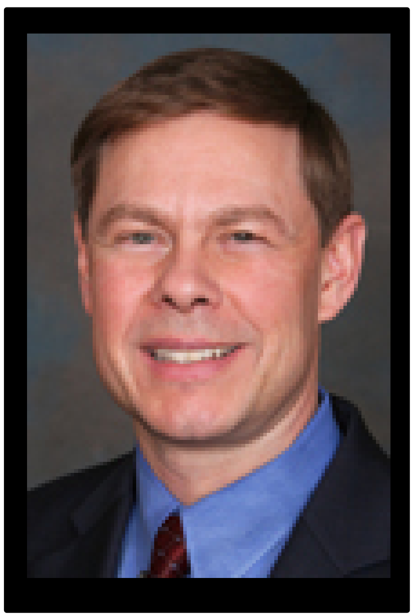
FOTC 2015

Fertilizer Outlook & Technology Conference

Harry Vroomen

Vice President, Economic Services
The Fertilizer Institute



U.S. Fertilizer Demand and Nutrient Use Issues Session

The Fertilizer Institute
Nourish, Replenish, Grow

Fertilizer Industry Round Table

Fertilizer Institute

Fertilizer Outlook and Technology Conference

“U.S. Fertilizer Demand and Nutrient Use Issues”

Harry Vroomen
Vice President, Economic Services
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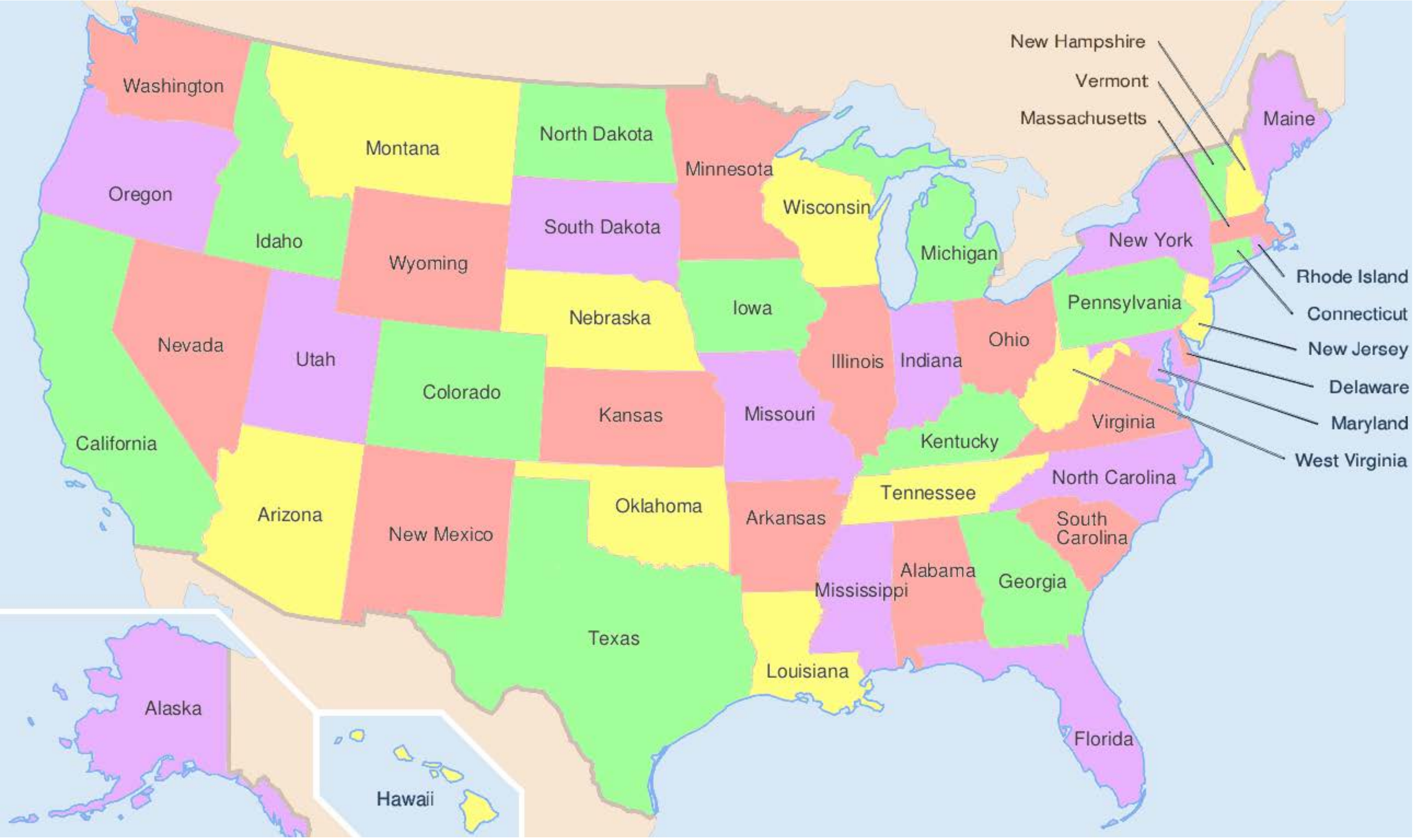
November 10, 2015

www.tfi.org

U.S. Fertilizer Nutrient Demand



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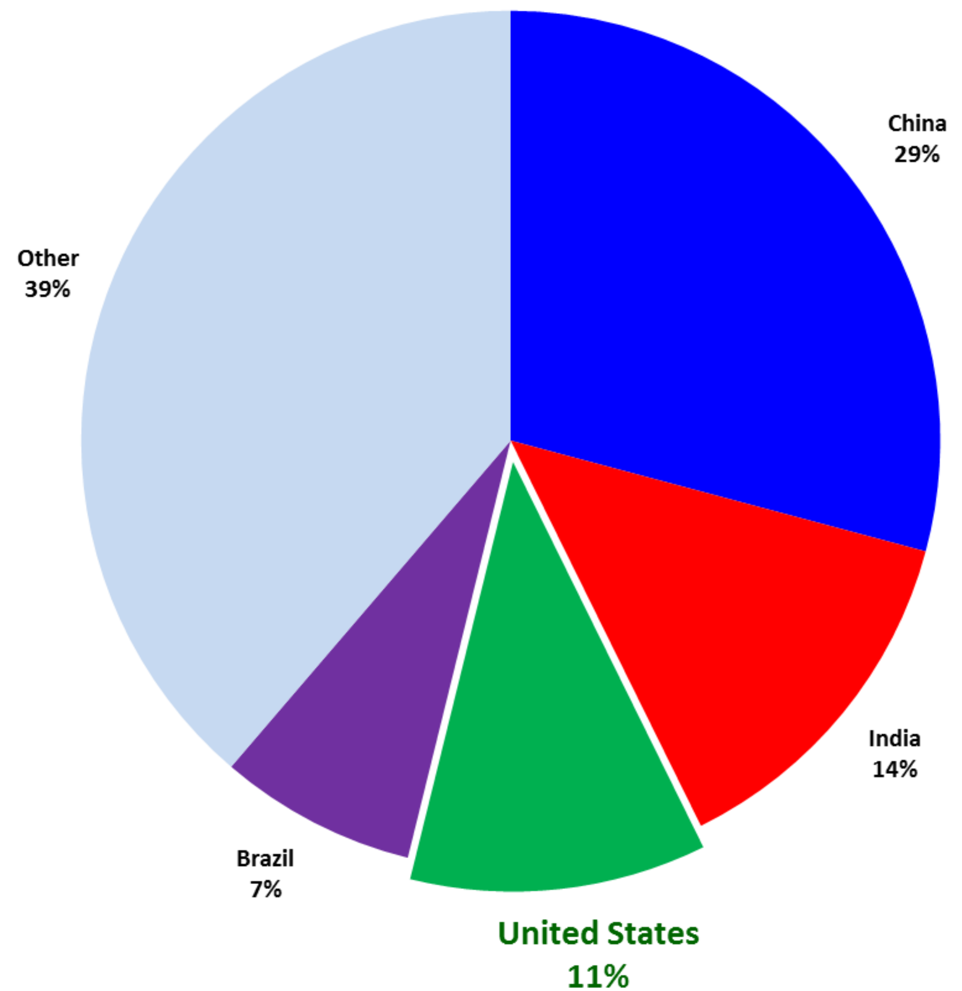
The Lion's Share of Global Nutrient Demand, 89 Percent, is Outside the United States

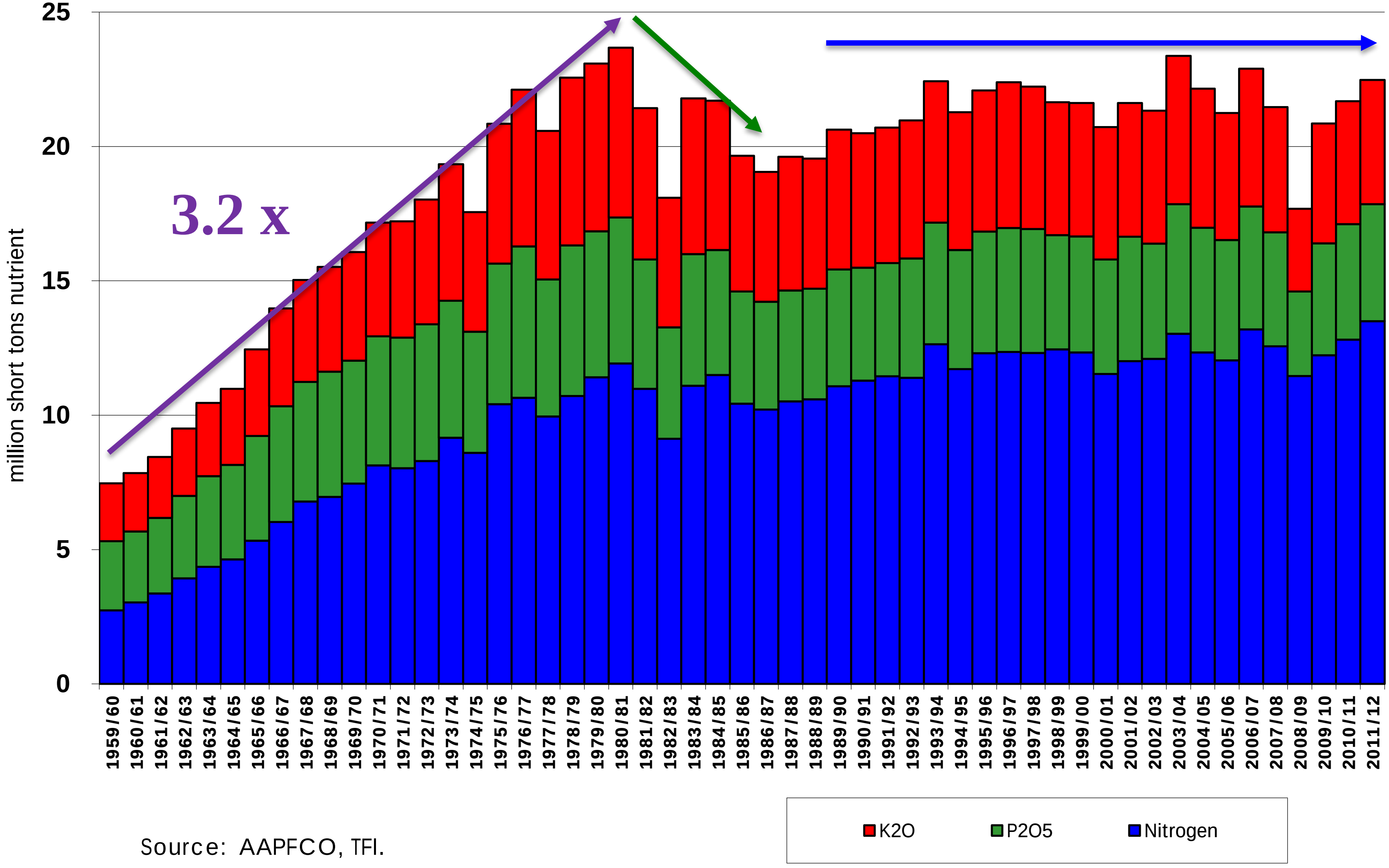
(180.8 Million Metric Tons N, P2O5 and K2O in 2013)



Top 4 Countries > 61 % of Agricultural Consumption

Source: IFA.

U.S. Plant Nutrient Consumption



Source: AAPFCO, TFI.

