Chicago Board of Trade

# Insurance & Hedging: Two Ingredients for a Risk Management Recipe

The past few years have seen a proliferation of market-based mechanisms available to agricultural producers for managing yield, price, and revenue risks. Making the right choices is becoming more complicated. Yet the fundamentals for making good risk management choices remain the same: 1) understanding the farm's risk environment, 2) knowing how the available risk management strategies work and which risks they address, and 3) selecting the strategy or combination of strategies that will provide the protection that best suits the farm's and the operator's individual circumstances.

USDA's Economic Research Service (ERS), using data from the Department's Risk Management Agency (RMA) and National Agricultural Statistics Service (NASS), has identified general conditions underlying farm-level risk management behavior in the U.S., how conditions relate to the performance of different risk management strategies, and why certain risk management strategies work better than others at reducing farm-specific risk across a range of different risk environments. This research has focused on three field crops with the highest acres planted—corn, soybeans, and wheat—but it provides a useful guide for risk management for other major field crops as well.

*This article is the second in a series on risk management. Insurance and hedging are among the variety of tools available to farmers to help reduce farm-level risk.*

## *Defining a Farm's Risk Environment*

Within a single crop year, once crop decisions have been made and resources have been allocated to production agriculture, the farm's principal risk lies in the uncertainty of the revenue generated by the production process. Farm revenue uncertainty, particularly the component related to field crop production, is principally a function of yield and price uncertainty, as well as the correlation between price and yield.

Weather is the principal cause of yield uncertainty. Within any given agro-climatic setting—characterized by weather pattern, soil type and fertility, growing season, day length—variability of yield is attributable mainly to factors such as temperature, cloud cover, and timeliness and amount of precipitation.

Price uncertainty for farmers combines two elements. Price-level uncertainty is the consequence of imperfect information about future domestic and international supply and demand conditions. Basis uncertainty—uncertainty about the difference between a commodity's local cash price and its nearest futures contract price—derives from uncertainty about future commodity movements and hauling costs. The tendency for price and yield to change in opposite directions provides a "natural hedge" which tends to stabilize farm revenues over time, particularly in major producing areas (*AO* March 1999).

Farmers' attitudes towards risk can vary greatly and are a key determinant in selecting risk management strategies. A farmer with a strong aversion to risk will be willing to pay more for a given level of risk reduction than a farmer with a weaker aversion to risk. An operator's overall level of wealth can also have a strong bearing on risk decision making. In general, at higher levels of wealth an individual is more willing to undertake a given level of risk—a phenomenon called decreasing absolute risk aversion—but there are exceptions to this rule. The preferred or optimal risk management strategy may also vary because of other management objectives, such as profit maximization or enterprise growth. In addition, lenders may strongly suggest or even require use of risk management tools to protect their stake in the farm's production outcome.

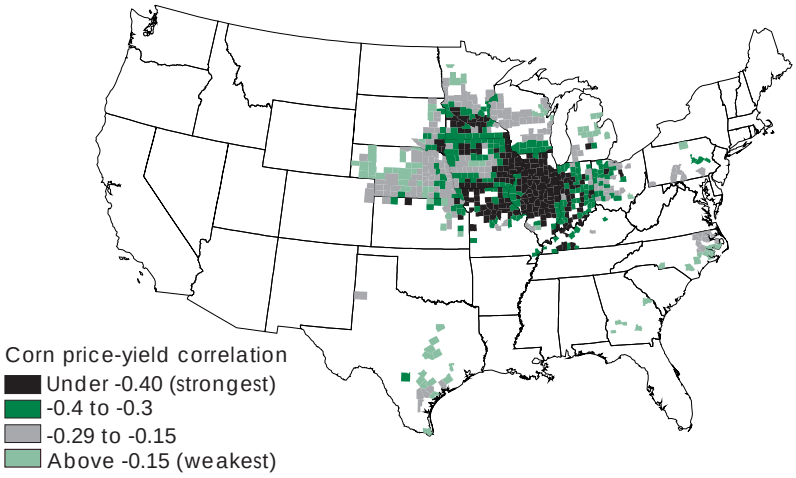
## *The Mechanics of Crop & Revenue Insurance*

The array of crop and revenue insurance policies and coverage levels available to U.S. farmers has been rapidly expanding over the past few years. In spite of the growing complexity of agricultural insurance programs, the majority of policies actually sold can still be fairly well represented by two generic types of agricultural insurance: standard yield-based crop insurance and revenue insurance.

