INTERNATIONAL
PLANT NUTRITION
INSTITUTE

Fertilizer Outlook and Technology 2011
St. Petersburg, Florida
November 15-17, 2011

Soil Nutrient Levels and Nutrient Balance in Major Fertilizer Consuming Countries

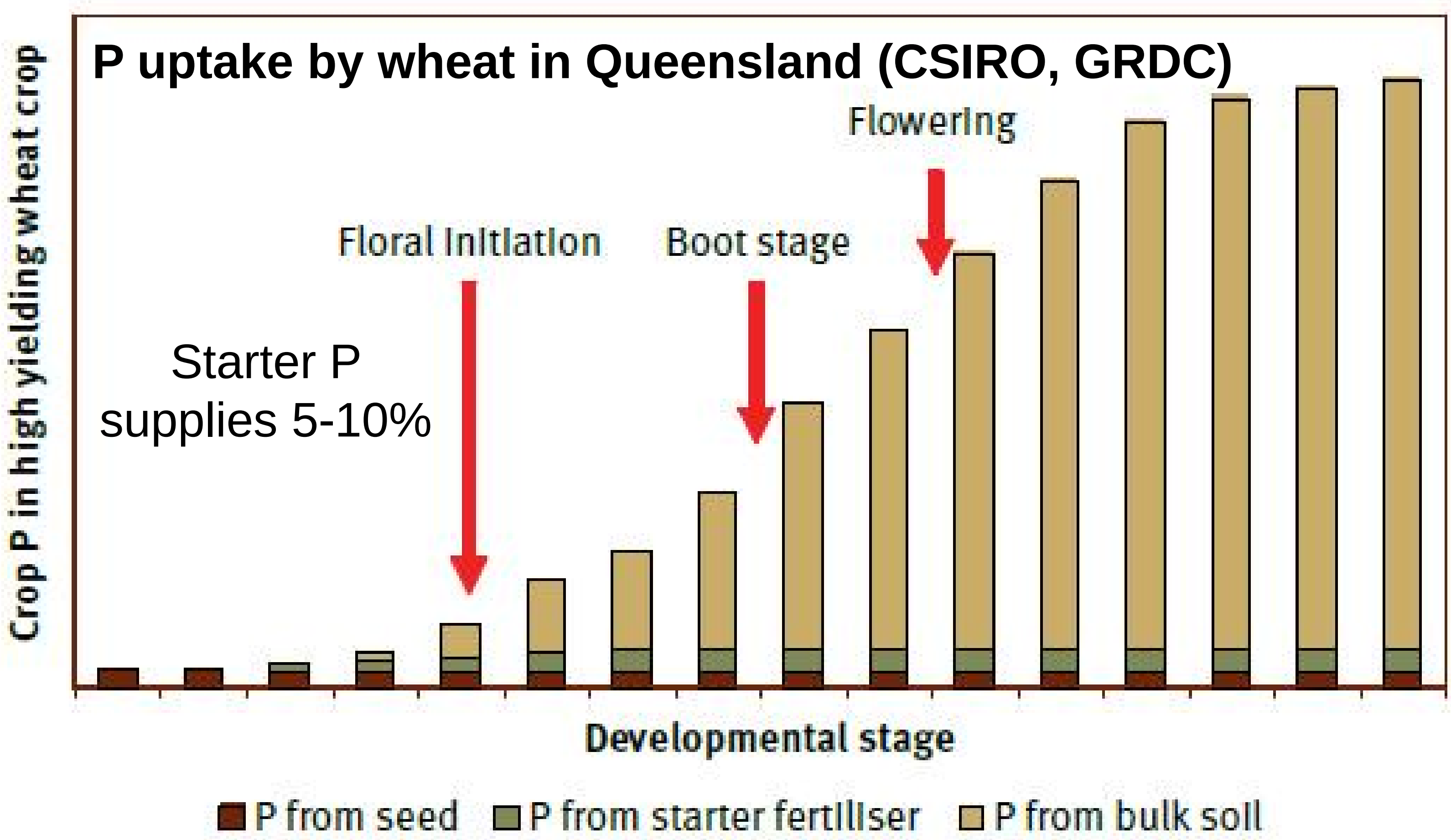
Paul E. Fixen, PhD
Sr. Vice President
pfixen@ipni.net

A primary function of nutrient management is to facilitate the balancing of removals with inputs at levels supporting optimum crop growth and minimal losses to the environment.

Balance defines the direction of soil fertility and is a critical indicator of sustainability.

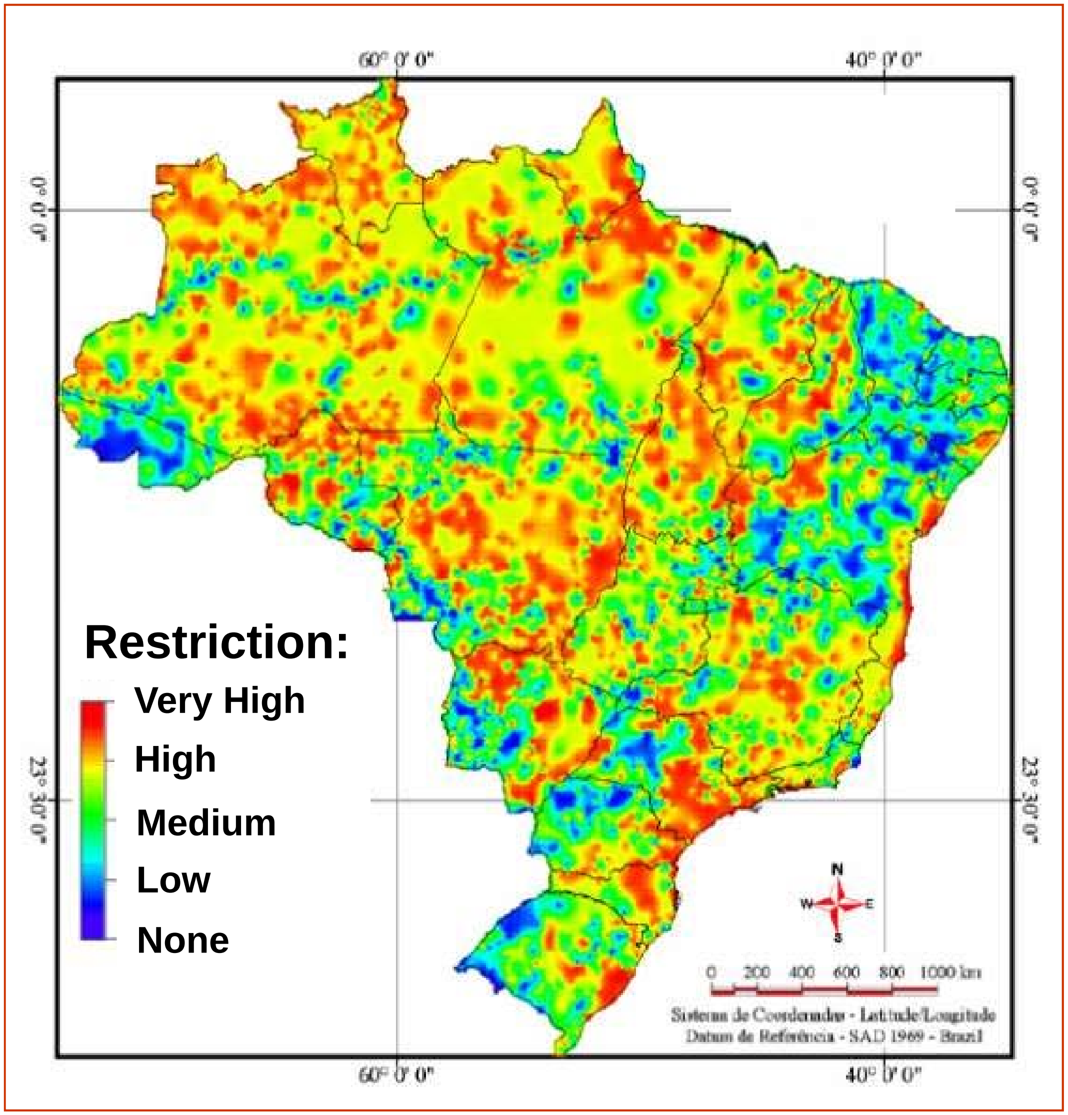
IPNI

How much of a plant's nutrition comes from fertilizer in a single growing season?



Usually less that 15% … the rest from the soil

Class restriction in fertility of Brazilian Soils



Sparovek et al., 2003.

