Module 2

Climatic Change: Impacts on Grain Yields, Price Variability, and Risk Management

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Topics

Introduction

Weather remains one of the most important uncontrollable variables involved in agricultural production systems. A recent rash of extreme weather conditions across the Midwest region included abnormally cool-growing-season temperatures in 1992, unprecedented heavy growing- season rainfall and flooding in 1993, and record-breaking winter cold, snowfall, and subsequent spring flooding in 1997. These extremes and associated impacts on crop performance, whether positive or negative, are generally considered a characteristic of the climate of a particular area, defined as the average of day-to-day weather conditions over an extended period of time. However, while commonly thought of as a stable or static system, climate is in reality a changing, dynamic process that has shifted significantly in the past (due to factors such as changes in earth-sun geometry and solar irradiance, continental drift and uplift, and changes in atmospheric composition and aerosol content) and will likely change again in the future.

This segment of the ***Managing Risks and Profits*** series focuses on documented past and projected future changes of climate and crop performance in the Midwestern U.S., and possible implications for regional agriculture. We also include a review of the creation and use of weather forecasts and a list of pertinent crop/weather information available to farmers, much of it free across the Internet. Because there is no sure way to totally control the weather (other than the impractical solution of moving all agricultural activities indoors!), perhaps the best strategy for coping with the uncertainty of weather is a good understanding of weather/climate systems. This includes a good knowledge of the climatology of an area of interest, the potential short- and long-term agricultural impacts of weather on agriculture, and a list of potential managerial strategies. The management strategies can used to hedge risk involved with future unforeseen weather events.

Yield Trends *(or go to* ***Topics*** *)*

Between 1900 and 1940, corn yields in the U.S. Plains (**Figure 1**) showed little indication of trend. Year-to-year variability was observed to be related to temperature and precipitation conditions. Dramatic increases in yield were realized between 1940 and 1970, and a diminished rate of yield improvement has been observed since 1972. Carlson, Todey and Taylor (1996) analyzed the yield trend as a logistic, "S-shaped," trend. They considered a deviation of 10% above or 10% below the "trend line" to be significant. The rapid increase in yield during the 1960-1970 period is typically attributed to technology, favorable weather, and the development of hybrids that respond well to high levels of production management. It may be argued that the technological potential yield has increased linearly since 1930; a straight line almost perfectly connects the "best" years from 1930 to the present, and it is assumed that all yields below the line resulted from adverse environmental or sub-optimal conditions. The flat period from 1900-1930 may reflect a period of little technological improvement or a period of declining weather that balanced technological advancements.

Regional Climate Trends *(or go to* ***Topics*** *)*

Karl, Easterling, Knight, and Hughes (1994) showed diminishing annual precipitation from 1900 through 1930 in the Northern Plains and the Great Lakes regions of the United States (U.S.). Precipitation trends were mixed from 1930-1960. Increasing annual precipitation has been noted since 1960. Annual mean temperature in the Northern Plains region of the U.S. was increasing during the 1900-1940 period, decreased from 1940-1972 and shows a warming trend since 1972. Near the Great Lakes, the temperature trend also shows warming, but of a lesser magnitude, possibly because of the moderating effects of water.

Variability and Weather Trends *(or go to* ***Topics*** *)*

The 1940-1972 interlude of decreasing temperature was a period of relatively consistent weather in the central U.S. Year-to-year yield variability was minimal during the period. Yield variability since 1972 has been notable and is similar to the variability observed previous to 1940 when analyzed as a percentage variation. The "leveling" of the yield trend in recent years in much of the Midwest appears to be caused by the impact of unfavorable years. That is, "bad" years hurt more than favorable years "benefit." The leveling is more pronounced in the western Corn Belt.

Anticipating Yearly Outcomes *(or go to* ***Topics*** *)*

Carlson, Todey, and Taylor (1996) showed that the SOI (Southern Oscillation Index) has a significant correlation with crop yield in the major corn-producing states. The SOI is a meteorological index associated with periodic major shifts of normal weather patterns and surface ocean currents across the equatorial Pacific region. Because of the potential interaction of the Pacific region climatic anomalies with the jet streams that circle the middle and upper latitudes of both hemispheres, these shifts may affect both summer temperatures and precipitation in the U.S. Corn Belt. The apparent impact of the SOI varies in magnitude across the Corn Belt. If the SOI is strongly negative the probability of having an adverse year is reduced and the possibility of a favorable season enhanced. A positive SOI is associated with increased risk of adversity. The dependence of trend corn yields on SOI from 5 Midwestern states, 1900-1994, is illustrated in Table 1.

Table 1. Frequency (number of years) of Trend Corn Yields vs. Southern Oscillation Index Values by State, 1900-1994* (from Carlson et al., 1996). *(or go to **Topics**)*

State	**Yield Code[2]**				
	SOI Code[1]	**>10%**	**In Between**	**<10%**	**Total**
Iowa	**<-0.8**	7	12	3	22
	>+0.8	1	8	6	15
	In Between	14	30	7	51
	Total	22	50	16	88
Illinois	**<-0.8**	7	14	1	22
	>+0.8	3	7	5	15
	In Between	14	28	9	51
	Total	24	49	15	88
Indiana	**<-0.8**	9	11	2	22
	>+0.8	3	9	3	15
	In Between	11	30	10	51
	Total	23	50	15	88
Missouri	**<-0.8**	10	9	3	22
	>+0.8	6	2	7	15
	In Between	16	19	16	51
	Total	32	30	26	88
Ohio	**<-0.8**	5	15	2	22
	>+0.8	1	9	5	15
	In Between	8	32	11	51
	Total	14	56	18	88

Table footnotes:

* Due to missing data, the years 1906-1908, 1914, 1915, 1921, 1927, 1931, and 1932 were

not included in the analysis.

