Inorganic Fertilizer Data

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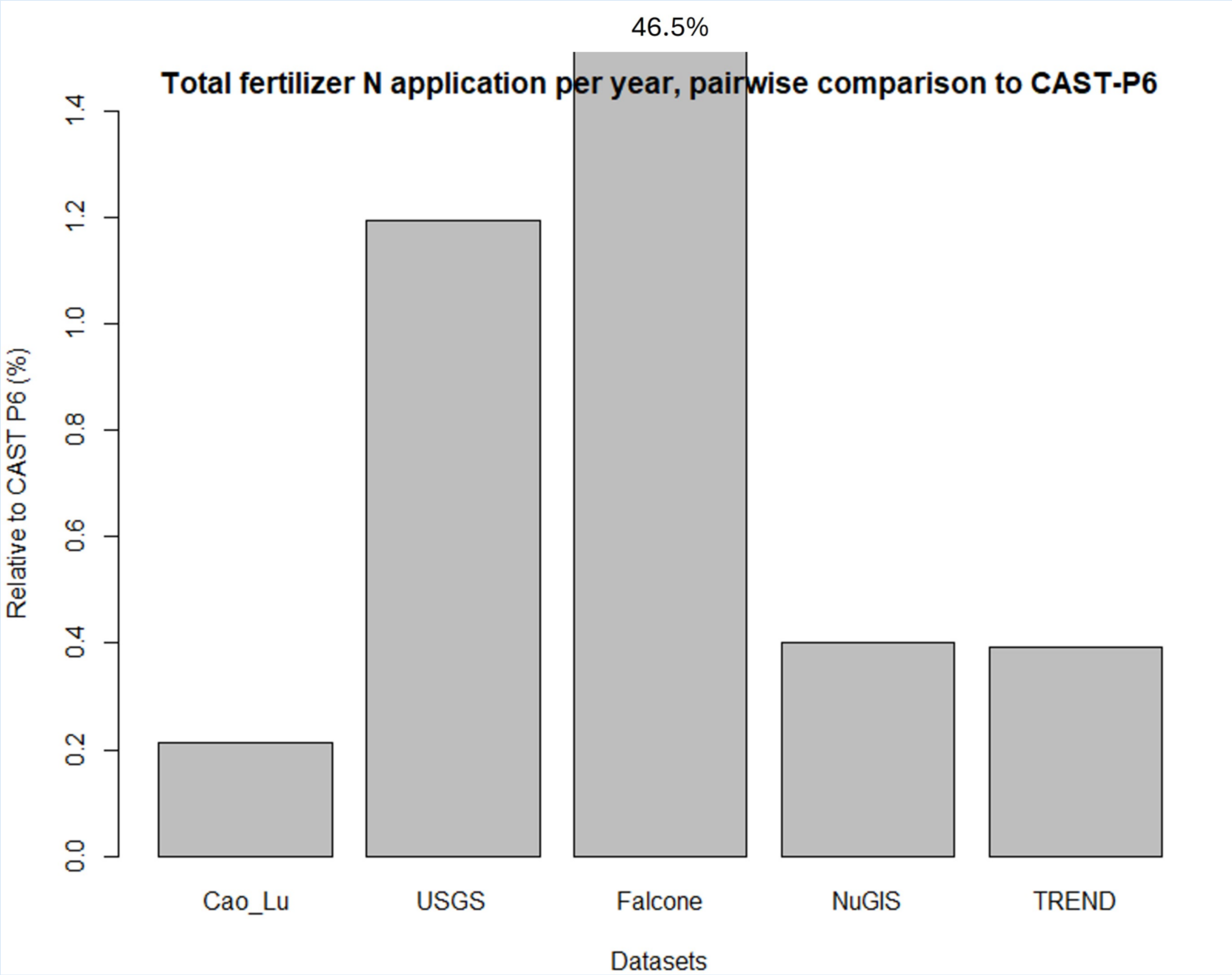
Other Datasets

- CAST '23 is comparable at the watershed scale
- Falcone uses CoA dollars spent on fertilizer as predictor
- All others use fertilizer sales with state buckets
- Most treat manure and fertilizer independently, Falcone is the exception



Takeaways:

- CAST 23 currently predicts (slightly) lower fertilizer across the watershed than several other data sets
- However, results are comparable except for Falcone

What is happening since 2009?

Let’s do some digging

Are trends in CAST fertilizer application related to real world observations?

Can we explain the variation in fertilizer application not accounted for by yields?

- These analyses are all done at the watershed scale and evaluate temporal trend rather than spatial distribution.

Fertilizer prices have been volatile over the CAST model period

Brief increase in the mid 90s, but a historic rise and peak through the ’00s.

“U.S. prices of fertilizer nutrients began to rise steadily in 2002 and increased sharply to historic highs in 2008 due to the combined effects of a number of domestic and global long- and shortrun supply and demand factors.”

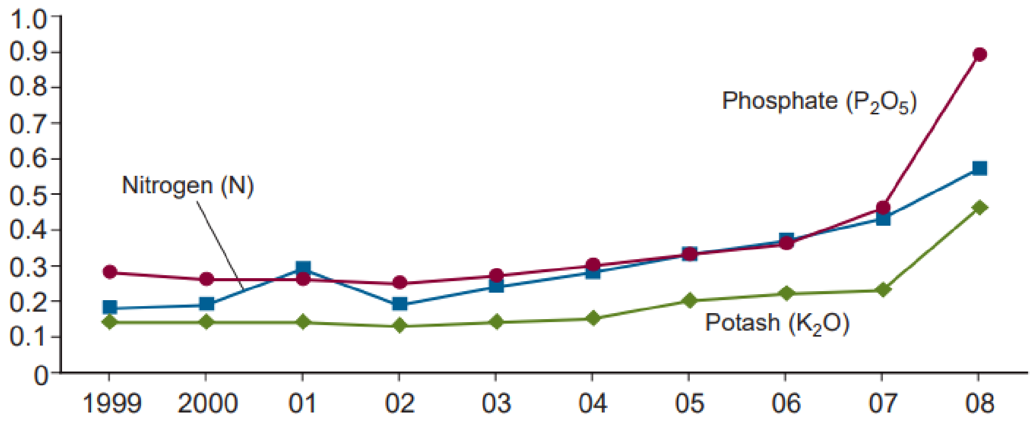
“…rapidly rising natural gas costs resulted in significantly higher production costs for domestic producers…”