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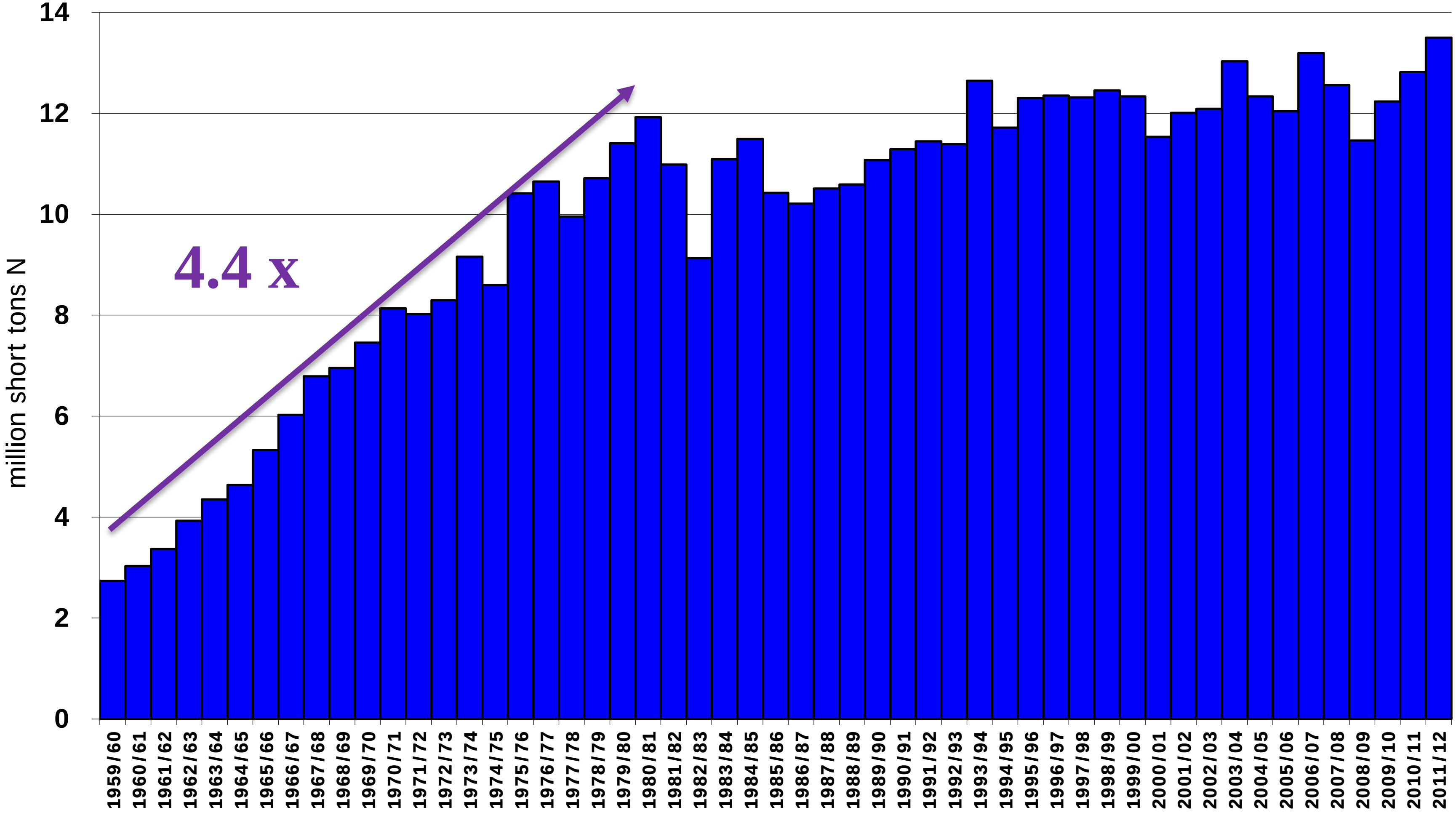
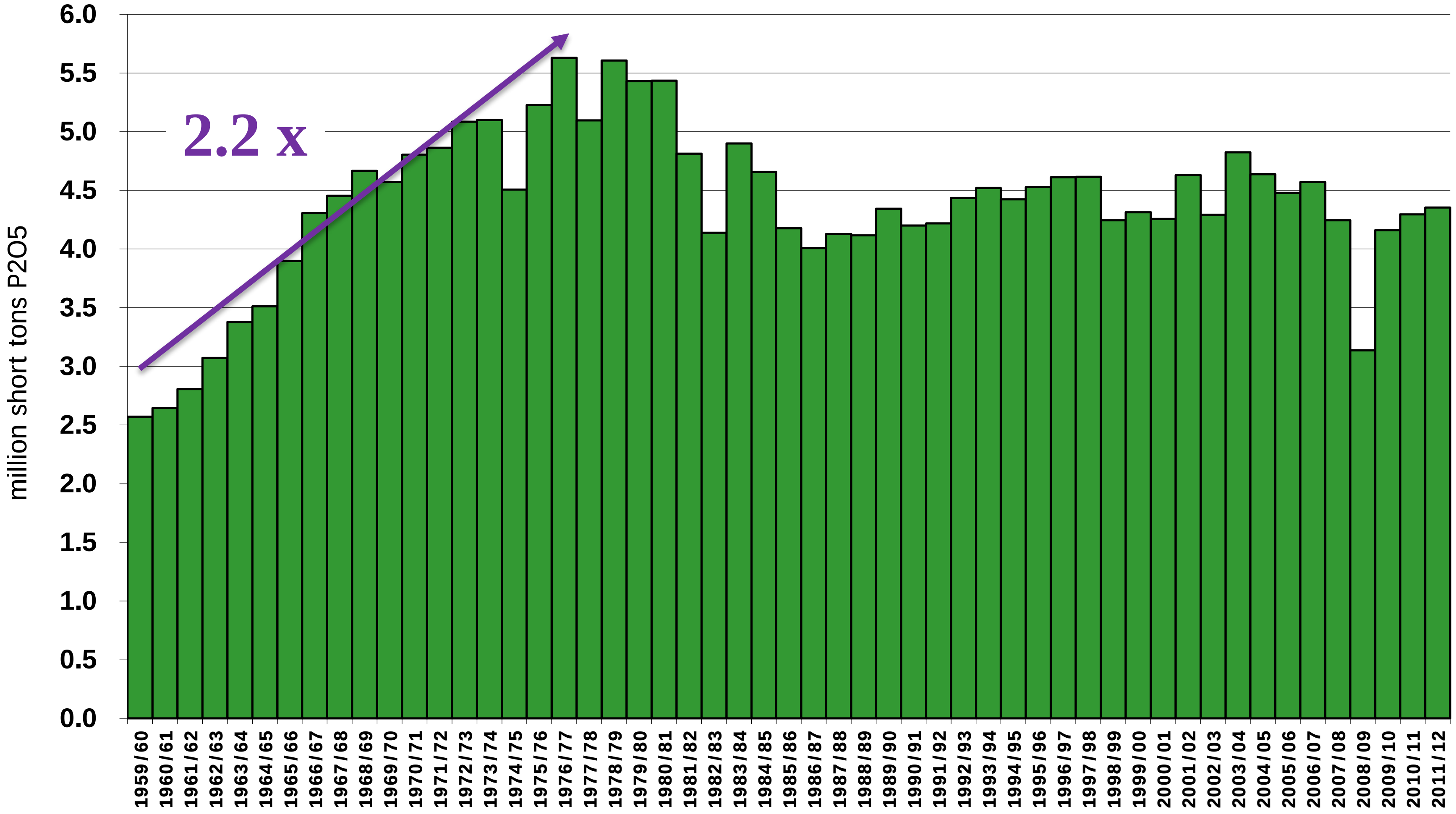
U.S. Nitrogen Consumption



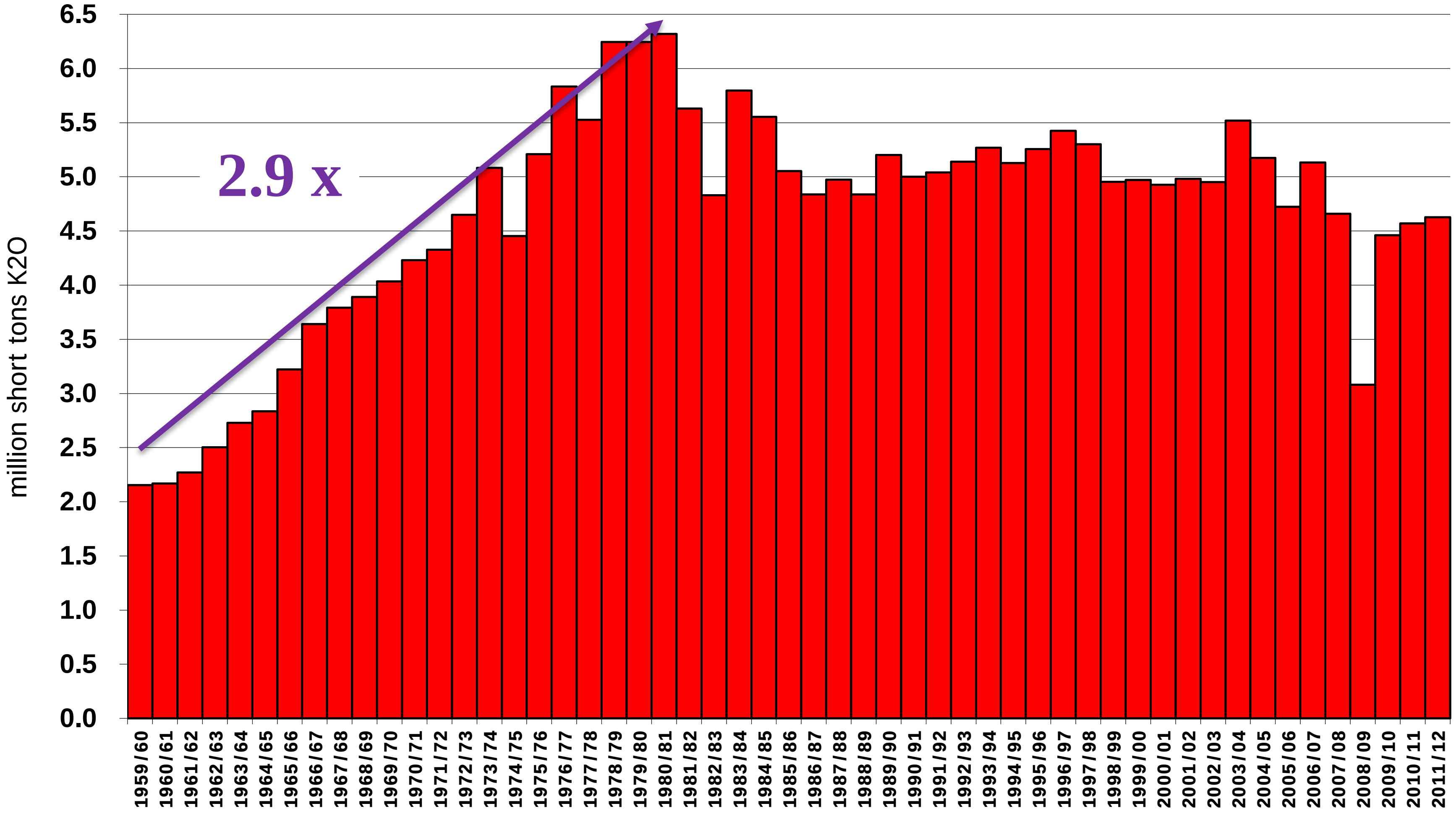
Source: AAPFCO, TFI.

U.S. Phosphate Consumption



Source: AAPFCO, TFI.

U.S. Potash Consumption



Source: AAPFCO, TFI.

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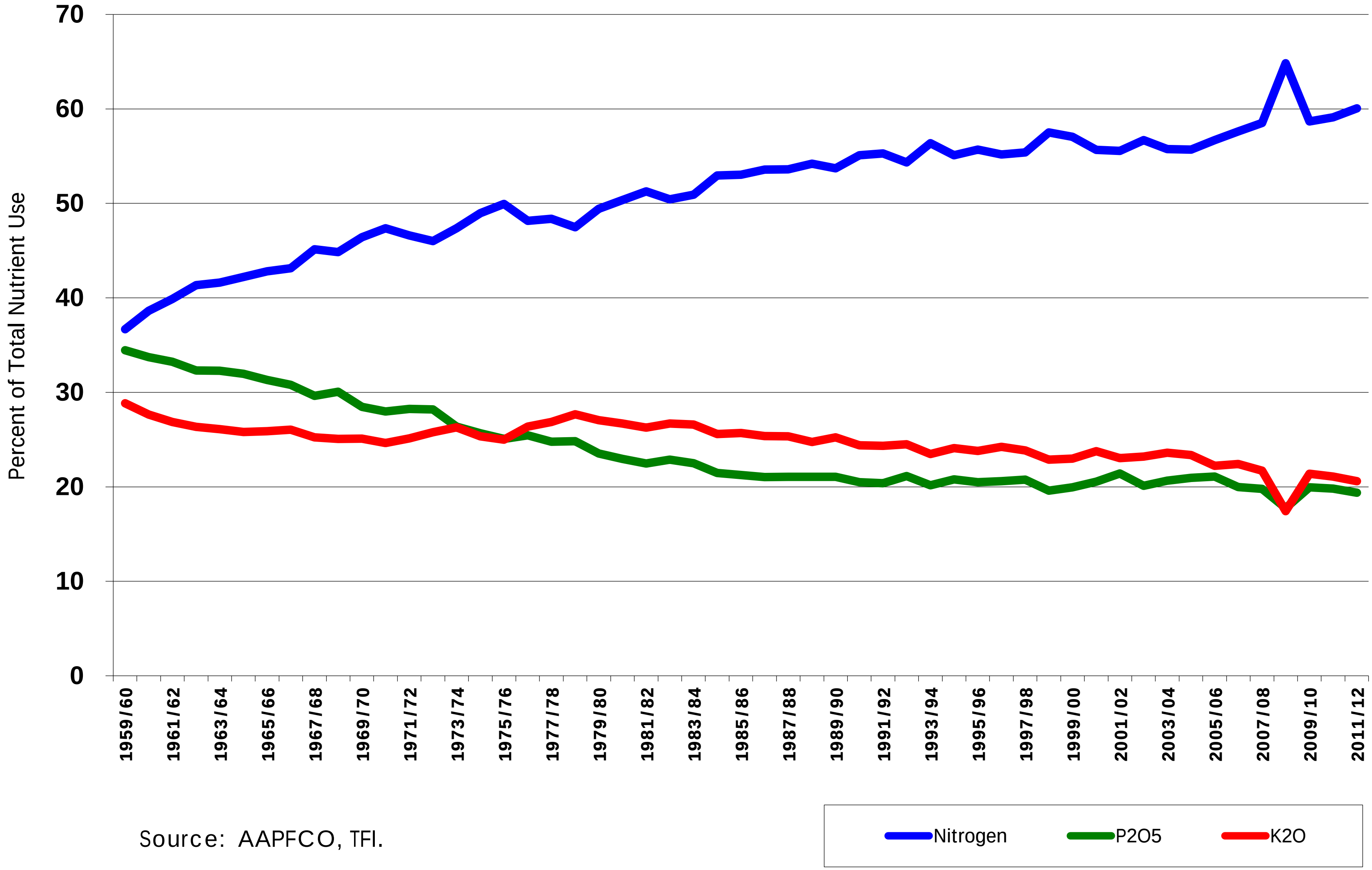
U.S. Plant Nutrient Consumption



Source: AAPFCO, TFI.

