A test to see if there is a commodity that could be used to perform a cross-hedge for cash purchased supreme alfalfa in Tulare, CA. with a single board traded commodity.

A Senior Project

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ABSTRACT

The objective of this project was to determine if cash purchased supreme alfalfa hay in Tulare, CA could be cross-hedged by dairy farmers with a single commodity that is exchanged on the board in order to manage the volatility of alfalfa prices. The first objective was to find commodities that are traded on the board that could potentially be used to cross-hedge cash purchased or grown alfalfa. Three commodities that are similar to alfalfa were selected. The commodities were soybeans, soybean meal, and No. 2 yellow corn. The fourth commodity used was crude oil because fuel is a large cost in the farming of alfalfa. Monthly average futures contract prices and monthly average cash prices of all of the commodities were found from 2005 to 2013. The monthly average cash prices paid to farmers in California and the U.S., the monthly average cash prices paid for alfalfa in the U.S., and the monthly average cash prices paid for delivered supreme alfalfa in Tulare, California were all gathered. The data was analyzed to see if the price variance of supreme alfalfa in Tulare, CA has a strong relationship to the commodities price fluctuations. The study determined that cash purchased supreme alfalfa hay in Tulare, CA cannot be cross-hedged with a single commodity that is exchanged on the board because it did not have a significant relationship to the commodities used in the test.

Key words: cross-hedge, alfalfa, commodities, futures contracts, volatility

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INTRODUCTION

In 2007 and the beginning of 2008, before the collapse of the dairy industry in California, record high cash milk prices were being paid to dairymen. Dairies were prospering and growing in size. Many dairymen were purchasing forward contracts for feed including corn, soybeans, and alfalfa to feed their cows. The prices of these commodities were high but affordable because the cash price of milk was so strong. Dairymen could not spend their money fast enough until the cash milk price dropped precipitously. The dairymen of California were hit by commodity volatility and they were helpless. This was the infamous year of 2009 and it was a nightmare for many of my close friends and my own family. Dairymen had made forward contracts for commodities and feed that they could either no longer afford to keep paying or they refused to pay. The year of 2009 almost broke the California dairy industry because most of the dairymen in California were not ready for a severe drop in the commodity market. Most dairymen did not have hedges in place to insure moderate margins. Instead, they were relying on the cash market for milk prices and they were forward contracting their inputs. Today, many of the dairymen that stayed in business through 2009 were either heavily diversified or hedging their milk and commodities to the best of their abilities along with the help of financial firms.

Alfalfa price played a large role in the collapse of the dairy industry because it is a large part of dairy cattle rations and it follows the volatile trend of other commodities. It is different than the other commodities because it is an open market commodity. Many other industries that use open market commodities use hedging as a sort of insurance for their business, but they hedge them with commodities that are traded on the board.

A cross-hedge can be used to hedge open market commodities with board traded commodities. I researched the concept of cross-hedging alfalfa with a commodity being traded on the board and found nothing. I decided to venture out and try to find a single commodity that has a strong enough price correlation and relationship with alfalfa to be used in a cross-hedge.

The objective of this study is to determine if cash purchased supreme alfalfa hay in Tulare, California could be cross-hedged with a single commodity that is exchanged on the board. The cross-hedge could help businesses in Tulare, California manage the volatility of alfalfa prices.

LITERATURE REVIEW

History of alfalfa

The “Queen of the Forage Crops” also known as alfalfa, has been important to farmers and businesses with livestock for a very long time. Alfalfa is classified as a legume. Legumes have been traced as far back as Turkey in 1300 B.C. Legumes have also found their way to the Greeks, the Persians, the Romans, and the rest of the world. Alfalfa was passed on for generations because it has the ability to; naturally perform nitrogen fixation to the soil it is grown on, yield large quantities of quality of forage, and it supplies energy, protein and fiber to livestock (Putman, et al., 2007).

Alfalfa was introduced to California soil during the Gold Rush of 1849. An individual from South America made his way to California to find his fortune in gold and brought what was called, “Chilean Clover” with him. The new clover grew very well in California because it came from a Mediterranean climate in Chile and California has the same climate. The Mediterranean climate has hot summers and mild winters that are optimum for farming alfalfa. The miners of 1849 that did not strike it rich in their gold claims started to move to the fields where they could grow alfalfa for a profit. Alfalfa production from 1850 to 1870 grew respectively from 2000 tons to 500,000 tons. Today, in California, alfalfa is the highest acreage crop and California is the leading producer of alfalfa at about 7 million tons per year (Putnam, et al., 2007). To put that into perspective, figure 1 shows one truck load or 30 ton of alfalfa bales.

California also leads the nation in dairy production today. As the dairy industry grew, the demand for alfalfa from dairymen grew also and needed to be filled by farmers in the valleys of California like the Central Valley. Dairymen started to want large quantities of alfalfa and they wanted the quality to coincide with large quantities. The dairymen's demands were met by the farmers with advances in irrigation, plant breeding, harvesting techniques, storage, and shipping (Putnam, et al., 2007).

Figure 1. Typical California semi hauling 30 tons of small alfalfa bales.

Irrigation

The farmers in the Central Valley needed to supply alfalfa with 4 acre-feet (1200mm) of water per year for their fields to yield what they are supposed to. The farmers started to pump ground water and manage the water in the rivers in order get enough water in an area where rainfall is for the year is only ten inches on average. Some farmers leveled the fields where flood irrigation is used in order to improve uniformity of irrigations. Others used sprinklers for irrigating their fields (Putnam, et al., 2007).

Plant breeding

Plant breeding played a large part in creating alfalfa varieties for the different climates and soils in California. The differences include dormancy patterns, resistance to diseases, nematodes, and insects, and round-up ready technologies (Putnam, et al., 2007). The different dormant patterns of the breeds are important to farmers in areas where the weather does not permit the growing of alfalfa in the fall or winter. Letting the alfalfa go dormant part of the year has also been proven to improve the quality of the harvested alfalfa (Putnam, et al., 2007). Resistance to diseases, nematodes, and insects improved the quality and decreased costs associated with growing the alfalfa. The round-up ready varieties supply the option to spray the fields with herbicides needed to control weeds. More weeds mean higher yields, but the weeds can decrease quality so the farmers spray them.

Harvesting

As alfalfa plants grow and the plants mature the expected quality of the alfalfa changes. The expected yield per acre of alfalfa is directly linked to plant maturity and quality. If a farmer cuts young or pre-bud alfalfa the quality is considered high because the proportion of leaves to stems is greater than that of a more mature alfalfa plant. This is because the stems lengthen over time and become more fibrous as the plant grows and matures. The leaves of alfalfa do not increase simultaneously with the stems so the proportion of leaves to stems decreases over time and the quality decreases also. There is a sort of perfect proportion that farmers desire depending on what kind of alfalfa they intend to sell and who their customers will be. In order to find that perfect proportion, farmers must maximize yields and quality without shortening the life span of the field to drastically.

In order to hit the perfect proportion, farmers must focus on the period in the life span of the alfalfa plant just before the flowers on the alfalfa plants appear. Before the flowers appear on the plants, the yield of the alfalfa field increases more rapidly than the quality decreases. Once the flowers appear, the decrease in quality is more rapid because fiber starts to concentrate in the stems of the plants in the form of cellulose and lignin. Other factors like weather, environmental conditions, and temperature also impact the quality of the alfalfa, but the maturity of the alfalfa plants at harvest has the greatest impact. This is a benefit of alfalfa because the farmer can easily control when harvest will occur but advances are still being made to understand the alfalfa plant.

The quality of alfalfa determines the value of alfalfa on the market and quality is usually sorted by fiber contents. High priced alfalfa has low concentrations of fiber and high concentrations of leaves. The fiber of alfalfa is sorted into two categories: acid detergent fiber (ADF) and neutral detergent fiber (NDF) (Mueller, Teuber, 2007). If the alfalfa is considered high quality, it will have high total digestible nutrients (TDN). TDN is an index of quality used in the market place to establish a grade scale for the alfalfa market. The TDN scale consists of supreme, premium, good, and fair. The prices follow accordingly (Hoyt, 2014). The TDN scale is the value used to place economic value on alfalfa in California. The TDN value comes from a fast chemical test that is supposed to simulate what will happen to the alfalfa if it is fed to livestock. The TDN has a negatively correlated relationship with high concentrations of non-digestible nutrients in the alfalfa plant. The main non-digestible nutrient is the ADF or structural fiber that is not hemicellulose (Robinson, 1998). Farmers that decrease the non-digestible nutrients or structural fiber with short intervals between cuttings can take advantage of high prices with supreme alfalfa. The root systems of alfalfa plants are negatively affected by short cutting intervals. The short cutting intervals do not give the roots enough time to become established before the alfalfa plant is cut. Alfalfa fields with roots that are not strongly established have reduced profitable life expectancy.

Dairies that are trying to purchase alfalfa that will be fed to ruminating milk cows will pay a premium for low fiber or high TDN alfalfa because of its high energy levels but dairies also need to feed NDF and ADF to their cows (Robinson, 1998). NDF and ADF are important parts of the alfalfa plant. California dairies that want to feed a ration that promotes high production will often feed high TDN alfalfa (Beauchemin, et al., 2003). This encourages milk production, but it can also lead to metabolic disorders in cows like: Subclinical ruminal acidosis, milk fat depression, a displaced abomasum, laminitis, and fat-cow syndrome (National Research Council, 2001). These disorders can cost the dairyman money and potentially harm or kill the cattle. Proper ruminal function of the cattle is driven by the stems of alfalfa where fiber is stored (Beauchemin, et al., 2008). The stems must be chewed more than other feeds. The act of chewing increases saliva output from the cattle, and the saliva controls the pH of the cattle. The previously listed health disorders are caused by unbalanced pH, so the reasoning behind feeding alfalfa is very economical (Beauchemin, et al., 2003).

