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THE PERFORMANCES OF PROBABILITY-BASED GRAIN MARKETING STRATEGIES

Daniel O'Brien and Robert Wisner*

The performances of probability-based corn marketing strategies are compared for alternative corn price forecast probability information sources for the 1992-1994 time period. Price forecast probability information from Extension grain price forecasts, grain options premiums, and price forecasting models are used. The probability-based decision rules are designed to "trigger" pre-harvest sales when certain probability and price level goals are met. The grain marketing strategies are based on the probability of prices increasing or decreasing, of profitability goals being attained, or of other combinations of crop condition and profitability criteria being met. During the 1992-1994 period, an average futures price $2.58-$2.60 per bushel was received by the highest performing strategies, compared to an average harvest time futures price of $2.24. The performance of these strategies during this period was dependent on whether or not pre-harvest sales were triggered during the key yield determination period of mid-June through July.

Introduction

A major factor in farmer's grain marketing decisions is the probability of price increases or decreases given the information known at a point in time in the grain market. In preharvest grain price decisions there can be considerable uncertainty regarding price direction, most of which is related to uncertainty about the effect of past, present and future weather conditions on grain yields. In their preharvest grain marketing strategies, farmers are implicitly making judgements about the likelihood of alternative harvest-time price levels based on their expectations about grain production and other supply and demand factors.

A number of studies have examined the performance of alternative grain marketing strategies, including Wisner for corn. There have also been a number of efforts to design decision making tools for farmers that assess the risks inherent in farm marketing and production. These include the Agricultural Risk Management Simulator (ARMS) program by Robert King at the University of Minnesota, and the Risk Rated Management Strategies program from Oklahoma State University, developed by John Ikerd and Kim Anderson. This paper focuses specifically on the probability related aspects of grain marketing strategies and on comparisions of the probability information available from alternative price information sources.

The objective of this paper is to develop and measure the performances of probability-based corn marketing strategies. The performance of these strategies are compared for alternative sources of harvest corn price forecast probability information for the 1992-1994 time period. Price forecast probability information is obtained from: (a) Extension grain price forecasts from

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Iowa State University; (b) price probability distributions derived from the premiums of harvest-time delivery put and call options; and (c) the price forecast confidence intervals from a harvest-time price forecasting model, using both USDA and private crop-weather model production and supply/demand forecast information.

In the first section of this paper, the sources of price probability information are discussed and their results for the 1992-1994 period are presented. Then probability-based preharvest marketing strategies are defined. The performance of these strategies during the 1992-1994 period for each of the price probability sources is then presented, followed by a summary and conclusions.

Sources of Price Forecast Probability Information

1. OPTIONS© Program Output:

The OPTIONS© program was developed by Robert King at the University of Minnesota as a tool to calculate the futures price probability distribution implied by the premiums of options puts and calls. The OPTIONS© program is used to calculate the implied probability distribution of Chicago Board of Trade December (new crop) corn futures at two week intervals during the 1992-1994 corn growing seasons. The information required on a specific date are: futures price, put and call option premiums at various strike prices for the futures option contract, the option expiration date, and a representative interest rate for borrowed money. The interest rate used was that charged by commercial agricultural lenders in Iowa for farm enterprises. Information in Table 1 is presented in the same form as the output from the computer program, including selected distribution percentiles, the mean implied price, the standard deviation, and the probability of prices declining. Probability of price decline is identified by finding the percentile at which the futures price lies along the implied cumulative price distribution. The proportion of the cumulative distribution below the futures price is the probability of price decline.

2. Harvest Time Corn Price Model:

A procedure was developed by O'Brien to forecast the probability distribution of harvest time average corn futures prices. A single equation log-linear (exponential) model of harvest time average corn futures prices was estimated, with harvest prices as a function of U.S. corn production, beginning stocks, feed use, the previous year's total corn usage, and exports. The variances of the forecast explanatory variables, their covariances with other forecast variables, and the estimation error of the corn price model are used in a multivariate Monte Carlo procedure to generate preharvest price forecasts and to derive corn price forecast probability distributions.

The harvest time corn price model was estimated as:

$$\ln(P_t) = \underset{(4.15)}{1.3197} - \underset{(-5.55)}{.013418 \bullet PRDN_t} - \underset{(-3.39)}{.0083431 \bullet BGSTKS_t} - \underset{(-1.03)}{.011406 \bullet FEED_t} + \underset{(2.95)}{.013081 \bullet USE_{t-1}} + \underset{(2.13)}{.014605 \bullet EXPTS_t}$$

19 observations (1973-1991) Standard Error = 0.10647

$R^2 = 0.8154$, Adjusted $R^2 = 0.7443$ Durbin-Watson Statistic = 1.27

where,

P_t = December corn futures average price during October 15-31
$PRDN_t$ = USDA U.S. corn production projection at harvest
$BGSTKS_t$ = USDA beginning stocks projection at harvest
$FEED_t$ = USDA feed use projection at harvest
USE_{t-1} = USDA total corn use projection at harvest for the previous year
$EXPTS_t$ = USDA U.S. corn exports projection at harvest
(All quantity variables are measured in 100 million bushel units)

Forecasts of $PRDN_t$ have a major impact on forecast harvest price levels. Two sources of $PRDN_t$ forecasts are used in this procedure. USDA National Agricultural Statistical Service (NASS) forecasts are released at the same time as the USDA World Agricultural Outlook Board (WAOB) U.S. corn supply/demand estimates, typically during the 8th to 12th of each month. These forecasts represent $PRDN_t$ expectations as of the first of each month. A second $PRDN_t$ forecast source can be obtained using crop-weather models to estimate U.S. Corn Belt yields and corn production (O'Brien). In this application, U.S. $PRDN_t$ forecasts are made for July 1, August 1, September 1 and October 1, given weather conditions up to the date of the forecasts. In this application, price forecasts for mid-June, mid-July, mid-August, and mid-September are made using USDA NASS $PRDN_t$ forecasts and USDA WAOB supply/demand estimates in the price model. Also, price forecasts are made for July 1, August 1, September 1 and October 1 using U.S. $PRDN_t$ forecasts from crop-weather models and the previous month's USDA WAOB supply/demand estimates. The variances and covariances among explanatory variables and a detailed description of the forecasting procedure are given by O'Brien. The forecasts from using this procedure for mid-month forecasts (using USDA NASS and WAOB supply/demand forecasts) and for beginning of the month forecasts (using crop-weather model forecasts and WAOB supply/demand forecasts) are presented in Table 2.

