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Predicting Fertilizer Prices

Introduction

Although fertilizer prices the last three years have been less expensive than they were for the period from 2012 through 2015, fertilizer is still a significant expense for most grain farms. Fertilizer currently accounts for 15% to 20% of total crop production expenses as shown in Figure 1. Fertilizer expense as a percentage of crop expenses varies across the state and is lowest in western Kansas. The 15% of production expenses for fertilizer is within historical percentages.

Figure 2 shows the average dollar expense for fertilizer per acre for east, central, and western Kansas. Both Figure 1 and Figure 2 are based on data from the Kansas Farm Management Association data. The values shown in Figure 2 have been adjusted for inflation by the CPI index to allow a more meaningful comparison of past costs to today. As shown in this figure, fertilizer cost per acre has varied greatly across time. Fertilizer costs ranged from $20 to $30 for much of the late eighties, nineties, and early two thousands. However fertilizer costs per acre started rising around 2005 and peaked in 2012 when in eastern Kansas the fertilizer cost per acre was near $80 per acre.

The higher dollar per acre fertilizer cost can be attributed to three factors. The first is higher fertilizer prices. As will be shown later, the fertilizer price is closed tied to the price of oil and this period saw higher oil prices. The second is a shift in the crop mix to more corn. Corn requires a high level of nitrogen fertilizer which means this crop is more expensive to grow. Third, the higher grain prices leading up to 2012 meant that it was profitable for farmers to fertilize at higher rates. Since 2012, fertilizer costs per acre have declined for the same reasons they increased. Even with this recent decline, fertilizer costs per acre are nearly double what they were in the nineties (in real dollars).

With profitability for grain farms limited by low grain prices, producers need to mange their expenses very closely if they want to be profitable. Fertilizer is a good candidate for analysis given that fertilizer is a major expense item for every crop farm. If farmers could predict fertilizer prices 6 months or more in advance, they could purchase their fertilizer at the low price points of the year and also adjust their crop mix to account for years where fertilizer was either higher or lower than normal. Also, the ability to predict fertilizer prices would help farmers with their planning as they work with lenders to obtain operating loans.

The purpose of this paper is to show a method that predicts fertilizer prices so that farmers can make crop mix decisions and timing of fertilizer purchases in order to improve profitability. The model developed here uses a combination of the oil price and the corn futures price. The oil price helps represent the supply side for fertilizer while the corn futures price represents the demand side of fertilizer.

Data and Model

Predicting nitrogen fertilizer prices is possible since the price of anhydrous ammonia is positively correlated with both the price of oil and corn. Nitrogen is one of the most important fertilizers in the production of corn, grain sorghum, and wheat so predicting anhydrous ammonia prices will cover a majority of the fertilizer expenses on a farm. Other nitrogen fertilizers start with ammonia so forecasting anhydrous ammonia provides an indication of prices for the other nitrogen products. In addition, anhydrous ammonia is positively correlated with other fertilizers besides nitrogen so correctly predicting anhydrous ammonia will give some indication of the price direction of other fertilizers.

Anhydrous ammonia is positively correlated with the corn price and the oil price because these two products represent something about the demand and supply of anhydrous ammonia fertilizer. Economic theory tells us that higher prices for an output will cause producers to produce more by using more of the production inputs. Thus higher corn prices lead to more nitrogen fertilizer per corn acre (i.e., increased demand for nitrogen fertilizer). Also, a higher corn price will shift more acres to corn (which uses nitrogen) and fewer acres to soybeans (which doesn't need nitrogen fertilizer). Figure 3 shows the relationship between the national anhydrous ammonia price and the national corn price since 2010 on a monthly basis. This monthly correlation is 0.79. National anhydrous ammonia prices come from the fertilizer reports published by Progressive Farmer (https://www.dtnpf.com/agriculture/web/ag/home). National monthly future corn prices are from (https://www.investing.com/commodities/us-corn-historical-data).

The supply side of anhydrous ammonia is represented by the oil price. Ammonia is produced as a result of a catalytic reaction from burning natural gas (the hydrogen) and the nitrogen in the air. Thus, the expectation is that lower natural gas prices should lead to more production of ammonia. However, the correlation between monthly natural gas prices and monthly anhydrous ammonia prices is low (0.14). This may be because natural gas prices are more volatile than other oil products. Figure 4 shows the historical monthly prices of anhydrous ammonia and natural gas. Even when allowing for a lag in the natural gas price, the correlation between natural gas prices and anhydrous prices is remains low.