Machines and packaging

The farmers in the early days of production did not have the knowledge of how to grow and when to chop alfalfa in order to have a high quality crop. Even with that knowledge, they did not have the machinery to chop and bale the alfalfa to maximize profitability and efficiency like we do today. The hand tools of the past were replaced with big diesel machines that can process hundreds of acres in just a few days. One of the first Machines that had the largest impact on not only alfalfa as forage, but it influenced the markets of the past and it influences the markets today. That product was the Petaluma Hay Press (Putnam, et al., 2007). The Petaluma Hay Press established a sort of currency for alfalfa called the bale. Figure 2 shows some farmers using the Petaluma Hay Press. Today, 98 percent of alfalfa is still baled in the field, but with modern machines (Putnam, et al., 2007). The bales are sold by weight in large quantities or by the bale when the transaction is small. Alfalfa is typically packaged in three

Figure 2. The Petaluma Hay Press. Shown packaging alfalfa into bales. Picture courtesy of Farm Collector.

ways: small bales (80-140 lb, 36-64 kg), large round bales, or big bales(750-2000 lb, 340-907 kg) (Shinners, et. Al, 2009). The large bales are becoming more common because they can be stacked and shipped with ease as long as the proper machinery is available. Figure 3 shows a large bale being packaged in the field with modern machines. Large California dairies often prefer the large bales because they can be dismantled and fed more efficiently than the small bales. The California dairy industry and the California alfalfa industry have a very tight bond. The alfalfa farmers need to make a profit by selling their alfalfa and the dairies purchase alfalfa because of the nutritional benefits it adds to their rations.

Figure 3. Typical California machine operated alfalfa large baler.

The dairymen of California purchase alfalfa from farmers or hay brokers, local or out of state, based on the quality, quantity, and the packaging of the alfalfa. Standards for quality have been set for three percentages of nutritional attributes of alfalfa, Crude Protein (CP), Neutral Detergent Fiber (NDF), and Acid Detergent Fiber (ADF) (Hopper, et al., 2004). All three of these attributs are taken into consideration when the value of alfalfa is being set, but an established quality index called Total Digestible Nutrients (TDN) is most commonly used. TDN is based on ADF (Putnam, et al., 2007). However, all of these factors and weed content are important when the alfalfa's quality is standardized by the USDA. Dairymen often demand alfalfa that fits the good to supreme ranges because including quality alfalfa in their rations with concentrates and silages increase energy that can be digested, which leads to higher milk production than lower quality alfalfa. The price of alfalfa is directly correlated to the quality for this very reason (Hopper, et al., 2004). Alfalfa is a commodity of the dairy industry that is used to feed cows. Alfalfa is also a commodity by nature, so the price of alfalfa is very volatile like other commodity prices. However, alfalfa is special because it is not traded on the Chicago Mercantile Exchange. Alfalfa is an open market commodity, so dairymen cannot control their input prices for alfalfa with risk management tools like hedging. They can only hope that they can get a forward contract when the price is the lowest of the year, buy the alfalfa with cash out of fields from farmers throughout the year, or grow their own alfalfa. In California, the majority of alfalfa is purchased by dairies rather than grown (Putnam, et al., 2007). The dairy could also decide to quit feeding alfalfa. If they do, they will ignore the health benefits associated with alfalfa like its ability to balance pH in lactating cows (Alamouti, et al., 2009). Another quality that would be ignored is the ability to feed large amounts of concentrates or silages to lactating cows along with alfalfa without disturbing the rumen (Eastridge et al., 2008). Those that decide to continue to feed alfalfa must overcome the obstacle of price volatility associated with alfalfa without the ability to control the price of it with risk management tools that are available to other board traded commodities.

Commodity volatility

Volatility is defined as the variation of commodity price changes from their mean or normal value (Hutchet, et al., 2011). When the prices of agricultural commodities like corn and soybeans are placed on a line graph over time, the prices resemble something that looks like a roller coaster. Figure 4 shows the volatility of corn grain prices received by farmers in the U.S. After the financial rise and decline in the years 2006 through 2009, the issue of price volatility

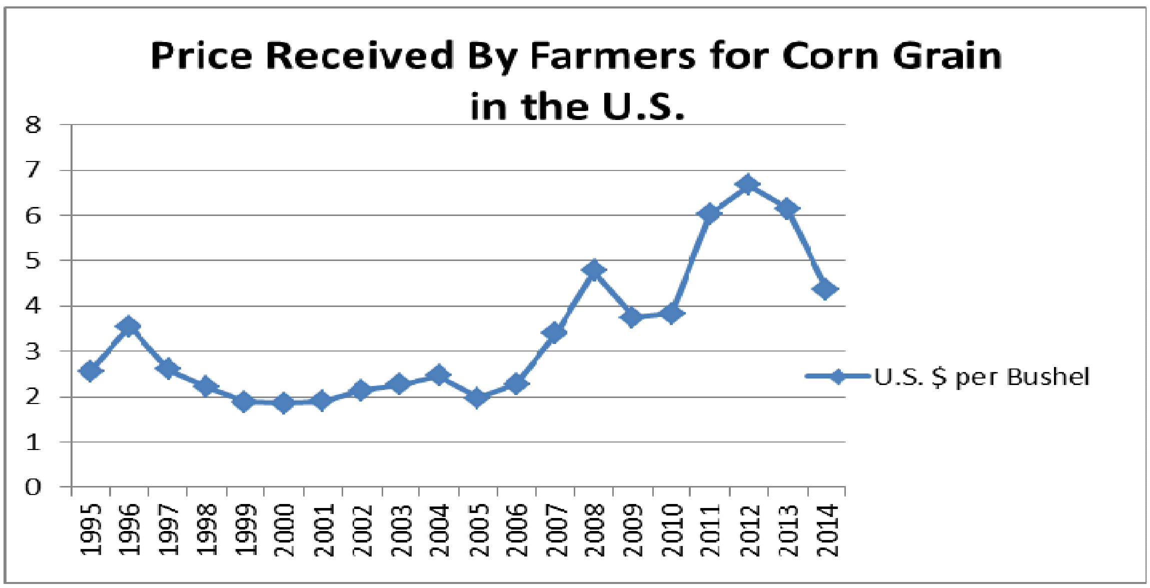

Figure 4. Volatility of corn prices from 1995 to 2014. The data were gathered by Brian Gould from the USDA and complied into a graph.

became a large reality to many farmers and dairymen. Farmers that were expecting to receive high prices in 2009 got hit with the harsh reality of very low prices. The risk of not knowing what the farmer might be paid or will have to pay for commodities has become one of the largest risks in business (Hutchet, et al., 2011).

Price volatility does not just affect the farmer; it also has a large impact on governments, and countries that are poor. Poor countries worry about price volatility of commodities because they directly influence the price of food for their citizens. The volatile food prices affect food security for the low income families (Hutchet, et al., 2011).

Volatile commodity prices are not a new idea or issue. Many studies have been done on the analysis of price volatility of agriculture commodities and the way they have changed over time. According to Hutchet, the amount or magnitude of volatility has not changed significantly on a statistical basis in the last 50 years when observing large periods of time. So the amount of risk that is at hand has not changed. Volatility is not constant, it is always variable and most commodity prices are also always volatile. The constant changes in volatility alter the total marginal cost of production for producers and for business that purchase commodities (Pindyck, 2004). When these important measures are altered, businesses have a hard time maintaining a constant cash flow.

The dairy industry is one of the ultimate examples of an industry that is affected by price volatility. The dairy industry is special because it is an industry that produces a commodity, milk, by feeding commodities. Dairymen are affected on both ends of their production, inputs and outputs. Therefore, the main goal of the dairy is to maintain income from milk sales after feeding the cows. This is called the income over feed cost (IOFC) (Neyhard, et al., 2013). In more recent years, economists have started to develop strategies to minimize the risk attributed to volatile feed and milk prices for dairies.

The Chicago Mercantile Exchange (CME) is the place that these economists go to manage the dairy's risk with hedging through options and future contracts for commodities that are traded on the board (CME, 2014). The problem with the dairy model is that the issue of volatile prices on both spectrums of the business inputs and outputs. The existence of this issue creates scenarios when hedging cannot be done to ensure a positive cash flow. In this case the farmer must stay in a cash position (Neyhard et al., 2013). In the case of alfalfa, the CME is not a tool that can be used because alfalfa is an open market commodity.

The Futures markets compared to forward contracting

Futures Contracts are often confused with forward contracts. The two contracts are very different in the realm of trading commodities. Forward contracts are private contracts or over the counter contracts. The terms and conditions are negotiated and controlled by the individuals who have agreed to a forward contract. The definition of a forward contract is "an agreement between two parties for the delivery of a physical asset at a certain time in the future, for a certain price fixed at the inception of the contract" (Kolb, et al., 2006). The asset never changes ownership until the agreed date arrives and the parties exchange the agreed amount for the asset. The price agreed is not altered from the initial agreement and the option to close the contract before the agreed settlement date is very difficult because they are regulated by contract law (Kolb, et al., 2006). For example, a dairyman buys a forward contract of 1000 tons of open market alfalfa large square bales to be delivered in five months at a certain price. If the price of alfalfa drops by 50% before the five months is up, the dairymen must pay the price that is 50% higher than the current value of the alfalfa. Alfalfa is a great example because it is an open market commodity that is not traded on the Chicago Mercantile board of Exchange (CME).

