YIELD LIMITING FACTORS RELATED TO SOIL CHEMICAL AND PHYSICAL PROPERTIES

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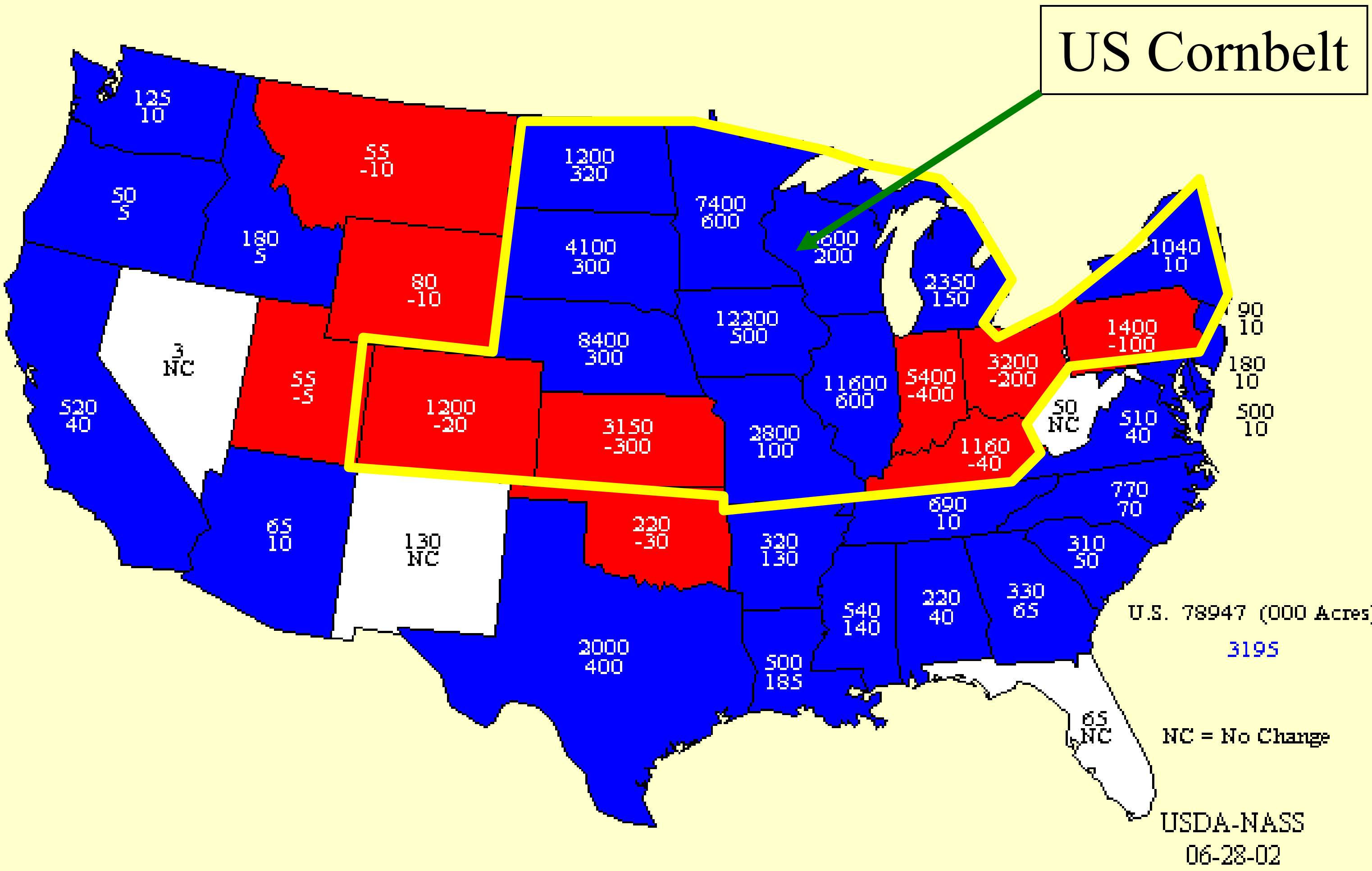
3º SIMPÓSIO SOBRE ROTAÇÃO SOJA/MILHO NO PLANTIO DIRETO
Piracicaba-SP, Julho 10-12, 2002