3. ISU Extension Grain Price Forecast Scenarios:

The Extension forecasts are based on the judgement of Iowa State University Extension grain marketing specialists. The preharvest probability weighted forecasts and their associated probability weights for the 1992-1994 corn growing seasons that were publically released are given in Table 3. These public forecasts are presented periodically (typically monthly or bi-weekly) throughout the corn growing season in the form of alternative crop production and price scenarios (i.e., for small, most likely, and large crops) with their associated probabilities. The 1992 and 1994 forecasts reflect weather and crop development uncertainty during the critical July time period, and reduced risk to the crop thereafter. The 1993 scenarios reflect both early season uncertainty and the developing short crop condition. Note that 1993 new crop futures prices did not react substantially to the short crop conditions until after the USDA November crop report. This information was transformed into a probability distribution in a representation similar to a triangular distribution. The probabilty of prices being lower or higher than a specific point along the triangular distribution was calculated by interpolation and summation of the appropriate probability weights along the four linear segments of the triangular distribution.

Comparison of Price Forecast Probability Results for 1992-1994:

Of the three years considered in this research, 1992 is considered a normal to large crop year, 1993 as a short crop year, and 1994 as a large crop year. Profitable forward pricing opportunities existed in the December futures contract during June-July of 1992 and 1994, in that preharvest futures were higher than eventual harvest time futures. However, during 1993 harvest futures prices were essentially the same during the July-early August period and at harvest, with an increase coming afterwards, once the full extent of reduced production was recognized in the

November crop report. All three price forecast information sources tended to forecast declining prices on into harvest. This was especially true for June and July forecasts. Although incomplete data for 1992-1993 limited the analysis of Extension grain price forecasts, the diminishing difference between the harvest price forecasts for the short and large crop scenarios reflected decreasing production and price uncertainty throughout the growing season. The format of the Extension forecast (short-normal-large crop scenarios) allowed for explicit definition of scenario probabilities, an advantage over the other price forecast probability sources. The options and harvest price model based forecasts had both consistently forecast price declines (the options model less so than the harvest price model). The only exception came during September, 1993 when the harvest price model using USDA NASS production estimates forecast that prices would increase. Generally, the USDA NASS based price projections where higher than for the Crop-weather model based price projections, due to consistently higher U.S. corn production forecasts from the Crop-weather models. The USDA NASS based price projections proved to be very accurate for 1992 and 1993, but forecast prices too low during 1994.

Probability-Based Grain Marketing Strategies

A key to developing realistic preharvest probability-based corn marketing decision rules is determining what factors farmers consider when they make preharvest forward pricing decisions. Among the factors farmers are likely to consider are: the probability and magnitude of price increases, the probability and magnitude of price decreases, the profitability of forward pricing opportunities, and the quantity of production farmers are willing to forward price. Probability-based decision rules should identify the time period or date on which the marketing decision is to be made, the price goal to be attained, and the "trigger" probabilities associated with specific forward pricing opportunities. The general structure of these decision rules can be as follows: *"If on* (date) *, there is a* trigger% *probability of* price goal *being attained, a sales decision will be made."* An additional element to consider is the proportion of expected production to be sold at that time, or %sales. This %sales element allows for so-called "scale up" marketing strategies. The general rule would then be adjusted as follows: *"If, on* (date) *, there is a* trigger% *probability of* price goal *being attained, a sales decision will be made on* %sales *of expected production."*

Farmer's marketing decision rules also should be defined in terms of information that they have ready access to. During the preharvest period farmers have access to (a) cost of production estimates, (b) production and price forecasts from public and private forecasters, (c) harvest forward pricing opportunities using harvest futures and historic average basis estimates; and (d) current crop conditions in the World, the U.S. and on a farmer's own acres. The probability-based price forecasts from ISU Extension and implied price forecast distributions from the options market are also available to farmers who choose to use them.

Five groups of preharvest marketing strategies will be analyzed in this study, based on the grain marketing strategy factors farmers may consider that were identified above.

Group 1: Probability of Increasing Prices (Opportunity Strategies)
Group 2: Probability of Decreasing Prices (Risk Aversion Strategies)
Group 3: Probability of Profits (Profitability Strategies)
Group 4: Crop Condition / Profit / Preharvest Sale Strategies (Combination Strategies)
Group 5: Nonprobability Profit Strategies

The specific elements of these strategies are identified in Table 4. In this paper each strategy has a 50% and 100% of preharvest total sales option. For the 50% sales option, on the initial date that the conditions for the strategy are met, 50% of preharvest sales are made. Then if the conditions are met again on a later date, the remaining 50% of preharvest sales are made. If the strategy conditions are not met again during the preharvest period for the remaining 50% of preharvest sales, then the remaining 50% is sold at harvest. For the 100% sales option, the total amount of planned preharvest sales is made at the initial time that the strategy's conditions are met, and none can be made at a later date during the preharvest period. If no sales are made prior to harvest with both the 50% and 100% options, then 100% of the preharvest sale amount is sold at harvest for the prevailing futures price. Only hedges (selling futures contracts, or "short" positions) are considered in these marketing strategies. Buying puts to set minimum or floor prices may be considered in future work.

