Ukraine and Russian Conflict: Fertilizer Effect

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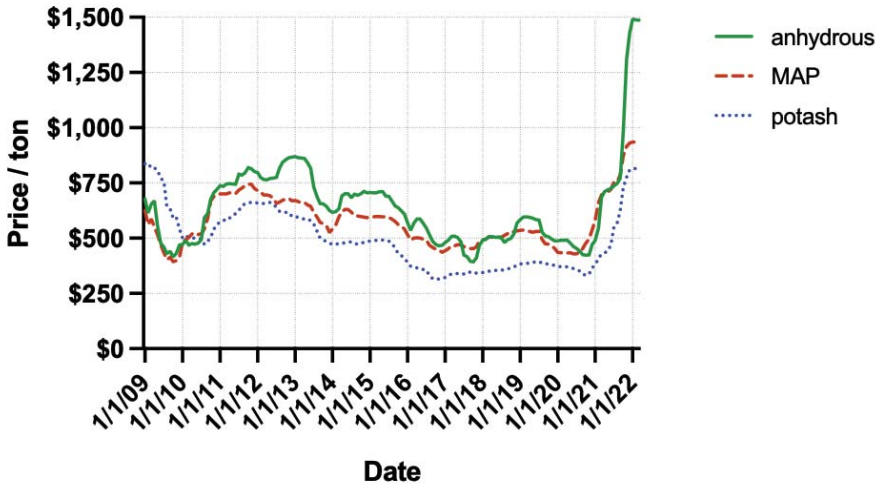
Historical fertilizer prices

- Most of the fertilizer price increase cannot be attributed to Russia
  - N prices tripled during 2021
  - Most of the price rise occurred during the 2nd half of the year



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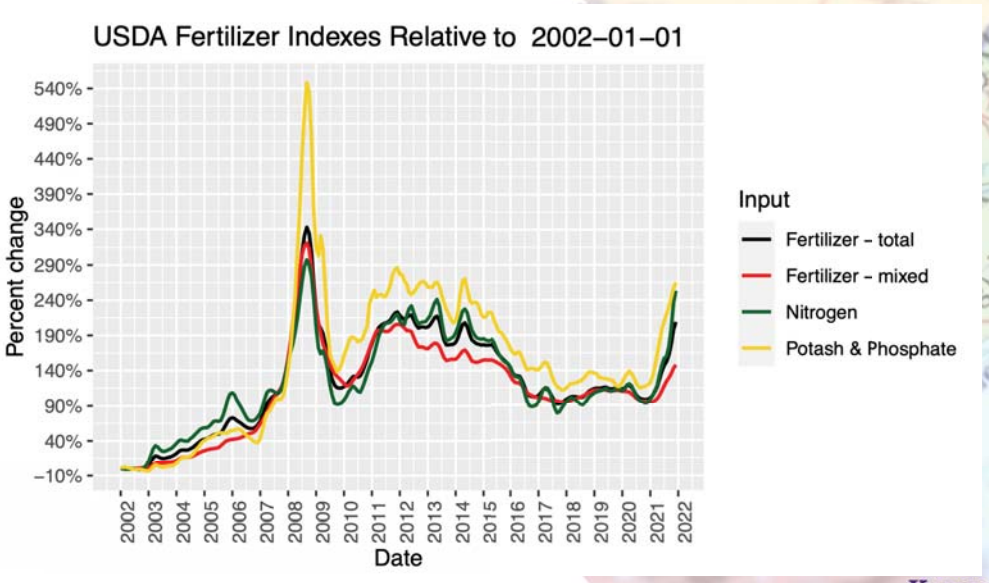
USDA fertilizer indexes – 20 years



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Background on fertilizers

- 3 macronutrients needed by farmers – N, P, and K
- Nitrogen fertilizers can be made from the nitrogen in the air
  - Haber-Bosch process
  - Heavy use of natural gas in the process
  - Produces ammonia which is then the basis for all the other N fertilizers
  - Any country with adequate natural gas could be a nitrogen fertilizer producer
- Phosphorus (P) and Potassium (K) must be mined
  - Not every country has these reserves