- USDA, 2009., Factors Contributing to the Recent Increase in U.S. Fertilizer Prices, 2002-08

Figure 1

Historic U.S. April prices of fertilizer nutrients

Dollars/pound nutrient

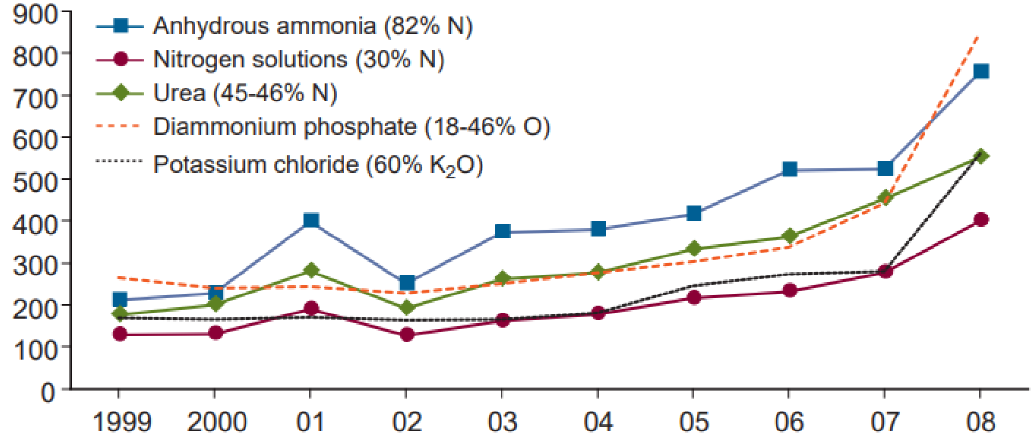


Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service, *Agricultural Prices, 1999-2008*.

Figure 2

Historic April prices of major fertilizers used in the United States

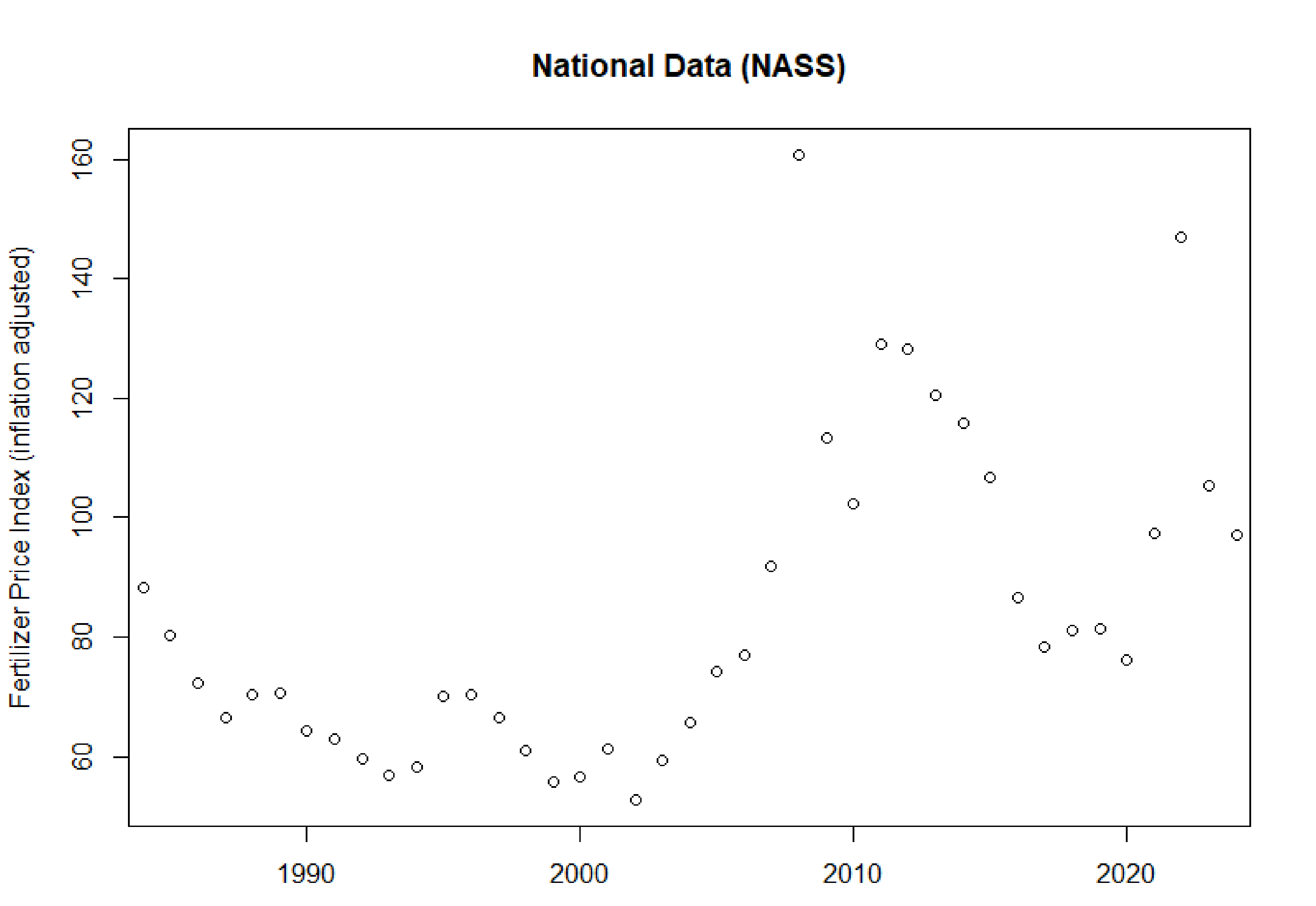
Dollars/ton material



Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service, *Agricultural Prices, 1999-2008*.

