Nutrient Use Trends in Production Agriculture

Nutrient Summit

Springfield, IL

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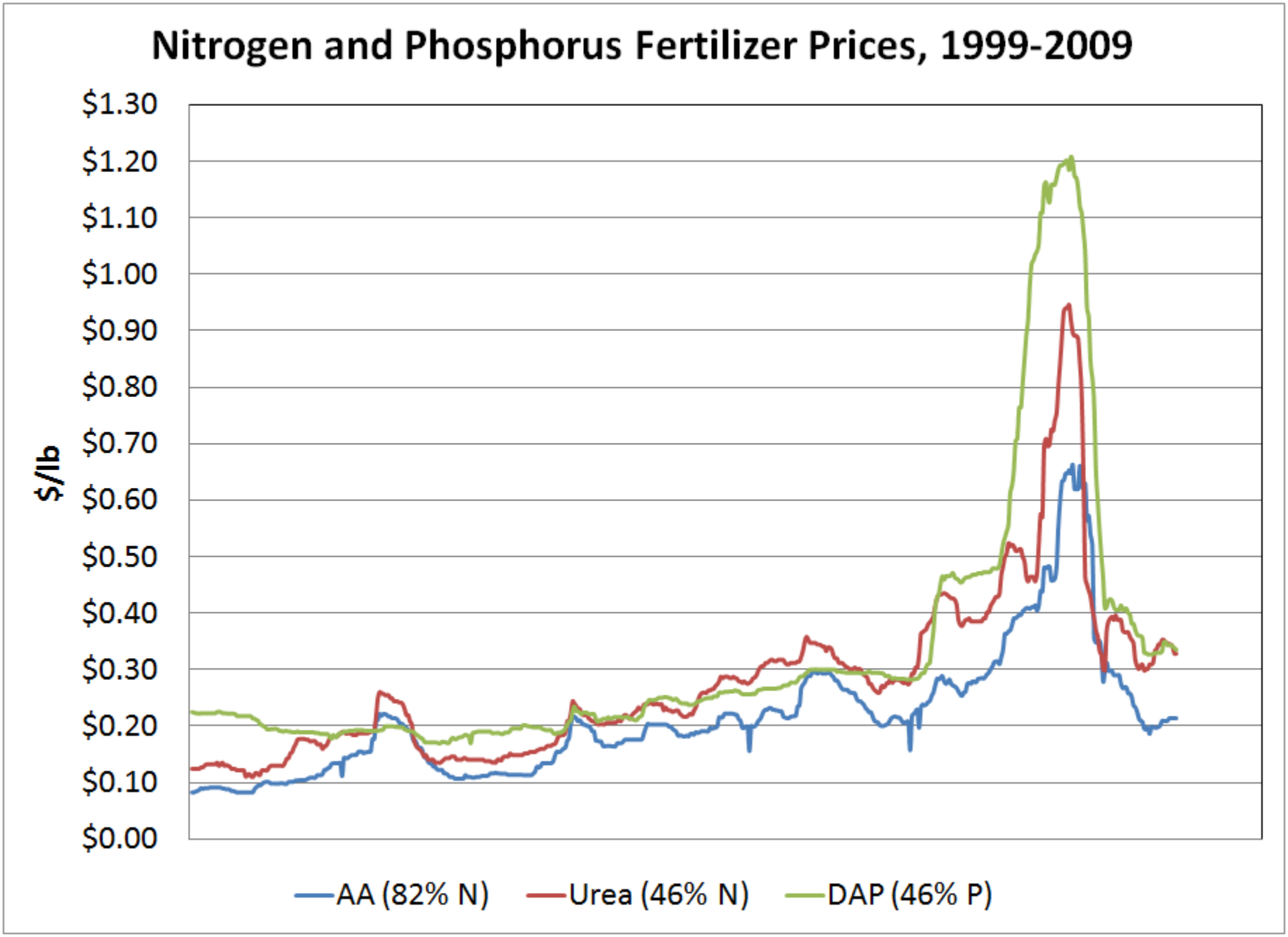
Outline

- Economics of Nutrient Use
- Trends in Nitrogen and Phosphorus Use
- New Technologies
  - Crop Genetics
  - Fertilizer Innovations
  - Application Method Innovations

Economics of Nutrient Use

- Farmers apply nutrients to maximize *expected* returns
  - Increases in relative input prices will lead to reductions in application rates
  - Fertility costs represent an increasingly large portion of total production costs
    - Increased from 33% to 40% of total direct costs over the past 10 years (Schnitkey and Lattz, *farmdoc*)