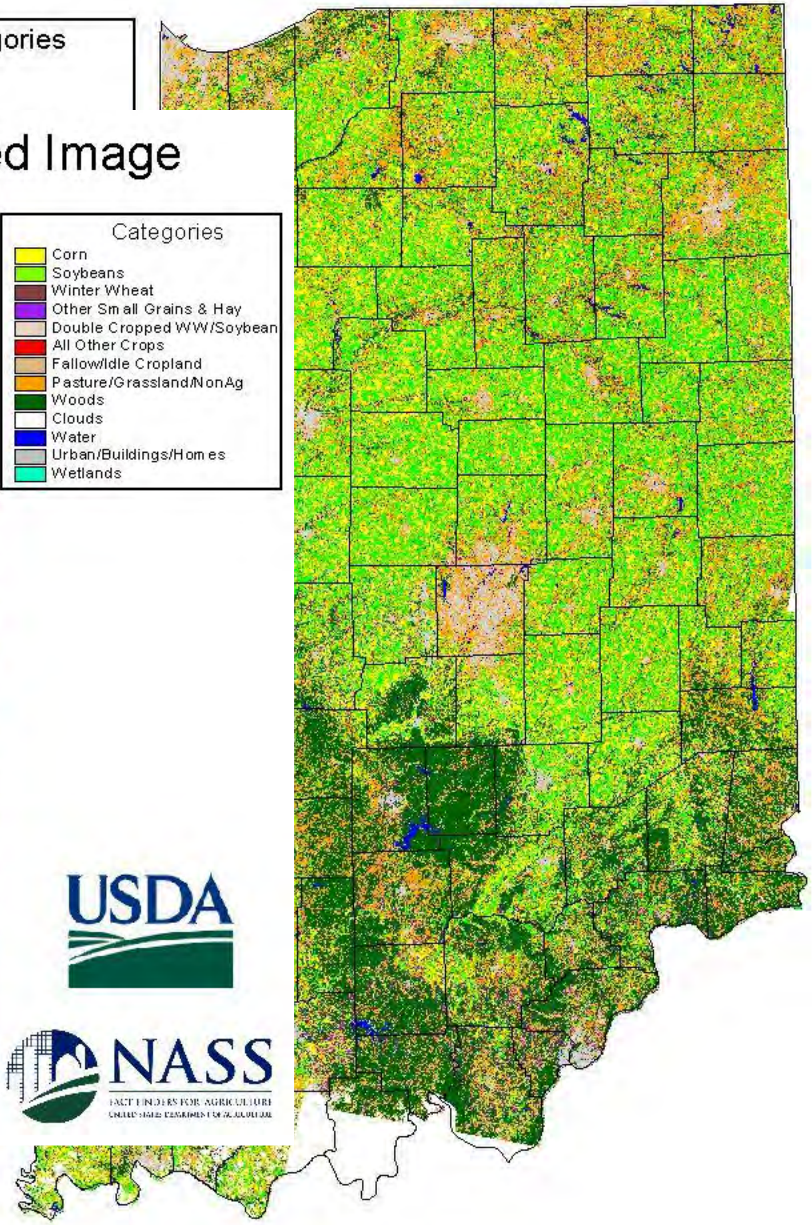
2002 Corn Planted Acres

Acres (000) and Change From Previous Year

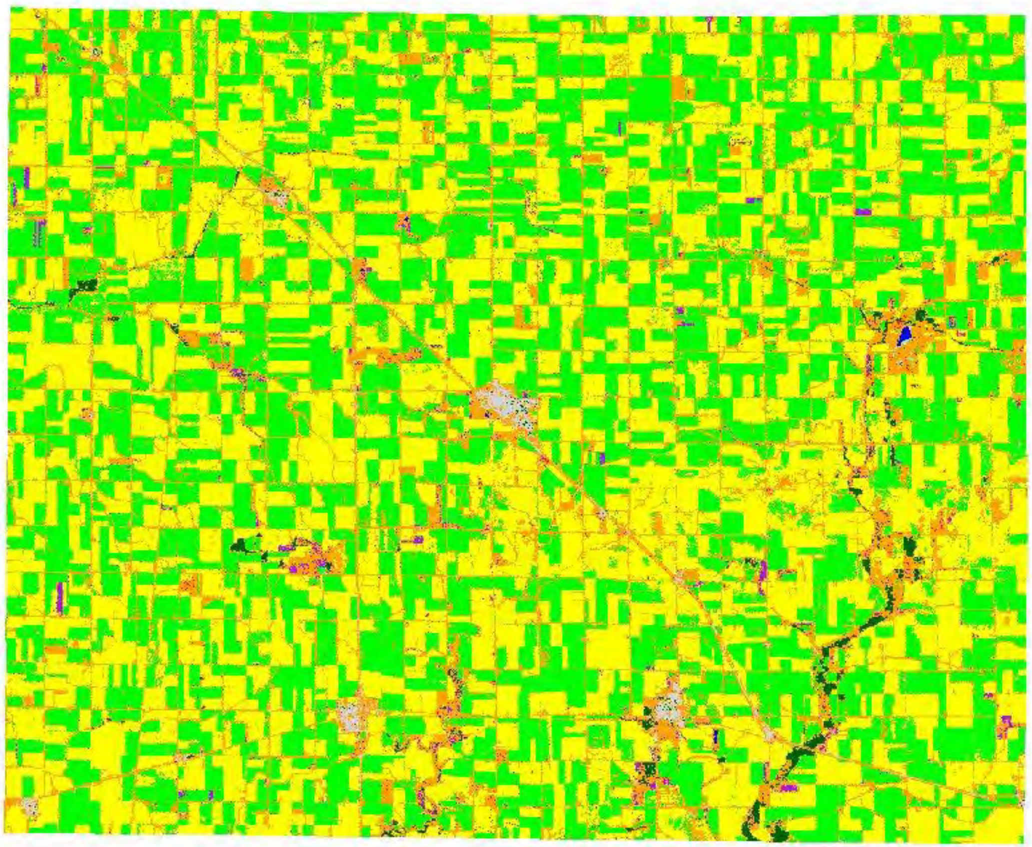


2001 Indiana Categorized Image

Categories
- Corn
- Soybeans



2001 Benton County, Indiana Categorized Image

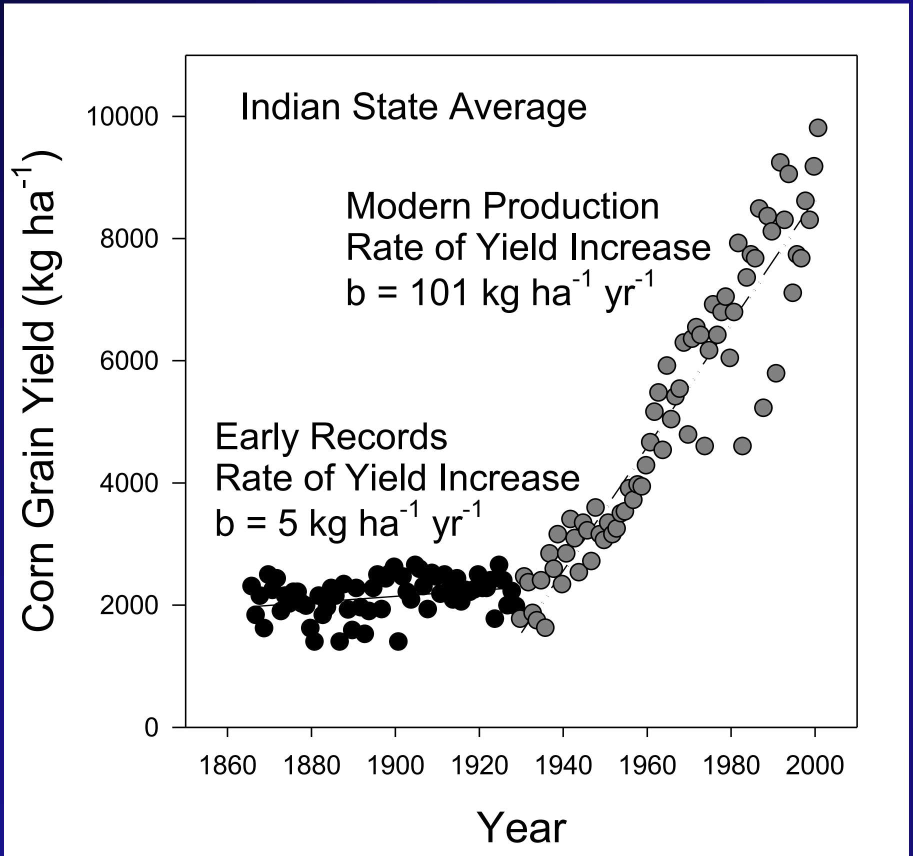