[1] The yield codes are broken down into categories of 10% less than the state trend yield in a given year, 10% greater than trend yield, and all yields in between 10% above and 10% below the trend yield.

[2] The SOI code represents the standardized SOI value during the summer months.

The probability for yield to exceed the plus 10% of trend is enhanced when the SOI is strongly negative. Note that Illinois yield did so in 7 of 22 years.

Use of Weather Forecasts *(or go to* ***Topics*** *)*

Given the strong dependence of so many agricultural activities on weather, forecasts of future weather conditions have the potential to be a key factor in managerial decision-making. Weather forecasts are frequently categorized into one of three major time frames: short term, which includes forecasts up through 48-60 hours into the future; medium range, which includes outlooks from 3-14 days in advance; and long lead forecasts, which include all outlooks longer than 2 month into the future. The forecast categories differ both in how they are prepared and what variables are being forecast. For short-range and medium-range forecasts, meteorologists use output from highly quantitative computerized process models that describe the motions and physical processes of the atmosphere. The models are started at a given time with representative real data from the surface and upper levels of the atmosphere, then allowed to run into the future following the given initial conditions. Even though these models are run on powerful supercomputers and could theoretically be run out days, weeks, and months into the future, there is one very important limitation. Since the atmosphere is a chaotic system (i.e., movements are characterized by occasional sudden and unpredictable changes), any small error in the initial condition the model is given at the start time of the model run can lead to increasing errors as the model runs into the future, eventually leading to a total loss of predictability. Given this limitation, the theoretical forecast limit of a computer process model is thought to be on the order of 10-14 days into the future. Thus, in general, the direct use of computer process models is limited to short and medium-range forecasts.

Beginning with medium-range outlooks and continuing into the long-range time frame, forecasters generally use empirical, statistical tools based on the behavior of the atmosphere in the past to generate forecasts. Medium-range outlooks are usually a "hybrid" forecast made up of a jet stream/upper air orientation taken from a computer process model and a statistical forecast of mean temperature and precipitation based on that particular jet stream pattern. The most common public medium-range forecast, the 6-10 day outlook, is issued by NOAA’s Climate Prediction Center (CPC) every Monday, Wednesday, and Friday afternoon at approximately 3 p.m.EST/EDT. The jet stream/upper air orientation forecast portion of this outlook is heavily based on output from two computer models: the National Weather Service (NWS) Medium range forecast (MRF) model, and the European Centre for Medium range Weather Forecasting (ECMWF) model. A third model from the United Kingdom Meteorological Office (UKMO) is also sometimes available for inclusion into the outlook. These models are often mentioned in news from the commodities markets, as medium-range forecasts are frequently used by meteorologists and other analysts for detecting major changes or shifts of weather over a region such as the Corn Belt. There are many sources of short and medium range weather information available on the worldwide web. An excellent site for those unfamiliar with meteorology and forecasting is the NOAA National Weather Service Interactive Weather Information Network (IWIN) at; http://iwin.nws.noaa.gov. Among the sites specializing in providing high quality satellite imagery is the University of Wisconsin's Space Science Engineering Center at http://www.ssec.wisc.edu/data/. For those seeking more detailed, in-depth information, including individual computer forecast output, try sites at Purdue University (http://wxp.atms.purdue.edu/) and Ohio State University (http://twister.sbs.ohio-state.edu/). Both of these sites include medium range forecast output from MRF and ECMWF models.

Until the mid-1990s, NWS long-range outlooks covered only 1-month and 3-month forecast periods. NWS long-lead outlooks are now available in 3-month increments out to 12 months into the future. As mentioned above, long-range outlooks of 1 month or more are generally based on statistical methods, including forecasts based on land/ocean surface temperature and precipitation anomalies during the past 12 months and forecasts based on the evolution of past upper air flow patterns similar to those at the forecast time (analog method). An important exception is the National Center for Environmental Prediction (NCEP) Coupled Ocean/Atmosphere Model, which is a process-based computer simulation of Pacific Ocean sea surface temperatures, which in turn are related to the El Nino Southern Oscillation, ENSO for which the Southern Oscillation Index (SOI) monitors as an index. Long-lead outlooks and other international climatic information are available from the CPC across the Internet at http://nic.fb4.noaa.gov. Another site with excellent information on the status of ENSO, including a visual time lapse of see surface temperatures across the Pacific Ocean is the NOAA Climate Diagnostics Center (http://www.cdc.noaa.gov/). Other long-lead outlooks (global precipitation) are available on the Internet from the Queensland Dept. of Natural Resources/Dept. of Primary Industries (Australia) at http://www.dnr.qld.gov.au/longpdk/. Finally, long-range outlooks may also be obtained from many different private meteorological firms.

