

Predicting Fertilizer Prices in 2021

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Introduction

Fertilizer prices have been in the news a lot more recently as prices have increased. Fertilizer is a major expense item for most grain farms so any price increase in fertilizer can have a significant effect on farm profitability. Two years ago, Agmanager published an article about predicting fertilizer prices based on the oil and corn price (<https://www.agmanager.info/production-economics/prices-and-price-forecasts/predicting-fertilizer-prices>). This article found that oil and corn prices did a much better job of predicting anhydrous ammonia prices than did the price of natural gas. The model used in this previous article resulted in the following equation:

$$\begin{aligned} \text{2019 model: Anhydrous ammonia (\$/ton)} = \\ 202 + 43.4 * \text{corn (\$/bu)} + 3.18 * \text{oil_9 mo lag (\$/ barrel)} \end{aligned}$$

The purpose of this paper is to update the model above with two more years of data so that more accurate predictions can be made of future fertilizer prices. With better predictions of fertilizer prices, farmers can decide when to buy fertilizer and what crop mix they should grow. This paper will also compare the 2019 model predictions to actual prices to see how well the model did from 2019 through 2020.

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. Surprisingly, anhydrous ammonia has a lower correlation to natural gas (See Figure 1). 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

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for 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). Figure 2 shows the relationship between the national anhydrous ammonia price and the national corn price since 2011 on a monthly basis. This monthly correlation is 0.84. A two-month lag in corn prices provided a slightly stronger correlation to Anhydrous prices so this lag was incorporated into the model below.

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 weak (0.43). This may be because natural gas prices are more volatile than other oil products. Figure 1 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 weaker than the correlation between oil prices and anhydrous ammonia prices.

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 0.62 correlation. The correlation between oil prices and anhydrous ammonia prices is 0.73. 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 0.83. Figure 3 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:

$$\begin{aligned} \text{2021 model: Anhydrous ammonia (\$/ton)} = \\ 163 + 53.4 * \text{corn_2 mo lag (\$/bu)} + 2.96 * \text{oil_9 mo lag (\$/ barrel)} \end{aligned}$$

This regression result has an adjusted R-squared of 0.86. An R-squared this high is usually considered a strong fit. Figure 4 shows the actual anhydrous ammonia price vs the predicted anhydrous ammonia price.

How did the 2019 prediction model work over the last 2 years? While the revised 2021 prediction model of anhydrous ammonia had a 0.93 correlation to actual prices, the 2019 model was almost the same at 0.92. Figure 5. shows the actual anhydrous ammonia price along with the predicted anhydrous ammonia prices from both the older 2019 model and the 2021 model. When looking at how well the 2019 model predicted the anhydrous ammonia prices for 2019 and 2020, the predicted values had a 0.67 correlation to actual prices.

Predictions for 2021

Current anhydrous ammonia prices should continue to rise until at least fall. The model currently predicts national anhydrous ammonia prices should reach \$600 per ton before tapering off in the fall. This would be nearly a 50% increase over prices during the summer of 2020. This price prediction actually might be on the low side since corn prices have been very volatile. Oil future prices are currently in the \$50 range. There is some speculation that oil prices might rise as well. This would put additional upward pressure on fertilizer prices.

Any price increase in nitrogen fertilizers will likely follow over to other fertilizers. Table 1 lists the correlation among fertilizers. The table is color coded to help indicate the degree of correlation. The entire table is dark blue which shows all fertilizer prices are highly correlated. It's probably not surprising that nitrogen fertilizers are highly correlated but even potash is highly correlated to nitrogen prices.