With monthly prices, the use of oil as opposed to natural gas provided a stronger correlation to anhydrous ammonia. Oil and natural gas can be substitutes for each other in certain situations and have a 0.58 correlation. The correlation between oil prices and anhydrous ammonia prices is 0.63. However, a visual inspection of oil and anhydrous ammonia historical prices indicates that anhydrous ammonia prices tend to lag oil prices. This is not surprising as ammonia producers need some time to adjust production to account for changes in their input prices. Testing of various oil price lags revealed that a 9 month lag in oil prices provided the best fit to anhydrous ammonia prices. With this lag, the correlation between oil prices and anhydrous ammonia increased to 0.82. Figure 5 shows the historical monthly prices of anhydrous ammonia, oil, and the oil price lagged by 9 months.

Model to predict anhydrous ammonia prices

With the corn price representing the demand for anhydrous ammonia and the oil price representing the supply for anhydrous ammonia, a formal regression model was developed using ordinary least squares. This model resulted in the following equation:

*Anhydrous ammonia ($/ton) = 202 + 43.4 * corn ($/bu) + 3.18 * oil_9 mo lag ($/ barrel)*

This regression result has an adjusted R-squared of 0.85. An R-squared this high is usually considered a strong fit. Figure 6 shows the actual anhydrous ammonia price vs the predicted anhydrous ammonia price.

Predictions for 2019

During 2018, producers saw fertilizer prices start to rise. Fertilizer prices ended the year higher than they were in 2016 and 2017 but less than they were in 2013, 2014 and 2015 (See Figures 7, 8, 9, and 10 for historical prices of anhydrous ammonia, urea, MAP and potash). Given that nitrogen fertilizer prices are dependent upon corn prices and oil prices this result is unsurprising as oil prices rose considerably during the last half of 2018.

Going forward into 2019, producers are likely to see some decreases in fertilizers prices later on during the year as oil prices have declined some from their fall/winter peaks of 2018. The model to predict anhydrous ammonia prices is based on a 9-month lag in oil prices. Current oil prices are at $57 per barrel and corn future prices for the fall are around $4 per bushel. Keep in mind the corn price is a forecast too as the model does not lag corn prices. Thus based on the above model, anhydrous prices for November are predicted to be $557. However, there are some higher oil prices from 2018 that have yet to show up in the model forecast. Oil prices were in the $70 range from May through October of last year. Thus, fertilizer prices may not start to decline for a few months yet and may actually increase a little.

Other fertilizers are likely to decrease during the course of 2019 as well as there is a strong positive correlation between anhydrous ammonia prices and the other fertilizer types (see Table 1).

