HIGHER AND MORE STABLE RETURNS FROM COTTONSEED

Wes Regmund
Texas A&M University
2124 TAMU
College Station, TX 77843-2124

John Robinson
Texas A&M University
Department of Agricultural Economics
Texas A&M AgriLife Extension Service
2124 TAMU
College Station, TX 77843-2124

David P. Anderson
Texas A&M University
The Agricultural & Food Policy Center
Department of Agricultural Economics
Texas A&M AgriLife Extension Service
2124 TAMU
College Station, TX 77843-2124
danderson@tamu.edu

ABSTRACT

Price variability is a significant source of risk in the market for whole cottonseed. Conventional risk management practices for similar commodities consist of longer term storage, forward contracting, and hedging using futures markets as a means to combat unfavorable price movements. However, no futures market currently exists for cottonseed, limiting users and growers in their marketing planning and approaches for risk reduction. The purpose of this study is examine cottonseed supply and usage patterns within Texas and to analyze the feasibility of price risk management strategies by cross hedging cash cottonseed with soybean and soybean meal futures.

Results from a survey disseminated to Texas gins gave credibility to the idea that finding an alternative method to managing price risk would be economically beneficial. The relationship between cash and futures prices are deemed to be significant enough to warrant further investigation and hedge ratios allowing for the proper risk coverage for a seller of seed are estimated. Additionally, a measurement of hedge effectiveness is considered and results in cross hedges using either soybean or soybean meal contracts reasonably reducing risk when compared to an unhedged position. Practical testing from a seller's perspective using historical data produced outcomes that showed that net effective prices from cross hedging are typically higher than unhedged cash prices over the considered time period. This presents an additional potential outlet for cotton gins to market cottonseed aside from the traditional methods, and possibly improve their financial position and profitability. The strategies analyzed will conceivably allow

growers, gins, oil mills, and livestock feeders to reduce price risk and uncertainty and aid in financial decisions.

INTRODUCTION

According the National Agricultural Statistics Service (NASS), 4.5 million acres of upland cotton were harvested in the state of Texas in 2015, which produced 5.72 million bales. This places cotton as the leading cash crop in the largest producing state. Cotton is mostly grown in counties within the West Texas Panhandle and along the Gulf Coast as seen in Figure 1. Generated from that harvest was 1.844 million tons of cottonseed valued at nearly $415 million, ranking it in the top seven crops grown within Texas in terms of production value. Cottonseed is an important joint product of upland cotton production, where roughly 700 pounds of seed on average are produced from each 480 pound bale of cotton (Cotton Inc.). The value of whole cottonseed is a significant factor in the overall economics of cotton production. Returns from whole cottonseed represent slightly below 20% of the estimated gross returns from total production in Texas.

There are four products that are derived from whole cottonseed, which are oil, meal, linters, and hulls. The oil and meal produced from crushing and further processing the kernel make up a large portion when determining the value of the overall seed. Meal is predominantly used for livestock feed, while the oil is almost entirely utilized in manufacturing salad dressings, cooking oils, and baking goods for human consumption. The linters, which are short fibers that cling to the seed, do have some use in making paper currency and upholstery. However, they along with the hulls, which are the protective coating for the kernel, mostly end up in livestock feed. Therefore, world markets for vegetable oils and feed ingredients have a substantial role in establishing cottonseed's value (National Cottonseed Products Assoc.).

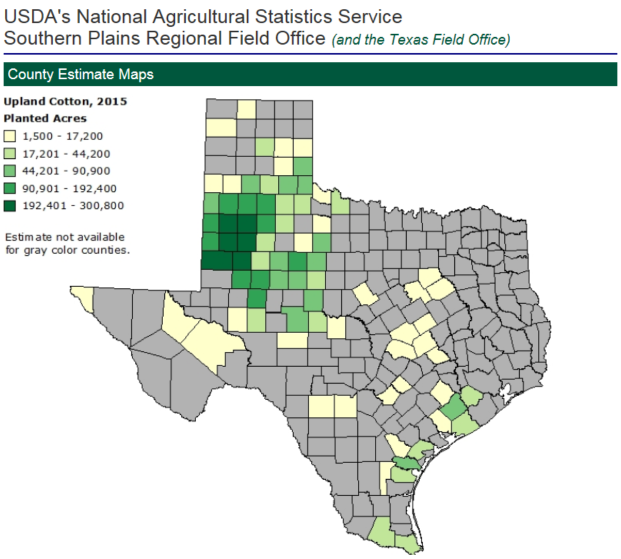

Figure 1: Map of Planted Acres in Texas in 2015 (NASS, USDA 2015)

Whole cottonseed is an important ingredient in livestock rations, especially for dairy cattle. It is considered a complete supplement that offers a protein content of 23%, energy in the form of fat of 20%, and 24% crude fiber on a dry matter basis (Cotton Inc.). The high energy and protein stem from the kernel of the seed, while the fiber comes from short strands commonly referred to as linters that remain on the seed after the cotton, or lint, is removed. Because of its use as a feedstuff, cottonseed competes with other ingredients such as corn, soybeans and soybean crush components, and other oilseeds. Cotton Incorporated describes one fourth of U.S. whole cottonseed as being sold directly from gins as livestock feed, and another quarter is distributed as livestock feed products after being processed by a cottonseed oil mill. Given the importance of the Texas livestock industry, it may be that the share of Texas whole cottonseed being fed to livestock is greater than the national average. Historically, a large portion the seed was sent to mills and resulted in crush products. However, since the late 1990s a majority of seed has been kept whole mostly in the form of feed. Production and usage data provided by NASS, estimates that in the 2014/15 marketing year roughly 57% of cottonseed remained whole compared to 37% being crushed and 5% being exported to world markets.