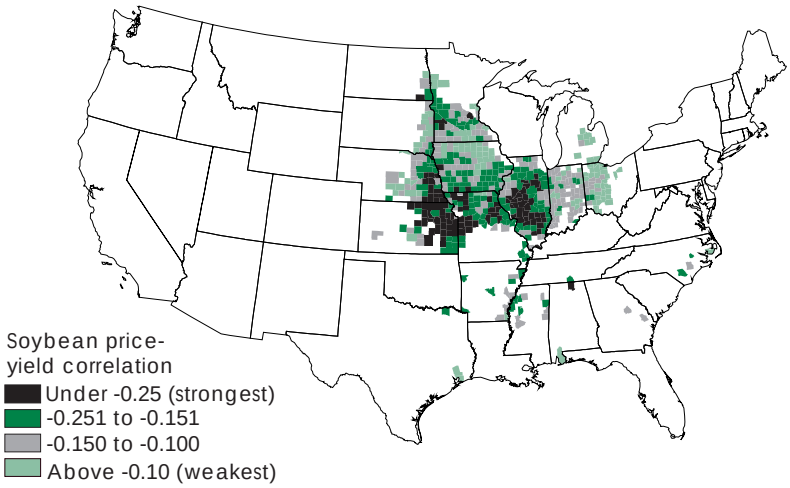
# Risk Management

**Offsetting Price-Yield Relationship, a Key Factor in the Farm Risk Environment, Varies by Region and Commodity**

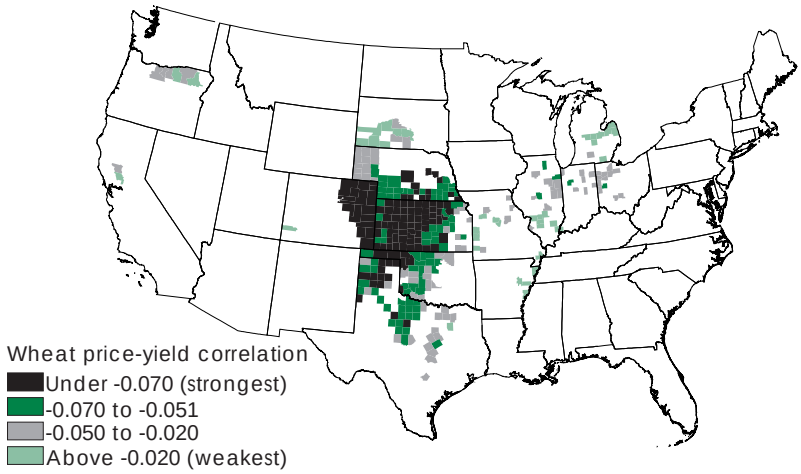
Corn Producers in Iowa, Illinois, and Indiana




Soybean Producers in Western Corn Belt




Winter Wheat Producers in Central Southern Plains




Price-yield correlation indicates strength of offsetting relationship between price and yield movements--the more negative, the better the "natural hedge" works to stabilize revenue. Based on annual county-level data, 1974-94.

Economic Research Service, USDA

The largest share of farm coverage continues to be traditional yield-based crop insurance, although revenue insurance coverage is rapidly gaining. Traditional yield-based crop insurance—referred to as multiple peril crop insurance (MPCI)—includes both the minimum catastrophic coverage (CAT) which insures against severe losses and whose premiums are fully subsidized by the Federal government, and higher levels of coverage—called "buy-up" coverage—with partially subsidized premiums. Revenue insurance policies include Income Protection, Revenue Assurance, and Crop Revenue Coverage. All three revenue insurance programs receive partial subsidization of premiums by the Federal government.

Two time periods are relevant in calculating insurance program prices. The first is planting time, when a *Projected Price* is used to set insurance premium rates and price elections, and to value coverage levels. The second is harvest time, when the *harvest-time futures price* is used to value the farm's production whether sold or stored.

For yield-based insurance purposes, RMA establishes a Projected Price about 3 months before the insurance signup period for each commodity. This yield-based-insurance version of the Projected Price is not derived solely from a futures market price average, but is a forecast of the season-average price that incorporates additional market information.

For revenue insurance valuation, the Projected Price is the average of the daily settlement prices of the harvest-time futures contract during the month preceding program signup. For the price at harvest time, the average closing price of the harvest-time futures contract during the month prior to the contract's expiration is used. For example, the Projected Price for a corn revenue insurance contract is the February average closing price of the Chicago Board of Trade's (CBOT's) December corn contract. And the harvest-time futures price for the December corn contract would be the average daily settlement price during November.

