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Corn and Soybean Pricing Strategies using FAPRI Baselines and Ranges

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Abstract

This research model examines the use of FAPRI baselines and ranges to develop marketing strategies for the sale of corn and soybeans. The goal was to create a disciplined and objective approach for selling crop which would ultimately increase prices received over the 2008-2018 10-year period. Three strategies were developed: A Price Objective strategy which makes upside sales, a Trailing Stop strategy which makes downside sales, and a Seasonal Sale strategy which makes structured sales during historically high times. Additional methods for selling were implemented into each strategy including All Time High sales, sales made when there is a Five Percent Drop from the Ten Day High, and End of the Year Trailing Stop sales. Multi-year sales were also considered separately and included the same strategies and methods for selling. Results showed that all strategies out-performed USDA average farm prices received for the period examined. The results of this research could shape future models and increase economic gains for agricultural producers.

Keywords: Futures market, grain marketing, corn, soybeans, forward contracting

Introduction

The question is often raised by producers and agri-business as to whether the University of Missouri's Food and Agricultural Policy Research Institute (FAPRI) baseline outlook projections can also be used as a tool for making marketing decisions and managing risk. FAPRI publishes a semi-annual agricultural outlook for use by policymakers as a baseline for analyzing and developing agricultural policy. This outlook publication includes long range farm commodity supply/use estimates that include average farm price projections. FAPRI's baseline price projections had been a previously unexplored means of meeting producer price risk management goals with expert levels of research to accurately assess crop markets. In order to answer this question, a rule-based approach will be implemented to identify optimal grain pricing opportunities for corn/soybean farmers.

Although many tend to focus on the baselines' average farm price results, the stochastic analysis of outcomes may be more appropriate to use for risk management. The FAPRI price baseline stochastic analysis is derived from a set of 500 possible outcomes using FAPRI's well-researched models to test various supply and use situations. While these 500 alternatives cannot capture all possible risks, they provide some estimate of potential risks. These 500 results are used to determine percentile ranges reflecting the probability distribution of the prices. For example, the seventieth percentile suggests that seventy percent of the stochastic price outcomes lie at or below this level, while only thirty percent of potential price outcomes are higher. The FAPRI stochastic analysis can be found on FAPRI's website under Publications and FAPRI-MU Baseline Outlook, whereas the ranges can be found under Farmer's and Marketing Strategies.

The underlying premise of this study is that market fundamental expectations for a given futures price are closely represented by one of the 500 possible stochastic analysis outcomes and the percentiles help identify favorable price levels. Grain futures market price variation and volatility result from changing supply and demand fundamentals. A given day's futures price reflects market participants changing supply and demand expectations during that day's trading period, which likely will be different from the final crop-year average price determination. For example, if December corn futures are trading higher based on expectations of dry weather yield reductions, it is assumed that day's market expectations may be similar to one of the stochastic outcomes that would also result in higher prices due to lower yields. However, as fundamental expectations change, futures price may again retreat to lower levels—having offered only a brief opportunity for higher prices. Targeting prices in the upper percentiles may enable producers to capture above average prices.

The project's approach utilizes FAPRI percentiles as price targets in price objective, trailing stop, and other strategies. The strategies are aimed at helping farmers with risk management issues such as avoiding low prices and capturing pricing opportunities. More specifically, can using the FAPRI percentiles as price objectives in selling strategies achieve above-average price outcomes in comparison to USDA's determined average market year farm price? Comparing the performance of several unique pricing strategies is necessary in answering this question, and will allow us to create a toolkit for making grain marketing decisions.

When creating several marketing strategies, a set of assumptions must be used across all models in order to test for true differences. First, basis adjustments to are necessary to equate the cash (farm) price and the FAPRI baselines to the futures price for all futures data. Second, the marketing year, pre- and post-harvest intervals, and contract use should be well-defined and consistent across strategies. Third, storage – both on-farm and commercial – should be calculated when necessary and considered as a marketing tool. Fourth, rules defining the use of the FAPRI baselines should be consistent across the strategies.

This project requires data from many different sources for both corn and soybeans. In all, the necessary data includes: FAPRI baselines and their respective ranges; USDA average prices; basis data; and historical futures market data. Formulas that consider storage and insurance costs must also be derived. It is assumed that producers will use a revenue-based crop insurance policy of 70%, or more, coverage to protect production risk associated with pre-harvest sales.

Literature Review

Recent research on whether certain types of marketing strategies are more effective than others is lacking; furthermore, older research fails to arrive at any consensus. On one side of the research, studies demonstrate that, based on the efficient market hypothesis (Fama 1991), no significant differences in returns should exist between various marketing strategies (Vyn 2012). This contradicts the results presented in this paper. Another side of research focuses in on whether pre-harvest strategies can improve returns over cash sales at harvest. According to some (Zulauf, Larson, Alexander, & Irwin 2001) pre-harvest strategies did not statistically improve returns over cash sales at harvest. However, other research has demonstrated, at least in Kansas (O'Brien 2000) and Ontario (Vyn 2012), pre-harvest marketing strategies that are more profitable than selling at harvest do exist. Conflicting research such as this may indicate that incentives to store grain in order to sell after harvest will differ among geographic regions.

Occasionally, due to many different market conditions, prices reach historically high levels. Times such as these offer unique pricing opportunities that can greatly benefit producers. In years with historically high prices, pricing three years of expected corn production did increase producer returns (Kenyon & Beckman 1996). However, producers must examine the potential risks of this strategy, and they must understand futures and options trading.

When considering the range of years to include in the models, many different market-altering events were considered. The 1996 Farm Bill, or the 1996 Federal Agriculture Improvement and Reform (FAIR) Act, restructured the income support payments that farmers receive. The immediate consequences of this act lasted 7 years, into 2002, and included decreasing production flexibility contract (PFC) payments (Peters, Langley, & Westcott 2009). As biofuels emerged in the early 2000s, they became a major source of demand for grains and oilseeds (Peters, Langley, & Westcott 2009). By 2007-08, ethanol production accounted for a significant portion of total corn use. These types of events, and the availability of FAPRI's stochastic ranges, push the model's range to after 2006.

Data

Considering the complexity and implications of the models designed, it is imperative that the data was collected from reputable sources and any formulas developed were well researched. In all, data was collected for historical futures market data, national basis, FAPRI baselines and their respective ranges, and USDA price averages.

Historical Futures Market

Following the futures market is an essential piece of the models. The daily prices are compared to the FAPRI baselines to determine if a sale is ultimately made. Futures market data is gathered from Track'nTrade and aggregated as necessary according to our marketing timelines.

National Basis

Basis is calculated by subtracting the futures price from the cash price. The average U.S. monthly basis is provided in the Season-Average Price Forecasts spreadsheets released by the USDA Economic Research Service (ERS) every month. Because the spreadsheets express basis in monthly averages, it was necessary to convert the data to yearly averages using the monthly marketing weights which are also provided by the ERS. The formula for this conversion is shown in Equation 1. Using the annual weighted average basis is imperfect but provides efficient estimates for calculating average prices for comparisons. It should also be noted that the marketing weights provided by the USDA differ from the marketing weights achieved through the experimental strategies developed. The marketing weights provided by the USDA are representative of what actually occurred for a given month, while the experimental weights are representative of what the models sold.

Sales are made based on the futures market since price discovery and the relevant pricing opportunities occur in the futures market. In contrast, both the FAPRI baseline prices and USDA average prices are described in terms of farm price. Thus, making basis adjustments to the FAPRI baselines and USDA average prices is imperative to capture these opportunities in a timely manner. The calculations for these adjustments are described further in the respective subsections.

If AB is the average basis for any *j* year, then

$$AB_j = \sum_{i=1}^{12} (AMB_i \times MMW_i) \qquad \textit{Eq. 1}$$

where *i* is the month, *AMB* is the average basis for the given month, and *MMW* is the marketing weight for the given month.

FAPRI Baselines

The FAPRI baselines are the foundation for our models. Twice per year, researchers at FAPRI release a baseline outlook which incorporates numerous interrelated markets and factors. The first outlook is released approximately at the end of March, and an update to the March publication is released approximately at the end of August. The final results come from two similar models: a deterministic model and a stochastic model. The deterministic model includes more factors and estimates to the state level, and results in a single set of outcomes, or estimates, for the given commodity. The stochastic model is built off the deterministic model, includes fewer factors, and estimates relating only to the national level. The result of the stochastic model is a set of 500 estimates (Figure 1), each of which include slight changes in the model in an attempt to capture more uncertainty. These 500 estimates represent many different market factors which, in turn are expected to simulate the market price variability in the futures market. The stochastic analysis result is a range of prices based on their probability of occurring. Specific baseline percentiles are then calculated from the results of the stochastic model. The percentiles are predesignated intervals (i.e., 70%, 80%, 90%) which are used to calculate the corresponding price. Essentially, the 70th percentile represents the price with which 70% of all data falls below. This means that 30% of the data lies above this price.

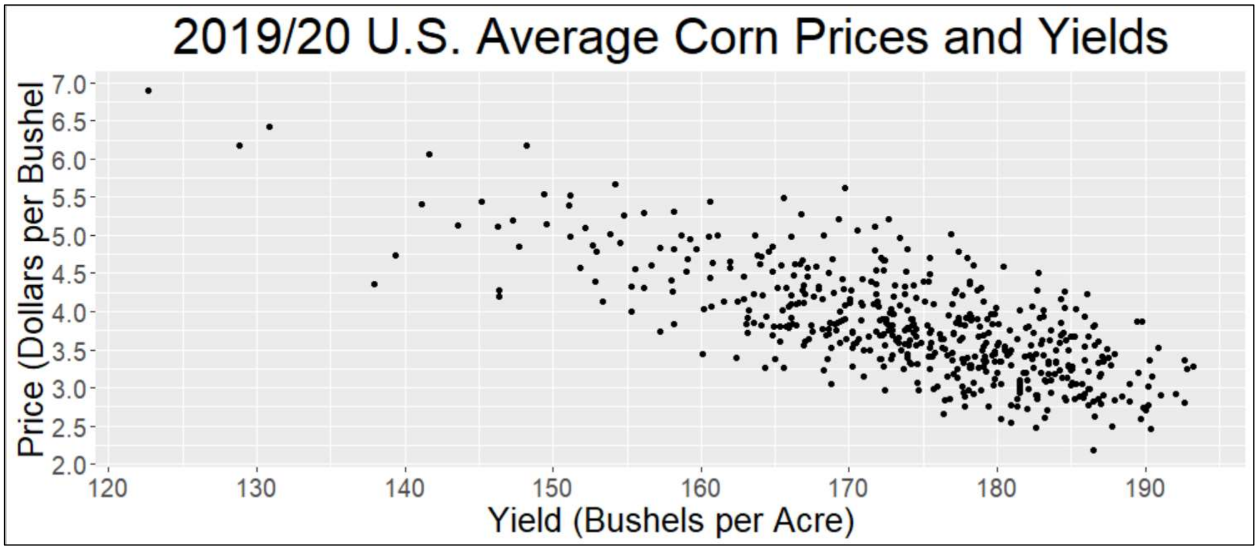


Figure 1: Visualization of Stochastic Simulation for Corn

The models described consider the 70th percentile to be the minimum for triggering a sale. Considering only the top 30% of price calculations is an integral piece in attempting to achieve higher than average prices. In this way, we are trying to achieve gains from market inefficiencies. It should be noted that basis adjustments are made uniformly to each percentile established by FAPRI (Equation 2).