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Fertilizer Nutrient Demand

What Drives Fertilizer Nutrient Demand?

- Acres Planted
- Percent of Acres Treated
- Nutrient Application Rates

Some Characteristics of Nutrient Demand

- Nutrient Demand is Inelastic
- And has Likely Become More Inelastic Over Time

Fertilizer Nutrient Demand is Inelastic

Inelastic Demand

- When the quantity of nutrients demanded by growers doesn't change as much as the (nutrient-relative-to-crop) price.

- FERT DEM is inelastic because of limited or poor substitutes:
  - While there are some longer-run practices like cover crops, crop rotations, etc., growers can use to substitute for fertilizer nutrients, there are fewer, if any, short-run substitutes. Adding a few extra tons of manure per acre, for example, is generally not practical, economic or a good environmental practice.
- So when relative fertilizer-to-crop prices change, fertilizer nutrient demand changes by less. Research indicates that for corn, these elasticities range*:
  - From -0.19 to -0.25 in the short run
  - To -0.31 to -0.41 in the long run, as growers have more time to change practices
- That is, all else equal, if the relative fertilizer-to-crop price increased by 10% we would expect fertilizer nutrient demand to decline by 1.9 to 2.5% in short run.

* M. Denbaly and H. Vroomen (1993), Dynamic Fertilizer Nutrient Demands for Corn: A Cointegrated and Error-Correcting System, *American Journal of Agricultural Economics*, 75, 203-209.

Nutrient Demands More Inelastic Over Time

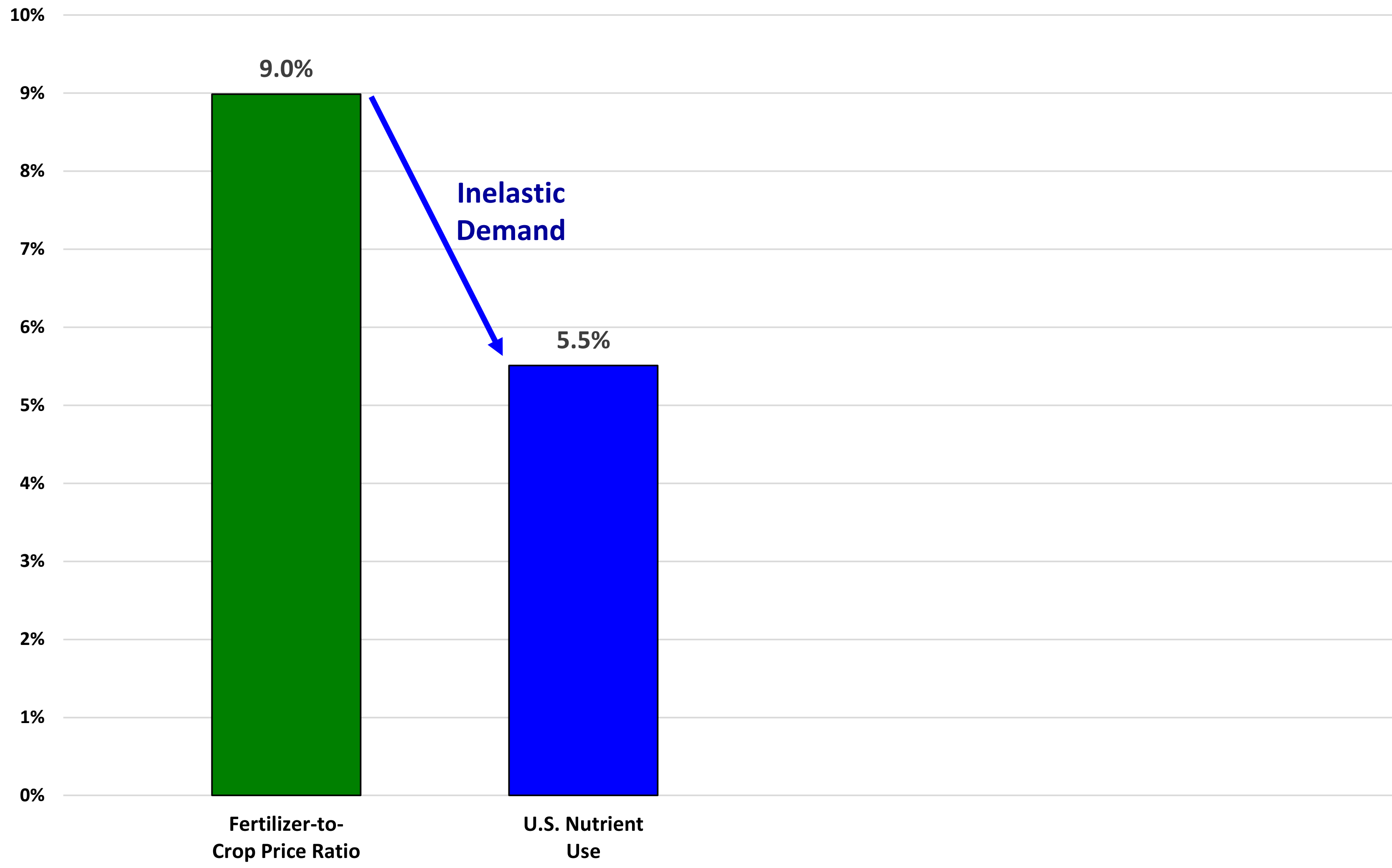
Demand More Inelastic due to structural and technological changes in U.S. Ag*

- **Agricultural operations have become less diverse:**
  - ➢ fewer crops grown on each farm => fewer opportunities for crop rotations
  - ➢ Farm programs likely contributed to this trend as by reducing economic risks associated with specialized farming and limiting crop substitution abilities to maintain program eligibility
- **Technological Breakthroughs Also Contributed:**
  - ➢ Adoption of hybrid corn varieties and genetically engineered (Bt and HT) crops:
    - Bt (insect resistant) crops and HT (Herbicide tolerant) crops
  - ➢ Depend on higher nutrient application rates for greater output potential
- **Production on more specialized farms also generally reduces the availability of farm-level fertilizer substitutes like manure**

=> Changes in farm structure, programs and technology created the technical ability and economic incentives for less responsive fertilizer input demands

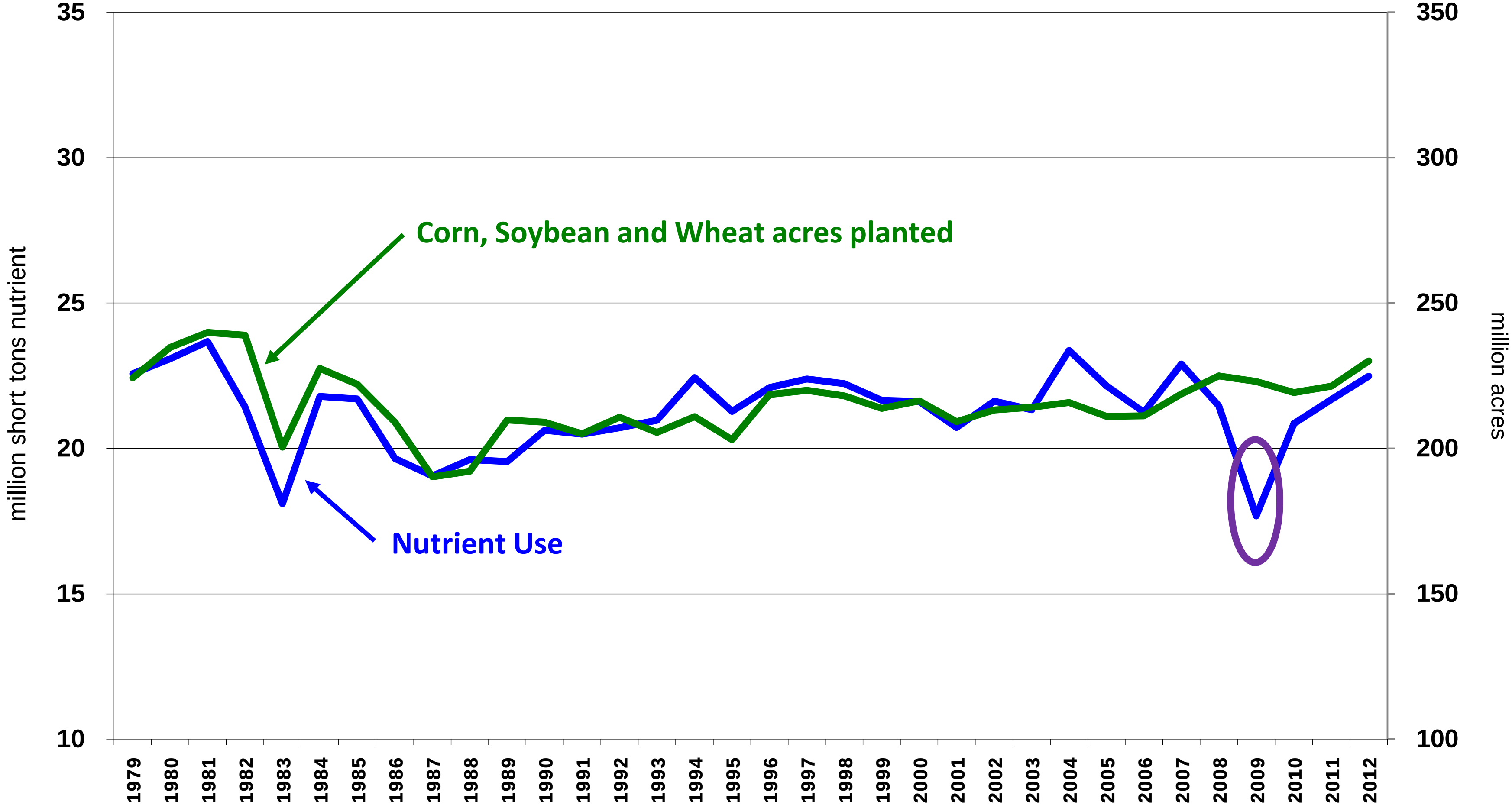
* B.A. Larson and H. Vroomen (1991), Nitrogen, Phosphorous and Land Demands at the U.S. Regional Level: A Primal Approach, *Journal of Agricultural Economics*, 42, 354-364.

Average (Absolute Value) of Annual Changes, 1980 - 2012



Computed from data reported by NASS, USDA and Commercial Fertilizers, 2012, AAPFCO and TFI.

U.S. Plant Nutrient Consumption vs. Acres Planted



Source: AAPFCO, TFI and USDA. Year-ending June 30 for nutrient use.