***Yield-based crop insurance (MPCI)*** pays the operator an indemnity if the actual yield falls below a yield guarantee, but

MPCI does not offer price protection. Under MPCI, the producer pays a processing fee for minimum CAT coverage and a premium for buy-up coverage to obtain partial protection against yield loss only. The *yield guarantee* is determined by multiplying the producer's average historical yield—referred to as the actual production history (APH)—by the coverage level. Coverage levels range from 50 to 75 percent (expanded to 85 percent in some areas for 1999) of the APH yield, and from 60 to 100 percent of the Projected Price.

**Example of crop insurance:**
Suppose a corn producer has an APH yield of 150 bushels per acre, the Projected Price is $2.50 per bushel, and the producer selects 75-percent APH coverage with 100-percent price coverage—referred to as the *elected price*. The producer's yield guarantee is 112.5 bushels per acre (75 percent of 150 bushels). An actual yield below 112.5 bushels will result in an indemnity payment to the producer equal to the elected price of $2.50 times the difference between the yield guarantee and the actual yield, even if the harvest-time price rises above the Projected Price. However, if the actual yield does not fall below the yield guarantee, even if the harvest-time price falls below the Projected Price, the operator gets no indemnity. Thus MPCI partially insures against production risk, but does not insure against price risk.

***Revenue insurance***—e.g., Income Protection and the standard Revenue Assurance programs—protects farmers against reductions in gross income when a crop's prices or yields decline from early-season expectations. The *revenue guarantee* equals the product of the farmer's APH yield, the Projected Price, and the coverage level selected by the producer. A producer receives an indemnity when the actual yield, multiplied by the harvest-time futures price, falls below the revenue guarantee. Since revenue insurance coverage is generally available at a maximum of 75 percent (85 percent in some designated counties), it provides only partial protection against both price and yield risk, and is less effective at reducing risk when the natural hedge is strong.

***Revenue insurance with replacement coverage protection*** is available to farmers via the Crop Revenue Coverage program or the Revenue Assurance program when purchased with an increased price guarantee option. The added replacement coverage protection (RCP) feature offers a revenue guarantee that depends on the higher of the price elected at signup or the harvest-time futures price. Thus, the producer's revenue guarantee may increase over the season, allowing the producer to purchase "replacement" bushels if yields are low and prices increase during the season. Replacement coverage complements forward contracting or hedging by partially ensuring that the farmer can buy back futures contracts or deliver on cash contracts when yields are low and harvest-time prices are high. Producers are still subject to basis risk, and only partial coverage (up to 85 percent in designated counties) can be obtained.

In general, the revenue guarantee of revenue insurance with RCP equals the product of the producer's APH yield, the coverage level selected, and the higher of the early-season Projected Price or the harvest-time futures price. Indemnity payments are triggered when the harvest-time revenue, based on the harvest-time futures price, falls below the revenue guarantee. Thus, revenue insurance with RCP also provides only partial protection against yield and price risk, and is less effective when the natural hedge is strong, because high prices offset low yields and revenue is more likely to stay at least somewhat above the guarantee.

The premium for revenue insurance with replacement coverage is more expensive than for revenue insurance without RCP, partly because the replacement cost protection provides greater price protection. Also, premium differentials increase when producers are permitted to subdivide their acreage into "units," such as by section and irrigated/nonirrigated status (as under CRC), rather than basing the premium on a producer's total acreage in a county (as under Income Protection).

Under 75-percent coverage, the standard revenue insurance guarantee for a corn producer with an APH yield of 150 bushels and a projected harvest-time price of $2.50 is $281.25 per acre. A revenue insurance policy with RCP (under 75-percent coverage) has $281.25 as an initial minimum revenue guarantee, but this guarantee may increase if market prices rise during the growing season. If a low or normal yield and low harvest-time price cause the market value of the crop to fall below the revenue guarantee, revenue insurance policies with or without RCP will pay the same indemnity. However, if the low yield is accompanied by a high harvest-time price, revenue insurance with RCP will pay an indemnity, while policies without RCP will pay a lower or no indemnity.

