IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

Preparing for Intensification

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

Fluid Fertilizer Forum
February 21, 2011

Underlying factors for the challenges of the coming decades

- Food quantity
- Food quality
- Food cost

Soil & nutrient management are common to all three

- Climate change
- Cheap energy
- Bioenergy
- Etc.

- Land use
- Soil quality
- Water use & quality
- Waste disposal
- Etc.

A triangle of opportunity for those offering solutions
or
a target for those perceived as contributing to problems

Carbon and land concept by Henry Janzen, 2009

IPNI

IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

Is intensification the solution or part of the problem?

http://www.initrogen.org/visualization.0.html

Nitrogen Visualization, ECN and MediaMonks, 2007.

Effect of decisions relative to 2030 forecast

Biomass use

Intensification

Nature area

Meat consumption

Transport efficiency

Energy saving

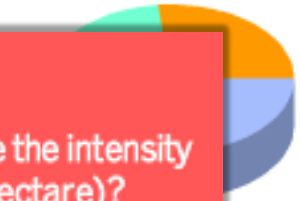
N-efficiency

Renewable energy

Intensification

How much do you want to change the intensity of agriculture (in crop yield per hectare)?

Area



Food	0
Energy	0
Nature	0
Urban	0

Sustainometer Index

Income

0

0%

Direct Effect

Emissions | Effects | Social

0%

NOx	0 %
NO3	0 %
NH3	0 %
N2O	0 %
CO2	0 %
CH4	0 %

1 2 3 4 5

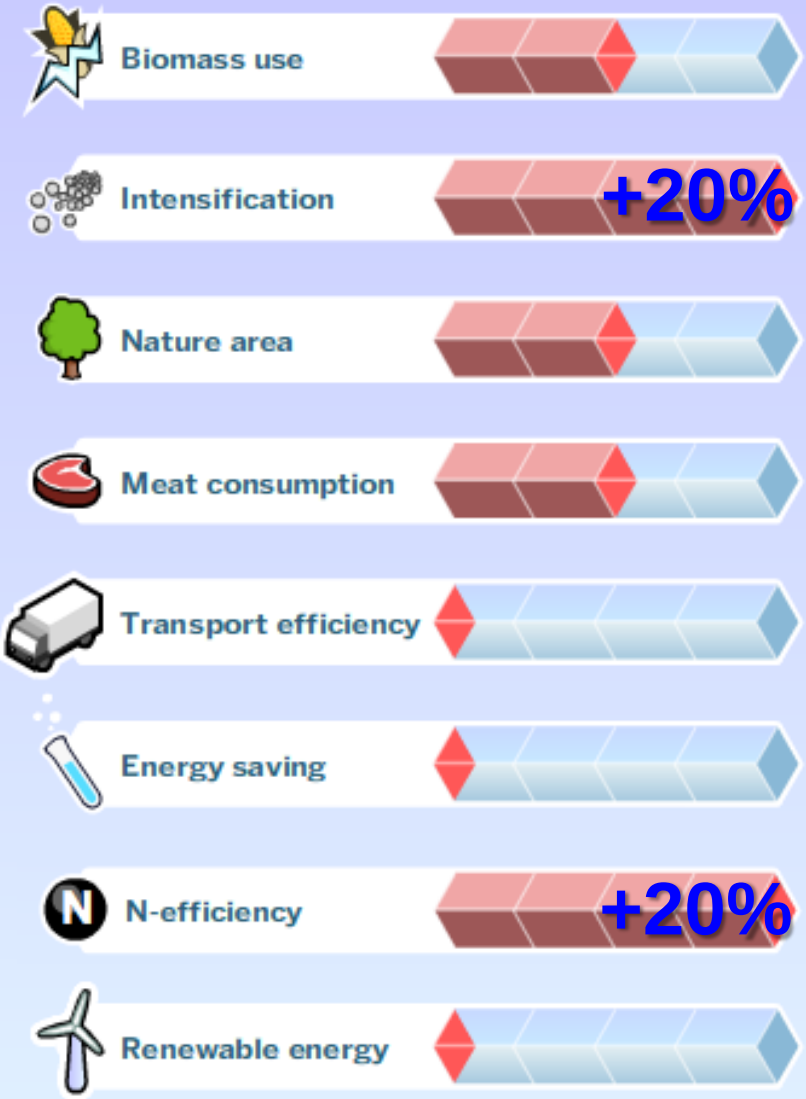
6 7 8 9 10

GO

reset to 2030

Press space for the menu

Effect of decisions relative to 2030 forecast



Press space for the menu

N efficiency +20%

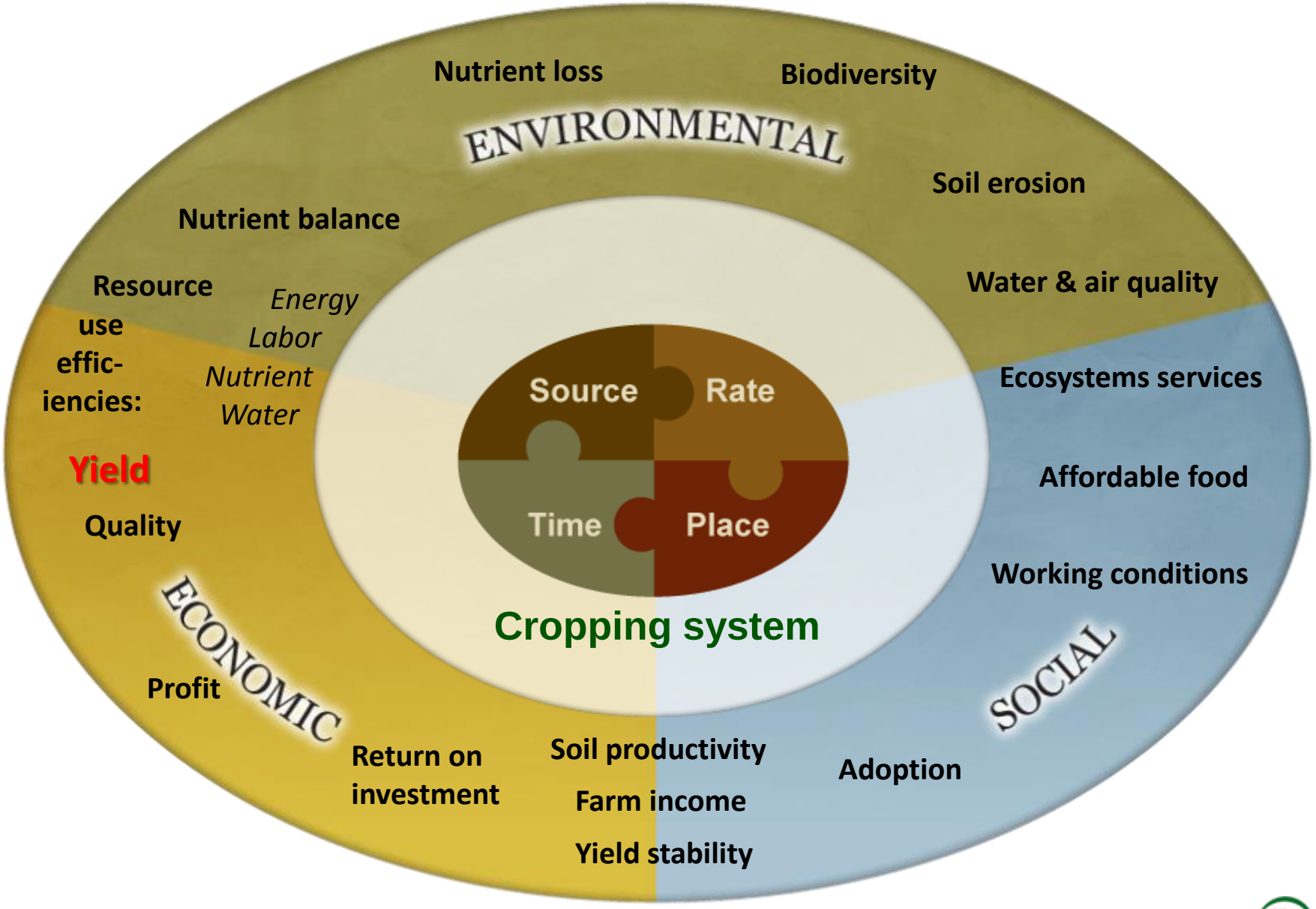
Prosperity index		5.5 %	7.1 %
Health index		-0.2 %	0.2 %
Available Food		15 %	19.6 %
Hunger		-11.9 %	-15.7 %
Transport		7.6 %	10 %
Energy use total		2.3 %	2.8 %
Artificial Fertiliser		40 %	12 %
Global warming		2.1 %	2.2 %
Air quality issues		2.1 %	1.4 %
Drinking water pollution		1.9 %	-7.7 %
Eutrofication		5.8 %	-5.6 %
Depletion of the ozon layer		2.8 %	3.2 %
Acidification		3.4 %	1.8 %
Loss of biodiversity		1.3 %	1.5 %
Emissions	NOx	3.9 %	5.3 %
	NO3	1.9 %	-7.7 %
	NH3	15 %	6.1 %
	N2O	3.5 %	0.6 %
	CO2	3.8 %	4.3 %
	CH4	5 %	4.7 %

IPNI

IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

Intensification must be seen as more than yield increases

Performance Indicators



Realizing a New Vision for Agriculture

"**Social**" has been replaced with "**Food Security**" …
Why?