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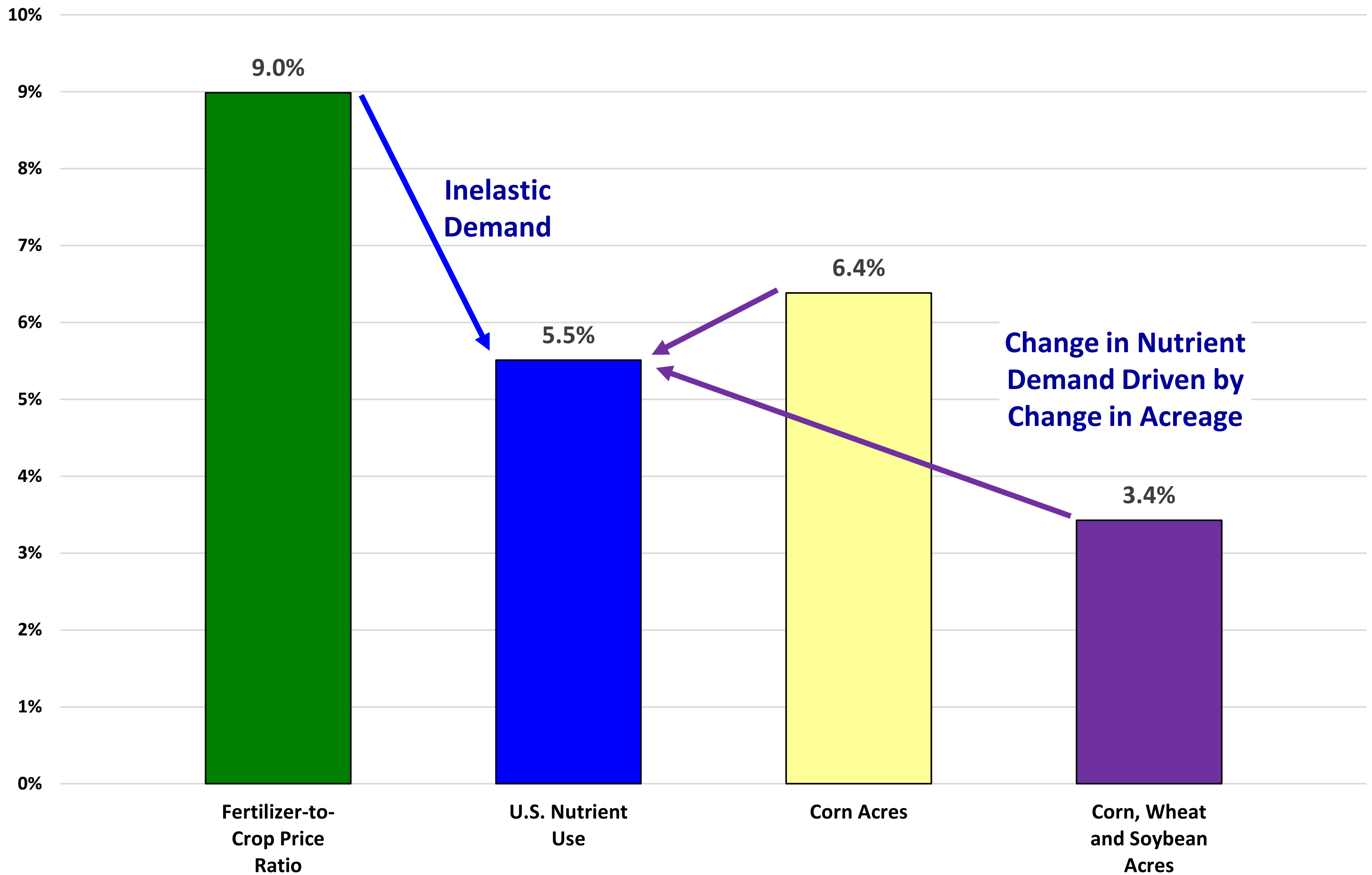
Average (Absolute Value) of Annual Changes, 1980 - 2012



Computed from data reported by NASS, USDA and Commercial Fertilizers, 2012, AAPFCO and TFI.

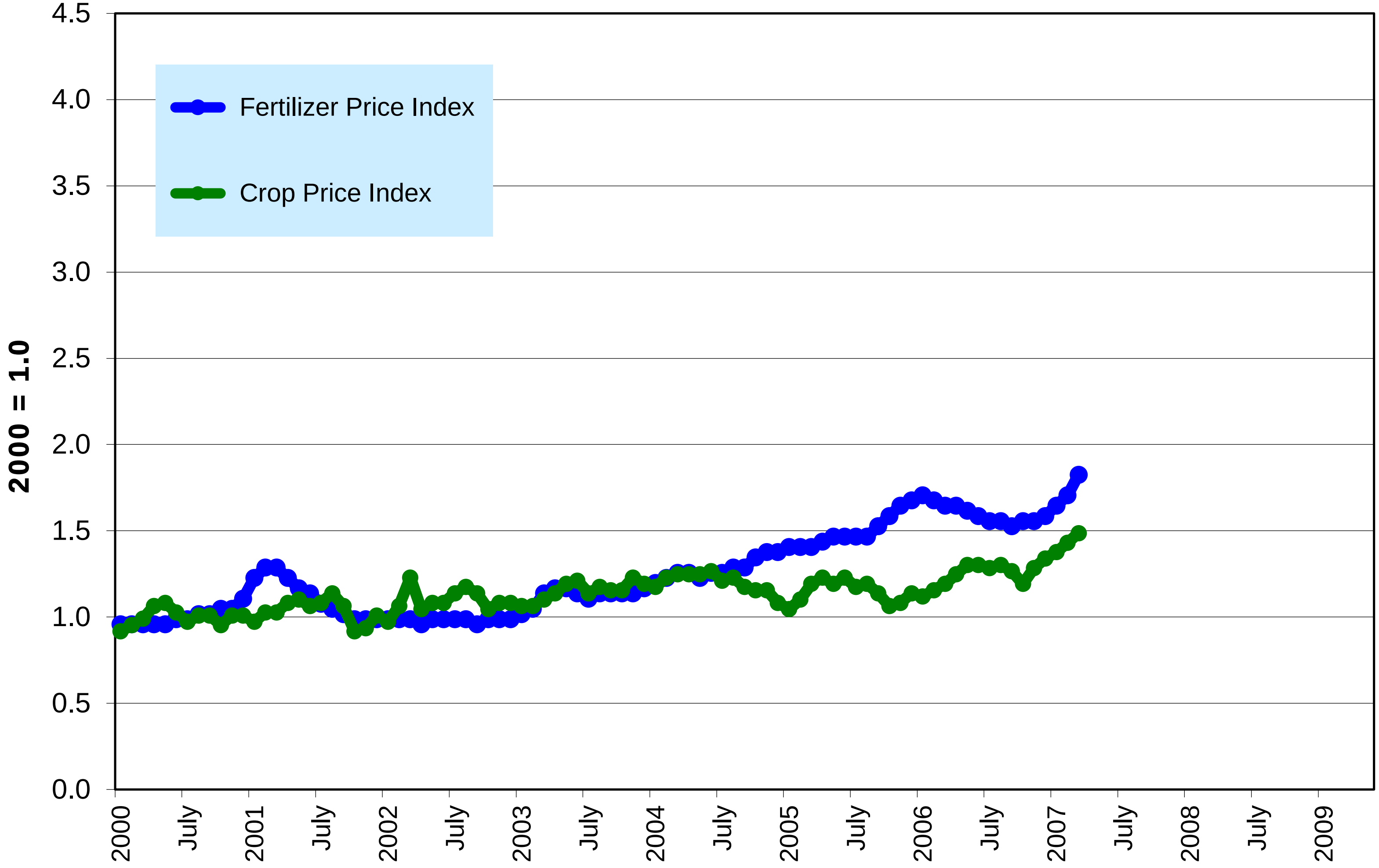
But Inelastic Demand

Does Not Mean

No Response to

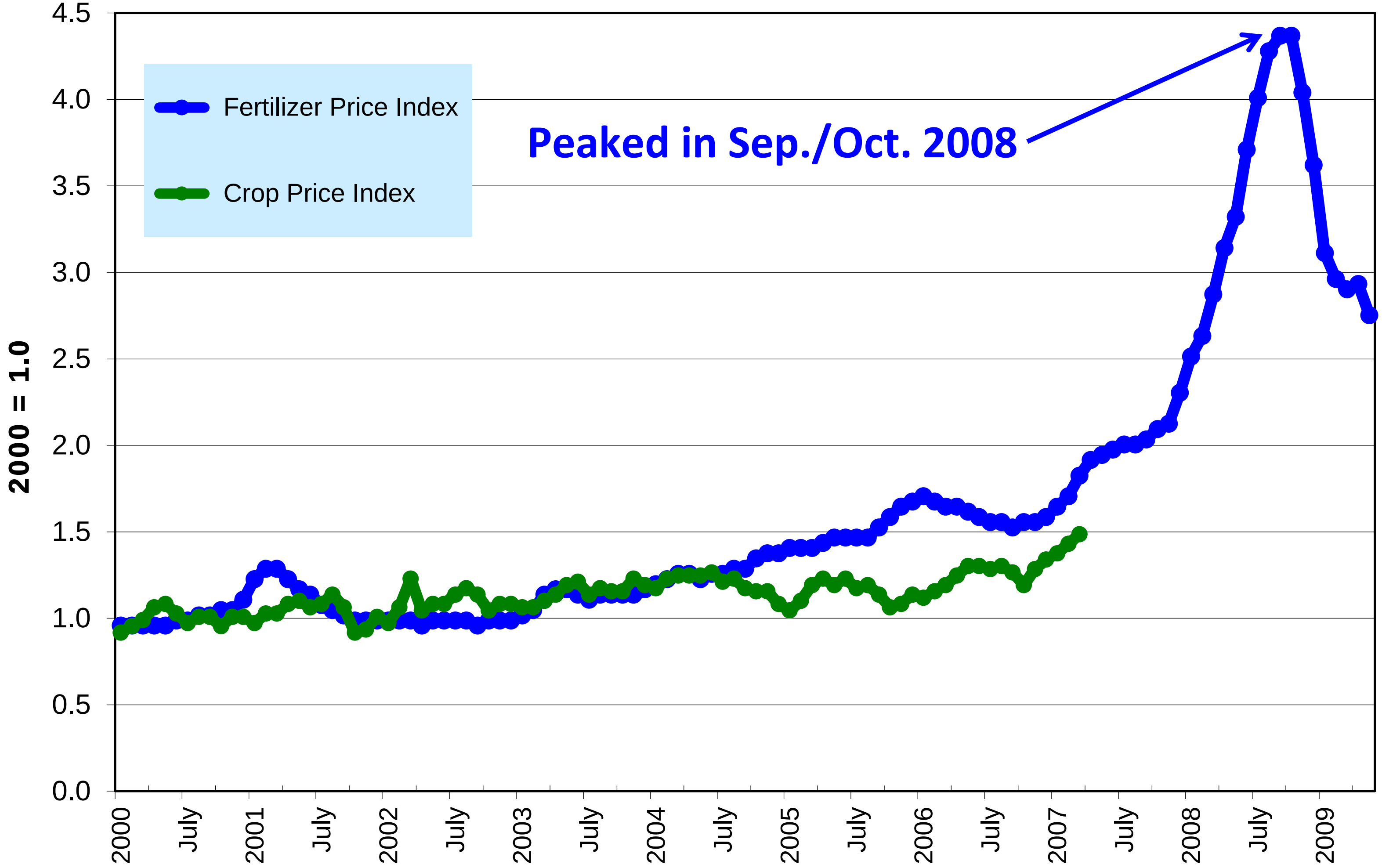
Relative Price Changes!

Index of Fertilizer Prices Paid and Crop Prices Received by Farmers



Source: Computed from data reported by the National Agricultural Statistics Service, USDA.

Index of Fertilizer Prices Paid and Crop Prices Received by Farmers



Source: Computed from data reported by the National Agricultural Statistics Service, USDA.

