The Russia-Ukraine Conflict and the Effect on Fertilizer

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Introduction

The Russia invasion of Ukraine has roiled the world. There is much uncertainty now about the consequences of this conflict. Agriculture has been affected as much as any other industry. Not only are grain prices very volatile but the input side of agriculture faces a new level of uncertainty because Russia is a major supplier of fertilizer for the world. In a year where fertilizer prices have already tripled, an additional layer of uncertainty is the last thing farmers want. This article will review the fertilizer production of both Russia and Ukraine and then examine what a disruption of that production might mean for world markets.

Background

There are three macronutrients that farmers are most concerned about: nitrogen (N), phosphorus (P), and potassium (K). Most nitrogen fertilizers used in the United States are produced from the nitrogen in the air. This process, the Haber-Bosch process, was invented in Germany before World War I began and uses natural gas to produce ammonia. With ammonia as a base, the other synthetic nitrogen products can be produced. Thus any country with ready access to natural gas can be a producer of nitrogen fertilizers. Russia fits this category.

Both phosphorous and potassium must be mined and not every country has reserves of these elements. While nitrogen needs to be applied every year for those crops needing nitrogen, that is not the case for phosphorous and potassium. P and K are relatively stable in soils and can be "banked" for later use. Thus, farmers can often apply more P and K in years where these fertilizers are cheaper and then less in years where these fertilizers are more expensive. The key though is to do soil testing to make sure P and K levels stay within recommended ranges.

The type of crop grown will also determine the fertilizer requirements in a given year. Legumes, like soybeans can fix their own nitrogen from the air and as a result, don't need a nitrogen fertilizer application. For grasses like corn, an application of nitrogen is critical.

Potash

Figure 1 lists the world's 10 largest potash producing countries. The figure has the percent of world production and the metric tons produced. Russia is the second largest producer of potash in the world with nearly 20% of the world production. Belarus is the third largest producer with 17%. The U.S. imposed sanctions against Belarus back in August of 2021. Together these two countries control over a third of the potash produced in the world. With sanctions against both Belarus and Russia, will this fertilizer be unavailable to world markets? Assuming that potash production is not destroyed, potash is a fungible commodity. That is, potash from Russia is identical to potash from Canada. Thus, much of the potash from Russia and Belarus could still make it to world markets but at a more costly and inefficient route.

The U.S. doesn't produce much potash. As shown by the USGS, the majority of the U.S. need for potash is imported (93%). Thus, the U.S. is more vulnerable to potash disruptions than it is from disruptions to other fertilizers.

Potash in the United States (1,000 MT)

Production	480
Imports	7,000
Exports	100
Consumption	7,400

Of the potash imported into the U.S., 75% comes from Canada, 10% from Russia, 8% from Belarus and 7% from other countries. Fertilizer use accounts for 85% of potash sales.

Phosphate Rock

Figure 2 lists the world's 10 largest phosphate rock producing countries. Russia is the fourth largest producer of phosphate rock but it's share of the world total production is only 6%. Because the U.S. is one of the world's biggest producers of phosphate rock, it doesn't rely on imports to a large extent. In 2021, the U.S. imported 13% of use but that figure has been as low as 2% in 2018.

Phosphate in the United States (1m MT)

Production	22.0
Imports	2.4
Exports	0.0
Consumption	25.0

Of the phosphate rock imported, 87% comes from Peru and 13% from Morocco.

Ammonia

Figure 3 lists the world's 10 largest ammonia producing countries. Because ammonia is created out of the nitrogen in the air rather than mined, any country with access to natural gas is a potential producer of ammonia. Russia is the second largest producer of ammonia while it's share of global production is less than 11%. The U.S. is the third largest ammonia producer in the world with over 9% of the global production.

The U.S. is mostly self-sufficient for ammonia production as imports account for 12% of consumption. According to the United States Geological Survey (USGS), ammonia is produced by 16 companies at 35 plants in 16 states. In 2021, this plant capacity was at 84% so there is the potential to increase U.S. production. Most of the ammonia produced in the U.S. is used for fertilizer (88%).

Ammonia in the United States (1m MT)

Production	14.0
Imports	2.2
Exports	0.3
Consumption	16.0

Of the ammonia imported into the U.S., 63% comes from Trinidad and Tobago, 34% from Canada, and the other 3% from other countries. U.S. production has been expanded and modernized over the last five years thanks to low natural gas prices. However, no new ammonia capacity has been announced by any of the ammonia companies.