World Agricultural Outlook Board (WAOB) season average price forecasts are used as a criteria to reflect the incentive farmers have to make preharvest pricing commitments. The rationale is that if the price that farmers can obtain at harvest is greater than the projected season average price, then farmers have an incentive to make preharvest sales. Crop conditions are considered to reflect the likelihood of a normal to large U.S. corn crop and subsequent lower prices. In the combination strategies (Group 4) the first strategy may trigger sales when U.S. crops are in good-to-excellent condition and a profitable hedging opportunity is still available. The second strategy in Group 4 signals for sales when U.S. crops are in good-to-excellent condition and there is a high probability that harvest futures prices will be greater than the WAOB projected season average futures equivalent price. The Nonprobability Profit strategies in Group 5 provide a basis for comparison with the probability-based strategies.

Table 5 lists the information used as decision criteria in the preharvest marketing strategies. The decision rule criteria include 1992-1994 biweekly harvest futures prices, cost of production and equivalent breakeven futures price estimates, estimates of hedgable profits (excluding farm program deficiency payments), World Agricultural Outlook Board (WAOB) season average cash and equivalent futures price projections, and biweekly USDA crop condition reports of the percentage of the U.S. corn crop rated good-to-excellent. The lower sections of Table 5 list 1992-1994 price probability information derived from Extension price forecasts, options premiums, harvest corn price model forecasts using USDA NASS production forecasts, and harvest corn price model forecasts using crop-weather model production forecasts. For each of these price probability sources the probability of prices increasing and decreasing are identified, as well as the probability of harvest futures prices being greater than total cost of production and also greater than the equivalent season average futures price from the WAOB projections.

Corn cost of production estimates were obtained from the Iowa State University Extension Service, and represent total costs of production on rented farmland with medium range expected yields (125 bu in 1992, 135 bu in 1993-1994) in a corn-soybean rotation. No adjustments are made to reflect cost per bushel changes for higher or lower than projected yields on an individual farm as the growing season progressed. To estimate a breakeven futures price, a $0.30 per bushel basis adjustment was made to the Iowa cost of production projections. This equals the basis estimate used in ISU Extension harvest price forecasts for north central Iowa cash prices. The basis adjustment to WAOB season average cash price forecasts to derive an equivalent season average futures price projection is $0.20 per bushel. Typically the Iowa basis is approximately $0.10 wider than for the U.S. overall, leading to a $0.20 basis estimate (i.e., $0.30 - 0.10 = $0.20). However, this basis estimate may be too wide (or strong) to represent the overall U.S. season average basis, causing a higher than normal WAOB equivalent season average futures

price projection, and diminishing the frequency of preharvest forward price commitments in some strategies. The probability of prices being greater than the futures equivalents of breakeven cost of production and the WAOB season average price are calculated by finding their percentile within the appropriate cumulative price forecast distribution. The proportion of the price distribution associated with higher (lower) prices than the breakeven cost or the WAOB price is identified here as the probability of prices being higher (lower) than those figures.

Marketing Strategy Results for 1992-1994

Tables showing the results of these probability-based preharvest marketing strategies for 1992, 1993 and 1994 are available from the authors upon request. In 1992 the best forward pricing opportunites came during June and early July, after which futures declined steadily into harvest. The Opportunity (Group 1) and Risk Aversion (Group 2) strategies generally performed best because they responded to early season market signals indicating a high probability of declining futures prices. Timeliness of price information availability affected strategy performance. The highest prices were available on June 15 ($2.55) and July 1 ($2.63). The Extension and the Crop-weather/Price Model-based forecasts were not available until July 1 to triggered sales. The options and NAS/Price Model forecasts were available on June 15th, and gave an earlier signal for sales at $2.55. Any strategies that had not completed preharvest sales by July 1 resulted in lower prices. Profitability strategies (Group 3) did not trigger preharvest sales, instead leaving the grain to be sold for lower prices at harvest. One exception was for the 50% profit probability: 100% sales strategy (#2a) based on Options price forecasts, which triggered a July 1 sale at $2.63. The associated 50% sales strategy (#2b) split sales between July 1 and harvest. As a rule, the Combination strategies (Group 4) were inferior to the other groups, with the best performance from 3a and 4a which triggered sales on July 15. Most of the Combination strategies triggered no preharvest sales and accepted the lower harvest price. The Nonprobability Profit strategies (Group 5) performed well if the profit objectives were not too high.

The impact on prices of the short crop of 1993 was not fully reflected in futures prices until after harvest. The strength in prices during late summer caused harvest futures prices to be essentially equal to early season price levels. The only cause of poor performance was from receiving a signal to forward price grain too early (i.e. on June 15 for $2.27) instead of waiting for the $0.18 to $0.20 gain from later foreward pricing or harvest sales. Also, some strategies were hurt by responding to a NAS/Price Model signal on September 15 to sell for $2.39. Overall, there was little difference in price received among any of the groups or any of the price information sources. In a more typical short crop year, prices may have been considerably higher at harvest than during the early season, rewarding strategies that did not aggressively trigger early preharvest sales.

In 1994, any strategy or price source that triggered sales on June 15 at $2.71 gave superior price results. Split sales strategies that triggered sales of 50% on June 15 and 50% sales on July 1 for $2.40 also did well. After these early season opportunities, futures declined to the $2.20-2.23 range during July through August, and to $2.18 through September. Timing and availability of price information had a major impact in 1994 strategies, as the options and NAS/Price Model forecasts were available to trigger June 15 sales. Initial Extension and Crop-weather/Price Model forecasts were not available till July 1. There was little difference between the Opportunity (Group 1) and Risk Aversion (Group 2) strategies keyed by probability of price increases or decreases, except when the options premium price forecasts are considered. For these, the Risk Aversion strategies were triggered on June 15 while the Opportunity strategies

were not. None of the WAOB related Risk Aversion strategies, the Profitability Strategies (Group 3), or the Combination strategies (Group 4) were triggered by early season pricing opportunities, except for those relying on options forecast information. The Nonprobability Profit strategies (Group 5) that sold 100% on June 15 performed very well, while those selling 50% at a time split sales between June 15 and harvest.