If *Adjusted Percentile* is any adjusted percentile in the year *i*, then

$$Adjusted\ Percentile_i = Original\ Percentile_i - AB_i \qquad \text{Eq. 2}$$

where *Original Percentile* is the percentile reported by FAPRI and *AB* is the average basis for the corresponding year calculated in Equation 1.

USDA Averages

USDA average farm prices are used strictly as a comparison tool for the models. The models were developed to do significantly better than the average. The average price, which is adjusted for basis, was calculated using the Season-Average Price Forecasts spreadsheets. Using Equation 3, we calculated the 10-year USDA average price to be $4.66 per bushel for corn, and $11.26 for soybeans. It should be noted that the USDA average prices do not account for storage, though our models do. Thus, the raw averages from the models will be used when comparing performance to the USDA average price.

If *TYA* is the calculated ten-year average in dollars per bushel, then

$$TYA = \sum_{i=2008}^{2018} (PRP_i - AB_i) \qquad \textit{Eq. 3}$$

Where *i* is the year, *PRP* is the price received by producers in dollars, and *AB* is the average basis in dollars which was calculated in Equation 1.

Methods

The methods and strategies outlined below were developed to answer the question as to if FAPRI percentiles can be used as price targets in objective strategies achieve above-average price outcomes in comparison to USDA average farm prices. The main goals were to help farmers with risk management issues such as avoiding low prices and capturing pricing opportunities.

Marketing Year

The marketing year utilized by the models goes from January 1st of one year to August 31st of the following year. The marketing year is split up into two sections: the pre-harvest and the post-harvest. Pre-harvest is defined as the time from January 1st of the current year to August 31st of the same year. Post-harvest is then the remaining time: September 1st of the current year to August 31st of the next year. September 1st of the current year is considered the harvest date which separates the two periods. The pre-harvest sales are always made using December contracts for December delivery. Post-harvest, sales are always made on the nearest month's futures contract available. Figure 2 depicts a chart of the marketing year. Note that while the marketing year differs from that of the USDA, the actual crop delivery period corresponds to USDA's crop production and marketing year. The USDA average farm price includes pre-harvest sales in their marketing year calculations. These sales are made using the December contract for corn or November contract for soybeans, with delivery being made within USDA's marketing period. Thus, comparisons between the empirical strategies and the USDA's average farm prices would provide valid estimates.

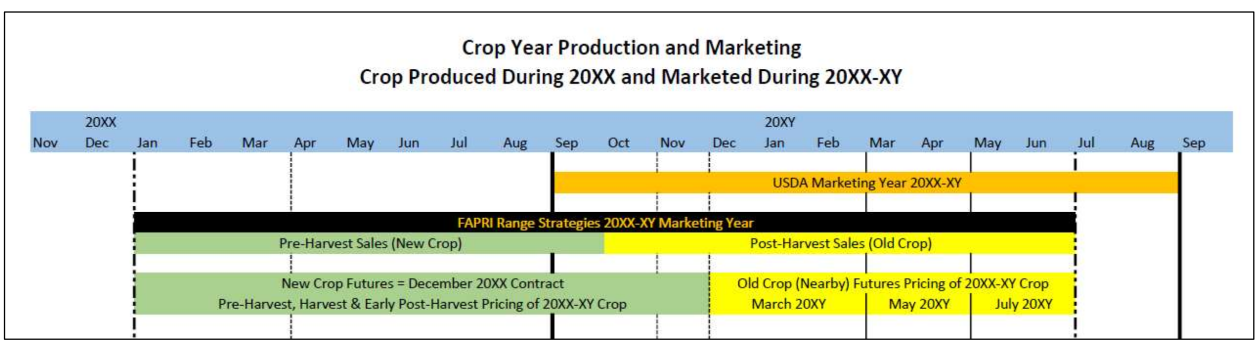


Figure 2: Visualization of Marketing Year

Time Between Sales

To avoid making multiple sales at the same price, sales are only made if no sales have occurred within one week of the current date. For example, if a sale had been made on February 13th, another sale could not be made until February 20th. Each sale accounts for 10% of annual crop production, limiting strategy sales to no more than five sales in that Pre-Harvest period and no more than ten sales in a marketing year. However, exceptions apply in some instances where alternate strategies are used.

Storage and Insurance

Storage is calculated the same across strategies and crops. Storage costs differ based on if on-farm (Equation 4) or commercial storage (Equation 5) is being utilized. It should be noted that some of our constraints account for insurance costs. On-farm storage is always filled first, and it is assumed that farmers have 50% of their crop production available in storage space. Storage is not calculated until post-harvest November. For example, if in post-harvest November 50% of the crop has been sold, the remaining crop will be put into on-farm storage. In contrast, if 70% of the crop is left, 20% will be put into commercial storage and the remaining 50% will be put into on-farm storage. In some cases where both on-farm and commercial storage is utilized, a sale is split such that some of the crop from the sale goes into on-farm storage and some of the crop goes into commercial storage. When commercial storage is utilized, crop is sold out of there first because the costs associated with long-term commercial storage are higher than the long-term costs for on-farm storage.

If *On Farm Storage* is the on-farm storage cost in dollars, then

$$On\ Farm\ Storage = \left(Price \times \left(1 + \frac{I}{12}\right)^{MSO} + IBSC + BSC \times (MSO - 1) \right) - Price \qquad Eq.\ 4$$

where *Price* is the price which the crop was sold for (dollars), *MSO* is the number of months since October, *IBSC* is the initial bin storage cost for the first month, and *BSC* is the bin storage cost for the reaming months.

If *Comm. Storage* is the commercial storage cost in dollars, then

$$Comm. Storage = \left(Price * \left(1 + \frac{I}{12}\right)^{MSO} + Max(MCSC \times MSO, TMM) \right) - Price \qquad Eq.\ 5$$

where *Price* is the price which the crop was sold for (dollars), *MSO* is the number of months since October, *MCSC* is the monthly commercial storage cost, and *TMM* is the three-month minimum storage charge.

Price Objective

The Price Objective (PO) strategy can be defined as an upside strategy. Building from the basic Price Objective principles, the models which were developed for this research also include the addition of FAPRI's baseline ranges as price targets. As prices trend higher, sales are triggered when a price hits or goes up through a higher baseline. For example, if the market was at the 90th percentile but then moved through the 95th percentile, a sale would be triggered. In general, Price Objective sales are made at 10%. It is important to note that just because a PO sale is triggered does not mean it will be actualized. Actualization rules are established below under *Actualization of Sales.*

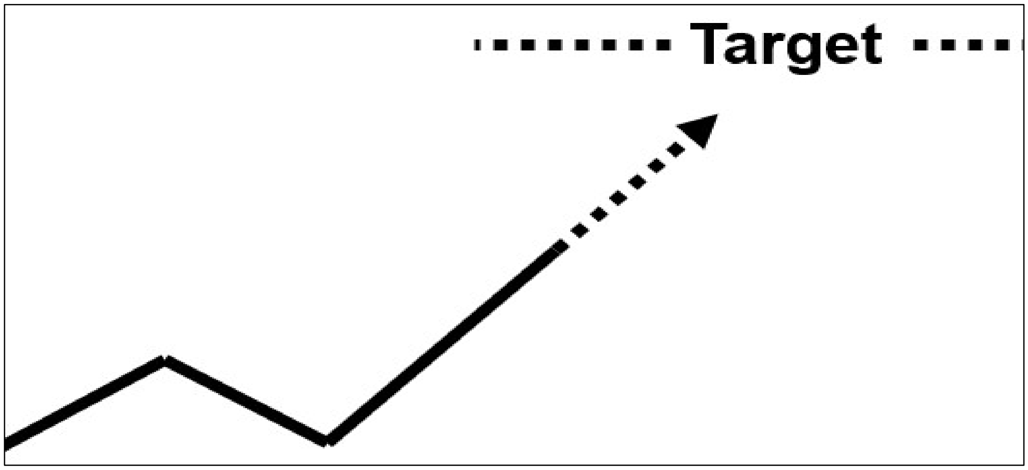


Figure 3: Price Objective Strategy

Trailing Stop

The Trailing Stop (TS) strategy can be defined as a downside strategy that attempts to follow price uptrends. Building from the basic Trailing Stop principles, the models which were developed for this research also include the addition of FAPRI's baseline ranges as price targets. As prices trend higher, sales are triggered when a price falls or goes down through a lower baseline. For example, if the market was above the 80^{th} percentile and then declined back through the 80^{th} percentile, a sale would be triggered. Because of the way this strategy is defined, the highest price will never be captured. In general, Trailing Stop sales are made at 10%. It is important to note that just because a TS sale is triggered does not mean it will be actualized. Actualization rules are established below under *Actualization of Sales*.

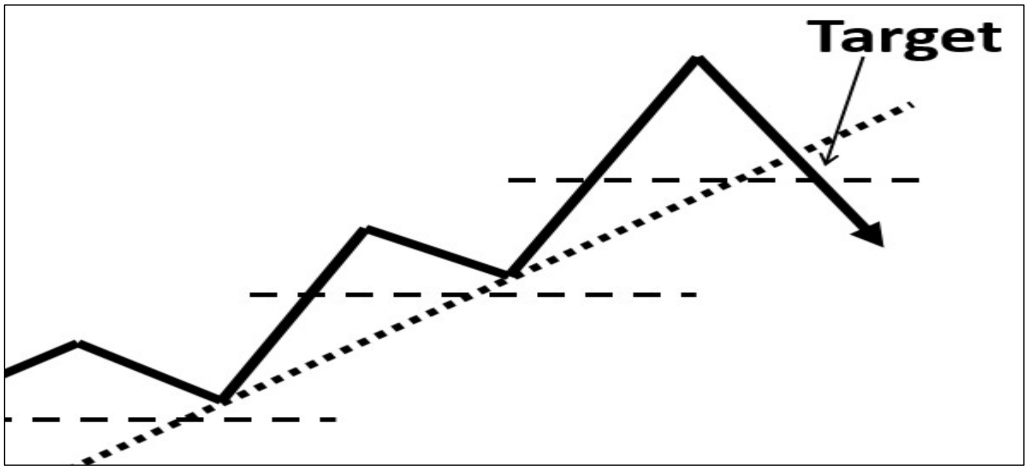


Figure 4: Trailing Stop Strategy

Actualization of Sales

In the Price Objective and Trailing Stop strategies, not all sales that are triggered are actualized. In other words, a sale is not made each time a price triggers a Trailing Stop or Price Objective sale. The following set of rules is used to objectively decide which sales are actualized.