Futures contracts

Futures contracts are similar to forward contracts because a futures contract also involves the trading of a commodity but the differences between the contracts are most important. The differences are that futures contracts are traded on large organized exchanges like the CME that require the ownership of a seat to participate in the act of trading. Futures contracts are not privately traded like forward contracts. The terms and conditions are standardized for all futures contracts and they are regulated by the Commodity Futures Trading Commission (CFTC). These include the size of each contract, the price fluctuation allowed each day, and the delivery date for each of the different available commodity contracts. The CFTC guarantees all futures contracts deliveries so the risk of not receiving a purchased asset is not a risk factor. In a futures contract, the buyer and seller can close their position in the futures contract before the agreed delivery date. The futures market is based on margins and daily price settlements. The act of trading a futures contract is much different than the over the counter style of trade that occurs in a forward contract (Kolb, et al., 2006).

The trading process for futures contracts occurs with a system called open outcry or on electronic trading platforms. The open outcry method occurs in a bowl like room called a pit. The traders are arranged in the pit where they use highly developed hand gestures and yelling to signal if they are going to obtain a short position by selling, or if they are going to obtain a long position by buying futures contracts. In recent years, electronic trading has taken over most of the trading in large exchanges like the CME (Kolb, et al., 2006).

The traders in the pits can be placed into two different categories, those who are speculating and those who are performing a hedge. A speculator is an individual who is trading in the pit in order to earn a profit. The speculator accepts the risks that come with the act of speculating the future prices of commodities. For example, if the speculator decides to obtain a short position on soybean meal and the price goes up, the speculator must cover the difference in the price at a loss. The individuals who are performing a hedge in the pit are most often brokers that are working for businesses that produce or use commodities as inputs in their business. The brokers work for firms that own spots on the floor or in the exchange pits, so they charge a fee to hedge for the businesses (Kolb, et al., 2006).

Hedging with options and futures contracts

Hedging is by definition, the act of buying or selling futures as a temporary substitute for a transaction in the cash market. Farmers might take a short position in the futures market for their anticipated crop before they grow the crop.

A dairyman might go long in the futures market for a certain commodity that they have not purchased yet. The act of performing a hedge is done to manage risk that comes from volatile commodity prices and the risk of not knowing what the prices are going to do (Kolb, et al., 2006). The factor of risk is the true factor for hedging and not to make a profit in the futures market like a speculator. Hedging is like insurance with speculators taking the price risk like an insurance company takes the risk of an accident. A hedge can only be done if the business has a position in the cash market of a commodity. The hedger must buy or sell a position in the futures market that is equal but opposite too their position in the cash market of the commodity. This makes the hedger a buyer and a seller at the exact same time. The risk of price volatility of commodities is decreased because of this buyer/seller position. The hedge is effective because the hedger will lose money in one of the markets and make money in the other because spot (cash) prices are positively correlated with futures markets. The price can go up or down, but the outcome will remain the same. If a business wants to hedge the commodities for their business, but the commodities they want to hedge are not traded on the board, the business must use a cross-hedge. Cross-hedging is when equal but opposite positions are taken in the futures and cash market just like a normal hedge. Cross-hedging can be used if the commodity that is not traded on the board is strongly related to a commodity that is traded on the board and follows similar price patterns (Carter, 2003).

Once a desired commodity is identified by the hedger on the exchange, the hedger can decide to use two methods of taking the desired position in the futures market. The hedger can either use a futures contract or an option on a futures contract. Both are effective approaches and very different. (Neyhard et al., 2013)

The first difference between futures contracts and an option on a futures contract is in the obligation of accepting or delivering a commodity or asset. An individual who has purchased a futures contract has made an obligation to either deliver or receive a commodity. The futures contract must be offset by another individual through the purchase of an opposite position on the same futures contract. Most of the times the commodities or assets are not delivered because another hedger is trying buy a position so the contracts cancel out (Carter, 2003).

The individual or hedger who has purchased an option on a futures contract has purchased the right rather than obligation to buy or sell a futures contract within a certain time period. There are two kinds of options. A put option gives the buyer of that put option the right to sell a futures contract at a specific price and over a specific period of time. It is up to the owner of the put option whether or not to exercise that right. A call option gives the buyer of that call option the right to buy a futures contract at a specific price and over a specific period of time. It is up to the owner of that call option whether or not to exercise that right. The seller of the option is called a writer. This individual sells the right to control a futures contract for a price called a premium. The price of an option is affected by the demand for options. The benefit of an option is that an option demands a much lower cash investment than futures contracts (Carter, 2003).

MATERIAL AND METHODS

Goals

My goal was to determine if an effective cross-hedge for alfalfa hay in Tulare, California could be performed with soybeans, corn, or Crude oil. A cross-hedge is useful for hedging commodities that are not traded on the board. Some examples are: alfalfa, jet fuel, lettuce, peanuts, and sunflowers (Carter, 2003). According to Carter, an effective cross-hedge could be attempted by producers and commercial consumers if the commodities are in related markets. The commodities must also have prices that are highly correlated with the non-futures cash commodity prices. A higher correlation between the cash and futures pricing the greater the chances of performing an effective cross-hedge and the greater the chances of reducing risk. Because alfalfa is a commodity that does not trade on a board or exchange like the CME or the New York Mercantile Exchange, a price correlation must be established with a commodity that has some similar characteristics (Kolb and Overdahl, 2006). The possibility of cross-hedging alfalfa brought me to my first objective of identifying commodities that have similarities or some sort of a relationship to alfalfa. The four commodities that I decided to use were: corn, soybeans, soybean meal, and crude oil. Corn, soybeans, soybean meal are all fed to animals like alfalfa, so there were obvious similarities. I chose to use crude oil because fuel price is correlated to the price of crude oil, and fuel is a large cost of agriculture. I was curious if it could have a correlation to the cost of alfalfa because it affects the cost of growing alfalfa.

Data collection

Before I could determine if alfalfa prices correlate strongly with the four commodities that were going to be analyzed, the price of alfalfa had to be established. I decided to establish that price with the combination of four United States Historical alfalfa price indexes. The four indexes are: the monthly average price received by farmers in the U.S., the monthly average received by farmers in California, the monthly average paid for alfalfa in the U.S., and the monthly average paid for alfalfa in Tulare, California because I live in Tulare, CA.

Monthly average cash price received by farmers in the U.S. (ARUS)

The monthly average ARUS was found on the homepage of the University of Wisconsin Dairy Marketing and Risk Management Program. The webpage is maintained by Professor Brian W. Gould of the Department of Agriculture and Applied Economics. Through the webpage, I found a chart of data that contained monthly average prices received by U.S. farmers for alfalfa hay. The prices were based on a U.S. Dollars per ton basis. The Information was gathered from the USDA National Agricultural Statistics Service and formatted into a table by Professor Gould. I downloaded the data from the beginning of 2007 to the end of 2013 and inserted the data into my own excel table.

Monthly Average Cash Price Received by Farmers in California (ARCA)

The monthly average ARCA was found on the homepage of the University of Wisconsin Dairy Marketing and Risk Management Program. The webpage is maintained by Professor Brian W. Gould of the Department of Agriculture and

Applied Economics. Through the webpage, I found a chart of data that contained monthly average prices received by California farmers for alfalfa hay. The prices were based on a U.S. Dollars per ton basis. The Information was gathered from the USDA National Agricultural Statistics Service and formatted into a table by Professor Gould. I downloaded the data from the beginning of 2007 to the end of 2013 and inserted the data into my own excel table.

Monthly average cash price paid for alfalfa in the U.S. (APUS)

The monthly average paid for APUS was found on the homepage of the University of Wisconsin Dairy Marketing and Risk Management Program. The webpage is maintained by Professor Brian W. Gould of the Department of Agriculture and Applied Economics. Through the webpage, I found a chart of data that contained monthly average paid for alfalfa in the U.S. by consumers of alfalfa. The prices were based on a U.S. Dollars per ton basis. The Information was gathered from the USDA National Agricultural Statistics Service and formatted into a table by Professor Gould. I downloaded the data from the beginning of 2007 to the end of 2013 and inserted the data into my own excel table.

Monthly average paid for delivered supreme alfalfa in Tulare, California (APTC)

I used a data collection service ran by Seth Hoyt called the Hoyt Report, Hay Market Analysis and Insights. Seth Hoyt gathers weekly prices paid for different quality alfalfa in California and sorts them by location. He then compiles a report and sends it to subscribers. The report has been made weekly by Seth Hoyt since March of 2007. I paid for a subscription to the Hoyt Report and gained access to all of the historical reports that were sent to subscribers. I accessed the reports and put all of the prices paid by dairies for delivered supreme alfalfa in Tulare, CA from all of the weekly reports and found a monthly average for each of months. Then, I put all of the monthly data from the beginning of 2007 to the end of 2013 into my own excel table.

Cash price of corn received by farmers in the U.S. (CRUS)

The CRUS was located with the United States Department of Agriculture (USDA) Economic Research Service. The USDA had a downloadable data set of historical prices paid to farmers in the U.S. under the section: Feed Grains: Year Book Tables. The data set contained monthly averages of prices received by farmers in the U.S. in U.S. dollars per bushel. I downloaded the data from the beginning of the year 2007 to the end of 2013 and inserted the data into my own excel table.