Table 6 gives an overall summary of the performance of these strategies for the 1992-1994 period. The average price received and the frequency with which the strategies were triggered relative to the number of potential preharvest opportunites are identified for each strategy and price information source. The average price received if all grain was sold at harvest during 1992-1994 was $2.24, while the high end of the 3 year average prices received for these strategies are in the $2.58-$2.60 range. The highest average price received ($2.60) was for a Profitability (Group 3) strategy (selling 100% when the probability of profit was greater than 50%) using options price forecast information. This strategy was triggered by early season profit opportunities at the market highs in 1992 and 1994, but received the harvest price in 1993. Interestingly, almost all of the other Profitability strategies resulted in lower prices, especially in 1992 and 1994.

Two Risk Aversion (Group 2) strategies triggered by options price information and a Nonprobability Profit (Group 5) strategy resulted in a $2.58 average price. The first Risk Aversion strategy triggered 100% preharvest sales when greater than 60% probability that harvest futures prices would be declining existed. The second Risk Aversion strategy triggered 100% preharvest sales when the probability of harvest prices being higher than the WAOB season average price was greater than 50%. Both of these strategies led to sales on 6/15/92 for $2.55, on 7/1/93 for $2.47, and on 6/15/94 for $2.71. The Nonprobability Profit strategy triggered sales decisions whenever an opportunity to hedge a profit occurred, with sales timing and prices being the same as for the Risk Aversion strategies above. As stated above, in a more typical short crop year price pattern than in 1993 these strategies involving aggressive early season selling may not have performed as well.

A number of other strategies resulted in average prices in the $2.47-2.51 range. These all were triggered by aggressive early season forward pricing in 1992-94 and were not penalized by the manner in which the 1993 short crop price pattern occurred. This was especially true for the Opportunity and Risk Aversion pricing strategies triggered by probabilities of price increases and decreases and using price information from the two harvest price models. The tendency of these models to forecast normal production resulting in moderate to low prices led to aggressive forward pricing, so much so that sales were triggered at the comparatively low price of $2.27 on 6/15/93. In general, the 50% two stage preharvest sales strategies did not perform as well as the 100% single stage strategies. This was due to the rewards to aggressive early season forward pricing, especially in 1994. Again, a more typical short crop price pattern in 1993 may have affected this result.

In comparing the performance of the price information sources across the strategies, the options price information has the advantage of being available on a timely basis. Note however, that the prices received for Opportunity (Group 1) 100% sale strategies with the options price information were lower than for the other price information sources. If other price information sources were available on as timely a basis as the options information, their marketing strategy performance may have been equal or better. This is especially true for the Extension price information. Also, the poor performance of the harvest corn price model-based forecasts in 1994 points out the need for (a) examination of the factors affecting prices during 1994, (b) revisiting

the issue of appropriate model structure, and (c) possibly reestimating the model for either the 1973-1993 or 1973-1994 time periods for use in future forecasting applications.

Conclusions

The objective of this paper is to add probabilistic content to preharvest grain marketing strategies used by grain producers. Also, it provides a comparison of price probability information available from alternative sources at periodic times during the 1992-1994 growing seasons. This research is timely due to likely reductions in U.S. farm program funding and price protection for feed grain producers. If farmers are forced to assume more responsibility in managing price and income risk, the tasks of quantifying the accuracy of grain price forecasts and managing the risk inherent in grain pricing decisions will take on even greater importance than they currently do.

The ideal marketing strategy would trigger early preharvest sales in normal to large crop years to take advantage of risk premium that typically exists in harvest futures. That strategy would also signal farmers to not sell too early in short crop years, instead waiting to take advantage of typically stronger bids at harvest. The Opportunity and Risk Aversion strategies show the potential to accomplish this. However, more work is needed on the historic behavior of these price probability sources in response to market information during the May - August time period, especially in short crop years, so that signal or "trigger" criteria can be developed for marketing strategies. Also, these strategies are "ad hoc" in nature, with more work needed to demonstrate whether or not they trigger optimal or near optimal preharvest marketing decisions. Before these strategies can be recommended to farmers, their historic performance must to be measured over a longer period of time.

The performance of these marketing strategies during the 1992-1994 period was dependent on sales signals given during the key yield determination period of mid-June through July. The best performing strategies triggered during mid-June to early July in the normal to large crop years of 1992 and 1994. These aggressive early season sales strategies were not hurt by July sales during the short crop year of 1993.

The options-based price probability information has an availability advantage over the periodically available Extension and Price Model information sources. However, the perspective and judgement of an informed market analyst may prove to be as or more accurate than the implied consensus forecast information from the options market. The Price Models hold promise and are valuable as an additional price forecast information source. However, because of the critical importance of having accurate production predictions, crop-weather model forecast accuracy either has to be improved or a way found to incorporate more accurate production forecasts from alternative sources.

References

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Table 1. Implied Harvest Futures Price Probability Distributions Derived from Options Premiums, 1992-1994