World Economic Forum, 2010.

Print

4th February 11

THISDAY
:: The voice of transparency ::

Food price volatility dominates farm ministers` summit

Correspondent

Farm ministers meeting on trade and food secur
improve transparency, information and fight abus

The call in a communiqué at the end of their sum
protests in the Middle East have been attributed

BBC NEWS

SCIENCE & ENVIRONMENT

24 January 2011 Last updated at 06:32 ET

Report: Urgent action needed to avert global hunger

od security has called for urgent

msnbc.com

Global food chain stretched to the limit

Soaring prices spark fears of social unrest in developing world

"We are entering a danger territo
Abbassian, chief economist at th
and Agriculture Organization (F
week.

Food costs at records as U.N. warns of volatile era

Recommend 92 people recommend this. Be the first of your friends.

A man carries onions at a wholesale market in Mumbai, January 25, 2011.
Credit: Reuters/Danish Siddiqui

By Svetlana Kovalyova and Christopher Doering
MILAN/WASHINGTON | Fri Feb 4, 2011 8:07am EST

(Reuters) - Global food prices tracked by a U.N. agency hit their highest level on record in January, a problem set to worsen after a massive snowstorm in the United States and floods in Australia.

Share this
Link this
1 digg
Email

Related News
World enteri
of food price
volatility
Thu, Feb 3 2011
FAO food pr
index hits re
high in Janu
Thu, Feb 3 2011
India food m
disappoint fa
retailers
Thu, Feb 3 2011
Bring back fo
commods tra
rules: FAO
Thu, Feb 3 2011

February 3, 2011

Middle East unrest related to food shortages

It's been reported that high unemployment and food shortages have aggravated [redacted] that have led to much of the unrest in Egypt and throughout the Middle East.

*Norman Borlaug – Nobel **Peace** Prize*

IPNI

IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

Preparing for intensification

1) In the field
2) On the farm
3) In the city

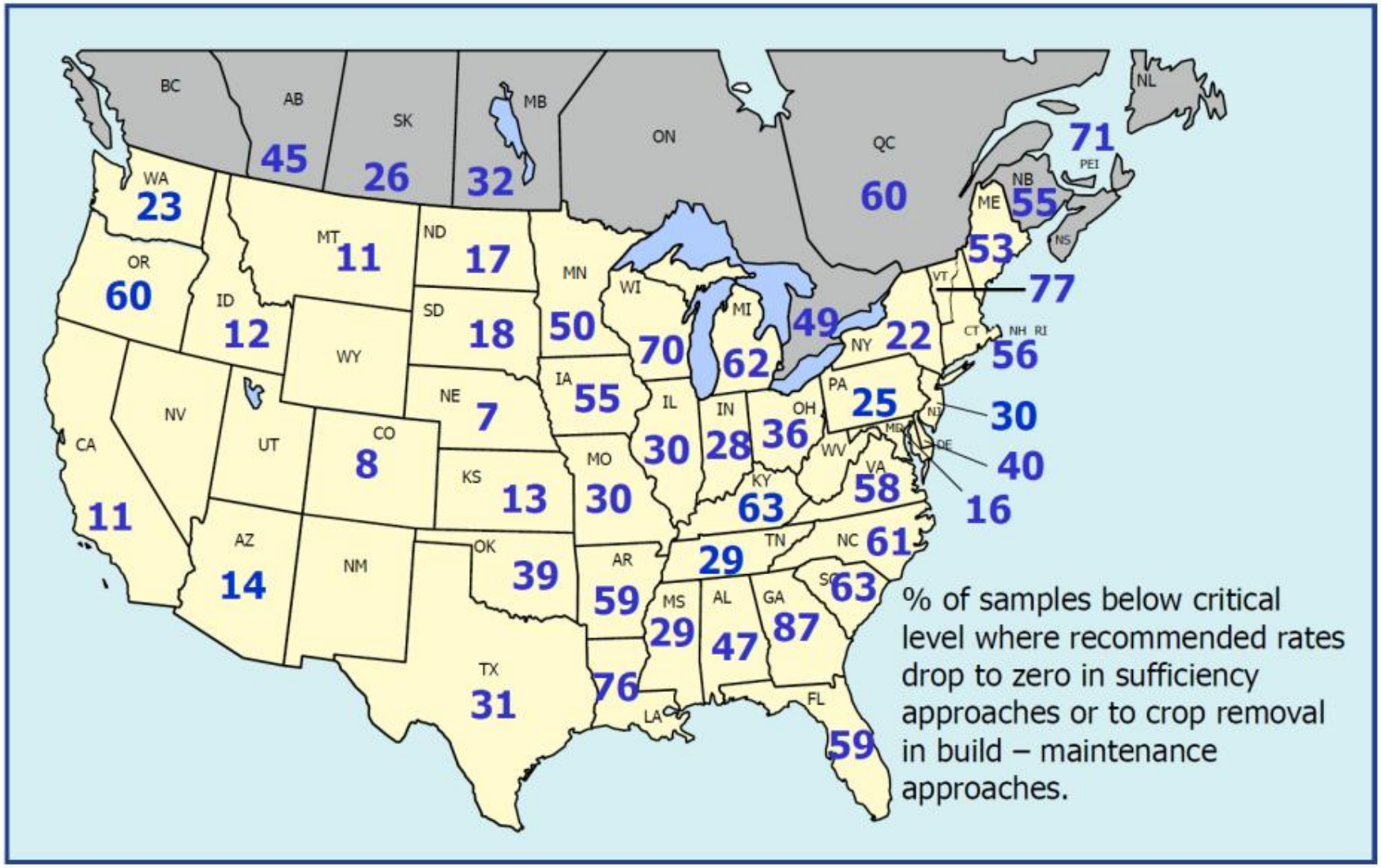
IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

Preparing for intensification

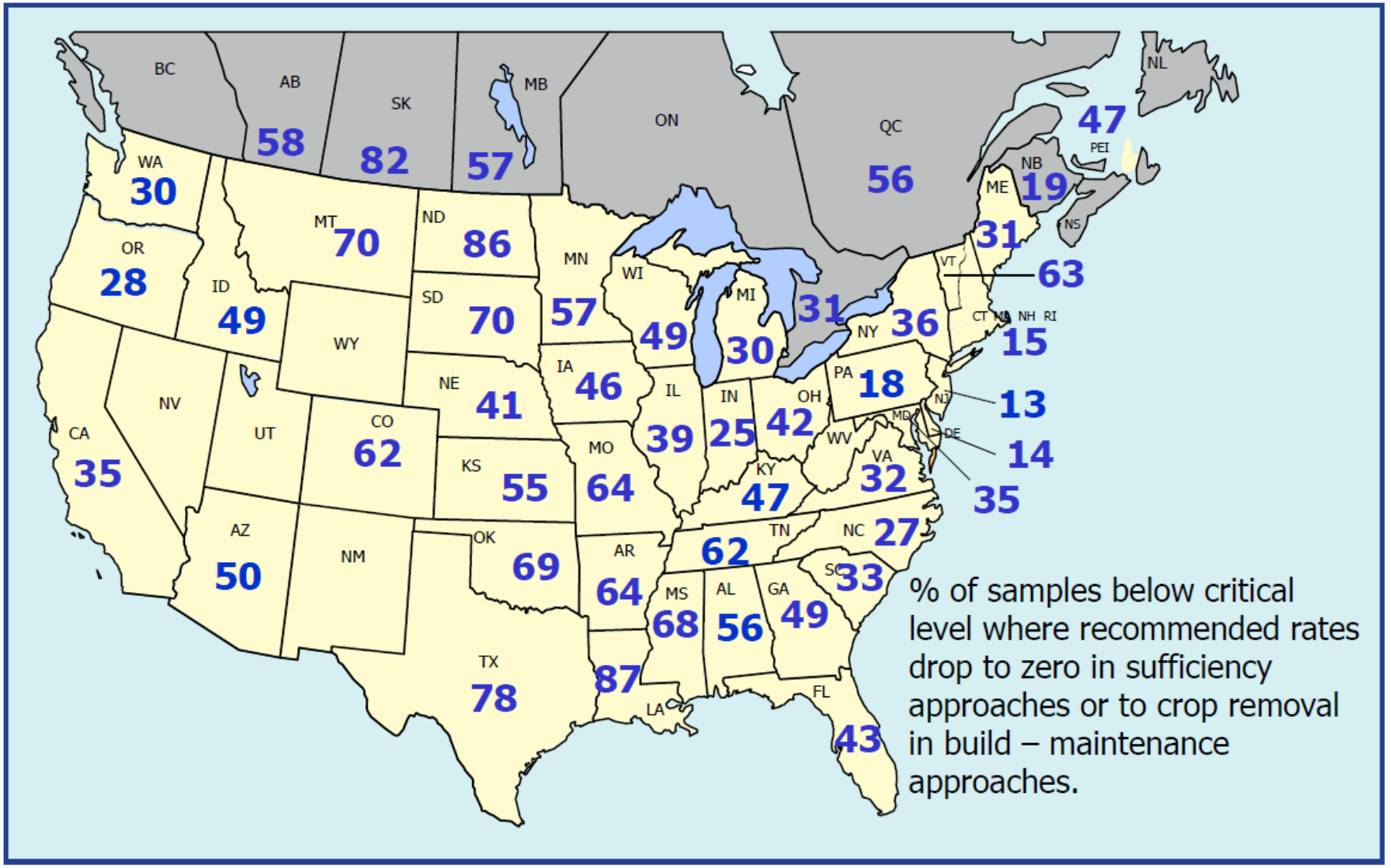
1) In the field

Much of the rest of the Forum:
Ismail, Fred, Tim, …

Percent of samples testing below critical levels for K for major crops in 2010.