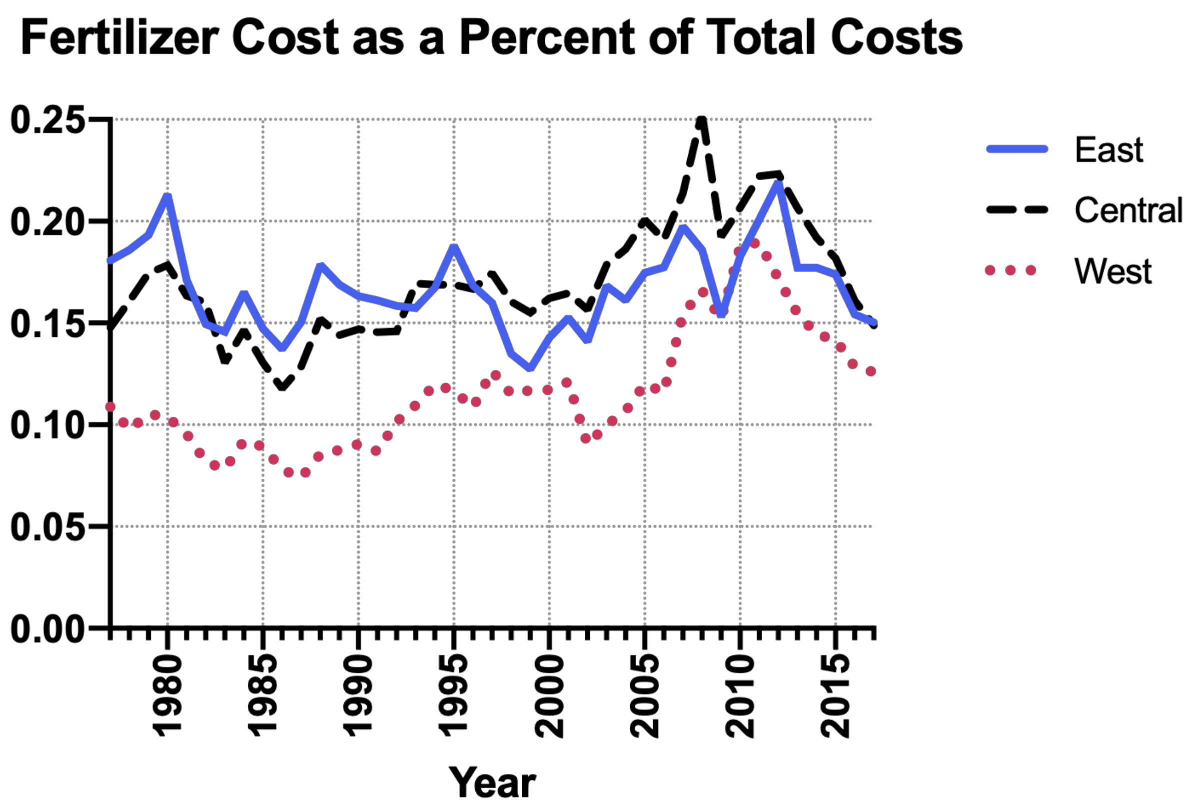

Figure 1. Fertilizer Cost Percentage by Region of Kansas (from KFMA data)

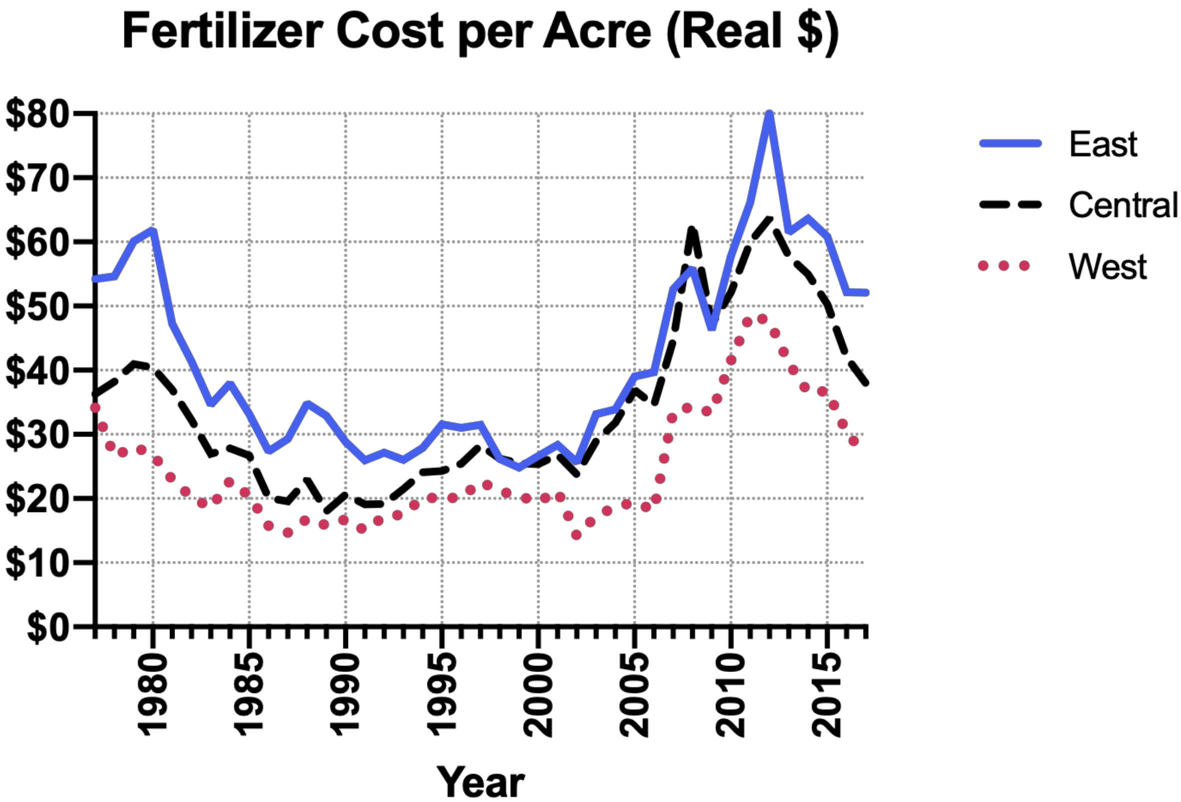

Figure 2. Fertilizer Cost in Real Dollars per Acre by Region of Kansas (from KFMA data)