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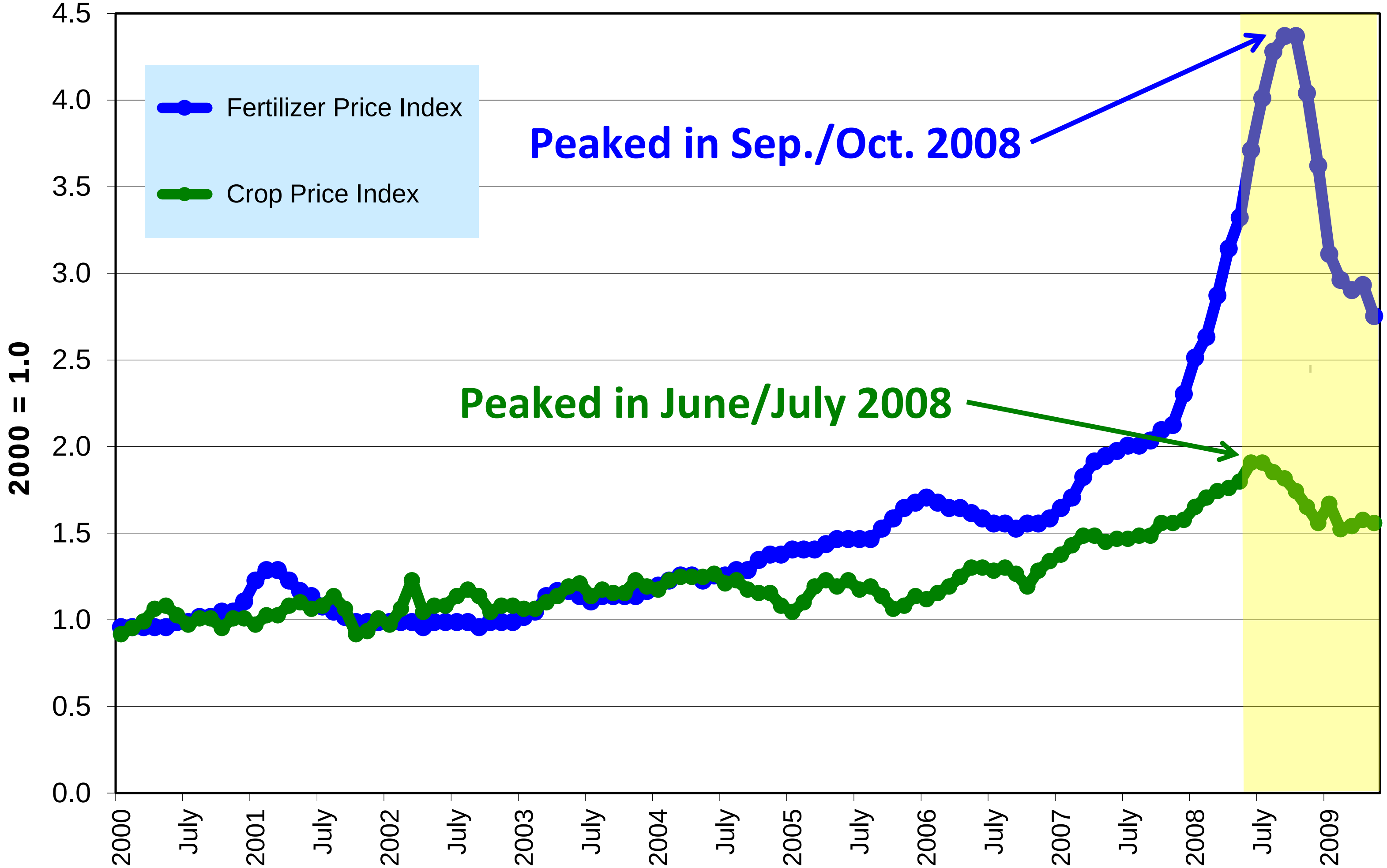
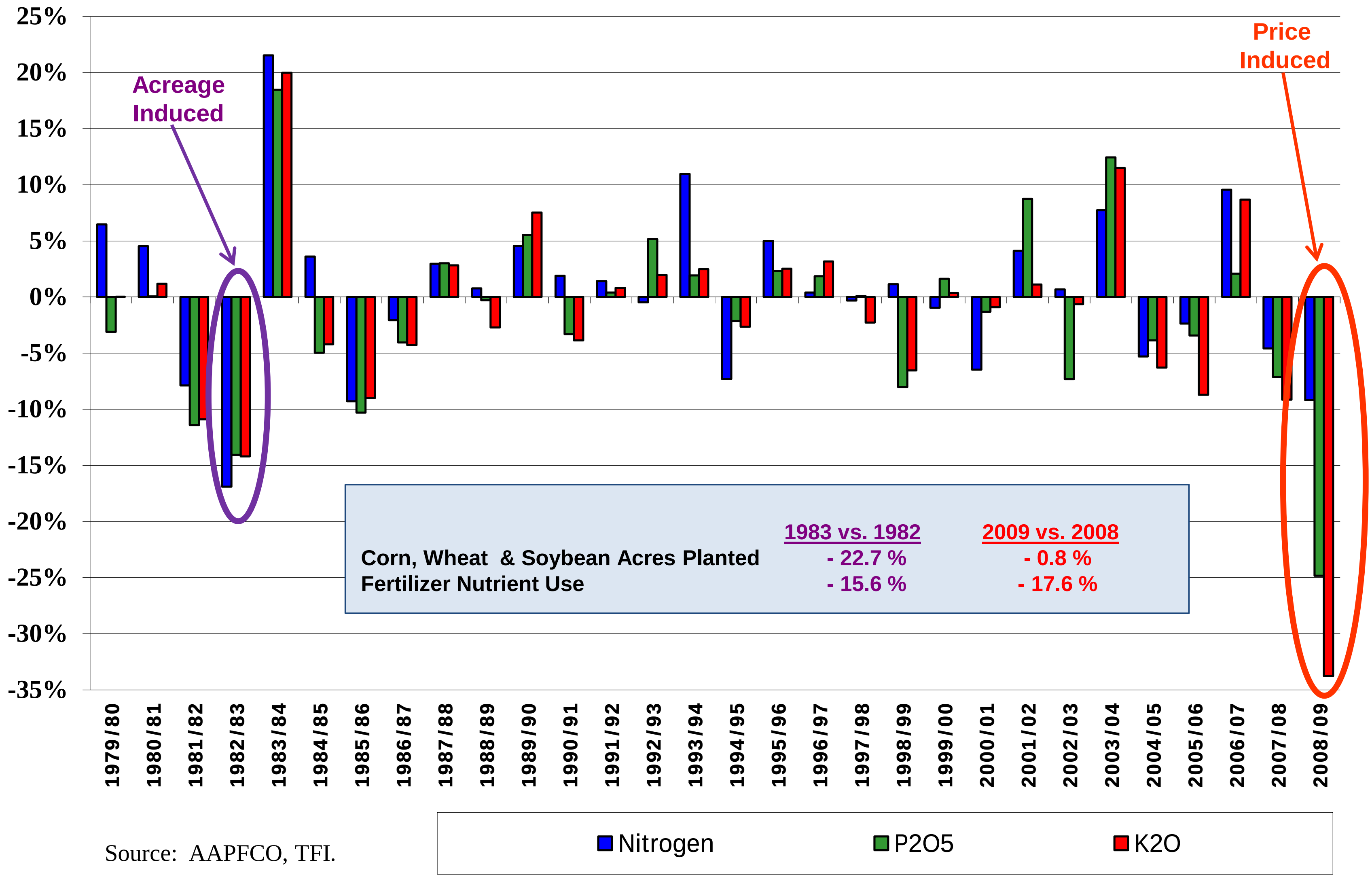


Source: Computed from data reported by the National Agricultural Statistics Service, USDA.

Annual Percentage Change in U.S. Fertilizer Tonnage by Nutrient



Source: AAPFCO, TFI.

FY08/09 : - 9% - 25% - 34%

What Role Does Fertilizer Play?

40-60% of yield in crop production attributable to fertilizer!

Agronomy Journal

Volume 97 January–February 2005 Number

FORUM

The Contribution of Commercial Fertilizer Nutrients to Food Production

W. M. Stewart,* D. W. Dibb, A. E. Johnston, and T. J. Smyth

ABSTRACT

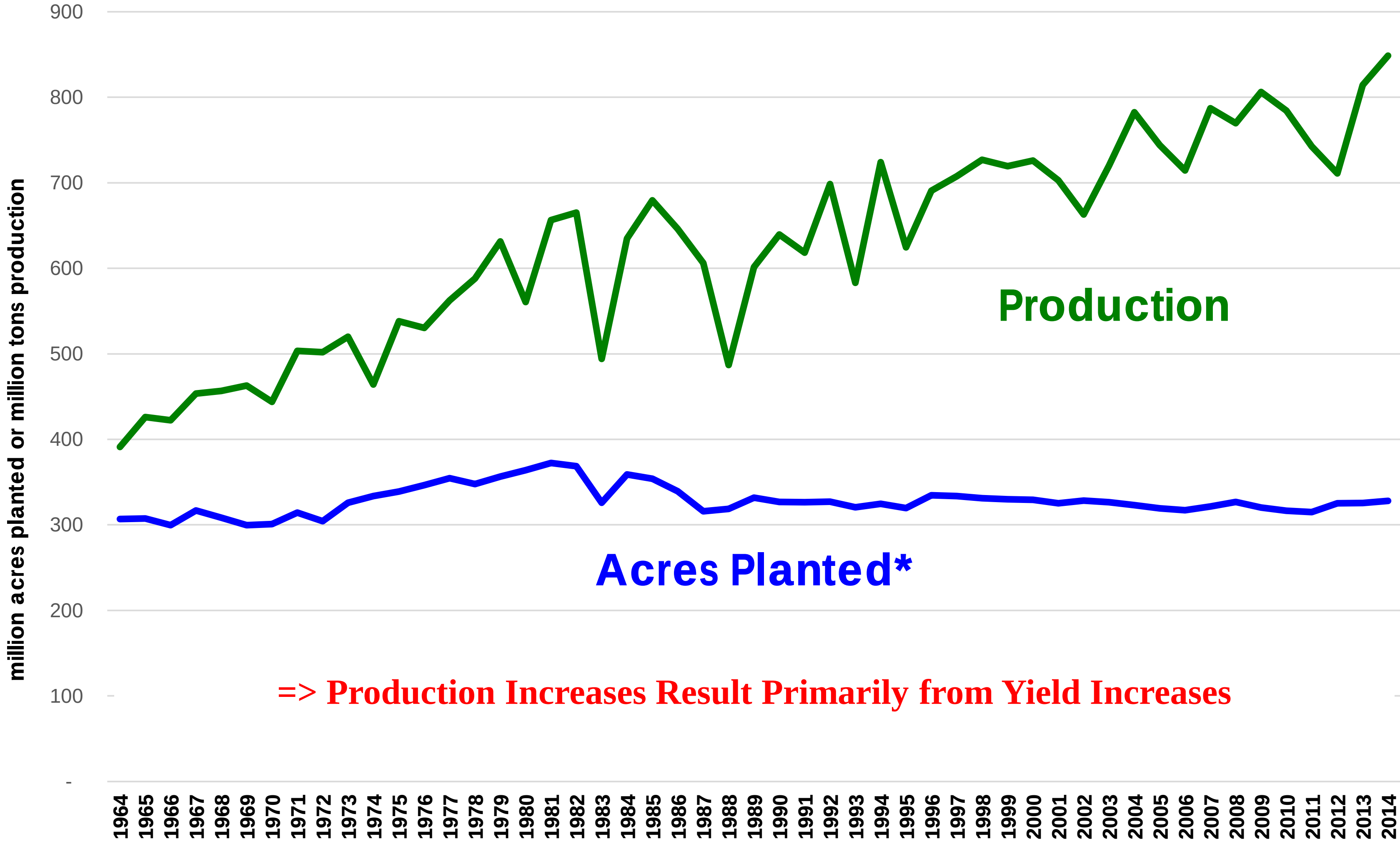
Nutrient inputs in crop production systems have come under increased scrutiny in recent years because of the potential for environmental impact from inputs such as N and P. The benefits of nutrient inputs are often minimized in discussions of potential risk. The purpose of this article is to examine existing data and approximate the effects of nutrient inputs, specifically from commercial fertilizers, on crop yield. Several long-term studies in the USA, England, and the tropics, along with the results from an agricultural chemical use study and nutrient budget information, were evaluated. A total of 362 seasons of crop production were included in the long-term study evaluations. Crops utilized in these studies included corn (*Zea mays* L.), wheat (*Triticum aestivum* L.), soybean [*Glycine max* (L.) Merr.], rice (*Oryza sativa* L.), and cowpea [*Vigna unguiculata* (L.) Walp.]. The average percentage of yield attributable to fertilizer generally ranged from about 40 to 60% in the USA and England and tended to be much higher in the tropics. Recently calculated budgets for N, P, and K indicate that commercial fertilizer makes up the majority of nutrient inputs necessary to sustain current crop yields in the USA. The results of this investigation indicate that the commonly cited generalization that at least 30 to 50% of crop yield is attributable to commercial fertilizer nutrient inputs is a reasonable, if not conservative estimate.

MODERN HIGH YIELD crop production and its associated inputs have come under intense scrutiny over the past several years. Concerns expressed often

technology and intensified production often involve a greater need for commercial fertilizer nutrients to avoid nutrient depletion and ensure soil quality and crop productivity. The need for increased inputs correctly raises questions about associated risks. Potential risks are often widely publicized while the associated benefits of an abundant, affordable, and healthful food supply can be overlooked or understated. To judge any such practice or system, the risks must be evaluated in comparison with the benefits. While misuses of agricultural fertilizers have undoubtedly occurred and concerns about how fertilizers affect the environment have sometimes been overstated, the purpose of this article is not to address these issues but to provide evidence of the impact commercial fertilizers have had on agricultural production.

Several attempts have previously been made to estimate how much of the crop production in the USA is attributable to commercial nutrient inputs. These estimates usually range from about 30 to 50% for major grain crops (Nelson, 1990). Determining these estimates presents significant challenges, and assumptions are always required regardless of the approach taken. One difficulty that arises is that crops respond differently to application of a specific plant nutrient. For example corn response to N fertilizer is much greater than the