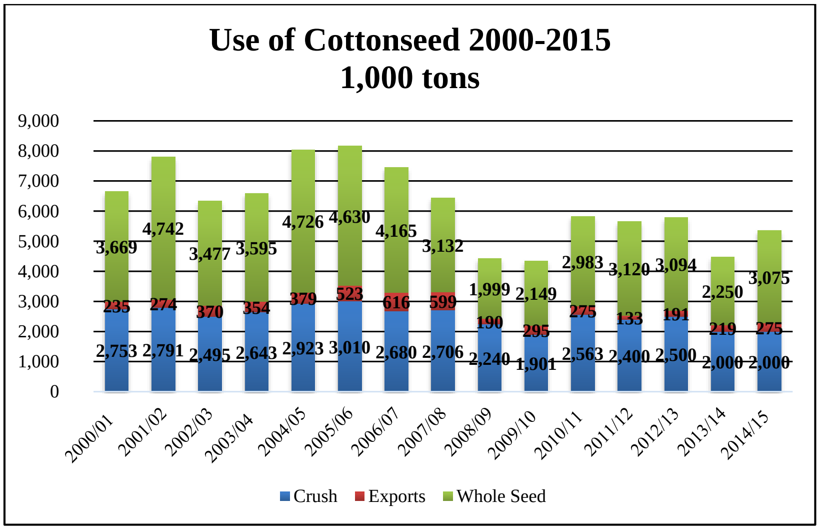

Figure 2: Cottonseed Usage from 2000-2015

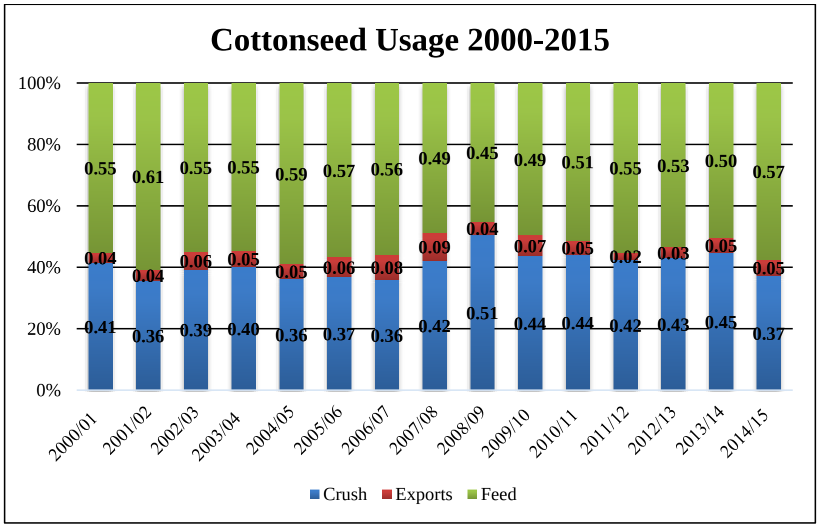

Figure 2: Cottonseed Usage from 2000-2015

A majority of cottonseed marketing takes place from the end of August to December after the typical harvest period in Texas, and the value of whole cottonseed is traditionally applied to offset ginning costs, which in some years has implied a rebate to growers. Swings in price have largely resulted due to a lack of adequate storage. Historical observations of Texas whole cottonseed price implies that most of the time the price will be within plus-or-minus $69 per ton around the average price of $290 per ton. This level of variation is enough to expose growers to occasional ginning cost increases.

Additionally, the significant decline in cotton lint prices in 2015, led to widespread expected financial losses for cotton producers. The 2014 Farm Bill eliminated cotton as a Title I commodity and implemented STAX, an insurance type program, instead of the ARC and PLC options used for other Title I commodities. A number of oilseed crops, primarily soybeans, have access to ARC and PLC. Cotton producers viewed cottonseed as an oilseed crop and requested its inclusion in farm program support. However, this appeal came well after the passage of the farm bill and its implementation. The Secretary of Agriculture subsequently ruled that cottonseed is not designated as a covered oilseed, therefore keeping it ineligible for payments provided by farm programs. This added uncertainty in managing price variation might also represent a significant risk to the financial position of gins, co-ops, livestock feeders, and other users.

Conventional risk management practices for similar commodities consist of longer term storage, forward contracting, and using futures markets as a means to combat unfavorable price movements. However, special considerations must be made for storing such products and no futures market currently exists for cottonseed, limiting users and growers in their marketing planning and risk reduction strategies. The purpose of this study is to examine commodities with established futures markets and determine an appropriate cross hedging vehicle that is sufficiently associated with the West Texas whole cottonseed price, which can then be used to hedge against price movements in a negative direction depending on the users need to buy or sell physical cottonseed. The strategies analyzed will conceivably allow growers, gins, oil mills, and livestock feeders to reduce price risk and uncertainty and aid in financial decisions. Although this study is primarily focused on markets within the state of Texas, the same methods can be used nationwide with presumably similar results.

REVIEW OF LITERATURE

The agricultural economics literature does not generally contain many studies involving cottonseed, and those that do exist are mainly focused on examining its value in beef or dairy cattle feeding or uses of the oil or meal produced from further processing the seed. Coppock, Lanham, Horner (1987) and Myer (2009) discuss the high nutritional value of whole cottonseed in cattle feeding rations and how to maximize its benefits most notably in the Southern states, where most of the nation's cotton is grown. They also touch on a toxic substance called gossypol, which is found when high levels of cottonseed are present in a ration. This toxin not only limits the amount of seed that can be fed to cattle, but also is a significant factor in hindering uses of whole cottonseed in non-ruminant and human consumption.

When addressing the reduction of price variability, hedging is a commonly used and effective risk management tool for agricultural producers and processors. This is typically accomplished through a direct hedge where one futures position offsets one cash position. However, in cases where physical commodities have no specific futures contract, such as cottonseed, Anderson and Danthine (1981) provide a groundwork strategy and suggesting that a cross hedge can be placed by taking a position in a related, although indirect, futures market. They also presented the concept that a correlation coefficient differing from zero indicates an appropriate cross hedging vehicle and that ratios of futures contracts can give optimal coverage for one's cash position.