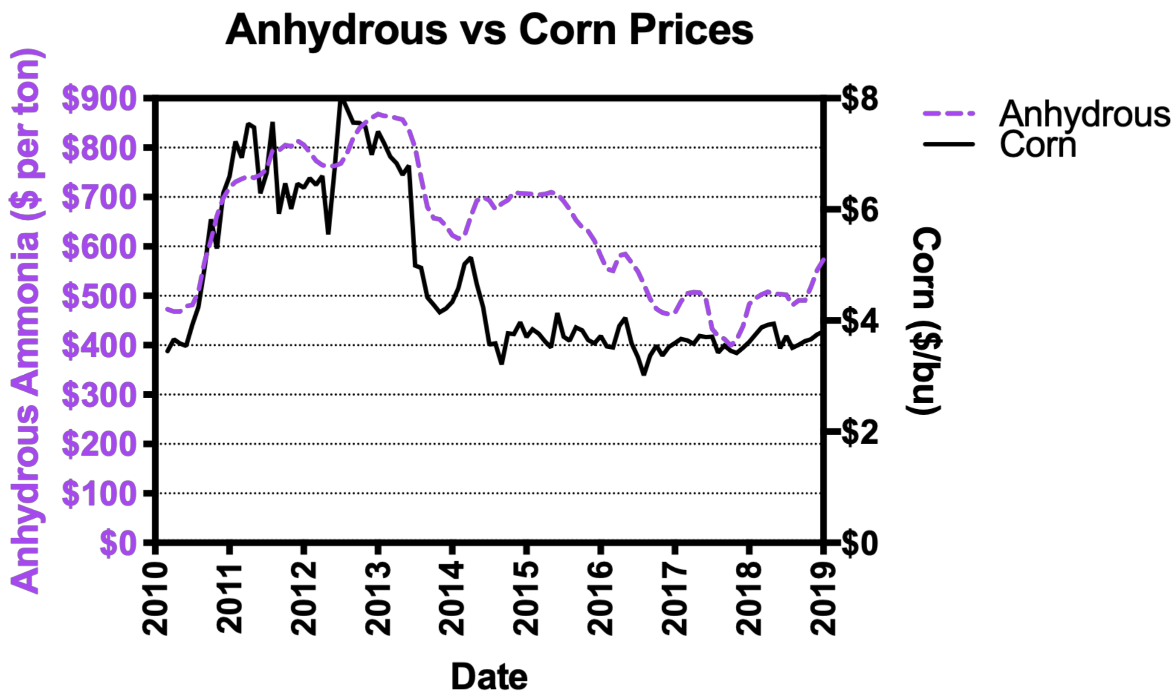

Figure 3. Monthly Anhydrous Ammonia Prices vs Monthly National Corn Prices

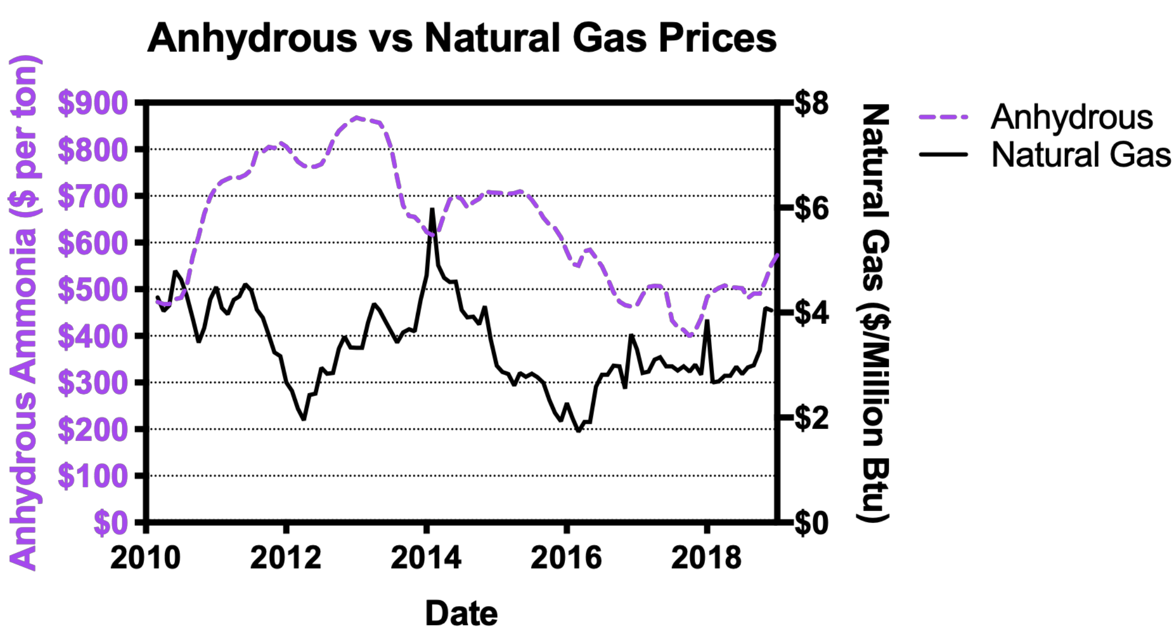