Effects of disruptions to Russian supply of fertilizer

Given the U.S. is largely self sufficient in ammonia production and the mining of phosphate rock, the nutrients N and P should be available for agricultural use in the U.S. World prices will certainly rise as Russia is also a major producer of N, P, and K. The U.S. price will rise too but the model developed by Ibendahl and discussed below, should provide some guidance about where the price of nitrogen and phosphate rock are headed.

The more difficult nutrient to estimate for price and availability is potash. The U.S. imports over 90% of its potash use, the majority from Canada. Although Russia and Belarus only account for 18% of U.S. imports, these two countries account for over a third of world production. A disruption to Russia fertilizer supplies is likely to have the greatest impact on potash. U.S. farmers should expect to see the largest price increase for this nutrient as well.

The expected price section below will discuss these aspects but there has already been some analysis of a disruption to Russian supply of potash. Safirova has a comprehensive look at a disruption of six minerals that Russia produces. Potash was part of this analysis. While this analysis was written over five years ago (and based on a 2014 supply shock), when world potash production was a third lower, Russia had nearly the same market share as it does now. Safirova estimates that the world potash price would increase by 18.4%. Countries like the U.S. that import less directly from Russia would like have a more secure source of potash even if it did become more expensive.

Estimated price increases

As detailed by Ibendahl in a February 2022, AgManager article, anhydrous price is a function of the corn price, oil price, and inflation expectations. Inflation was added to the model to help explain the rapid increase in fertilizer prices in the fall of 2021. This model provides the following equation to estimate anhydrous prices:

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

Other fertilizers are highly correlated to the anhydrous price. Figure 4 shows the national monthly prices of anhydrous, MAP, and potash. MAP fertilizer is monoammonium phosphate fertilizer (11-52-0) and is used to show the phosphate nutrient. DAP, the other major phosphate fertilizer in the U.S.,is diammonium phosphate fertilizer (18-46-0).

Anhydrous and MAP have a 0.91 correlation while anhydrous and potash have a 0.66 correlation. With such strong correlations, other fertilizer prices can be predicted based on forecasting anhydrous and then looking at the price ratio of the other fertilizers to anhydrous. As shown in Figure 5, the price of MAP is 92% of the anhydrous price on average while the price of potash is 75% of the anhydrous price on average. Currently, MAP and potash are lower in price than their historical relationship to anhydrous would indicate. This was part of the reason Ibendahl speculated in early February that nitrogen prices might come down during the summer of 2022.

Using the model above and assuming 9% inflation, Table 1 lists the estimated anhydrous, MAP, and potash prices for a range of oil and corn prices. As of March 1, 2020, DTN reported a national anhydrous price of $1487. If anhydrous hits $1,800 a ton, that would be an additional 20% price increase for nitrogen. Anhydrous prices are currently above what the model would predict with a lower inflation rate so the market may have already baked some of these higher inputs into the model. Thus, while a 20% increase may seem small, keep in mind anhydrous prices have already tripled in the last year.

The MAP price as reported by DTN on March 1, 2020, was $937. Because the price of MAP relative to anhydrous is currently relatively low based on historical norms, MAP prices could increase by 60%. Such an increase would put the MAP price more in line with the anhydrous price. Given the very high correlation between MAP and anhydrous (0.91) it is somewhat surprising that MAP prices aren't already higher.

The potash price as reported by DTN on March 1, 2020 was $815. Historically, the correlation between anhydrous and potash is 0.66. While that is a strong relationship it is weaker than the relationship between anhydrous and MAP. Figure 5 reflects that lower correlation. Typically, potash is about 74% of the anhydrous price. However, there is a long upper tail meaning potash at times has been near the anhydrous price or above the anhydrous price. Figure 4 shows that in 2009, potash prices were higher than the anhydrous price for much of the year and in 2017 and 2020, the potash price was near the anhydrous price.

Because the U.S. imports most of its potash, this is likely to be another period where the price relationship between potash and anhydrous narrows. The forecast potash price shown in Table 1 uses an 80% potash to anhydrous price. With this relationship, potash prices could very well increase by 75%.

Conclusions

Prices of N, P, and K will almost certainly go higher given higher fuel prices and because Russia is a major fertilizer producer. The U.S. produces the bulk of its N and P so these nutrients should remain available for agricultural use. While the U.S. imports the majority of its K supply, these imports mostly come from Canada so again agricultural use should not be limited. However, potash prices are likely to rise the most.