	1992								1993								1994							
Date:	6/15	7/1	7/15	8/3	8/17	9/1	9/15	10/1	6/15	7/1	7/15	8/2	8/16	9/1	9/15	10/1	6/15	7/1	7/15	8/1	8/15	9/1	9/15	10/1
Futures $:	2.55	2.63	2.36	2.23	2.26	2.20	2.21	2.14	2.27	2.47	2.45	2.47	2.41	2.34	2.39	2.43	2.71	2.40	2.23	2.22	2.20	2.23	2.18	2.18
Interest %:	9.27	9.05	9.05	8.90	8.90	8.90	8.90	8.90	8.41	8.41	8.41	8.41	8.41	8.41	8.41	8.41	9.27	9.39	9.39	9.39	9.39	9.39	9.39	9.53
Percentile:																								
1%	1.59	1.42	1.79	1.70	1.77	1.26	1.35	1.77	1.73	1.78	1.95	1.35	1.99	1.94	2.04	2.10	1.89	1.44	1.79	1.74	1.87	1.90	1.85	1.86
5%	1.87	1.69	1.96	1.87	1.95	1.77	1.87	1.88	1.89	1.96	2.08	1.66	2.09	2.06	2.12	2.20	2.12	1.76	1.94	1.88	1.97	1.99	1.96	1.96
10%	2.01	1.96	2.05	1.95	2.01	1.91	1.97	1.94	1.97	2.06	2.15	2.04	2.15	2.11	2.17	2.23	2.23	1.92	1.99	1.96	2.02	2.05	2.00	2.00
20%	2.17	2.26	2.15	2.04	2.09	2.02	2.06	2.01	2.07	2.16	2.22	2.20	2.21	2.18	2.23	2.28	2.36	2.08	2.07	2.05	2.08	2.10	2.07	2.06
30%	2.28	2.36	2.21	2.11	2.14	2.10	2.12	2.06	2.13	2.23	2.27	2.27	2.26	2.22	2.27	2.33	2.46	2.18	2.12	2.10	2.11	2.14	2.11	2.11
40%	2.38	2.44	2.27	2.16	2.19	2.15	2.16	2.10	2.18	2.30	2.31	2.34	2.32	2.27	2.31	2.37	2.53	2.26	2.16	2.15	2.15	2.18	2.14	2.14
50%	2.47	2.54	2.33	2.21	2.24	2.20	2.21	2.14	2.24	2.38	2.36	2.40	2.37	2.31	2.36	2.41	2.61	2.34	2.20	2.20	2.19	2.22	2.18	2.17
60%	2.55	2.64	2.38	2.26	2.29	2.25	2.25	2.17	2.29	2.44	2.42	2.46	2.43	2.36	2.40	2.45	2.71	2.41	2.25	2.25	2.23	2.26	2.22	2.21
70%	2.68	2.73	2.45	2.31	2.35	2.30	2.29	2.21	2.36	2.51	2.52	2.54	2.50	2.40	2.46	2.49	2.81	2.48	2.30	2.30	2.27	2.30	2.26	2.25
80%	2.81	2.88	2.52	2.39	2.42	2.37	2.35	2.27	2.45	2.58	2.64	2.64	2.56	2.48	2.55	2.55	2.91	2.57	2.38	2.36	2.31	2.36	2.30	2.29
90%	2.96	3.14	2.64	2.52	2.53	2.45	2.43	2.33	2.56	2.68	2.80	2.85	2.78	2.58	2.65	2.65	3.05	2.74	2.49	2.46	2.40	2.45	2.35	2.36
95%	3.17	3.42	2.72	2.64	2.61	2.52	2.50	2.41	2.71	2.79	2.95	3.25	3.21	2.65	2.71	2.74	3.20	2.87	2.56	2.54	2.48	2.53	2.40	2.41
99%	3.85	4.17	4.99	3.33	3.32	2.68	2.71	2.57	2.91	3.07	3.31	4.83	4.60	2.84	2.99	3.02	3.57	3.13	2.81	2.72	2.60	2.66	2.50	2.65
Avg Futures$	2.50	2.56	2.36	2.24	2.23	2.18	2.19	2.14	2.26	2.37	2.43	2.45	2.46	2.33	2.39	2.43	2.64	2.33	2.23	2.21	2.20	2.23	2.18	2.18
Std Dev'n $	0.42	0.49	0.39	0.28	0.27	0.25	0.22	0.16	0.24	0.26	0.28	0.51	0.41	0.19	0.20	0.18	0.33	0.33	0.20	0.20	0.15	0.16	0.14	0.15
Probability of Price Decline	60%	59%	55%	54%	55%	51%	51%	50%	55%	63%	63%	61%	56%	56%	58%	54%	60%	59%	56%	53%	54%	53%	51%	51%

Table 2. Preharvest Corn Futures Price Forecast Distributions for 1992-1994
Using a) USDA NASS (NAS) $PRDN_t$ for mid-month forecasts,
b) Crop-weather model (Cwm) $PRDN_t$ forecasts for beginning-of-month forecasts