Futures contract prices of maize (corn), U.S. No. 2 yellow, FOB Gulf of Mexico, U.S. (CFUS)

The CFUS was found with the help of a data portal called Index Mundi. Index Mundi gathered the contract prices from the USDA Market News. The futures contracts were priced as U.S. dollars per metric ton. The data was set by year and by month. I downloaded the data from the beginning of the year 2007 to the end of 2013 and inserted the data into my own excel table.

Soybean cash price received by farmers in the U.S. (SRUS)

The SRUS was gathered with the help of a data collection website called Farmdoc that is ran by the University of Illinois. I researched the data base for monthly average price received by farmers in the U.S. based on the calendar year for soybeans for the beginning of the year 2007 to the end of 2013. The website gathered the prices from the National Agricultural Statistical Service (NASS) of the USDA. The monthly average prices were given in units of U.S. dollars per bushel. I downloaded the data from the beginning of the year 2007 to the end of 2013 and inserted the data into my own excel table.

Futures contract soybeans, Chicago soybean (first contract forward) No. 2 yellow and par, Chicago, U.S. (SFUS)

The monthly average price of SFUS was collected with the help of a data portal called Index Mundi. Index Mundi gathered the contract prices from the Chicago Mercantile Exchange group. The futures contracts were priced as U.S. dollars per metric ton. The data was set by year and by month. I downloaded the data from the beginning of the year 2007 to the end of 2013 and inserted the data into my own excel table.

Futures contract soybean meal, Chicago soybean meal (first contract forward) minimum 48 percent protein (MFUS)

The price of MFUS was located with the help of a data portal called Index Mundi. Index Mundi gathered the contract prices from the Chicago Mercantile Exchange group. The futures contracts were priced as U.S. dollars per metric ton. The data was set by year and by month. I downloaded the data from the beginning of the year 2007 to the end of 2013 and inserted the data into my own excel table.

Monthly average OK, WTI spot price FOB crude oil (OSUS)

The prices of OSUS were gathered with the help of the U.S. Energy Information Administration. This data base finds the average closing spot prices of the day that is being analyzed. The price was given in U.S. dollars per barrel of oil. The data was set by year and by month. I downloaded the data from the beginning of the year 2007 to the end of 2013 and inserted the data into my own excel table.

Monthly average OK crude oil futures contract 1 (OFUS)

The OFUS prices were gathered with the help of the U.S. Energy Information Administration. This data base collects prices of closing contracts from the trading floor of the New York Mercantile Exchange. The price was given in U.S. dollars per barrel of oil. The data was set by year and by month. I downloaded the data from the beginning of the year 2007 to the end of 2013 and inserted the data into my own excel table.

Statistical analysis

PROC GLM in SAS (SAS, 2014) was used to perform an analysis of variance on the collected data. The dependent variables were: the monthly average paid for alfalfa in Tulare, California by dairies, the monthly average received by farmers in California, the monthly average price received by farmers in the U.S., and the monthly average paid for alfalfa in the U.S. The independent variables were: the cash price of corn received by farmers in the U.S., futures contract prices of maize (corn) U.S. No. 2 Yellow, FOB Gulf of Mexico, U.S. price, soybean cash price received By farmers in the U.S., Chicago soybean futures contract (first contract forward) No. 2 yellow and par, Chicago soybean meal futures (first contract forward) minimum 48 percent protein, monthly average OK, WTI spot price FOB crude oil, and the monthly average OK crude oil futures contract 1.

RESULTS

Figures 5-15 show the nature of each of the variables used in the study over time.

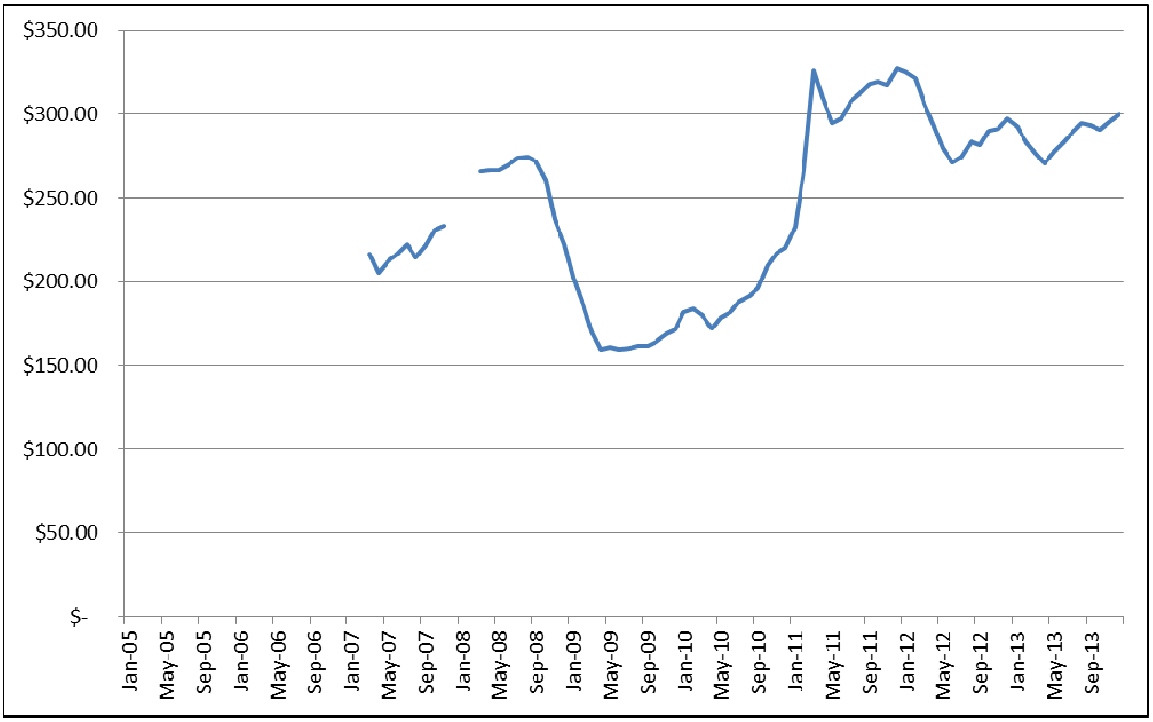

Figure 5. Price paid for delivered supreme alfalfa in Tulare, California, U.S. dollars per ton