The utility of weather forecasts for decision-making on the farm generally boils down to two major factors: 1) the historical skill of the forecast (i.e., how consistently is it correct and by how much?); and 2) how much risk is a grower willing to take? Public NWS or private forecasts of conditions during the upcoming 1-2 days are frequently correct more than 90% of the time, with declining skill as the length of the forecast increases. Short-term forecasts can be made even more effective when combined with real-time weather information, such as weather radar data, significantly reducing the odds of a grower making a weather-related mistake (e.g., a grower who decides to cut hay on the basis of a forecast of less than 30% chance of measurable precipitation during the upcoming 72 hours holds off his decision at the last minute due to the development of an isolated thundershower upwind from his farm that he has detected on a TV weather radar display). In contrast, claims of a long-lead outlook, 3-12 months in the future, being "useful" for agricultural applications, depend greatly on whether a manager can afford to make a decision based on forecast odds being 55-60% correct. Before using forecasts operationally in your management scheme, we advise obtaining some type of record indicative of past forecast performance (including all forecasts issued in a given time period, not just the successful ones!). Be cautious if this type of information is not available.

Some generalizations of forecast skill and accuracy: 1) the expected skill of a forecast generally decreases as one goes out in time; 2) forecast skill depends on the variable being forecast and the season (e.g., precipitation frequency and amounts are generally more difficult to forecast than max./min. temperature); and 3) both public NWS and private meteorologists generally start with the same information. The difference in the resulting forecasts is in the interpretation of the data/information by the forecaster. Finally, due to improvements of the simulation of the climate system, including the interaction between the earth-atmosphere interface, and increases in computational power, the skill of forecasts is increasing. For example, a recent study of forecasting skill indicated that medium-range forecast models, which in the early 1980s had a useful length (i.e., the forecast is more accurate than the use of climatological statistics alone) of 5.5 days, now have a useful life of over 7 days, an improvement of more than 25% (Kerr, 1996).

Sources of International and Domestic Crop and Weather Information *(or go to **Topics**)*

In the fast-paced environment of major U.S. commodity markets, rarely a day goes by without some mention of crop conditions or weather problems in major international production areas. If you've ever wondered about agriculture in other parts of the world (and given the international nature of today's markets, you should have), especially which crops are planted where and when, we offer a couple of pieces of information that you will find valuable and helpful in making sense of international trends.

The first is the **Weekly Weather and Crop Bulletin**, published weekly by the NOAA/USDA Joint Agricultural Weather Facility (JAWF) in Washington, D.C. This bulletin, which has been published since 1895, gives detailed crop and weather information for the U.S. and all major international crop areas, with occasional articles on major weather events such as heat waves, droughts, etc. The consistent format (e.g., weekly tables of average temperatures and total precipitation, U.S. crop conditions by state and crop) of the bulletin allows readers to keep track of growing conditions and anomalous weather trends year-round. The bulletin is available at JAWF's Internet web site at (**http://www.usda.gov/oce/waob/jawf/index.html).** Otherwise, one major drawback of the bulletin is that it is available only via first class mail, resulting in information about 1 week old by the time it reaches your doorstep. For information about subscriptions, call (202) 720-7917 or FAX number (202) 720-1455. Specific domestic and international crop supply and demand figures for major production areas are also available over the Internet from the USDA World Outlook Board (one of the parent organizations of JAWF) at **(http://www.usda.gov/oce/waob/waob.htm).**

A second publication recommended for reference is **Major World Crop Areas and Climatic Profiles** Agricultural Handbook no. 664, published by USDA/WAOB/JAWF in 1994. This reference provides a very current framework for assessing weather's impact on crop production around the world. It includes geographical information on international crop areas and crop calendars, as well as graphical and tabular climatic profiles (for temperature and precipitation) at representative locations. Crops covered include coarse grains, wheat (spring and winter), rice, major oilseeds, sugar, and cotton. Besides general information on the topics above, the 279-page volume contains detailed articles on the El Nino Southern Oscillation phenomenon, the Indian monsoon (which generally governs the success or failure of agriculture on the Indian subcontinent), and the climate and agriculture of the former Soviet Union. A copy of this handbook is available via Internet at the address listed for JAWF above. Paper copies can be ordered over the phone from USDA/ERS/NASS at (800) 999-6779 or by writing (with a $20 check payable to ERS-NASS) to: ERS-NASS, 341 Victory Drive, Herndon, VA 22070.

Future Climatic Changes *(or go to **Topics**)*

Improvements in the physical understanding of the climate system during the past few decades have led to concern about levels of atmospheric carbon dioxide and other trace gases, which have steadily increased in concentration since the industrial revolution, and may ultimately result in significant increases in mean global surface temperatures of 2-6ºF by the end of the next century (IPCC, 1995).

These estimates represent the consensus of a large international group of scientists working in this discipline and are largely the result of research with General Circulation Models (GCM), which are complex, physically based models of the earth's atmospheric/oceanic system (similar to models used for short- and medium-range forecasting, except on a larger scale). For the Midwestern U.S., the GCMs generally suggest increases in both mean temperatures and precipitation, which could lead to either crop yield increases or decreases, depending on location and crop. New research studies that also include the fertilization or enrichment effect of increasing carbon dioxide levels on crop growth suggest that any yield decreases due to unfavorable climatic shifts should be at least partially offset by CO_2 enrichment, especially for C-3 crops such as wheat and soybean (Curry et al., 1995).

