What's Up With Fertilizer Prices

Gregg Ibendahl

Introduction

Fertilizer prices literally exploded this past fall. Not only is the price difficult to estimate month-to-month but there are many reports of fertilizer being in short supply. Fertilizer is a major expense item for most grain farms so any price increase in fertilizer can have a significant effect on farm profitability. Some famers may be weighing a switch to soybeans since soybeans don't need nitrogen, resulting in lower fertilizer costs.

In February of 2021, Ibendahl published an updated model to estimate the anhydrous ammonia price based on the price of corn and the price of oil. Previous analyses by Ibendahl found oil and corn prices did a much better job of predicting anhydrous ammonia prices than did the price of natural gas. However, the run-up in fertilizer prices in the fall of 2021 was not predicted by this model.

The purpose of this article is to examine what may have changed in the fertilizer markets to cause the price of fertilizers to escalate so quickly. Is this a new level of higher prices for most fertilizers or can farmers expect fertilizer prices to moderate sometime in 2022. This article will modify the earlier models to include an inflation component to see if that might improve the ability of the model to forecast anhydrous prices.

Data and Model

All the fertilizer prices in the analysis come from DTN (accessed from ProphetX). Monthly national prices are used in this analysis because there is a longer dataset of prices available. However, the Kansas anhydrous price tracks very closely to the national price as shown in Figure 1. Kansas prices are typically $30 to $40 per ton less than the national price in any given month.

Previous analyses showed that predicting the anhydrous price was possible since the price of anhydrous ammonia is positively correlated with both the price of oil and corn. Even though anhydrous ammonia is produced from natural gas, models using natural gas as a price predictor for anhydrous never worked very well. The price variations in natural gas never seemed to match the variability of anhydrous. Because natural gas and oil have similar uses, the correlation is high. Thus, substituting oil into a price predictor model for anhydrous accomplished the goal of using natural gas but the correlation better aligned with how anhydrous prices varied.

Gregg Ibendahl email: ibendahl@ksu.edu twitter: @ibendahl

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 of nitrogen fertilizer). Also, a higher corn price (relative to other crops) will shift more acres to corn (which uses nitrogen) and fewer acres to soybeans (which doesn't need nitrogen fertilizer).

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. Earlier models indicated a 9 month lag in oil prices provided the best fit to anhydrous ammonia prices. With the current model, a 6 month lag worked as well as a 9 month lag. Thus, a 6 month lag was used here.

Because other nitrogen fertilizers start from ammonia, the correlation between nitrogen products is high. Thus, forecasting anhydrous will provide guidance for the prices of other nitrogen fertilizers. 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. These other fertilizer price relationships are explored later on in this article.

A model just using corn and oil as the explanatory variables does not predict the recent rise in fertilizer prices very well. Thus, other factors were considered. One thing that has changed over the last 6 months is inflation expectations. Inflation is now higher than it has been in many years. To incorporate this into the model, the University of Michigan monthly survey of inflation expectations was used.

The historical prices since 2009 for the dependent variable (anhydrous) and the three independent variables (corn, inflation, and oil) are shown in Figure 2. The correlation for these factors is shown in Figure 3. Figure 3 packs a lot of information. The diagonal of the figure has the histogram and the density plot of the factor under consideration. For example, anhydrous, in the upper left hand corner has a bar graph for the histogram and the line is the density plot. A density plot can be thought of as a smoothed histogram. The other three factors can be interpreted similarly. The number along the sides are the scale for each individual figure. The prices for anhydrous can be found at the very bottom in the first column. Since 2009, only the last couple of months have been above $1,000 a ton so the histogram has a very wide and narrow upper tail.

The other boxes in Figure 3 represent the relationship between the factors. In the upper quadrant is the correlation. To find the correlation, draw a horizontal line or vertical line

from the two factors you are interested in. Where those line cross in the upper quadrant is the correlation. For example, the correlation for anhydrous and corn is in the first row and the third column. This particular correlation is 0.70.