## *What Is Forward Pricing?*

Forward pricing involves setting the price, or a limit on price, for a product to be delivered in the future. Forward pricing strategies include contracts such as cash forward, futures, options, delayed pricing, basis, minimum price, and maximum price (for feed purchases). Three general types of forward pricing strategies—a cash forward sale, a futures hedge, and a put option hedge—are described here for comparison with the risk-reducing power of crop and revenue insurance programs.

A ***cash forward sale*** is a contract between a seller (e.g., a farmer) and a buyer (e.g., an elevator) requiring the seller to deliver a specified quantity of a commodity to the buyer at some time in the future for a specified price or in accordance with a specified pricing formula. Most crop growers sell forward at a fixed or "flat" price based on an observed futures price quote. Some farmers use basis contracts that specify a "set" price difference relative to the futures price to be applied at delivery time. Some use "hedge-to-arrive" contracts that fix the futures price component and leave basis to be determined at delivery time. Cash forward contracts eliminate both price-level and basis risk by locking in a local cash market price for the quantity under contract, but any production in excess of the hedged amount is still subject to routine market price risk.

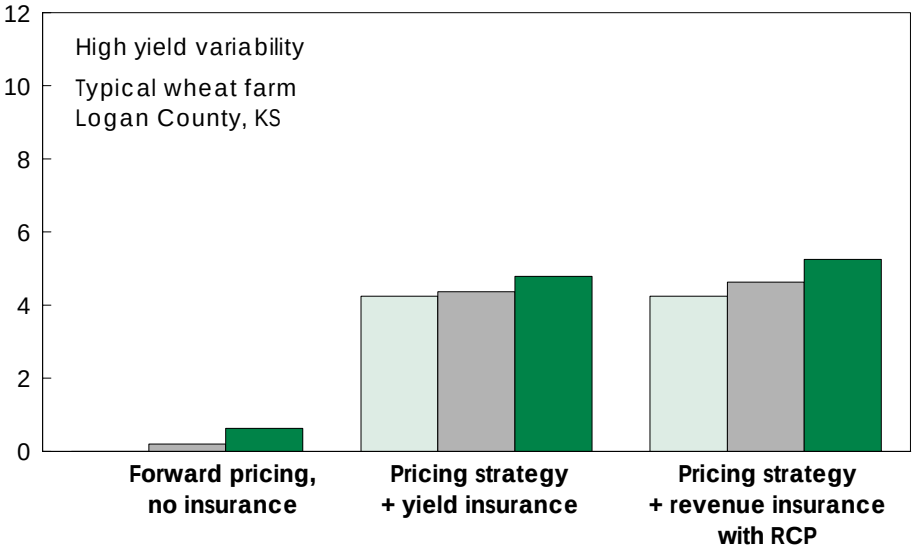
**Example of a cash forward sale:**
Suppose that a corn producer has planted 100 acres of corn with an APH yield of 150 bushels per acre. At planting time, the projected harvest-time price is $2.50 per bushel, the local cash price is $2.38, and

# Risk Management

## With Prices Moving Strongly Opposite Yield . . .

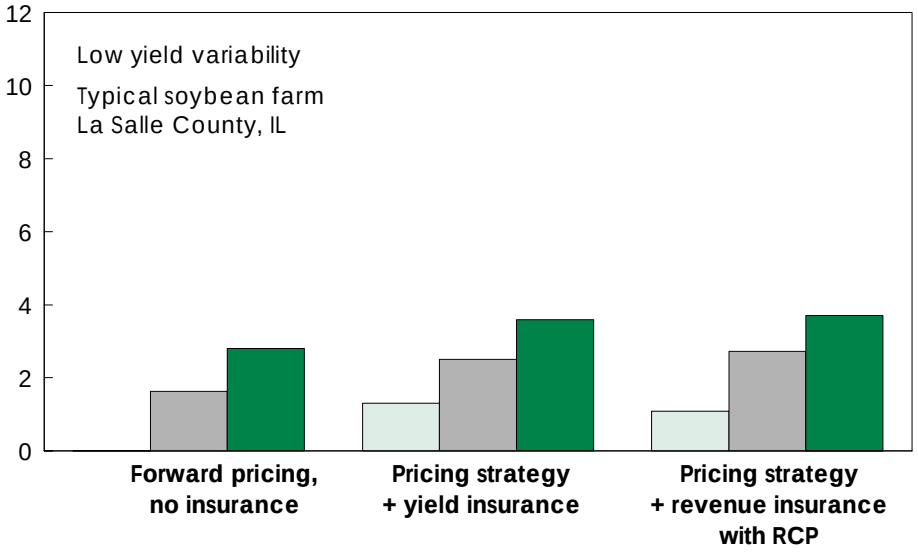
### Insurance Provides More Risk Reduction Than Forward Pricing When Yield Variability Is *High*