Following the path of Anderson and Danthine, Blake and Catlett (1984) examined corn futures contracts as a means to hedge against price variations in United States and New Mexico spot alfalfa hay markets. After finding sufficient correlation between prices, the pair used multiple regression techniques to determine the optimal contract months for both production and storage based hedges and the optimal ratio of coverage based on the Mid-America Exchange's 1,000-bushel corn contract. Simulated routine cross hedges were performed using previous years' data and showed that gross return per ton of hay increased compared to a non-hedged scenario.

Likewise, while evaluating the possibility of cross hedging rice bran and millfeed, Elam, Miller, and Holder (1986) discovered that a simple hedge using solely corn futures provided less risk in divergent net and target prices than without a hedge in place. They also discovered that risk associated with cross hedging using corn futures was not significantly different from when other futures contracts were included to implement a multiple cross hedging strategy.

In order to gain a better understanding of how effective these hedging strategies were for various products depending on the type of hedge being considered, Witt, Schroeder, and Hayenga (1987) suggested that the technique to properly estimate the hedge ratio varies. For a purely anticipatory hedge where the current cash price is irrelevant; the hedge ratio can appropriately be found by price level regression. If the current cash price is relevant, such as with storable goods, a price change model is more appropriate.

When determining how to best calculate the appropriate amount of the cash position to hedge in order to minimize the variance of terminal wealth, Lence, Kimle, and Hayenga (1993) examined a dynamic minimum variance hedge in their paper by the same name that allows for an agent to adjust the positon of both the cash and futures in the hedge. Their estimations of a corn storage problem found that this dynamic hedge ratio is more practical and operational than other dynamic models, but gains in hedge effectiveness when compared to a simpler static minimum variance hedge ratio were negligible.

With grain by-products gaining prevalence within livestock feeding rations, Coffey, Anderson, and Parcell (2000) examined the possibilities of cross hedging corn gluten feed (CGF), hominy, and distiller's dried grain (DDG) using corn futures and soybean meal futures as hedging vehicles. Their research concluded that while there was some correlation in price levels between the futures contracts and non-exchange traded products, the reduction in price risk did not outweigh the risk introduced by the hedge. Therefore it is difficult to use cross hedging as a means to reduce risk associated with each by-product.

In similar fashion, Dahlgran (2000) examined cross hedging opportunities for outputs produced by the cottonseed milling process, such as meal, oil, and hulls. He discovered that a combination of contracts from various exchanges can be used to implement a sufficient hedge for the cottonseed "crush". However, while this study was statistically significant in reducing risk, in application this example is uneconomical due the cost and time associated with managing large positions in multiple contracts and exchanges.

Adding to the work of Dahlgran, Rahman, Turner, and Costa (2001) explored the feasibility of using soybean meal futures as a cross hedging vehicle for cash cottonseed meal. They found that cash cottonseed prices and soybean meal futures prices show a direct price movement relationship. They then provided examples of cross hedging using estimated hedge ratios and concluded that hedged net realized prices were generally higher than cash prices.

A common method for evaluating hedge effectiveness in all previous work was a comparison of R^2 values. Sanders and Manfredo (2004) claimed this is done with no attempt to determine if the results are statistically significant. They proposed a methodology which determined whether or not the improved hedging performance of one contract compared to another is more meaningful. By using OLS regression of changes in cash prices on changes in futures prices, the residual basis risk can be determined. The correlation of basis risk between different contracts was then used to calculate the significance and weight given to each contract in reducing risk. They then illustrated this method by comparing two competing futures markets, choosing multiple cross hedges, and evaluating a proposed futures contract.

METHODOLOGY

Because whole cottonseed market distribution information is not widely available, an on-line survey was created and disseminated to cotton gins throughout Texas to gain a better understanding of distribution and utilization patterns, and assess the risk associated with buying and selling cottonseed for gins, growers, and livestock feeders. Many respondents, which consisted of both cooperative and independently owned gins across all regions of Texas, noted that there is a significant risk of fluctuating prices of cottonseed which influences their financial position, and that longer term storage of seed and forward contracting is used to help mitigate this risk. Cross hedging was mentioned in discussions with gin members as a means to manage price volatility, but this strategy is not typically implemented. The results of the ginner survey show there has been a very limited study or application of hedging strategies for whole cottonseed

With no current contract available for trade on any widely used commodities exchange, various grain and oilseed futures contracts were considered as candidates for cross hedging cottonseed cash prices at the gin or oil mill level. Possible cross hedging contracts evaluated included soybeans, soybean meal, soybean oil, and corn, all of which are traded at the Chicago Board of Trade, and act as substitutes for cottonseed as protein in livestock rations. Additionally, the canola contract offered by the Winnipeg Commodity Exchange was considered as well as the cotton contract on the New York Mercantile Exchange. In order for cottonseed to be hedged effectively, there needs to be

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an adequate correlation between the cash and futures price series. Once proper correlation was established, basis risk introduced by the proposed hedge instruments was assessed. The basis is defined as the cash cottonseed price minus the price of the specified futures contract. Futures prices were converted into dollars per ton ($/ton) and the basis was calculated. The standard deviation of this basis series, or basis risk, can be compared to the standard deviation of the price series which forms the general price risk. The commodities were evaluated and contracts that showed less variation of the basis compared to overall price variation received further consideration in the study since this does not create greater total risk when a hedge is put in place.

Next, because a cottonseed contract does not exist and alternative commodity contracts that have differing factors affecting price movement are being used, a perfect hedge cannot be achieved. Therefore, determining the appropriate number of contracts needed within the futures position to sufficiently cover ones spot or cash position is necessary. This was done using simple ordinary least squares regression of futures prices on cottonseed prices and calculating the slope coefficient which is also the optimal hedge ratio. After estimating the ideal number of contracts, empirical tests simulating hedging strategies were conducted to analyze returns by a cotton gin in both hedged and unhedged scenarios.