Soil P and K levels in Brazil (2004)

Fertility class	Nutrient[1]	
	P	K
	%	
Very Low	**60**	**29**
Low	**16**	**24**
Medium	15	26
High	6	17
Very high	4	4

[1]ESALQ/USP Laboratory; 13,164 samples.

76% test VL/L in P

53% test VL/L in K

Lesson: Soil type influences soil fertility levels – Oxisols will generally be less fertile than less weathered soils

Soil P levels in Southern India

State	Fertility Class	
	Low	Medium
	% of districts	
Andhra Pradesh	81	19
Karnataka	84	16
Kerala	30	70
Tamil Nadu	62	38
Four states	**70**	**30**

Satyanarayana, IPNI.

No districts had high fertility status

Lesson: Fertility levels reflect past nutrient use relative to nutrient removal in crop harvest

Soil P levels in Southwest China

Province	Dominant Crop[1]	
	Grain crops	Vegetables
	% Deficient	
Sichuan	78	9
Chongqing	93	21
Yunnan	70	
Guizhou	88	

All of China[2]:
44% Deficient

[1]Tu (late 1990s); [2]Liu (2001-2006).

Lesson: Fertility levels vary with cropping system – high value crops are more heavily fertilized than grain crops.

Soil P and K levels in Russia (2005)

Fertility class	Nutrient[1]	
	P	K
	%	
Very Low	**6**	**1**
Low	**16**	**9**
Medium	**35**	**22**
Heightened	22	28
High	14	25
Very high	8	15

Ivanova, IPNI

57% test VL/L/M in P

32% test VL/L/M in K

Lesson: Current fertility reflects past nutrient use

Soil K levels in Bulgaria

Fertility class	Years[1]	
	1985-1989	2003-2006
	%	
Low	12	22
Medium	18	31
High	70	53

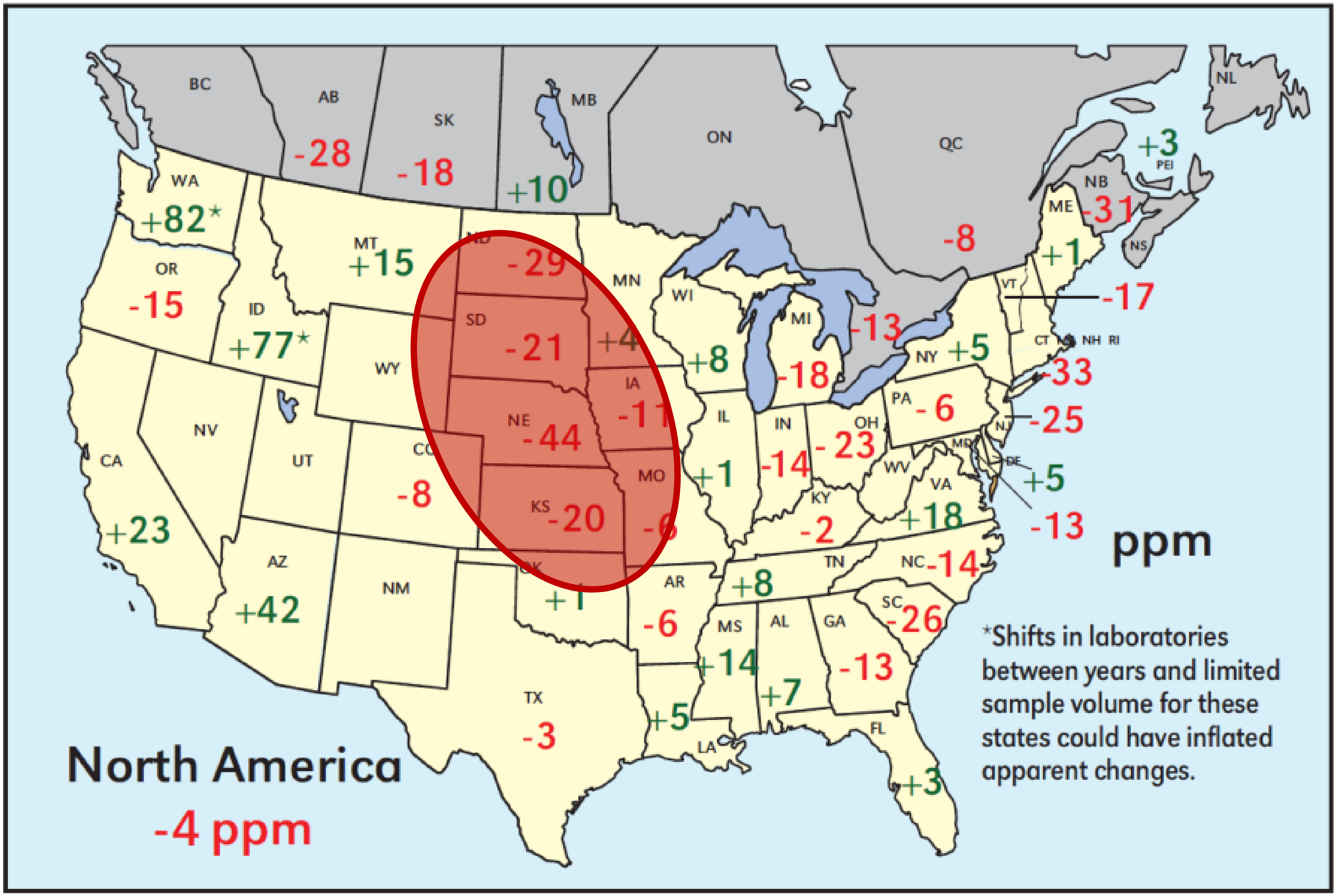
[1]Nikolova

L or M increased from 30% to 53% over 18 yrs

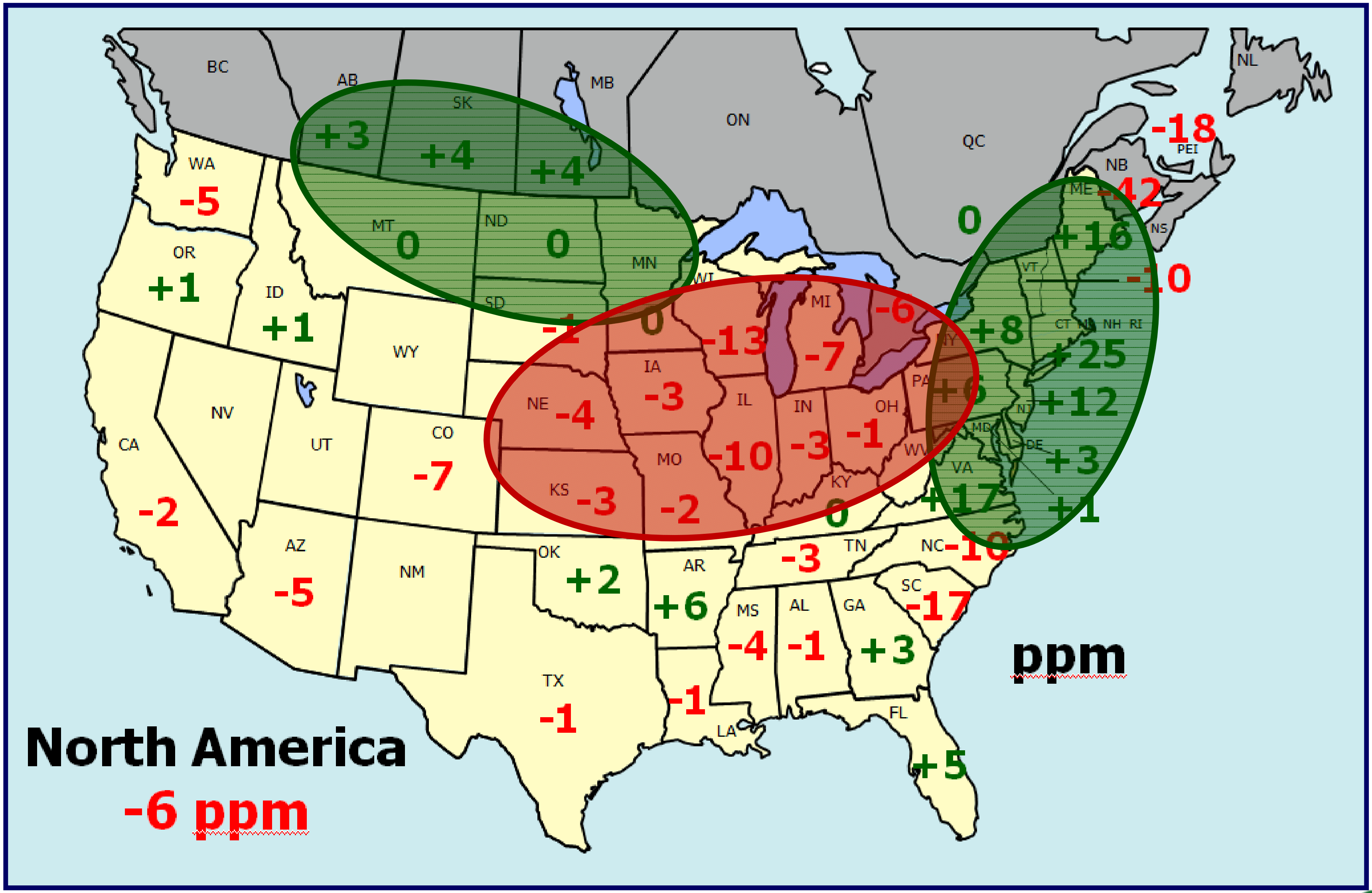
Lesson: Soil K levels decline during years of negative nutrient balance