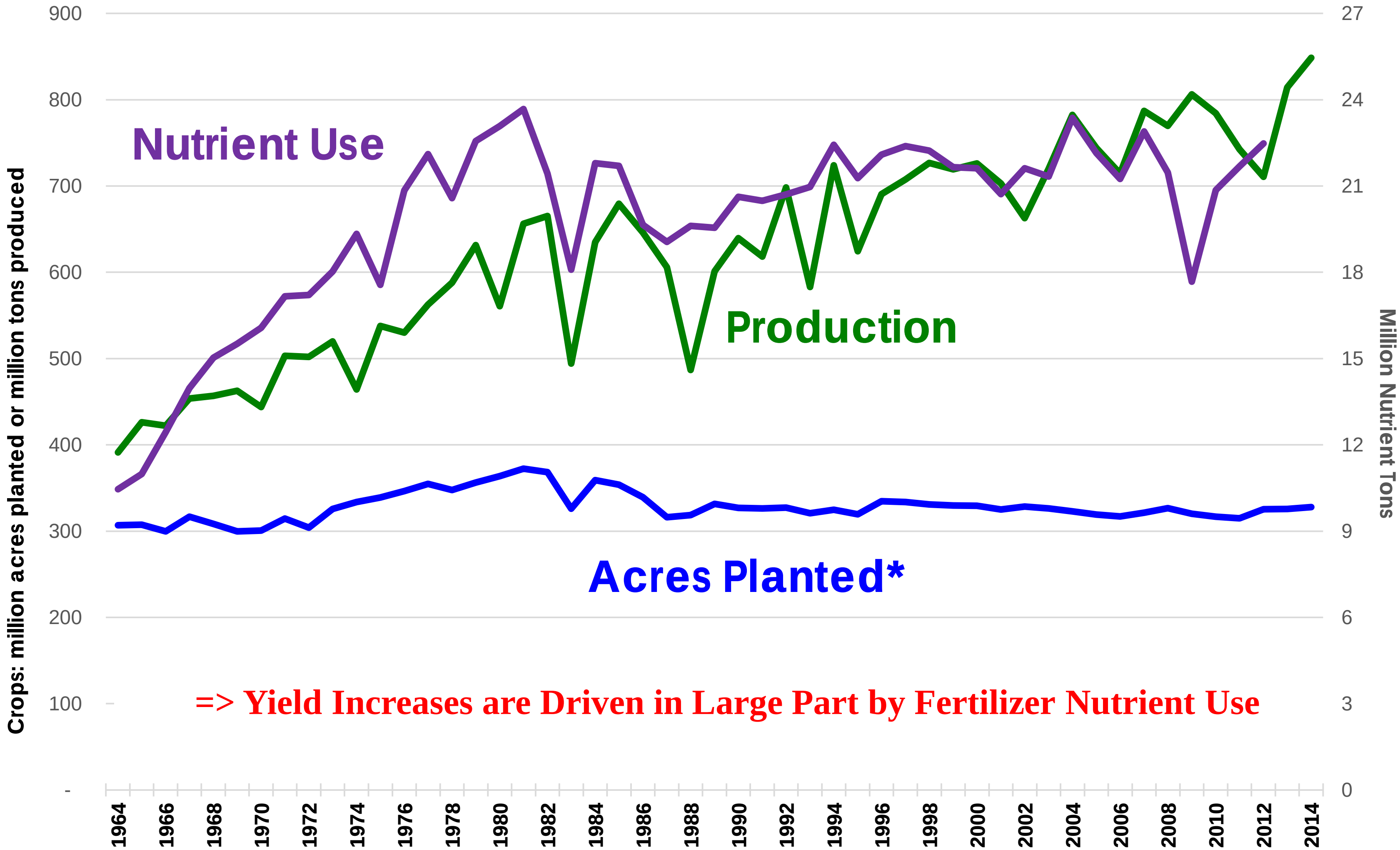
Principal U.S. Crops: Production and Acreage Planted*



Source: USDA NASS Quick Stats, downloaded on 9/25/2015.

*Note: USDA only reports harvested acres for hay, hops, sugarcane, and tobacco.

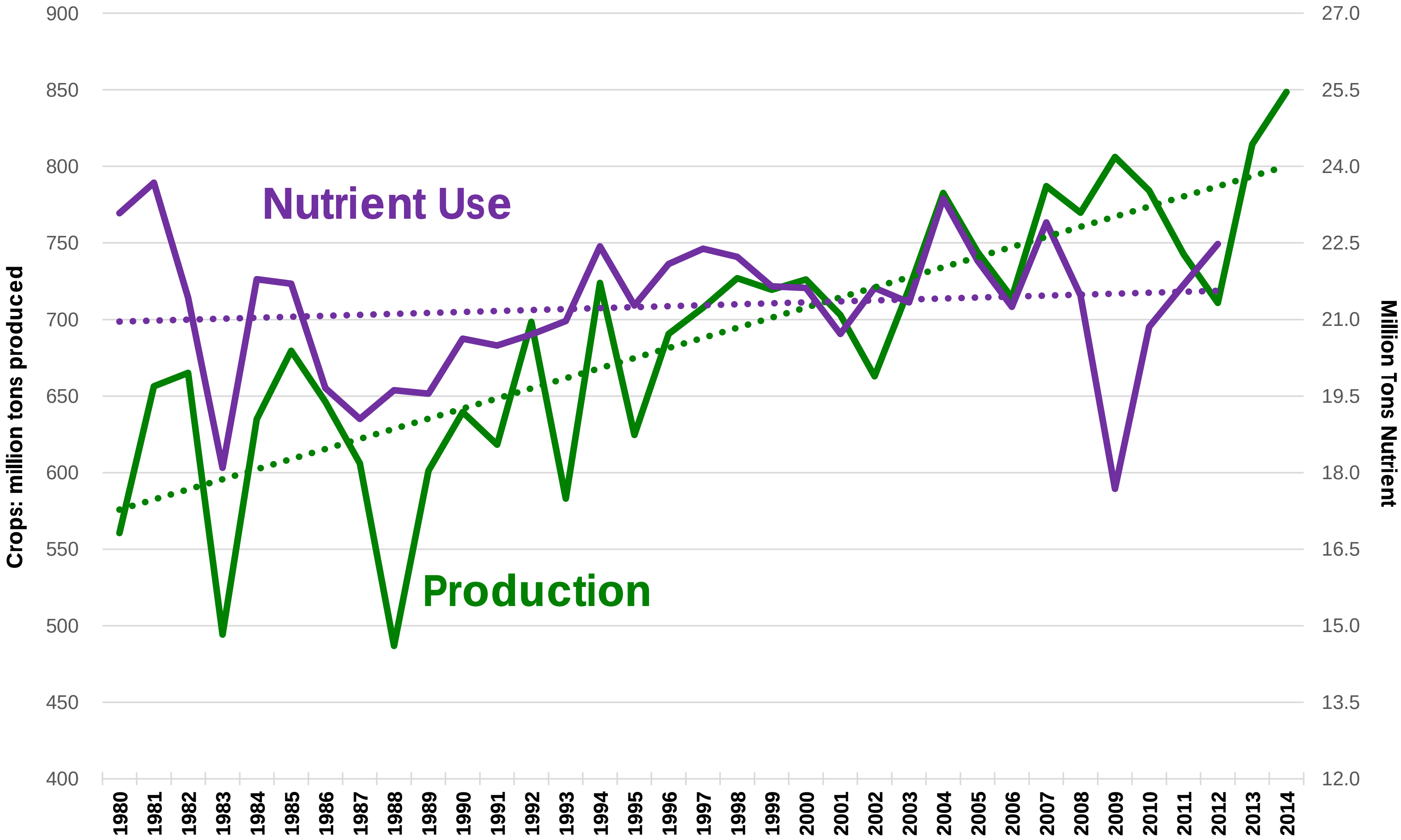
Principal U.S. Crops: Production and Acreage Planted*



Source: USDA NASS Quick Stats, downloaded on 9/25/2015.

***Note: USDA only reports harvested acres for hay, hops, sugarcane, and tobacco.**

Production of Principal U.S. Crops vs. Total U.S. Nutrient Use



Source: USDA NASS Quick Stats, downloaded on 9/25/2015 and Commercial Fertilizers, 2012, AAPFCO and TFI, Jan. 2014.

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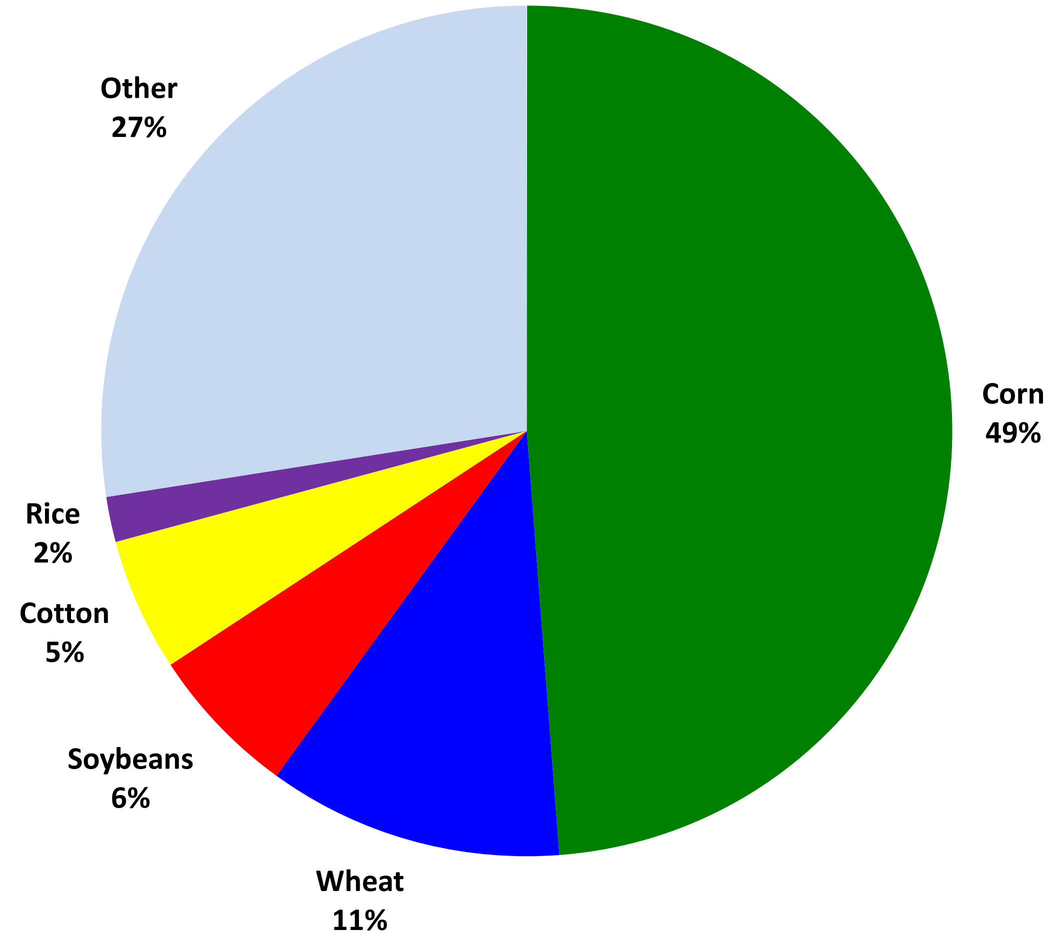
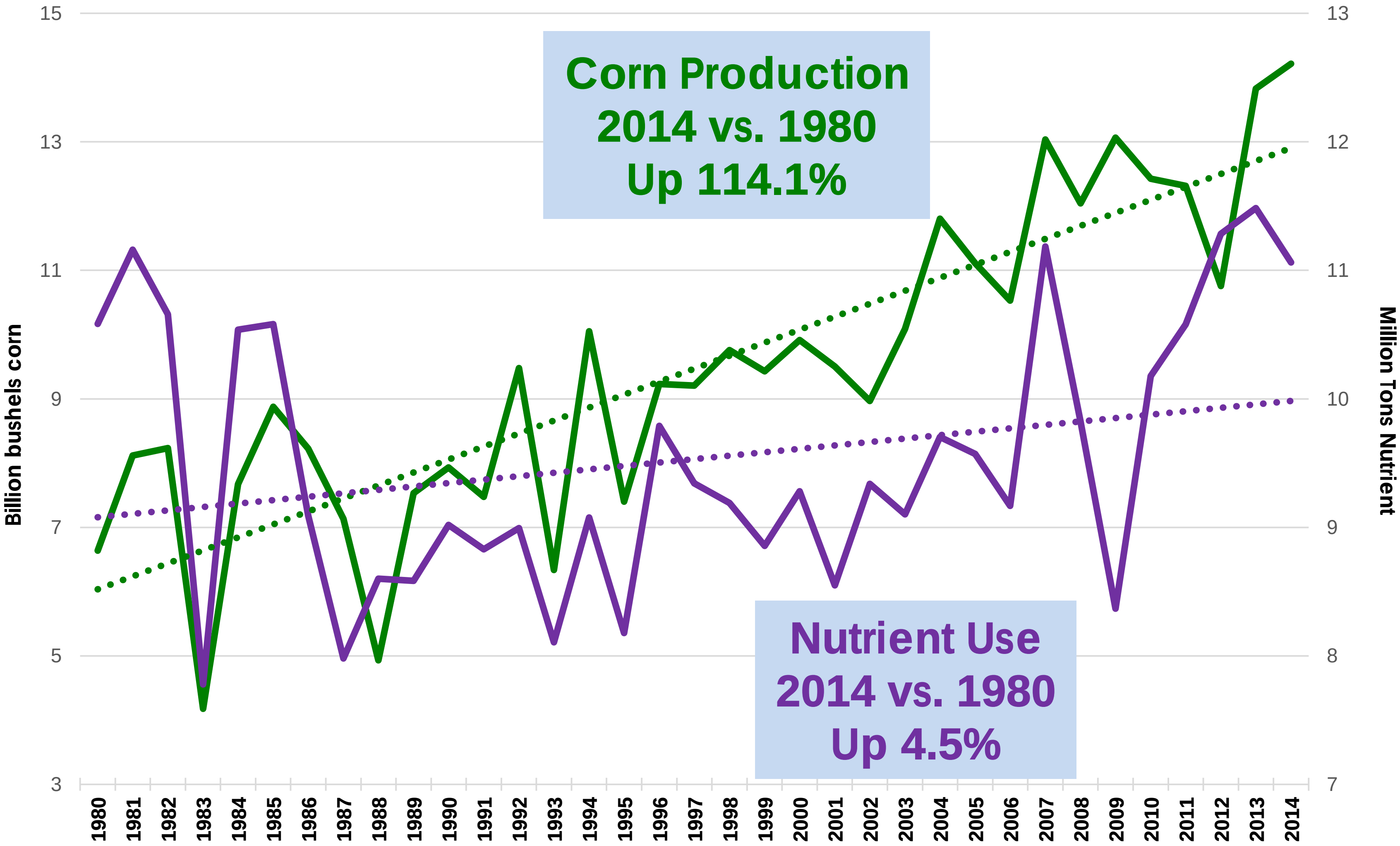
Estimated U.S. Nutrient Use By Crop - 2010/11