There are several very important factors to consider regarding global climate change. First, while current theories strongly suggest some type of global surface temperature increases associated with increasing trace gases, there remains a great deal of uncertainty about the magnitude and timing of any changes. The uncertainty is due to a number of factors, including an incomplete knowledge of a few key feedback mechanisms within the climatic system (such as the amount of clouds in tropical areas of the world) and a lack of computer power needed to run GCMs for longer time periods on finer spatial and temporal scales. Secondly, for the bulk of agricultural activities, it is not long-term changes in the means of individual climatic variables, but changes in variability, such as the frequency of extreme temperatures or rainfall events, that likely pose the greatest potential threat to producers (Parry and Carter, 1985). Research of observed trends of climatic variability in the U.S. since 1895 indicated some increases in extreme events such as heavy 1-day rainfall events (Karl et al, 1996). However, recent studies of results derived from GCM output indicate mixed trends, including some variability decreases (Winkler et al, 1997; IPCC, 1992). Finally, based on past performance, there is a likelihood that new technological innovations in agriculture and related fields in future years will allow farmers to keep pace with most climatic changes, provided that they do not include rapid changes in variability (IPCC, 1995).

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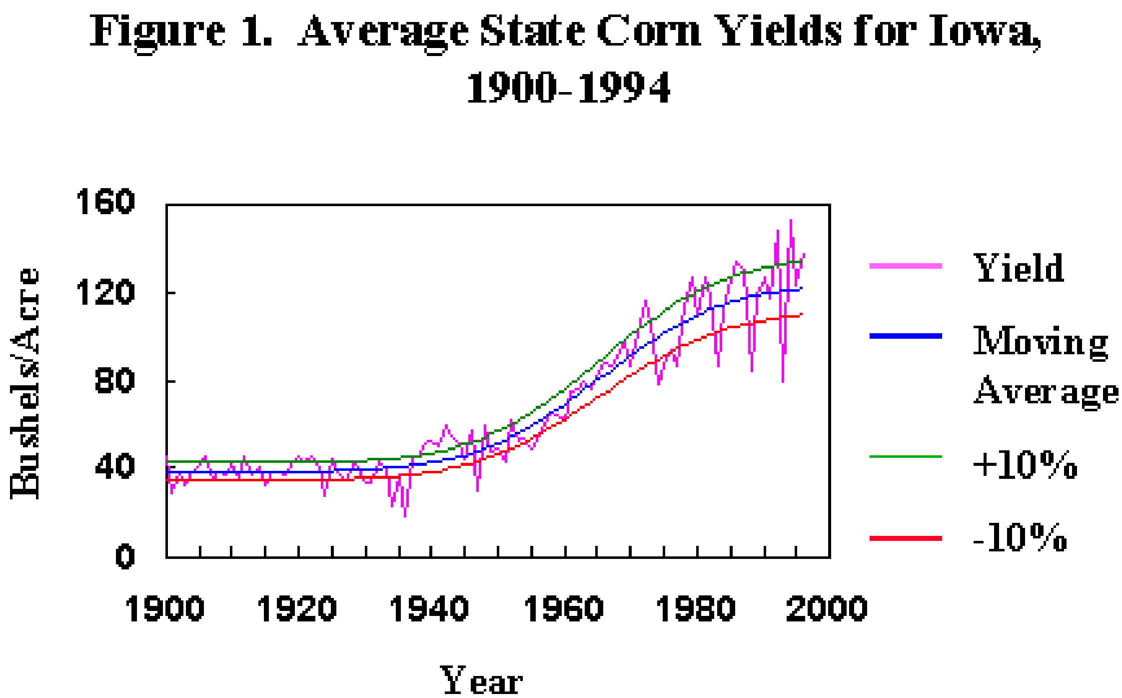
End of Module *(or go to **Topics**)*

Go to Module 3 | **Introduction** | **MRP Introduction**
Universities and Agribusinesses |**Table of Contents** | **or Go to Modules :**

1 | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **Questionnaire**
Supplementary Material

Go back to text



Module 7

Risk Exposure and Risk Management with Various Grain Pricing Tools

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Topics

Introduction

There are actively traded futures and options contracts for most of the major crops produced in the United States, including corn, wheat, and soybeans. These contracts, considered separately or in combination, result in a large number of pricing alternatives or "tools" for producers. In the pricing of their crops, producers can trade futures or options contracts directly or indirectly through futures and options based cash contracts. Commonly used pricing techniques include: cash sales, forward cash sales, selling futures contracts, buying put option contracts, hedge-to-arrive contracts, minimum price contracts, minimum-maximum price contracts, basis contracts, delayed pricing contracts, buying futures contracts, and buying call option contracts. Some of these tools can also be used in combination with others. In addition, the Commodity Futures Trading Commission (CFTC) has considered lifting the ban on off-exchange agricultural trade options. The lifting of that ban could result in another generation of pricing tools for grain producers, which would not necessarily have to be traded in or linked to futures and options markets.

Producers need to understand how to use the various pricing tools to manage market risks and how to select the proper pricing tool to accomplish their objectives. Some tools manage only one of the primary market risks, while others may manage several sources of risk. Knowing how to use the various alternatives involves understanding the mechanics of such things as opening a trading account with a commission house, placing orders with the broker, and meeting margin requirements. It also includes understanding obligations and responsibilities for delivery, and conditions under which contracts can be canceled or modified.