1. Only up to 50% of crop can be sold in the pre-harvest. This should not be confused as a quota we need to reach. Less than 50% of crop can be sold in the pre-harvest, but never more than 50%. In the post-harvest, all remaining crop is sold. In the multi-year strategy, this percentage increases to 60%.
2. When used as an alternative strategy for PO and TS sales, Seasonal Sales are not to be made when the market is at or above the 70th percentile due to being within the FAPRI ranges.
3. During some intervals, sales are limited based on sales having already been actualized in that percentile. This ensures that crop is still available in later marketing periods which may result in higher prices. In other words, only one sale can be actualized per percentile. Figure 5 below shows the timeline for the marketing year and when sales are limited, unlimited, or not allowed. During the limited times, Price Objective and Trailing Stop sales are limited, whereas alternative strategies are not. For example, if a 70th percentile Price Objective sale was actualized in a limited interval, another 70th percentile sale could not be actualized until after the limited period ends.

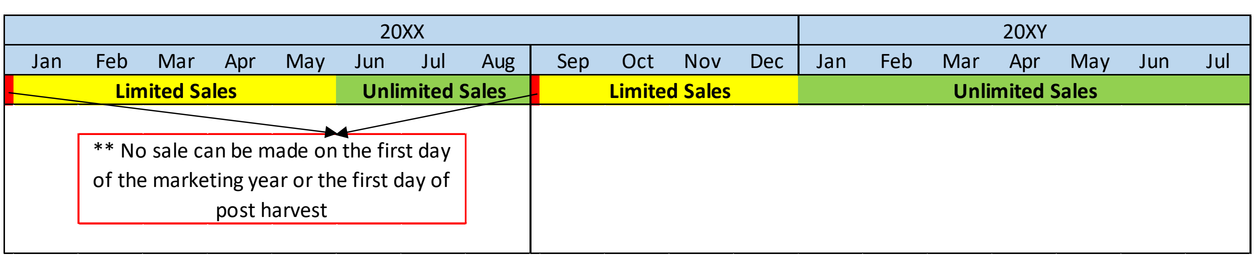


Figure 5: Limiting Sales

Seasonal Sales

Commodity markets tend to have seasonal trends. Prices tend to rise in the spring, when supplies are perceived to get tighter, and typically decline in the fall as supply concerns ease. Although it varies from year-to-year, historical data suggests that prices will generally be higher in March and June of each crop year for corn, and May and July for soybeans. This was determined by looking at the monthly averages. In the Seasonal Sales strategy, sales are made on the 10th and 20th of March and June for corn (May and July for soybeans), and no other types of sales are made. Seasonal sales will always be made at 12.5% of crop production. This is because there are 8 seasonal sale opportunities in each marketing year, and an equal share of crop is sold for each sale.

Alternative Strategies

Alternative strategies are essential to making sales outside of the FAPRI baselines. These strategies apply to the Price Objective and Trailing Stop models exclusively.

1. ***Five Percent Drop from the Ten Day High (5%DFTDH):*** Though rare, the futures market will sometimes rise above the 95th percentile. Because there is no chance that PO or TS sales (based on FAPRI range percentiles) could be triggered in this situation but there are obvious reasons to make sales at these prices, the 5% DFTDH strategy was employed. This strategy is self-explanatory. When the market is above the 95th percentile and is at a price that is equal to or less than 95% of the highest price over the previous ten days, a sale is triggered.
2. ***All-Time High (ATH):*** When prices are at or near an all-time high, it is prudent to make as many strategic sales as possible, since prices rarely reach this level. The ATH strategy is a way to make these sales, regardless of percentile price objectives. When the market at an all-time high, a 10% sale will be made if the market drops 5% from the ten-day high. This strategy is quite similar to the 5% DFTDH strategy but is conditioned on the market being at the all-time high and not on the market being above the 95th percentile.
3. ***End of Year Trailing Stop (EYTS):*** If stored crop remains in Post-Harvest June and the market is not below the 70th percentile, EYTS sales are utilized. For the Price Objective strategy, these PO sales will made as usual (at 10% of crop). But, if the market passes down through a percentile, a sale is made relative to the remaining crop. For example, if it is Post-Harvest June, 40% of the crop is remaining, and the price is at the 80th percentile, 20% of the crop would be sold when the market passes down through the 80th percentile and the final 20% would be sold when the price passes through the 70th percentile. This strategy ensures that all crop will be cleared by the end of the crop year. The rule limiting the time between sales does not apply to EYTS because we are trying to sell out the crop.
4. ***Seasonal Sales:*** Like the Seasonal Sale strategy, this alternative strategy used in conjunction with the Price Objective or Trailing Stop strategy aims to take advantage of historical times of high prices. This strategy is only considered beginning in post-harvest March for corn or post-harvest May for soybeans. It is also conditioned on the price being below the 70^{th} percentile. These sales ensure that old crop supplies are sold prior to the end of the marketing year in the years when the market does not offer prices at or above

the 70th percentile. Seasonal sale dates for corn are March 10th and 20th and June 10th and 20th. The soybean dates are May 10th and 20th and July 10th and 20th. Sales must be made at 10% or more. It should be noted that these dates were chosen out of convenience and consistency across the models, and a producer might choose different days or spread many sales throughout the month.

To determine the percent to be sold, the percent of crop remaining is divided by the number of seasonal sales days left for the marketing year. By this, the first seasonal sale date must have at least 40% of crop left, the second must have 30% etc. For example, for corn, if on March 10th 30% f crop is remaining, a Seasonal Sale would not be made. If on June 10th 30% of crop remaining, a Seasonal Sale of 15% would be made. This is because there are two seasonal sale dates remaining, and half of 30% is 15%.

Multi-Year Sales

Multi-Year (MY) sales attempt to take advantage of unusually high prices above the 95th FAPRI baseline percentile. These sales are only triggered by the All Time High Trailing Stop or the 5% Drop from the Ten-Day High, and sales are made on the December futures contracts for 3 consecutive years. When multi-year sales are being made, up to 60% of crop can be sold pre-harvest, 10% higher than usual. Additionally, if in the current year 60% of pre-harvest crop has been sold, but in the next two crop years less than 60% has been sold, multi-year sales can still be made for the next two crop years, using the appropriate December futures contract for each year.

Results

After gathering the data, implementing the model requirements, and applying the futures market, many different plots and tables were produced to better understand the results. A plot of the strategy performance and corresponding table were created for each strategy for each marketing year. A sample of these plots can be found in the appendix.

Unless otherwise stated, all averages are representative of the 10 consecutive marketing years that were examined. The raw average price per bushel, one in which storage is not included, was used to compare the models to the USDA since the USDA average price does not factor for storage.

Corn

All strategies performed better than the USDA average price ($4.66) for corn. The Price Objective strategy resulted in a raw average price $4.89; Trailing Stop: $4.85; and Seasonal Sales: $4.81. The 2012 drought which was encompassed by the 2012-2013 marketing year saw the highest average prices for the PO and TS strategies, achieving $6.60 and $6.78 respectively. The worst performing marketing year for the PO and TS strategies was 2016-2017 in which the average prices were $3.81 and $3.75, respectively. The best marketing year for SS was 2011-2012 in which an average price of $6.37 was achieved. The worst marketing year for SS was

2017-2018 in which the average price was $3.81. Detailed results for the best and worst marketing years can be found in Figures 6 – 11 in the appendix.

Multi-year sales saw the same positive gains across all strategies. The raw average price was the same for all strategies at $5.21. Similar years stood out as the best and worst as were found in the non-multi-year strategies. For PO and TS, the best marketing year was 2012-2013 in which the average was $6.60 and $6.78 respectively. The worst year for PO, 2016-2017, saw an average price of $3.81. The worst year for TS was 2017-2018 in which the average was $3.75. The best marketing year for SS was 2010-2011, with an average of $6.48. The worst performing year was 2017-2018, with an average of $3.81.

Table 1: Results from Corn Strategies

Strategy	Raw Average	Difference from USDA Average	Pre-Harvest Raw Average	Post-Harvest Raw Average	Storage-Adjusted Average	Storage-Adjusted Post-Harvest Average
PO without MY	$4.89	$0.23	$5.38	$4.66	$4.63	$4.30
PO with MY	$5.21	$0.55	$6.01	$4.59	$5.01	$4.23
TS without MY	$4.85	$0.19	$5.23	$4.69	$4.58	$4.31
TS with MY	$5.21	$0.55	$6.03	$4.64	$4.99	$4.26
SS without MY	$4.81	$0.15	$4.86	$4.76	$4.60	$4.35
SS with MY	$5.21	$0.55	$5.57	$4.74	$5.03	$4.33
USDA Average	$4.66					

Soybeans

All strategies performed better than the USDA average price ($11.26) for soybeans. The Price Objective strategy achieved an average of $11.87; Trailing Stop: $11.85; and Seasonal Sales: $11.72. The best marketing year for PO and TS was 2011-2012 where the averages were $14.69 and $14.97, respectively. PO and TS also shared the same worst marketing year. In 2017-2018, the strategies each averaged $9.35. The best marketing year for SS was 2012-2013, with an average price of $14.94. The worst marketing year for SS was 2017-2018, with an average price of $9.66. Detailed results for the best and worst marketing years can be found in Figures 12 – 17 in the appendix.

Multi-year sales saw the same positive gains across all strategies. The Price Objective strategy achieved an average price of $12.06; Trailing Stop: $12.07; and Seasonal Sales: $11.99. For PO and TS, the best and worst marketing years and respective averages did not differ from the non-multi-year strategies. For SS, the best marketing year was 2012-2013 in which the average was $15.03. Like PO and TS, the worst marketing year and average achieved for SS did not differ from the non-multi-year strategies.