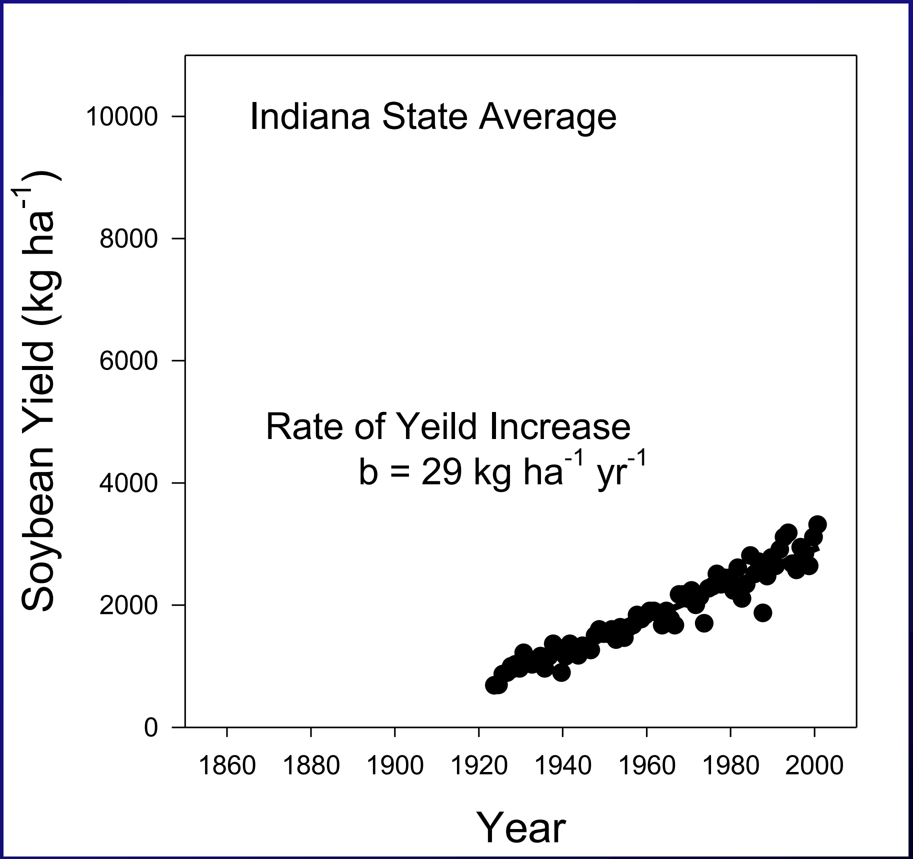
Categories
- Corn
- Soybeans
- Winter Wheat
- Other Small Grains & Hay
- Double Cropped WW/Soybean
- All Other Crops
- Fallow/Idle Cropland
- Pasture/Grassland/NonAg
- Woods
- Clouds
- Water
- Urban/Buildings/Homes
- Wetlands