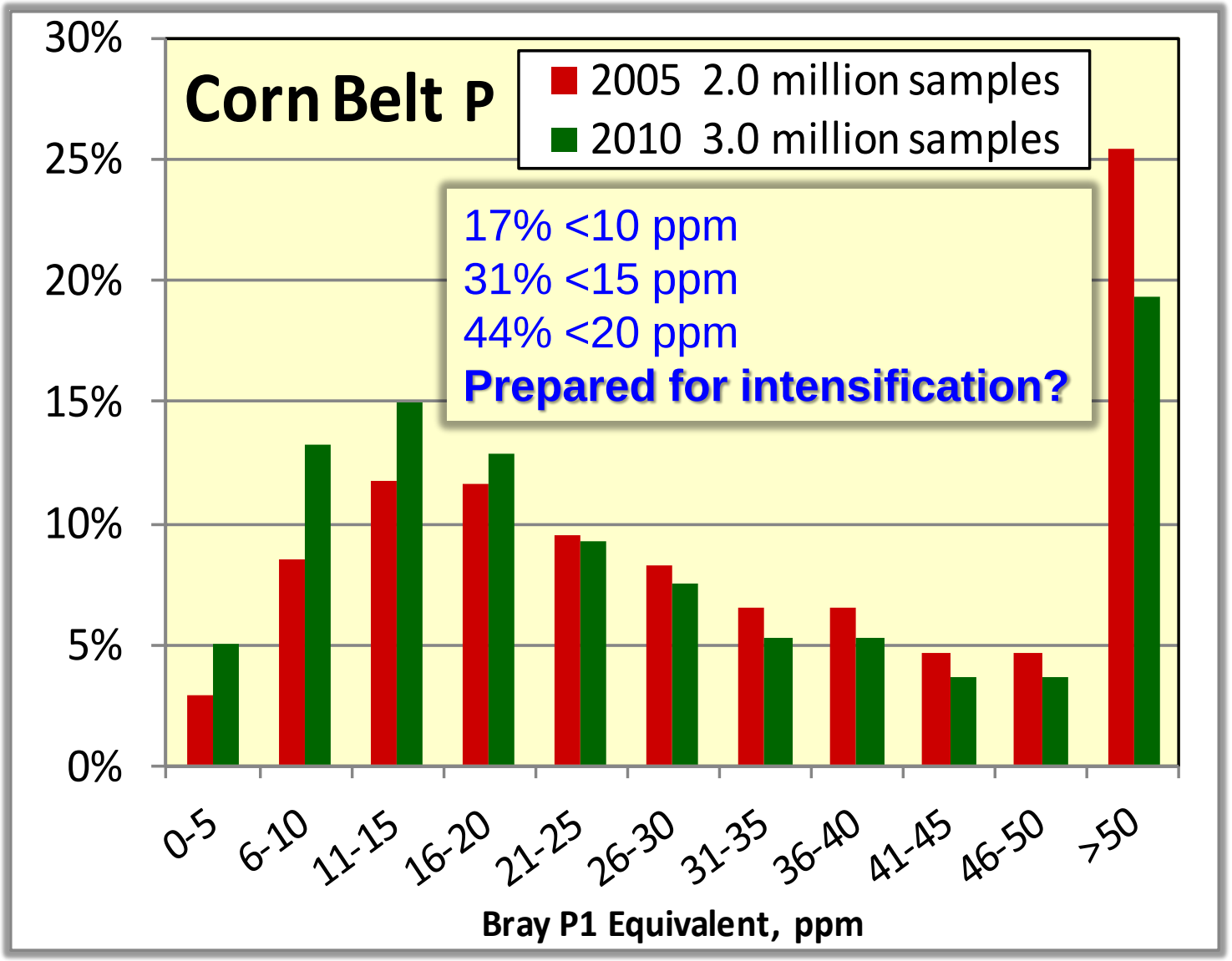


Percent of samples testing below critical levels for P for major crops in 2010.