Knowing how to use the various pricing tools is rather straightforward. Selecting the most appropriate pricing tool for the farm financial and marketing situation is more complicated. That is, knowing what to do is usually more difficult than knowing how to do it. The most appropriate pricing tool depends on: 1) the producer's risk management objectives and price expectations; 2) current price relationships and expectations about changes in those relationships; and 3) the producer's attitude toward risk. Proper tool selection involves answering two basic questions: (1) What is it that I want to accomplish? and (2) What is the best way to reach that objective considering my financial situation? More than one pricing tool may be available to accomplish a producer's objective. Part of the decision process is to evaluate the risk associated with each pricing tool.

Areas of Risk Exposure *(or go to* ***Topics*** *)*

The three components of price risk that were identified and examined in Module 7 were price level, basis, and spreads. Several other areas of risk that affect a farmer's net income should also be considered in the selection and implementation of pricing tools. Let's look at some of these other areas of risk:

Cash flow risk is typically associated with pricing tools that involve trading in futures or certain types of options positions. It is the risk that net cash inflows may fall short of cash outflows for business and family living needs. That risk stems from the necessity to maintain a margin account. Once a margin account is established and a futures position is taken, an adverse price movement may require additional deposits in the margin account. Rising prices from a short futures sale position, for example, would result in margin calls if the futures price rises sufficiently. The "loss" from rising prices would presumably be offset by a similar increase in the value of the grain owned by the producer. However, that gain cannot be captured until the grain is sold. In order to maintain a futures position, there is risk of substantial margin payments, even if for only short periods of time. The sharp rise in the price of corn during the 1995-96 marketing year is an excellent example of the potential cash flow risk of a futures position. Conversely, declining prices would result in money flowing into the margin account of a short hedge to offset the decline in value of the grain owned. Producers and their lenders need to recognize the cash flow risk associated with futures trading and make provisions to meet the potential need for additional margin requirements.

Production risk is associated with pricing a crop prior to harvest, with the primary concern being that production may fall short of expectations. The extent of production risk varies with location and by type of pricing tool used. For example, with short hedges or forward cash contracts implemented early in the growing season, there is risk that a production short-fall will cause a portion of the hedge or forward contract to become speculative. In that case, not enough grain is available to increase in value and offset losses occurring in the futures market. Losses in futures or in the forward contract thus become outright losses, and can reduce income below originally planned levels if prices rise sharply. With put option purchases or minimum price contracts and unexpectedly low yields, financial exposure in the market does not increase from the initial level. Thus, with puts purchases, price changes do not increase the risk exposure when your own yield prospects are deteriorating. In short, there are tradeoffs among production risk and other types of risk. Crop insurance tools should be considered as a way to help manage production risk, with or without the use of forward pricing tools.

Business risk or counter-party risk is the risk that the grain buyer will not be able to fulfill part or all of the contract agreement. Financial failure of the grain buyer represents the extreme of business risk. In such cases, not all creditors have the same priority in receiving payment. The risk is especially important for producers who have forfeited title to the grain, but have not yet received payment. In most states these contracts do not have the same financial safeguards as warehouse receipts. In addition, business failure likely results in the cancellation of forward contracts, leaving the producer in an open position on grain that was previously priced.

Grain quality risk is the risk that grain goes out of condition during storage or in the field due to disease, and is subject to price discounts. This risk is associated with any pricing tool that involves on-farm storage of grain, and may be associated also with a growing crop.

Tax risk includes the risk that losses associated with positions in the futures and options markets will be capital losses versus ordinary business expenses. For individuals, a maximum of $3,000 per year in speculative losses can be deducted as capital losses unless offset by capital gains, although capital losses can be carried forward.

Market volatility risk is associated with pricing tools involving the options market. The risk is that option premiums do not change one-for-one with cash or futures prices so that the net prices on such contracts do not move one-for-one with the change in price level. The size of the risk varies with market volatility, the closeness of the options strike price to the underlying futures price, length of time until contract delivery, and whether the producer intends to hold the options position until maturity or to exit early.

Control risk is associated with the number of decisions required in fully implementing a pricing tool. Some tools require only one decision -- a cash grain sale for example. Other tools, such as futures and options, require an initial decision and one or more subsequent decisions. When a series of decisions is required there is a risk of adverse market action that will reduce the net price before subsequent decisions are made.

Some grain pricing tools manage only one or a few elements of risk. Others are designed to manage or are capable of managing several aspects of risk. Tools can also be used in combination to extend risk management capabilities.

Evaluation of Grain Pricing Tools *(or go to* ***Topics*** *)*

The following discussion addresses some of the common pricing tools and their risk management capabilities. It is useful to categorize pricing tools based on the primary objective of the tool. For purposes here, three categories are used:

(1) tools for establishing a price level;

(2) tools for establishing a minimum price; and

(3) tools for retaining ownership after sale.

Tools for Establishing a Price Level *(or go to* ***Topics*** *)*

Four alternatives are available for establishing the price level of a grain commodity. These include: cash sales; forward contract sales; sale of futures contracts (hedging), and hedge-to-arrive contracts (substitute for hedging). Each has different risk exposure and risk management capabilities.