RESULTS

Survey of Texas Gins

Of the 214 active gins surveyed across the state, 49 replied to questions about the location and governing structure of the gin, how much cottonseed the gin sold in 2014, the type of purchaser and method of sale, the time of year in which the seed is typically sold, and any price risk management strategies the gin may put into practice. Naturally, a large portion of the responding gins were located in the Panhandle and West Texas, as well as along the gulf coast in the southern part of the state. The geographical representation can be seen in Figure 2.

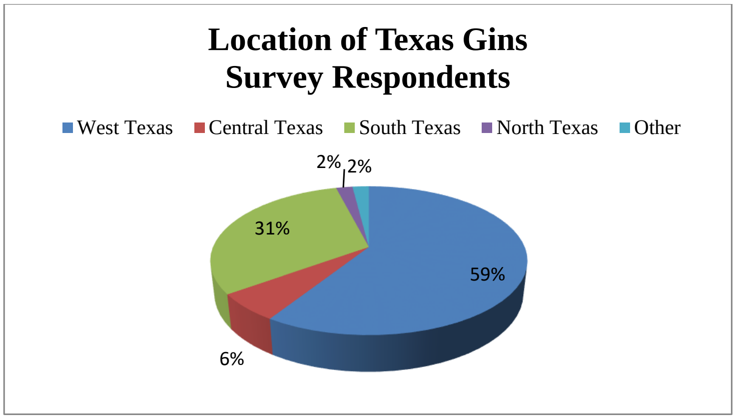

Figure 3: Location of Gins from Survey Responses

Gins, consisting of 59% with cooperative ownership and 41% independently owned distributed an average of approximately 12,000 tons of cottonseed during 2014 to various users such as oil mills, dairies, and feedlots depending on their location, and roughly 82% of that seed was sold beginning in August until December, as seen in Figure 3. A majority stated that the price received for cottonseed had a significant impact on the gin's financial position and only listed contracting forward sales and storing seed as means of taking advantage of more favorable prices. These results gave credibility to the idea that finding an alternative method to manage price risk would be economically beneficial for gins in Texas.

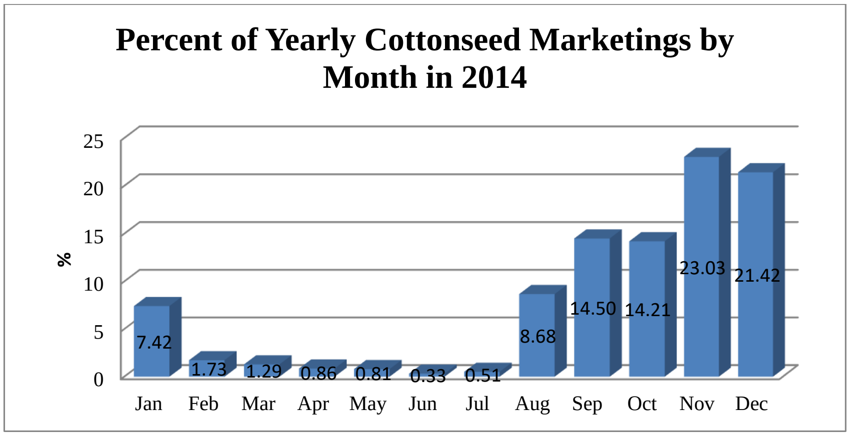

Figure 4: Percentage of Cottonseed Marketings by Month in 2014

Data & Correlations

West Texas whole cottonseed price information came from *Feed Ingredient Weekly* published by Informa Economics and is comprised of weekly average prices in this region. Data were unavailable for a few weeks throughout the time period and this was corrected by averaging the prices of the previous and following week. Price data consisting of the weekly average of the nearby futures contract price for each examined commodity were provided by the Commodity Research Bureau beginning in June 2007 through the end of 2015. This price information was then converted from its contract price per unit into United States dollars per ton ($/ton), the common price quotation for West Texas whole cottonseed. Correlations between the weekly cottonseed cash price and weekly near month futures prices of the aforementioned contracts were calculated for the price level, price changes, and percent changes in price. Witt, Schroeder, and Hayenga (1986) determined that price change models are more appropriate for storable goods since the current price is relevant. While whole cottonseed can be considered a storable commodity, from a practical standpoint it is more perishable than other feed grains and has more limited and unique storage capabilities due to its bulky nature and tendency to retain moisture. Also, as a feedstuff, it is not typically sold a great deal in advance. This suggests a more anticipatory hedging point of view may be necessary. In addition, as previous works propose, (Parcell, Boessen, Altman, Sanders (2000), and Brinker, Parcell, Dhuyvetter, Franken (2009) many observed prices for cottonseed are similar from week to week. This causes numerous values of zero to occur from price changes suggesting that using price level data is most appropriate in this scenario. Likewise, Myers and Thompson (1989) found that hedge coefficients were only marginally better when first differences were used. The correlation coefficients were calculated using the complete price series from June 2007 through December 2015. Shorter time periods were also considered as suggested by Costa and Turner (2013) as well as lagged prices to account for autocorrelation; however, increases in correlation using these methods were varied and not significantly improved. Soybeans and soybean meal appear to be most aligned with cottonseed price movement shown in Table 1.