Table 2: Results from Soybean Strategies

Strategy	Raw Average	Difference from USDA Average	Pre-Harvest Raw Average	Post-Harvest Raw Average	Storage-Adjusted Average	Storage-Adjusted Post-Harvest Average
PO without MY	$11.87	$0.61	$11.88	$11.87	$11.46	$11.24
PO with MY	$12.06	$0.80	$12.49	$11.72	$11.72	$11.11
TS without MY	$11.85	$0.59	$11.77	$11.89	$11.43	$11.24
TS with MY	$12.07	$0.81	$12.36	$11.86	$11.70	$11.21
SS without MY	$11.72	$0.46	$11.54	$11.89	$11.36	$11.18
SS with MY	$11.99	$0.73	$12.11	$11.84	$11.67	$11.13
USDA Average	$11.26					

Pre-Harvest and Post-Harvest Observations

An interesting result emerged when the pre-harvest and post-harvest sales were considered separately. It was found that, in corn, the pre-harvest average prices were consistently higher than the post-harvest averages, even when storage was not considered. Interestingly, the pre-harvest average prices for soybeans were lower than the post-harvest averages much more often than they were for corn. It should be noted that these are futures price results and do not reflect cash market merchandising gains from utilizing storage along with the ability to arbitrage more distant market delivery points.

Discussion

The results achieved through the models developed provide promising evidence in support of our research question. The FAPRI percentiles can be used as price targets in objective strategies to achieve above-average price outcomes when compared to USDA average prices. In both the corn and soybean markets, the average price-per-bushel for the 10 marketing years considered was above the USDA average price.

When these results get broken down further, into a year by year basis, there is a clear pattern in the years which were found to be the best. In both crops, the best performing marketing years for the strategies was 2011-2012 and 2012-2013. The emergence of these years as the highest performing is no surprise. In 2012, Missouri and the nation faced a large drought, driving the supply down while the demand remained. By the principles of simple economics, the price rose to some of the highest points in the 10-year period – over $8 per-bushel for corn and nearly $18 per-bushel for soybeans. The rules implemented by the strategies took advantage of these unusually high prices, resulting in above-average gains. Further, multi-year sales which were triggered during this period ensured that the prices were locked in for a portion of the crop the following 3 years.

When looking at the worst marketing year for soybeans, 2017-2018 was the consistent choice. Again, this comes as no surprise. The trade war between the United States and China severely decreased the demand for US-grown soybeans, dropping the price-per bushel to some of the lowest prices in the 10-year period. During this time, soybeans fell to just over $8 per-bushel. With prices so low, opportunities to reach above the USDA average price were not available.

A few unexpected results emerged when comparing the results of the models to each other. As described above, the Price Objective strategy functions on the upside, triggering sales after the market hits or passes through a higher percentile. In contrast the Trailing Stop strategy works on the downside, triggering sales after the market hits or passes through a lower percentile. It was hypothesized that the Trailing Stop sales would perform better as they would follow price trends to higher percentiles until the market started dropping to trigger sales, which should also mean that the crop was not sold out too quickly. Instead, what was found was that the Price Objective strategy was doing slightly better. After further examination, we found that when a Price Objective sale was triggered due to small price up-trends, a Trailing Stop sale would be triggered just below it when the market retreated lower. Price Objective sales are getting the advantage over Trailing Stop, resulting in their prices and averages to be slightly higher.

Seasonal Sales also produced somewhat surprising results. The Seasonal Sales strategy makes sales only on specific sale dates or using the All Time High or 5% Drop from the Ten-Day High strategies. In this way, minimal attention is necessary for the markets, unlike the PO and TS strategies. It was surprising to see how well SS performed when compared to PO, TS and USDA average prices.

Future Directions

The present research represents the results from the 6 base models which were developed as an objective way to sell corn and soybeans. Current work is being conducted to explore the addition of new rules and modifications on the FAPRI baselines. More specifically, additional versions of the models have been constructed which consider many different adjustments to the base model. These adjustments include modified scale-up selling, alternative selling percentages (other than 10%), liquidation dates, March new crop futures pre-harvest sales, and lowering the FAPRI baselines by 1%. While these strategies show promise, more should be done to thoroughly compare each model.

The timeframe for each marketing year is another aspect of the models which could be changed. Currently, the marketing year is fixed at January 1st of one year to August 31st of the next year. This could be constrained further or expanded to include more pre-harvest opportunities. Since pre-harvest sales are available up to 3 years prior to delivery, there may be situations in which starting earlier would prove to be beneficial.

Another important factor to be considered is storage. While our models do incorporate storage and can be compared that way from model to model, we are not yet able to compare the results incorporating storage to the averages provided by the USDA. Storage is not only an integral marketing tool but also one that is used often by farmers. Developing a way to view storage-adjusted USDA average prices would be beneficial in comparing the models further.

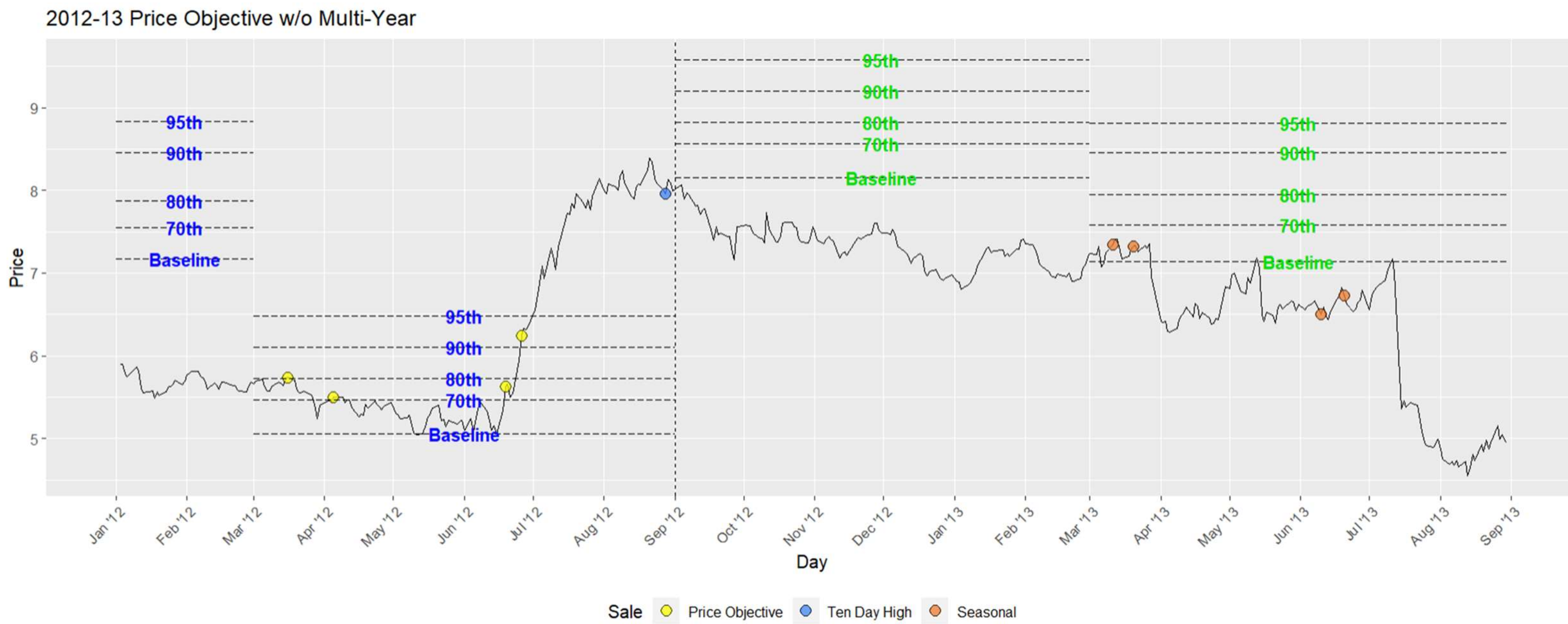
Examining the pre-harvest and post-harvest sales separately exposed the behavior of the markets and revealed a few unexpected results. For corn, the pre-harvest average price was lower than the post-harvest average for 2-3 out of the 10 marketing years, depending on the strategy. However, for soybeans, this was not always the case. In 6-7 out of the 10 marketing years, the pre-harvest average price was lower than that of the post-harvest. The producer's convention is believed to be weighted toward storing corn and selling soybeans at or before harvest, but these results suggest that the soybean market was more profitable in the post-harvest period for the 10 years which were examined. More research should be done to identify reasons for this and explore potential rules for limiting the pre-harvest sales of soybeans further.

The models were developed with ideal conditions which should be modified in the future to be more realistic. By making 10% sales pre-harvest, it is assumed that farmers base their pre-harvest sales off a percentage of their expected crop. The actual amount of production is unknown to them until harvest. Farmers may under- or over-produce their expectations, making the amount of crop available for post-harvest sales either more or less than what was expected. In actual practice, the post-harvest sales portion of production would be sold in 20% increments of actual remaining stocks, and this should be explored in future models. Another element not included in the models is futures contract margins. Future research should include methods to account for the both the initial margin and the maintenance margin to get an estimate of the cash needs for each strategy.

In all the strategies, it was assumed that commercial storage was readily available in any situation where it may be needed. Realistically, this is not always the case as elevator storage space is limited and may be full at a given time. The producer may have to find alternative temporary storage, use delayed payment contracts, or be forced into harvest-time sales. Commercial storage may also have to be reserved earlier in the production year. These scenarios were not considered, and future research should implement conditions in which storage is unavailable to better understand more realistic situations.