The lower quadrant is the scatter plot and regression line between the two factors being considered. Using anhydrous and corn again for an example, the scatter plot is in the third row and the first column. The axis labels for these scatter plots can again be found along the sides. Anhydrous has the prices along the bottom in the first column while corn prices are along the right side in the third row. As all these scatter plots show, there is just not enough data points where anhydrous is above $1,000 to get a good read on the price relationships.

Model to Predict Anhydrous Ammonia Prices

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

2022 model: Anhydrous ammonia ($/ton) =
- 104
+ 36.7 * corn ($/bu)
+ 2.14 * oil_6 mo lag ($/ barrel)
+ 140 * inflation expectations

This regression result has an adjusted R-squared of 0.65. This R-squared is not near as good a fit as the model used last year. Prices of anhydrous over the last several months have made the model less reliable even when adding an inflation factor.

Figure 4 shows the actual anhydrous ammonia price vs the predicted anhydrous ammonia price across time. Figure 5 shows a scatter plot of the actual vs predicted values. According to the model, anhydrous prices should be about to peak at around $1,000/ton.

Obviously, anhydrous prices are near $1,500 so the model hasn't done so well the last several months. The main question then is whether this increase is of a more lasting nature or is the increase more of a temporary phenomenon. If it is the former, then the model is missing a key piece or pieces for an independent variable. It it is the latter, then anhydrous prices could decline substantially during 2022.

The best guesstimate here is the price rise in somewhat temporary as prices may decline more slowly on the way down than they went up. A rapid price rise and decline in fertilizer has happened before. As shown by Ibendahl in "USDA Expense Indexes

Through 2021" (https://www.agmanager.info/production-economics/prices-and-price-forecasts/usda-expense-indexes-through-2021), fertilizer prices spiked in 2008 for several months. Fertilizer was actually more expensive at that time than it is now. Thus there has been precedent for a rapid increase in fertilizer prices followed by a rapid decline. Part of the issue currently is Covid and supply chain issues have disrupted much of what was "normal". Assuming inflation and supply chain issues stabilize, anhydrous prices could very well start declining this spring. The EIA is predicting $75 oil and with current future prices used to estimate corn prices, fertilizer should at the very least level off this spring.

Other Considerations

There are many other events happening in the world right now that could easily throw the fertilizer market into more turmoil. The EIA is predicting $75 oil but any kind of conflict with Russia and Ukraine could totally change oil prices and the fertilizer outlook. Also, Covid continues to affect supply chains to some extent and just last week there was a big fire at a fertilizer plant in North Carolina. All of this uncertainty is likely to lead to fertilizer prices being about what they would be in more "normal" times.

Other Fertilizers

As mentioned above, most fertilizers are highly correlated. Figure 6 shows this information in a similar manner to Figure 3. The nitrogen products are more highly correlated as expected. However, even potash and anhydrous are strongly correlated at 0.66. DAP and MAP are the most highly correlated of all at 0.99.

References

Corn (ZC) Historical Data. Nasdaq. "https://www.nasdaq.com/market-activity/commodities/zc/historical

Monthly oil prices. U.S. Energy Information Administration. "https://www.eia.gov/dnav/pet/pet_pri_spt_s1_m.htm

"Surveys of Consumers, University of Michigan, University of Michigan: Inflation Expectation© [MICH], retrieved from FRED, Federal Reserve Bank of St. Louis https://fred.stlouisfed.org/series/MICH/, (Accessed on date)"