IPNI

Change in median soil K level from 2005 to 2010

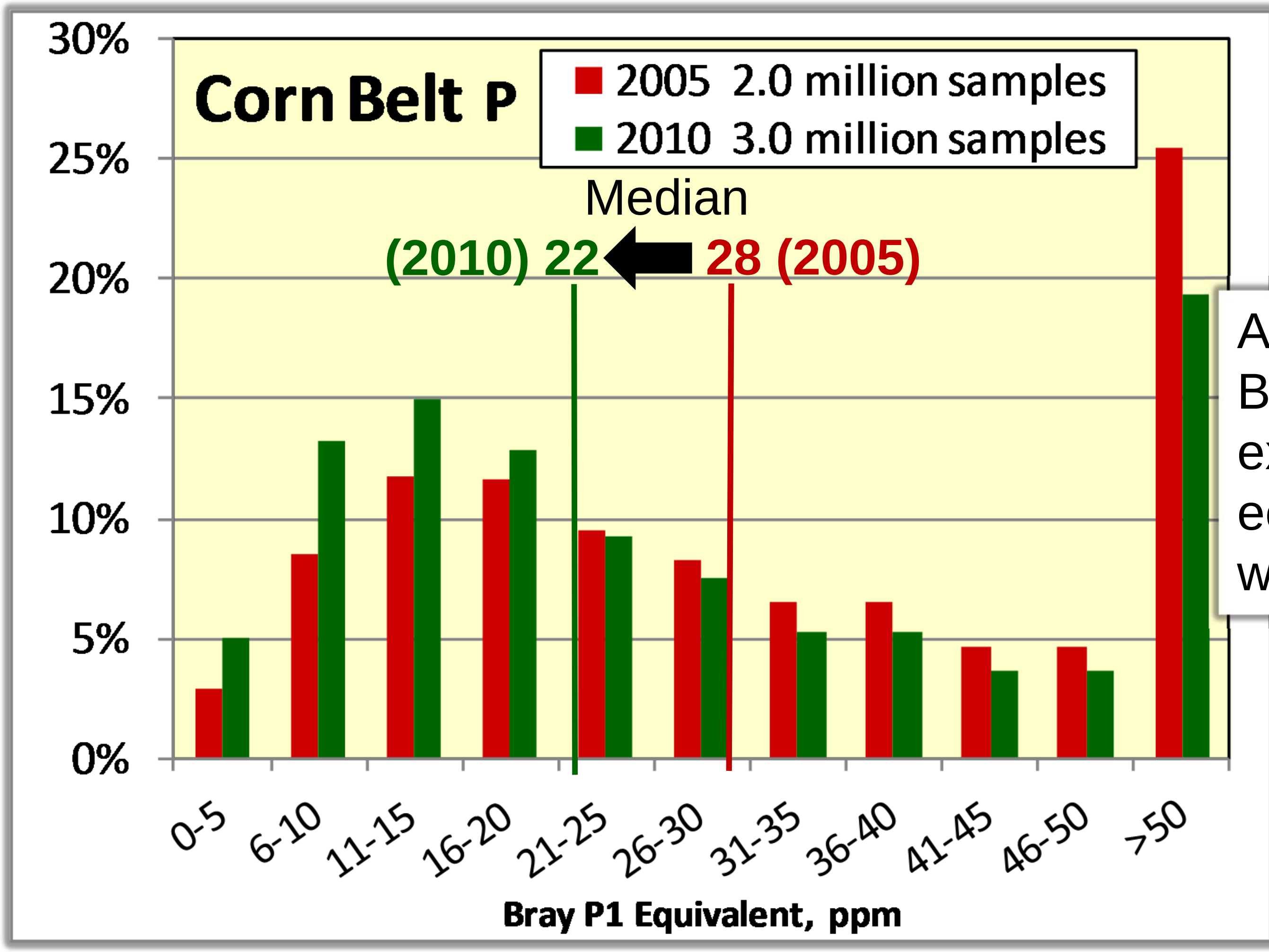


Change in median Bray P equivalent soil test levels from 2005 to 2010.



Soil test P distribution in 2010 compared to 2005 for the Corn Belt

9/2/2010 (12 states plus Ontario)



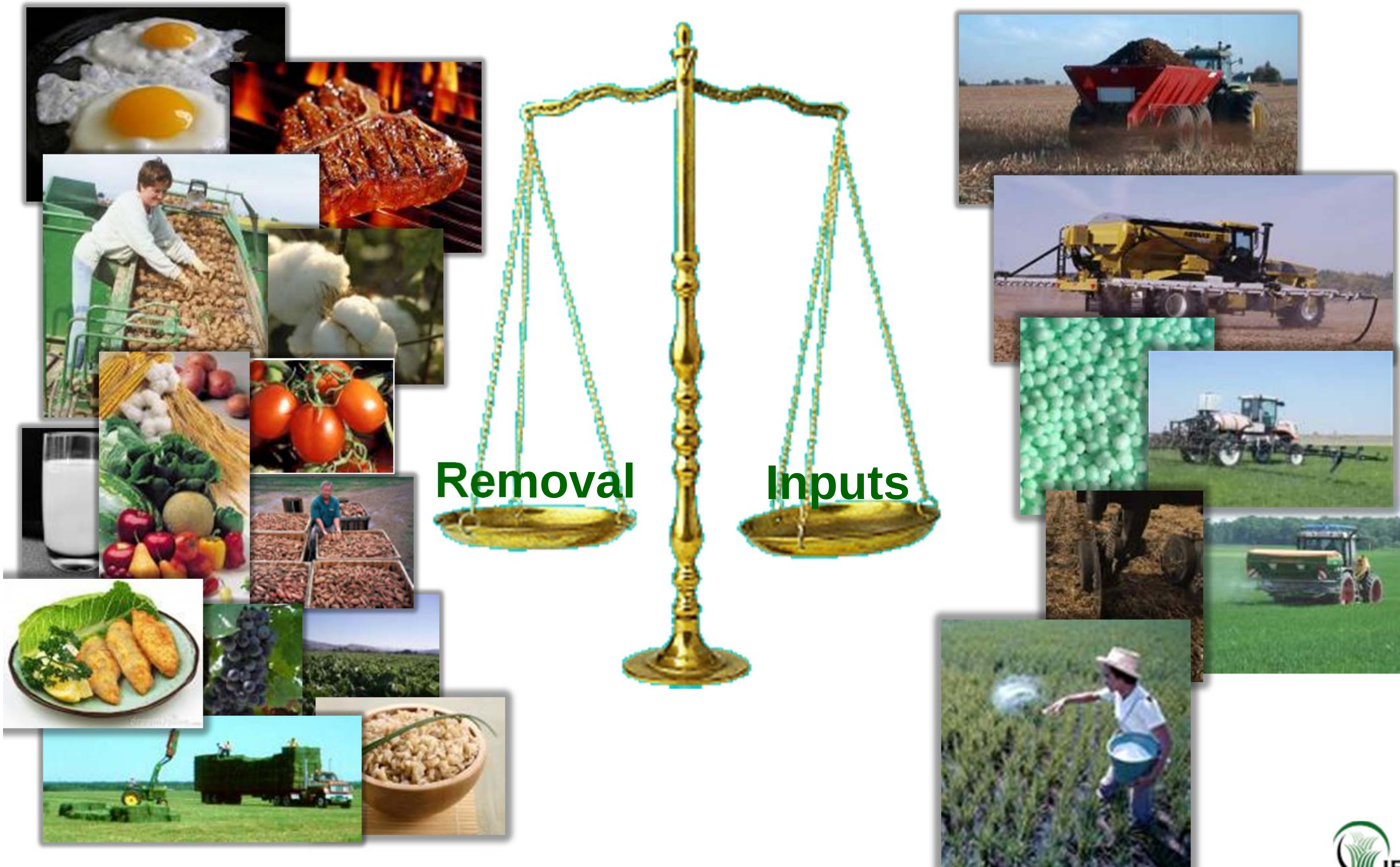
At least 50% of Corn Belt fields will now experience immediate economic yield loss without P addition.