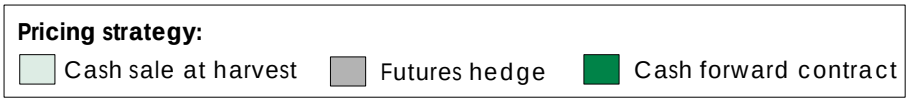
$/acre in risk reduction value*




### Forward Pricing Outperforms Insurance When Yield Variability Is *Low*

$/acre in risk reduction value*




* Risk reduction value is the certainty equivalent gain--estimated value to the operator of reducing risk by adding one or more risk management strategies.

RCP = Replacement coverage protection.

Price-yield correlation indicates strength of the offsetting relationship between price and yield movements--the more negative (opposite), the better the natural hedge works to stabilize revenue.

Economic Research Service, USDA

the basis is $0.12. The producer agrees to forward contract the farm's entire expected corn production of 15,000 bushels at a price of $2.38, for an expected revenue of $35,700. If the price at harvest-time is $1.80, the operator still gets $35,700 for the crop, $8,700 above the cash market. However, if the producer harvests only 85 bushels per acre, even though the futures price rises to $3.50 (local cash price $3.38 with constant basis), the net revenue under this contract will fall to $13,730 ($35,700 less $21,970) because the operator has to purchase the shortfall (6,500 bushels @$3.38) in the cash market. This outcome illustrates the income risk associated with yield risk when an operator forward contracts 100 percent of the expected production at planting time based on the projected harvest-time price.

***Hedging*** is designed to reduce price-level risk prior to an anticipated cash sale or purchase. A ***futures hedge*** involves the sale (short hedge) or purchase (long hedge) of ***futures contracts***—standardized contracts traded on a commodity exchange—as a temporary substitute for an intended sale or purchase on the cash market. The futures contract is later bought (sold) to eliminate the futures position as the actual commodity is sold (bought). Crop growers are generally short hedgers against crops they intend to sell later in the season.

For example, every corn futures contract traded on the Chicago Board of Trade (CBOT) calls for delivery of 5,000 bushels of No. 2 yellow corn during one of five designated delivery months each year. Hedging requires relatively little investment, because only a small portion of the futures contract's face value is required as a margin good-faith deposit to guarantee performance of the contract. Hedging also provides flexibility, since the hedger can eliminate a position in the futures market by simply contracting for an equal number of offsetting contracts. Still, the primary advantage of a futures hedge is the elimination of the price-level risk of an existing cash position by locking in a price.

A producer can hedge by selling futures contracts—short hedge—covering part or all of anticipated output. For example, a

corn grower could sell 10,000 bushels of December corn futures in May to hedge an expected 20,000-bushel corn crop. Such a hedge normally is lifted by buying an equal number of futures contracts as the cash commodity is sold. Since parallel movements in cash and futures prices during the period of the hedge tend to offset each other, any losses (gains) in the cash market are made up by gains (losses) in the futures market.

Any contract, cash or futures, that tends to fix the price prevents the seller from gaining from subsequent price increases as well as losing from subsequent price declines. Moreover, forward pricing contracts contain an element of nonperformance or production risk—if the quantity actually produced turns out to be less than the contracted quantity and the price at delivery lies above the contracted price, the producer must make up the shortfall at a loss. Thus, risk is minimized by forward pricing only part of a crop until yield is assured.