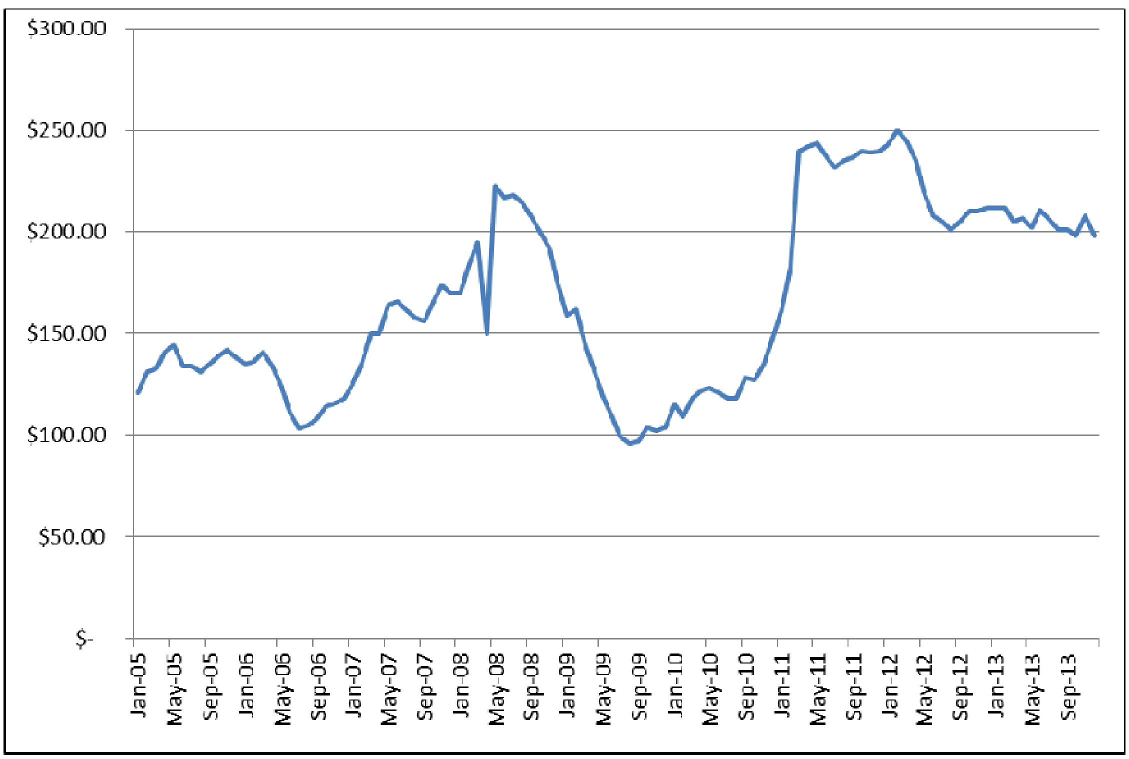

Figure 6. Price received for alfalfa in California, U.S. dollars per ton

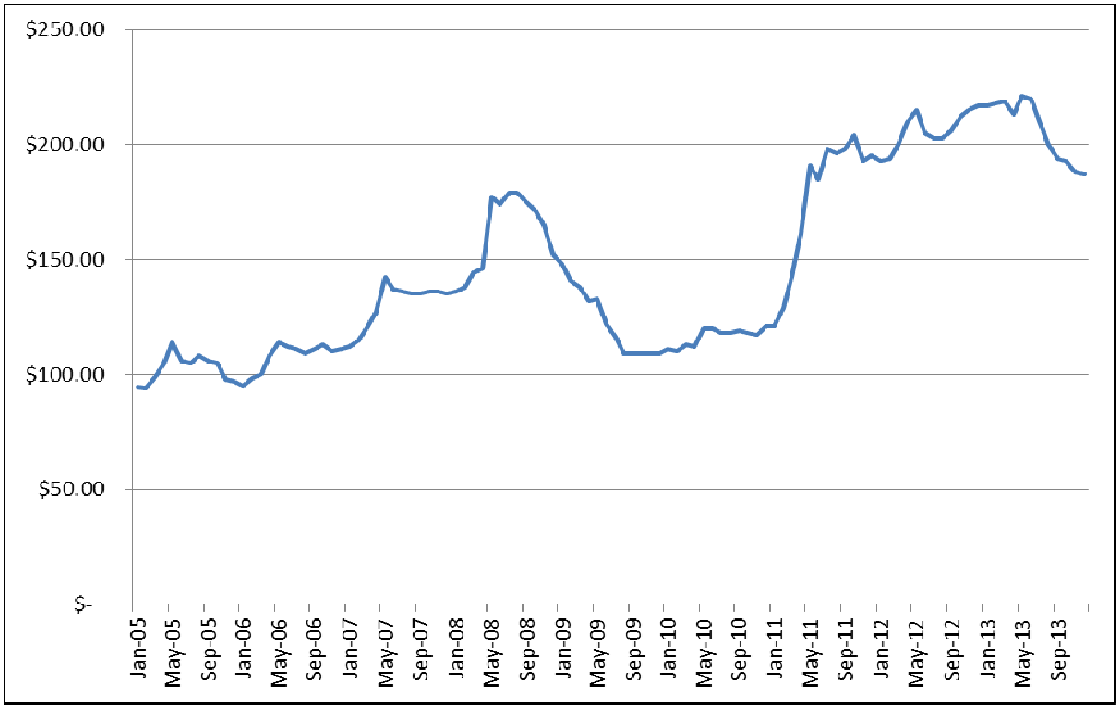

Figure 7. U.S. price received for alfalfa, U.S. dollars per ton

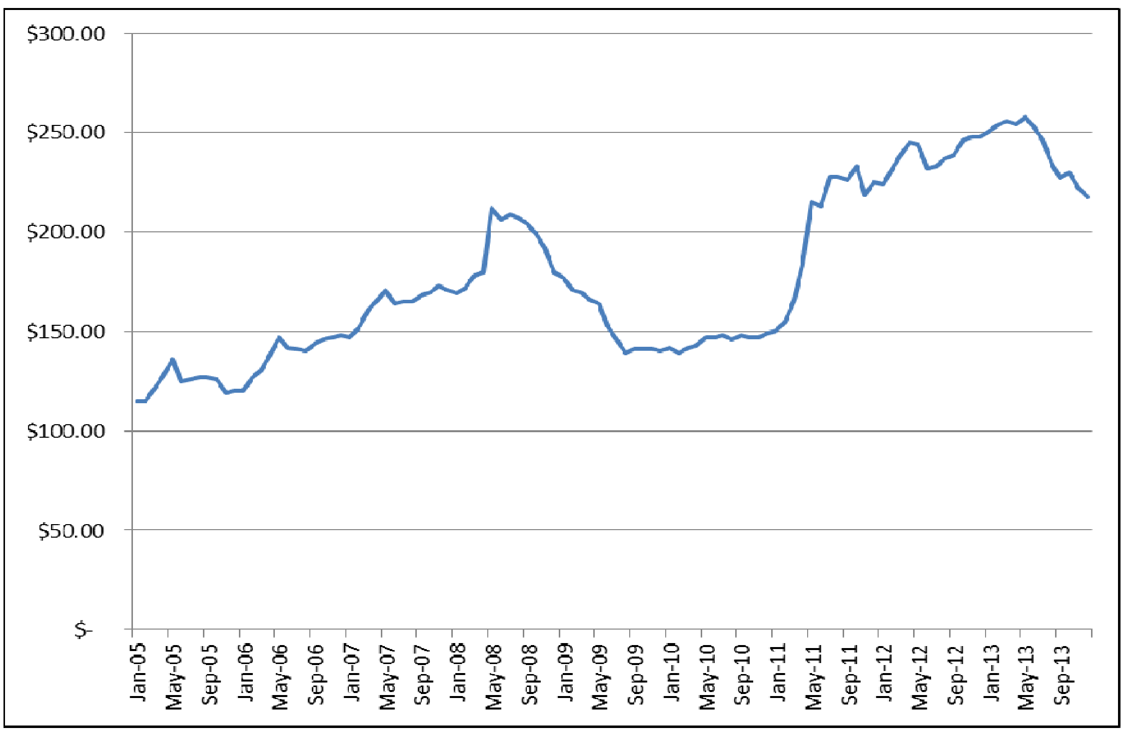

Figure 8. U.S. price paid for alfalfa, U.S. dollars per ton

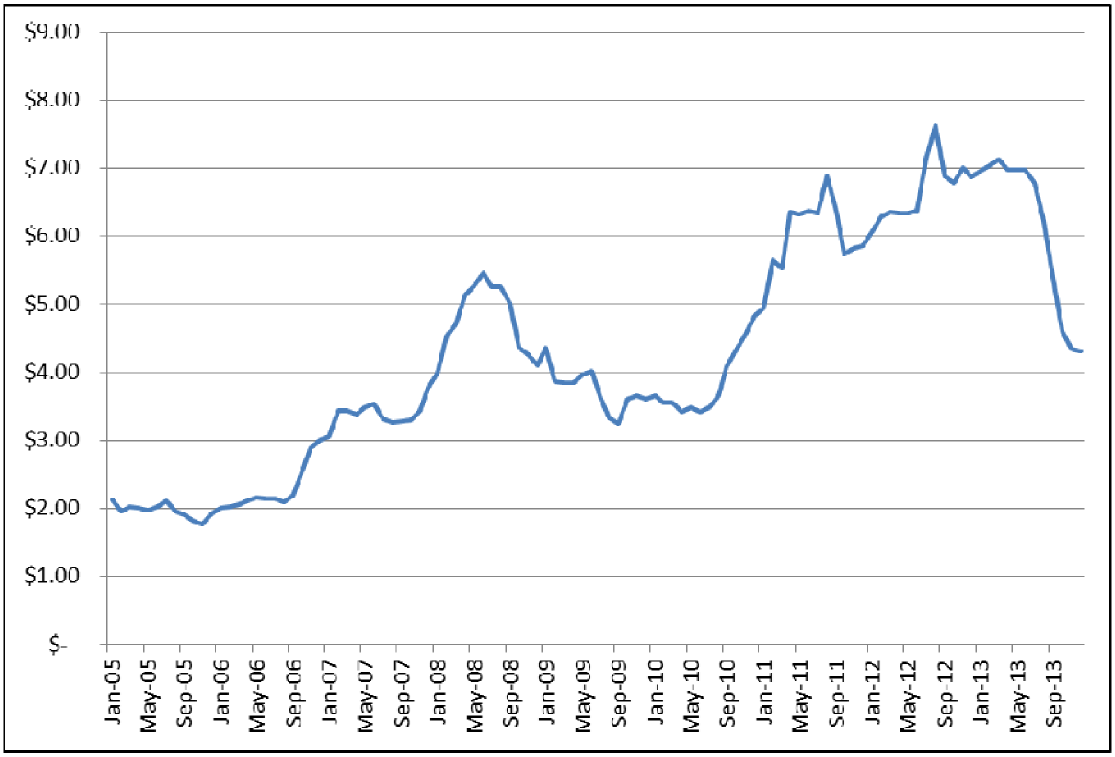

Figure 9. Corn Cash Price Received by farmers in the US, U.S. dollars per ton

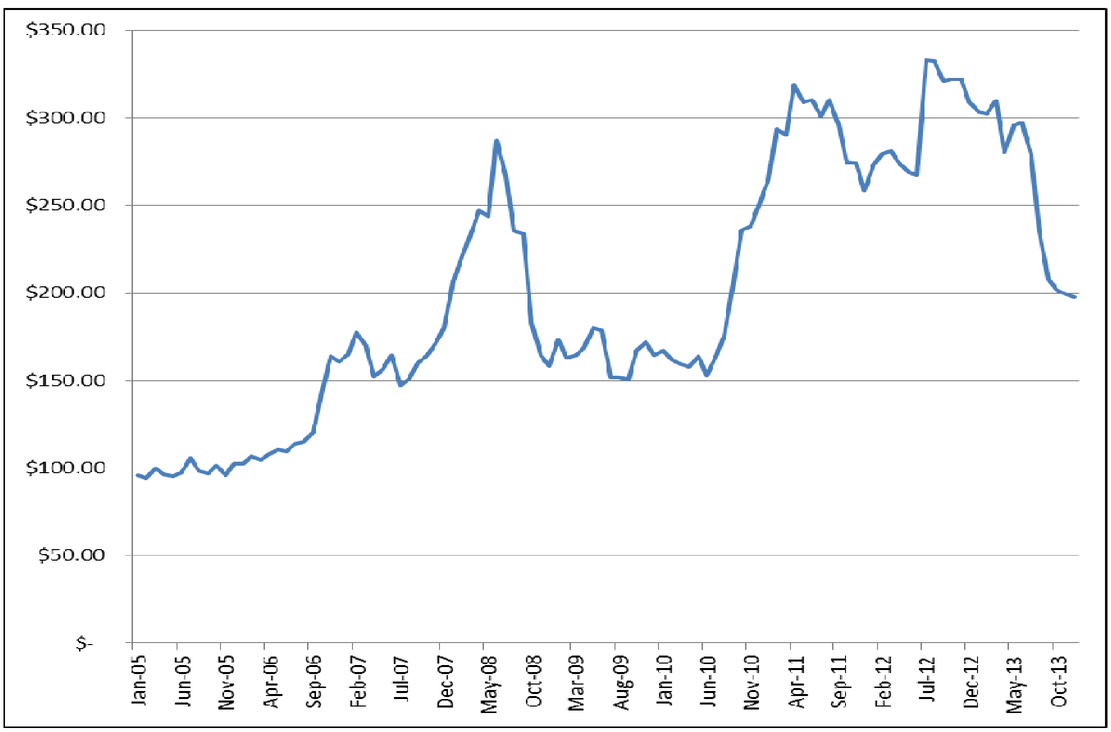