IPNI
International
Plant Nutrition
Institute

Native soil properties determine where you start with soil fertility but **nutrient balance** determines where you end up

What do we mean by nutrient balance?

Nutrient inputs minus removal



Balance consequences

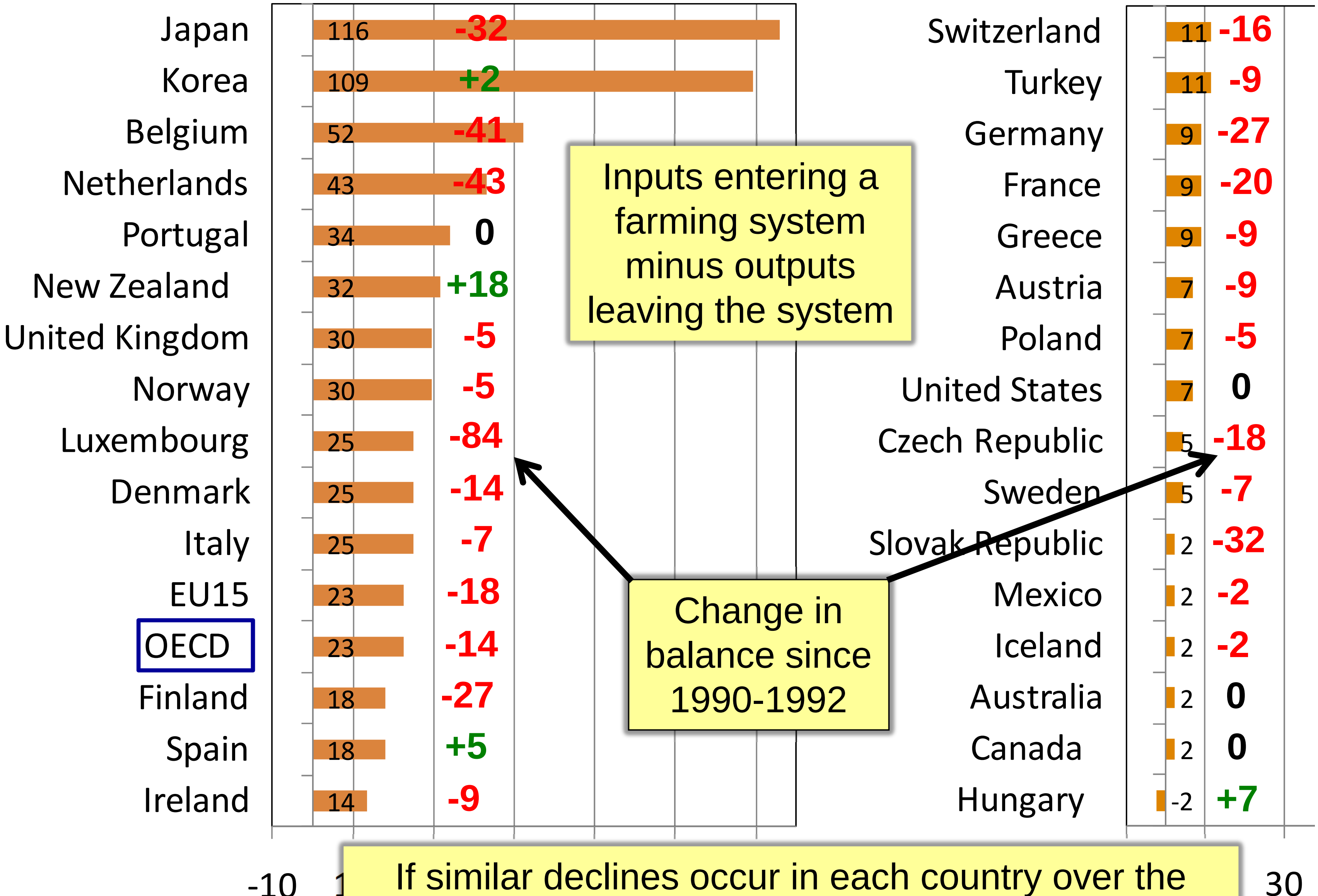
Negative balance (removal exceeds use): leads to declining soil fertility and eventually to reduced productivity once nutrient supplies drop below critical levels.

Positive balance (use exceeds removal): usually associated with increasing soil fertility and may eventually lead to an elevated risk of nutrient loss to the environment.

Zero balance (use equals removal): usually associated with soil fertility maintenance.

IPNI

Average gross P balance estimates for OECD countries, 2002-2004.



If similar declines occur in each country over the next decade, 13 would have 0 or negative balances

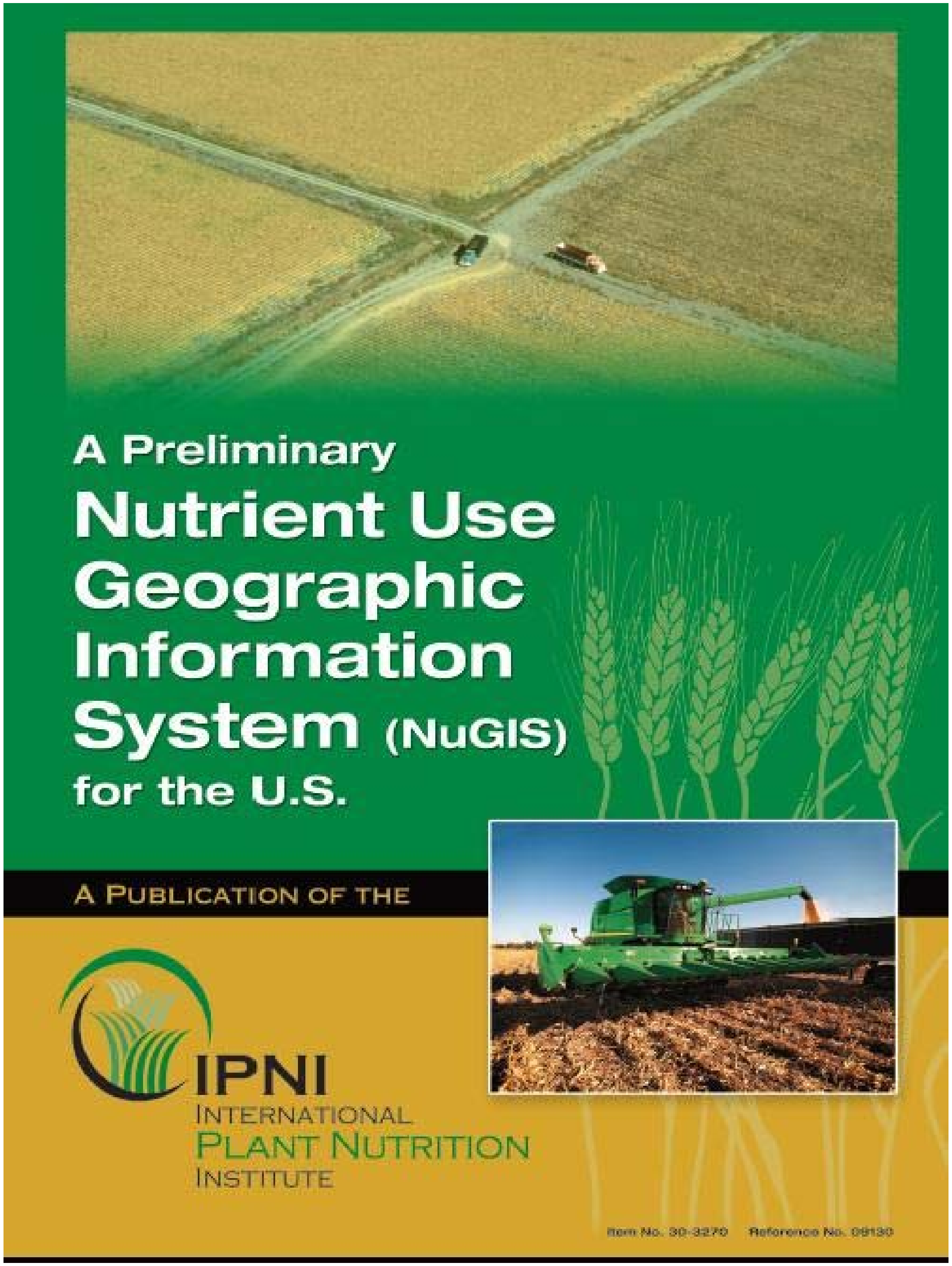
OECD, 2008

Gross P and K balances for various countries.