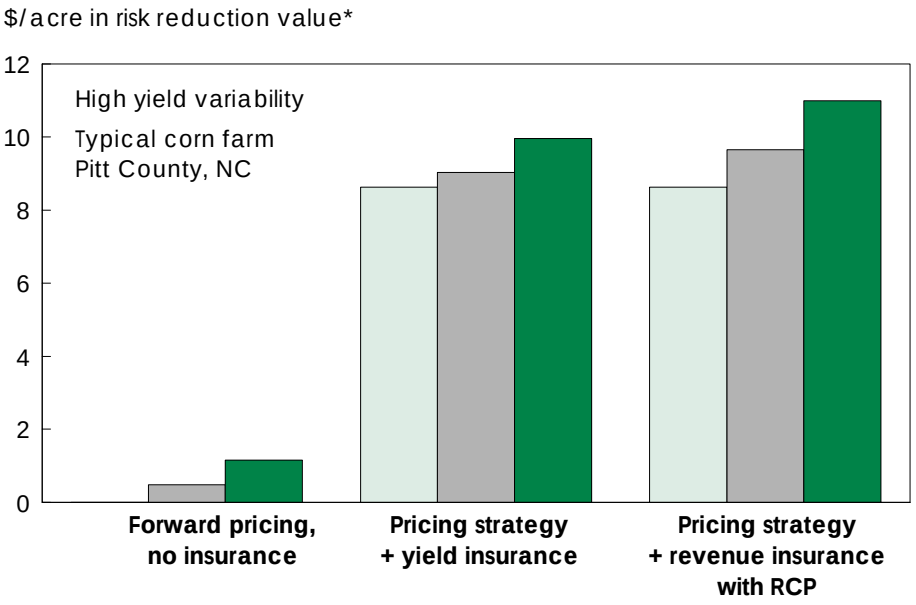
Finally, hedging replaces price risk with basis risk—uncertainty about the price difference between the futures contract and the cash market—and if the basis is wider than was expected when the futures position was entered, the producer's preliminary price guarantee is reduced by the change in the basis. Basis risk is absent for hedgers who can make delivery against their futures contracts, but the cost of making delivery exceeds the loss on the basis in most cases.

The holder of a futures contract also incurs the risk of additional payments (margin calls) necessary to maintain that contract position when the quoted price for the futures contract changes against the short position. Unexpected additional payments could result in a strain on the farm's cash flow and/or credit reserves, particularly if eventual losses in the futures market cannot be offset by actual cash sales into the higher price cash market due to a production shortfall.

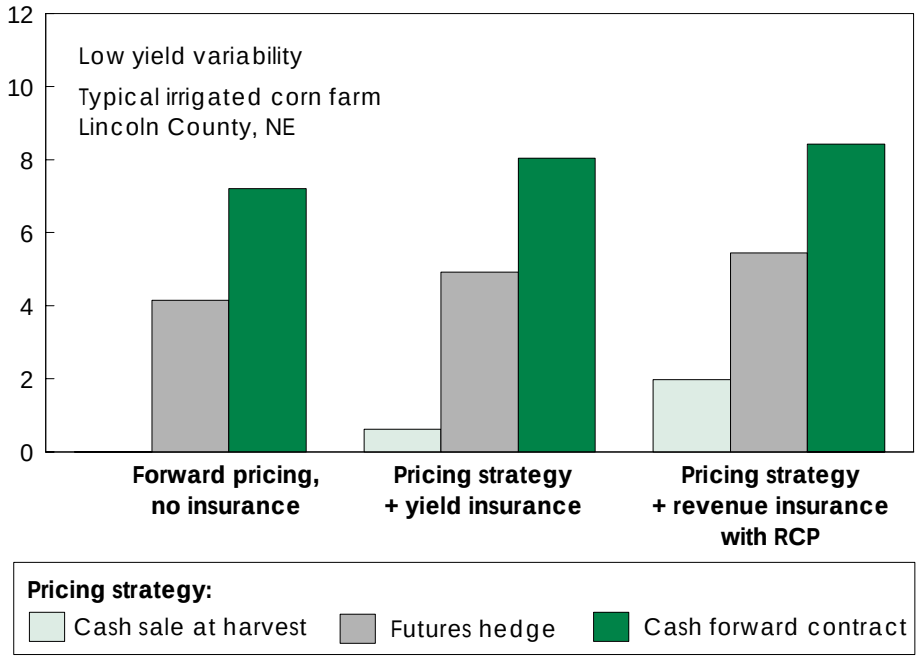
Hedging in futures offers farmers many of the benefits of forward contracting, but requires establishing an account with a certified broker, placing orders with the broker, and being prepared to meet margin calls during periods of adverse price

## With Weak Price-Yield Correlation . . .

### Insurance Surpasses Forward Pricing in Reducing Risk When Yield Variability Is *High*




### Forward Pricing Is the More Effective Strategy When Yield Variability is *Low*

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Economic Research Service, USDA

movements. Consequently, most farmers prefer to access futures markets indirectly by forward contracting with their local elevator.

**Example of direct use of the futures market** (transferring price-level risk but not basis risk or yield risk):
Suppose a corn producer planted 100 acres of corn with an expected yield of 150 bushels per acre. At planting time, a December corn futures contract is trading at $2.50 per bushel, the local cash price is $2.38, and the basis is $0.12. The producer sells two December corn futures contracts on the CBOT (equivalent to 10,000 bushels of corn) at a price of $2.50 per bushel.