In the very short run, agricultural access to nitrogen is the most critical. Crops like corn depend on nitrogen to achieve yields. Farmers do have the option to switch to a legume like soybeans to reduce overall nitrogen use. Agricultural use of P and K is not quite as critical as N given that farmers can mine the soil for those two nutrients, assuming P and K levels are adequate. Longer term though, farmers will need adequate supplies of all three nutrients in order to maintain current yield levels.

The northeast Kansas corn budget was revised in January and it has the fertilizer expense at $180 per acre. This is about 30% of all crop expenses per acre. Assuming fertilizer expenses increase by an additional 30% due to the Russian/Ukraine conflict. Fertilizer costs per acre could increase by another $50 per acre. This means fertilizer could account for 35% of all crop expenses.

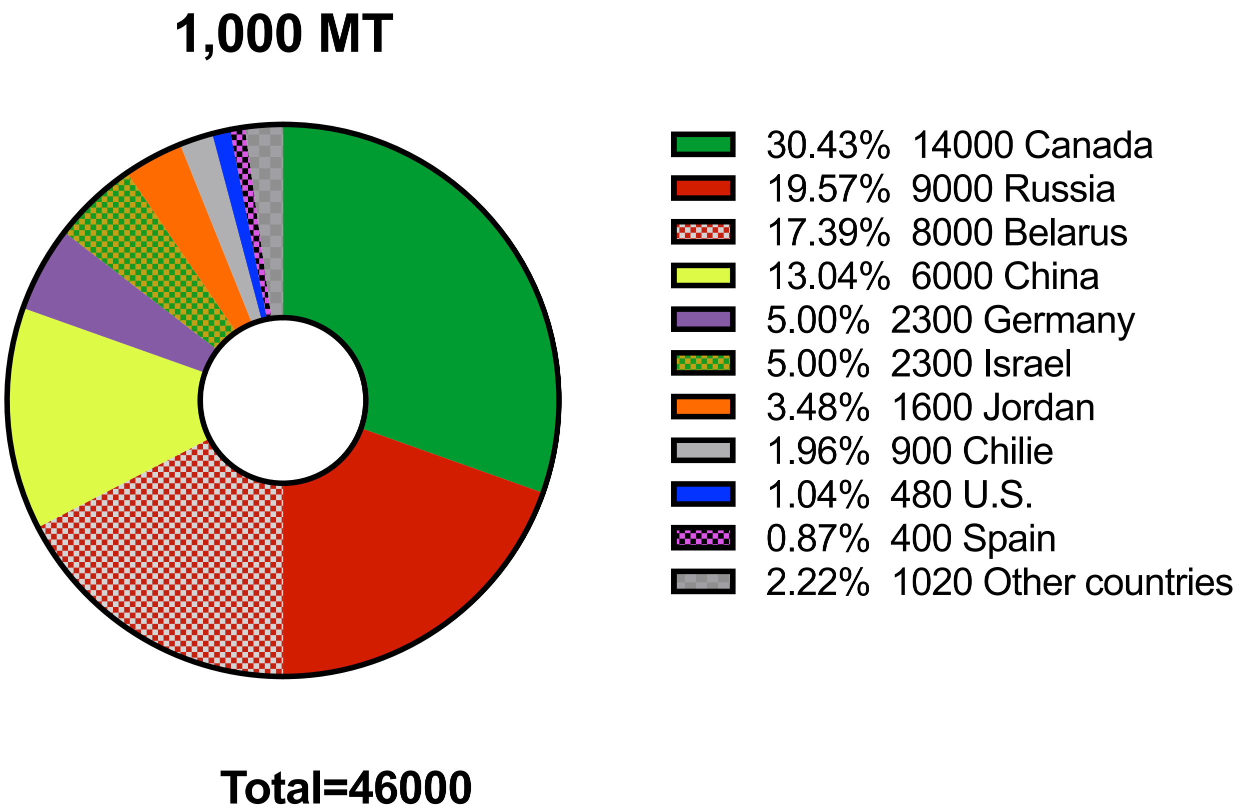