Nitrogen and Phosphorus Fertilizer Prices, 1999-2009
$/lb
$1.30
$1.20
$1.10
$1.00
$0.90
$0.80
$0.70
$0.60
$0.50
$0.40
$0.30
$0.20
$0.10
$0.00
AA (82% N)
Urea (46% N)
DAP (46% P)

Economics of Nutrient Use

- Farmers face a significant amount of uncertainty
  - Nutrient availability
  - Weather and timing of field operations
- Application rates must account for each of these
  - “Over-application” is easy to observe in hindsight, but planning occurs before weather and growing conditions are known

Application Methods and Timing

Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug
	Harvest						**Corn Planting**				

Tillage alternatives

Typical Tillage:	"Heavy" tillage		Spring tillage
Strip tillage	Strip Tillage	<---------- or ---------->	Strip Tillage

Nitrogen application alternatives

Fall	<---------- or ---------->	Spring	< or >	Side dress

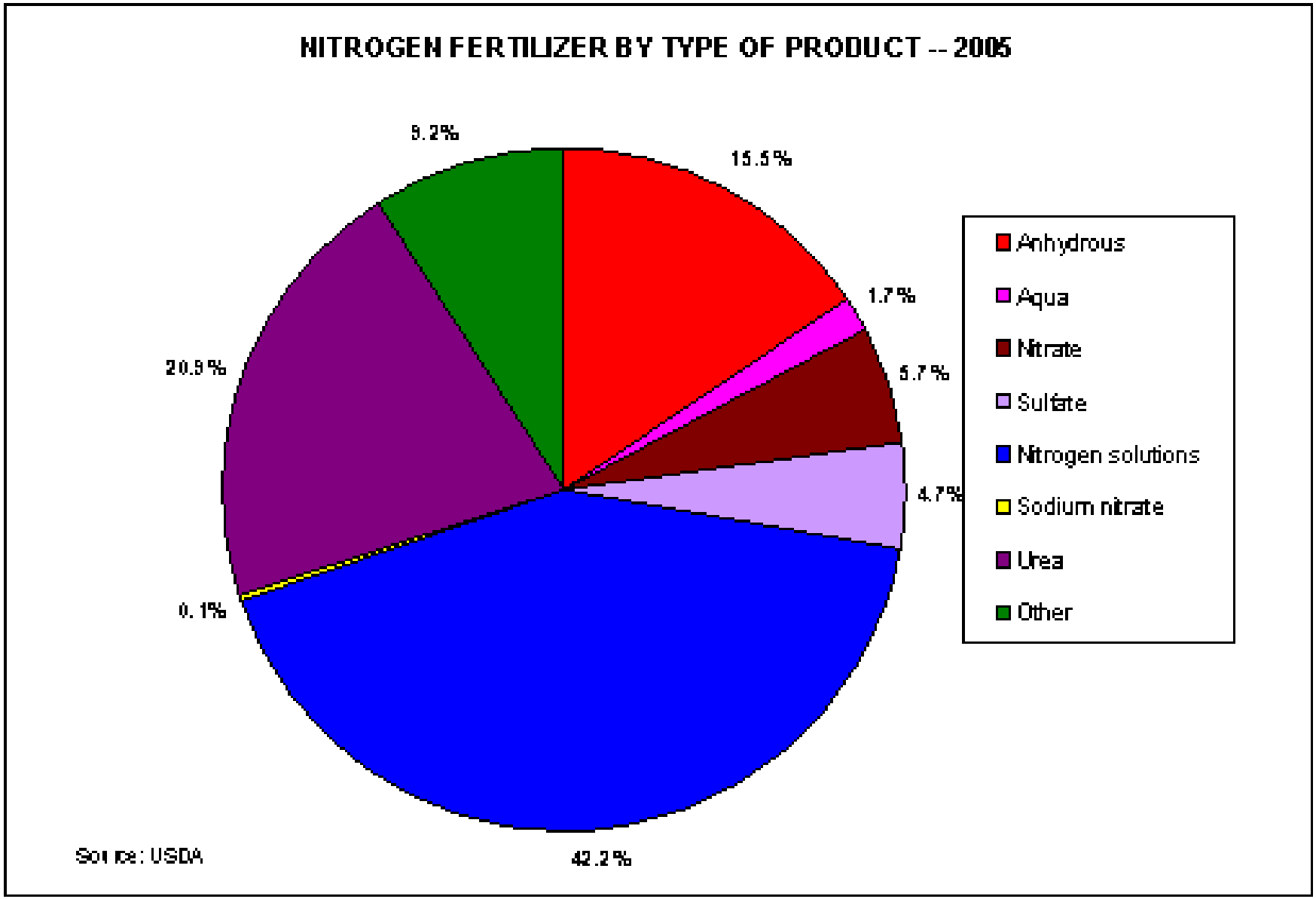
Figure 1. Typical Timing of Field Operations for Corn Production in the Midwest.