Prices returned to normal levels in the late ‘10, but spiked again in 2022

Model runs currently limited to 2020



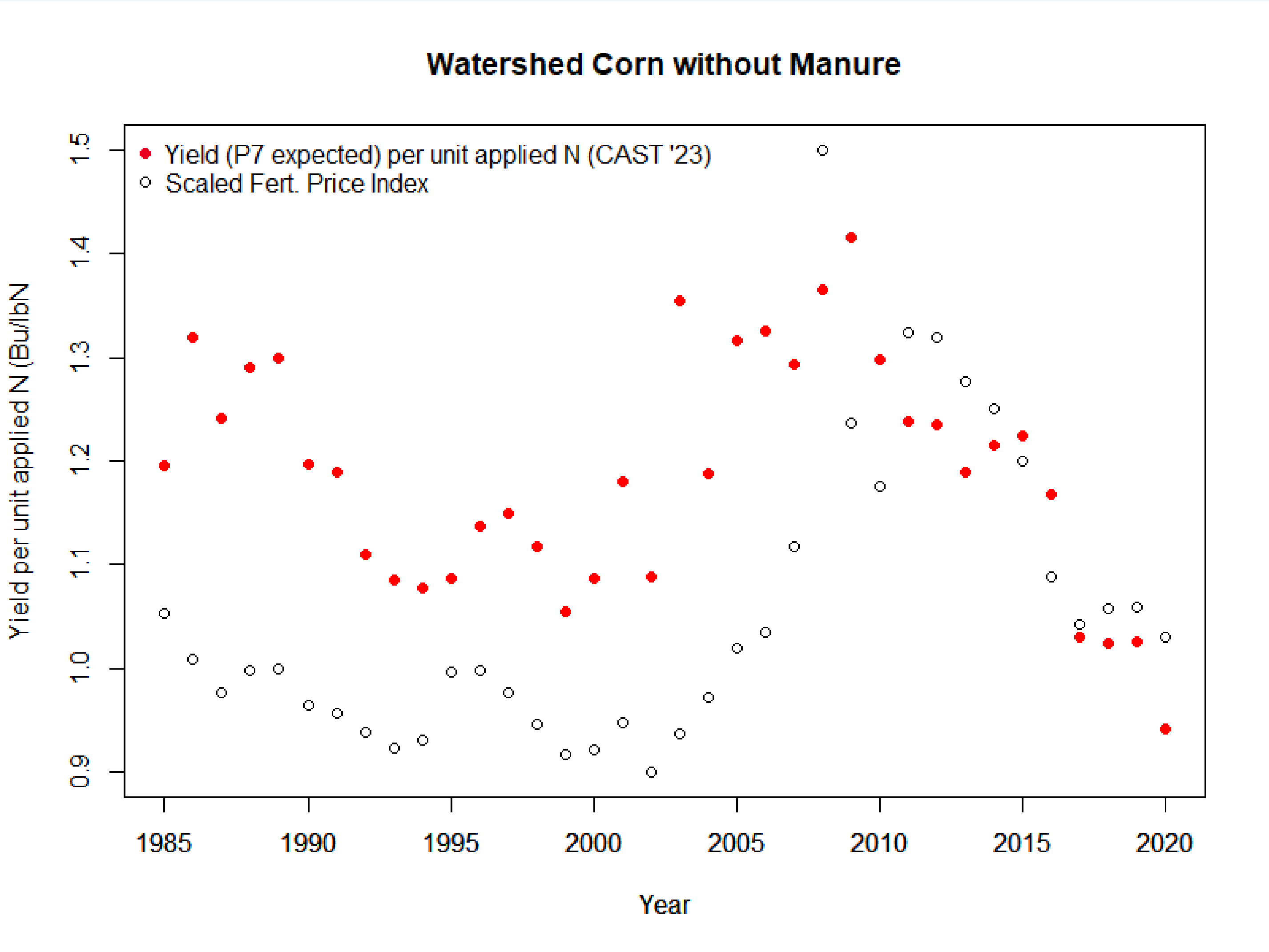
N Efficiency

There are lots of ways to visualize the impact of price on applications.

Nutrient efficiency ratio, aka, The Ken way

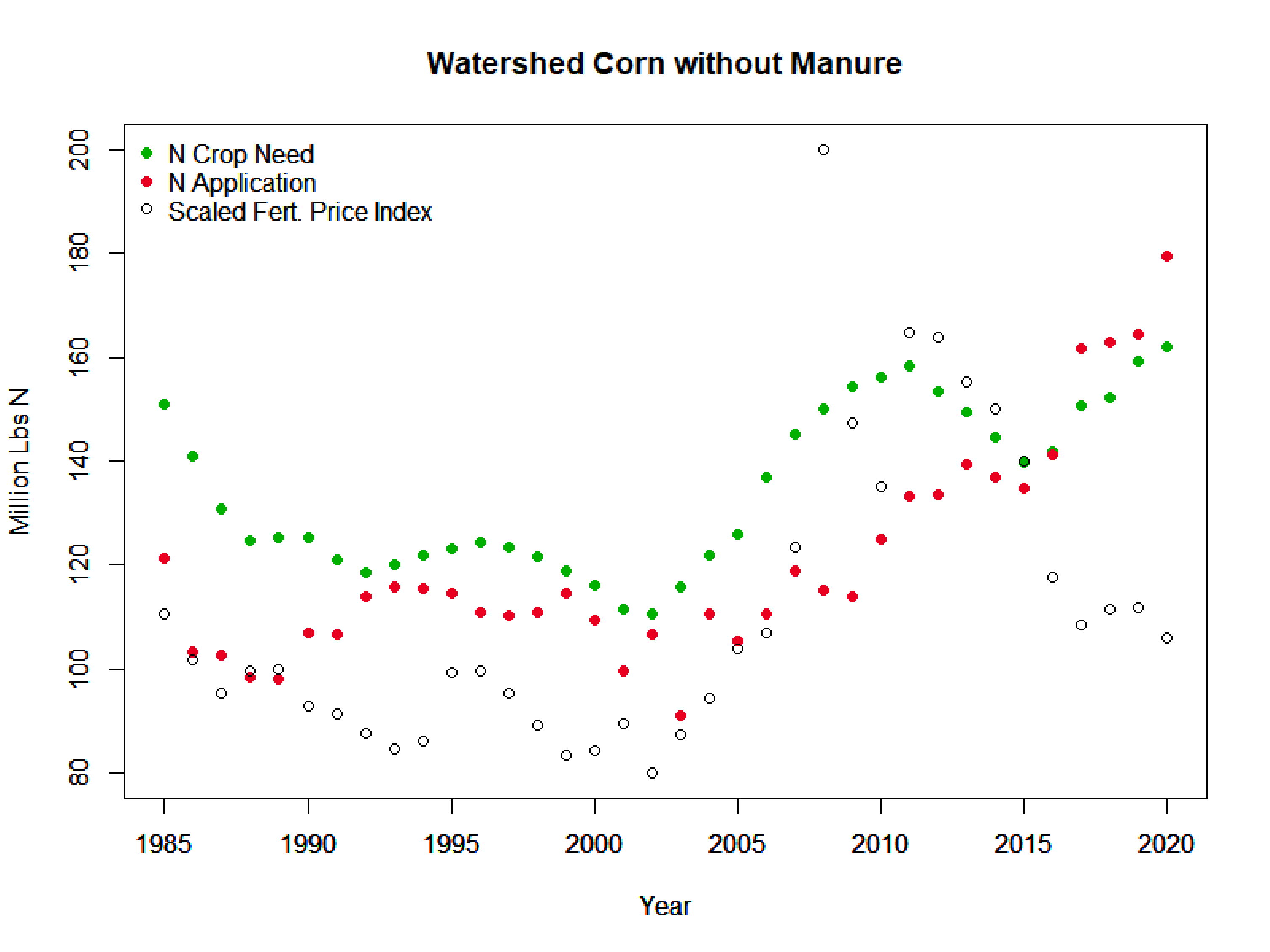
This is the yield of corn in Bu divided by the applied N.