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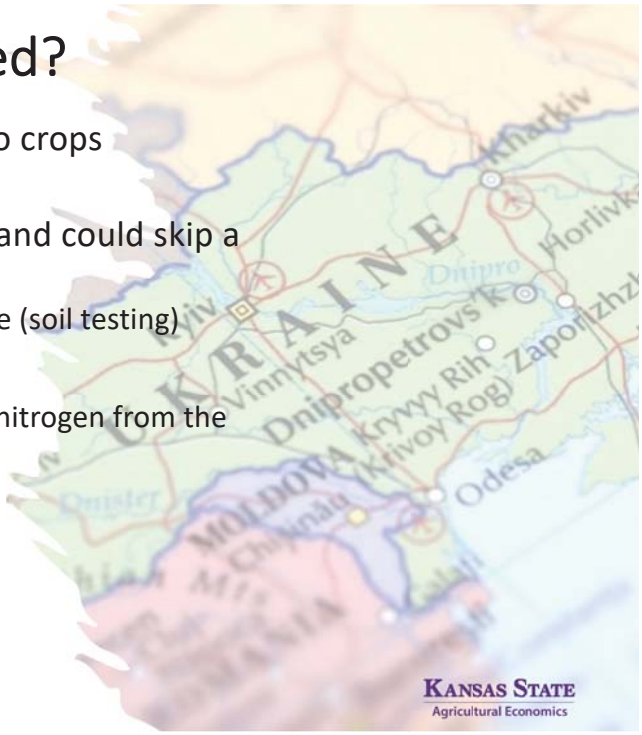
When is fertilizer needed?

- N needs to be applied every year to crops requiring N (grasses)
- P and K are relatively stable in soil and could skip a year
  - Key is to make sure levels are in range (soil testing)
- Crop choice is important too
  - Legumes like soybeans fix their own nitrogen from the air and don't need an N application.



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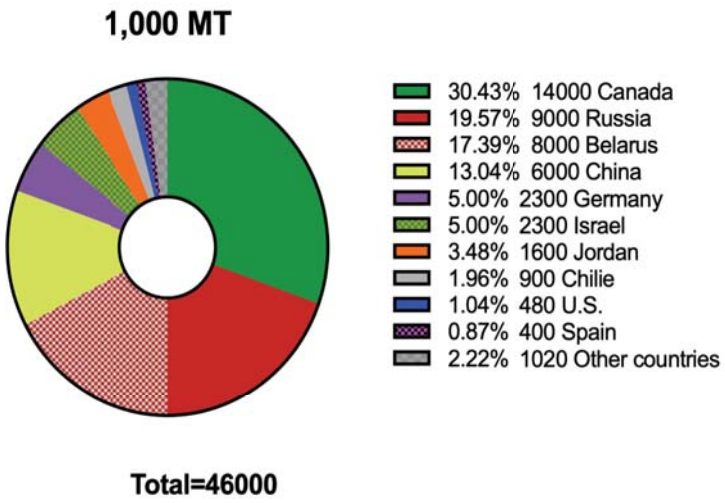
Potash (K) – leading production by country

- Canada is the leading producer in the world.
  - 30% of production
  - 14 million MT
- Russia is number 2
  - 20% of production
  - 9 million MT
- Belarus is number 3
  - 17% of production
  - 8 million MT
  - Already had sanctions - 8/21
- Together, Russia and Belarus produce over a third of the world's potash



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Potash (K) – United States

- U.S. depends almost entirely on imports
- Potash in the United States (1,000 MT)
  - Production 480
  - Imports 7,000
  - Exports 100
  - Consumption 7,400
- Where do imports come from?
  - 75% Canada
  - 10% Russia
  - 8% Belarus
  - 7% other countries
- Fertilizer use accounts for 85% of sales

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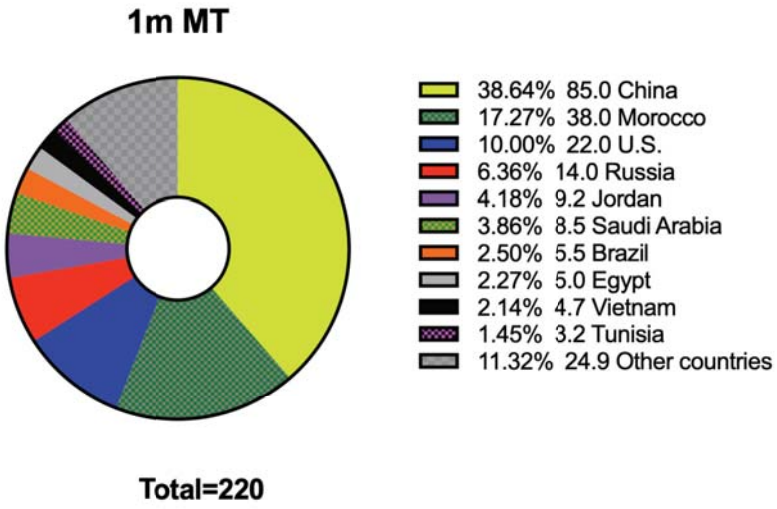
Phosphate Rock (P) – leading production by country