Application Methods and Timing

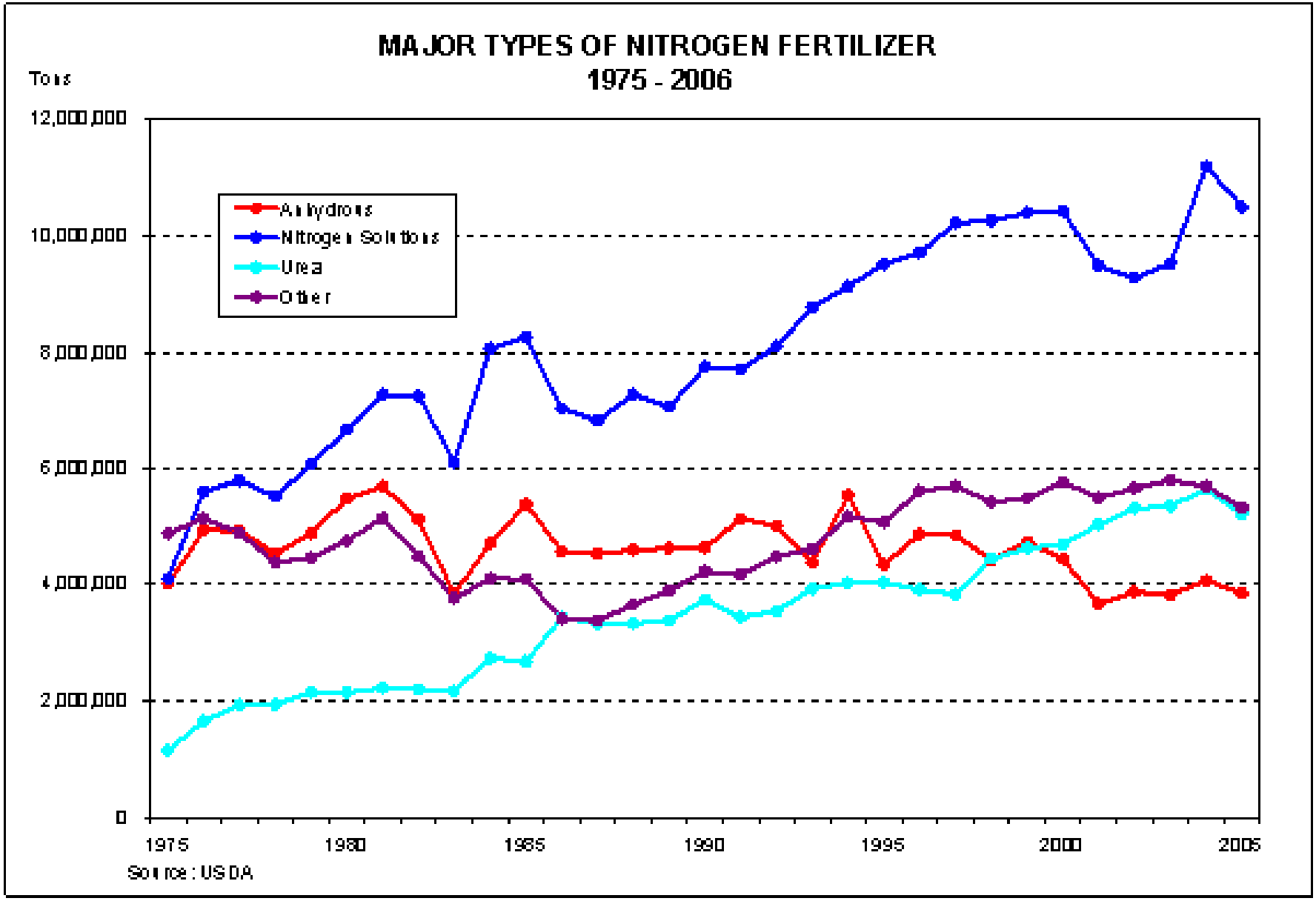
- Fall: 77% chance of a working field day
  - Typically anhydrous ammonia (82% N) would be applied