At harvest-time, if actual yield equals expected yield and the basis remains constant but prices fall, say futures to $2/bushel and local price to $1.88/bushel, the operator's total revenue, ignoring transaction costs, would still be $33,200—$5,000 profit from futures trading (sell 10,000 @ $2.50 and buy 10,000 @ $2) plus $28,200 (15,000 @ $1.88) from sale to the local elevator. If the basis widens because the local price falls faster than the futures price, the gains from hedging would remain the same, but total revenue would be lower. However, if yield falls, say to 85 bushels/acre, even if harvest-time prices rise, say futures to $3.50 and local to $3.38 so basis is constant, the $10,000 loss from hedging (sell 10,000 @ $2.50 and buy 10,000 @$3.50) would more than offset the higher local price (8,500 @ $3.38 = $28,730), bringing net revenue down to $18,730, again ignoring transaction costs.

A ***put option*** is the right, but not the obligation, to sell a specified number of futures contracts at a designated price (called the strike price), at any time until expiration of the option. Hedging with a put option is very similar to buying price insurance in that the buyer/farmer pays a premium to the seller/grantor of this option to protect against a fall in price. The put option eliminates downside price-level risk by giving the buyer the right to enter into a short position in the futures market at the strike price if the option is exercised, even if futures prices fall below the strike price. The farmer who hedges by buying a put option knows the premium in advance and is not subject to margin calls as is the futures hedger. And the put option holder stands to gain if the futures price rises by more than the cost of the premium—if prices rise, the farmer can simply choose not to exercise the put option and instead sell in the higher priced cash market.

As with a futures hedge, a put option hedge is subject to both production risk and basis risk, since ultimately, any futures position entered into upon the exercise of a put option will likely be liquidated and the grain sold into cash markets. But unlike a futures contract hedge, the premium is forfeited upon payment even if the put option is never exercised.

**Example of a put option:**
Consider again the example of the corn producer with 100 acres planted to corn and an expected yield of 150 bushels per acre. At planting time a December corn futures contract is trading at $2.50 per bushel, the local cash price is $2.38, and the basis is the difference or $0.12. The producer buys two put options based on the CBOT December corn futures contract (equivalent to 10,000 bushels of corn) with a strike price of $2.50 per bushel for a premium of $0.16 per bushel or $1,600.

At harvest-time the December corn contract price is down to $2 per bushel, and the local price is $1.88 (basis is constant). If the harvested yield is the 150 bushels per acre expected yield and the producer wants to finalize marketing decisions on November 1, by exercising the put option at $2.50 and immediately offsetting the short position in the futures market by buying two December corn contracts at $2, the producer realizes a gain of $0.50/bushel, or $5,000. Selling the harvested corn locally for $1.88/bushel, total revenue (ignoring broker's fees and transaction costs) is $31,600 (15,000 bushels @ $1.88 plus $5,000 minus the $1,600 premium).

## *Optimal Hedge Ratio Varies Across Pricing Strategies*

To price forward, a farmer must choose not only the type of contract—cash, futures, or options—but also the share of the expected crop to hedge. For the farmer, the optimal proportion (in a risk-reducing sense) of the expected crop that should be forward priced—called the optimal hedge ratio—depends on the extent of basis and production risk faced by the producer.

While forward pricing in either the cash, futures, or options markets eliminates price-level risk, it fails to eliminate production risk, and cash forward contracting alone eliminates basis risk. Basis risk generally is small relative to price-level risk, but can be important, particularly at locations distant from the futures delivery points.

The production risk associated with a forward pricing contract depends on a farm's yield variability. As yield variability increases, optimal hedge ratios decrease and the risk-reducing effectiveness of a hedge declines. In the presence of high yield variability, the probability of having insufficient crop to deliver on a forward contract is high and the associated risk lowers the effectiveness of forward contracting.

Yield variability can be only partially offset by crop or revenue insurance, since coverage levels are generally limited to 75 percent, so the optimal hedge ratio will vary with both the availability and type of insurance coverage. Further, since yield protection permits a higher optimal hedge ratio, and because crop and revenue insurance do not fully eliminate production risk, combinations of forward pricing and insurance generally result in lower risk than either alone.