Appendix

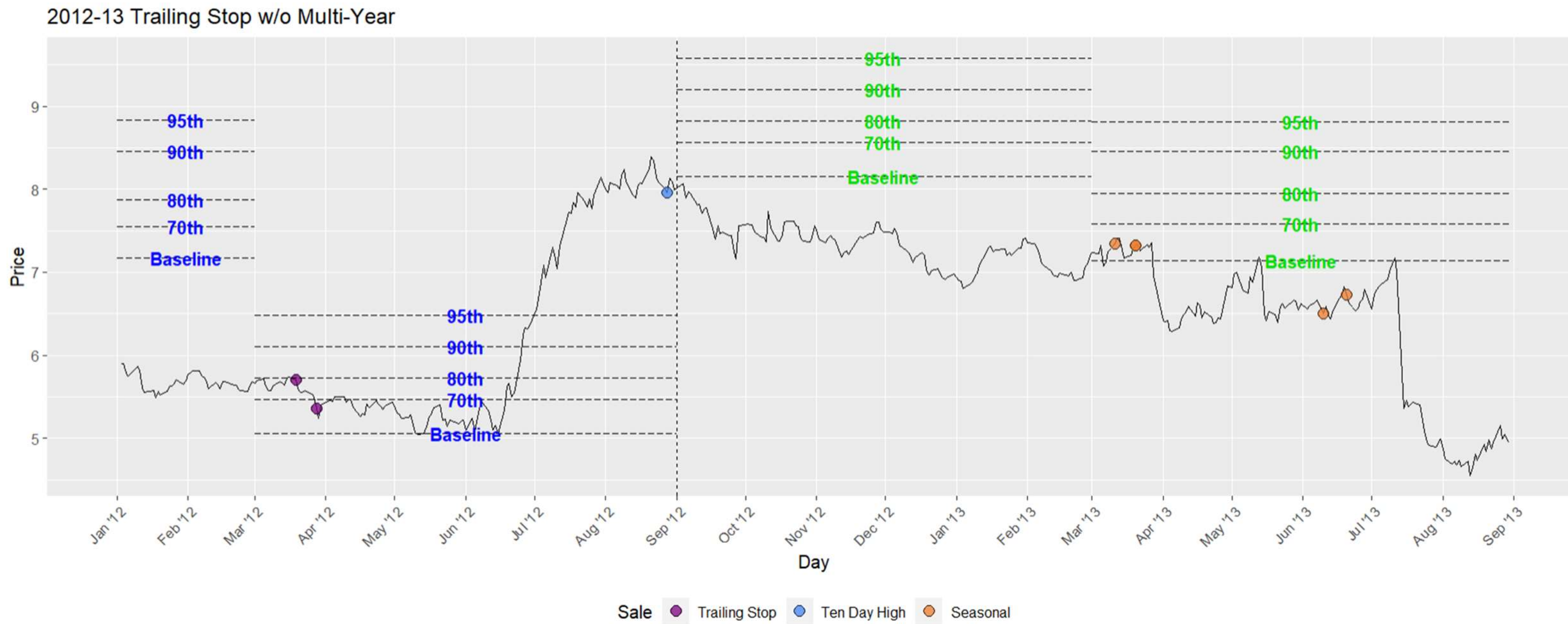
The following charts each represent the performance of a singular strategy for a given marketing year. At the top of the chart, the marketing year and the type of strategy is defined. The plot depicts the futures contract price used at each moment in time. Each dot represents a sale, and the color of each dot shows type of the sale (Price Objective, Trailing Stop, Seasonal, etc.). A key is given under each plot. The FAPRI baseline percentiles that have been adjusted for basis are also shown in the plot. The vertical, dashed line in the middle of the plot divides the year into pre-harvest and post-harvest. Under the plot, there is a Sales Summary table. This table provides detailed information such as the price and type of the sale, the percentage sold, and storage information for each sale that is depicted in the plot.



Sales Summary

Date	Mar-16-12	Apr-05-12	Jun-19-12	Jun-26-12	Aug-28-12	Mar-11-13	Mar-20-13	Jun-10-13	Jun-20-13
Price	5.74	5.50	5.64	6.24	7.95	7.34	7.32	6.50	6.73
Percentage	10	10	10	10	10	12.5	12.5	12.5	12.5
Trigger	Price Objective	Price Objective	Price Objective	Price Objective	Ten Day High	Seasonal	Seasonal	Seasonal	Seasonal
On Farm	0.00	0.00	0.00	0.00	0.00	0.43	0.43	0.51	0.52
Commercial	0	0	0	0	0	0	0	0	0
Price - Storage	5.74	5.50	5.64	6.24	7.95	6.92	6.90	5.99	6.21

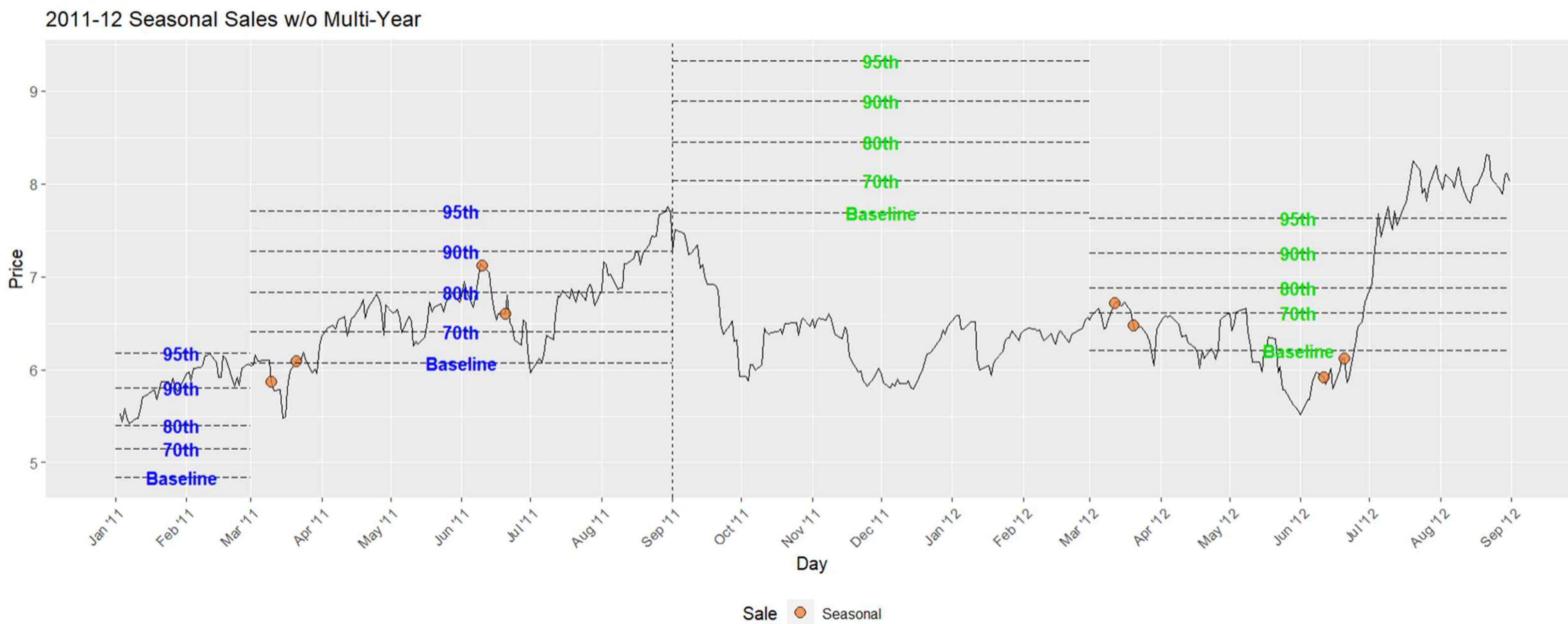
Figure 6: Best Performing Year for Price Objective Corn



Sales Summary

Date	Mar-19-12	Mar-28-12	Aug-28-12	Mar-11-13	Mar-20-13	Mar-20-13Split1	Jun-10-13	Jun-20-13
Price	5.70	5.36	7.95	7.34	7.32	7.32	6.50	6.73
Percentage	10	10	10	17.5	2.5	15	17.5	17.5
Trigger	Trailing Stop	Trailing Stop	Ten Day High	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal
On Farm	0	0	0	0	0	0.43	0.51	0.52
Commercial	0.00	0.00	0.00	0.42	0.42	0	0	0
Price - Storage	5.70	5.36	7.95	6.93	6.91	6.90	5.99	6.21

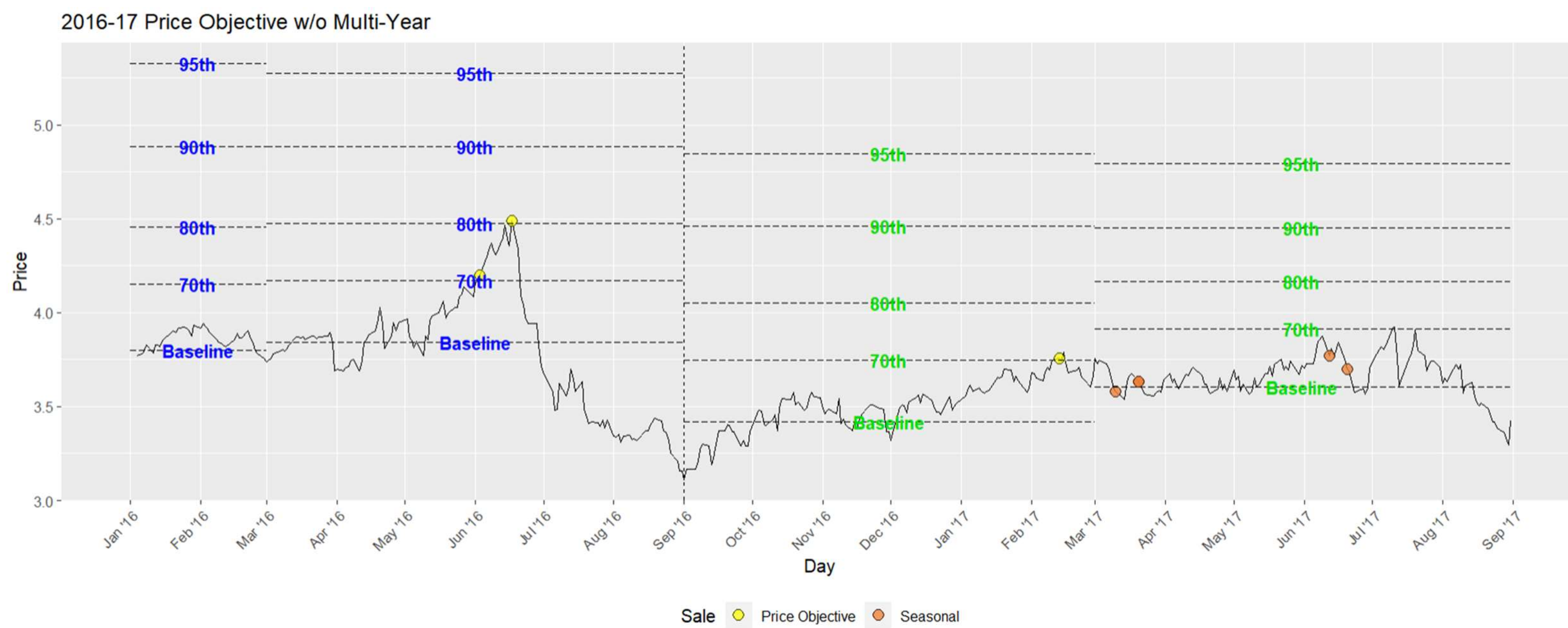
Figure 7: Best Performing Year for Trailing Stop Corn