A spot cash sale represents the least flexible and least risky pricing tool. A cash sale establishes the price level and basis for immediate delivery for existing inventory of grain with payment to be made at delivery. A cash sale eliminates the risk of a lower price level and weaker basis. The primary risk is in the form of opportunity cost -- higher prices and/or improving basis after the sale is made. For a crop inventory that is still in the production process, relying on marketing through cash sales at harvest or later does not provide any assurance that costs of production and/or storage will be covered, or that prices will be profitable. Hence, when viewed from this perspective, the cash market can involve considerable risk exposure.

A cash forward contract (CFC) for a crop already in inventory carries less price level and basis risk than a spot cash sale. Quality risk is introduced if the grain is stored on the farm. Business or counter party risk is introduced in that the exchange of grain for cash is to take place in the future and the buyer must still be in business for that to happen. If the contracted grain is under warehouse receipt with the buyer, most state laws provide recovery for the seller if there is a business failure and sufficient assets are available. The recovery, however, may be at the current cash price rather than at contracted price.

A cash forward contract for a crop not yet harvested may amplify exposure to production risk while reducing exposure to price level and basis risk, as we noted earlier. The greater the percentage of production that is contracted and the earlier in the season that contracting is completed, the greater the production risk. Part of that risk can be managed with certain types of crop insurance tools. Those tools will be discussed in following modules.

The most flexible tool for establishing a specific price level is the sale of futures contracts (short hedge) (see Hedging Article). The initial transaction establishes the price level for the grain commodity and therefore, eliminates downside price level risk. The opportunity for higher prices is also eliminated. A number of other risks are introduced with the short hedge. The sale of futures contracts does not establish the basis so there is risk that the basis will weaken as well as the opportunity that the basis will improve. Cash flow risk is also associated with taking a position in the futures market because a short position in a rising market would result in margin calls. The short hedge also introduces some control risk. At some point, the futures sale must be offset and a cash sale made. The producer has to decide when to do that. In addition, a futures position can be "rolled" forward and delivery of the cash commodity delayed. That decision is a function of the magnitude of the spreads in the futures market and the availability and cost of storage. If the short hedge is established prior to harvest, some increase in production risk also may be encountered.

Some producers practice "selective" hedging. One variation of this might be a short futures position that is offset early, while the cash grain sale is made at a later time. Another variation of selective hedging would be to hedge only when the market offers the producer specific price objectives. If the desired prices are not available with this pricing procedure, the producer would wait for possible higher prices later. The former practice is common if futures prices have declined and a rebound in the price is expected. It introduces significant price level risk and tax risk. In this case, gains or losses in the futures market are actually speculative gains or losses and will be treated as such for income tax purposes. Using futures markets directly rather than indirectly through cash contracts provides the producer with considerable flexibility as to when and where to deliver the cash commodity.

Short futures positions may be taken in one marketing year with plans to "roll" that position to the following marketing year. This might be done when there is a large inverse in the prices between crop years and the inverse was expected to narrow prior to the maturity of the nearby contract. The extent to which that inverse narrows would add to the price of the crop to be delivered the following marketing year. This strategy might be relatively safe if quantities are small in relation to total production and the producer has the choice of delivering the current year's crop as an alternative to rolling and delivering next year's crop. The strategy can be extremely risky if large quantities are involved so that at least some of the futures will have to be rolled. The risk is that the inter-year price spread widens rather than narrows so that a lower price is received for the following year's crop. That type of situation occurred in 1996 corn futures. In addition, a large short position can create a large cash flow risk if prices rise significantly. Finally, significant control risk is introduced as large, quick price movements can result in an unacceptable position before action can be taken.

The hedge-to-arrive (HTA) contract was introduced to offer the producer some of the elements of both the cash forward contract and hedging. In its simplest form, the HTA involves the grain buyer selling a specific futures contract delivery month to establish the price level for the producer. The buyer establishes and maintains the futures account and the seller agrees to deliver grain to the buyer at a designated time and place. The basis portion of final cash price is to be established on or before the time of delivery. The seller chooses the day to establish the basis and the HTA is essentially converted to a cash contract. Compared to selling futures directly, the producer eliminates the cash flow risk of maintaining a futures account, but is subject to some business risk. The producer also gives up some flexibility as to time and place of delivery. Other risks are similar to direct use of the futures market.

In some instances, at the time the contract is written, producers are afforded the flexibility of "rolling" HTA contracts forward within the marketing year. Rolling becomes an alternative if storage space is available and carrying charges exceed the cost of storage and the extra transaction cost of rolling. If carrying charges do not exceed these costs, presumably the contract would not be rolled. If carrying charges do exceed costs, producers are faced with the decision of when to roll and perhaps how far into the future to roll the contracts. These intra-year rolling HTAs introduce spread risk into the producers marketing decisions in the same fashion that direct trading of futures involves spread risk. The roll feature, if allowed in the contract, typically involves a cost.

Multi-year sales with HTA contracts have also been offered (see **Module 7**). The concept is identical to that described using futures contracts directly. With HTA contracts, the buyer has the short position in the futures markets and allows the producer to roll the delivery period into the following marketing year. The producer then takes on the inter-year spread risk as described above. If the buyer is to maintain the futures account, the producer does not have the cash flow risk associated with margin calls, but may take on some business risk as extreme price movements requiring large margin payments could jeopardize the financial position of the buyer. Multi-year rolling HTAs can involve large exposure to spread risk if the contracts are not specifically based on harvest-delivery futures contract months, but are designed to be rolled from one crop year to the next. To avoid the need for rolling, the Chicago Board of Trade now has December corn and November soybean futures contracts being offered three years out. Pricing with harvest-delivery futures two or three years out involves considerable exposure to production risk that can be amplified by the futures position.