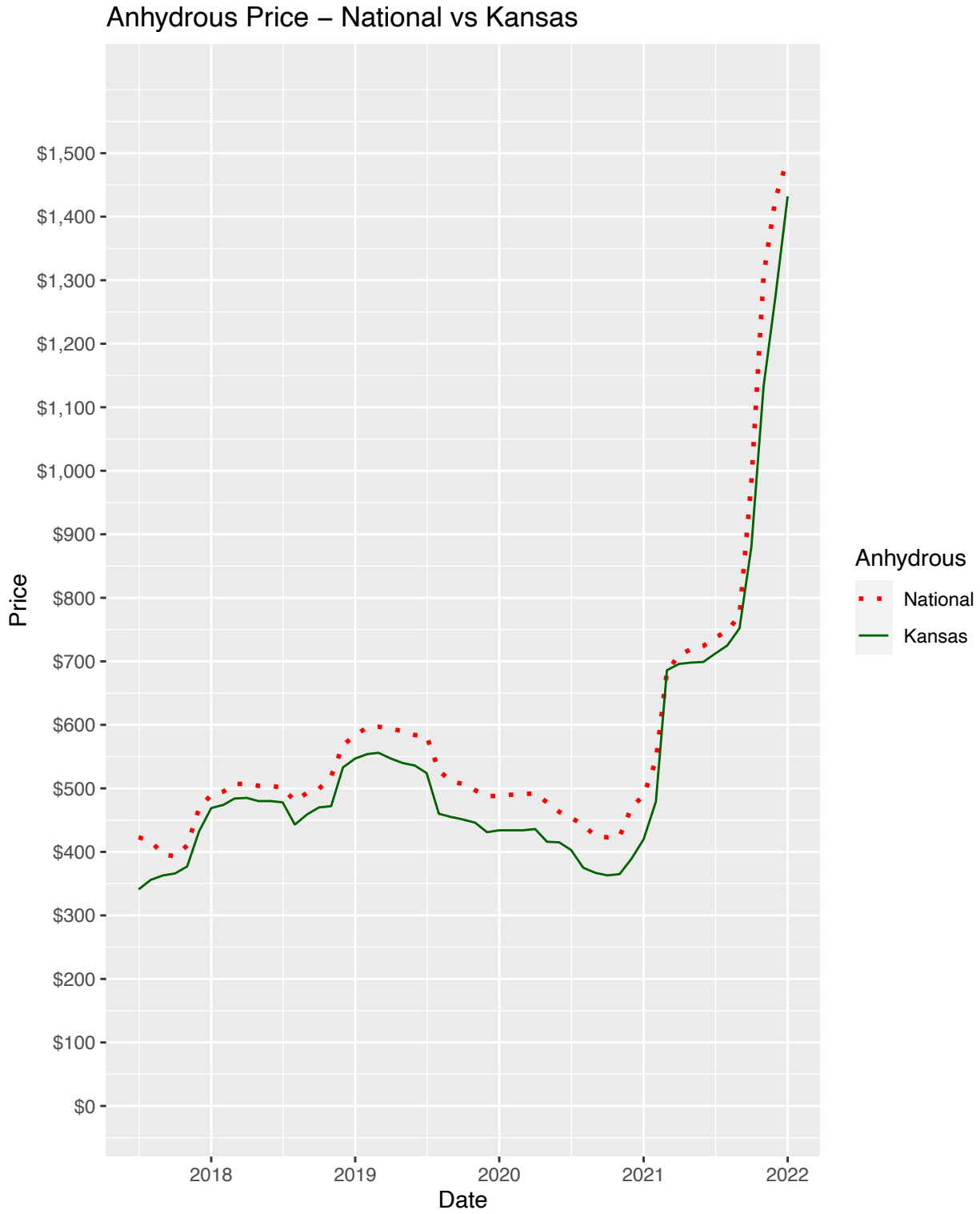

Figure 1. Comparison of National and Kansas Anhydrous Prices