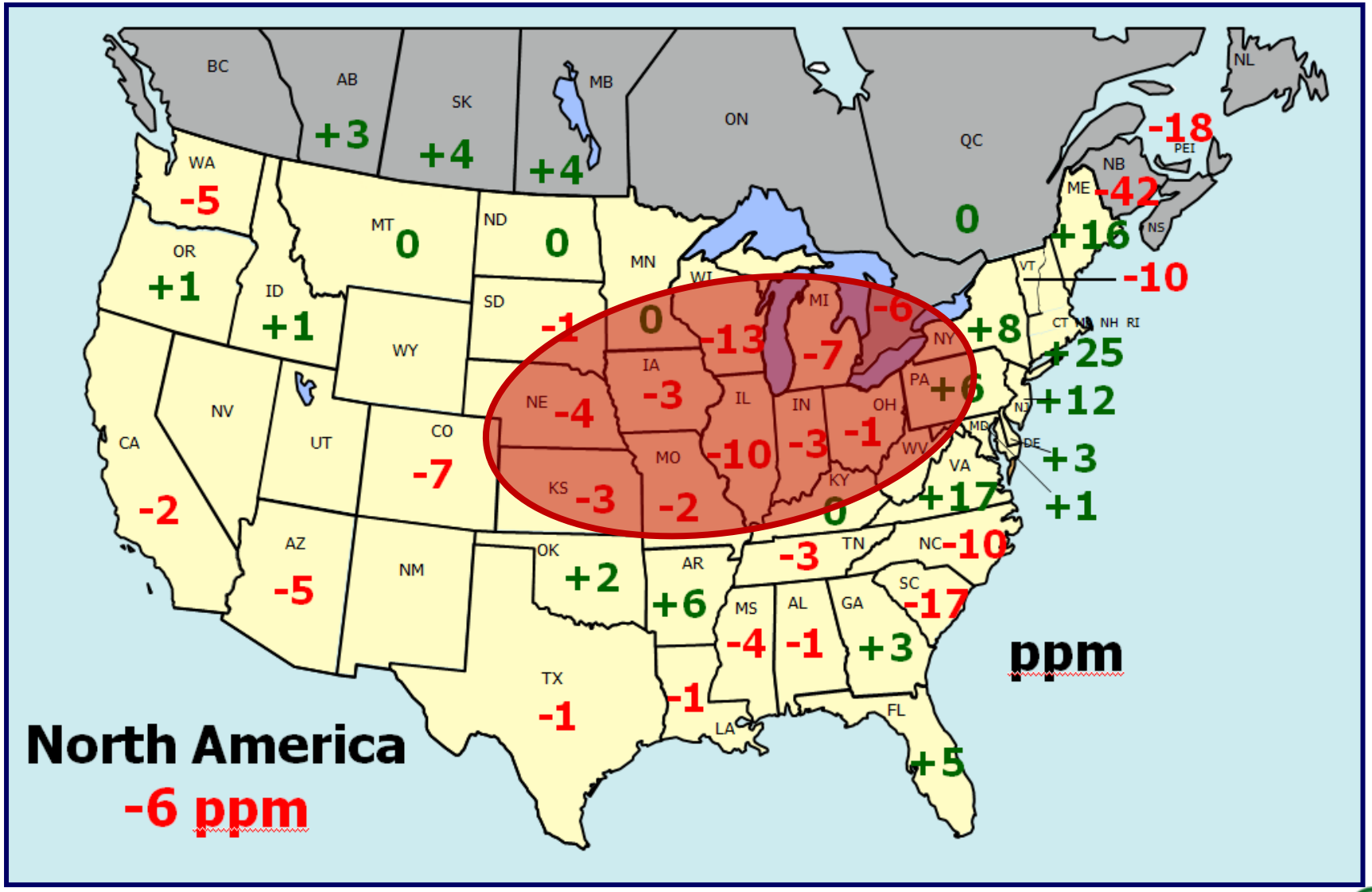


Soil test P distribution in the Corn Belt

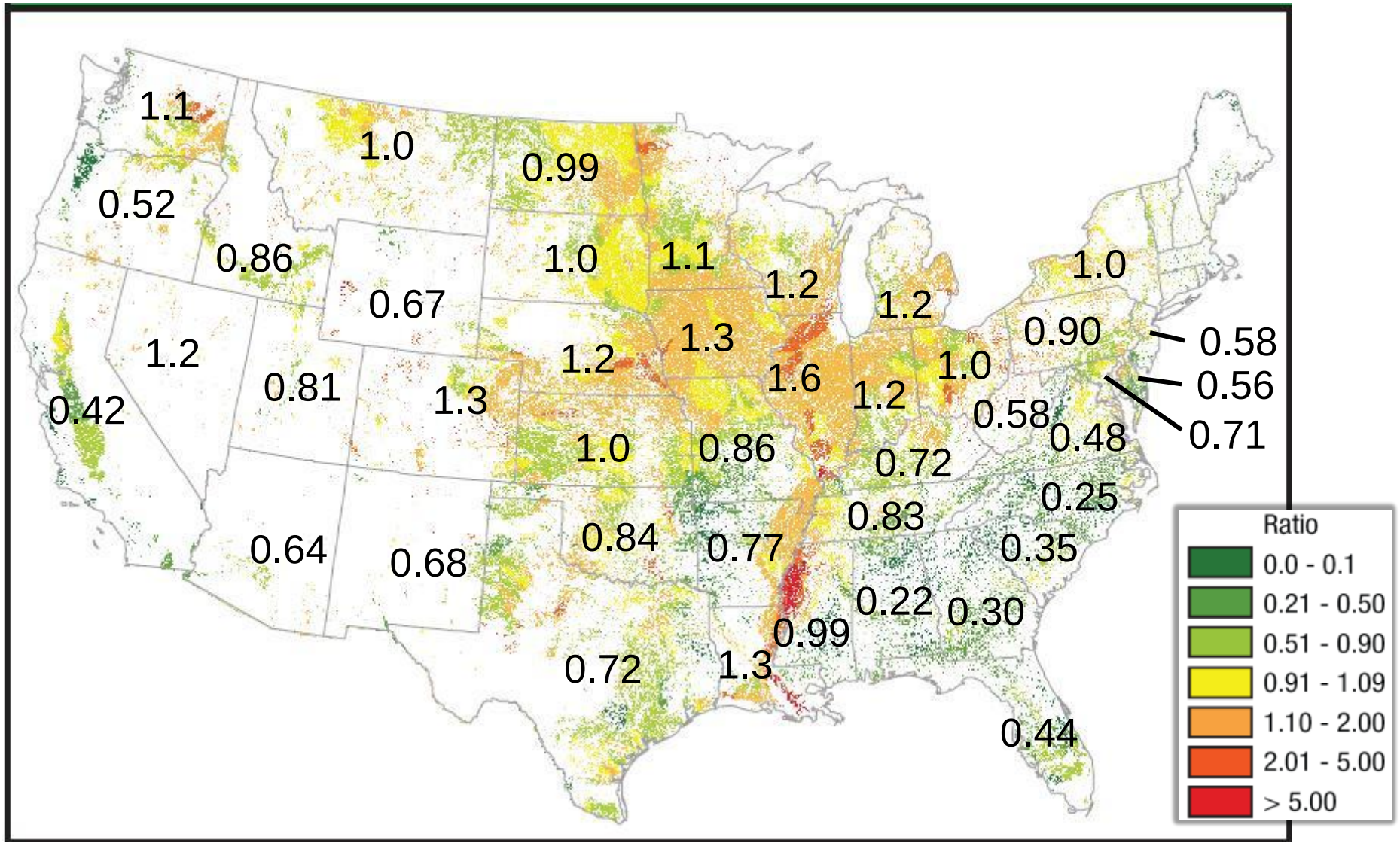
(12 states plus Ontario)



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

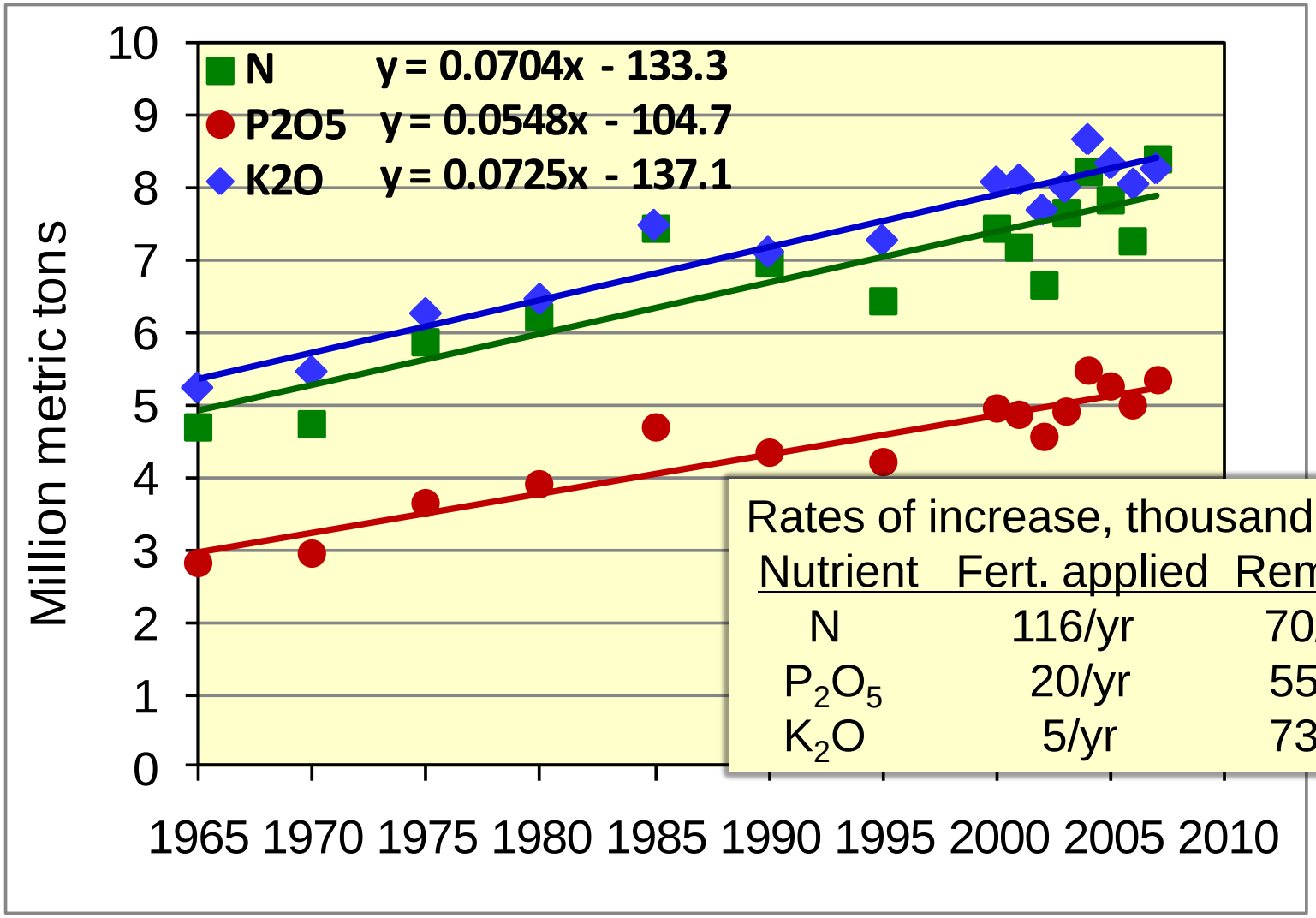


Estimated P removal to use ratio by watershed, 2007. (Numbers are state ratios)



IPNI, 2010

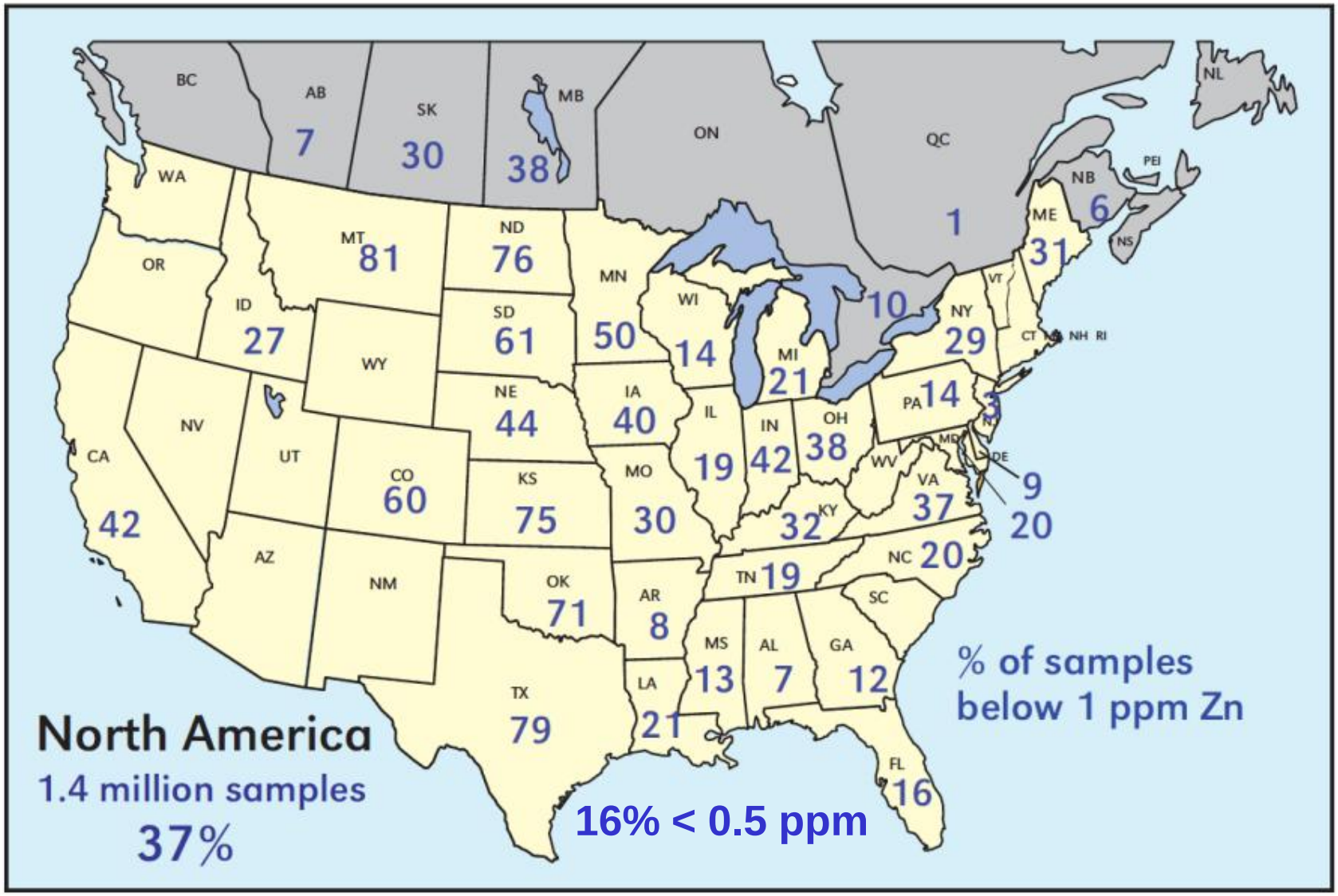
Nutrient removal by crops in the U.S. (N removal by alfalfa, soybeans and peanuts excluded).