Figure 4. Monthly Anhydrous Ammonia Prices vs Monthly Natural Gas Prices

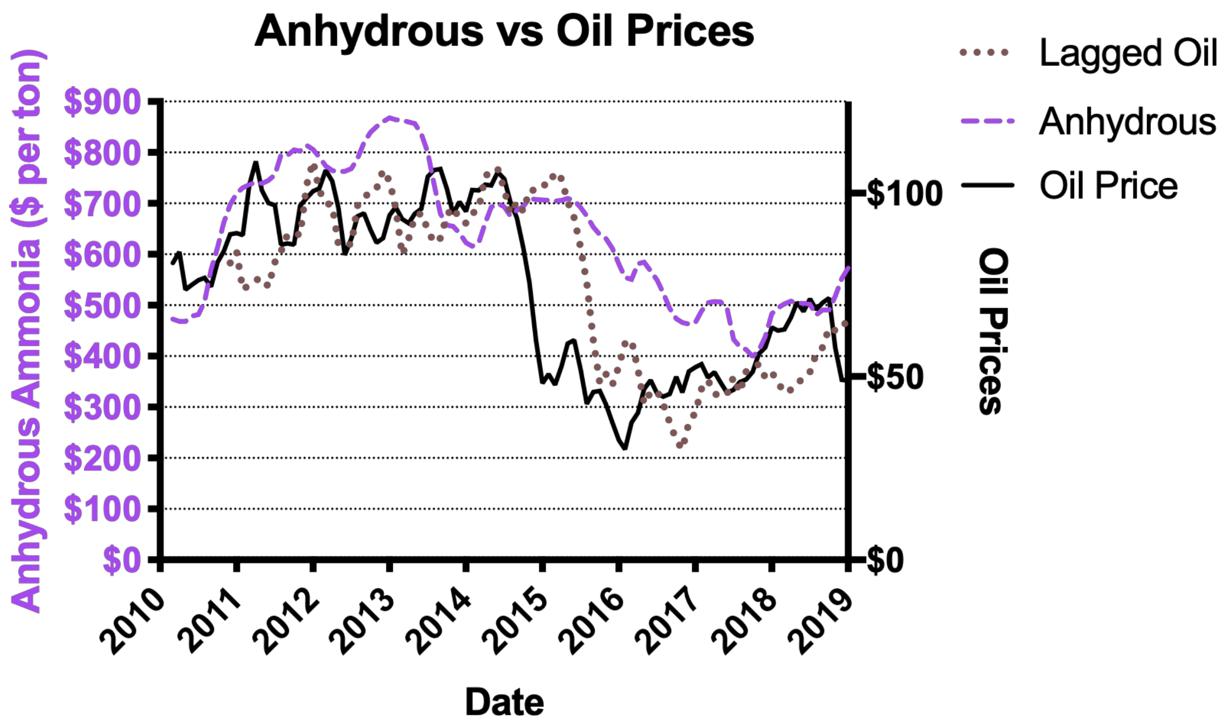

Figure 5. Monthly Anhydrous Ammonia Prices vs Monthly Oil Prices and Lagged Oil Prices