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Table 1: Price Level Correlation Coefficients between Cottonseed and Exchange Traded Commodities

	Soybean	Soybean Meal	Soybean Oil	Corn	Canola	Cotton
Cottonseed	0.67	0.69	0.37	0.55	0.52	0.19

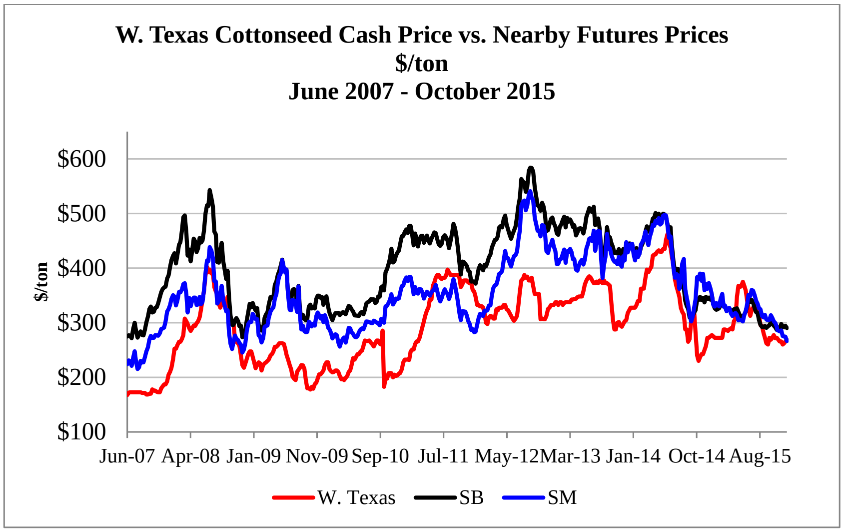

Figure 5: W. Texas Cottonseed Cash Price vs. Nearby Futures Prices

Although a standard correlation coefficient needed for effective hedging is not established in previous works, the correlation between cash cottonseed price and futures prices are slightly below what former studies examining cross hedging found and suggest as reasonable. However, Coffey Anderson, and Parcell (2000) show that assessing basis risk can also help in determining the relationship needed for an effective hedge.

Table 2: Descriptive Statistics of Price Series and Basis Series June 2007—December 2015

	Cottonseed	Soybean	Soybean Meal	Soybean Oil	Corn	Canola	Cotton	
Price Series								
Mean	292.89	396.47	353.96	873.81	178.34	585.33	1,611.56	
St. Dev.	69.11	75.16	67.47	192.79	50.66	82.72	584.28	Price Risk
Basis Series								
Mean		(103.57)	(61.07)	(580.59)	114.55	(291.82)	(1,318.34)	
St. Dev.		58.92*	53.48*	178.91	58.81	74.45	575.06	Basis Risk

Note: The basis series is composed of the weekly cash cottonseed prices minus the futures prices from June 2007 to December 2015. * Indicates that basis risk is less than overall price risk of the commodity and lower than price deviations of cash cottonseed.

Given that the basis risk associated with these contracts, aside from corn, is less than the price risk, additional exploration of cross hedging cottonseed seemed warranted. Further examination will focus on the soybean and soybean meal contracts, as they exhibit the highest correlation with cottonseed price, have a lower basis risk compared to their price risk, and do not appear to introduce greater amounts of risk when a hedge is put in place.

When further examining these two contracts, measuring the correlation of basis risk can help determine if a composite hedge provides greater risk reduction or if a single contract is an appropriate tool. Using the encompassing principles suggested by Sanders and Manfredo (2004), the relatively high correlation of basis risk between soybean and soybean meal of 0.78 advises against the use of a combination of these contracts since no further benefits of diversification are included with the additional commodity.

Hedge Ratios

A reoccurring issue for hedgers and traders is how to best select the appropriate number of contracts needed within the futures position to sufficiently cover ones spot, or cash, position. Since a cottonseed contract does not exist and alternative commodity contracts that exhibit differing factors affecting price movement, a perfect hedge cannot be achieved. The traditional benchmark in hedging literature to estimating the optimal hedge ratio is to use the slope coefficient from a simple regression either on price levels or prices changes. This is a static ratio of the futures position relative to the cash position to be hedged by minimizing the variance in total value for a risk adverse user. The Ordinary Least Squares (OLS) regression model for cash cottonseed and soybean meal futures prices can be shown as:

$$WTC_S = \beta_0 + \beta_1 SBM_F + \epsilon$$

where WTC_S is the weekly West Texas cottonseed spot price, SBM_F is the weekly soybean meal futures price, and ϵ is simply the error term. The intercept term, β_0, represents the average difference between the cash cottonseed price and the soybean meal futures price. The slope coefficient, β_1, indicates the typical cash price change associated with a one dollar price change in the futures. This method has been criticized for not recognizing time-varying distributions or cointegration between prices, and imposing unrealistic restrictions on decision makers as it implies that neither the cash position nor the futures position can be revised or adjusted between the time the hedge is placed and the time it is lifted. Recent studies using time-varying and dynamic models to allow for the optimal hedge ratio to change over time have shown differences from that of static models; however, as shown by Lence, Kimle, and Hayenga (1993), McNew and Fackler (1994) as well as others, the gains in hedge effectiveness when compared to a static variance minimizing ratio are often insignificant. General acceptance of the OLS established ratio has occurred because it is relatively simple to empirically estimate and provides an easy to understand and practical tool while still providing reasonably accurate estimates.

Table 3: Estimated Regression Parameters

	Soybean Meal	Soybean
Intercept	42.12	49.66
Slope	0.71	0.61
R-Square	0.48	0.45
F-Ratio	412.25	361.10
Prob(F)	0.00	0.00
S.E.	0.035	0.032
T-Test	20.30	19.00

Slope coefficients produced for soybean and soybean meal contracts regressed on cottonseed at the price level are 0.614 and 0.709, respectively. Using these ratios, the equation to calculate the necessary number of contracts to offset a given amount of cottonseed to be hedged can be written as,

$$N_F = (Q_{cs}/Q_F) \times h^*$$

where N_F is the number of futures contracts, Q_{cs} is the amount of cottonseed to be hedged, Q_F is the size of the futures contract converted into tons for this scenario, and h^* represents the optimal hedge ratio. If a gin needs to hedge 1,000 tons of cottonseed, then selling four soybean futures contracts (1,000/150 × 0.614 = 4.09) is needed to appropriately hedge the selling of the seed. A single soybean contract consists of 5,000 bushels or 150 tons. Since trading fractional contracts is not possible, rounding to the nearest integer is required when calculating the number of contracts. Similarly, if a seller were using the soybean meal contract, which equals 100 tons, as a cross hedging tool, then selling seven futures contracts becomes the requirement (1,000/100 × 0.709 = 7.09).