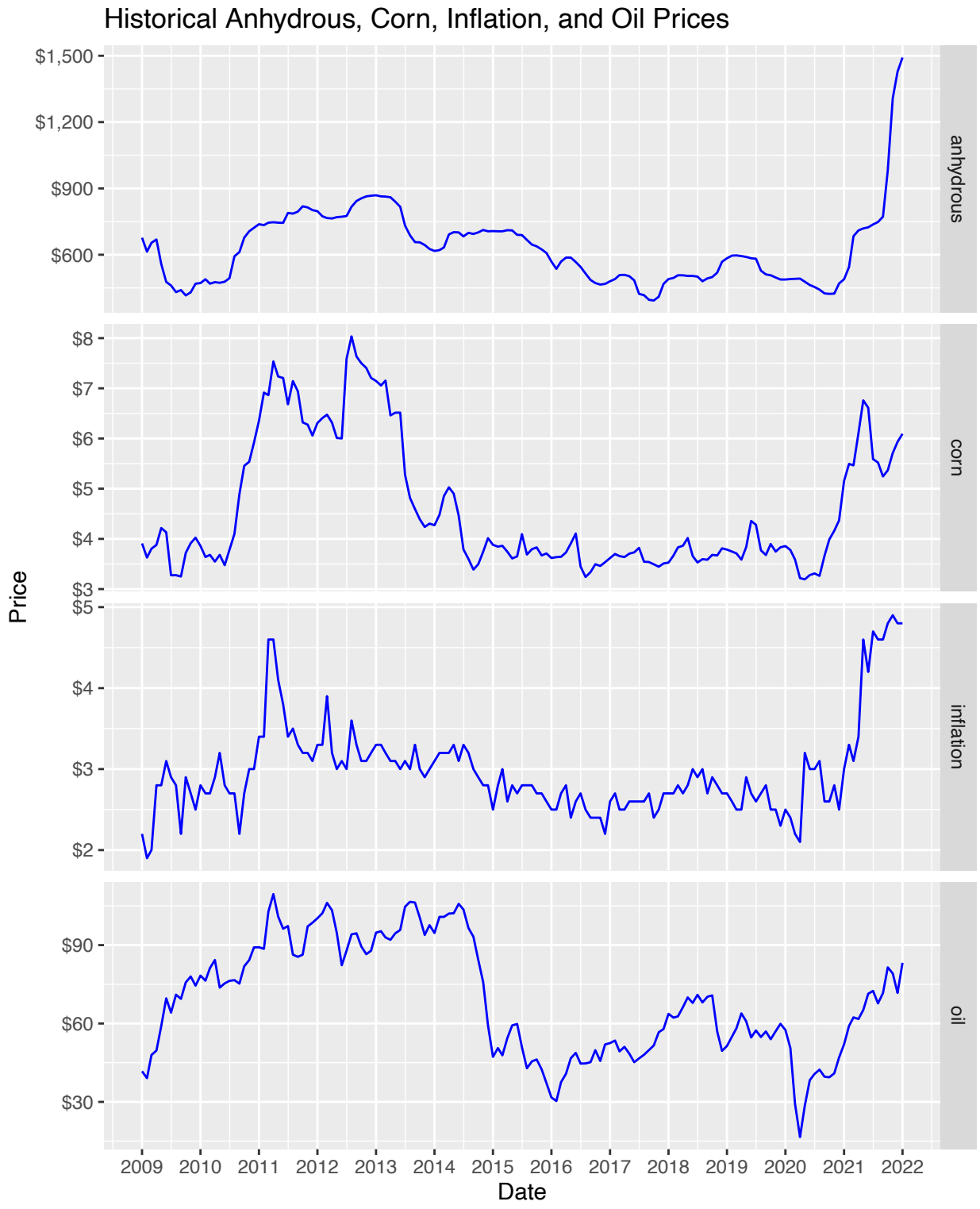

Figure 2. Historical Prices of Model Factors

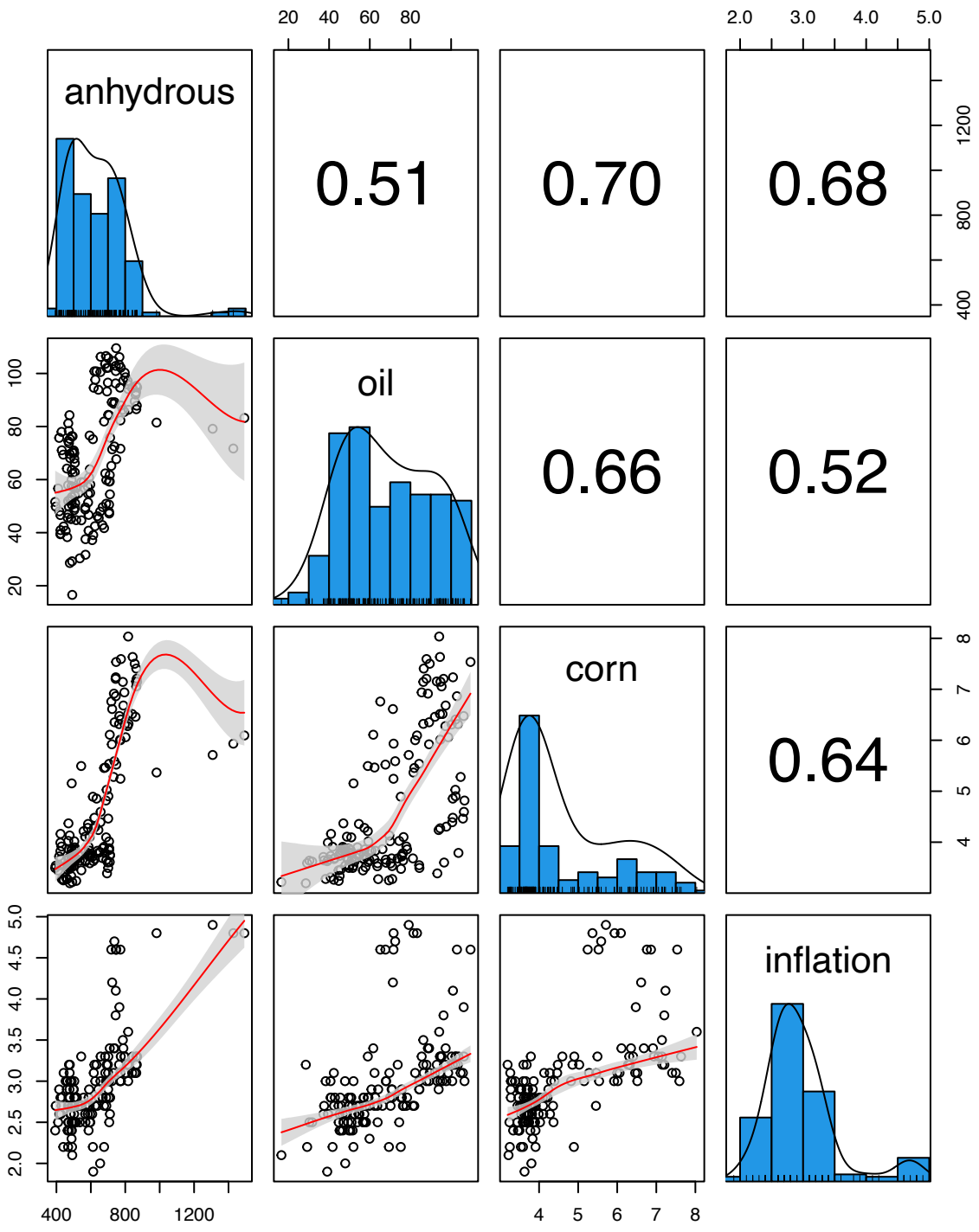