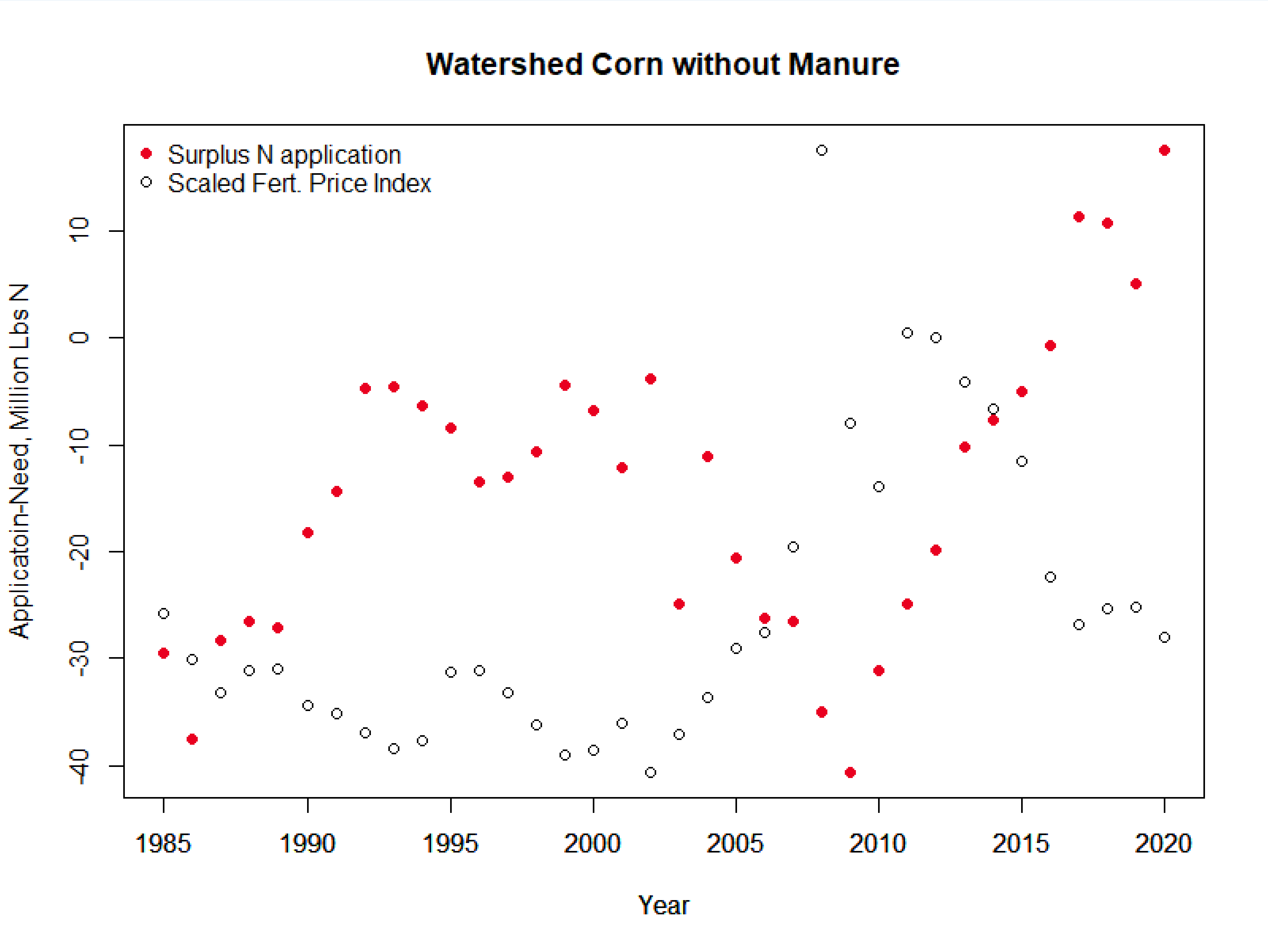
The nutrient efficiency tracks the fertilizer price index.



Crop Need and Applications

The difference between crop need and application is the largest when price is high.