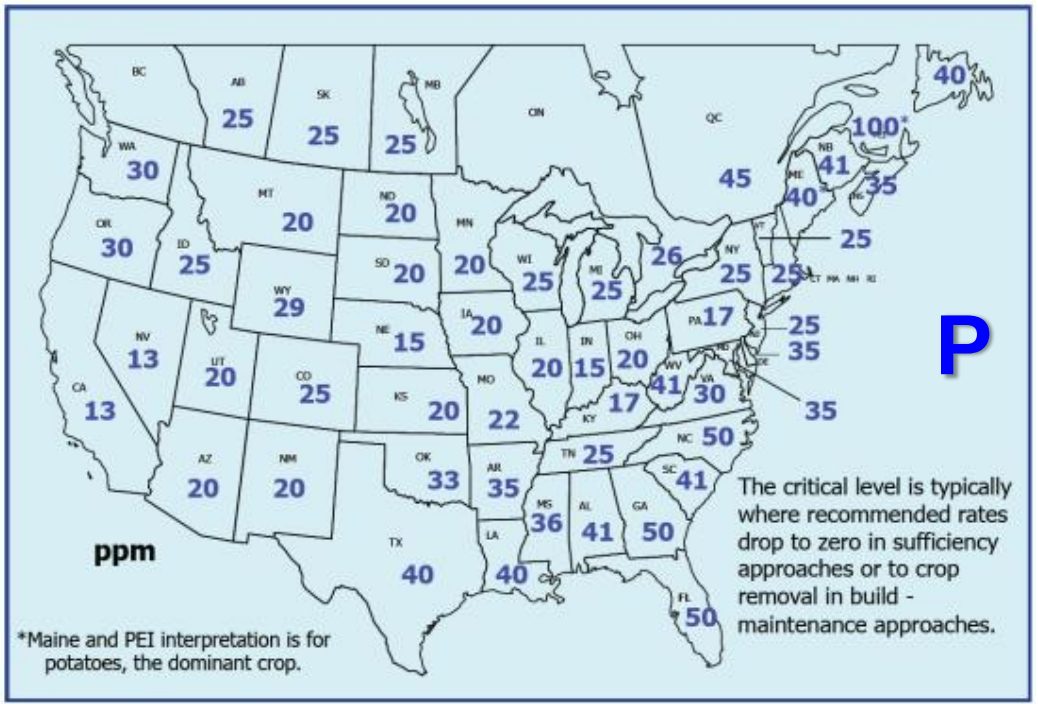


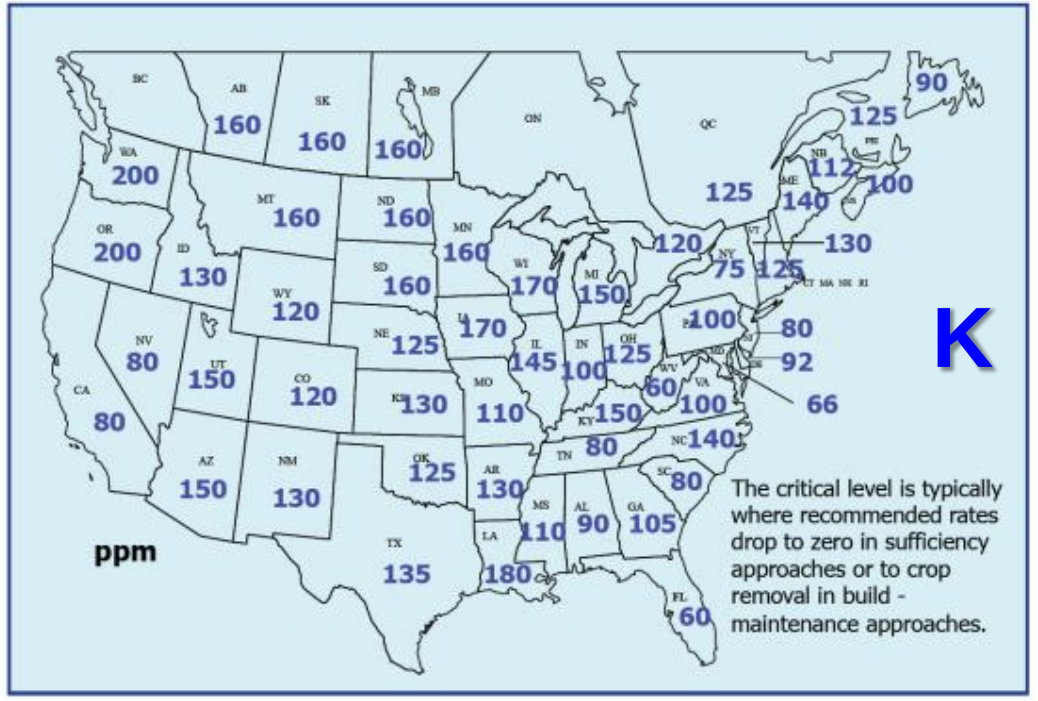
Rates of increase, thousand tons

Nutrient	Fert. applied	Removal
N	116/yr	70/yr
P_2O_5	20/yr	55/yr
K_2O	5/yr	73/yr

Percent of samples testing < 1.0 ppm DTPA equivalent Zn in 2010.







Critical Bray P1 and ammonium acetate equivalent soil test levels, 2010.

Are these levels correct for intensively managed cropping systems?

Zn levels?

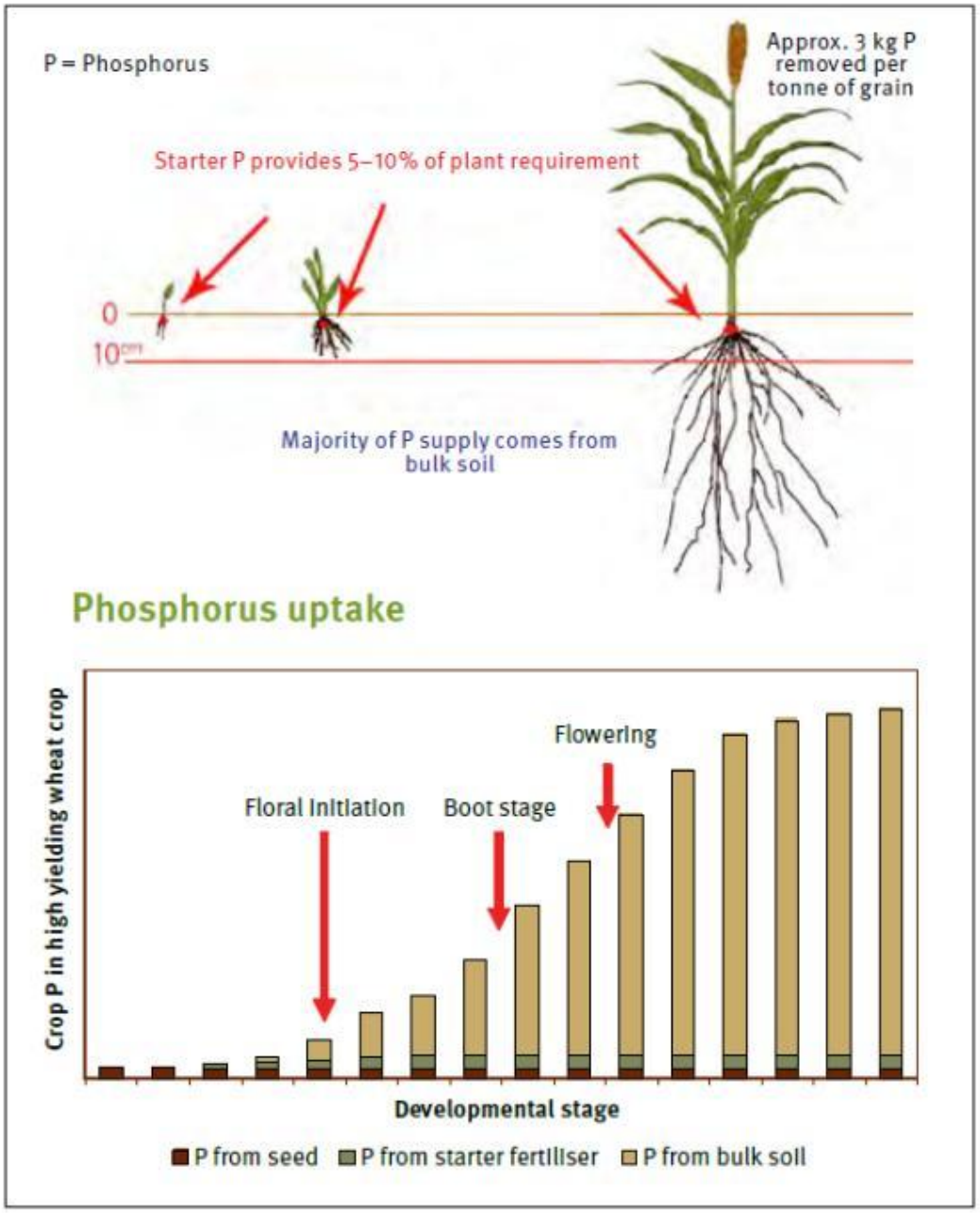
Mn levels?