## *Combination of Strategies Depends on Risk Environment*

ERS used historical data to construct representative corn, soybean, and wheat enterprises for a variety of risk environments—i.e., across ranges of yield variability and price-yield correlations—to analyze the risk reducing effectiveness of different crop and revenue insurance programs and forward pricing strategies in different risk environments. The level of risk aversion and wealth for a given enterprise is held constant across risk management strategies, and all enterprises are assumed to minimize risk per acre of the crop produced.

The estimated certainty equivalent income—the income an individual is willing to receive with certainty in lieu of undertaking a risky prospect—associated with a straight cash sale at harvest (no insurance, no forward contracting) is the baseline scenario against which all other risk management strategies are evaluated. Certainty equivalent gains/losses—the estimated value of gains/losses in risk reduction—are then calculated to reflect the differences in revenue risk reduction and costs (e.g., premiums) over the different strategies.

Federal subsidies are not included, in order to compare the pure risk reduction effectiveness of crop and revenue insurance programs and forward pricing strategies, independent of government influence. The incorporation of Federal insurance premium subsidies per acre would be a direct addition to certainty equivalent income for the relevant risk strategies. Using this framework, some general relationships emerge between revenue variability and risk management.

*For a farm with high yield variability and a weak natural hedge*, crop yield or revenue insurance alone provides substantial revenue risk reduction. Forward pricing combined with insurance—crop yield or revenue insurance—further reduces risk, although the gains are small relative to the risk-reduction gains of insurance alone. Forward pricing alone—without crop yield or revenue insurance—provides relatively little risk reduction, because price variability contributes less to revenue variability than does yield variability. Without crop yield or revenue insurance, the revenue risk stemming from yield variability greatly reduces the effectiveness of forward pricing. However, as the natural hedge strengthens, the risk reduction provided by insurance weakens, even when yields remain highly variable, and forward pricing remains fairly ineffective as a risk transfer tool.

*When yields are relatively less variable*, crop yield insurance alone affords some risk reduction, but provides much greater risk reduction when combined with forward pricing, particularly forward cash contracting. Since price variability predominates when yield variability is low, cash forward contracting, which eliminates both price-level and basis risk, is a very attractive option to a producer whose primary concern is minimizing risk.

*With low yield variability and a strong natural hedge*, forward pricing strategies are more effective than either crop or revenue insurance. Under a strong natural hedge, low yields are generally associated with high prices, thus moderating overall revenue variability, even without insurance or forward pricing. Still, crop revenue insurance, when combined with forward pricing, can provide additional marginal risk reduction.

*When low yield variability coexists with a weak natural hedge*, forward pricing alone easily outperforms crop yield and revenue insurance in reducing risk, because price variability plays the dominant role in determining revenue variability, and because of the weaker relationship between the on-farm yield and the aggregate market price. Still, additional marginal gains in risk reduction can be obtained by combining crop revenue insurance with forward pricing.

In summary, ERS findings indicate that:

- Price variability faced by growers of a given crop is approximately the same across the country, and basis risks are relatively small, so differences in revenue variability between farms are caused primarily by differences in yield variability and price-yield correlation.
- Yield variability is generally proportionally higher than price variability at the farm level. As yield variability increases, optimal hedge ratios decrease and the risk-reducing effectiveness of hedging declines. Partially offsetting yield variability with crop or revenue insurance raises the optimal hedge ratio.
- Price-yield correlations are generally negative in major growing areas, particularly for corn. Since a farmer's revenue risk diminishes as price-yield correlation becomes more negative, crop or revenue insurance purchased with low coverage levels may be superfluous in the face of a strong natural hedge. Also, optimal hedge ratios decrease as farm price-yield correlation becomes more negative.
- Price correlation between farms is generally higher than yield correlation.
- The risk-reducing effectiveness of hedging increases as correlation between farm and futures price increases. In other words, the more closely the futures market price mirrors the farm price, the better it works for hedging risk.
- Combining forward pricing with insurance generally results in lower risk than either alone. With high yield variability, the difference among the forward pricing strategies is slight, but with low yield variability—where price variability contributes a larger share to revenue variability—the difference may be significant. When used in combination with a given type of insurance, cash forward contracting provides the greatest risk reduction for a risk-minimizing producer. AO

*Randy Schnepf (202) 694-5293, Richard Heifner (202) 694-5297, and Robert Dismukes (202) 694-5294*
*rschnepf@econ.ag.gov*
*rheifner@econ.ag.gov*
*dismukes@econ.ag.gov*

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