Figure 10. Maize (corn), U.S. No. 2 Yellow, FOB Gulf of Mexico, U.S. price, US$ per metric ton .

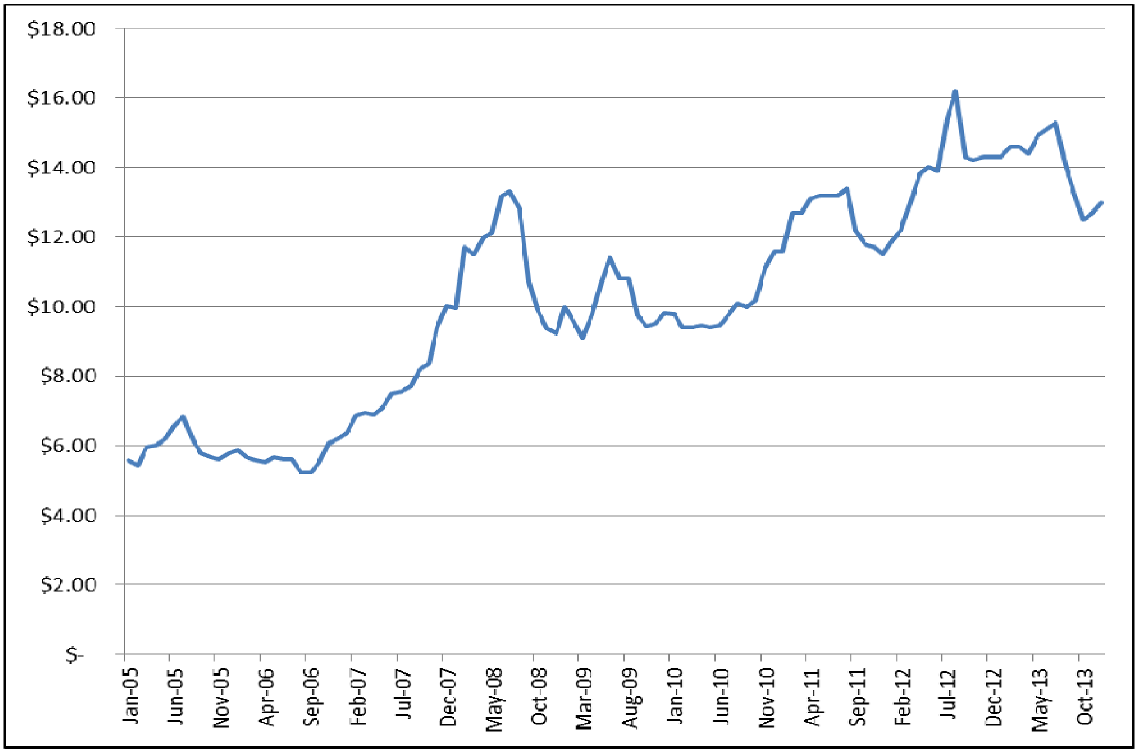

Figure 11. Soybean cash price received by farmers in the U.S., US dollars per bushel

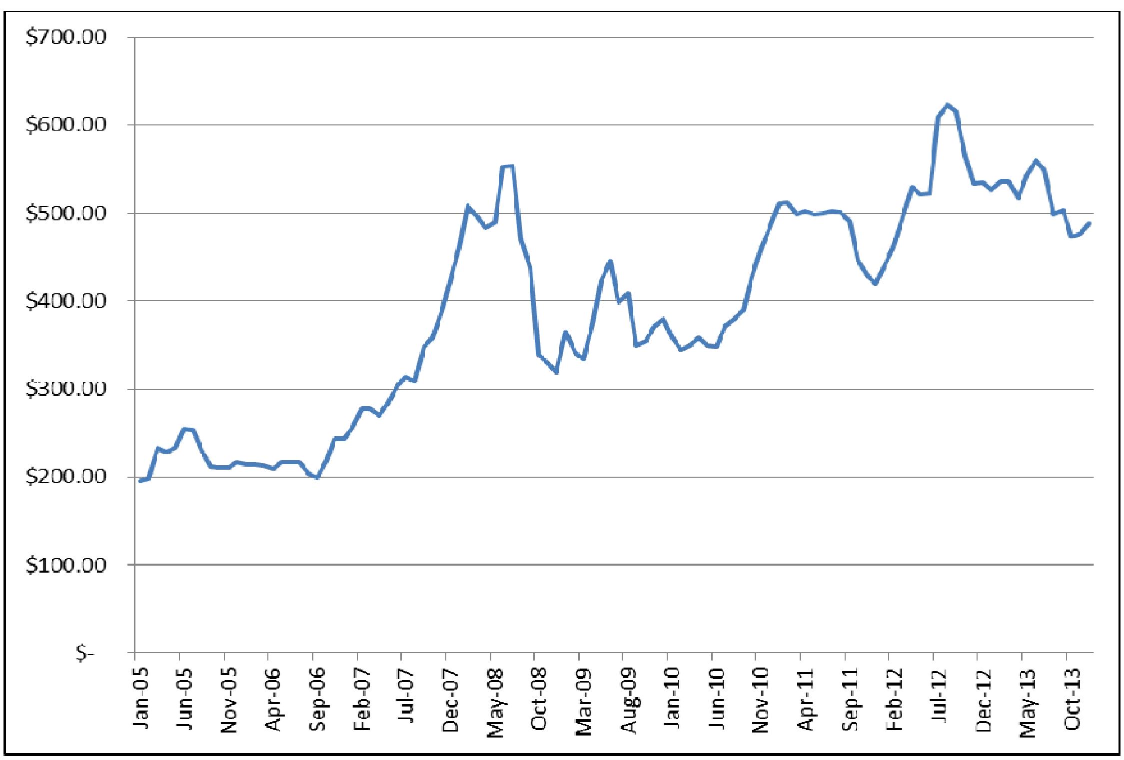

Figure 12. Soybeans, U.S. soybeans, Chicago soybean futures contract (first contract forward) No. 2 yellow and par, US dollars per metric ton

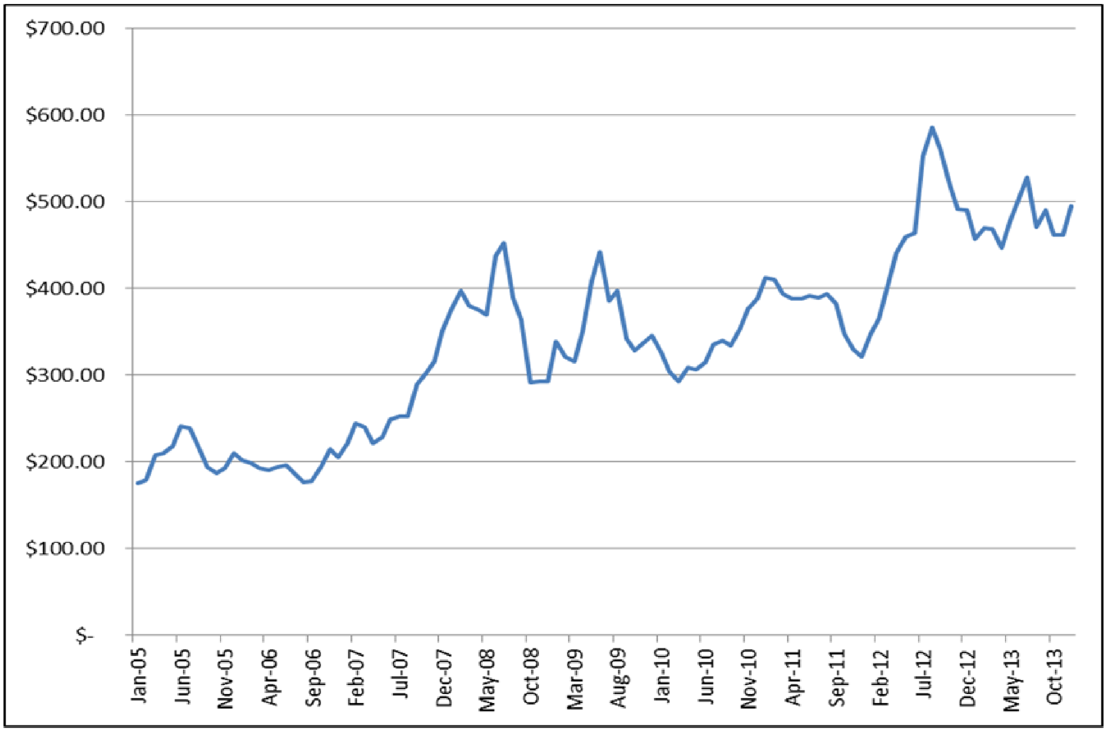

Figure 13. Soybean meal, Chicago soybean futures contract (first contract forward) minimum 49 percent protein, U.S. dollars per ton