S levels?

SSSA Symposium for 2011 Annual Meeting

IPNI

Subsoils … are they changing and does it matter??

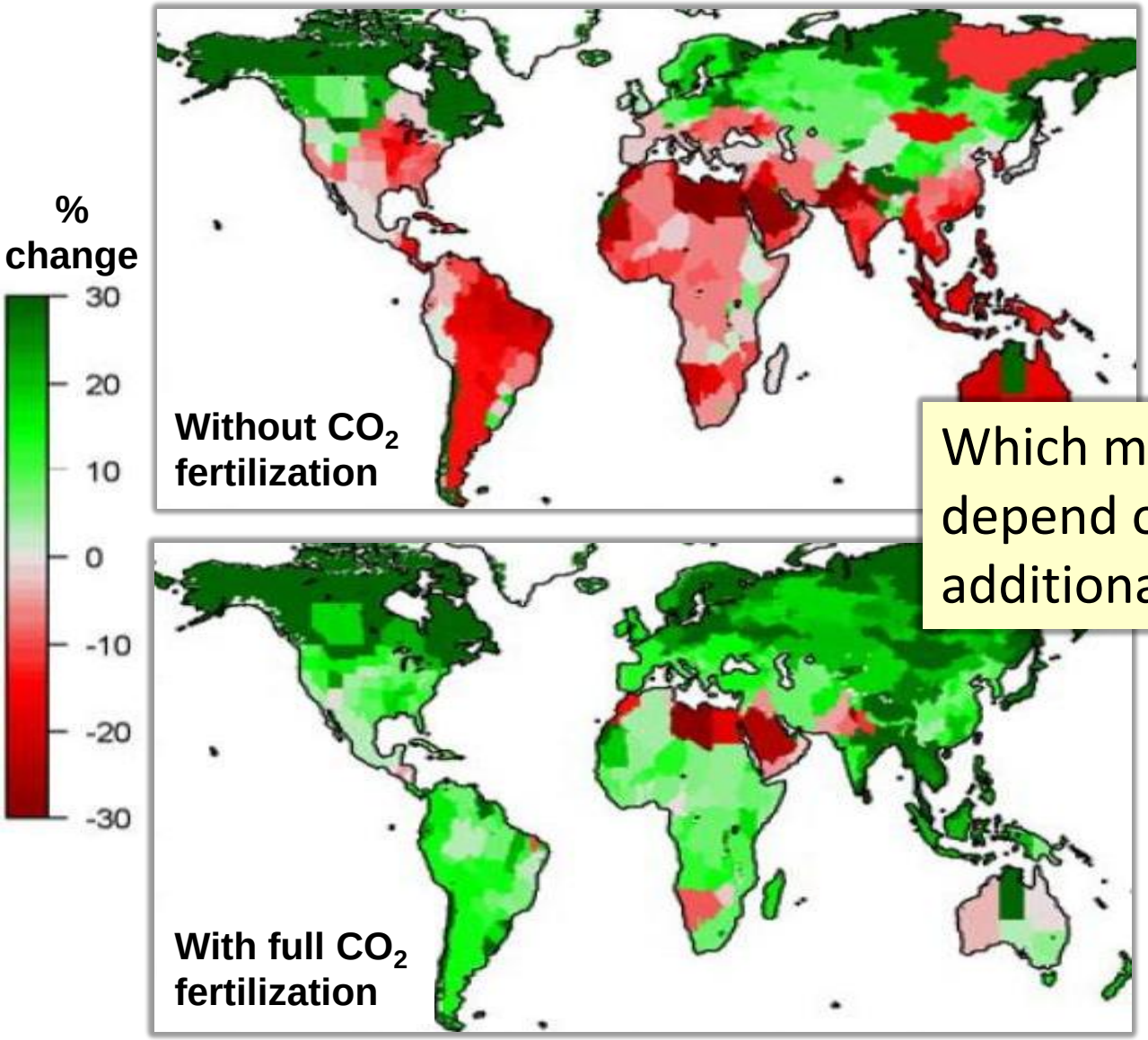


- Australia – Queensland
  - 50% of P uptake from below 10 cm
  - Starter P supplies only 5-10%
- Subsoils being depleted of P
- Placement via:
  - Mechanical means
  - Chemical mobility
  - Nanotechnology

CSIRO, GRDC

IPNI

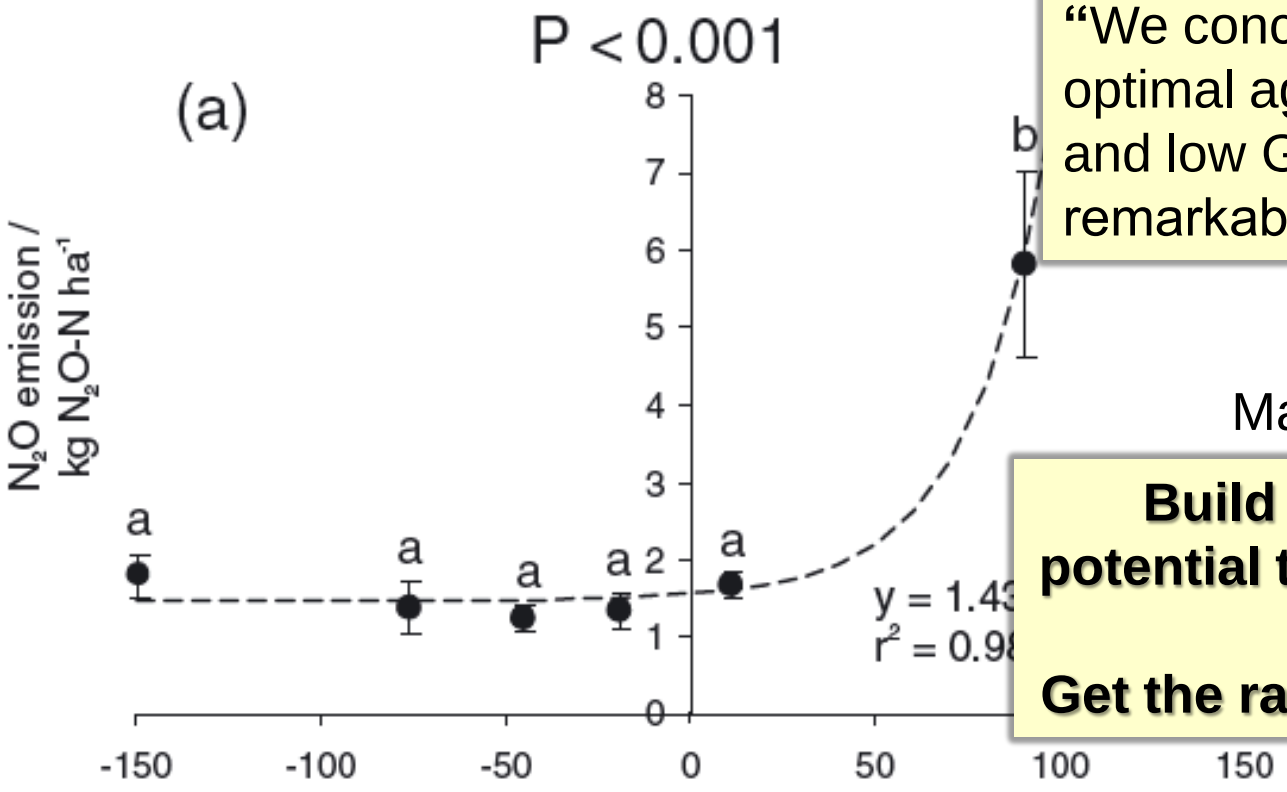
Potential impact of climate change on crop yields in 2050 relative to 2000



Which map "… will much depend on availability of additional inputs, especially N."

World Bank (Background note to the World Development Report 2010).

Does greater N input mean greater GHG emissions? (Survey of 19 studies, ½ in NA)



N surplus relative to above ground N uptake, kg/ha

"We conclude that the aims of optimal agricultural production and low GHG emissions are remarkably similar …."

Marching orders:

Build and protect yield potential to maximize N uptake

Get the rate right (& other 3Rs)

Van Groenigen et al., 2010 and 2011 (Wageningen University).