Figure 3. Correlation Comparison of Factors in Price Estimation Model

Figure 4. Actual Anhydrous Price vs Predicted Price

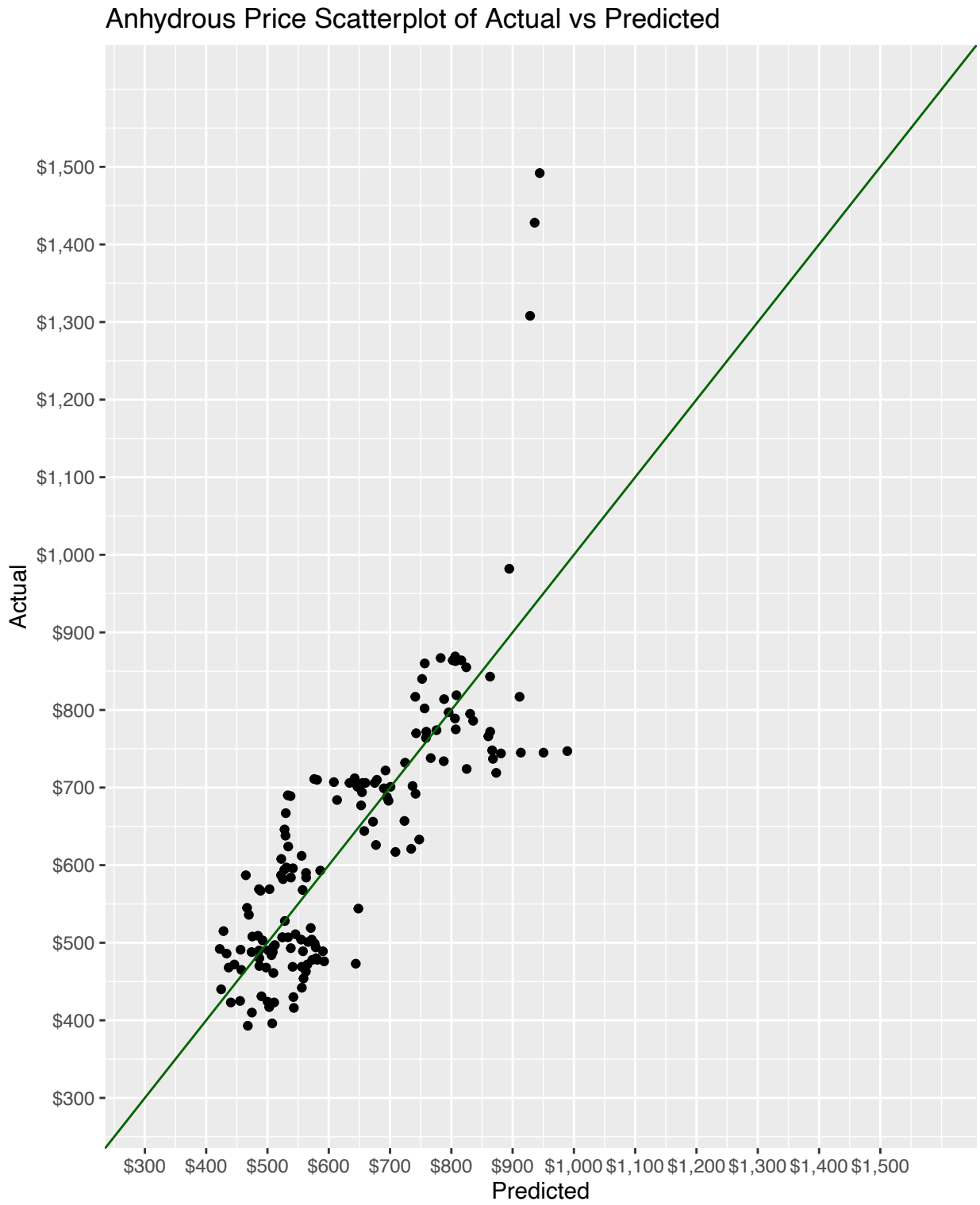

Figure 5. Model Analysis - Scatterplot of Actual vs Predicted