USDA

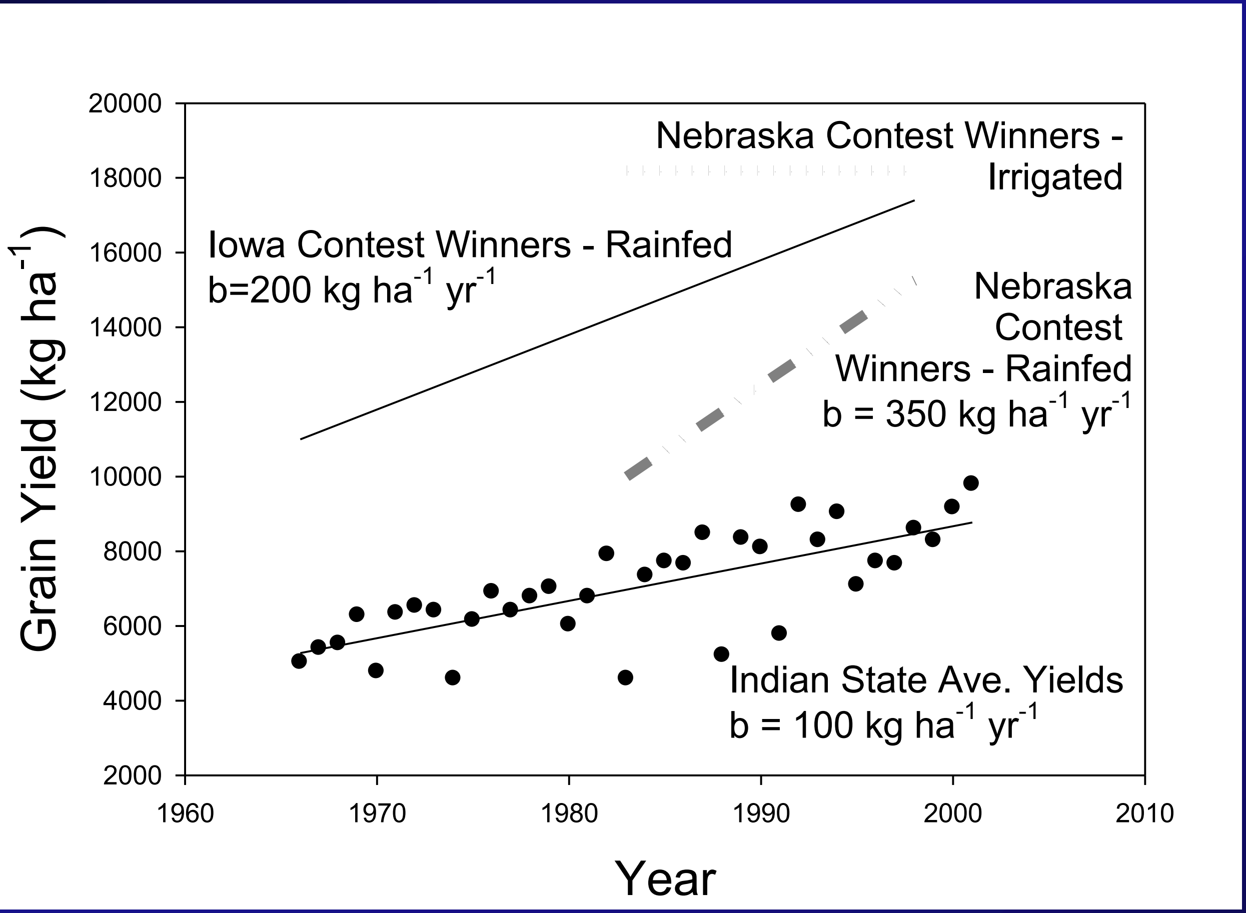
NASS
FACT FINDERS FOR AGRICULTURE

Historical Yield Data





Comparison of average & contest winning yields



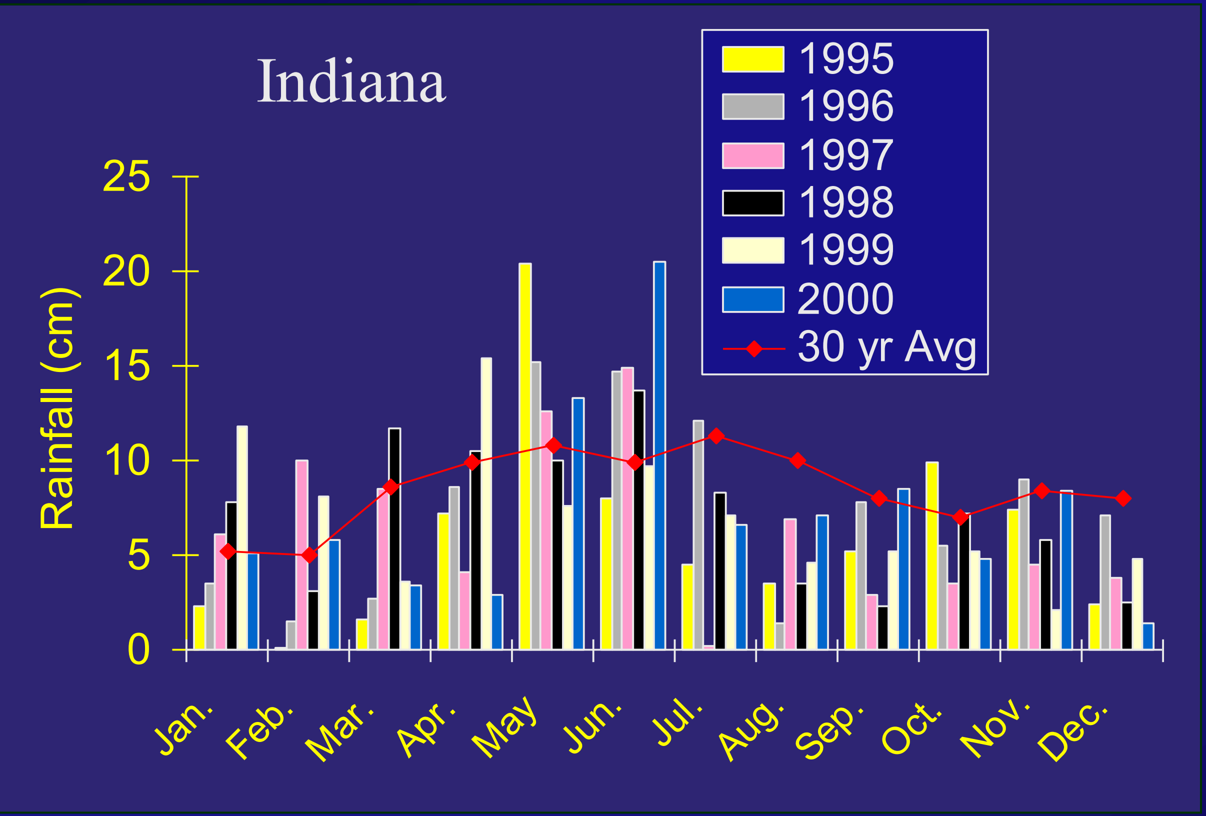
- Irrigated CWs at hybrid yield potential
- Water limits yields
- Some farmers are doing a better job of managing water and related production factors

Management opportunities?

Soil chemical and physical property limitations on growth, development and harvestable yield

As influenced by soil water and water, nutrient and residue management

Water in Excess in Spring (especially eastern cornbelt)



- April – June heaviest rainfall quarter of the calendar year.
- Optimum corn planting date approximately last week of April

Eastern cornbelt – Enhanced subsurface drainage creates most productive agricultural land.