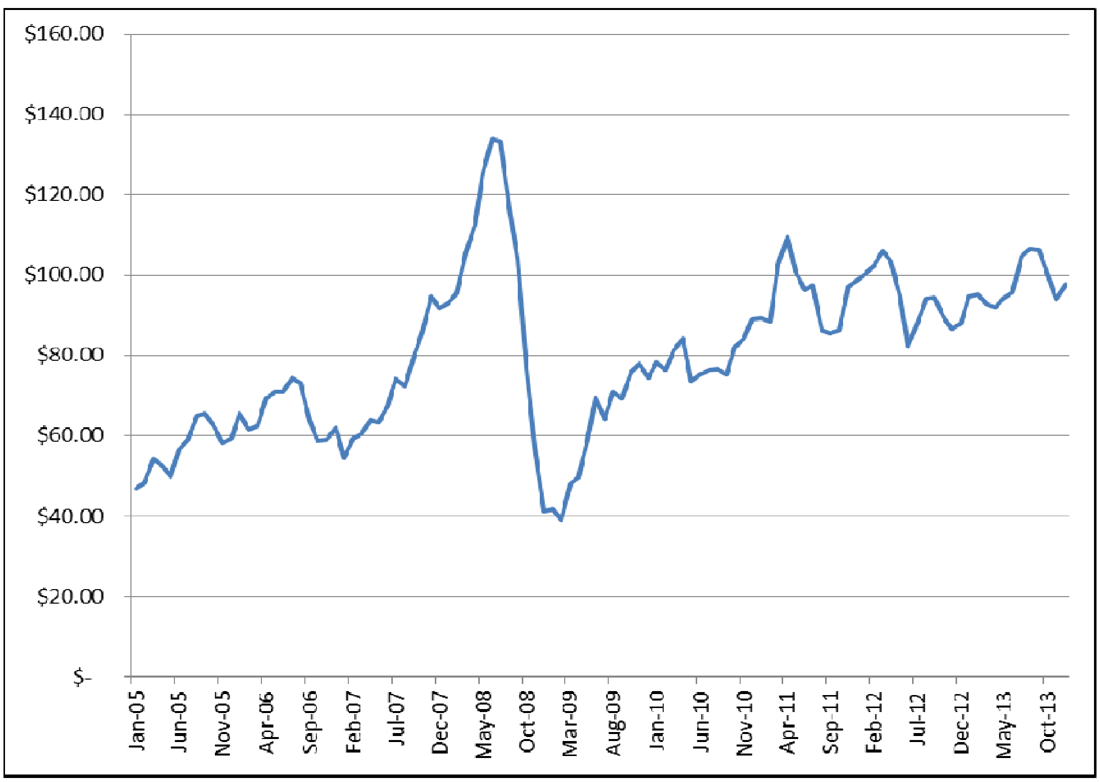

Figure 14. OK, WTI spot price FOB crude oil, U.S. dollars per barrel

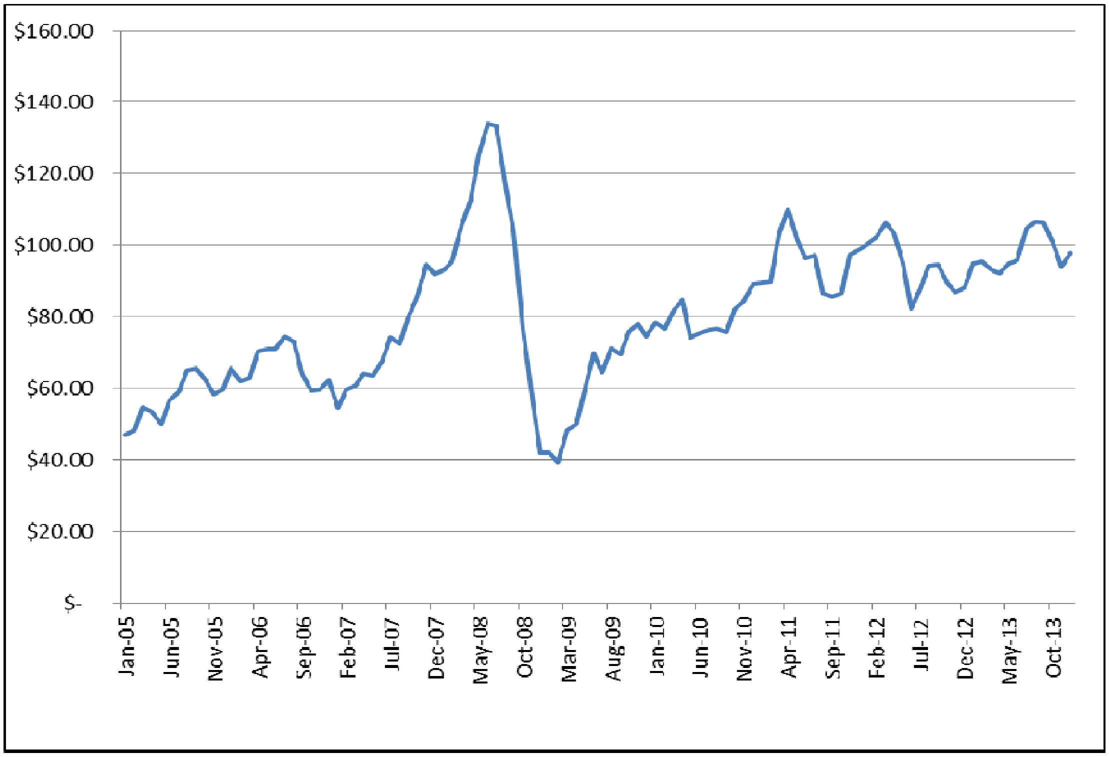

Figure 15. OK, crude oil futures contract 1, U.S. dollars per barrel

Tables 1 and 2 show the characteristics of the data gathered on the variables used in the study. The results of the analysis can be seen in tables 3-6.

Table 1. Data characteristics

Data	Sample Size	Mean	Standard Deviation
APTC	79	247.00	53.18
ARCA	108	166.97	45.80
ARUS	108	147.80	41.09
APUS	108	178.15	43.19
CRUS	108	4.31	1.69
CFUS	108	200.80	73.03
SRUS	108	10.14	3.13
SFUS	108	390.44	121.21
MFUS	108	339.04	104.78
OSUS	108	80.26	20.07
OFUS	108	80.37	20.04

[1]Data: APTC= The Monthly Average Paid for Delivered Supreme Alfalfa in Tulare, California; ARCA= The Monthly Average Cash Price Received by Farmers in California; ARUS= The Monthly Average Cash Price Received by Farmers in the U.S.; APUS= The Monthly Average Cash Price Paid for Alfalfa in the U.S; CRUS= The Cash Price of Corn Received by Farmers in the U.S.; CFUS= Futures Contract Prices of Maize (corn), U.S. No. 2 Yellow, FOB Gulf of Mexico, U.S.; SRUS= Soybean Cash Price Received By Farmers in the U.S.; SFUS= Futures Contract Soybeans, Chicago Soybean (first contract forward) No. 2 yellow and par, Chicago, U.S.; MFUS= Futures Contract Soybean Meal, Chicago Soybean Meal (first contract forward) Minimum 48 percent protein; OSUS= Monthly Average OK, WTI Spot Price FOB Crude OIL; OFUS= Monthly Average OK Crude Oil Futures Contract 1.

Table 2. Correlations between each of the commodity prices

	Data										
Data	APTC	ARCA	ARUS	APUS	CRUS	CFUS	SRUS	SRUS	SFUS	MFUS	OSUS
APTC	1.000	0.955	0.851	0.835	0.813	0.807	0.699	0.685	0.505	0.687	0.688
ARCA		1.000	0.877	0.854	0.811	0.799	0.725	0.710	0.606	0.682	0.683
ARUS			1.000	0.995	0.916	0.851	0.860	0.814	0.791	0.652	0.652
APUS				1.000	0.916	0.851	0.858	0.817	0.796	0.657	0.658
CRUS					1.000	0.974	0.951	0.930	0.878	0.694	0.695
CFUS						1.000	0.919	0.927	0.844	0.734	0.736
SRUS							1.000	0.981	0.967	0.736	0.738
SFUS								1.000	0.965	0.775	0.776
MFUS									1.000	0.670	0.671
OSUS										1.000	1.000
OFUS											1.000

[1]Data: APTC= The Monthly Average Paid for Delivered Supreme Alfalfa in Tulare, California; ARCA= The Monthly Average Cash Price Received by Farmers in California; ARUS= The Monthly Average Cash Price Received by Farmers in the U.S.; APUS= The Monthly Average Cash Price Paid for Alfalfa in the U.S; CRUS= The Cash Price of Corn Received by Farmers in the U.S.; CFUS= Futures Contract Prices of Maize (corn), U.S. No. 2 Yellow, FOB Gulf of Mexico, U.S.; SRUS= Soybean Cash Price Received By Farmers in the U.S.; SFUS= Futures Contract Soybeans, Chicago Soybean (first contract forward) No. 2 yellow and par, Chicago, U.S.; MFUS= Futures Contract Soybean Meal, Chicago Soybean Meal (first contract forward) Minimum 48 percent protein; OSUS= Monthly Average OK, WTI Spot Price FOB Crude OIL; OFUS= Monthly Average OK Crude Oil Futures Contract 1.