Tools for Establishing a Minimum Price Level *(or go to* ***Topics*** *)*

The various tools for grain pricing described above have different risk exposure, but the one common ingredient is that they eliminate downside price level risk. The converse, however, is true as well -- they eliminate the opportunity to benefit from a higher price level at a later date. The options market offers a way to establish a minimum price level and also allows the producer the opportunity to benefit from higher price levels. The purchase of put options gives the producer the right to sell futures at a predetermined price, therefore establishing a minimum price level. The producer pays a premium for the put. If futures prices decline, the premium value increases, providing some compensation for the decline in prices. If prices do increase, the grain can be sold at the higher price and the option either sold to capture any remaining premium value or allowed to expire if it has no value. Like a short position in the futures market, put options involve basis risk. There is no cash flow risk associated with margin calls, but there is volatility risk associated with put options. That is, premium values will not always move one-for-one with the change in the underlying futures price. Production risk is encountered if options are purchased prior to harvest, as is the case with cash marketing. However, the production risk exposure is greater than for cash sales, because of the extra cost incurred in buying the puts. Some control risk also is introduced by using the options market. Once the options are purchased, the producer must still decide when and how to price the grain in the cash market. In addition, option positions can be rolled forward, or upward if the market rises. The initial purchase decision requires subsequent decisions.

A minimum price can also be established by pricing grain by any of the methods described in the previous section and buying call options. Pricing the grain establishes a price level, while call options will increase in value if the futures price substantially increases. The call options decline in value if prices decline, but the amount at risk is the premium paid for the options. Under this arrangement, the producer takes on any of the risks of the pricing tool used as well as the risk associated with the call option. The primary risks of owning call options are volatility and control.

When put options are purchased, or grain is priced and call options purchased, producers are sometimes interested in also selling deep out-of-the money call options. By selling call options (receiving the premiums) the net cost of establishing the minimum price is reduced. However, selling the call option also establishes a price ceiling. If futures prices move above the strike price of the option sold, losses on that option will offset gains on the call options owned or will offset increases in the price of the crop still owned. Selling call options as part of a minimum price strategy establishes a price fence. It also introduces cash flow risk into the strategy since the short call option position has to be margined. Control risk is expanded as well, since subsequent decisions about liquidating the options will have to be made.

A minimum price can also be established with a minimum price contract (MPC) with a grain buyer. In this instance, the buyer trades the options and reflects the minimum price in the cash contract. This contractual arrangement has the same basic risk exposure as trading options directly. It differs from a direct put option purchase in that the minimum price contract requires delivery of the grain to a specific location. It cannot be allowed to expire, and the producer gives up the opportunity to sell at another market that might have a stronger basis.

Tools for Retaining Ownership After Harvest *(or go to **Topics**)*

Retaining a long position in the grain market after the crop is harvested can be accomplished in a number of ways: storage, ownership of futures, basis contracts, delayed pricing contracts, ownership of call options, or minimum price contracts. The common characteristic of these tools is that they allow the producer to benefit from higher price levels if the market strengthens later on. Other aspects of risk, however, vary considerably among the various contracts.

Storage is the most common way to retain ownership after grain is harvested. Storage on the farm carries price level risk, basis risk, and grain quality risk. For storage to be profitable, the eventual sale price must cover the cost of storage and any loss of value due to quality deterioration. The required price increase can come through a combination of price level and basis change. Exposure to risk of declining prices should also be considered.

Storage under warehouse receipt carries similar risk to on-farm storage. The primary difference is that quality risk is shifted to the issuer of the warehouse receipt. Business risk is generally quite limited due to state laws protecting the rights of warehouse receipt holders.

A long position can be established in the futures market rather than in the cash market. This may be attractive when storage space is limited or when basis is unseasonably strong and/or spreads are narrow. The "cost" of owning futures instead of cash grain is the cost of trading futures plus the opportunity cost of any improvement in the basis, plus possible tax risk. Basis improvement can only be captured by owning the grain. If the expected basis improvement is less than storage costs, owning futures may be an attractive alternative. However, the risks associated with such a strategy are numerous. In addition to price level and control risk, the owner of futures contracts has cash flow risk associated with potential margin requirements. Spread risk may also be encountered if the futures position is to be rolled at a later date. Finally, gains or losses on this type of futures position are subject to capital gains treatment rather ordinary income treatment.

A basis contract can be used to capture most elements of a long futures position. With a basis contract, grain is delivered to the buyer and a partial payment based on today's cash price is made, but a final price is not established. The basis is fixed at the current level and the producer then chooses the day to accept the futures price prior to maturity of the contract. The buyer of the grain buys futures contracts to hedge the position. Risks for the producer are similar to those for long futures, except that cash flow risk from the futures position is shifted to buyer and the tax risk may be eliminated.