Benefit / Risk considerations for artificially enhancing drainage

Benefits

- Timely preplant field operations
- Timely planting
- Reduction of seedling root zone stress of anoxia (coupled with cold temperatures &/or soil compaction)

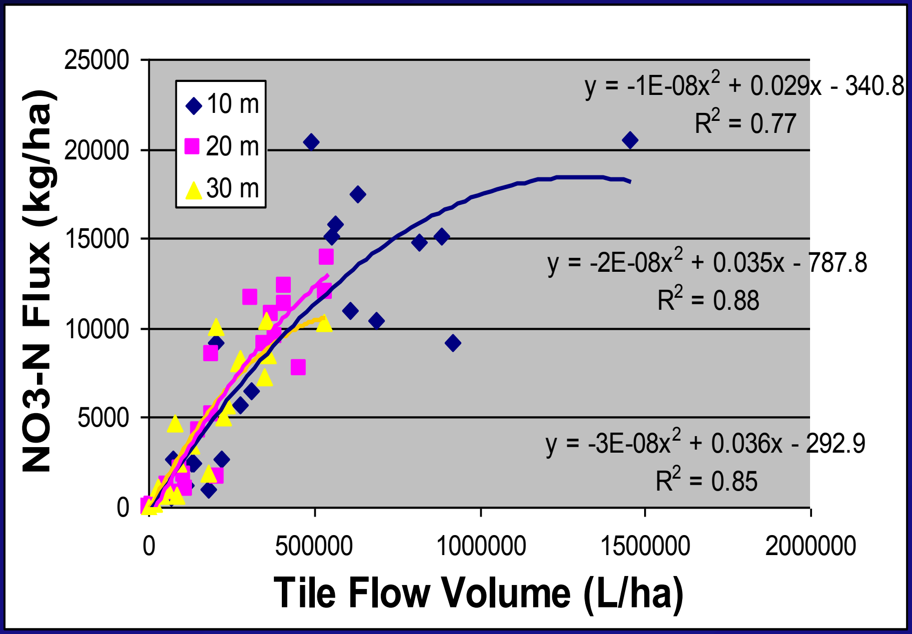
Risks

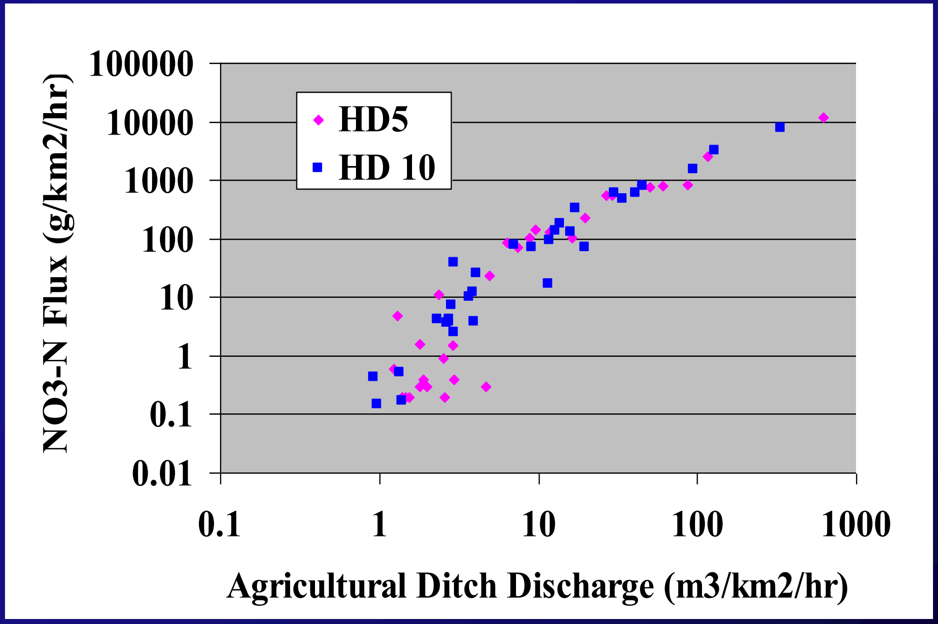
- Return on investment
  - Yields optimized at 20 m spacing of drainage tile but 30+ m is economic optimum
- Pending environmental regulation on nonpoint source water pollution mandates nutrient load reductions from farms

Insufficient drainage

- Poor stand due to excessive soil moisture during field preparation and planting

*Flow volume from tile drains is key determinant of the **load of nutrients** that a water body will receive*





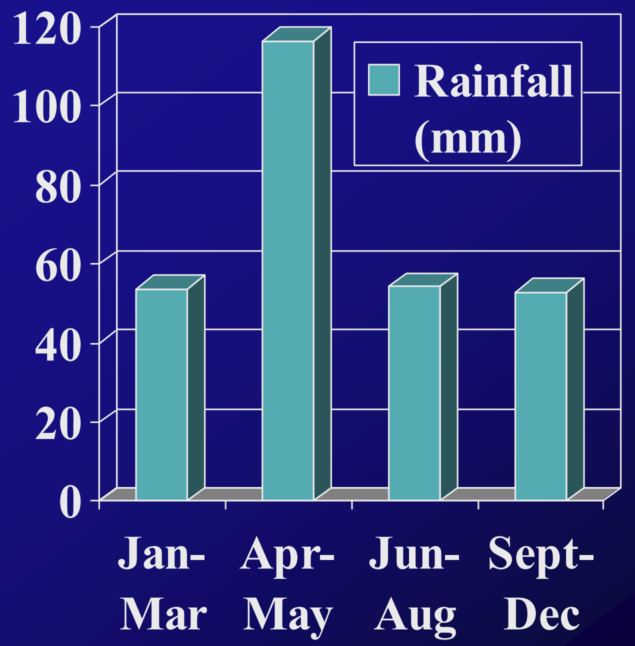
Purdue University
Water Quality Field Station