	1992								1993								1994							
Date:	6/15	*7/1*	7/15	*8/3*	8/17	*9/1*	9/15	*10/1*	6/15	*7/1*	7/15	*8/2*	8/16	*9/1*	9/15	*10/1*	6/15	*7/1*	7/15	*8/1*	8/15	*9/1*	9/15	*10/1*
E[$PRDN_t$] Source:	NAS	*Cwm*	NAS	*Cwm*	NAS	*Cwm*	NAS	*Cwm*	NAS	*Cwm*	NAS	*Cwm*	NAS	*Cwm*	NAS	*Cwm*	NAS	*Cwm*	NAS	*Cwm*	NAS	*Cwm*	NAS	*Cwm*
Harvest Futures $	2.55	*2.63*	2.36	*2.23*	2.26	*2.20*	2.21	*2.14*	2.27	*2.47*	2.45	*2.47*	2.41	*2.34*	2.39	*2.43*	2.71	*2.40*	2.23	*2.22*	2.20	*2.23*	2.18	*2.18*
U.S. Prod'n Fcst	8.58		8.45		8.76		8.77		8.50		7.85		7.42		7.23		8.73		9.00		9.21		9.26	
(Billion Bushels)		*8.56*		*10.1*		*10.6*		*10.6*		*8.33*		*8.71*		*8.39*		*8.23*		*8.74*		*9.50*		*9.92*		*9.79*
Percentile:																								
1%	1.45	*1.66*	1.61	*1.37*	1.63	*1.28*	1.64	*1.29*	1.39	*1.62*	1.64	*1.54*	1.85	*1.62*	1.90	*1.68*	1.34	*1.53*	1.40	*1.38*	1.43	*1.30*	1.44	*1.36*
5%	1.63	*1.79*	1.77	*1.47*	1.77	*1.38*	1.77	*1.38*	1.56	*1.75*	1.80	*1.66*	2.00	*1.75*	2.05	*1.80*	1.51	*1.64*	1.53	*1.48*	1.56	*1.41*	1.56	*1.45*
10%	1.74	*1.86*	1.86	*1.54*	1.84	*1.44*	1.84	*1.43*	1.67	*1.82*	1.90	*1.73*	2.08	*1.82*	2.14	*1.86*	1.61	*1.71*	1.61	*1.55*	1.62	*1.46*	1.62	*1.51*
20%	1.86	*1.95*	1.98	*1.61*	1.93	*1.51*	1.93	*1.50*	1.78	*1.91*	2.01	*1.82*	2.19	*1.92*	2.24	*1.95*	1.72	*1.79*	1.71	*1.62*	1.70	*1.54*	1.70	*1.58*
30%	1.96	*2.02*	2.06	*1.67*	2.00	*1.57*	2.00	*1.55*	1.88	*1.98*	2.10	*1.89*	2.27	*1.99*	2.32	*2.02*	1.81	*1.86*	1.78	*1.69*	1.76	*1.60*	1.76	*1.63*
40%	2.06	*2.09*	2.13	*1.72*	2.06	*1.62*	2.05	*1.60*	1.97	*2.04*	2.17	*1.94*	2.33	*2.05*	2.39	*2.08*	1.90	*1.92*	1.85	*1.73*	1.82	*1.65*	1.81	*1.68*
50%	2.15	*2.15*	2.20	*1.77*	2.12	*1.66*	2.11	*1.65*	2.06	*2.10*	2.24	*2.00*	2.40	*2.11*	2.45	*2.14*	1.99	*1.98*	1.91	*1.79*	1.87	*1.70*	1.86	*1.73*
60%	2.25	*2.22*	2.28	*1.83*	2.18	*1.71*	2.17	*1.69*	2.15	*2.17*	2.32	*2.06*	2.46	*2.17*	2.52	*2.20*	2.08	*2.04*	1.98	*1.84*	1.92	*1.75*	1.91	*1.78*
70%	2.35	*2.28*	2.37	*1.89*	2.25	*1.77*	2.23	*1.75*	2.25	*2.23*	2.41	*2.13*	2.55	*2.24*	2.59	*2.27*	2.17	*2.10*	2.05	*1.90*	1.97	*1.81*	1.97	*1.84*
80%	2.46	*2.37*	2.47	*1.96*	2.33	*1.84*	2.31	*1.80*	2.36	*2.32*	2.52	*2.21*	2.63	*2.33*	2.69	*2.35*	2.28	*2.18*	2.14	*1.97*	2.05	*1.88*	2.04	*1.90*
90%	2.65	*2.48*	2.62	*2.06*	2.44	*1.93*	2.43	*1.89*	2.54	*2.43*	2.67	*2.33*	2.76	*2.45*	2.82	*2.46*	2.45	*2.28*	2.27	*2.08*	2.16	*1.97*	2.14	*1.99*
95%	2.83	*2.60*	2.74	*2.15*	2.54	*2.02*	2.53	*1.97*	2.71	*2.54*	2.79	*2.42*	2.87	*2.55*	2.94	*2.56*	2.61	*2.39*	2.38	*2.16*	2.25	*2.06*	2.23	*2.07*
99%	3.14	*2.80*	2.98	*2.32*	2.71	*2.18*	2.74	*2.12*	3.01	*2.74*	3.03	*2.62*	3.07	*2.77*	3.18	*2.75*	2.90	*2.57*	2.58	*2.34*	2.44	*2.23*	2.42	*2.23*
Mean Futures$	2.18	*2.16*	2.22	*1.79*	2.13	*1.68*	2.13	*1.66*	2.09	*2.12*	2.27	*2.02*	2.41	*2.13*	2.47	*2.16*	2.01	*1.99*	1.93	*1.80*	1.88	*1.71*	1.87	*1.74*
Std Dev'n $	0.37	*0.25*	0.30	*0.21*	0.23	*0.19*	0.23	*0.18*	0.35	*0.24*	0.30	*0.23*	0.27	*0.25*	0.27	*0.24*	0.34	*0.23*	0.26	*0.21*	1.87	*0.20*	0.21	*0.19*
Probability of	86%		69%		71%		72%		72%		74%		52%		40%		97%		88%		93%		93%	
Price Decline		*96%*		*98%*		*99%*		*99%*		*92%*		*97%*		*81%*		*88%*		*95%*		*97%*		*99%*		*98%*

Table 3. ISU Extension Preharvest Grain Price Forecast Scenarios, 1992-1994

	Year:	1992			1993			1994				
	Date:	7/1	7/15	8/3	7/15	9/7	9/30	7/1	7/12	8/3	9/6	9/30
	CBOT Dec Corn:	$2.63	$2.36	$2.23	$2.45	$2.33	$2.45	$2.40	$2.25	$2.20	$2.27	$2.16
Scenario												
Short Crop	Season Av Cash$	$3.10	$2.90	$2.45	$2.65	$2.50	$2.50	$2.85	$2.45	$2.40	$2.25	$2.25
	Harvest Cash $	3.25	3.05	2.20	2.65	2.40	2.35	2.75	2.25	2.25	2.00	2.00
	Harvest Futures $	3.55	3.35	2.50	2.95	2.70	2.65	3.05	2.55	2.55	2.30	2.30
	% Probability	25%	12%	5%	25%	25%	35%	20%	15%	10%	10%	10%
Normal Crop	Season Av Cash$	$2.30	$2.20	$2.10	$2.25	$2.25	$2.35	$2.20	$2.15	$2.05	$2.05	$2.05
	Harvest Cash $	2.10	2.00	1.90	2.05	2.05	2.12	2.00	1.85	1.80	1.80	1.80
	Harvest Futures $	2.40	2.30	2.20	2.35	2.35	2.42	2.25	2.15	2.10	2.10	2.10
	% Probability	60%	75%	75%	65%	65%	60%	65%	65%	70%	70%	75%
Large Crop	Season Av Cash$	$2.00	$2.00	$1.95	$2.00	$2.10	$2.25	$2.05	$1.95	$1.95	$1.95	$1.95
	Harvest Cash $	1.85	1.85	1.80	1.90	1.95	2.02	1.95	1.70	1.70	1.70	1.70
	Harvest Futures $	2.15	2.15	2.10	2.20	2.25	2.32	2.15	2.00	2.00	2.00	2.00
	% Probability	25%	13%	20%	10%	10%	5%	15%	20%	20%	20%	15%
Probability of Price Decline		64%	53%	62%	50%	48%	37%	55%	62%	66%	71%	70%

Table 4. Probability-Based Corn Marketing Strategies

Group 1: Opportunity Strategies

1. If there is > (50%) 60% probability of futures prices increasing, then no sales are made. If not, then sell (50%) 100%.