Hedge Effectiveness

In this case, the R^2 levels for soybean and soybean meal, seen previously in Table 3, are below the 80% explanatory value recommended by some previous studies of cross hedging effectiveness. However, it seems unreasonable to expect one competing commodity to have such a profound impact on cottonseed price movement given the wide ranging and differing factors that affect the crops. Additionally, as Sanders and Manfredo (2004) found, many of the previous studies that considered the R^2 value as the standard for determining hedge effectiveness did so without defining its statistical significance.

Wilson (1989) and Srinivasan (2011) concluded that a measure of hedge performance can be used to determine how well the spot price risk is reduced when a hedge is introduced. To do this, the variance from an optimally hedged portfolio is compared to the variance from an unhedged portfolio. The variances are simply:

$$VAR_{UNHEDGED} = \sigma_S^2$$

$$VAR_{HEDGED} = \sigma_s^2(1 - \rho^2)$$

where σ_s is the standard deviation of the spot price and ρ is the correlation coefficient between cash and futures prices. From this, the effectiveness of hedging can be measured by the percentage reduction in variance that a hedged position creates contrasted with the variation from an unhedged position. This reduction can be calculated as:

$$HE = 1 - \frac{VAR_{HEDGED}}{VAR_{UNHEDGED}}$$

The value produced from this equation can be interpreted as the average decrease in cash price risk that is realized when hedging takes place. A hedge that completely eliminates risks results in $HE = 1$, and implies a 100% reduction in variation. Alternatively, risk reduction approaches 0% as *HE* falls to zero. The corresponding value using soybeans as hedging tool is 0.45. Applying a soybean meal cross hedge has a value of 0.48, indicating that either option is reasonably effective at reducing risk when compared to an unhedged position.

Practical Application

Empirical testing of cross hedges is explored from the viewpoint of a cotton gin or a seller of physical seed. Since cotton harvest begins in late August, gins naturally start receiving cottonseed from the ginning process at this time and sales of the seed to either oil mills or livestock feeders continues mostly from then through the end of December. Gins can employ either a production based cross hedge or one that takes the limited time of storage into account. A production cross hedge involves taking a position in either soybeans or soybean meal before the cotton harvest and then lifting that position as possession of the cottonseed occurs and selling takes place. Alternatively, in the event of storing and holding cottonseed before the sale date, a position is taken in the nearest futures delivery month when the seed arrives and the hedge is maintained until the time of sale arises. In this situation, if the cottonseed remains in storage when the futures contract matures, the cross hedge is lifted and simply rolled forward into the next delivery month as necessary.

In the first scenario examined, it is assumed that in the first week of May a cotton gin anticipates the need to sell cottonseed in the first week of September, four months away. Because the price of cottonseed is expected to be lower at that time due to increasing supplies at harvest, the gin manager protects downside risk by currently selling the appropriate number of contracts using either soybean or soybean meal futures. If the futures price declines, a gain is made on the short position and offsets a decline the price of cottonseed. On the other hand, a loss is incurred if the futures price rises. Once the gin takes possession and sells the seed in the spot market on the first week of September, the manager buys back the same number of futures contracts to lift the hedge. The loss or gain on the futures transaction can then be added to the value of the cottonseed sold and a net effective price received by the gin can be determined. A successful cross hedge is evaluated by its ability to capture gains from falling prices while minimizing variation and results in an effective net price that is greater than the unhedged cottonseed cash price.

For example, on the first week of May in 2014 the price of cottonseed in the West Texas cash market was $430 per ton. With the need to sell 1,000 tons of cottonseed at what the gin manager foresees as a lower price at harvest, the manager sells four soybean future contracts at the Chicago Board of Trade which is currently trading at $14.65 per bushel or $488.37 per ton. On the first week of September, the gin sells its new crop cottonseed at the now traded cash price of $287.50 per ton for total revenue of $287,500. Although the gin did not have ownership of the seed back in May, this represents a $142.50 per ton decline in the spot price. At the same time, the manager lifts the hedge by buying four soybean futures contracts for $339.73 per ton. The futures transaction results in a gain of $148.64 per ton per contract, not including commission on trades, or a total payoff of $89,191($148.64 × 150 × 4). The total return of $376,691($287,500 + $89,191) results in a net realized price the gin receives of $376.69 per ton. This net price is $89.19 per ton greater than what the gin would have collected by selling unhedged seed in the spot market. This example is shown in Table 4.The same calculations were made every week until the last week of December with the futures position taken four months before the sale date and lifted when the physical cottonseed was marketed. This strategy resulted in an effective net price received due to cross hedging that was greater than the unhedged cash price 69% of the time, over the same months in 2007 through 2015, with the average effective price being $289.36 per ton compared to $271.03 per ton in a no hedge scenario.