- Spring
  - April: 47% chance of a working field day
  - May: 57% chance of a working field day
  - Field operations limited by plant growth
  - Typically nitrogen solutions (28% N) or urea (46% N) could be applied
    - Prior to and/or at planting
    - Side-dressed after emergence

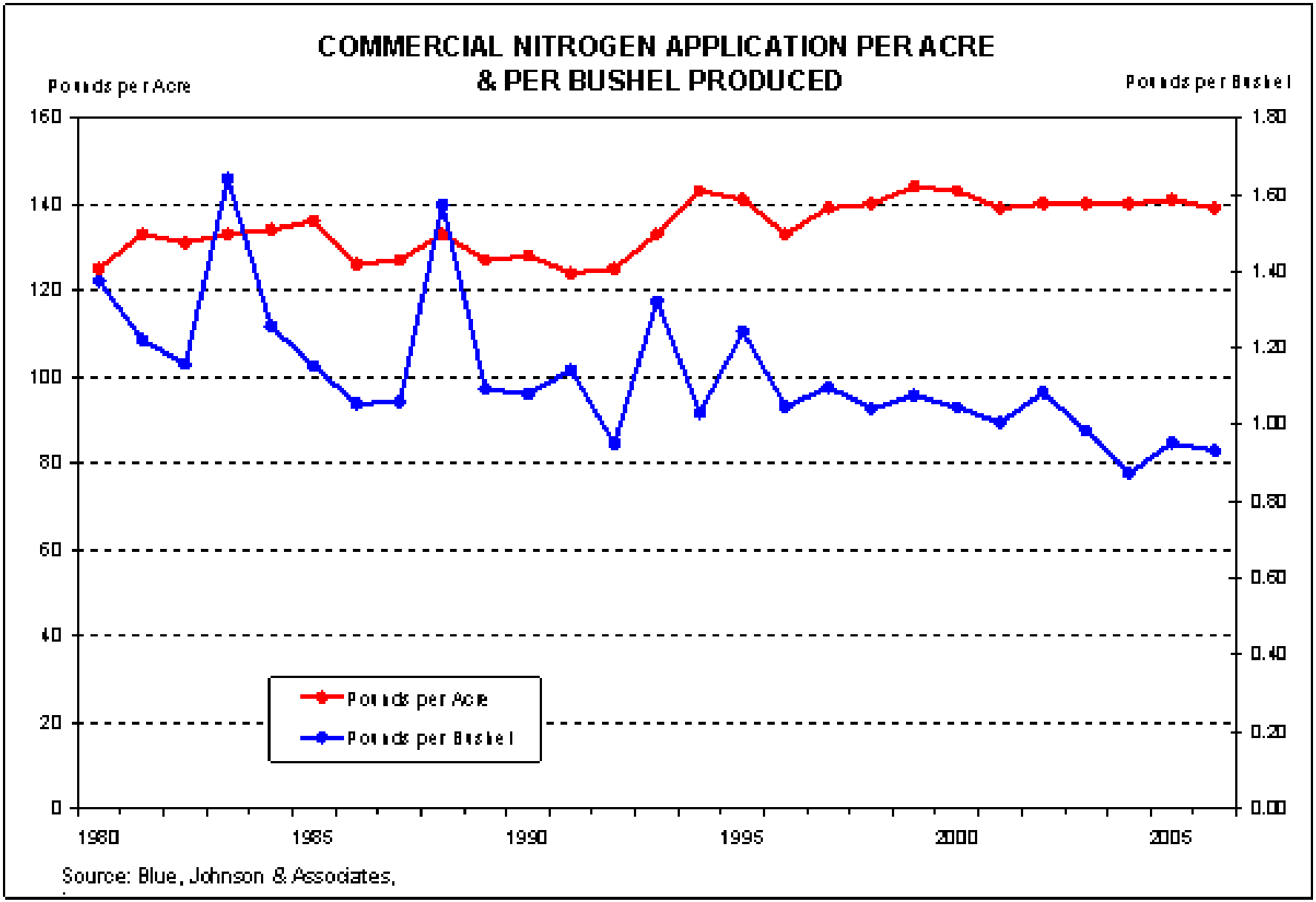
Fertilizer Use by Type – U.S.