Visitor | Prospective Student | Current Student | Faculty & Staff | Business, Industry & Government | Search: | UNL Web

UNIVERSITY OF NEBRASKA–LINCOLN

UNL Quick Links

UNL › Hybrid-Maize > *Maize-N* Program

cal/people/weather/cam

Department of Agronomy & Horticulture

Hybrid-Maize: A Simulation Model for Maize Growth and Yield

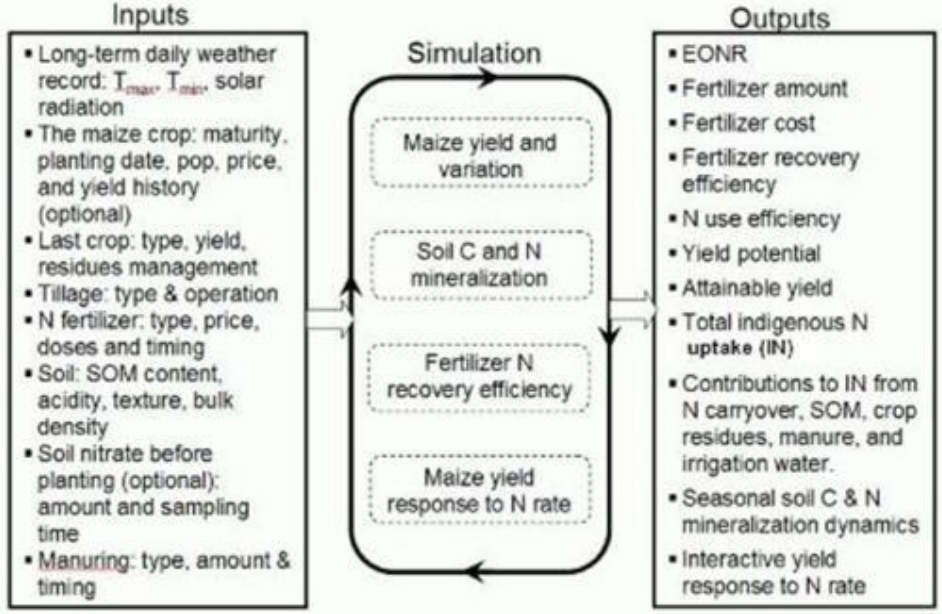
Navigation

Hybrid-Maize

Overview

Maize-N Model

The inputs, engine, and outputs of *Maize-N* model



Go to Maize-N collaborators' page

simulates fertilizer requirement for Maize crop grown under intensive management.

ld potential and its variability based on historical weather data;
and fertilizer N required based on climatic and management factors such
and plant density, N application method and timing, manuring, and soil
charateristics.

Invest more resources in on-farm decision making … use the science!

IPNI

IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

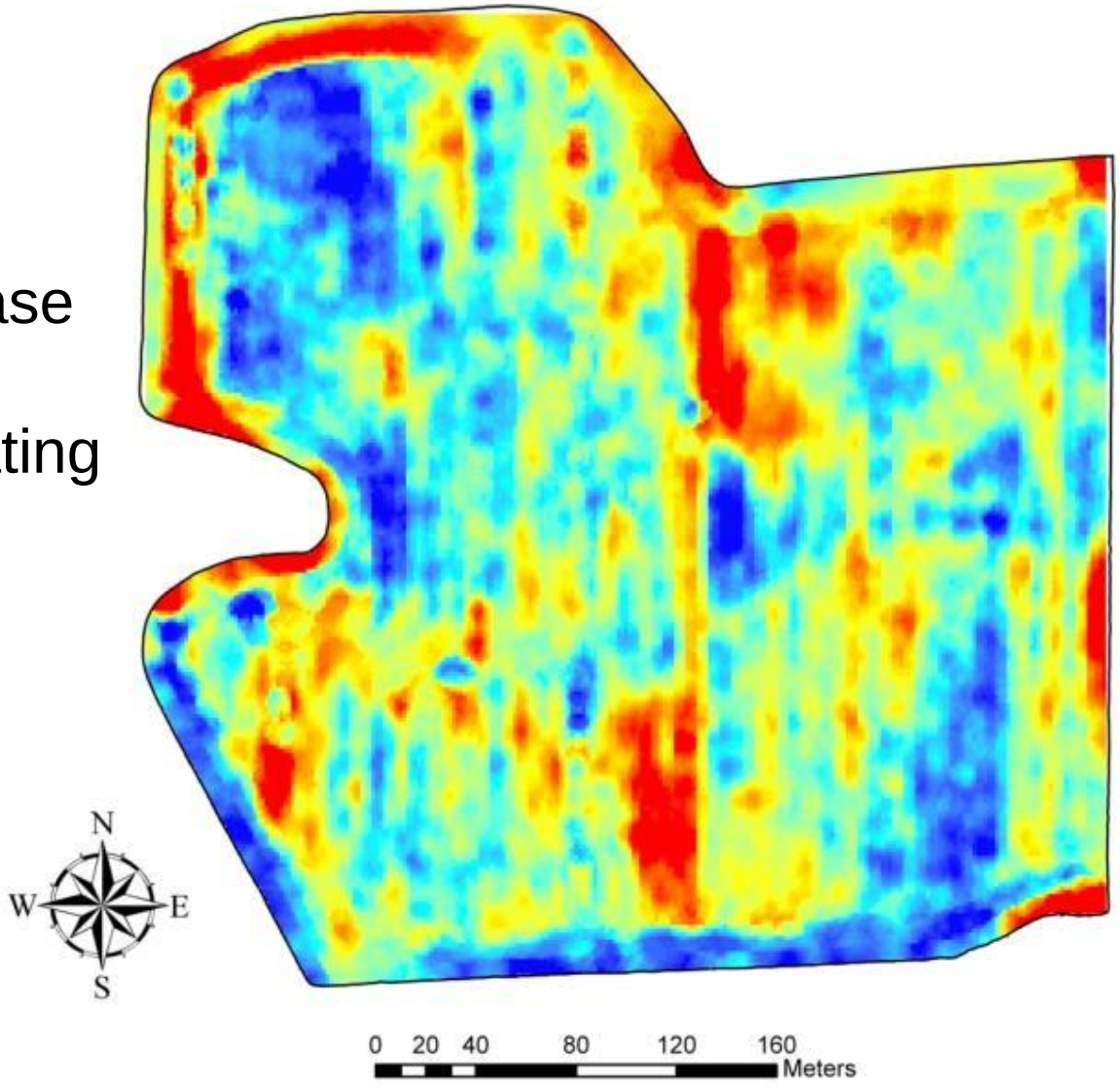
Preparing for intensification

1) In the field

2) On the farm (beyond field boundaries)

Corn Grain Yield - AERF

Corn's sensitivity to changing landscape position presents opportunities to increase overall landscape productivity by integrating other crops into the landscape.



Gregg Johnson, U of MN (Waseca)

IPNI

Gregg Johnson, U of MN (Waseca)

Productivity Matrix for Biomass Crops

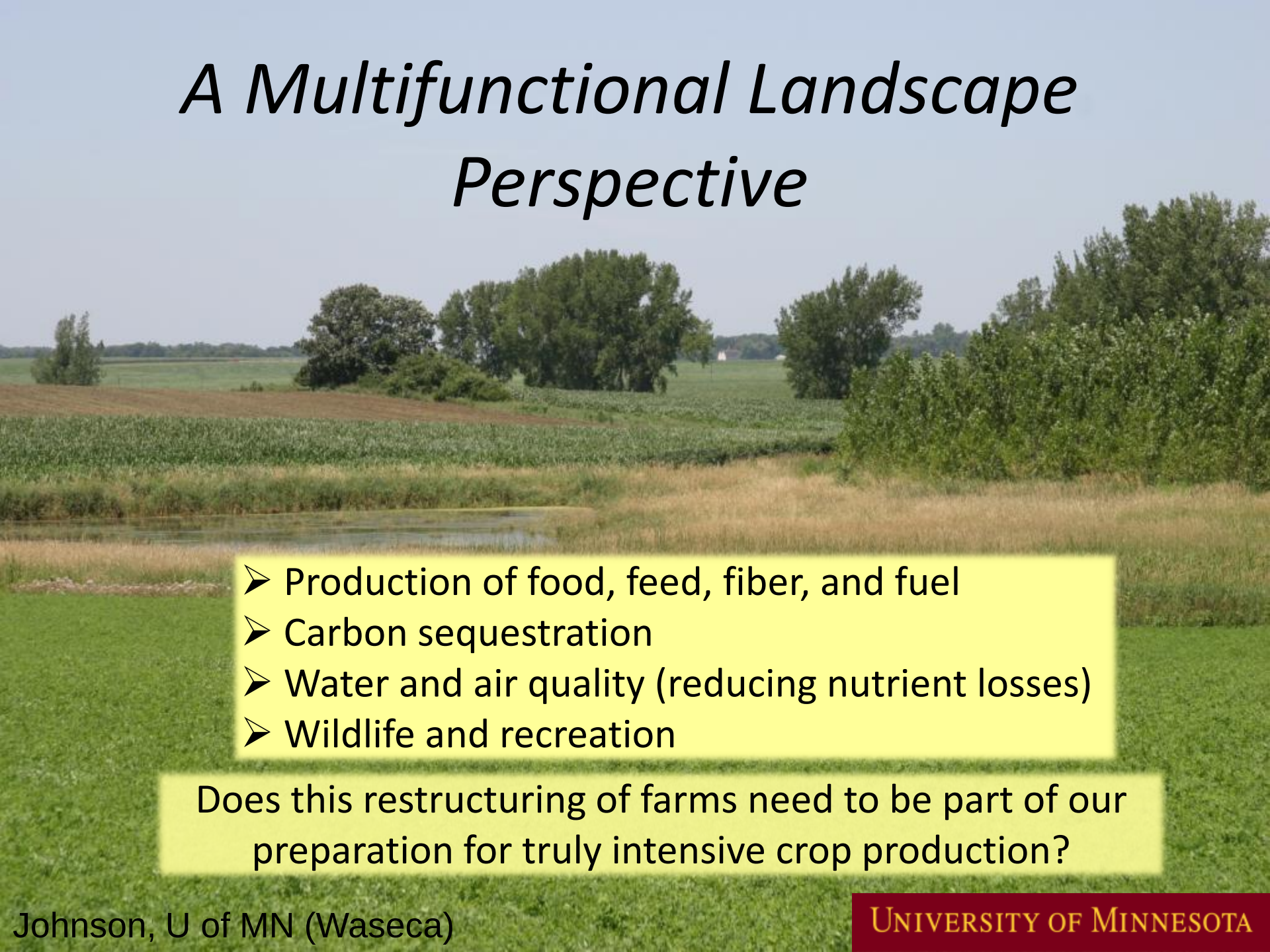
	Summit	Depositional	Flat	W hillslope	S hillslope	SW hillslope	N hillslope
Switchgrass	+	-	-	+	-	-	-
Alfalfa	+	-	+	-	+	+	+
Corn Stover	+	-	-	+	+	+	+
Corn Grain	+	-	-	+	+	-	+
Willow SX67	-	+	+		-	+	-
Willow 9882	-	+	+	-	-	-	-
Cottwd.D125	+	+	+	+	+	+	+
Poplar NM6	+	-	+	+	+	+	+