Sales Summary

Date	Mar-10-11	Mar-21-11	Jun-10-11	Jun-20-11	Mar-12-12	Mar-20-12	Jun-11-12	Jun-20-12
Price	5.87	6.09	7.12	6.61	6.72	6.47	5.92	6.12
Percentage	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Trigger	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal
On Farm	0.00	0.00	0.00	0.00	0.42	0.41	0.49	0.50
Commercial	0	0	0	0	0	0	0	0
Price - Storage	5.87	6.09	7.12	6.61	6.30	6.07	5.43	5.62

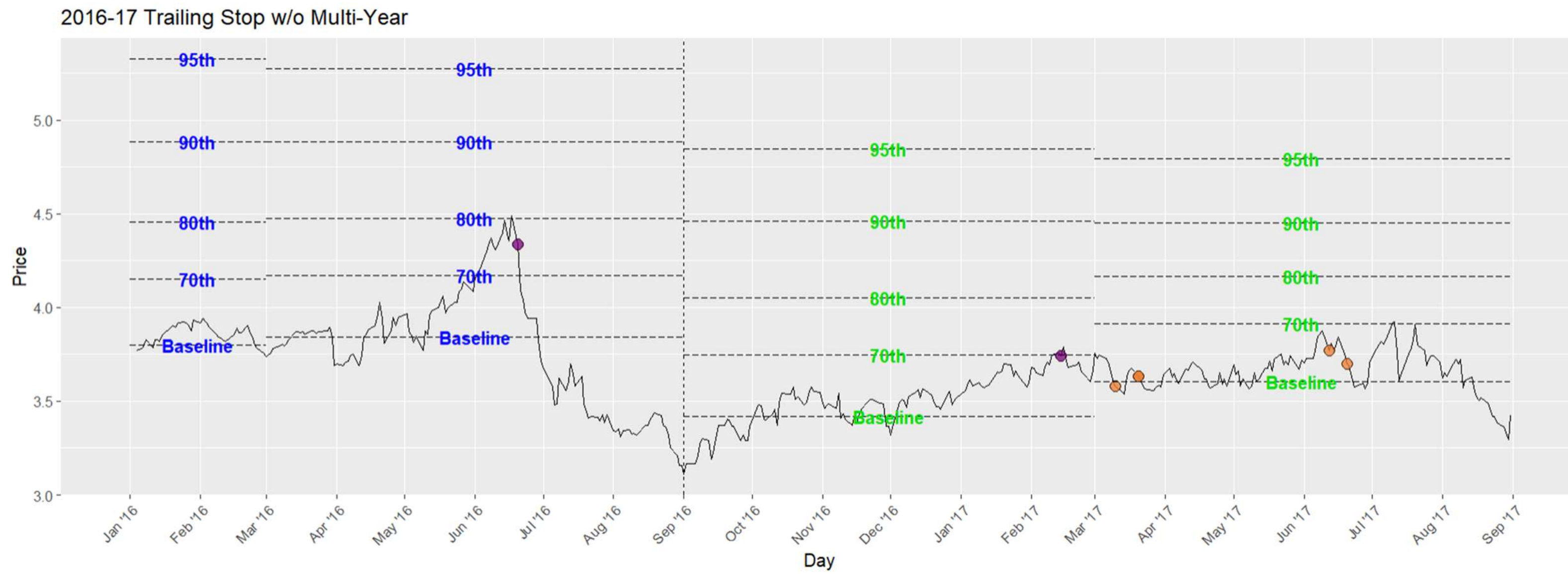
Figure 8: Best Performing Year for Seasonal Sale Corn



Sales Summary

Date	Jun-03-16	Jun-17-16	Feb-13-17	Mar-10-17	Mar-20-17	Mar-20-17 Split1	Jun-12-17	Jun-20-17
Price	4.20	4.49	3.76	3.58	3.63	3.63	3.77	3.70
Percentage	10	10	10	17.5	2.5	15	17.5	17.5
Trigger	Price Objective	Price Objective	Price Objective	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal
On Farm	0	0	0	0	0	0.34	0.41	0.41
Commercial	0.00	0.00	0.27	0.33	0.33	0	0	0
Price - Storage	4.20	4.49	3.49	3.25	3.30	3.29	3.36	3.29

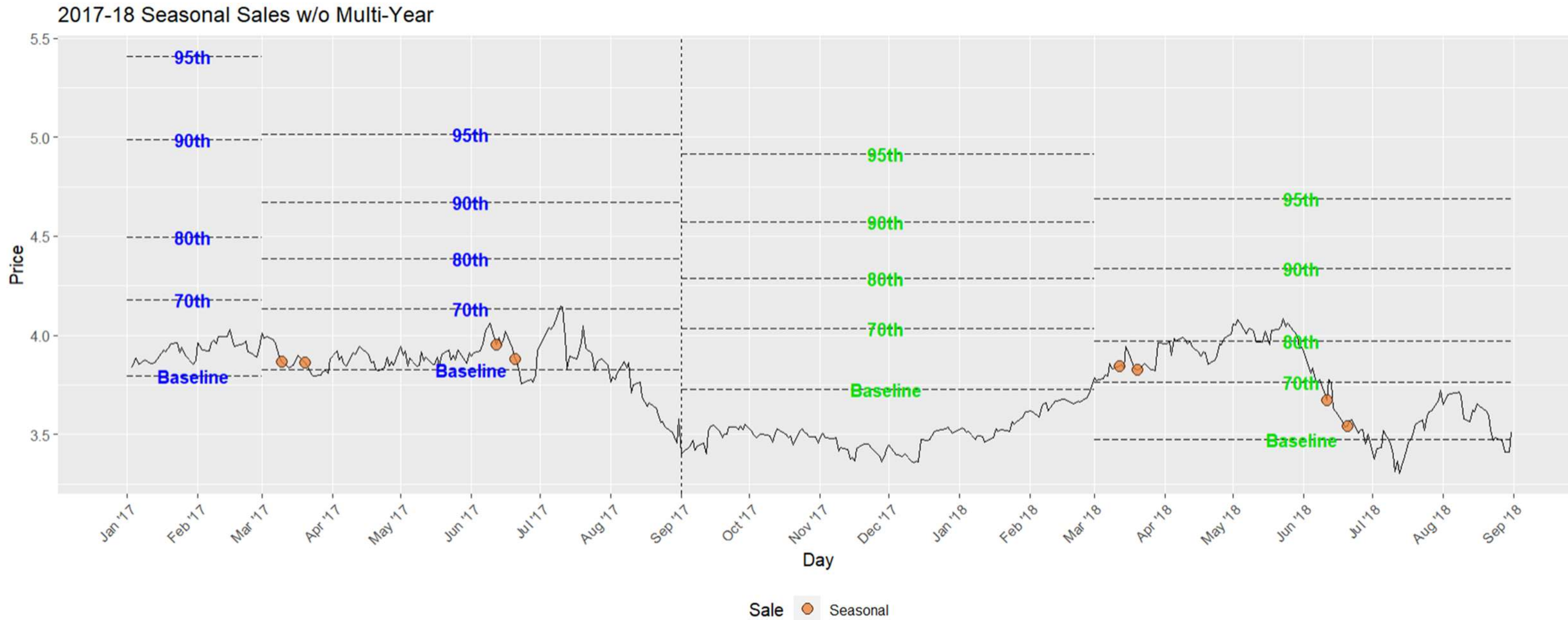
Figure 9: Worst Performing Year for Price Objective Corn



Sales Summary

Date	Jun-20-16	Feb-14-17	Mar-10-17	Mar-20-17	Mar-20-17Split1	Jun-12-17	Jun-20-17
Price	4.34	3.74	3.58	3.63	3.63	3.77	3.70
Percentage	10	10	20	10	10	20	20
Trigger	Trailing Stop	Trailing Stop	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal
On Farm	0	0	0	0	0.34	0.41	0.41
Commercial	0.00	0.27	0.33	0.33	0	0	0
Price - Storage	4.34	3.47	3.25	3.30	3.29	3.36	3.29

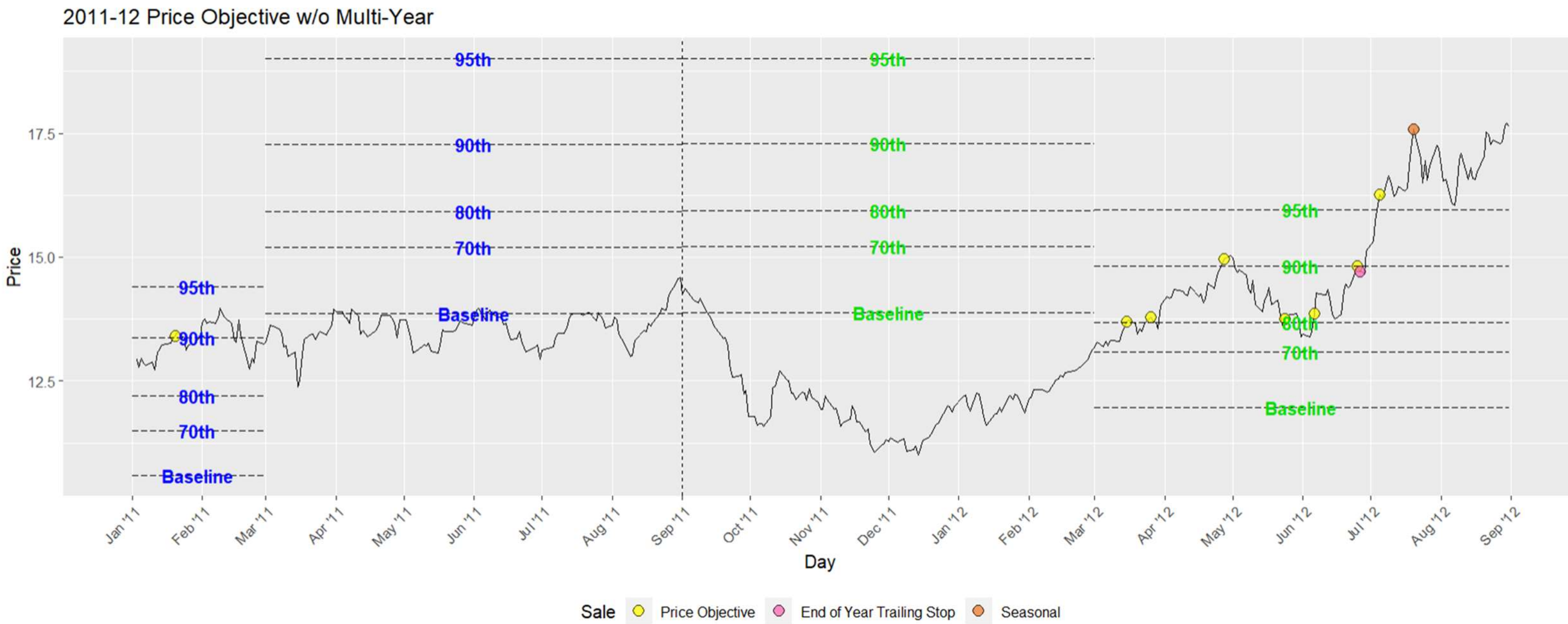
Figure 10: Worst Performing Year for Trailing Stop Corn