- China is the leading producer in the world
  - 39% of production
  - 85m MT
- U.S. is number 3
  - 10% of production
  - 22m MT
  - We use all our production domestically
- Russia is number 4
  - 6% of production
  - 14m MT



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Phosphate Rock (P) – United States

- Mostly self-sufficient
  - Imports were 13% in 2021
  - That percentage is often lower (2% in 2018)
- Phosphate in the United States (1m MT)
  - Production 22.0
  - Imports 2.4
  - Exports 0.0
  - Consumption 25.0
- Where do imports come from?
  - 87% Peru
  - 13% Morocco

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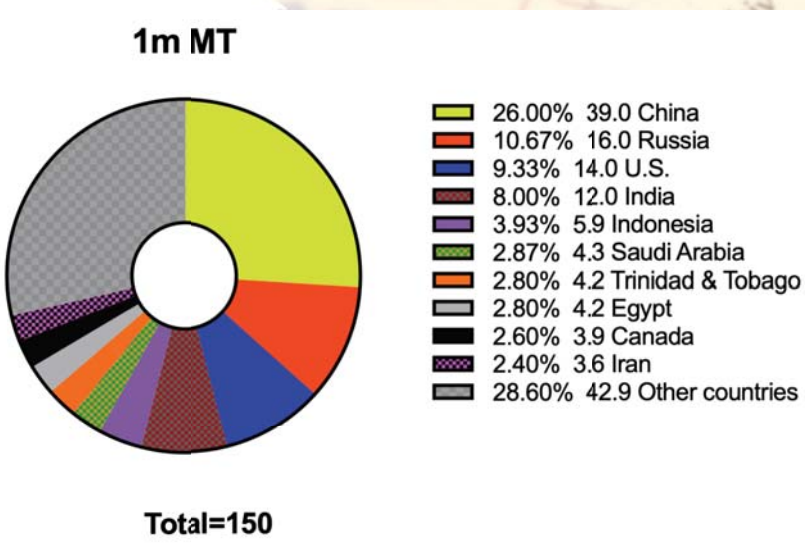
Ammonia (N) – leading production by country

- China is the leading produce in the world
  - 26% of world production
  - 39m MT
- Russia is number 2
  - 11% of world production
  - 16m MT
- U.S. is number 3
  - 9% of world production
  - 14m MT
- Many countries produce nitrogen
  - Almost 30% of world production



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Ammonia (N) – United States

- U.S. is mostly self-sufficient
  - Imports 12%
  - 16 companies, 35 plants, 16 states
  - Plant capacity is at 84%
  - 88% of ammonia is for fertilizer
- Ammonia in the United States (1m MT)
  - Production 14.0
  - Imports 2.2
  - Exports 0.3
  - Consumption 16.0
- Where do imports come from?
  - 63% Trinidad and Tobago
  - 34% Canada
- No new announced plans for expansion

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Effects of disruption to Russian supplied fertilizer

- U.S. is largely self-sufficient for:
  - Ammonia production (N)
  - Phosphate rock (P)
- No supply issue for N and P anticipated
  - Likely price increases
- Potash (K) is the big question
  - Both supply and price
  - Most from Canada so less direct influence from Russia
  - Greatest price increases
  - Potash may be underpriced relative to anhydrous even before this started

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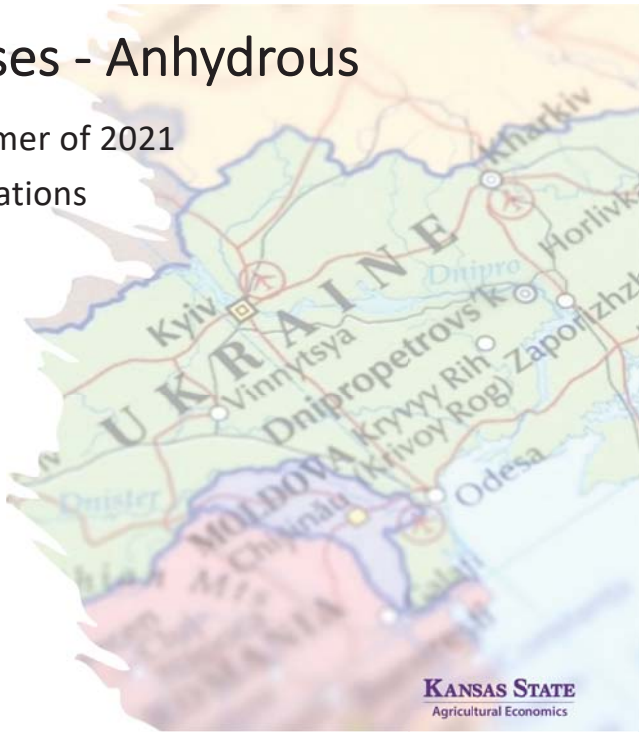
Estimating price increases - Anhydrous