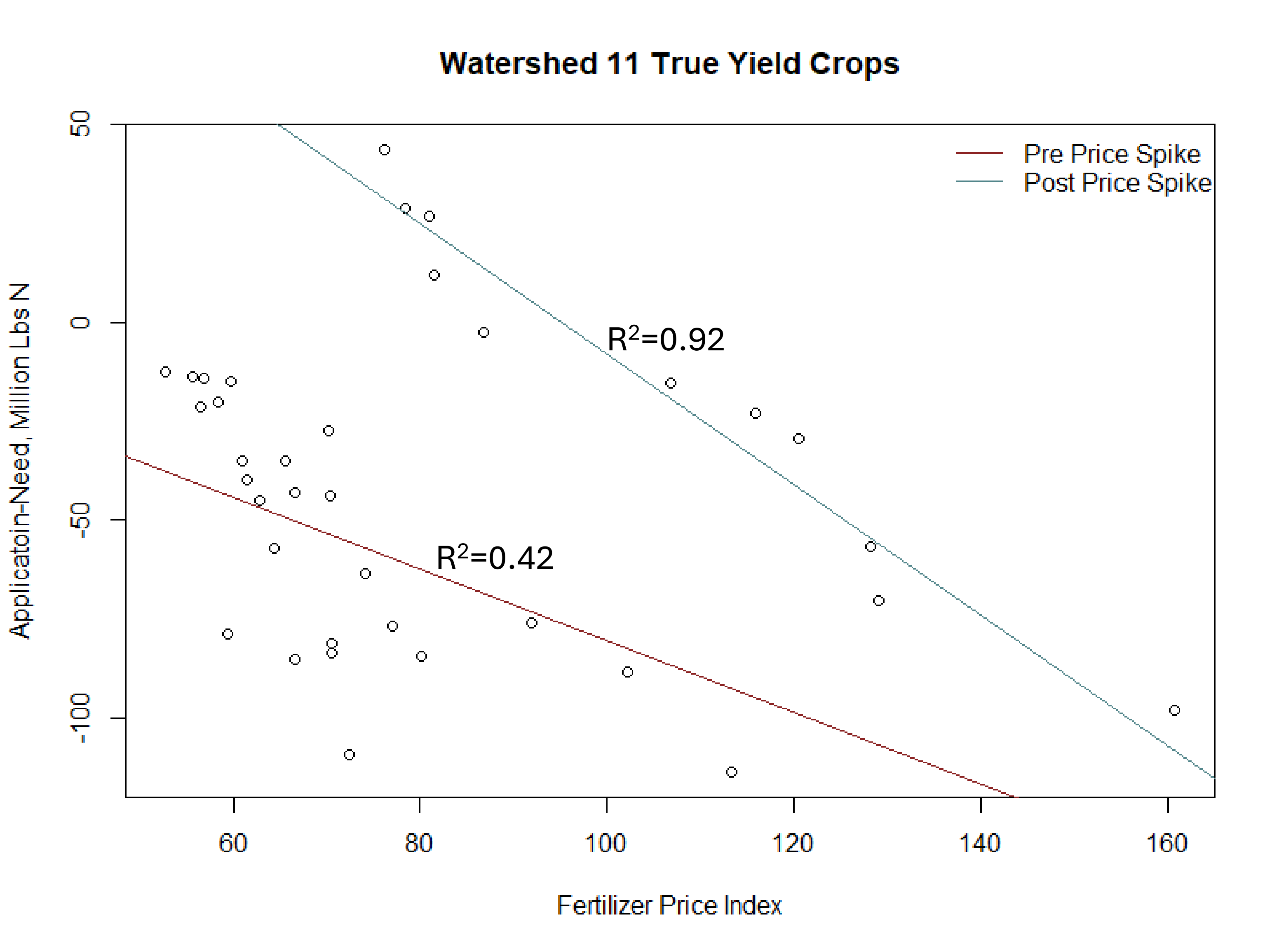
Watershed Corn without Manure
Surplus N application
Scaled Fert. Price Index
Applicatoin-Need, Million Lbs N
10
0
-10
-20
-30
-40
1985
1990
1995
2000
2005
2010
2015
2020
Year

Surplus v. Fertilizer Price Index: Nitrogen

This trend is consistent across all major crops.

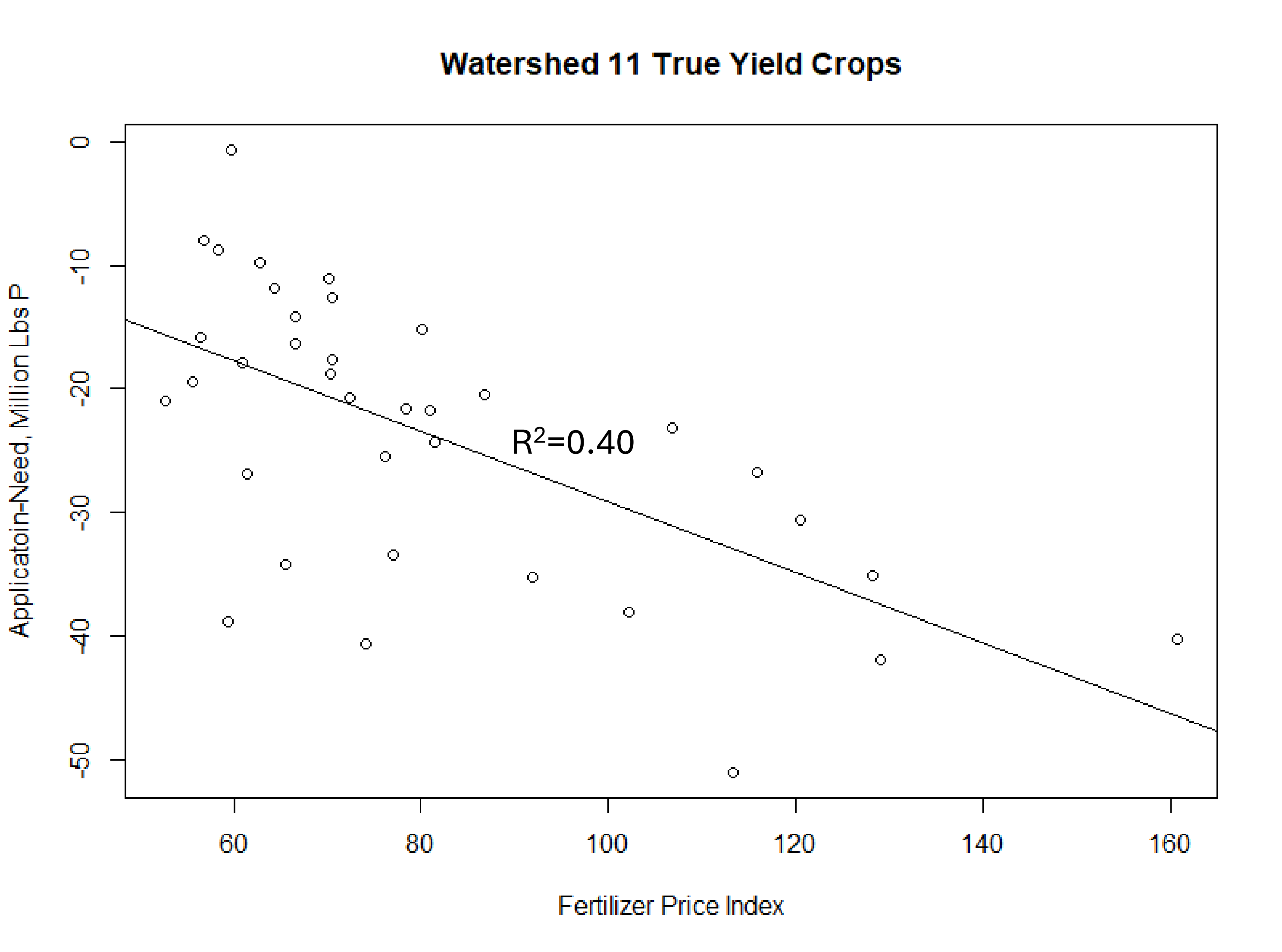
The surplus, defined as application – crop need, is well correlated to the fertilizer price index.