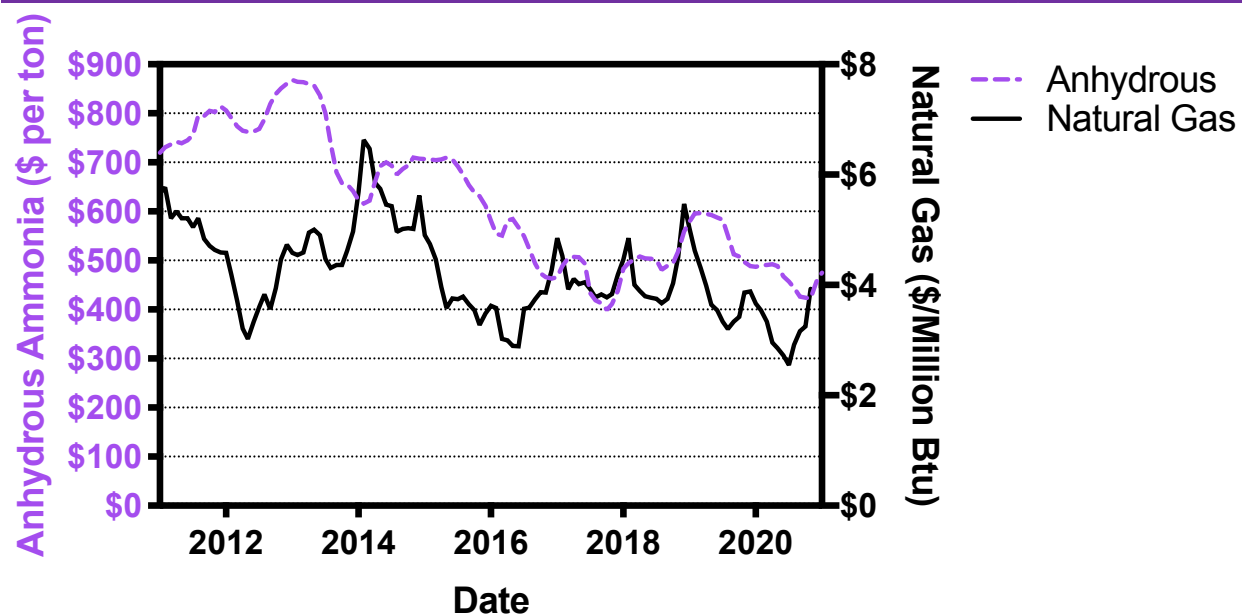


Figure 1. Monthly Anhydrous Ammonia Prices vs Monthly Natural Gas Prices

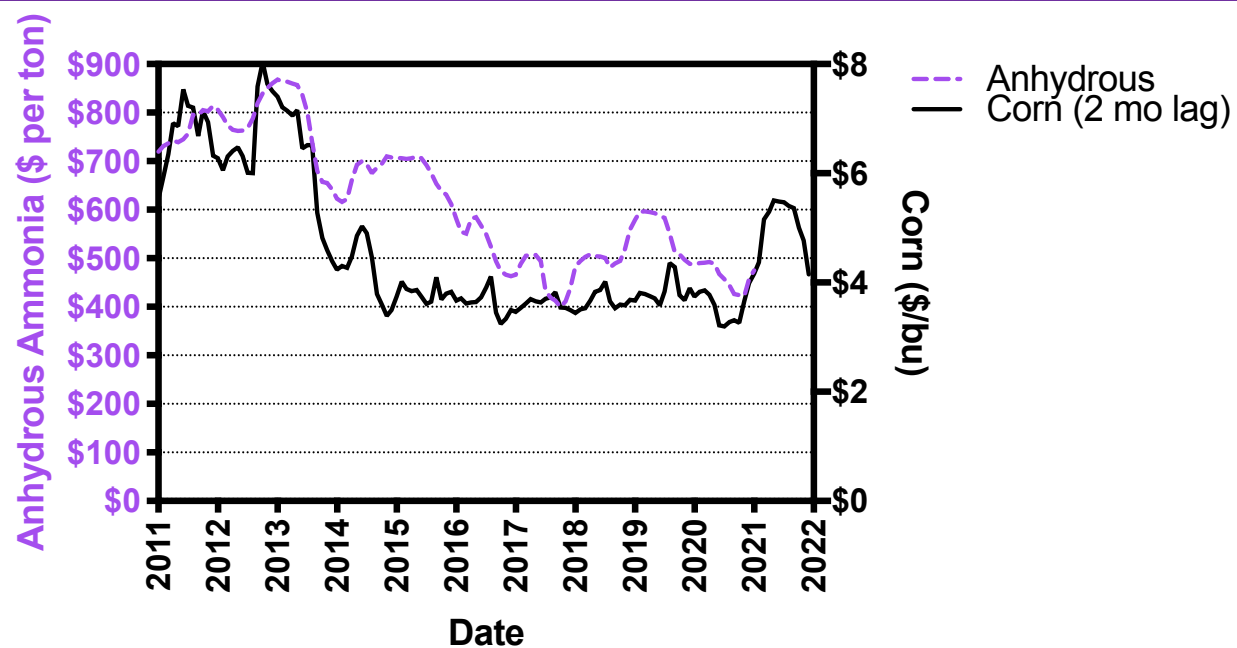