Sales Summary

Date	Mar-10-17	Mar-20-17	Jun-12-17	Jun-20-17	Mar-12-18	Mar-20-18	Jun-11-18	Jun-20-18
Price	3.87	3.86	3.95	3.88	3.84	3.83	3.67	3.54
Percentage	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Trigger	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal
On Farm	0.00	0.00	0.00	0.00	0.35	0.35	0.41	0.40
Commercial	0	0	0	0	0	0	0	0
Price - Storage	3.87	3.86	3.95	3.88	3.49	3.48	3.27	3.14

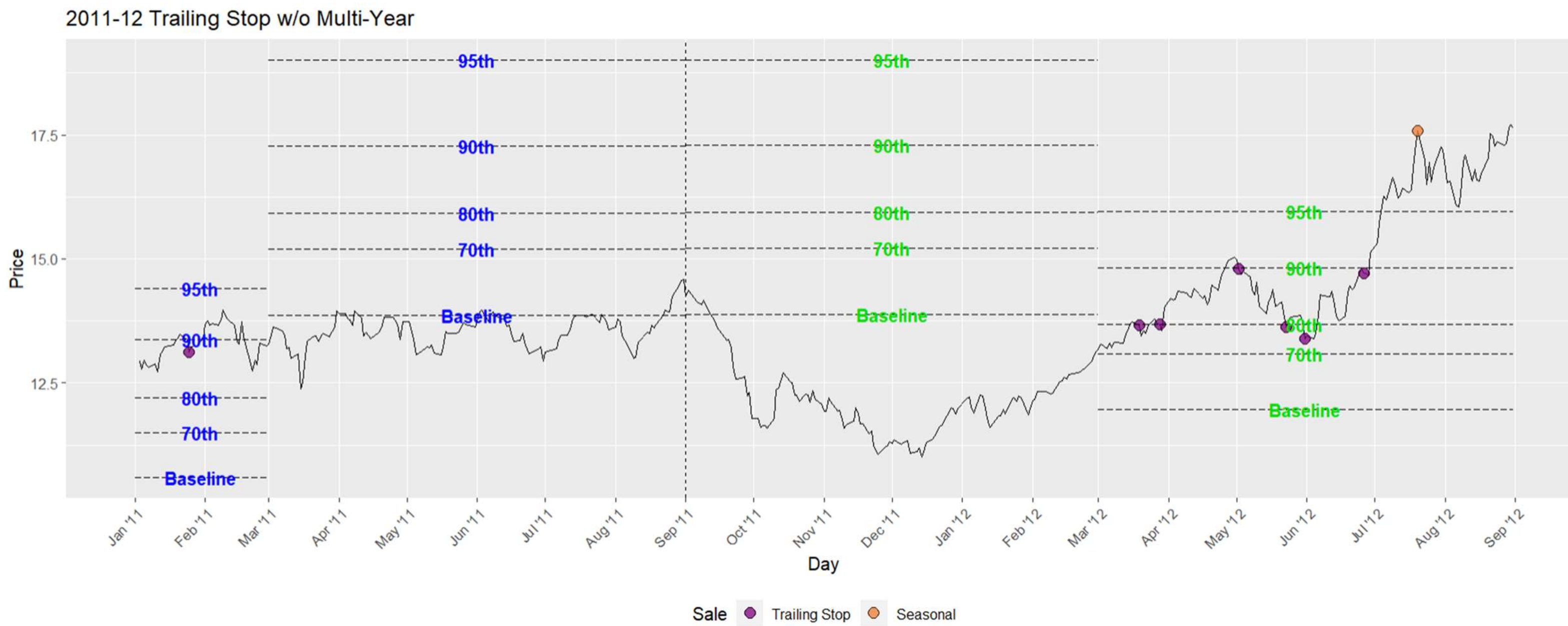
Figure 11: Worst Performing Year for Seasonal Sale Corn



Sales Summary

Date	Jan-20-11	Mar-15-12	Mar-26-12	Apr-27-12	May-24-12	Jun-06-12	Jun-25-12	Jun-26-12	Jul-05-12	Jul-20-12
Price	13.42	13.69	13.80	14.97	13.76	13.86	14.82	14.70	16.26	17.58
Percentage	10	10	10	10	10	10	10	10	10	10
Trigger	Price Objective	Price Objective	Price Objective	Price Objective	Price Objective	Price Objective	Price Objective	End of Year Trailing Stop	Price Objective	Seasonal
On Farm	0	0	0	0	0	0.79	0.82	0.82	0.96	1.01
Commercial	0.00	0.57	0.57	0.72	0.80	0	0	0	0	0
Price - Storage	13.42	13.12	13.23	14.25	12.96	13.08	14.00	13.89	15.31	16.56

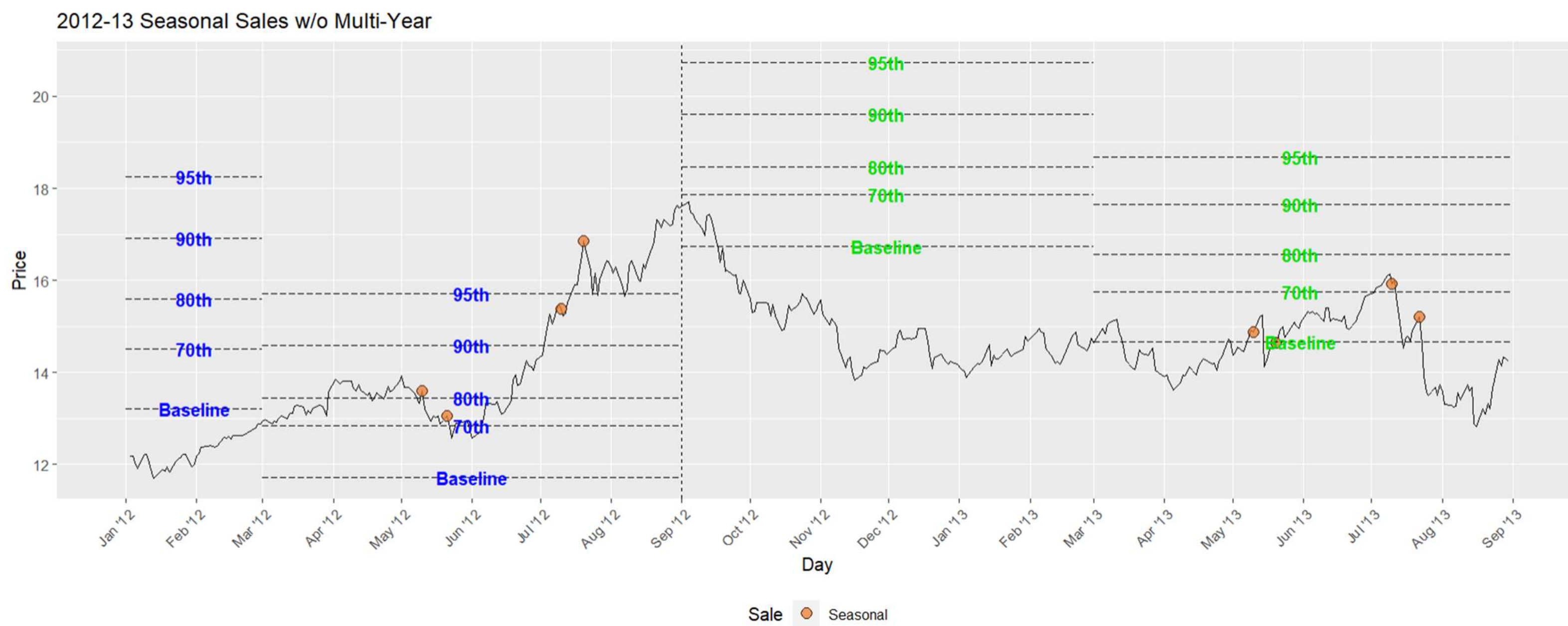
Figure 12: Best Performing Year for Price Objective Soybeans



Sales Summary

Date	Jan-25-11	Mar-19-12	Mar-28-12	May-02-12	May-23-12	May-31-12	Jun-26-12	Jul-20-12
Price	13.13	13.66	13.68	14.80	13.62	13.40	14.70	17.58
Percentage	10	10	10	10	10	10	10	30
Trigger	Trailing Stop	Trailing Stop	Trailing Stop	Trailing Stop	Trailing Stop	Trailing Stop	Trailing Stop	Seasonal
On Farm	0	0	0	0	0	0.70	0.82	1.01
Commercial	0.00	0.57	0.57	0.83	0.79	0	0	0
Price - Storage	13.13	13.10	13.11	13.97	12.83	12.70	13.89	16.56