Nitrogen shows distinct behavior pre and post price spike.



Surplus v. Fertilizer Price Index: Phosphorus

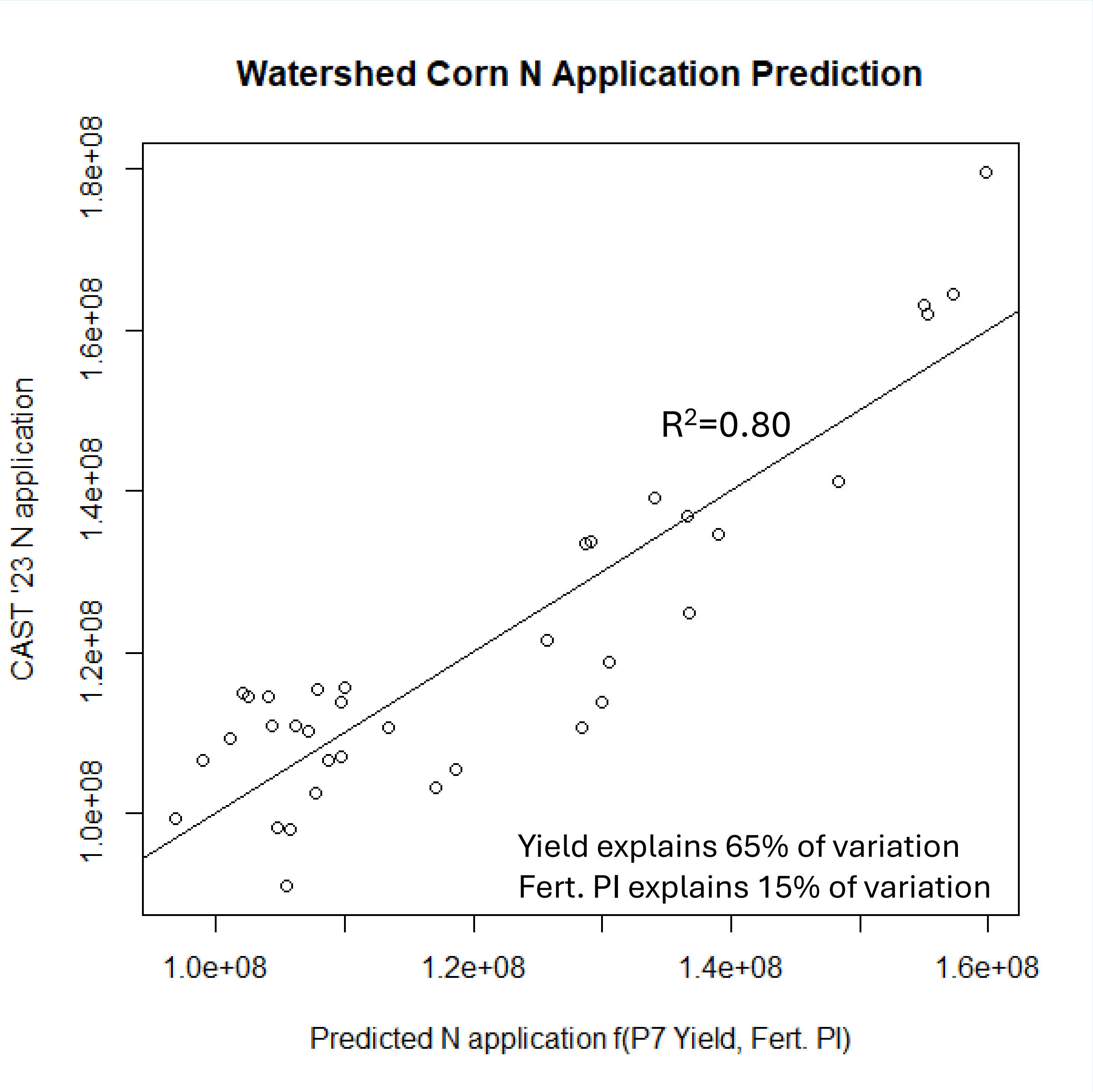
The correlation between phosphorus surplus and fertilizer price index has been more consistent through time.



Modeled with Real World Obs.

Well predicted by yields and fertilizer price.

The expected yield, which is fit to the combined census and survey observations, and the fertilizer price index, are well correlated to CAST fertilizer application estimates.



In Summary…

CAST predicted application of fertilizer is well correlated to observed data (yields and fertilizer price).

This suggests that at the watershed scale, CAST captures trends in fertilizer application. Trends are the most important inputs to CAST.