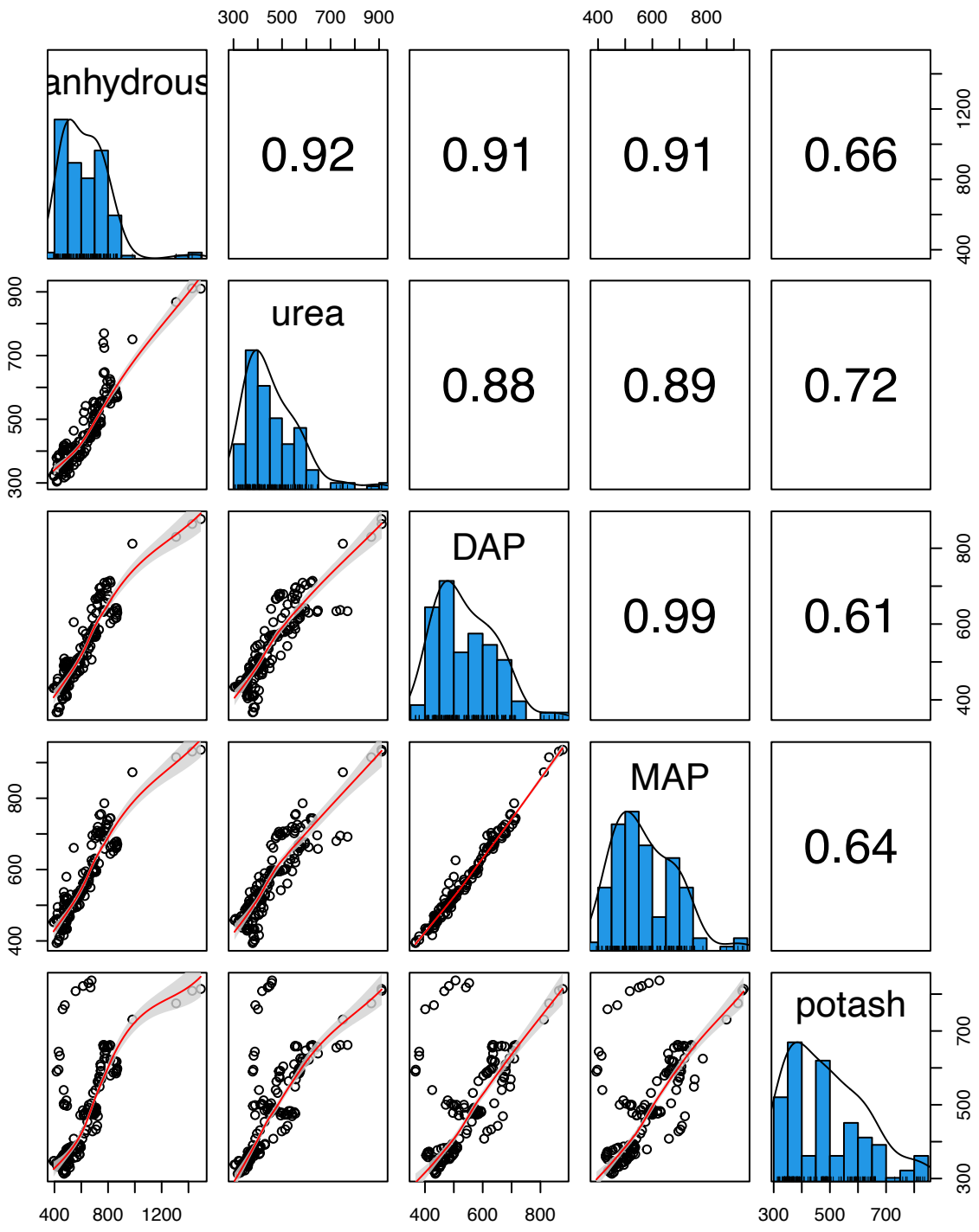

Figure 6. Correlation Comparison of Other Fertilizers