs.

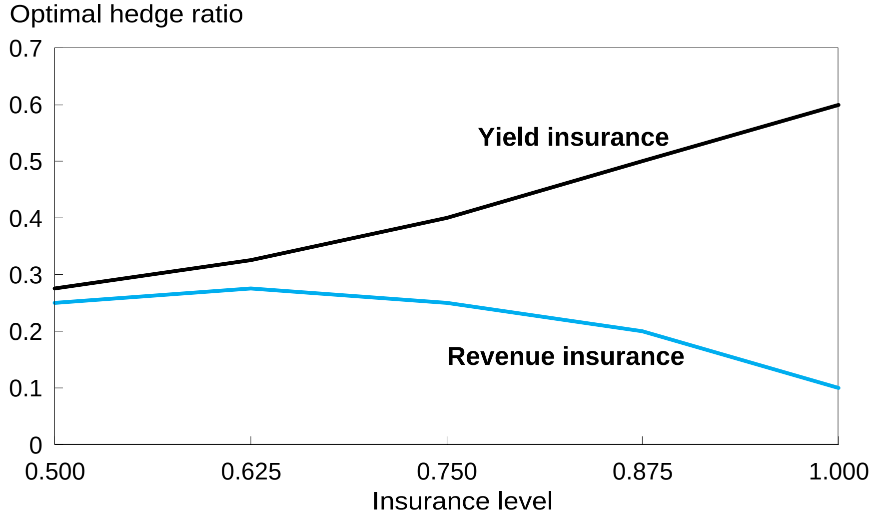
Yield insurance tends to raise, and revenue insurance tends to lower, optimal hedge ratios, but these effects are small at insurance levels up to 75 percent.

Revenue Insurance Generally Does Not Fully Substitute for Forward Pricing

By protecting against both price declines and low yields, revenue insurance partially substitutes for both forward pricing and crop insurance. It does not in all cases, however, completely replace hedging or forward contracting in protecting against price declines. This is because revenue insurance guarantees no more than 75 percent of expected revenue (85 percent for some commodities and locations), whereas forward pricing can guarantee as much as 100 percent of the expected market price. Thus, for example, a farmer with irrigated land and low yield risk (or a farmer with crop insurance) might reduce risk to a greater degree by guaranteeing 100 percent of the expected price with an at-the-money put option (or a short futures hedge) than with the purchase of 75-percent revenue insurance.

Recent research shows how revenue insurance as well as crop insurance affects risk-minimizing hedge ratios for corn producers (Coble and Heifner). The effect of different levels of yield and revenue insurance on optimal hedge ratios for Iroquois County, Illinois, is illustrated in figure 19, where the minimum-risk hedge without insurance is estimated to be 25 percent (see Heifner and Coble, 1998). The figure shows that with 50-percent yield or revenue insurance, the optimal hedge is essentially the same as with no insurance. With 75-percent yield insurance, the optimal hedge ratio rises to 40 percent, while it remains at near 25 percent with 75-percent revenue insurance. In other words, 75-percent revenue insurance has little impact on the optimal amount to hedge. The figure shows that higher levels of revenue insurance, if available, would reduce optimal hedge ratios.

Figure 19
Effect of insurance level on optimal hedge ratio, Iroquois County, Illinois



Note: Assumes expected utility maximization for a farmer with 500 acres of corn, a $300,000 net worth, and average risk aversion.
Source: Estimated by ERS.