What if we use a different dataset with more fertilizer?

CAST 23	TREND

• Annual 1985-present
• AAPFCO and state data
	• 0.4% higher annual application
	• Annual 1930-2017
	• Composite of multiple datasets
	  • Several USGS, Cao et al 2018, USDA ERS
	  • Generally, state bucket AAPFCO
	• Have only run N (P recently available)

Results: Distribution of calibration stations

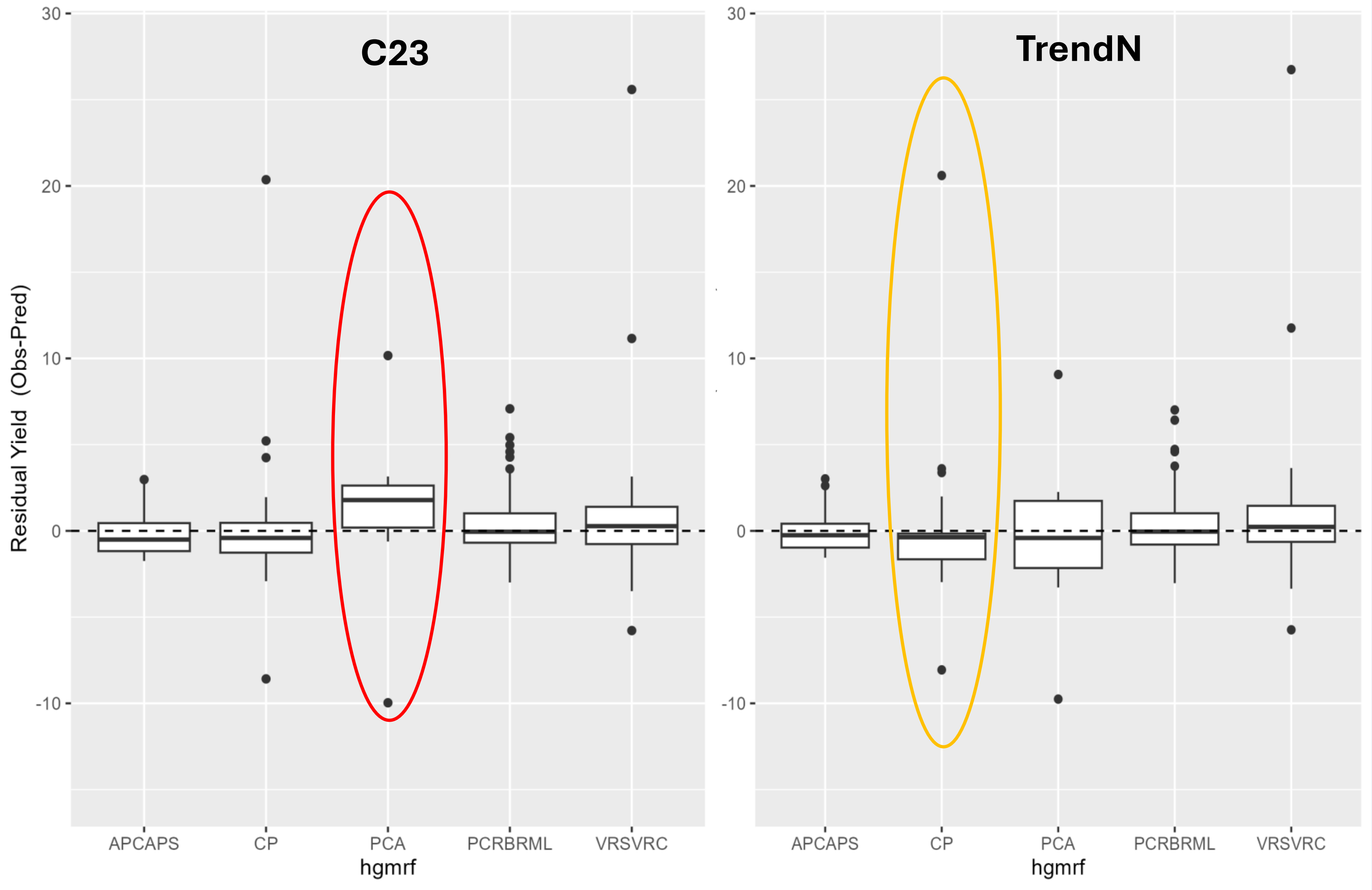
APCAPS:	Appalachian Plateau Carbonate, Appalachian Plateau Siliciclastic	38 stations
CP:	Coastal Plain	21 stations
PCA:	Piedmont Carbonate	7 stations
PCRBRML:	Piedmont Crystalline, Blue Ridge, Mesozoic Lowland	74 stations
VRSVRC:	Valley and Ridge Carbonate, Valley and Ridge Siliciclastic	66 stations

Residual yield (lbs/ac) by hydrogeomorphic region

No substantial difference to total loading or to model fit!

There are small differences spatially:

- C23 tends to underpredict fertilizer N load in the Piedmont
- TrendN tends to slightly overpredict fertilizer N load in the Coast Plain



Another bonus of CalCAST: seeing the math

- CalCAST looks to change coefficients to statistically find the optimal parameters
- If two data sets are similar these coefficients will not substantially change
  - What did the results of CalCAST show us?