A fourth alternative is delayed pricing **(DP)** contracts. With these, the producer delivers grain and transfers title of the grain to the buyer, but does not establish a price. The price paid to the producer is the cash price on the day of the producer's choice prior to contract maturity. The buyer will typically charge a service fee. The magnitude of the fee depends on what the buyer does with the grain. If the grain is stored until the producer prices it, the schedule of service charges may be very similar to the schedule of storage charges. If the buyer sells the grain and hedges by buying futures contracts, the service charges reflect the anticipated improvement in the basis. "Free" delayed pricing contracts are often offered when basis is unseasonably strong and little or no improvement is expected. The producer risks associated with delayed payment contracts include price level, basis, and business risk. Business risk stems from the fact that the producer has become an unsecured creditor to the buyer. Some state laws provide partial protection for the holder of a delayed pricing contract, but generally at a lower level than for holders of warehouse receipts.

Several risk factors must be considered with all of the alternatives for retaining a long position, but the common risk is that of lower prices. One way to manage risk is with call options. Owning calls instead of futures or grain gives the producer the right to buy futures at a predetermined price. The premium paid for the option will increase in value if the underlying futures price increases substantially. The maximum loss from owning with call options is the premium paid. Price level risk is limited, but volatility risk is encountered. The call option alternative is attractive when basis is unseasonably strong and low price volatility has resulted in relatively low premiums.

Minimum price contracts can be used instead of direct use of the options market. Under such a contract, the grain buyer trades the option contracts and establishes a minimum price for the producer. Increased premium values on the call option would result in a higher price for the producer. The producer must choose the time for establishing price prior to the maturity of the contract.

Summary

*(or go to **Topics**)*

The risk characteristics of the various pricing tools discussed here are summarized in the following table. In addition, an overall risk rating is assigned to each of the alternatives. The selection of the appropriate pricing tool involves: 1) a clear understanding of the pricing objectives; 2) the formation of price level and basis expectations, and 3) an evaluation of the risk elements inherent in each of the tools.

Sources for more information

(or go to ***Topics*** *)*

Illinois Regional Corn and Soybean Basis Data by D. Good can be found at **http://www.ag.uiuc.edu/~stratsoy/**

P. Baumel and J. Miranowski, Managing Risk, Managing Change, Iowa State University Department of Economics (Ames, Iowa) October 1996.

R. Wisner, Commonly Used Grain Contracts, Pm-1697a, Iowa State University Extension, (Ames, IA), December 1996.

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Questions for Your Farming Operation

(or go to ***Topics*** *)*

1. What is the average harvest time basis for corn, wheat and soybeans in markets where you sell your grain? What have been the high and low ranges of your harvest basis during the past four years?

2. What is the average change in basis under near-by futures for your area from the weakest basis at harvest to the strongest post-harvest basis? How does this compare with your costs of storing grain?

3. When does the strongest post-harvest basis usually occur for corn, soybeans, and wheat in your area?

4. If you hedged 30 percent of your crop (corn, soybeans, and wheat), what total amount of margin call exposure would you expect with recent price volatility.

Areas of Risk Exposure											
Pricing Alternatives	Price Level	Basis	Spread	Cash Flow	Volatility	Business	Tax	Control	Production	Quality	Risk Rating
Selling out of inventory or Establishing Pre-harvest Price Level											
1. Cash Sales	X	X							X[1]	X[2]	Moderate Large
2. Forward Contracts						X			X[1]	X[2]	Low to Large[3]
3. Short Futures		X		X				X	X[1]	X[2]	Low to Large[3]
4. Non-roll single or multi-year H-T-A		X				X		X	X[1]	X[2]	Low to Large[3]
5. Intra-year rolling H-T-A		X	X			X		X	X[1]	X[2]	Low to Large[3]
6. Inter-year rolling H-T-A		X	X			X	X	X	X[1]	X[2]	Extreme

Areas of Risk Exposure											
Pricing Alternatives	Price Level	Basis	Spread	Cash Flow	Volatility	Business	Tax	Control	Production	Quality	Risk Rating
Establishing Minimum Price											
1. Buy Put Options	X[4]	X			X			X	X[1]	X[2]	Low
2. Price Grain Buy Call Options	X[4]	X			X	X[5]	X	X	X[1]	X[2]	Low
3. Minimum Price Contracts	X[4]				X	X		X	X[1]	X[2]	Low

Areas of Risk Exposure											
Pricing Alternatives	Price Level	Basis	Spread	Cash Flow	Volatility	Business	Tax	Control	Production	Quality	Risk Rating
Retaining Ownership											
1. Storage	X	X	X							X[2]	Moderate
2. Sell grain, buy futures	X		X	X			X	X			Moderate Large
3. Basis Contract	X		X			X		X			Moderate Large
4. Delayed Pricing Contracts	X	X	X			X		X			Moderate Large
5. Sell grain, buy call options	X[4]				X		X	X			Low
6. Minimum Price Contracts	X[4]				X	X		X			Low

1. If priced before harvest
2. If stored on the farm
3. If priced before harvest without crop insurance
4. Downside risk limited to premium paid
5. If priced with forward contract rather than cash sale
Source: Adapted from National Grain and Feed Association White Paper, May 1996.

End of Module *(or go to **Topics**)*

Go to Module 8 | **Introduction** | **MRP Introduction**
Universities and Agribusinesses |**Table of Contents** | **or Go to Modules :**

1 | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **Questionnaire**

Supplementary Material