Fertilizer Use by Type – U.S. Trends



Historical Application Rates: N



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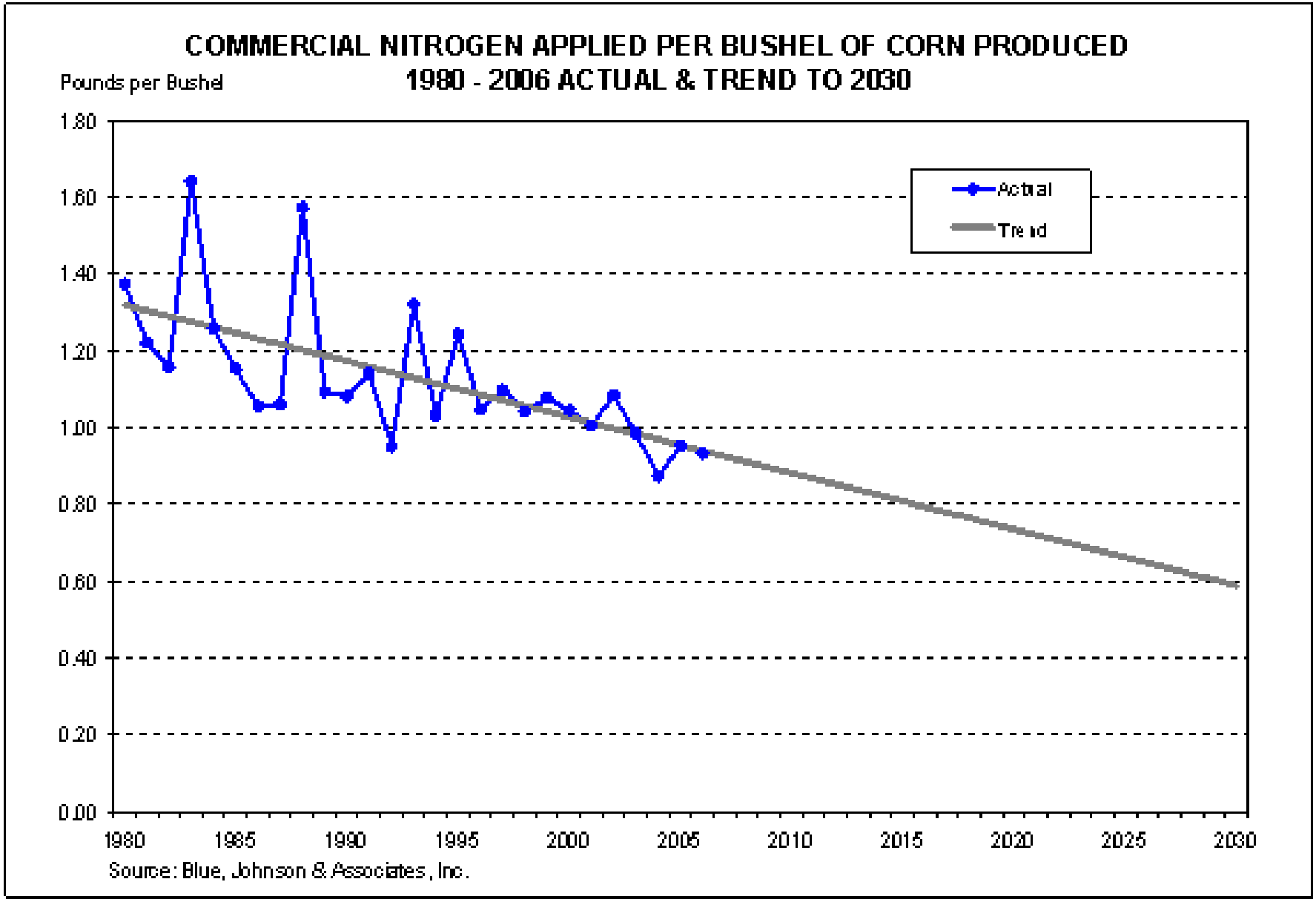