Figure 2. Monthly Anhydrous Ammonia Prices vs Monthly National Corn Prices

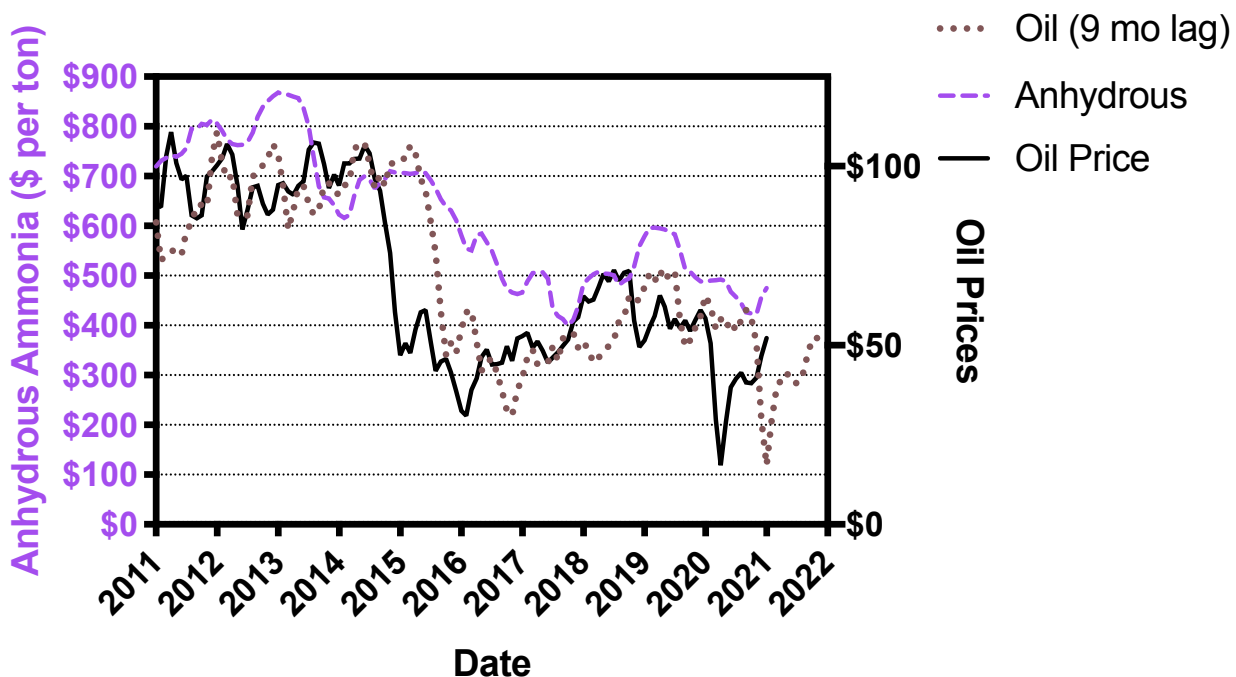


Figure 3. Monthly Anhydrous Ammonia Prices vs Monthly Oil Prices and Lagged Oil Prices