Table 4: 4 Month Production Cross Hedging Example Using Soybean Futures

Time	Cash	Futures
First week of May 2014 (Four Months Prior to Sale Date)	$430/ton	Short 4 soybean futures contract @ $488.37/ton
First week of September 2014	Sell 1,000 tons of cottonseed @ $287.50/ton	Buy 4 soybean futures contracts @ $339.73/ton Gain = $148.64/ton
Revenue from selling cash cottonseed = $287.50 × 1,000 = $287,500 Profit from futures transaction = $148.64 × 150 × 4 = $89,191 Total revenue = $287,500 + 89,191 = $376,691		
Net effective price = $376,691 ÷ 1,000 = **$376.69/ton**		

Another situation was tested using a storage cross hedge that begins with the seller of seed taking a short position in the futures market on the first week of July regardless of the expected selling date. July was chosen as the naïve month to place the hedge because it exhibited the highest and most frequent profit from the futures transaction of all months observed. The gin manager will then lift the hedge whenever the spot sale occurs. In this example, cottonseed is priced at $327.50 per ton and nearby soybean meal futures are trading at $350.93 per ton on the first week of July in 2015.

Shorting seven soybean meal contracts is necessary for the gin to protect against a decline in price for 1,000 tons of cottonseed, as mentioned earlier using the optimal hedge ratio. As ginning begins and new crop cottonseed arrives in the warehouse, the gin manager decides to store the seed until the last week of December with the hope that cash prices will increase later in to or after harvest. Unfortunately, on the last week of December when the physical cottonseed is sold, the spot price has fallen to $265.50 per ton; however, the soybean meal futures price has also declined by $76.60 per ton and is trading at $274.33 per ton. Once the futures position is reversed and the hedge is lifted, the transaction has a subsequent profit of $53,620 ($76.60 × 100 × 7), excluding the cost of commission. The cottonseed is sold to an oil mill or livestock feeder at this time for a total of $265,500 ($265.5 × 1,000). This combined with the gain in the futures results in a total return of $319,120 or an effective price of $319.12 per ton received by the gin, which exceeds the unhedged cash price by $53.62 per ton. These calculations can be seen in Table 5. Placing the hedge using soybean meal futures on the first week of July and lifting the position every week from the first week of September until the last week of December produced a higher realized price relative to an unhedged price by an average of $24.62 per ton. The better price experienced by the gin was a 67% occurrence from 2007 to 2015 with an average value of $295.65 per ton.

Table 5: July Storage Cross Hedging Example Using Soybean Meal Futures

Time	Cash	Futures
First week of July 2015	$327.50/ton	Short 7 soybean meal futures contract @ $350.93/ton
Last week of December 2015	Sell 1,000 tons of cottonseed @ $265.50/ton	Buy 7 soybean futures contracts @ $274.33/ton Gain = $76.60/ton
Revenue from selling cash cottonseed = $265.50 × 1,000 = $265,500 Profit from futures transaction = $76.60 × 100 × 7 = $53,620 Total revenue = $265,500 + 53,620 = $319,120		
Net effective price = $319,120 ÷ 1,000 = **$319.12/ton**		

The same test procedures were implemented for the production scenario using soybean meal futures as the cross hedging vehicle and taking a short position four months prior to selling cottonseed. Additionally, soybean futures were assessed while taking storage into account by placing the hedge on the first week of July and lifting it at the time of sale between the first week of September through the last week of December. Cash and net effective prices for the four different hedging scenarios were averaged over the 2007 to 2015 sample period and are reported in Table 6. The storage-like hedge using soybean futures as the tool for cross hedging provided the highest returns and most consistent results over this time period. Outlying years in 2007 and 2010 produced no weeks in which the hedges were profitable and further investigation into the reasoning behind the divergence of prices during these years is required. The cost of trading in the form of brokerage commissions and margin requirements were taken into consideration;

however, the varying amounts for these costs and their lack of any significant influence on the ultimate outcome resulted in their exclusion during calculations. When selecting the appropriate strategy, if a hedger is not merely seeking the highest return but is concerned with cost minimization and liquidity then these factors are important and will need to be accounted for.

Table 6: Average Effective Price September-December 2007-2015

	Cash Cottonseed	Soybean July Hedge	Soybean 4 Mo. Hedge	Soybean Meal July Hedge	Soybean Meal 4 Mo. Hedge
Average Net Price ($/ton)	$271.03	$296.60	$289.36	$295.65	$289.06
% Hedged Net Price > Cash Price		74%	69%	67%	63%
Avg. Amount Over Cash Price		$25.58	$18.81	$24.62	$18.51