Group 2: Risk Aversion Strategies

1. If there is > (50%) 60% probability of futures price decreasing, then sell (50%) 100%. If not, then no sales.
2. If the probability of harvest futures being > WAOB season avg. price is > (50%) 70%, then sell (50%) 100%. If not, then no sales.

Group 3: Probitability Strategies

1. If the probability of futures prices being greater than total cost is > (50%) 70%, then sell (50%) 100%. If not, then no sales.

Group 4: Combination Strategies

1. If U.S. corn is rated > 70% good-to-excellent and there is > (40%) 50% prob.of profit, then sell (50%) 100%. If not, then no sales.
2. If U.S. corn is rated > (50%) 70% good-to-excellent and the prob. that the forecast price being greater than the WAOB forecast season average price is > (40%) 50%, then sell (50%) 100%. If not, then no sales.

Group 5: Nonprobability Profit Strategies

1. If there is > (0%) 5% profit over total cost available, then sell (50%) 100%. If not, then no sales.

Table 5. Preharvest Marketing Strategy Decision Criteria

	1992								1993								1994							
Date:	6/15	7/1	7/15	8/3	8/17	9/1	9/15	10/1	6/15	7/1	7/15	8/2	8/16	9/1	9/15	10/1	6/15	7/1	7/15	8/1	8/15	9/1	9/15	10/1
Harvest Futures Price	2.55	2.63	2.36	2.23	2.26	2.20	2.21	2.14	2.27	2.47	2.45	2.47	2.41	2.34	2.39	2.43	2.71	2.40	2.23	2.22	2.20	2.23	2.18	2.18
Iowa Prodn. Cost/bu	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20
Breakeven Futures $	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Profit *(Loss)*/bu	0.04	0.12	*0.15*	*0.28*	*0.25*	*0.31*	*0.30*	*0.37*	*0.18*	0.01	0.00	0.02	*0.04*	*0.11*	*0.06*	*0.02*	0.21	*0.11*	*0.26*	*0.28*	*0.30*	*0.27*	*0.32*	*0.33*
% Profit *(Loss)*/bu	1.7	4.7	*6.2*	*11.3*	*10.0*	*12.4*	*12.0*	*14.8*	*7.6*	0.6	0.0	0.7	*1.6*	*4.6*	*2.6*	*0.9*	8.5	*4.2*	*10.5*	*11.3*	*12.0*	*10.7*	*12.7*	*13.0*
WAOB Season Avg Price Forecast	2.10	•	2.20	•	2.05	•	2.05	•	2.05	•	2.20	•	2.35	•	2.35	•	2.30	•	2.20	•	2.15	•	2.20	•
WAOB Season Avg Futures $ Equivalent	2.30	•	2.40	•	2.25	•	2.25	•	2.25	•	2.40	•	2.55	•	2.55	•	2.50	•	2.40	•	2.35	•	2.40	•
%U.S.Corn Rated Good to Excellent	53%	53%	70%	79%	79%	78%	77%	79%	57%	56%	50%	53%	51%	53%	52%	49%	75%	81%	85%	85%	83%	79%	84%	86%
Extension Forecasts																								
Pr. of Price Decrease		64%	53%	61%							50%				48%	37%		55%	62%	66%			71%	70%
Pr. of Price Increase		36%	47%	39%							50%				52%	63%		45%	38%	34%			29%	30%
Pr. Prices > Total Cost		46%	41%	5%							50%				45%	59%		39%	13%	9%			1%	1%
Pr. Prices > WAOB$		70%	48%	39%							54%				32%	38%		39%	23%	18%			>1%	>1%
OPTIONS© Forecasts																								
Pr. of Price Decrease	60%	59%	55%	54%	55%	51%	51%	50%	55%	63%	63%	61%	56%	56%	58%	54%	60%	59%	56%	53%	54%	53%	51%	51%
Pr. of Price Increase	40%	41%	45%	46%	45%	49%	49%	50%	45%	37%	37%	39%	44%	44%	42%	46%	40%	41%	44%	47%	46%	47%	49%	49%
Pr. Prices > Total Cost	46%	53%	22%	10%	12%	6%	5%	3%	20%	39%	37%	42%	37%	24%	33%	41%	64%	28%	9%	8%	4%	7%	1%	4%
Pr. Prices > WAOB$	68%	76%	37%	19%	47%	39%	39%	23%	48%	66%	44%	50%	23%	13%	20%	21%	64%	28%	18%	16%	16%	22%	5%	6%
Price Model (NASS#s)																								
Pr. of Price Decrease	86%		69%		71%		67%		72%		74%		52%		40%		97%		88%		93%		93%	
Pr. of Price Increase	14%		31%		29%		33%		28%		26%		48%		60%		3%		12%		7%		7%	
Pr. Prices > Total Cost	17%		17%		6%		6%		14%		4%		42%		50%		8%		2%		>1%		>1%	
Pr. Prices > WAOB$	35%		27%		30%		27%		30%		6%		29%		36%		8%		4%		4%		1%	
Price Model (CWM#s)																								
Pr. of Price Decrease		96%		98%		99%		99%		92%		97%		81%		88%		95%		97%		99%		98%
Pr. of Price Increase		4%		2%		1%		1%		8%		3%		19%		12%		5%		3%		1%		2%
Pr. Prices > Total Cost		8%		>1%		>1%		>1%		8%		4%		10%		11%		2%		>1%		>1%		>1%
Pr. Prices > WAOB$		28%		>1%		>1%		>1%		28%		4%		5%		5%		2%		>1%		>1%		>1%