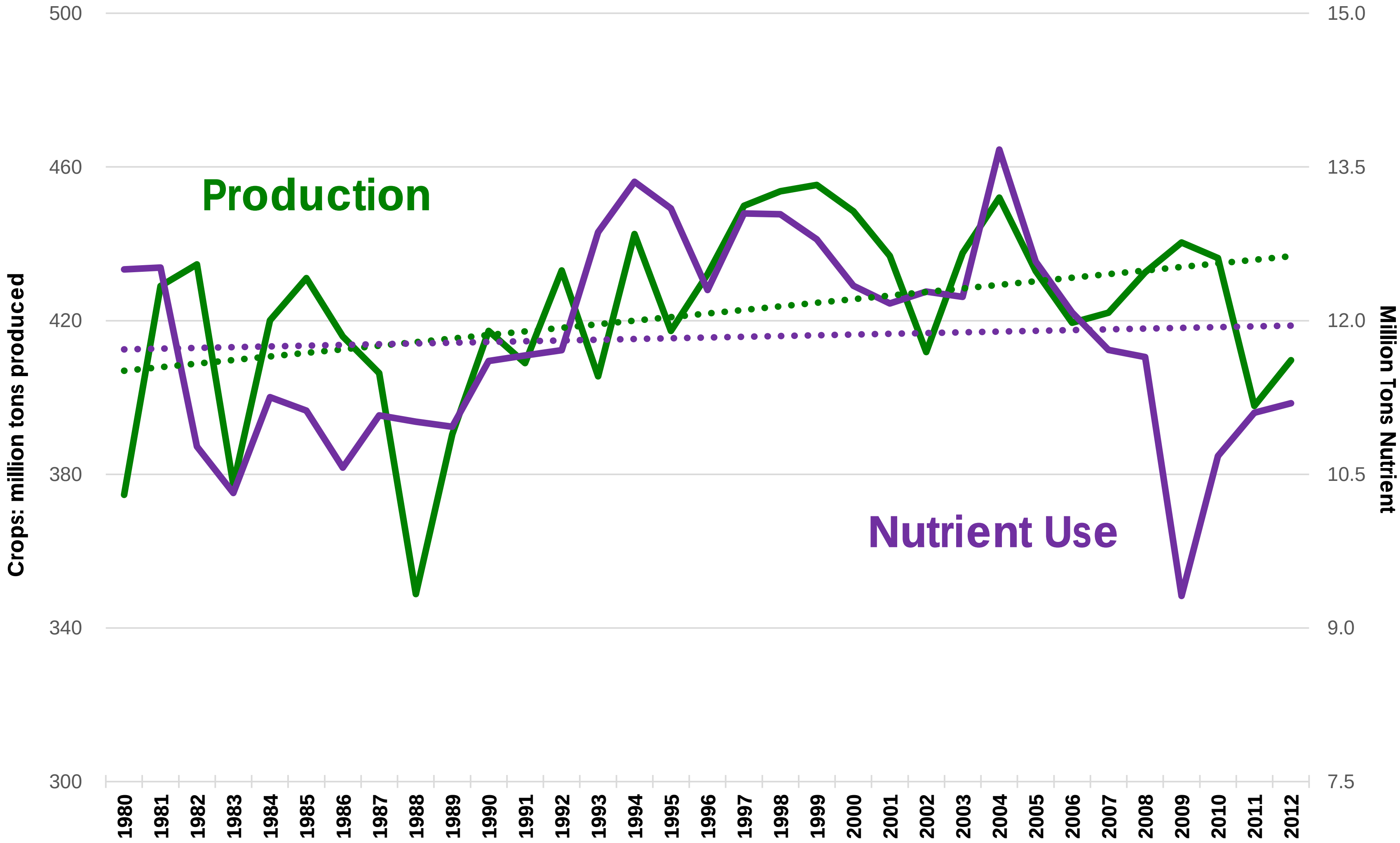
Source: Computed from data reported by USDA and AAFPCO/TFI.

Corn: Production and Estimated Nutrient Use



Source: USDA NASS Quick Stats, downloaded on 9/25/2015; nutrient use calculated from USDA nutrient. app. rates on corn.

Production of Principal U.S. Crops vs. Total U.S. Nutrient Use, Excluding Corn



Source: USDA NASS Quick Stats, downloaded on 9/25/2015; nutrient use calculated from nutrient use application rates on corn and Commercial Fertilizers, 2012, AAPFCO and TFI, January 2014.

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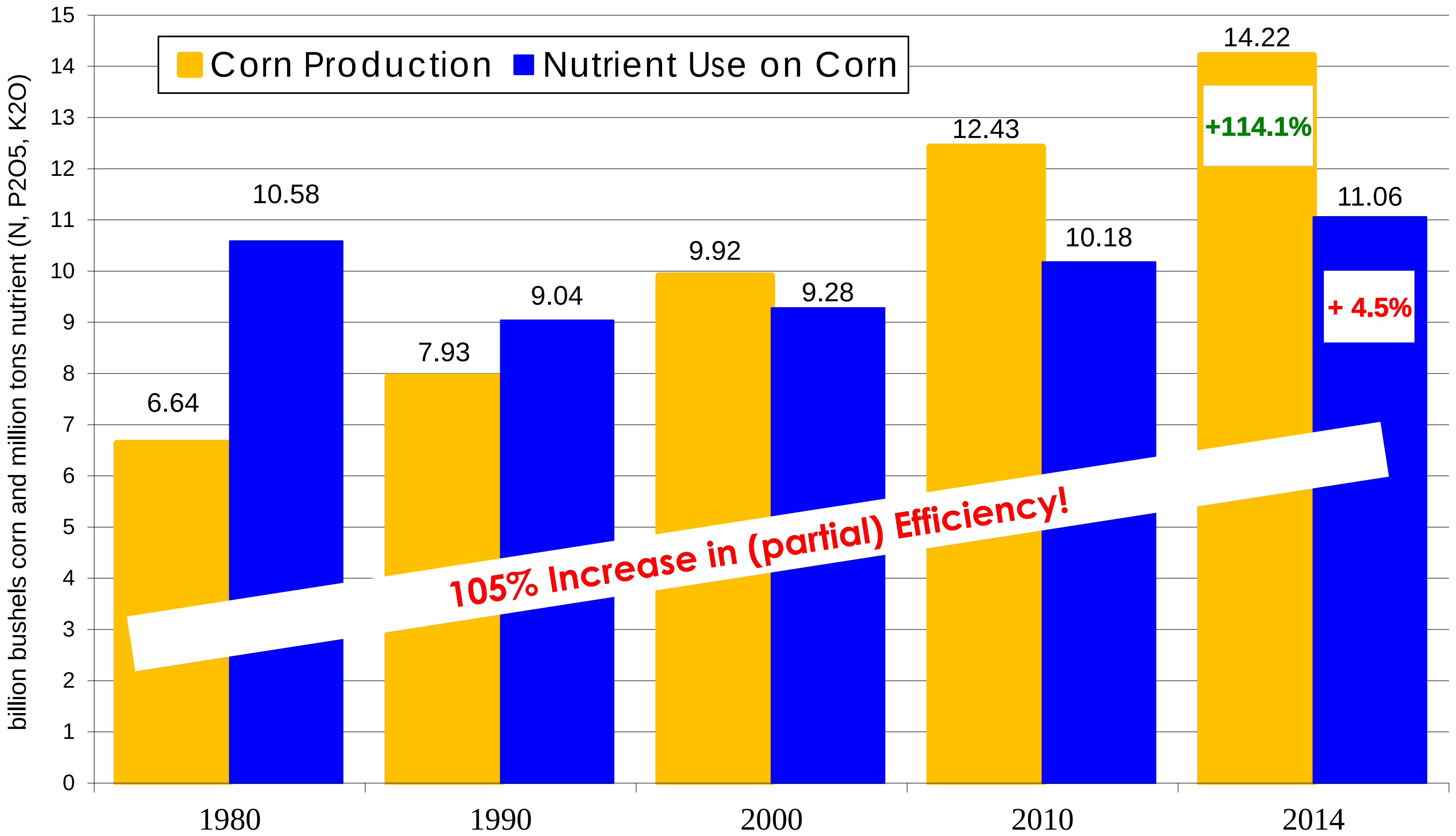
U.S. Corn Production and Nutrient Use on Corn



Source: Computed by The Fertilizer Institute from data reported by NASS, USDA.

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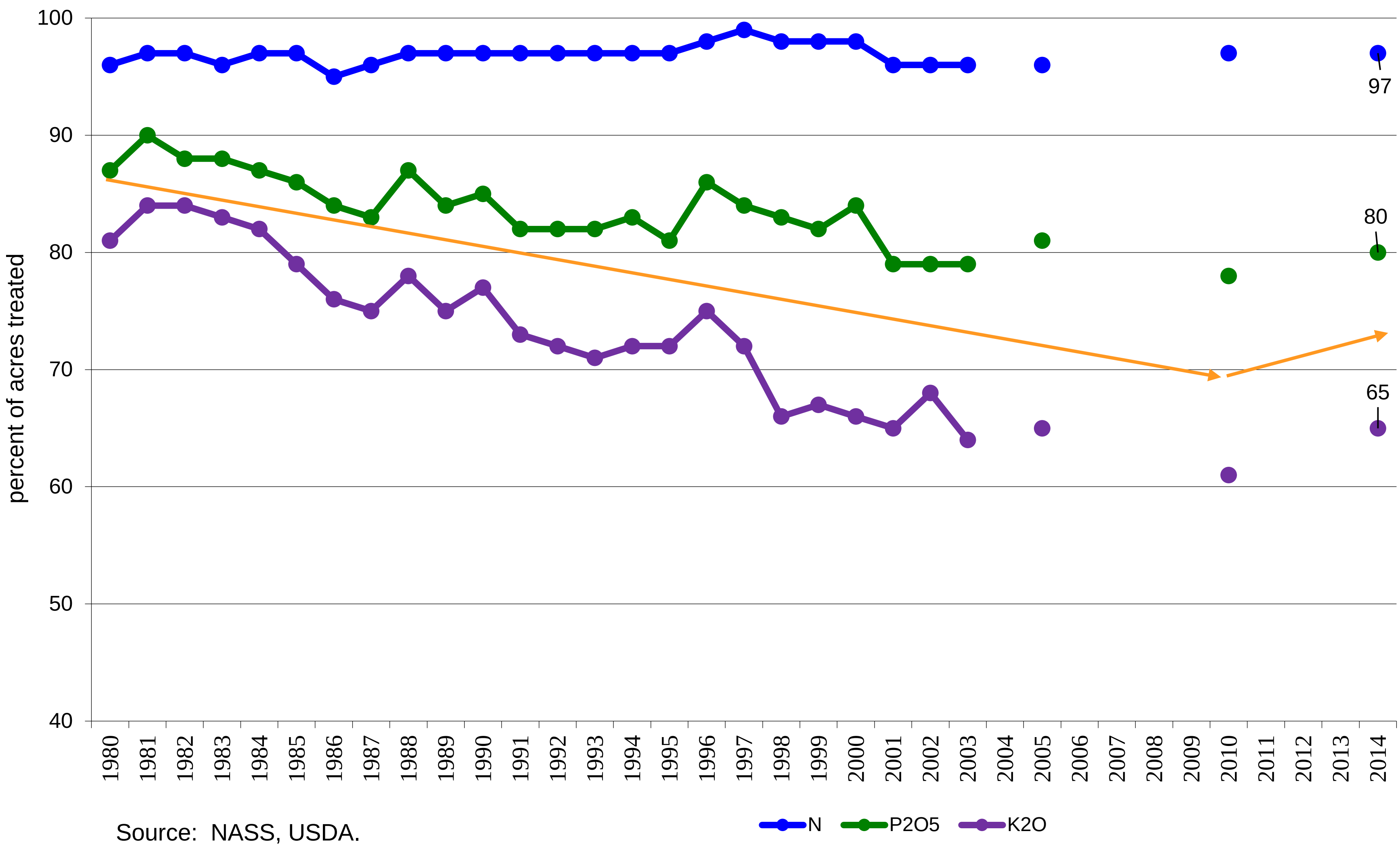
Fertilizer Nutrient Use in U.S. Corn Production

	Lbs. Nutrient per Bushel Corn Produced				% change from 1980			
	N	**P2O5**	**K2O**	**NPK**	**N**	**P2O5**	**K2O**	**NPK**
1980	1.580	0.727	0.882	3.188				
1985	1.276	0.485	0.624	2.384	-19%	-33%	-29%	-25%
1990	1.197	0.477	0.605	2.278	-24%	-34%	-31%	-29%
1995	1.209	0.438	0.563	2.210	-23%	-40%	-36%	-31%
2000	1.069	0.384	0.418	1.872	-32%	-47%	-53%	-41%
2005	0.975	0.346	0.402	1.723	-38%	-52%	-54%	-46%
2010	0.964	0.332	0.342	1.638	-39%	-54%	-61%	-49%
2014	0.890	0.326	0.340	1.556	-44%	-55%	-61%	-51%

Source: Computed by The Fertilizer Institute from data reported by USDA, 1980-2014.