Hoagland Ditch in
White County, Indiana

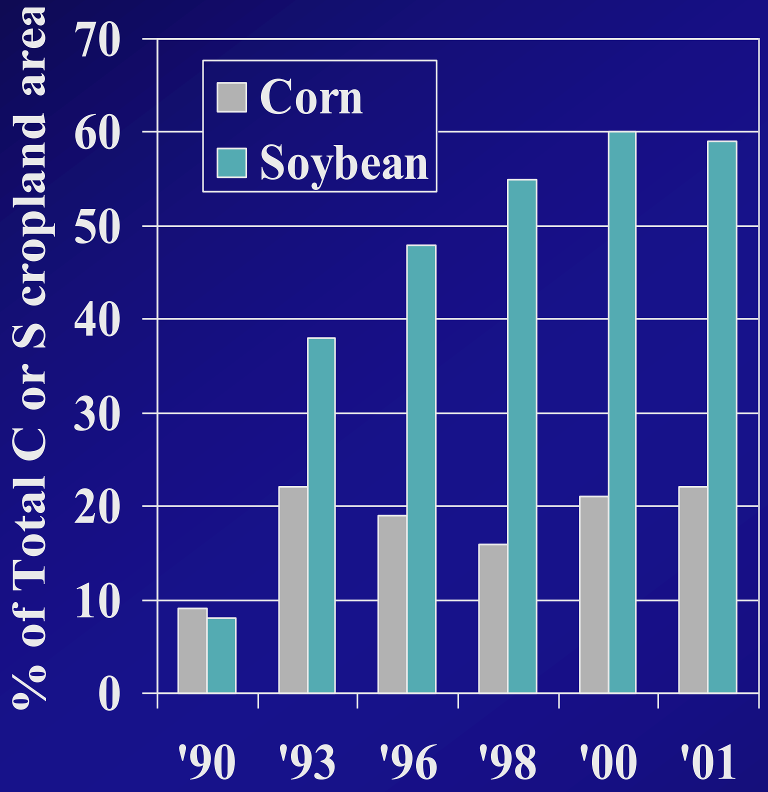
Strategies to remove water and reduce environmental nutrient loss

- Controlled drainage
  - Watertable management
    - Tiles periodically closed – promote denitrification
  - Wetland filters
  - Combination – subsurface irrigation
    - More soil water during pollination / maturation

'95 - '00 Ave Total Rainfall



Prevalence of reduced or no-till residue management

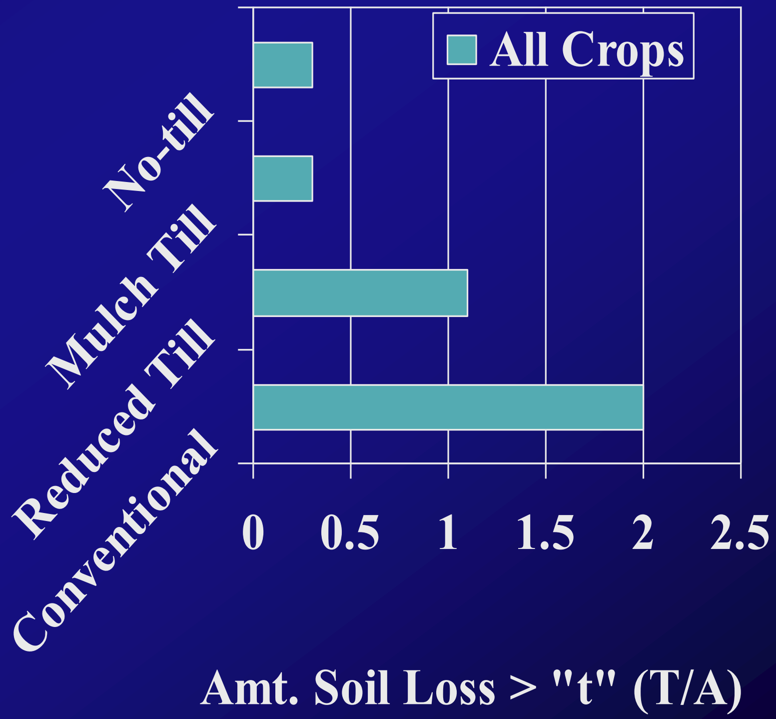


Trends in residue management

- T x 2000 program
- In 2001
  - 34% of all cropland in no-till
  - 47% of all cropland in conservation tillage
  - Remaining cropland – chisel and disk has replace mold board plow

2000 Indiana soil loss in excess of "tolerable limits" or "t"

- "t" in Indiana ~ 4 T/A/yr
- Universal Soil Loss Equation estimates soil loss in 2000
  - 5.3 T/A for conventional tillage
  - 1.6 T/A for no-till