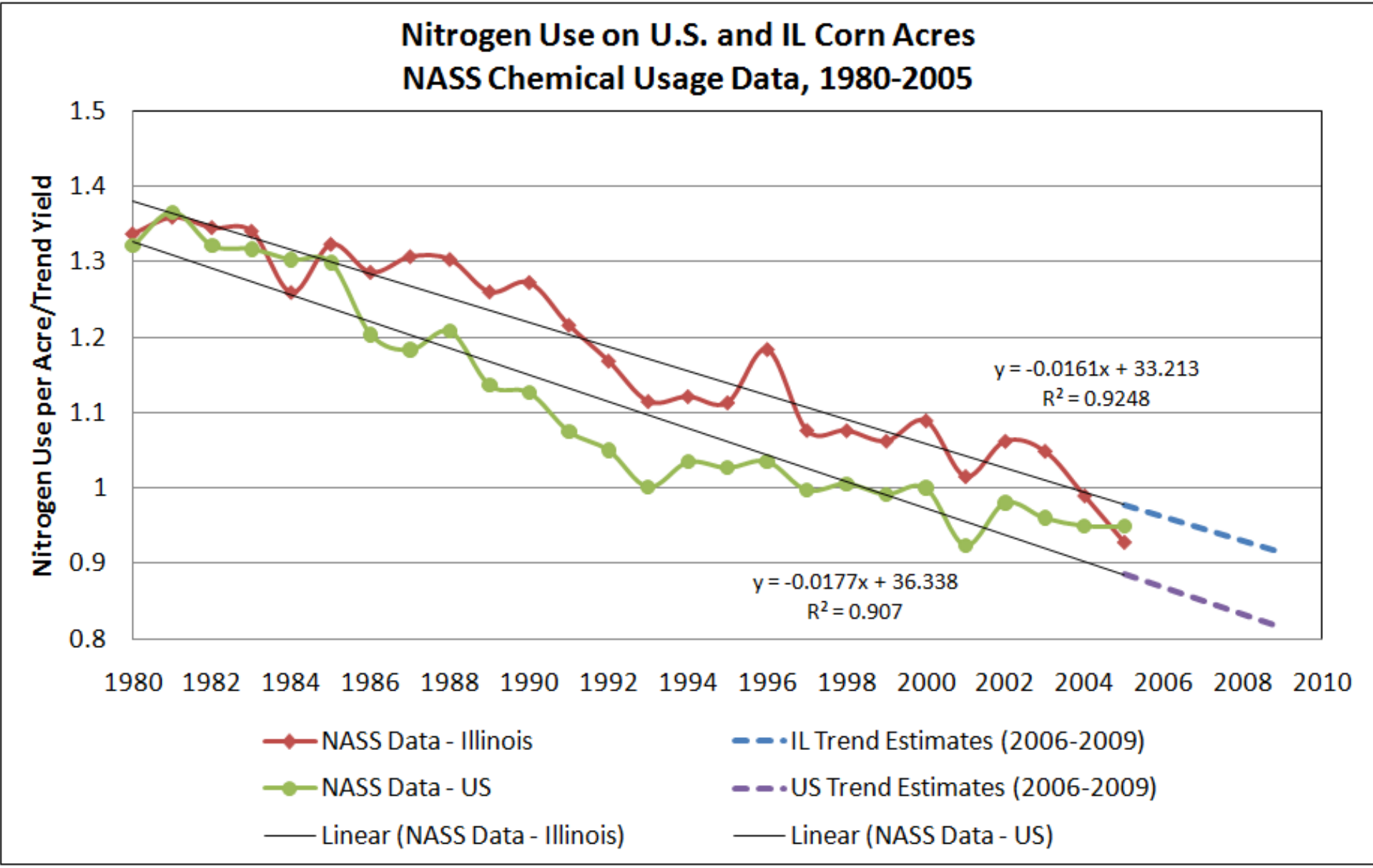
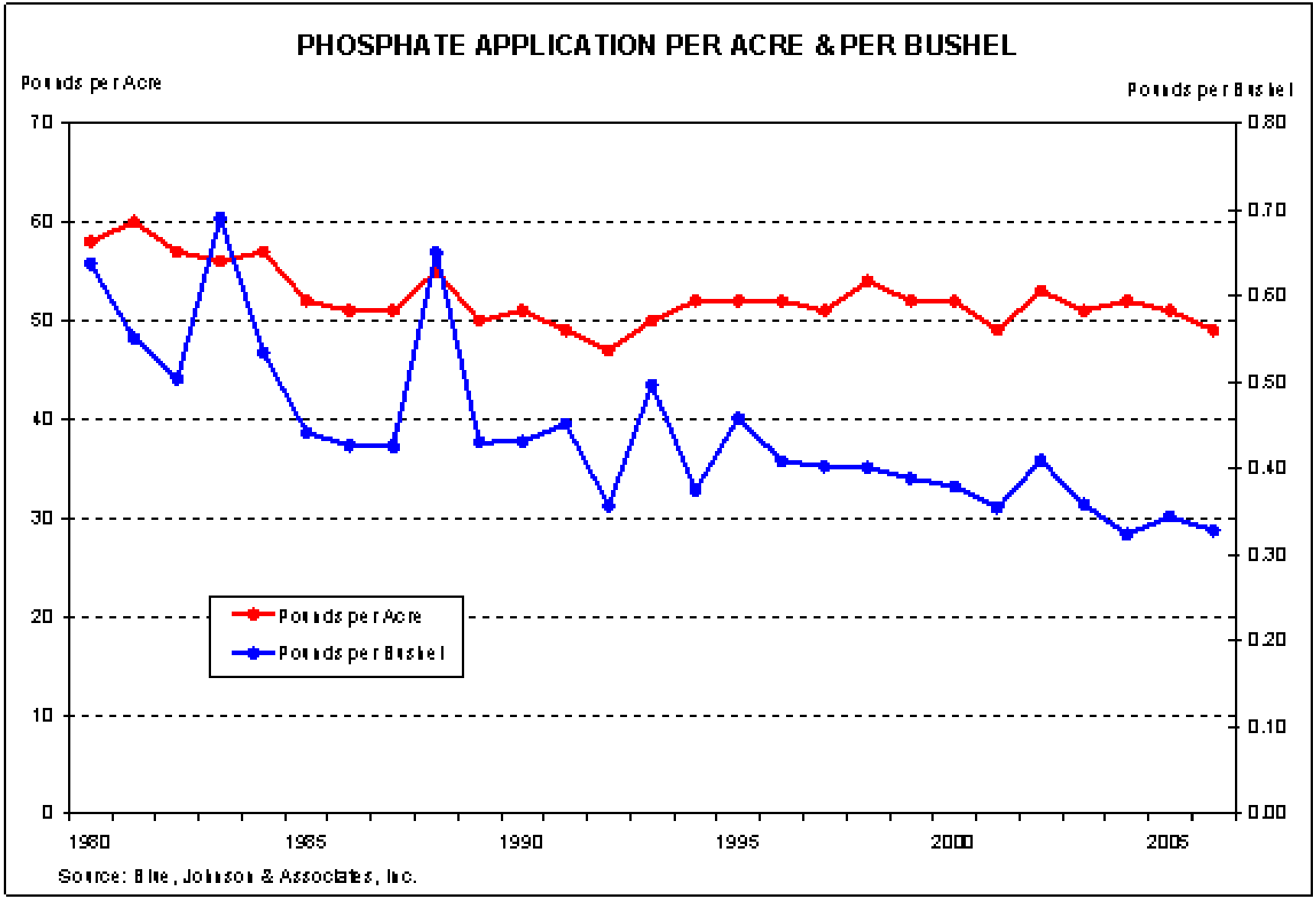


