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Implied Probabilities for Corn and Soybeans Prices for 2016

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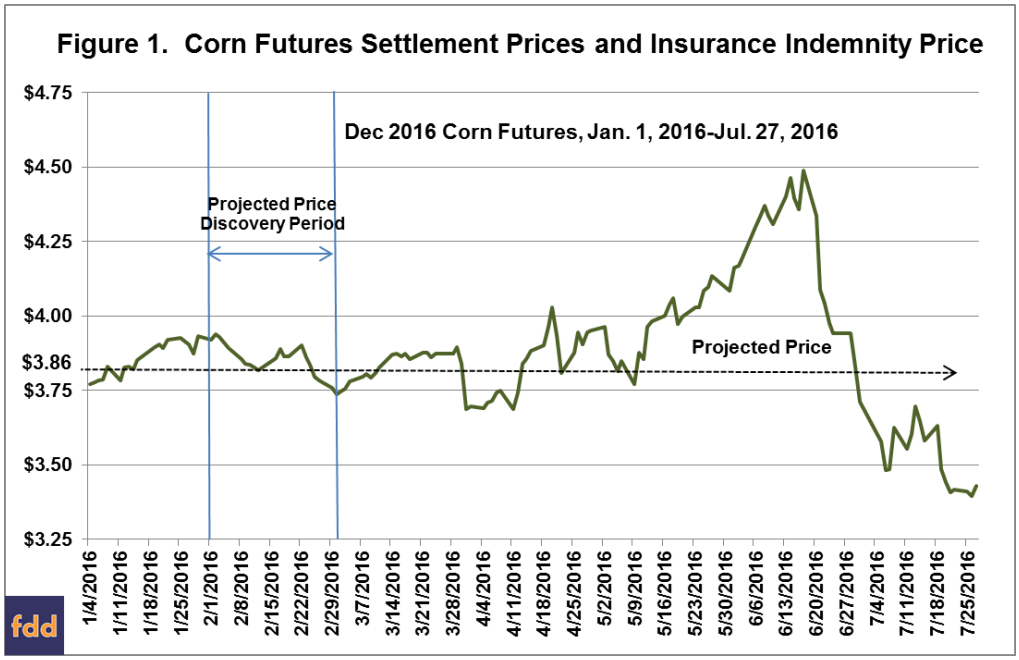
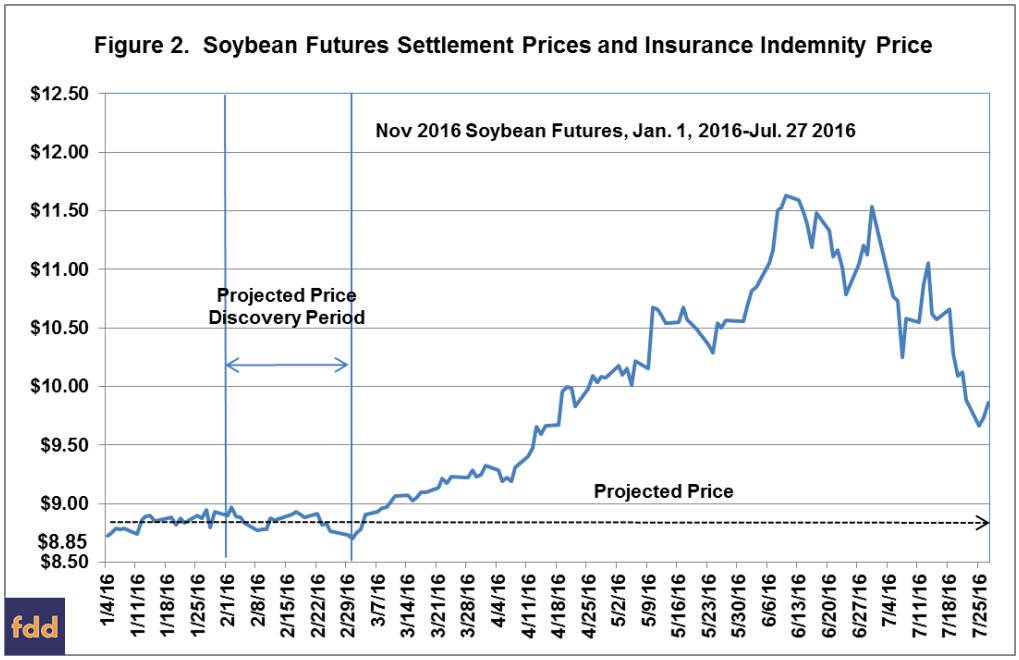
RMA establishes Projected Prices (PP) each year at the end of February for crop insurance contracts that serve as minimum indemnification prices for crop insurance contracts. For revenue insurance contracts not specifically designated with Harvest Price Exclusion (HPE), the PP can be supplanted by a Harvest Price if prices during the month of October average higher levels than the PP. During the time between the determination of the Projected Price and the final Harvest Price, market prices move in response to changes in growing conditions, expected usage, and remaining future supply and demand risks. It is important to understand the evolving probabilities of future price levels to effectively manage revenue risk. The purpose of this post is to introduce a new tool available at the *farmdoc* crop insurance evaluation site that helps to understand the market's implied price distribution at any point in time and the implication for possible levels of crop revenue.