- Old model worked great until summer of 2021
- New model added inflation expectations

2020 model: Anhydrous ammonia ($/ton) =
202
+ 43.4 * corn ($/bu)
+ 3.18 * oil_9 mo lag ($/ barrel)

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



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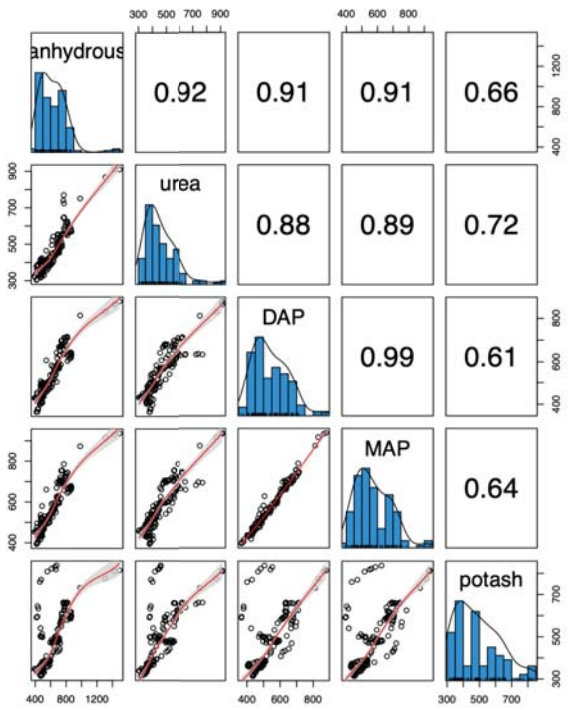
Other fertilizers are highly correlated to anhydrous



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Representation of N, P, and K

- Nutrients
  - N – Anhydrous ammonia (82-0-0)
  - P – MAP (11-52-0)
  - K – Potash (0-0-60)
- Correlations with anhydrous
  - MAP – 0.91
  - Potash – 0.66

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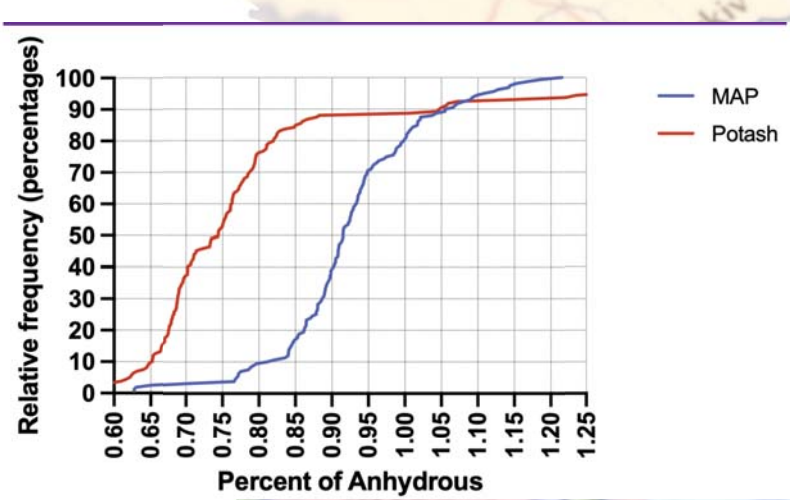
Pricing relationship of anhydrous to MAP and Potash

- Map – 92% of anhydrous price
- Potash – 75% of anhydrous price
  - Wider variation is reflected on lower correlation



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Predictions

- Assuming 9% inflation
- Both MAP and Potash are currently priced lower than expected relative to historical norms
- Possible increases
  - Anhydrous – 20% increase
  - Map – 60% increase
  - Potash – 75% increase

Anhydrous		Corn $ 6.00	Corn $ 7.00	Corn $ 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	Corn $ 7.00	Corn $ 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	Corn $ 7.00	Corn $ 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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Conclusions

- N, P, and K are likely headed higher due to higher fuel prices and because Russia is a major producer of all 3 fertilizer nutrients
- Availability of N and P should be adequate
- Availability of K less certain but importing from Canada helps
- Potash prices likely to rise the most
- Short-term - Nitrogen needs are the most critical to maintain yields
- P and K needs could be restricted and still not hurt yields this year
- Higher fertilizer prices could add $50/acre to cost of growing corn
  - Fertilizer might now be 35% of all crop expenses

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Questions?

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