How low can these go?

Percent of Corn Acres Treated with N, P2O5 and K2O



Source: NASS, USDA.

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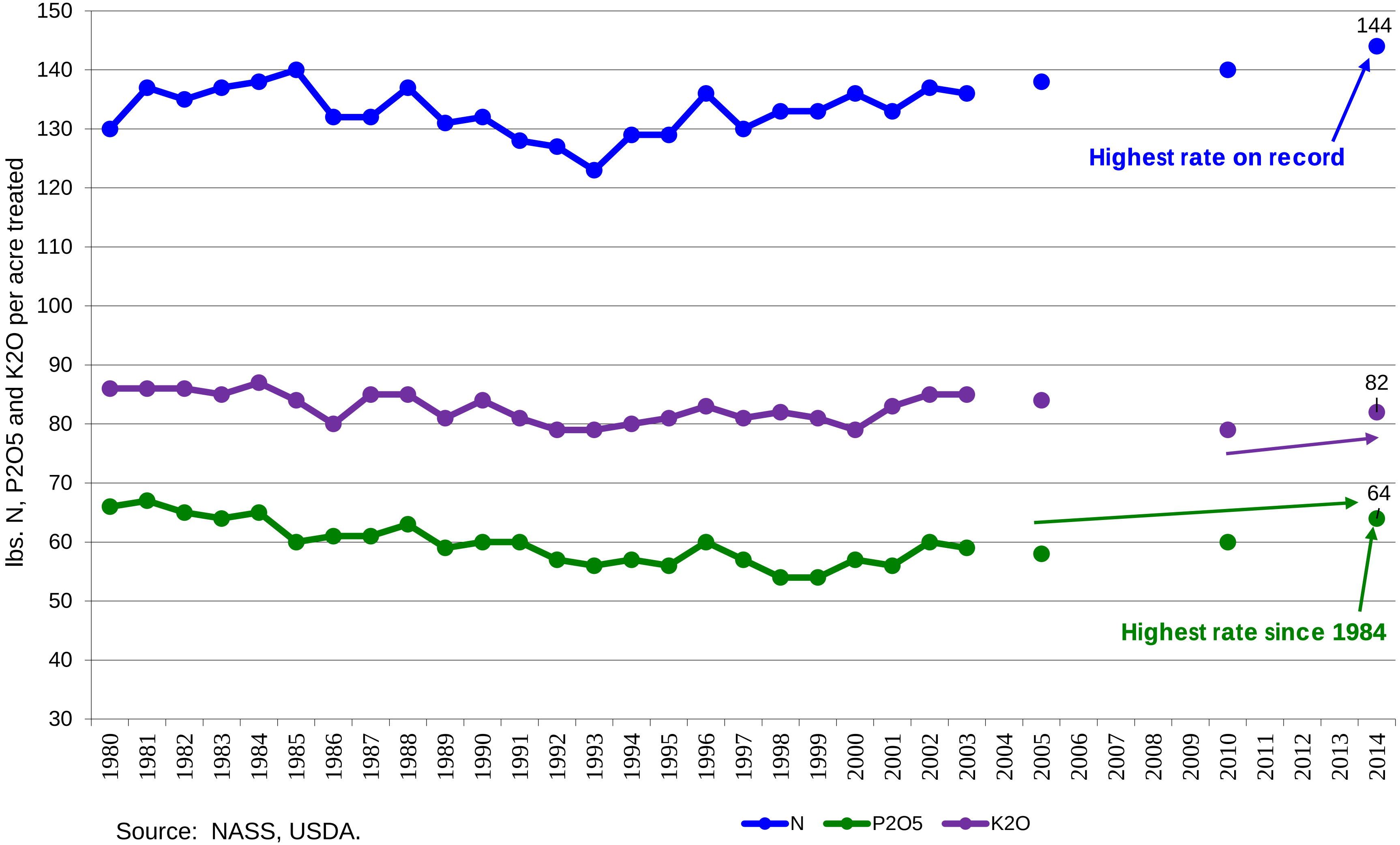
N, P2O5 and K2O Application Rates per Treated Corn Acre



Source: NASS, USDA.

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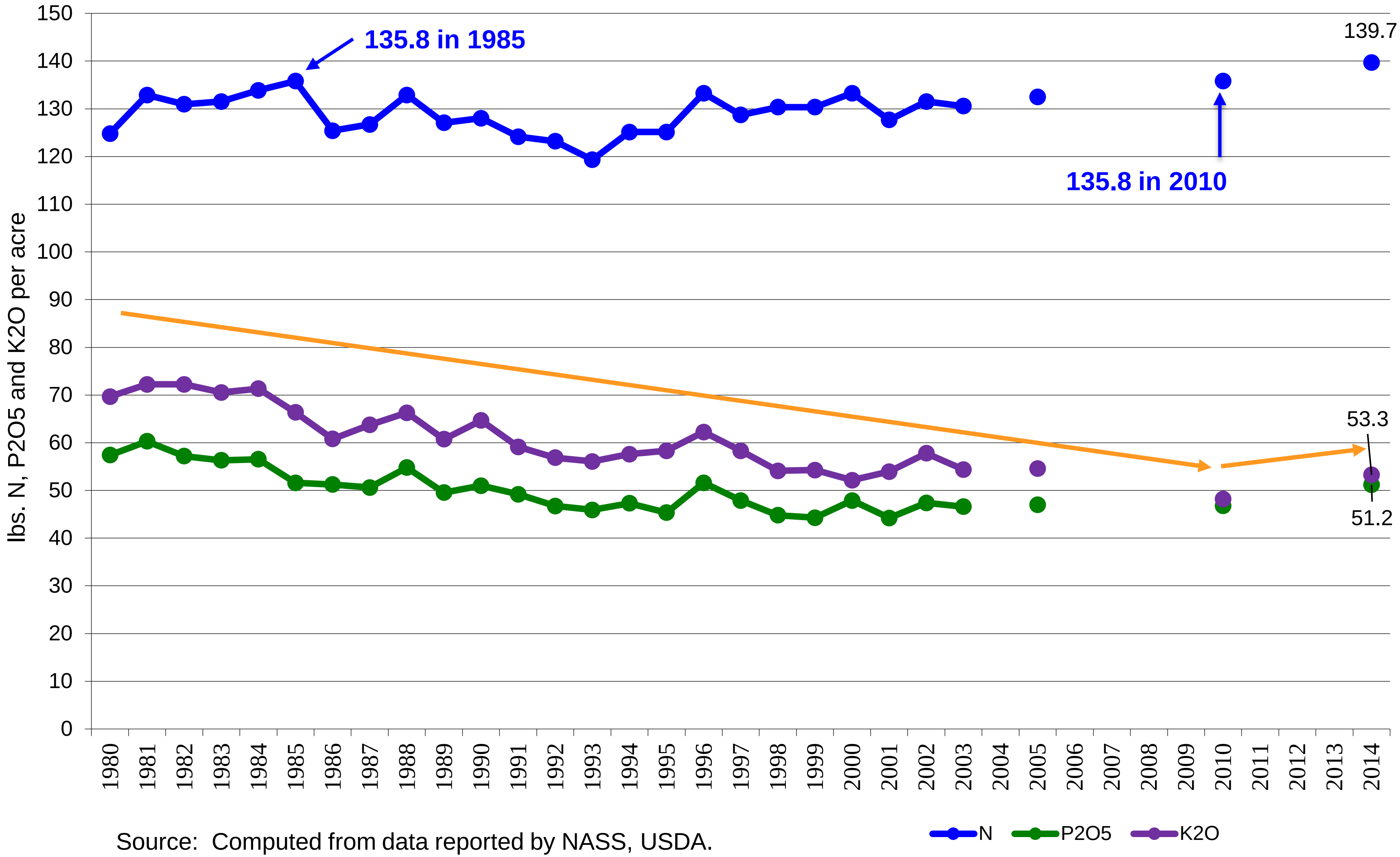
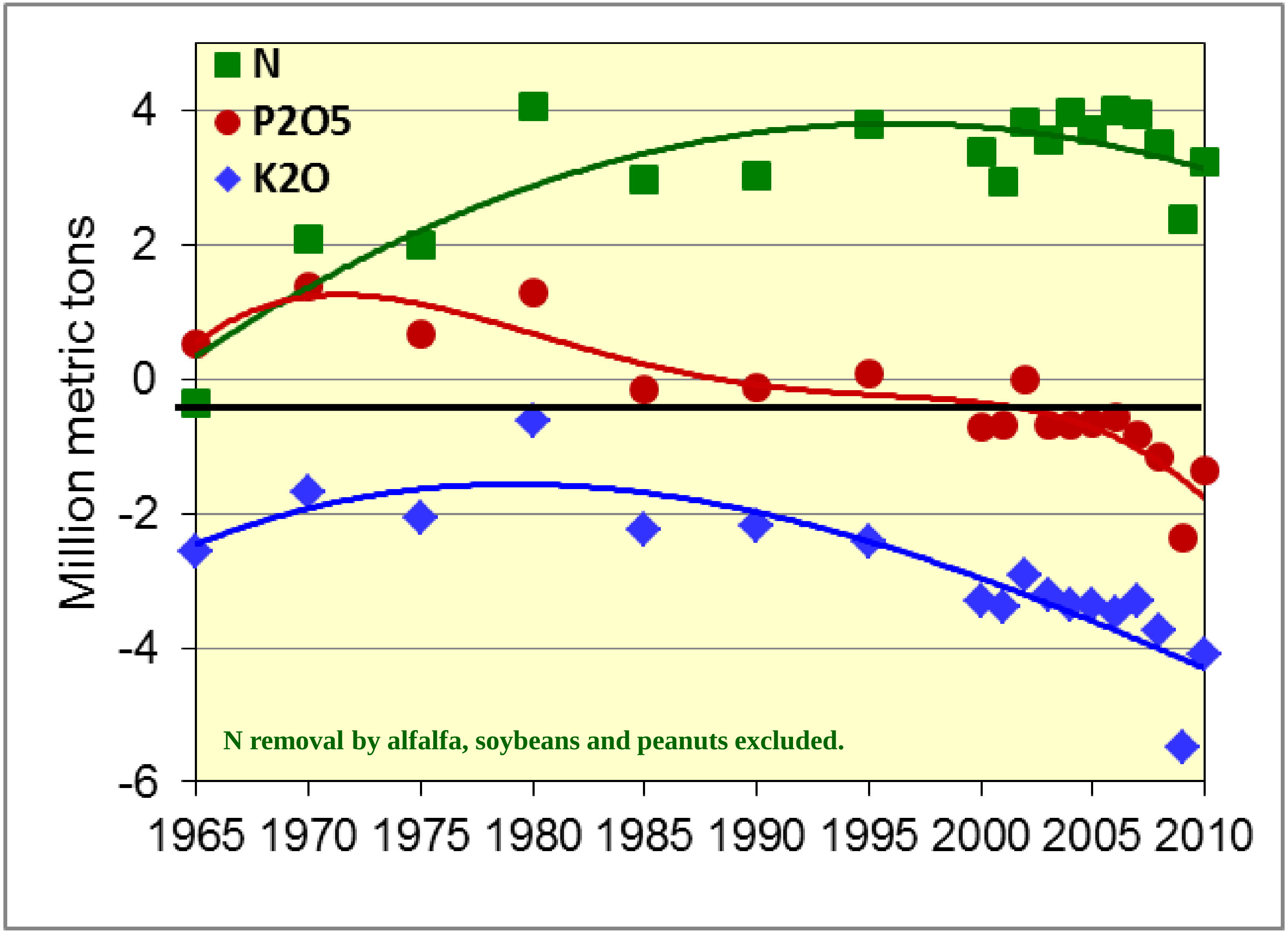
Average N, P2O5 and K2O Application Rates on Corn



Source: Computed from data reported by NASS, USDA.

Fertilizer nutrient use minus removal by crop harvest in the U.S.



Source: International Plant Nutrition Institute.

Longer-run Influence

The United Nations Forecasts that:

- The number of people in the world will rise from 7.3 Billion today to 9.7 Billion by 2050
- The rise in global population, coupled with a switch to eating more meat as incomes rise, will result in a big increase in food demand

➢ **humanity will need 70% more food by 2050!**

Some Nutrient Demand Questions

1. (partial) nutrient use efficiency in U.S. corn production has risen significantly; what were the major factors which allowed growers to produce a bushel of corn with fewer fertilizer inputs?

2. Given the relatively low quantity of fertilizer inputs used to produce a bushel of corn in 2014, will the factors noted in question 1 or other factors continuing to drive down these numbers or is it more likely that these figures will level-off or possibly even rise in the near-to-mid future?

3. In combination with the IPNI data on nutrient removal, USDA's application rate data for corn, although limited, indicate that we may have reached a turning point on nutrient use trends for P and/or K. Are P and K at levels where growers will, over time, be forced to increase applications?

Some Nutrient Demand Questions

4. Excluding corn, U.S. crop production has been more closely tied to nutrient use. Are there any technical or other developments taking place for any other crops which may lead to the kind of fertilizer use efficiency gains we have witnessed for corn?

5. How will the world, and the US in particular, increase food production by 70% by 2050?

   And how might this impact future U.S. Nutrient demand?