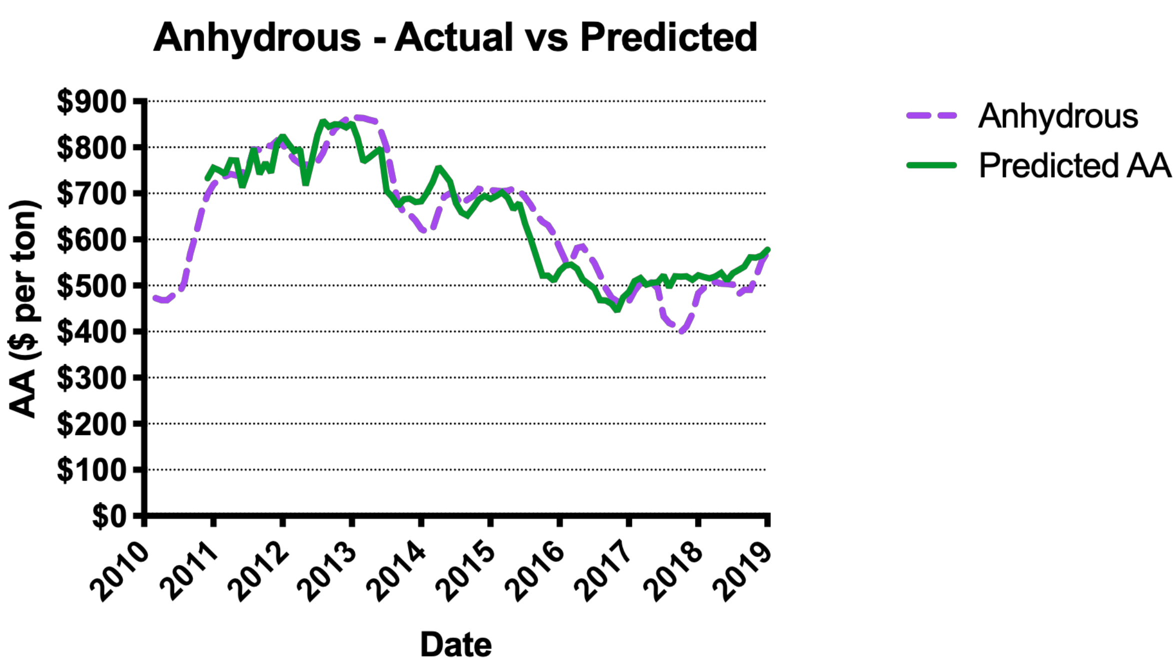

Figure 6. Actual vs Predicted Anhydrous Ammonia Prices

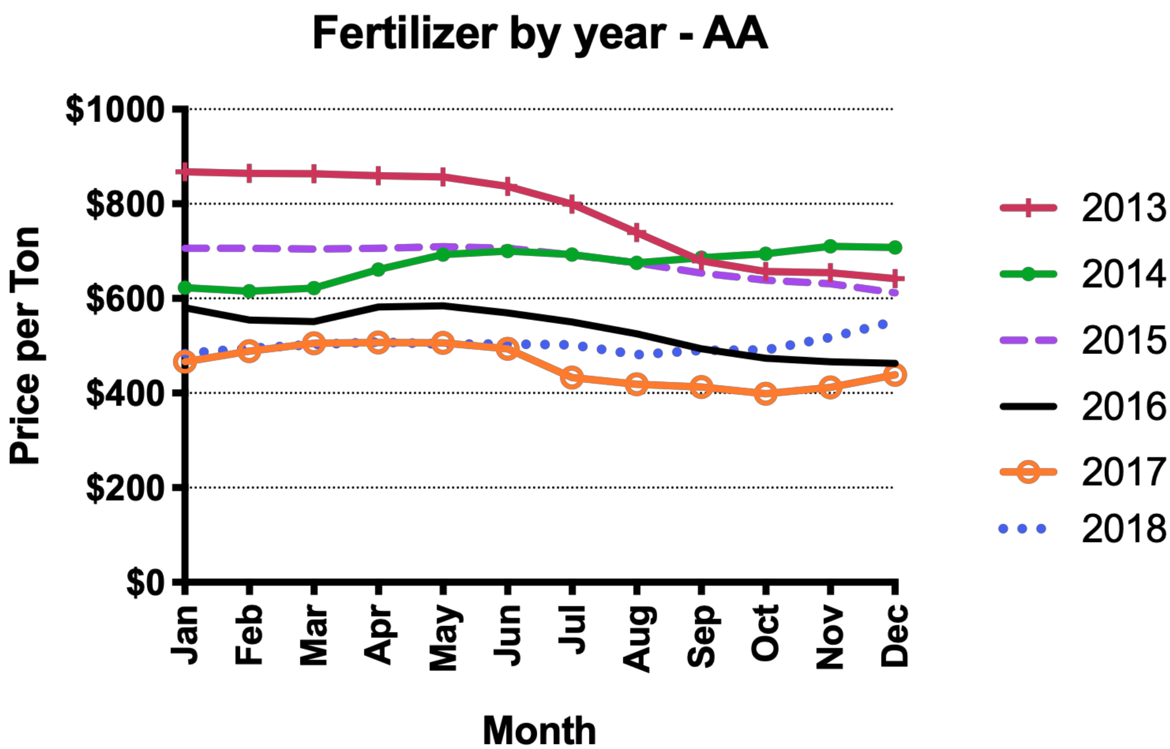

Figure 7. Historical Monthly Anhydrous Ammonia Prices by Year

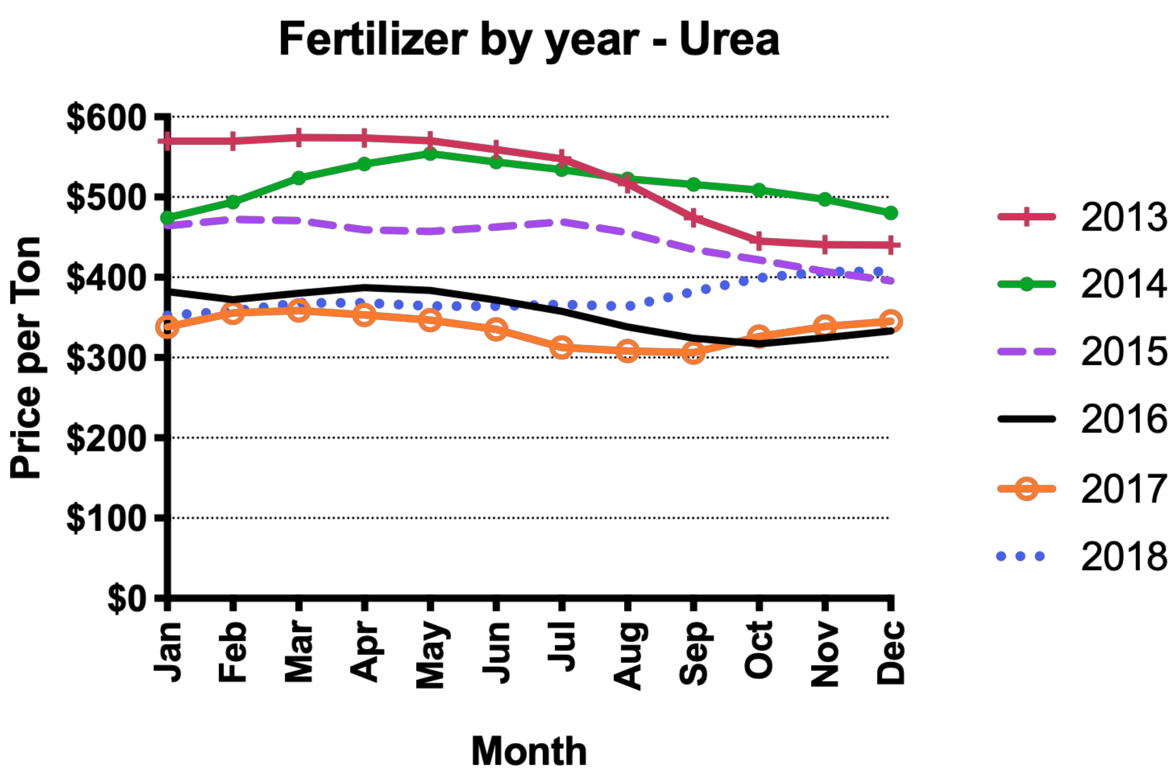

Figure 8. Historical Monthly Urea Prices by Year