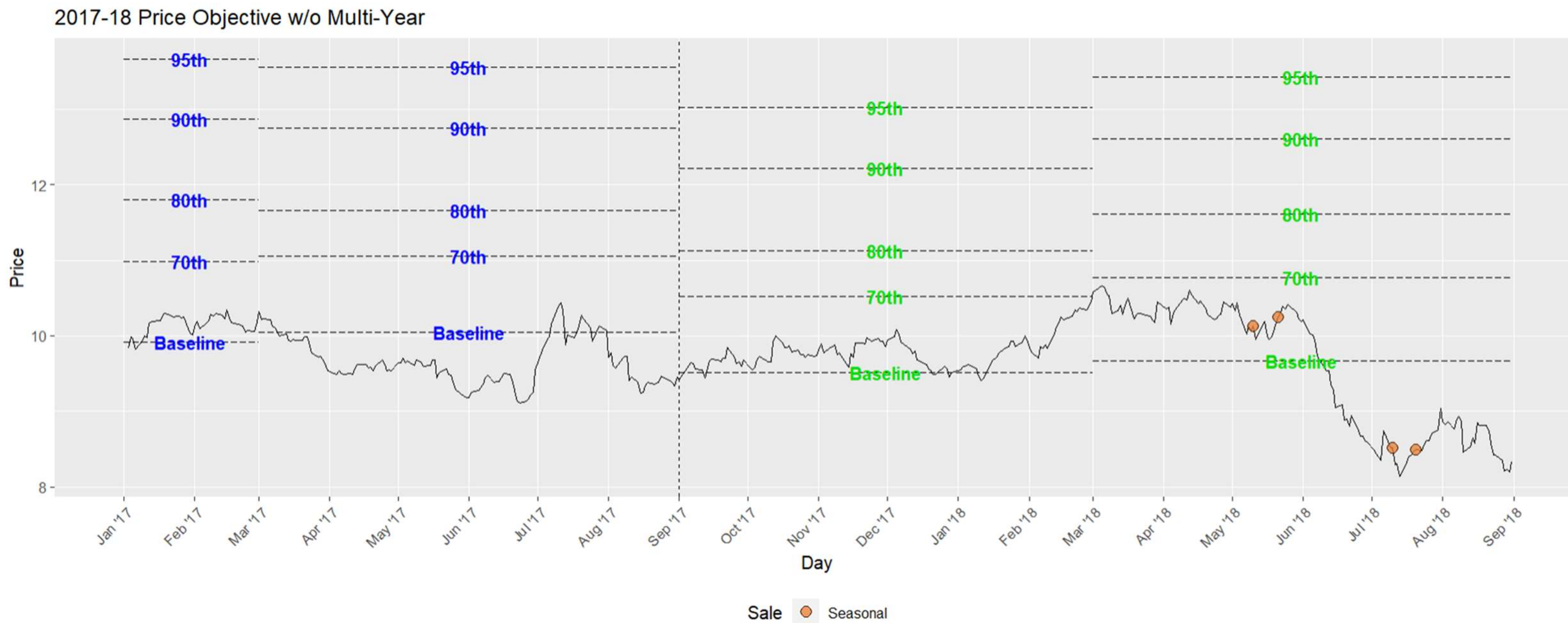
Figure 13: Best Performing Year for Trailing Stop Soybeans



Sales Summary

Date	May-10-12	May-21-12	Jul-10-12	Jul-20-12	May-10-13	May-20-13	Jul-10-13	Jul-22-13
Price	13.59	13.06	15.39	16.86	14.88	14.65	15.92	15.20
Percentage	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Trigger	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal
On Farm	0.00	0.00	0.00	0.00	0.75	0.74	0.94	0.91
Commercial	0	0	0	0	0	0	0	0
Price - Storage	13.59	13.06	15.39	16.86	14.13	13.90	14.98	14.29

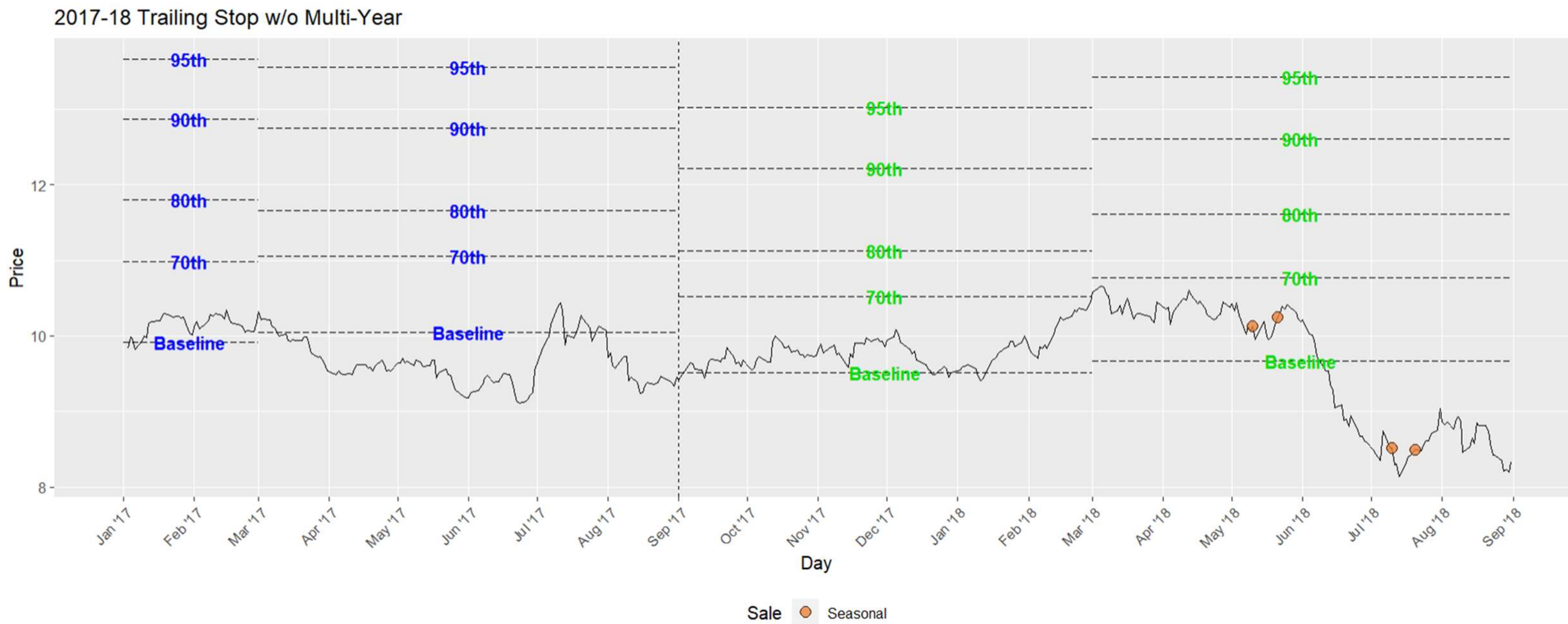
Figure 14: Best Performing Year for Seasonal Sale Soybeans



Sales Summary

Date	May-10-18	May-21-18	Jul-10-18	Jul-20-18
Price	10.13	10.25	8.52	8.50
Percentage	25	25	25	25
Trigger	Seasonal	Seasonal	Seasonal	Seasonal
On Farm	0	0	0.63	0.63
Commercial	0.68	0.68	0	0
Price - Storage	9.45	9.57	7.89	7.87

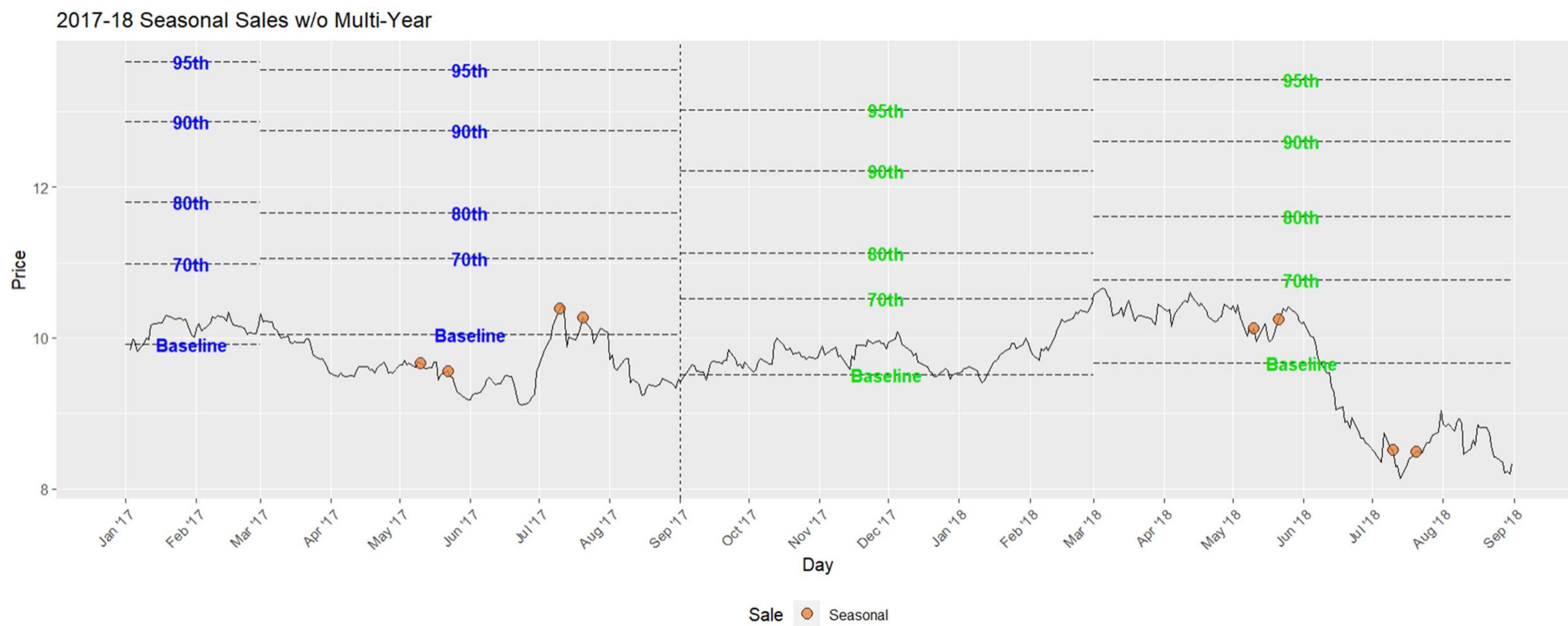
Figure 15: Worst Performing Year for Price Objective Soybeans



Sales Summary

Date	May-10-18	May-21-18	Jul-10-18	Jul-20-18
Price	10.13	10.25	8.52	8.50
Percentage	25	25	25	25
Trigger	Seasonal	Seasonal	Seasonal	Seasonal
On Farm	0	0	0.63	0.63
Commercial	0.68	0.68	0	0
Price - Storage	9.45	9.57	7.89	7.87

Figure 16: Worst Performing Year for Trailing Stop Soybeans



Sales Summary

Date	May-10-17	May-22-17	Jul-10-17	Jul-20-17	May-10-18	May-21-18	Jul-10-18	Jul-20-18
Price	9.67	9.56	10.39	10.27	10.13	10.25	8.52	8.50
Percentage	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Trigger	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal
On Farm	0.00	0.00	0.00	0.00	0.60	0.60	0.63	0.63
Commercial	0	0	0	0	0	0	0	0
Price - Storage	9.67	9.56	10.39	10.27	9.54	9.65	7.89	7.87

Figure 17: Worst Performing Year for Trailing Stop Soybeans

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