Table 6. Summary of Probability-Based Marketing Strategy Results for 1992-1994

Strategies	ISU Extension Average$	Freq	Option Premiums Average$	Freq	Price Model NAS PRDN, Average$	Freq	Price Model Cwm PRDN, Average$	Freq
Group 1: Opportunities Strategies								
1a. If >60% $\$\uparrow \Rightarrow$ No Sale; Othrws 100%	$2.49	3/3	$2.38	1/3	$2.51	3/3	$2.50	3/3
2a. If >50% $\$\uparrow \Rightarrow$ No Sale; Othrws 100%	2.47	3/3	2.38	1/3	2.51	3/3	2.50	3/3
1b. If >60% $\$\uparrow \Rightarrow$ No Sale; Othrws 50%	*2.41*	*6/6*	*2.40*	*2/6*	*2.43*	*4/6*	*2.40*	*6/6*
2b. If >50% $\$\uparrow \Rightarrow$ No Sale; Othrws 50%	*2.41*	*6/6*	*2.40*	*2/6*	*2.43*	*4/6*	*2.40*	*6/6*
Group 2: Risk Aversion Strategies								
1a. If >60% $\$\downarrow \Rightarrow$ Sell 100%; Othrws 0%	$2.44	2/3	$2.58	3/3	$2.51	3/3	$2.50	3/3
2a. If >50% $\$\downarrow \Rightarrow$ Sell 100%; Othrws 0%	2.49	3/3	2.51	3/3	2.51	3/3	2.50	3/3
1b. If >60% $\$\downarrow \Rightarrow$ Sell 50%; Othrws 0%	*2.37*	*4/6*	*2.49*	*5/6*	*2.43*	*6/6*	*2.40*	*6/6*
2b. If >50% $\$\downarrow \Rightarrow$ Sell 50%; Othrws 0%	*2.42*	*5/6*	*2.50*	*6/6*	*2.43*	*6/6*	*2.40*	*6/6*
3a. If Prb $ >WAOB$ >70% $\Rightarrow$ Sell 100%	2.41	1/3	2.41	1/3	2.24	0/3	2.24	0/3
4a. If Prb $ >WAOB$ >50% $\Rightarrow$ Sell 100%	2.41	2/3	2.58	3/3	2.24	0/3	2.24	0/3
3b. If Prb $ >WAOB$ >70% $\Rightarrow$ Sell 50%	*2.32*	*1/6*	*2.32*	*1/6*	*2.24*	*0/6*	*2.24*	*0/6*
4b. If Prb $ >WAOB$ >50% $\Rightarrow$ Sell 50%	*2.32*	*2/6*	*2.43*	*5/6*	*2.24*	*0/6*	*2.24*	*0/6*
Group 3: Profitability Strategies								
1a. If Prb of Profit > 70% $\Rightarrow$ Sell 100%	$2.24	0/3	$2.24	0/3	$2.24	0/3	$2.24	0/3
2a. If Prb of Profit > 50% $\Rightarrow$ Sell 100%	2.24	1/3	2.60	2/3	2.22	1/3	2.24	0/3
1b. If Prb of Profit > 70% $\Rightarrow$ Sell 50%	*2.24*	*0/6*	*2.24*	*0/6*	*2.24*	*0/6*	*2.24*	*0/6*
2b. If Prb of Profit > 50% $\Rightarrow$ Sell 50%	*2.24*	*1/6*	*2.42*	*2/6*	*2.23*	*1/6*	*2.24*	*0/6*
Group 4: Combination Strategies								
1a. If U.S.Corn > 70% Gd-Ex & >50% Prob. of Profit $\Rightarrow$ Sell 100%	$2.24	0/3	$2.42	1/3	$2.22	1/3	$2.24	0/3
2a. If U.S.Corn > 70% Gd-Ex & >40% Prob. of Profit $\Rightarrow$ Sell 100%	2.32	1/3	2.42	1/3	2.24	0/3	2.24	0/3
1b. If U.S.Corn > 70% Gd-Ex & >50% Prob. of Profit $\Rightarrow$ Sell 50%	*2.24*	*0/6*	*2.33*	*1/6*	*2.22*	*1/6*	*2.24*	*0/6*
2b. If U.S.Corn > 70% Gd-Ex & >40% Prob. of Profit $\Rightarrow$ Sell 50%	*2.28*	*1/6*	*2.33*	*1/6*	*2.24*	*0/6*	*2.24*	*0/6*
3a. If U.S.Corn > 70% Gd-Ex & Pr $> WAOB$ > 50% $\Rightarrow$ Sell 100%	2.24	0/3	2.42	1/3	*2.24*	*0/3*	*2.24*	*0/3*
4a. If U.S.Corn > 70% Gd-Ex & Pr $> WAOB$ > 40% $\Rightarrow$ Sell 100%	2.32	1/3	2.47	2/3	2.24	0/3	2.24	0/3
3b. If U.S.Corn > 70% Gd-Ex & Pr $> WAOB$ > 50% $\Rightarrow$ Sell 50%	*2.24*	*0/6*	*2.33*	*1/6*	*2.24*	*0/6*	*2.24*	*0/6*
4b. If U.S.Corn > 70% Gd-Ex & Pr $> WAOB$ > 40% $\Rightarrow$ Sell 50%	*2.28*	*1/6*	*2.36*	*2/6*	*2.24*	*0/6*	*2.24*	*0/6*
Group 5: Nonprobability Hedging Strategies								
1a. If > 5% Profit $\Rightarrow$ Sell 100%							$2.42	1/3
2a. If > 0% Profit $\Rightarrow$ Sell 100%							2.58	3/3
1b. If > 5% Profit $\Rightarrow$ Sell 50%							*2.33*	*1/6*
2b. If > 0% Profit $\Rightarrow$ Sell 50%							*2.49*	*5/6*