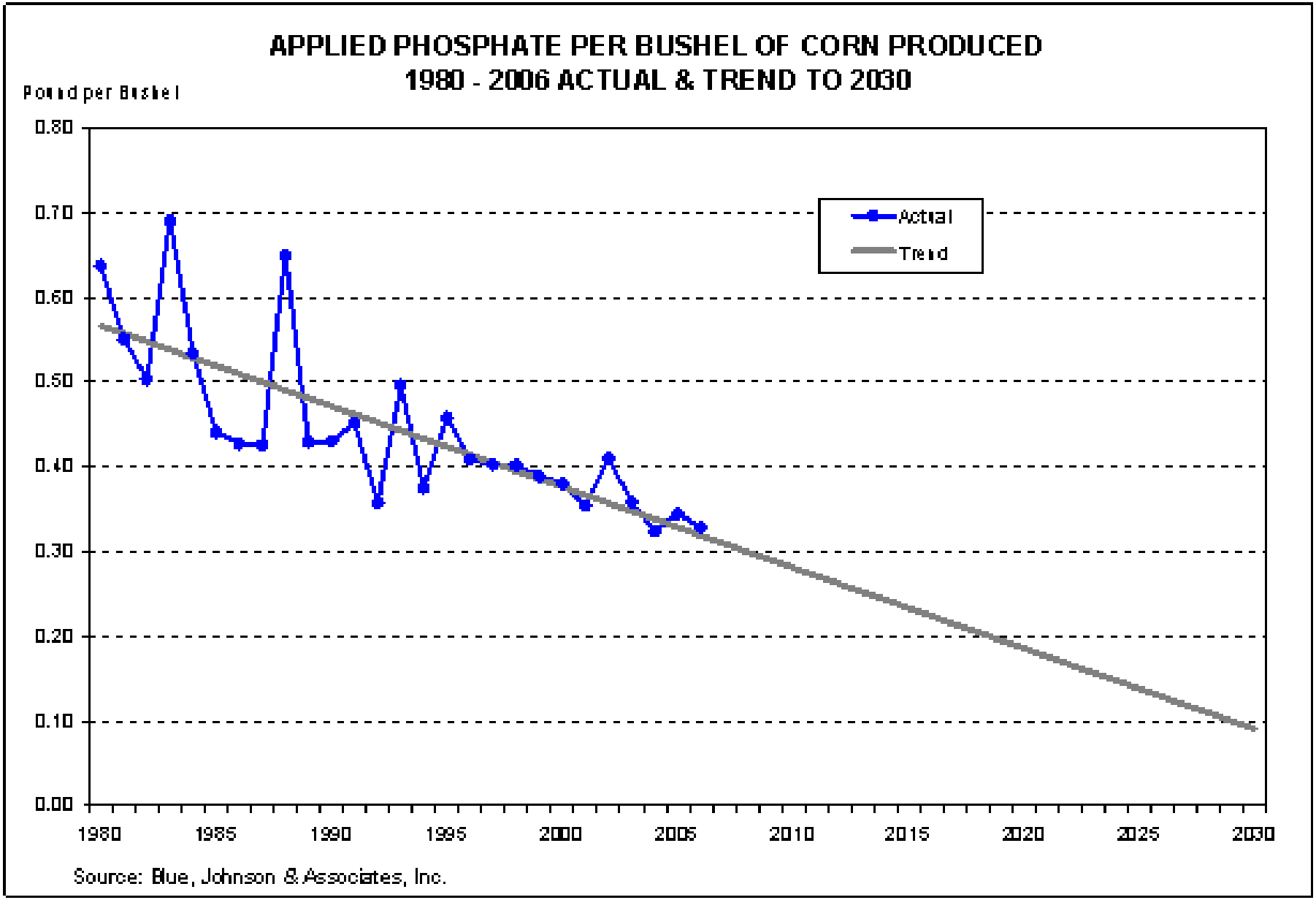
Historical Application Rates: N



Historical Application Rates: P



Historical Application Rates: P



How have we achieved this?

- Combination of
  - Improved crop genetics and agronomics
  - Improved management techniques
  - Improvements in other technologies (i.e. machinery)

- But can this continue?
  - Yes, there are a number of innovations which continue to be made on each of these fronts

Crop Genetics

- Range of estimates for yield increases
  - 4 bu/acre per year, 200 bu/acre by 2030 (Historical Trend)
  - 7 bu/acre per year, 300 bu/acre by 2030 (Monsanto)
- Relatively flat nitrogen use per acre, continued decline in nitrogen use per bushel
- Better nitrogen utilization/efficiency traits
  - Monsanto
  - Pioneer/DuPont
  - Syngenta

Fertilizer Innovations

- Slow-release fertilizers
  - Polymer coated urea
  - Been shown to significantly reduce N losses in field trials
  - Additional research is still needed in the Corn Belt
- Nitrification inhibitors
  - Reduce emissions by 35-80% in field trials

Sources: Shoji et al. (2001), Grant and Wu (2008)

Application Innovations

- Continued adoption of precision agriculture technologies
  - Matching soil types, nutrient needs, and application rates through soil testing on denser grids using GPS
  - Variable rate application technologies

- Continued machinery innovations improve precision agriculture options and functionality, and reduce risks related to timing field operations

GHG Emissions

- Tillage: Traditional vs. No-Till
  - Reduced or no-till systems can help promote carbon sequestration, create carbon sinks

- NO_2 emissions and fertilizer type
  - Anhydrous ammonia associated with higher emissions levels, relative level of use declining
  - Organic vs. inorganic

Summary

- Farmers care about reducing nutrient losses and improving efficiency
  - Environmental/stewardship motivations
  - Economic motivations

Summary

- Over the past 30-40 years, production agriculture has made significant advances in the area of nutrient use efficiency
  - Combination of genetic, agronomic, management, and technology factors
- This trend should continue
  - Additional advances in crop genetics geared directly towards this issue
  - Enhance management
  - Continued technological advancement