Benefits / Risk considerations for reducing tillage intensity

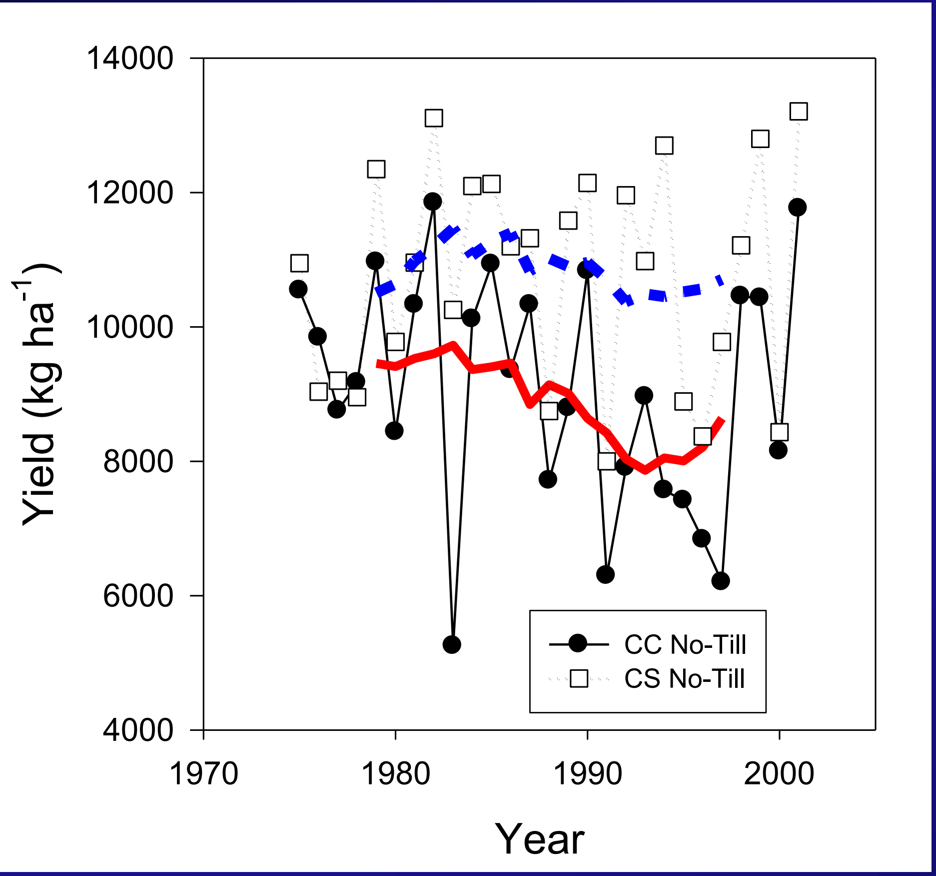
Benefits

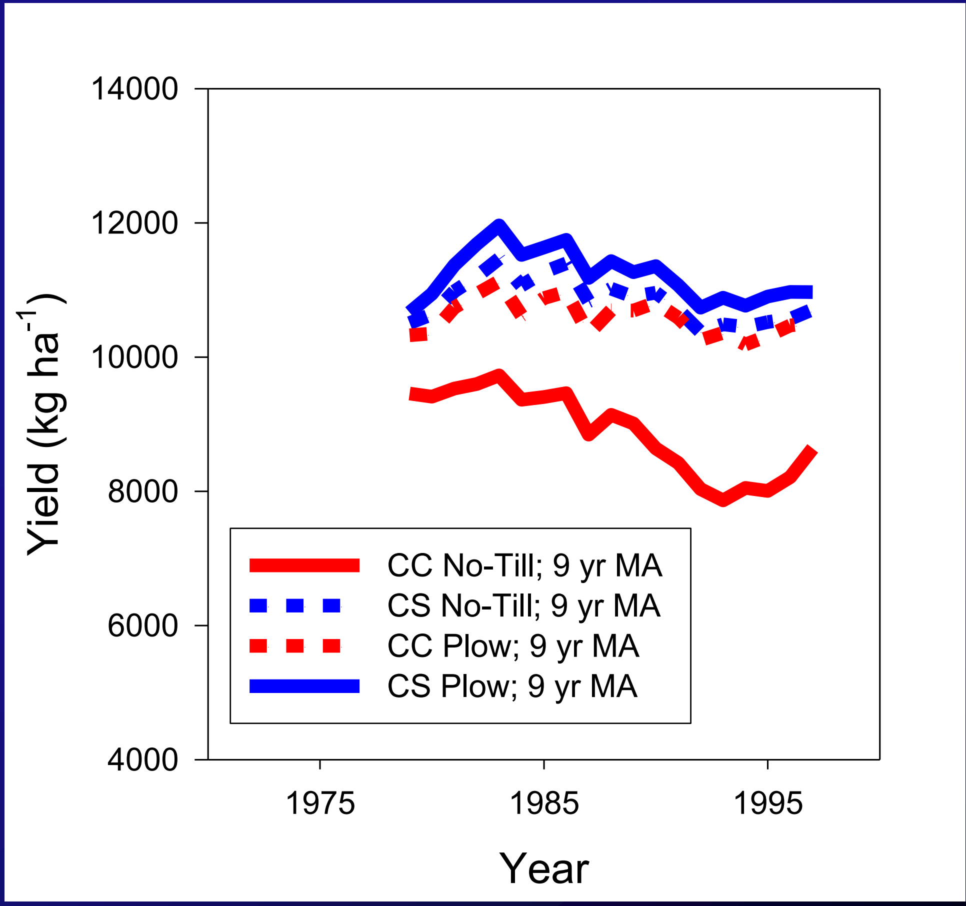
- Reduced production costs (increased profit margins)
- Improved surface water quality
  - Reduced sediment load
  - Reduced nutrient (P) load
- Carbon Sequestration?

Risks

- Corn yield reductions linked to seedling stand establishment problems
  - Colder / wetter soils at planting
- Fewer N management options
- Stratification of immobile nutrients and soil pH in the root zone
  - Asynchronous availability of water and nutrients

Effect strongest on corn grown w/o rotation





Timing of N applications

Basic recommendation is for applying all N in a preplant application

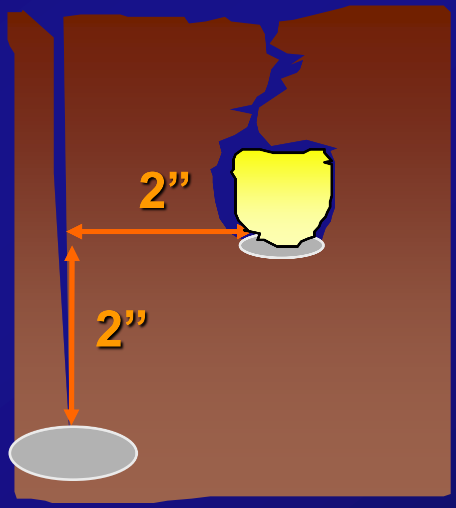
- A split application (sidedress) is recommended for sandy or poorly drained soils
  - Indiana: 50% preplant / 50% sidedress
  - Fall application is not encouraged
- Common materials are anhydrous and UAN solutions

No-till adjustments

- Place N below the residue
- Broadcast urea not recommended
  - N loss through volatilization
- Starter N or N, P and K is strongly recomended

"Starter" fertilizer promotes seedling stand establishment when root environment is poor

- When planting early
- When soil test P less than 30 kg/ha (15 ppm)
- When soil test K less than 150 kg/ha (75 ppm)
- When N applied sidedress after 6-leaf with conventional or conservation tillage
- When no-till planting