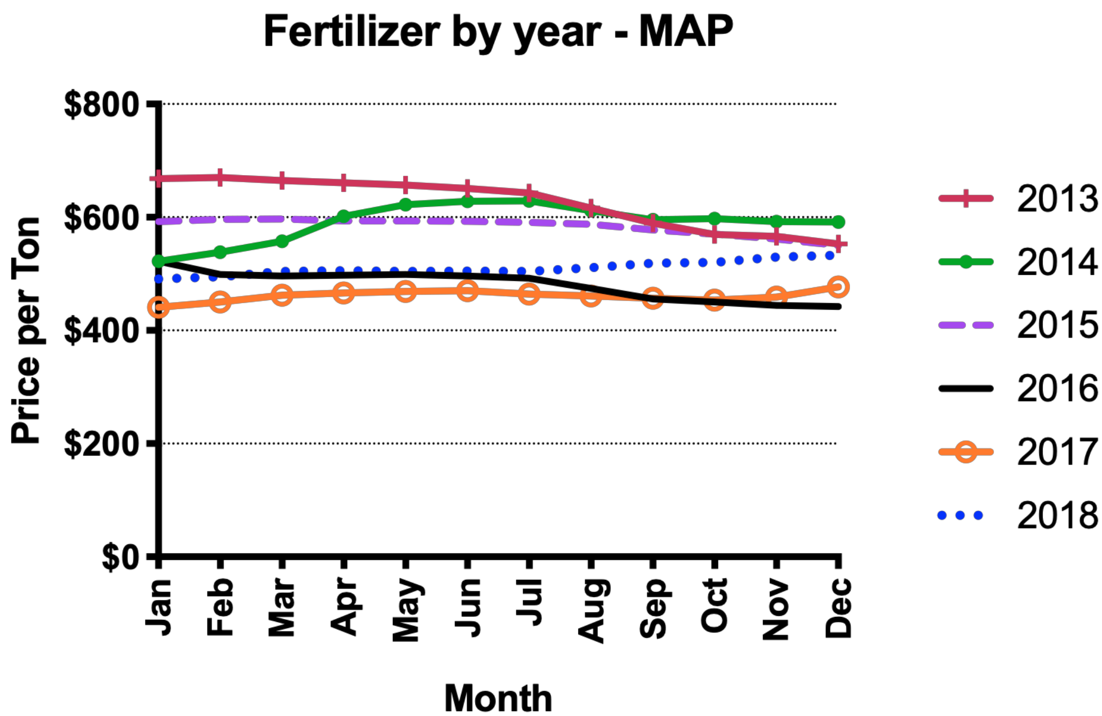

Figure 9. Historical Monthly MAP Prices by Year

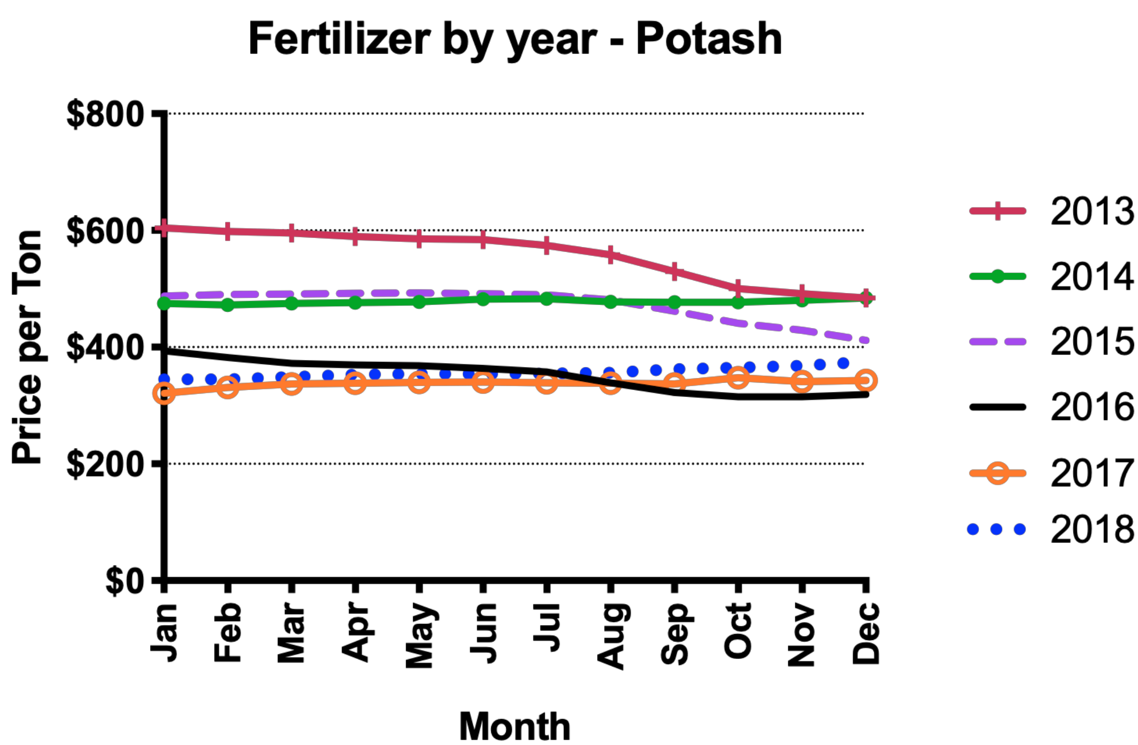

Figure 10. Historical Monthly Potash Prices by Year

Table 1. Correlation of Monthly Fertilizer Prices Since 2010

	Anhydrous	*MAP*	*Urea*	*DAP*	*Potash*	*UAN28*	*UAN32*	*10-34-0*
Anhydrous	1							
MAP	0.92	1						
Urea	0.89	0.88	1					
DAP	0.89	0.99	0.85	1				
Potash	0.89	0.94	0.91	0.92	1			
UAN28	0.96	0.95	0.95	0.92	0.95	1		
UAN32	0.95	0.94	0.95	0.90	0.93	0.99	1	
10-34-0	0.82	0.86	0.79	0.82	0.81	0.85	0.87	1

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