CI=90%

Johnson, U of MN (Waseca)

IPNI

A Multifunctional Landscape Perspective



- Production of food, feed, fiber, and fuel
- Carbon sequestration
- Water and air quality (reducing nutrient losses)
- Wildlife and recreation

Does this restructuring of farms need to be part of our preparation for truly intensive crop production?

Controlled drainage as part of the intensification package

University of Minnesota, Lamberton

Year	Performance indicator	Drainage	
		Free	Controlled
2008	Soybean yield, bu/A	22	19
2008	NO_3-N load, lb/A	**18**	**7**
2009	Corn yield, bu/A	**202**	**224**
2009	NO_3-N load, lb/A	3	2

Multifaceted solution to drainage issues:

- Controlled drainage
- Appropriate drainage system designs
- Bioreactors
- Two-stage/managed ditches
- Buffers
- Water storage
- Side inlet controls
- Alternative practices

Jeff Strock (U of MN – Lamberton), 2011.

IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

Preparing for intensification

1) In the field
2) On the farm
3) In the city

Food and Beverage Companies Tracking Water and Carbon Footprints

Demand for More Sustainable, Less Chemically Dependent Agriculture

Wal-Mart sets out fresher-foods goals

Retailer aims

STEVE PAINTER
ARKANSAS DEMOCRAT-GAZE

Wal-Mart Stores Inc
nounced several new g
Thursday aimed at get
more fresh foods on its s
shelves while at the s
time reducing the envi
mental impact of grov
those products.

The announcement came as Wal-Mart executives and employees met with suppliers and representatives of environmental groups at the company's headquarters in Bentonville. About 700

of Wal-Mart's business. Yet only four of our 39 public sustainability goals address food," Mike Duke, president and chief executive officer, said in prepared remarks for the gathering.

medium farms.

■ Train a million farmers and farm workers in sustainable farming practices and crop selection.

■ Boost the income of small farmers supplying the retailer

manager in Bentonville for the corporate partnerships program of the Environmental Defense Fund, said the initiative revealed Thursday began early in the summer of

See **WAL-MART**, Page 6D

"…..boost the incomes of small and medium-sized farmers….while reducing the use of pesticides and fertilizer"

Arkansas Democrat- Gazette, October 15, 2010

EPA Lays Out Five-Year Plan on Agency Priorities – Oct. 7, 2010

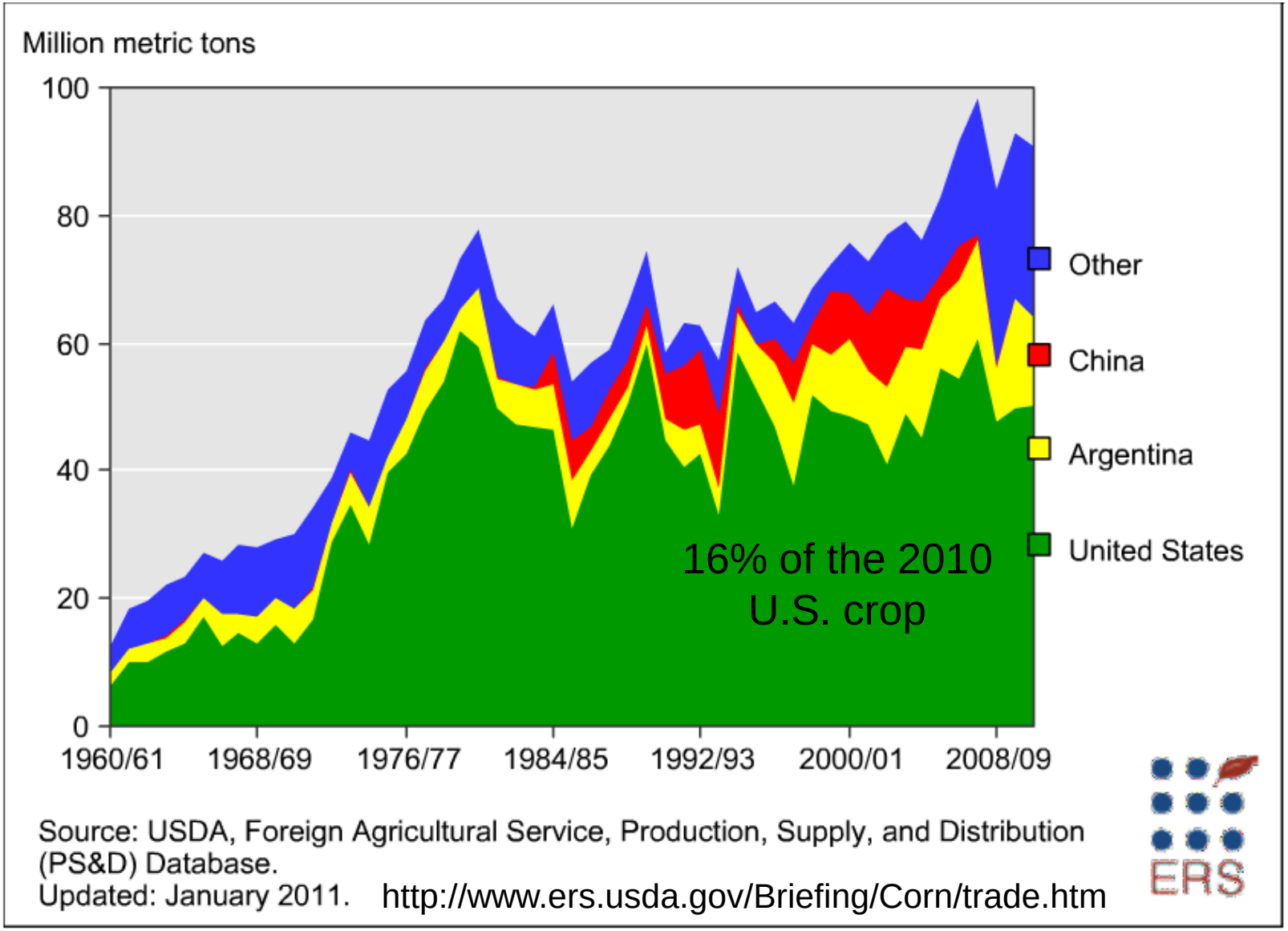
- **Five strategic goals to advance EPA's environmental and human-health mission:**
  - **Taking action on climate change and improving air quality**
  - **Protecting America's waters**
  - Cleaning up communities and advancing sustainable development
  - **Ensuring the safety of chemicals and preventing pollution**
  - **Enforcing environmental laws**

Preparation should likely include use of environmental footprint estimation tools

(ex - Field to Market Field Print Calculator)

IPNI

Leading world exporters of corn



Preparation in the “shining city on the hill”

- **Communicating** to funding agencies the critical need for research on agronomic and environmental aspects of intensively managed high yield systems
- Example of the challenge: research proposals for Federal support are criticized for being too focused on corn, even though corn …
  - Greatest crop acreage; A major U.S. export
  - Consumes 43% of fertilizer N, 45% of P, and 44% of K
  - Primary near term source of feedstock for biofuels
  - Very effective at sequestering C
- Intensification of corn production is being viewed as the problem rather than the solution … **we have a communication challenge**

IPNI

Preparing for intensification

- **Cropping intensification can be viewed as either a solution or a problem … increases the importance of preparation**
- **Preparation is needed:**
  - **In the field**
    - See Forum topics
    - Soil fertility that will support intensive production
    - A focus on N efficiency through N management & uptake maximization
  - **On the farm**
    - Management (and research) beyond fields to landscapes
  - **In the city**
    - Communicating credible environmental footprints to the public
    - Refinement of funding agency priorities
    - Utilizing 4R Nutrient Stewardship in communication efforts