Reported as published – methods, assumptions and time vary

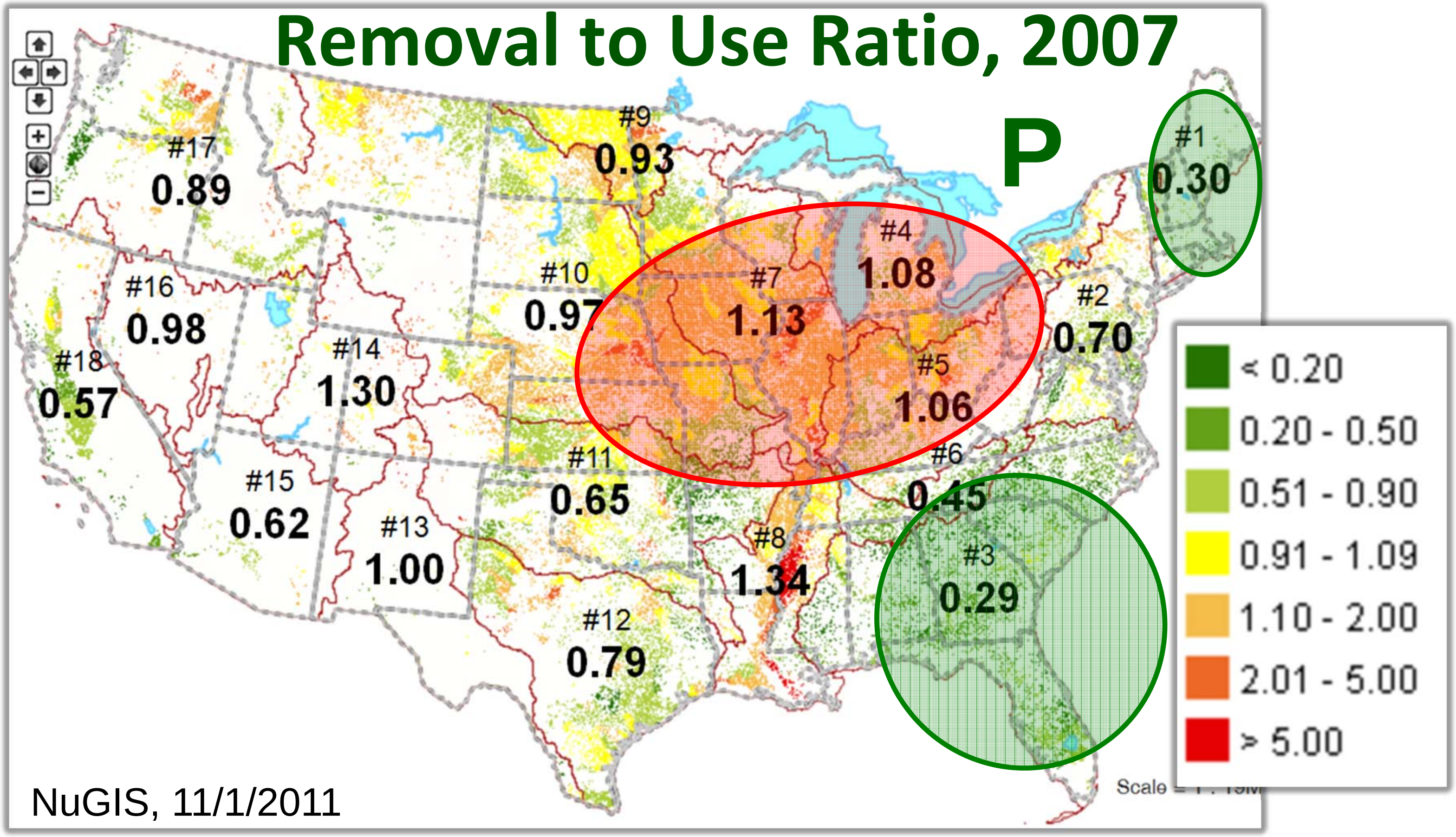
Country	Gross balance	Nutrient	
		P_2O_5	K_2O
OECD[1], 02-04	Kg/ha	23	--
India[2], 2009	Kg/ha	3	-53
China[3], 2005	Kg/ha	79	-24
Brazil[4], 2008	Kg/ha	21	12
Russia[5], 96-07	Kg/ha	-6	-23
US[6], 2007	Kg/ha	4	-12

[1]Organization for Economic Co-operation and Development, 2008; [2]Based on FAI 2009 statistics reported by Satyanarayana, 2010; [3]LIU, 2008. [4]da Cunha et al., 2010; [5]Sichev et al., 2010; [6]IPNIa, 2011.

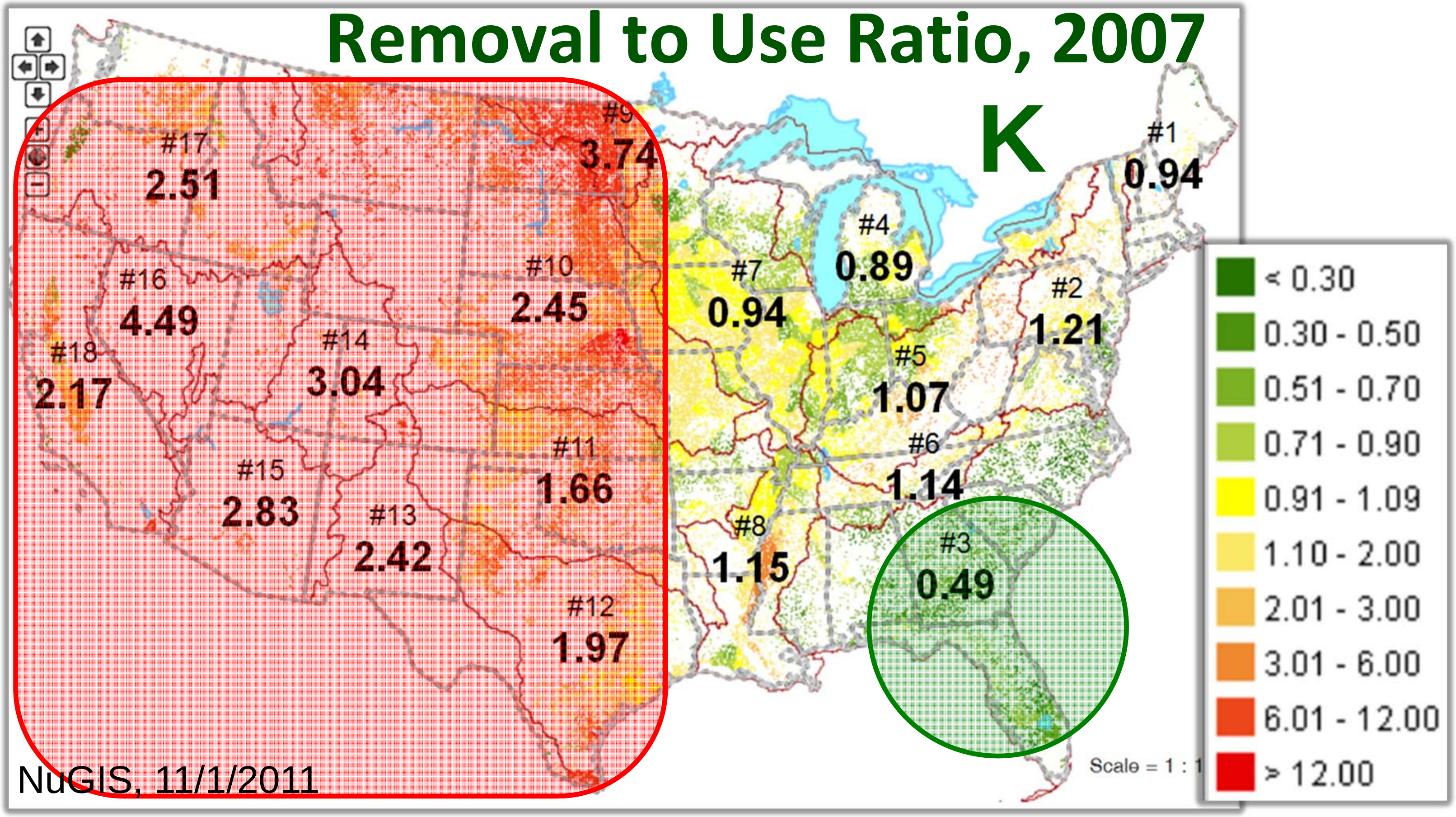


- Preliminary NuGIS
  - Released summer of 2010 (bulletin & web tool)
  - Under review and extensive revision
- Final version
  - Released Nov. 1, 2011
  - Improved accuracy
  - Export data files and maps
  - Data from 1987-2007; soon 2008-2009.