Because it is often useful to understand possible price levels in relationship to established floor prices in crop insurance contracts, a visual sense of the process for establishing PPs and the movements in prices since initiation of the crop insurance period is provided in figures 1 and 2 below.

At the beginning of March, it would have been reasonable to conclude that there was about a 50% chance of final prices being either above or below $3.75 given the futures prices at that date. As can be seen, prices generally fell throughout the averaging period resulting in an average price of $3.86 – about $.10 above the prevailing futures prices during the signup period for crop insurance. The PP is fixed for the life of crop insurance contract and is shown as the horizontal dotted line. However, through April and into July, prices moved substantially higher due to the "slow" planting season, and then dropped substantially below the PP in late June when conditions improved. At present, it appears that the market prices will be substantially below the projected price, and thus that the PP rather than the HP is more likely to be the price used in insurance indemnity calculations for corn.

In contrast to corn, soybeans have rallied and partially retreated, but have remained considerably above the established PP thereby increasing the likelihood that guaranteed insurance levels will increase in Revenue Protection policies, and that harvest prices will be above the initial PPs at harvest time.



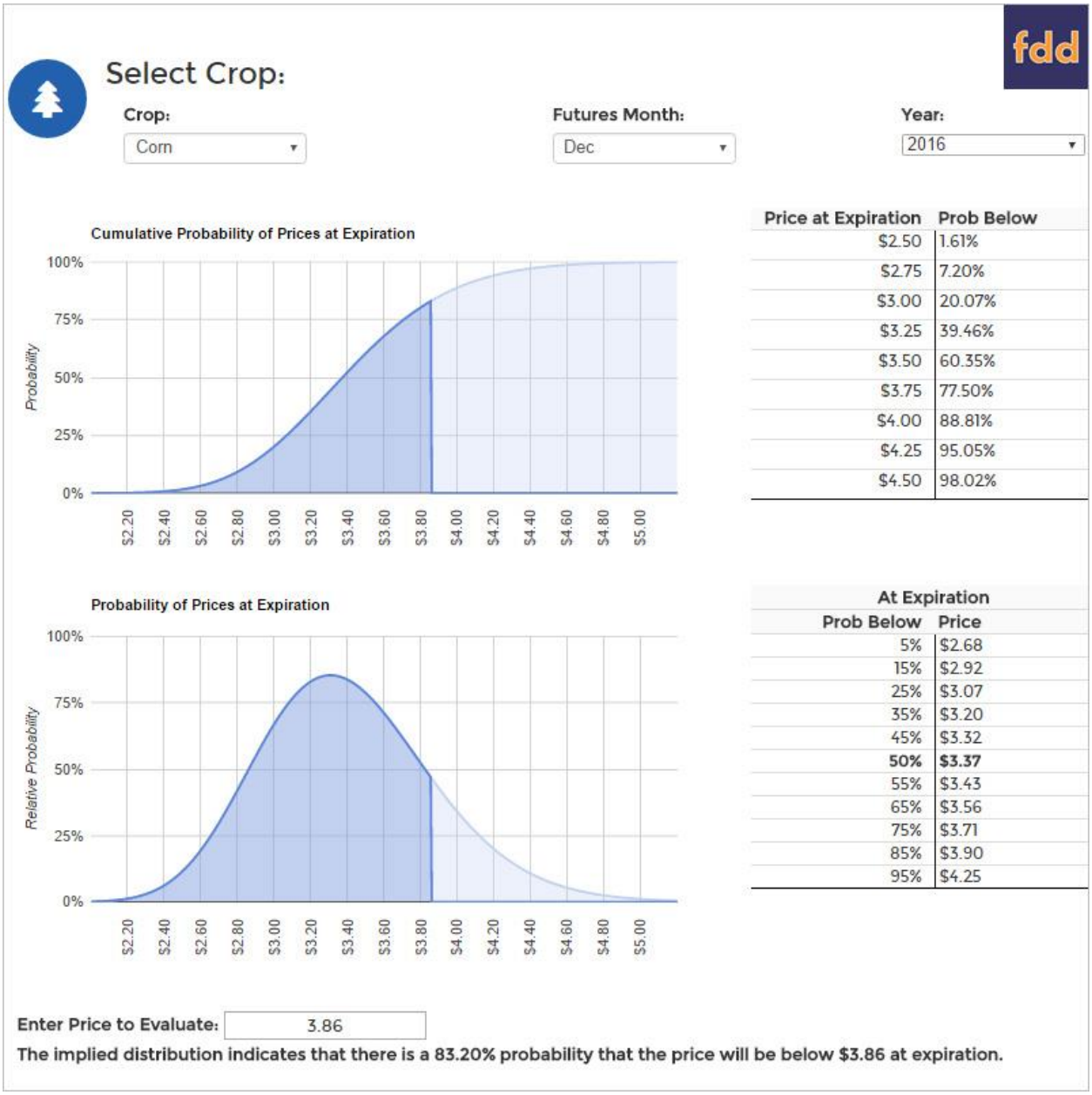


Assessing the Likelihood for Future Price Movements

In addition to providing information about future price levels, options markets provide information that allows us to recover a measure of the remaining price risk, or the likelihood for prices to *change* by any given amount prior to expiration of the contracts shown. To recover probabilistic information from options markets, a technique is used that identifies a best fitting distribution given observed prices of both puts and calls across the set of actively traded strike prices. The specific approach used is somewhat akin to using a variant of the Black-Scholes option pricing model, but solving it "backwards" across all options simultaneously. To make this information readily available, a new Price Evaluation Tool is being released at the *farmdoc* Crop Insurance site that allows a user to select an underlying futures contract and the tool returns probabilistic price information (initially released for remaining 2016 corn and soybean contracts, with contract to be extended through time). The tool is accessible here.

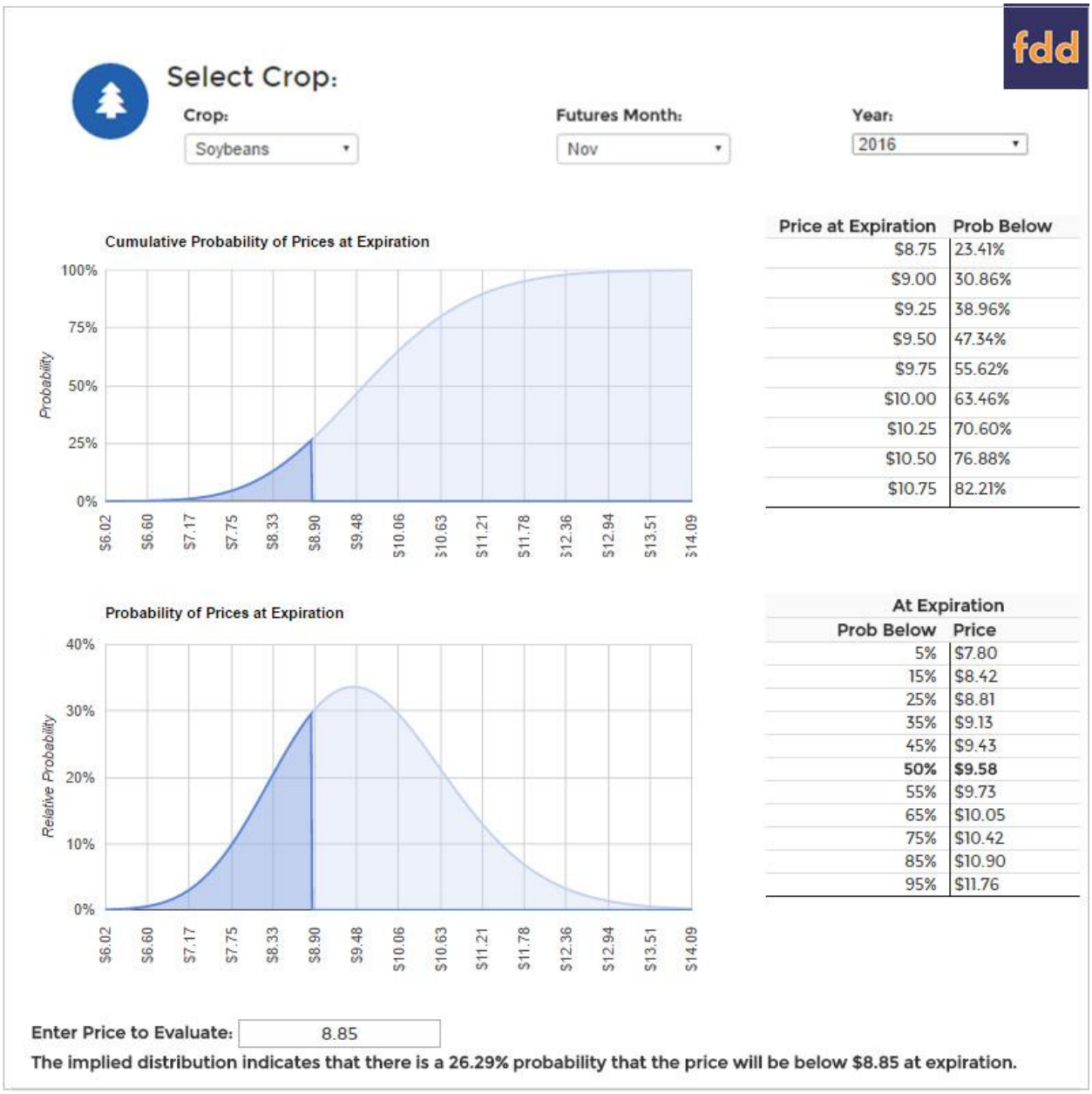
To understand the information provided, a couple of cases are taken from the site and used in a few examples to understand the implications for future crop revenue. First consider the December 2016 Corn