Coefficent	Cast 23 estimated mean (95% confidence Interval)	Trend N estimated mean (95% Confidence Interval)
watershed-wide average crop loading rate (lbs/ac)	40.07 (38.14-42.01)	39.43 (37.49-41.29)
land-to-water coefficient for groundwater recharge	0.61 (0.54-0.67)	0.66 (0.60-0.72)
land-to-water coefficient for % carbonate lithology	0.23 (0.07-0.39)	0.31 (0.13-0.54)
land-to-water coefficient for soil K-factor	0.8 (0.70-0.88)	0.83 (0.73-0.94)
land-to-water coefficient for density of small streams	-0.36 [(-0.55)-(-0.14)]	-0.58 [(-0.76)-(-0.39)]

Things to note:

- In the end there is no clear “winner”
- Spatial variations exist between data sets

The processing of data matters too

- Two sectors
  - Agriculture
  - Urban

Ag fertilizer processing

Six State Level

AAPFCO/State

X

- Fertilizer lbs are summed to the state level and smoothed
- The fraction of fertilizer for agricultural use is determined for each state
- Each states smoothed agricultural data are combined into a single stock

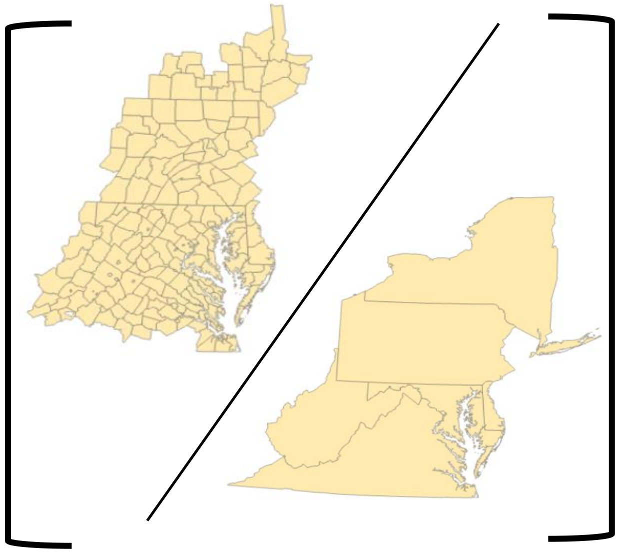
Ag fertilizer processing

Six State Level

AAPFCO/State

X

Expenditures Fraction



Ag Census

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- Fertilizer lbs are summed to the state level and smoothed
- The fraction of fertilizer for agricultural use is determined for each state
- Each states smoothed agricultural data are combined into a single stock

- Census of Agriculture Soil Amendment Expenditures are used to determine the ratio of USD spent on fertilizer in the watershed portions of each state

Ag fertilizer processing

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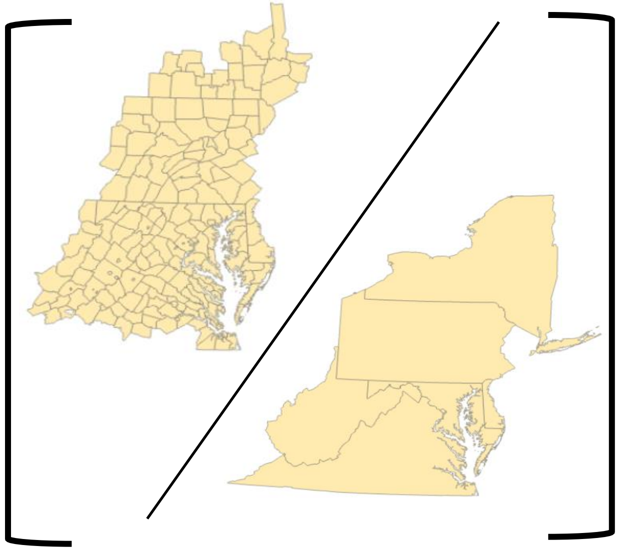

Ag Census

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Counties & CBW Levels

AAPFCO/State & Ag Census

- Fertilizer lbs are summed to the state level and smoothed
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- Each states smoothed agricultural data are combined into a single stock

- Census of Agriculture Soil Amendment Expenditures are used to determine the ratio of USD spent on fertilizer in the watershed portions of each state

- The watershed amount of fertilizer is calculated by multiplying the agricultural stock by the proportion of fertilizer purchased within the watershed

Urban fertilizer processing

Individual state level

AAPFCO/State

- Non ag fertilizer lbs are summed to the state level and smoothed

Urban fertilizer processing

Individual state level

AAPFCO/State

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Individual state Turfgrass acres

State (CAST)

- Non ag fertilizer lbs are summed to the state level and smoothed
- Turfgrass acres in CAST are summed for each state
- Each state has a specific application rate for turfgrass

Urban fertilizer processing

Individual state level

AAPFCO/State

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Individual state Turfgrass acres

State (CAST)

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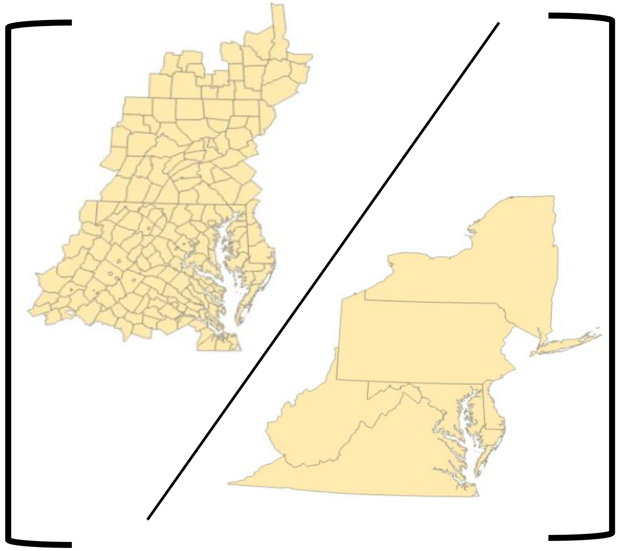
State specific application rate



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- Each state has a specific application rate for turfgrass

NOTE* DC is a combination of MD and VA rates

Key differences in fertilizer processing:

Agriculture	Urban
• Watershed scale • Fraction of ag vs urban • Exclusion of non watershed fertilizer with economic ratio	• State scale • State application per acre to avoid outside of watershed effects

Questions?

What should we do?

- Update state data
  - July 11th
- Discuss methodology
  - Processing
    - Stay with current ag?
    - Move towards urban?
  - Scale
    - State?
    - At what point in the processing?

Updating state data

Jurisdiction	POC
DE	Justin Lontz
MD	Phil Davidson
NY	Jan Morawski
PA	David Dressler
VA	Wayne Pendleton
WV	Chad Linton

- Collect fertilizer tonnage
- July 11th due date
- Example of data fields requested:

Year State FinalFIPs RepPeriod FarmReal RealTons RealLbs Nconc Pconc FarmNLbs NonFarmNLbs UnknownNLbs FarmP205Lbs NonFarmP205Lbs UnknownP205Lbs