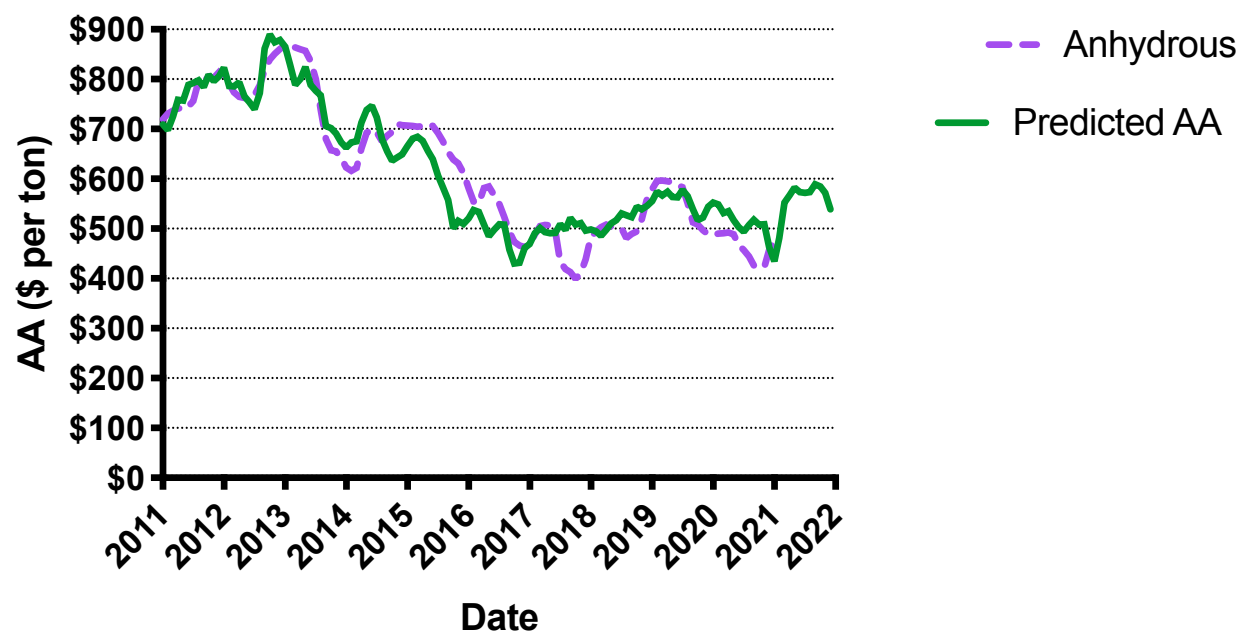


Figure 4. Actual vs Predicted Anhydrous Ammonia Prices

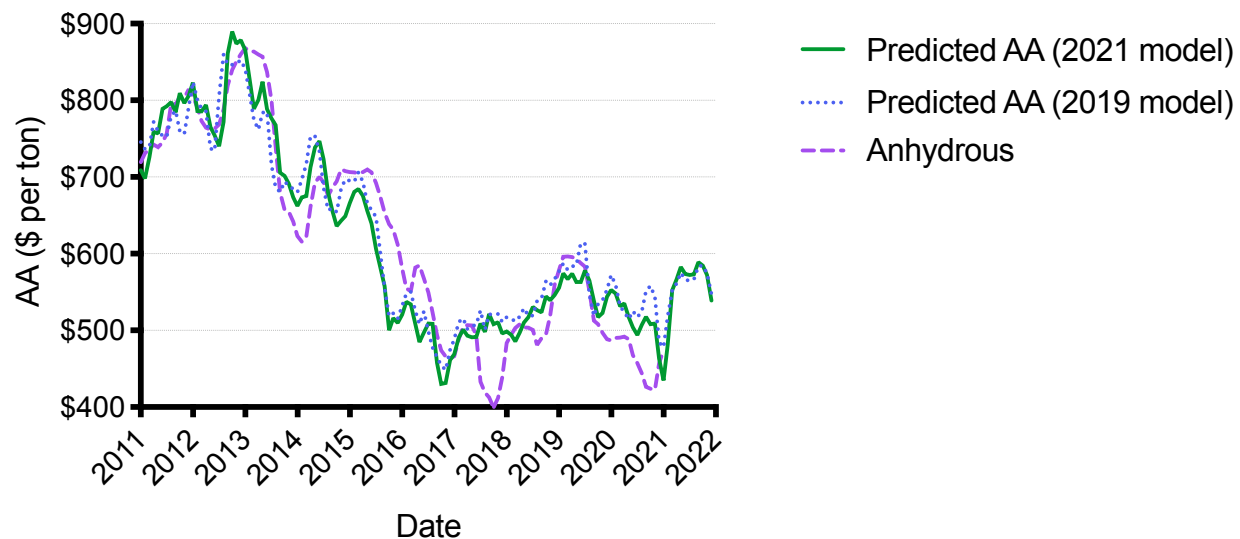


Figure 5. Actual vs Predicted Anhydrous Ammonia Prices for Both Old and Current Prediction Models

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Table 1. Correlation Coefficient for Fertilizers