http://www.ipni.net/nugis

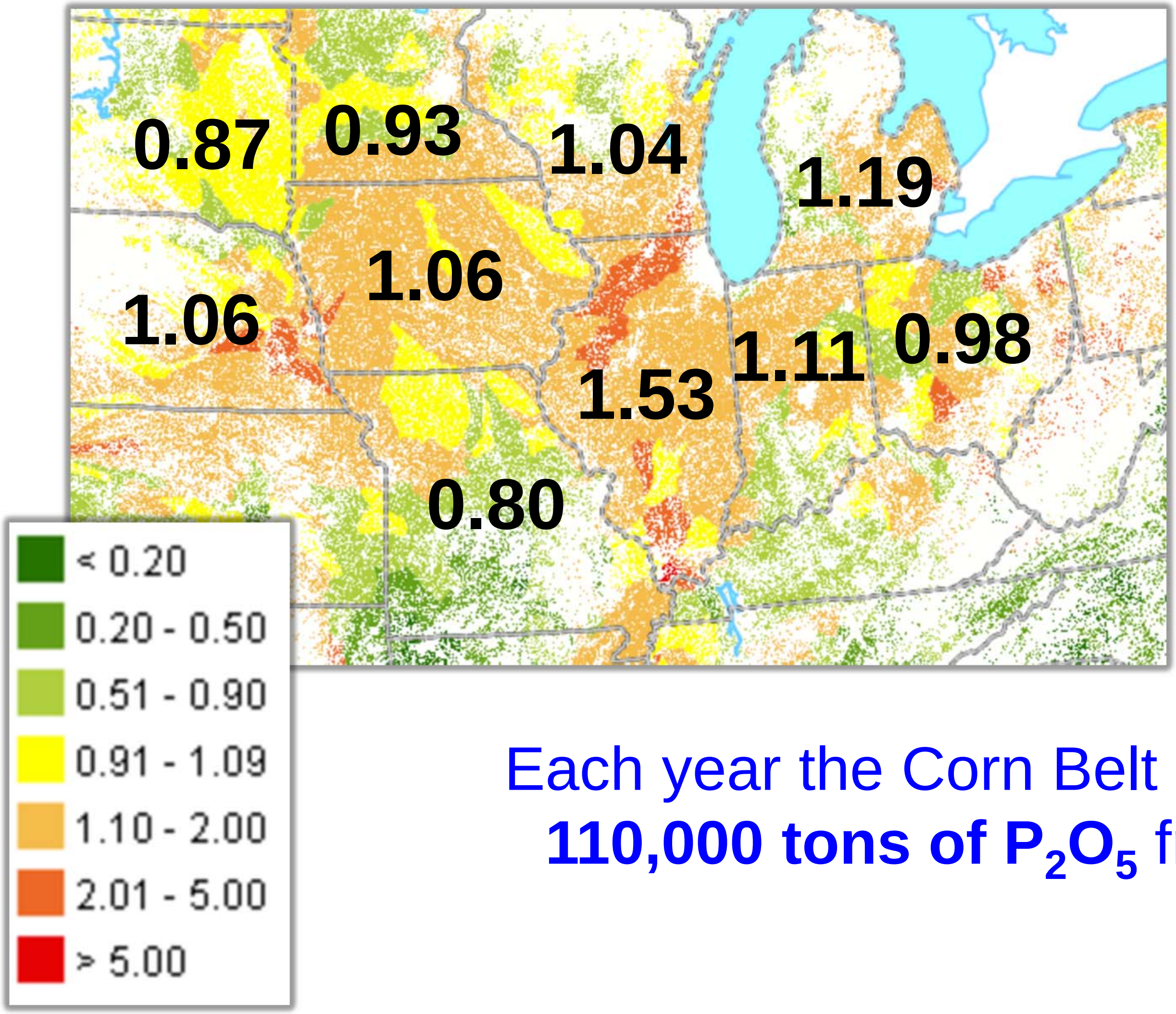


- Lower ratios are in the SE and NE and are usually associated with high cash value crops or high livestock density per unit of arable land.
- Highest ratios found in the Corn Belt and lower Mississippi.



- Ratios very high in West due to high indigenous soil K levels
  - Most soils continue to supply ample K for crops, but
  - Soil K summaries do show reductions; with time K use will need to increase.
- Low ratios in the Southeast
  - Soils with very low cation exchange capacity that do not store K effectively
  - Also, area of high cash value crops.

Ratio of P removal by crops to fertilizer plus recoverable manure across the Corn Belt, 2007



12 Corn Belt States

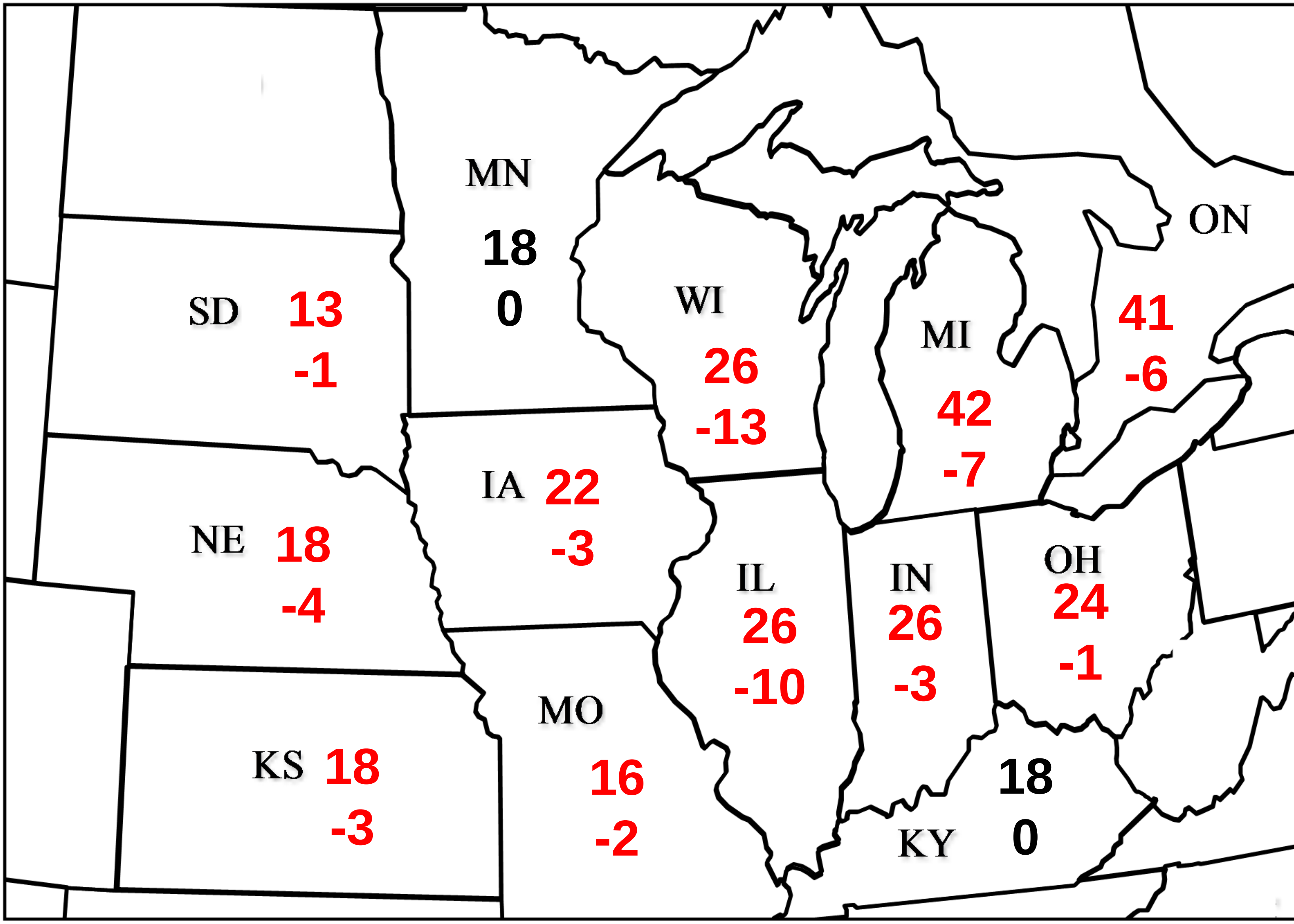
	P_2O_5 million tons
Fertilizer used	2.47
Crop removal	3.36
Fert use – rem.	**-0.90**
Recov. manure	0.78
Balance	**-0.11**

Each year the Corn Belt mines at least **110,000 tons of P_2O_5** from its soils.