Table 3. Dependent Variable: The Monthly Average Paid for Delivered Supreme Alfalfa in Tulare, California

R- Square= 0.826905

Source	Mean Square	F Value	Pr > F
Year	2739.149096	4.95	0.0293
Month	5189.24206	9.38	0.0031
CRUS	8625.997727	15.59	0.0002
CFUS	135.463528	0.24	0.6223
SRUS	1379.228814	2.49	0.1189
SFUS	10.416998	0.02	0.8913
MFUS	340.108888	0.61	0.4357
OSUS	140.071973	0.25	0.6164
OFUS	190.35578	0.34	0.5594

[1]Data: CRUS= The Cash Price of Corn Received by Farmers in the U.S.; CFUS= Futures Contract Prices of Maize (corn), U.S. No. 2 Yellow, FOB Gulf of Mexico, U.S.; SRUS= Soybean Cash Price Received By Farmers in the U.S.; SFUS= Futures Contract Soybeans, Chicago Soybean (first contract forward) No. 2 yellow and par, Chicago, U.S.; MFUS= Futures Contract Soybean Meal, Chicago Soybean Meal (first contract forward) Minimum 48 percent protein; OSUS= Monthly Average OK, WTI Spot Price FOB Crude OIL; OFUS= Monthly Average OK Crude Oil Futures Contract 1.

Table 4. Dependent Variable: The Monthly Average Cash Price Received by Farmers in California

R- Square= 0.768156

Source	Mean Square	F Value	Pr > F
Year	1923.948689	3.62	0.0599
Month	155.93766	0.29	0.5891
CRUS	9225.515167	17.37	<.0001
CFUS	1213.240659	2.28	0.1339
SRUS	22.943224	0.04	0.8358
SFUS	40.817782	0.08	0.7822
MFUS	2049.957688	3.86	0.0523
OSUS	155.470926	0.29	0.5897
OFUS	188.079646	0.35	0.5531

[1]Data: CRUS= The Cash Price of Corn Received by Farmers in the U.S.; CFUS= Futures Contract Prices of Maize (corn), U.S. No. 2 Yellow, FOB Gulf of Mexico, U.S.; SRUS= Soybean Cash Price Received By Farmers in the U.S.; SFUS= Futures Contract Soybeans, Chicago Soybean (first contract forward) No. 2 yellow and par, Chicago, U.S.; MFUS= Futures Contract Soybean Meal, Chicago Soybean Meal (first contract forward) Minimum 48 percent protein; OSUS= Monthly Average OK, WTI Spot Price FOB Crude OIL; OFUS= Monthly Average OK Crude Oil Futures Contract 1.

Table 5. Dependent Variable: The Monthly Average Cash Price Paid for Alfalfa in the U.S

R- Square= 0.918725

Source	Mean Square	F Value	Pr > F
Year	1923.948689	3.62	0.0599
Month	155.93766	0.29	0.5891
CRUS	9225.515167	17.37	<.0001
CFUS	1213.240659	2.28	0.1339
SRUS	22.943224	0.04	0.8358
SFUS	40817782	0.08	0.7822
MFUS	2049.957688	3.86	0.0523
OSUS	155.470926	0.29	0.5897
OFUS	188.079646	0.35	0.5531

[1]Data: CRUS= The Cash Price of Corn Received by Farmers in the U.S.; CFUS= Futures Contract Prices of Maize (corn), U.S. No. 2 Yellow, FOB Gulf of Mexico, U.S.; SRUS= Soybean Cash Price Received By Farmers in the U.S.; SFUS= Futures Contract Soybeans, Chicago Soybean (first contract forward) No. 2 yellow and par, Chicago, U.S.; MFUS= Futures Contract Soybean Meal, Chicago Soybean Meal (first contract forward) Minimum 48 percent protein; OSUS= Monthly Average OK, WTI Spot Price FOB Crude OIL; OFUS= Monthly Average OK Crude Oil Futures Contract 1.

Table 6. Dependent Variable: The Monthly Average Cash Price Received by Farmers in the U.S.

R- Square= 0.912049

Source	Mean Square	F Value	Pr > F
Year	165.05033	1.02	0.3154
Month	834.80709	5.15	0.0254
CRUS	13231.15934	81.62	<.0001
CFUS	2512.75322	15.5	0.0002
SRUS	293.42436	1.81	0.1816
SFUS	857.28123	5.29	0.0236
MFUS	1179.94139	7.28	0.0082
OSUS	158.06162	0.98	0.3259
OFUS	132.13345	0.82	0.3688

[1]Data: CRUS= The Cash Price of Corn Received by Farmers in the U.S.; CFUS= Futures Contract Prices of Maize (corn), U.S. No. 2 Yellow, FOB Gulf of Mexico, U.S.; SRUS= Soybean Cash Price Received By Farmers in the U.S.; SFUS= Futures Contract Soybeans, Chicago Soybean (first contract forward) No. 2 yellow and par, Chicago, U.S.; MFUS= Futures Contract Soybean Meal, Chicago Soybean Meal (first contract forward) Minimum 48 percent protein; OSUS= Monthly Average OK, WTI Spot Price FOB Crude OIL; OFUS= Monthly Average OK Crude Oil Futures Contract 1.

Monthly average paid for delivered supreme alfalfa in Tulare, California

The dependent variable, monthly average paid for delivered supreme alfalfa in Tulare, California, had a strong relationship with three of the independent variables or sources. The sources that had a significant relationship to the dependent variable were: Year (Pr> F= 0.0293), Month (Pr> F= 0.0031), and CRUS (Pr> F= 0.0002).

Monthly average cash price received by farmers in California

The dependent variable, monthly average cash price received by farmers in California, had a strong relationship with two of the independent variables or sources. The sources that had a significant relationship to the dependent variable were: Year (Pr > F= 0.0599) and CRUS (Pr> F= <0.0001).

Monthly average cash price received by farmers in the U.S.

The dependent variable, monthly average cash price received by farmers in the U.S., had a strong relationship with five of the independent variables or sources. The sources that had a significant relationship to the dependent variable were: Month (Pr > F= 0.0254), CRUS (Pr > F= <0.0001), CFUS (Pr > F= 0.0002), SFUS (Pr > F= 0.0236), MFUS (Pr > F= 0.0082).

Monthly average cash price paid for alfalfa in the U.S

The dependent variable, monthly average cash price paid for alfalfa in the U.S., had a strong relationship with six of the independent variables or sources. The sources that had a significant relationship to the dependent variable were: Month (Pr > F= 0.0343), CRUS (Pr > F= <0.0001), CFUS (Pr > F= <0.0001), SRUS (Pr > F= 0.0045), SFUS (Pr > F=0.0786), MFUS (Pr > F=0.0009).

DISCUSSION

Tulare, California and the California hay markets as a whole seem to have less of a relationship to the grain market than the U.S. hay market does. My theory behind the reason for this finding is that California has some variables that might affect the hay market that the rest of the U.S. does not have. The three things that I think might be the variables are: high demand for California grown alfalfa from China, concentrated competition between buyers in California, and the current drought in the Western U.S.

The dairy industry in China has been on the rise and so has their demand for quality California grown alfalfa. A simple supply and demand graph might describe why the price of alfalfa in California is not similar to the rest of the U.S. It might be that California farmers are not supplying enough alfalfa for the dairymen of California and China.

Tulare, California is located in Tulare County. Tulare County just happens to be the largest dairy county in the U.S. All of these dairies are highly concentrated and demand quality, California grown, alfalfa to feed their livestock. This might be a reason for the existence of a special alfalfa market in Tulare, California.

The large demand for alfalfa in California from China and the California dairymen could be enough to create a special market. Lately the situation has been worsened with the drought. The supply of alfalfa is probably being decreased with the lack and rising cost of water for farmers growing alfalfa in the Western U.S.

CONCLUSION

Performing a cross-hedge for cash purchased supreme alfalfa in Tulare, California with a single board traded commodity is something that might be too risky because California is not like the U.S. hay market.

The dairy industry in China has been on the rise and so has their demand for quality California grown alfalfa. A simple supply and demand graph might describe why the price of alfalfa in California is not similar to the rest of the U.S. It might be that California farmers are not supplying enough alfalfa for the dairymen of California and China.

Tulare, California is located in Tulare County. Tulare County just happens to be the largest dairy county in the U.S. All of these dairies are highly concentrated and demand quality, California grown, alfalfa to feed their livestock. This might be a reason for the existence of a special alfalfa market in Tulare, California.

The large demand for alfalfa in California from China and the California dairymen could be enough to create a special market. Lately the situation has been worsened with the drought. The supply of alfalfa is probably being decreased with the lack and rising cost of water for farmers growing alfalfa in the Western U.S. These are the reason why a cross-hedge might not be possible. Further studies will need to be done to prove these theories.

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