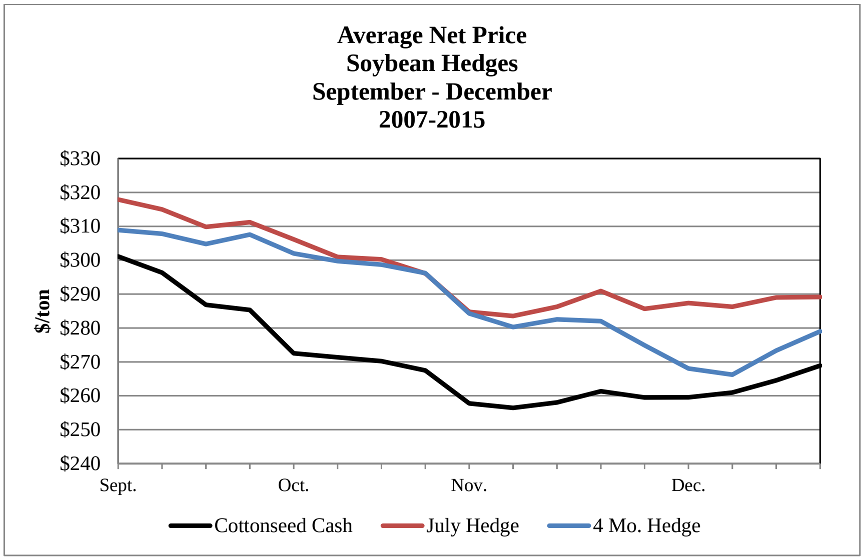

Figure 6: Average Net Effective Price from Cross Hedging Using Soybeans

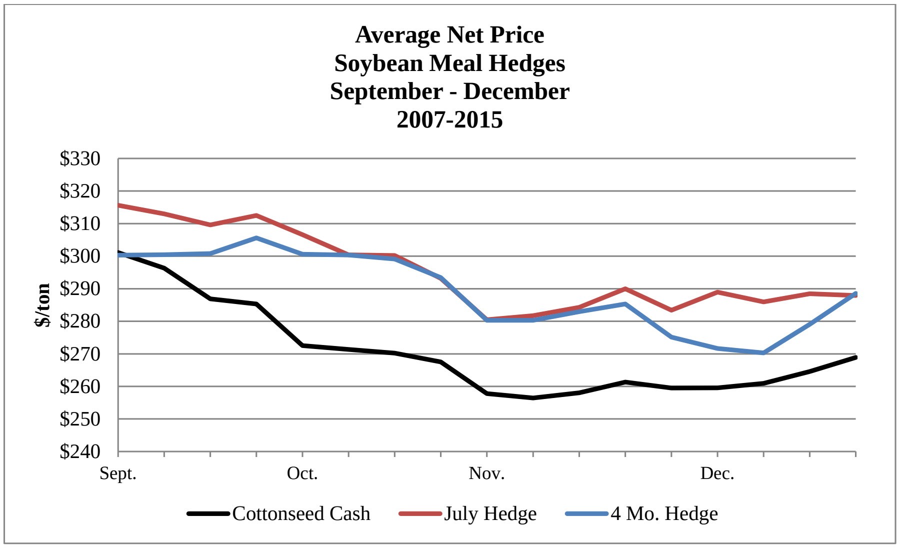

Figure 7: Average Net Effective Prices from Cross Hedging Using Soybean Meal

CONCLUSION

The main objective of this study was to examine cottonseed supply and usage patterns within Texas and to analyze the feasibility of price risk management strategies by cross hedging cash cottonseed with soybean and soybean meal futures. The relationship between cash and futures prices were deemed to be significant enough to warrant further investigation and hedge ratios allowing for the proper risk coverage for a seller of seed were estimated. Additionally, a measurement of hedge effectiveness was considered and resulted in cross hedges using either soybean or soybean meal contracts providing reasonable amounts of risk reduction when compared to an unhedged position. Practical testing from a seller's perspective using historical data produced outcomes that showed that net effective prices from cross hedging were typically higher than unhedged cash prices over the considered time period. This allows for an additional potential outlet for cotton gins to market cottonseed aside from the traditional methods, and possibly improve their financial position and profitability.

Opportunities for research to build upon this study exist as it assumed that there are numerous factors affecting cottonseed that do not necessarily have an impact on soybean or soybean meal prices. Since the amount of seed produced is tied to the amount of cotton grown, demand for cotton and its products is an example of outside influences on the price and quantity of cottonseed available. Additionally, different hedging horizons and lengths could be explored and dynamic time-varying hedge ratios can be implemented for possibly more effective hedges. Using the same approaches with out-of-sample data or simulating future values would also aid in determining the effectiveness of these methods and could better forecast possible outcomes.

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APPENDIX A

SURVEY INSTRUMENT

Cottonseed Utilization Survey

This is a representation of an online Qualtrics survey.

The following is a five minute survey to get a current picture of cottonseed utilization in Texas. There is no current, publicly available source of this information. We are collecting it for two reasons: 1) to provide the industry with a statewide snapshot of average utilization patterns, and 2) to begin to explore the feasibility of cross hedging cottonseed using other oilseed futures markets. Hedging whole cottonseed could conceivably stabilize cash prices for buyers and sellers. So it is important that we know which types of buyers account for what share of the supply. Please answer the following to reflect your gin's typical situation for selling cottonseed. Your individual responses will be kept completely confidential (click Consent Form to see additional assurances/consent form) and used only to calculate regional averages. Regional average utilization patterns will be reported in early 2016 on John Robinson's website http://agrilife.org/cottonmarketing/. A feasibility study of cross hedging whole cottonseed will be presented at the 2017 Beltwide Conference in Dallas, as well as on Dr. Robinson’s website. For any additional questions or comments, please email John Robinson at jrcr@tamu.edu or call 979-845-7268

1. In what region of the state is your gin located?

- West Texas (1)
- Central Texas (2)
- South Texas (3)
- North Texas (4)
- Other (5) ____________________

2. What is your gin's governing structure?

- ❍ Cooperative (1)
- ❍ Independent (2)

3. How much cottonseed did your gin process and sell in 2014? (In tons)

[ ]

4. Buyer/Destination in 2014 (please see the table below)

	% of total cottonseed sold to this type of buyer	Sale Terms. Ex: FOB the gin, etc.
Oil Mill: ADM		
Oil Mill: PYCO		
Oil Mill: VALCO		
Oil Mill: Other		
Feed Mill		
Feed Lot		
Dairy		
Broker (Please specify)		
Other (Please specify)		

5. Timing. How spread out (in months) are your cottonseed sales? Please indicate with typical percentage of sales by month. (If it varies by year, please reflect 2014)

______ % January (1)

______ % February (2)

______ % March (3)

______ % April (4)

______ % May (5)

______ % June (6)

______ % July (7)

______ % August (8)

______ % September (9)

______ % October (10)

______ % November (11)

______ % December (12)

6. Price Risk. Does the price you receive for cottonseed vary enough within the year or across years to significantly affect your gin's financial position? How serious of an issue is cottonseed price risk? (Please comment)

7. Please indicate if you do (or have tried) any of the following. (Select all that apply)

- ❑ Longer term storage of cottonseed for future spot market sales (1)
- ❑ Forward cash contracting of cottonseed. If so, to whom: (2) ____________________
- ❑ Cross hedging cash cottonseed prices. If so, which market(s) (e.g., soybeans, soybean meal, soybean oil, corn, canola, etc.). (3) ____________________
- ❑ Other price risk management for cottonseed (please specify) (4) ____________________