NuGIS, 11/1/2011

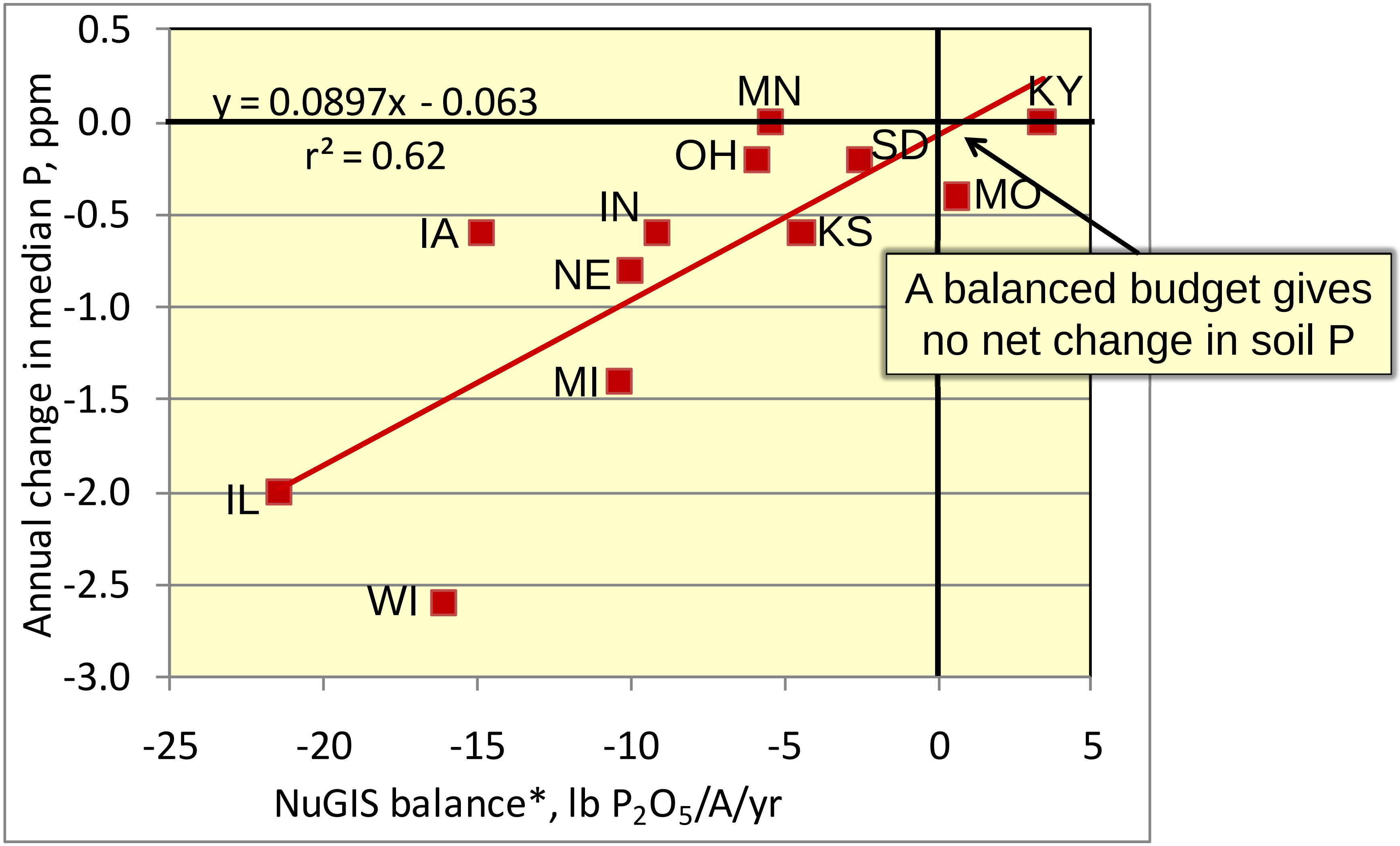
IPNI

2010 median soil P levels* and change from 2005 (Soil samples, millions: 2005=2.0; 2010=3.0)



*Median Bray P1 equivalent, ppm

Annual change in median soil P level for 12 Corn Belt states as related to state P balance, 2005-2009.



*Preliminary NuGIS

Nutrient use in U.S. Corn Production

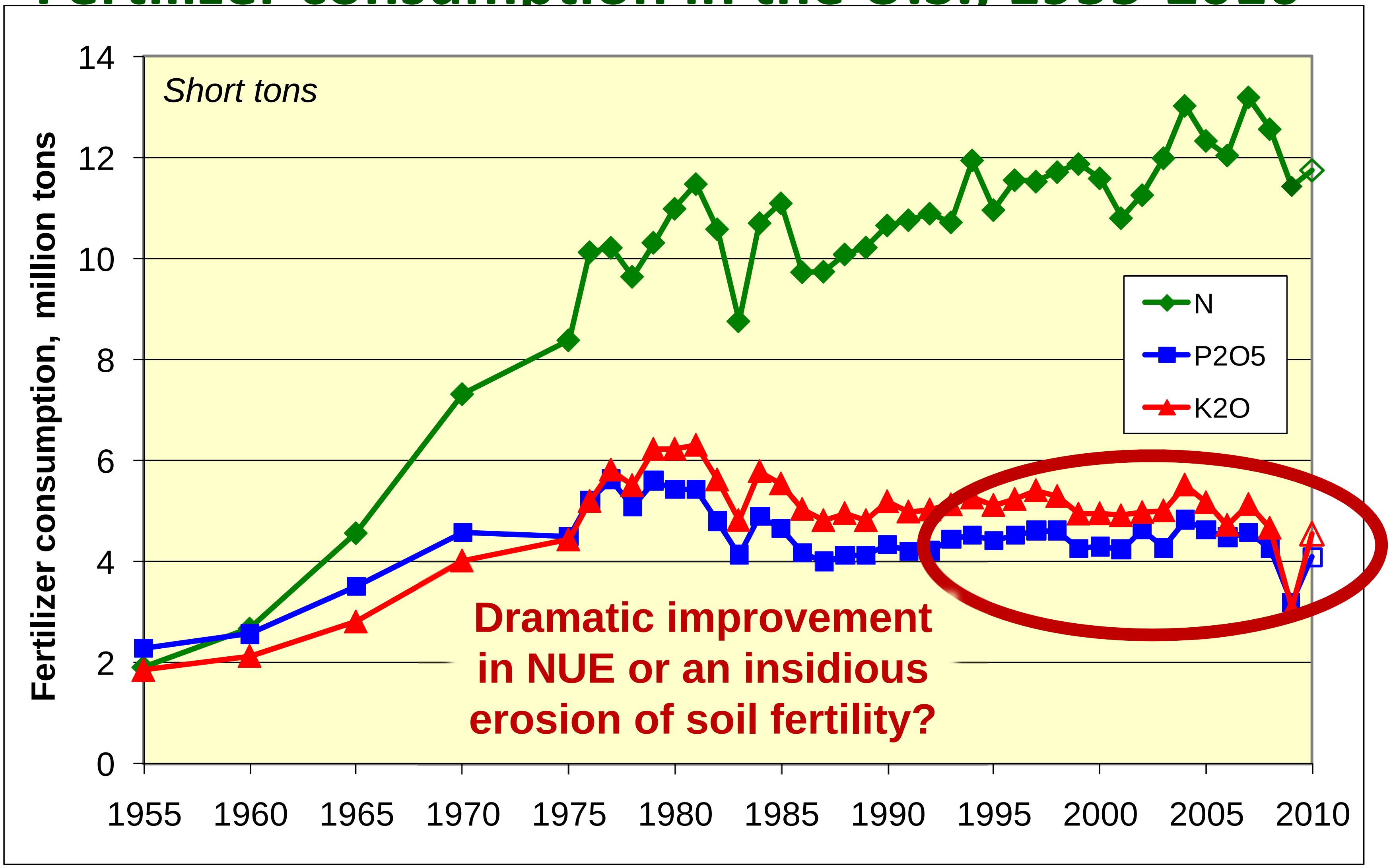
Nutrient Use in U.S. Corn Production			
	Lbs. Nutrient per Bushel Corn Produced		
	N	P2O5	K2O
1970	1.665	0.996	0.917
1975	1.330	0.672	0.740
1980	1.580	0.727	0.882
1985	1.276	0.485	0.624
1990	1.197	0.477	0.605
1995	1.209	0.438	0.563
2000	1.069	0.384	0.418
2005	0.975	0.346	0.402
2010	0.962	0.332	0.341

- Huge reductions in use per bushel in each of the last 4 decades.
- "Through improvements in modern technology and old fashioned ingenuity, our farmers are using fertilizer with the **greatest efficiency in history** and have again shown why U.S. Agriculture will continue to feed the world." *Ford West, 5/31/2011*

- Are these P and K use reductions sustainable?