Figure 1. World Potash Production by Country

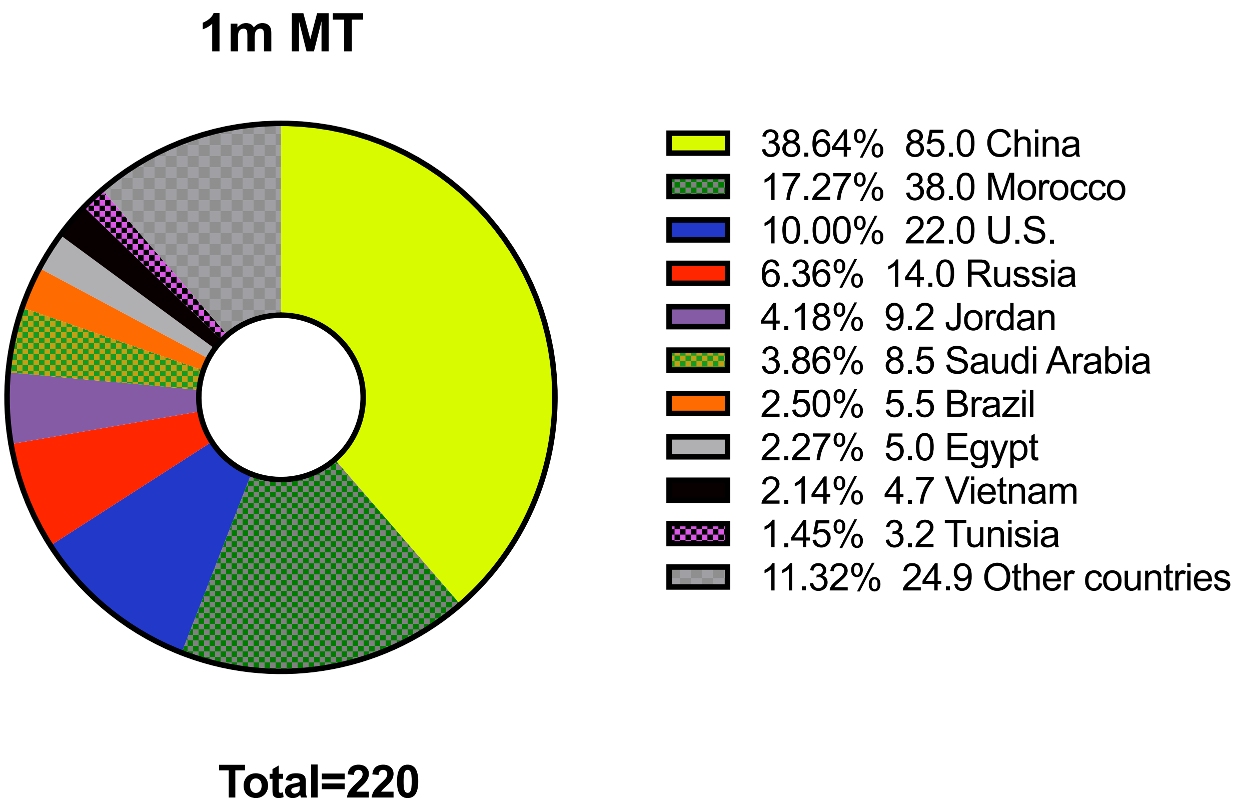

Figure 2. World Phosphate Rock Production by Country

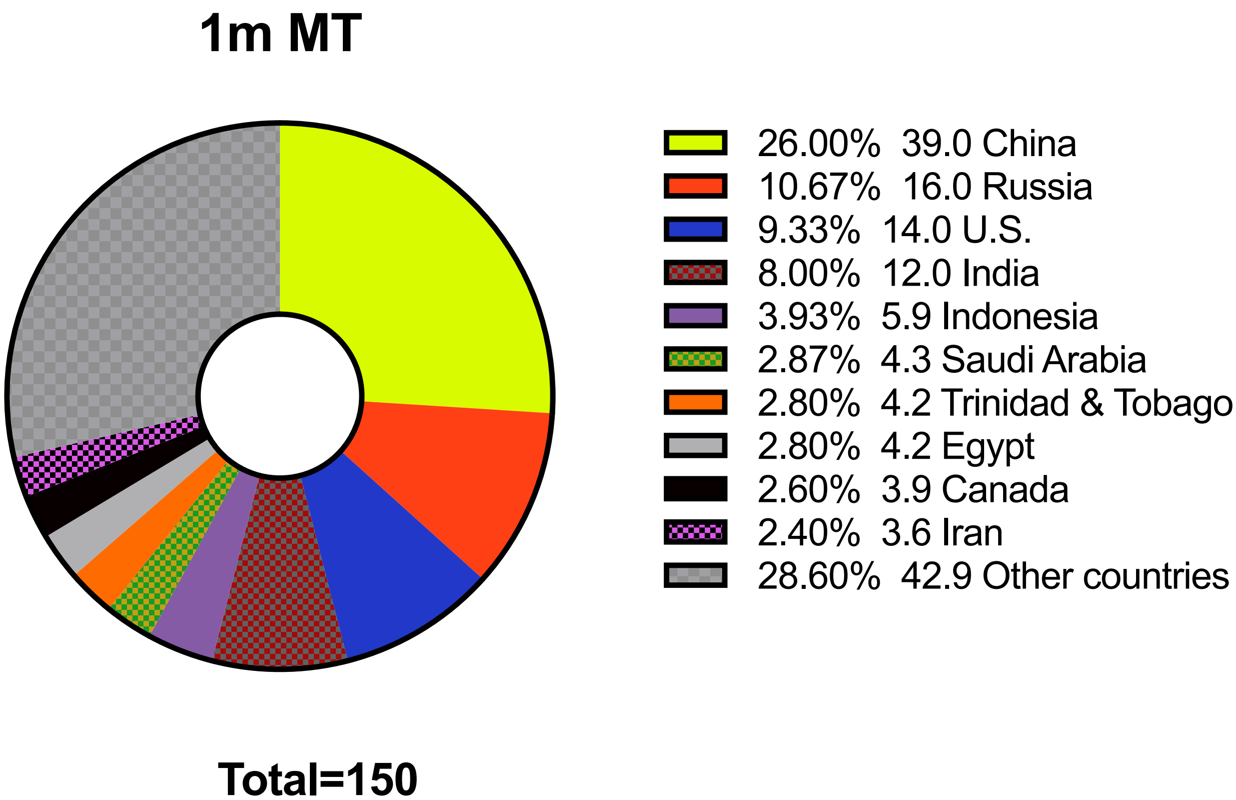

Figure 3. World Ammonia Production by Country

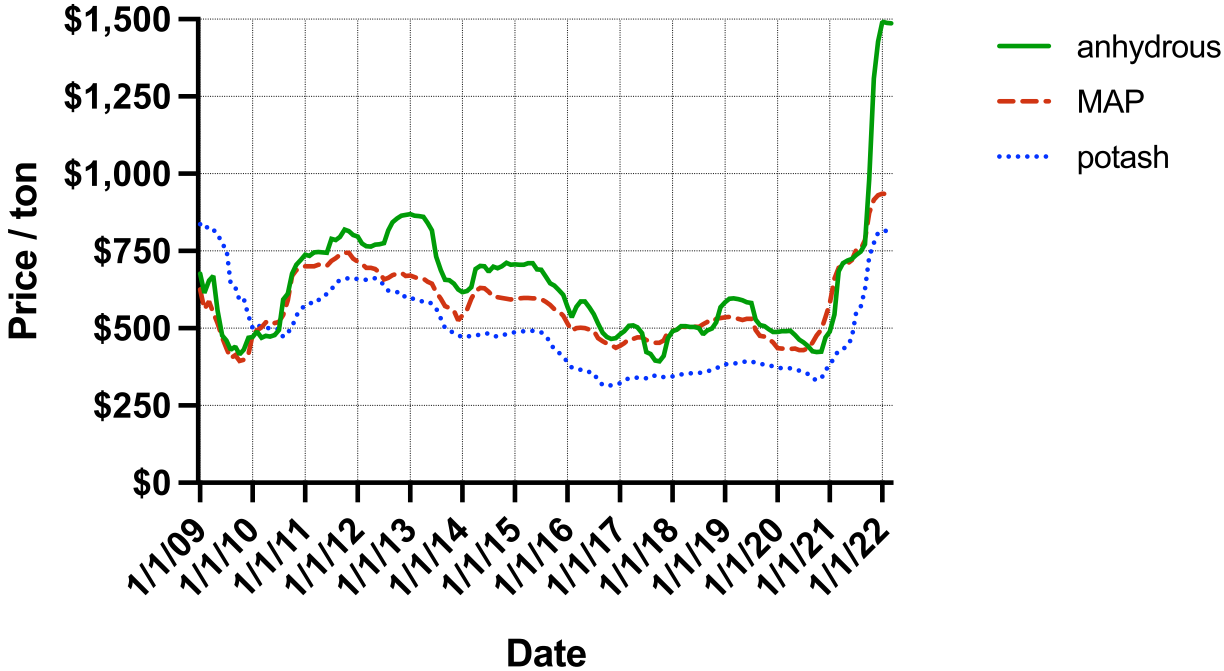

Figure 4. Monthly National Fertilizer Prices

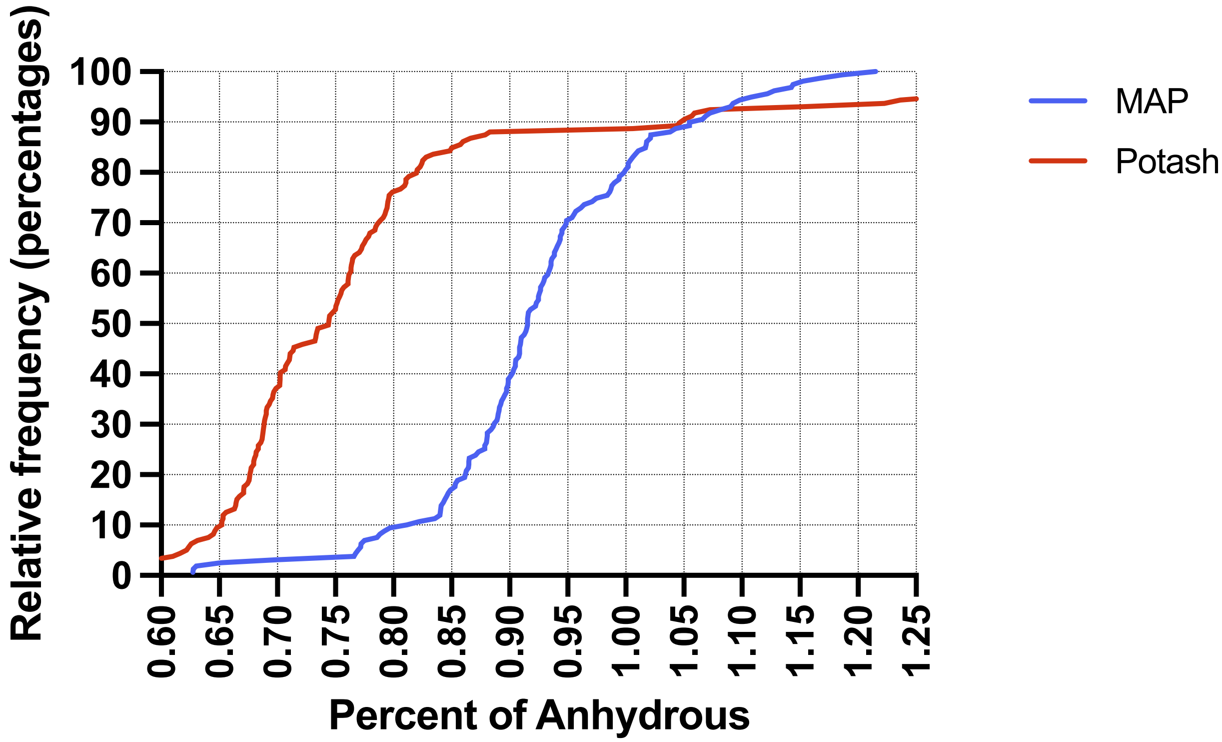

Figure 5. Frequency Distribution of MAP and Potash as a Percentage of Anhydrous

Table 1. Estimated Fertilizer Prices with 9% Inflation and Listed Corn and Oil Prices

Anhydrous		Corn $ 6.00	$ 7.00	$ 8.00
Oil	$ 100	$ 1,590	$ 1,627	$ 1,664
	$ 125	$ 1,644	$ 1,680	$ 1,717
	$ 150	$ 1,697	$ 1,734	$ 1,771

MAP		Corn $ 6.00	$ 7.00	$ 8.00
Oil	$ 100	$ 1,352	$ 1,383	$ 1,414
	$ 125	$ 1,397	$ 1,428	$ 1,460
	$ 150	$ 1,443	$ 1,474	$ 1,505

Potash		Corn $ 6.00	$ 7.00	$ 8.00
Oil	$ 100	$ 1,272	$ 1,302	$ 1,331
	$ 125	$ 1,315	$ 1,344	$ 1,374
	$ 150	$ 1,358	$ 1,387	$ 1,416

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