contract shown in figure 3 below taken from the site on July 27, 2016 (importantly, these update continuously to reflect market information at the time the site is accessed so results will differ in future as prices change).



The top panel shows the cumulative probability distribution for prices at the expiration and can be interpreted by reading the probability on the (left) vertical axis of any price of interest on the (bottom) horizontal axis. In the lower panel, the more commonly depicted bell-shaped curve of probability is provided. In the case shown, a price to evaluate of $3.86 was chosen to correspond to the crop insurance projected price, with the corresponding regions shaded in the graphic. In the case shown, current market prices indicate that there is about 83% chance that the expiration price for the Dec 2016 Corn futures will be below $3.86 – in other words, there is only a 17% chance that harvest price will be above the established floor crop insurance price. The tables to the right of the graphics provide identical information in two alternative layouts. In the top table, various possible expiration prices are shown on the left and the associated probability of prices below that level at expiration given on the right. For example, the tool indicates that this is about a 39.46% chance that futures prices will be below $3.25 at expiration, and that there is currently only about a 12% chance that prices will be above $4.00 (or 100%-88% shown at $4.00). In the lower table, it can be seen that there is about a 50% chance that expiration prices will be below $3.37 according to the option's market prices, and a 95% chance that prices will be

below $4.25. An implication of the price distribution is that it is unlikely that corn crop insurance contracts will have HPs that exceed PPs.



In the case of Nov. 2016 Soybeans shown above, there is currently only about a 26% probability that expiration prices will be below the established PP of $8.85 (users can enter any value of interest in the box near the bottom to return the associated probability). The tables on the right again provide a few other specific examples corresponding to the information in the graphs. An obvious implication of the current price distribution is that the guaranteed revenue under crop insurance has likely increased substantially. As an example, if a producer had an APH of 60 bushels and purchased 85% coverage, the initial guaranteed revenue would have been $451.35 (.85*60*8.85). Given the current information in the market, there is now a 50% chance that Harvest Price will be $9.58 or higher resulting in an increase of guaranteed revenue to $488.58 -- an increase of over $37/acre relative to expected revenue at the time of insurance signup.

As the growing season continues and as uncertainty is further resolved about final production and demand, the prices will continue to shift and evolve and collapse on final values. For corn, it is increasingly unlikely that harvest prices will be greater than projected prices, and thus the effective price for much of the crop insurance coverage is likely to be at the original Projected Prices. For soybeans, the

prospects favor substantially increased prices, and higher associated guaranteed revenues in Revenue Protection crop insurance policies. Hopefully the *iFARM* Price Probability tool will continue to provide a simple presentation of the market's estimated prices and their associated probabilities in an easily understood and easily updated form.

Notes: Futures data were conveniently accessed through the API at ag-analytics.org *(J.D. Woodard, open source, open data platform for agricultural & environmental finance, insurance, and risk, accessed July 27, 2016), options data provided by Barchart.com. Primary programming support provided by National Center for Supercomputing Applications (Tim Dudek and Nathan Tolbert). All calculation errors are the responsibility of the author.*

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