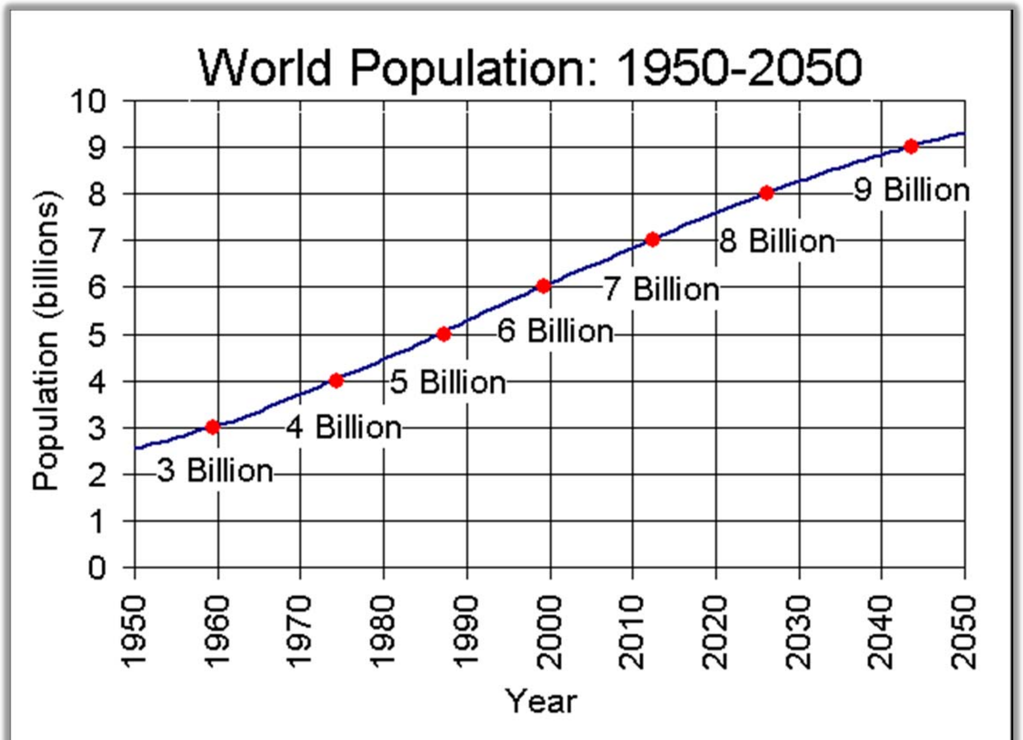
Nutrient use calculations from Harry Vroomen based on USDA-NASS data(TFI, 6/3/2011).

Fertilizer consumption in the U.S., 1955-2010



Source: AAPFCO, TFI (2010 estimate by H. Vroomen, 6/3/2011).

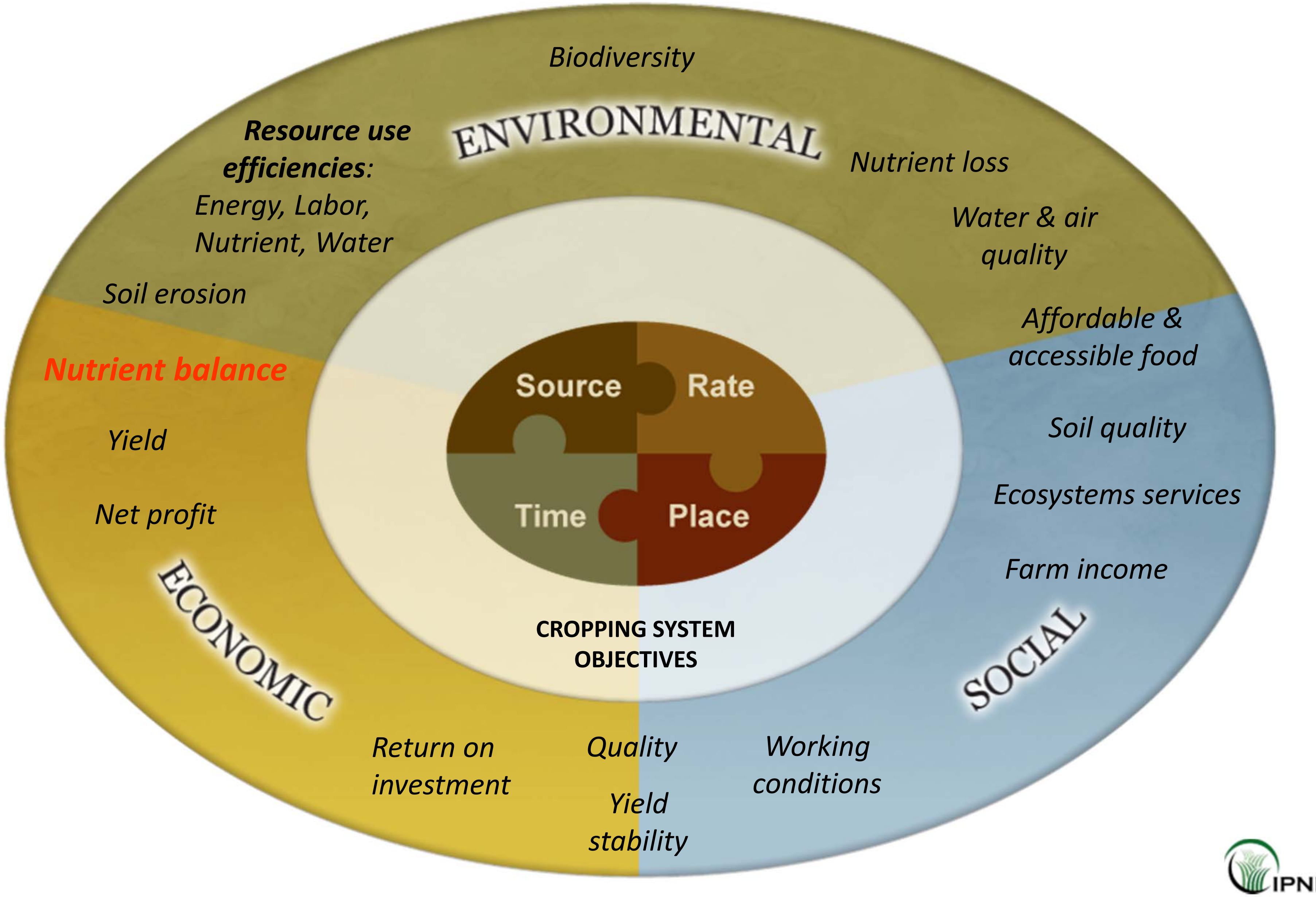
Anticipated changes impacting future nutrient needs



Source: U.S. Census Bureau, International Data Base, June 2009 Update.

- **Population growth** and **economic development** will increase global demand for traditional crops.
- Producing a billion tons of feedstock for **bioenergy** by 2030 will further increase removal and U.S. fertilizer needs.
- Changing crop genetics and **increased yield potential** is likely to increase nutrient demand per unit area.
- In major production regions, a higher portion of crop demand will need to be met by fertilizer due to **depleted soil reserves**.

The 4R nutrient stewardship framework.



"I can't change the direction of the wind, but I can adjust my sails to always reach my destination."

- Jimmy Dean

Needed adjustments …

- **Declining soil fertility** indicates that **negative P and K balances** of the **Corn Belt** require **correction** to avoid **losses in future productivity.**
- **Nutrient relationships** on the farms of the world **are changing**
  - **They need to continue to change** with the direction needed being farm and field dependent.
  - **4R nutrient stewardship** offers a useful framework to guide those changes towards **more sustainable systems.**

Needed adjustments …

- The resulting **challenge** for the fertilizer **industry** is to:
  - Use its **marketing** and **delivery** strength to **increase nutrient balances** where they are inappropriately **low**
  - While **providing** the technology, service and educational **programs to reduce balances** where **inappropriately high**.
- The associated **challenge for science** is to **identify which is which.**