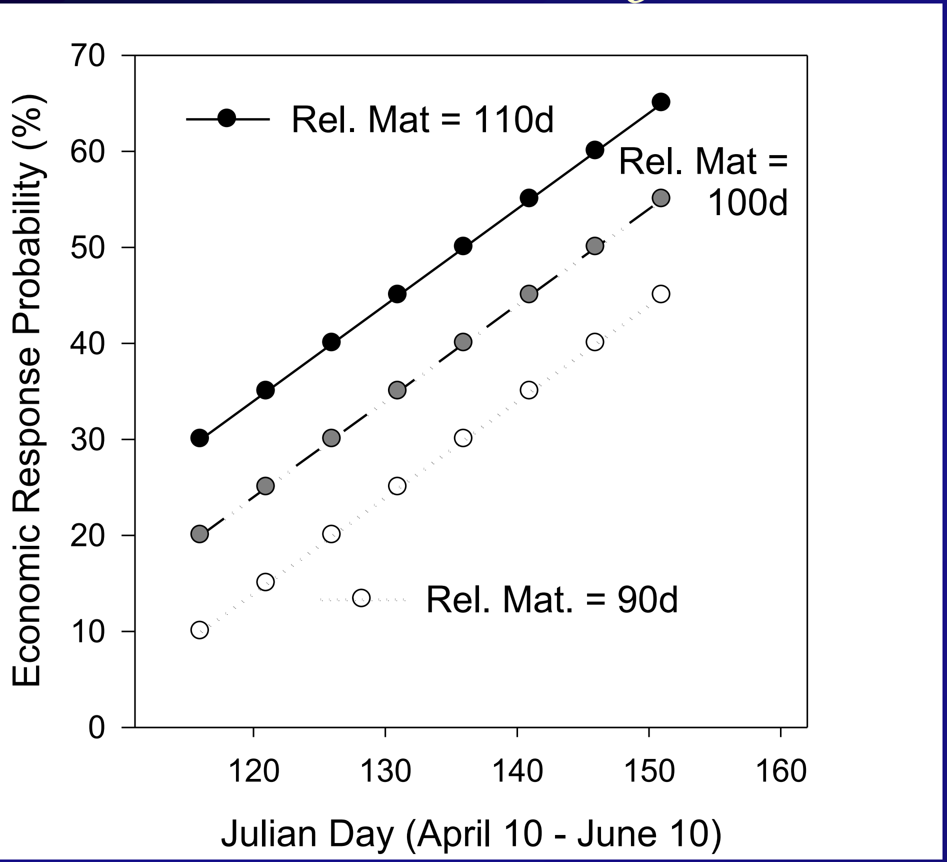
"Pop-up" ~ placement with seed a planting

"2 x 2" ~ 2 in (5 cm) to the side, 2 in below the seed at planting.

Use starter in high P / K Soils?

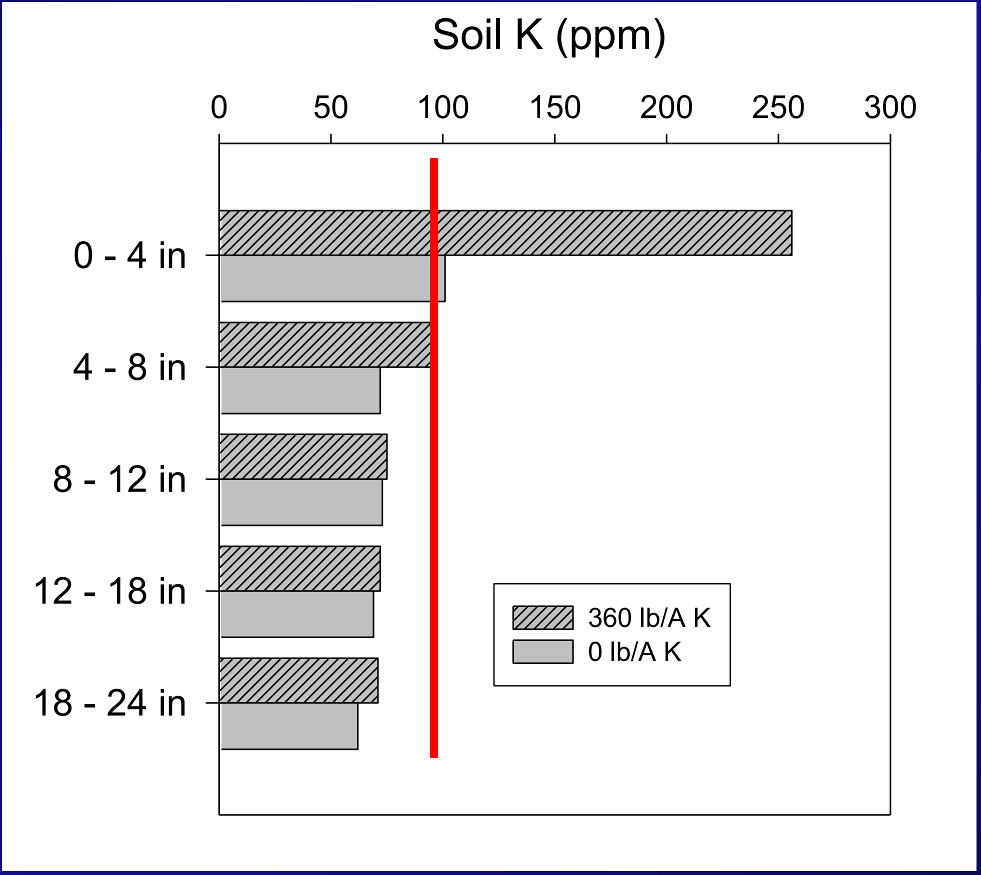
- Conventional wisdom ~ No benefit to using starter when soil test levels are high, especially when planting delayed.
- New research ~ starter N-P-K accelerates establishment / seedling growth allowing late planted corn to reach maturity faster

Starter benefits late planted corn

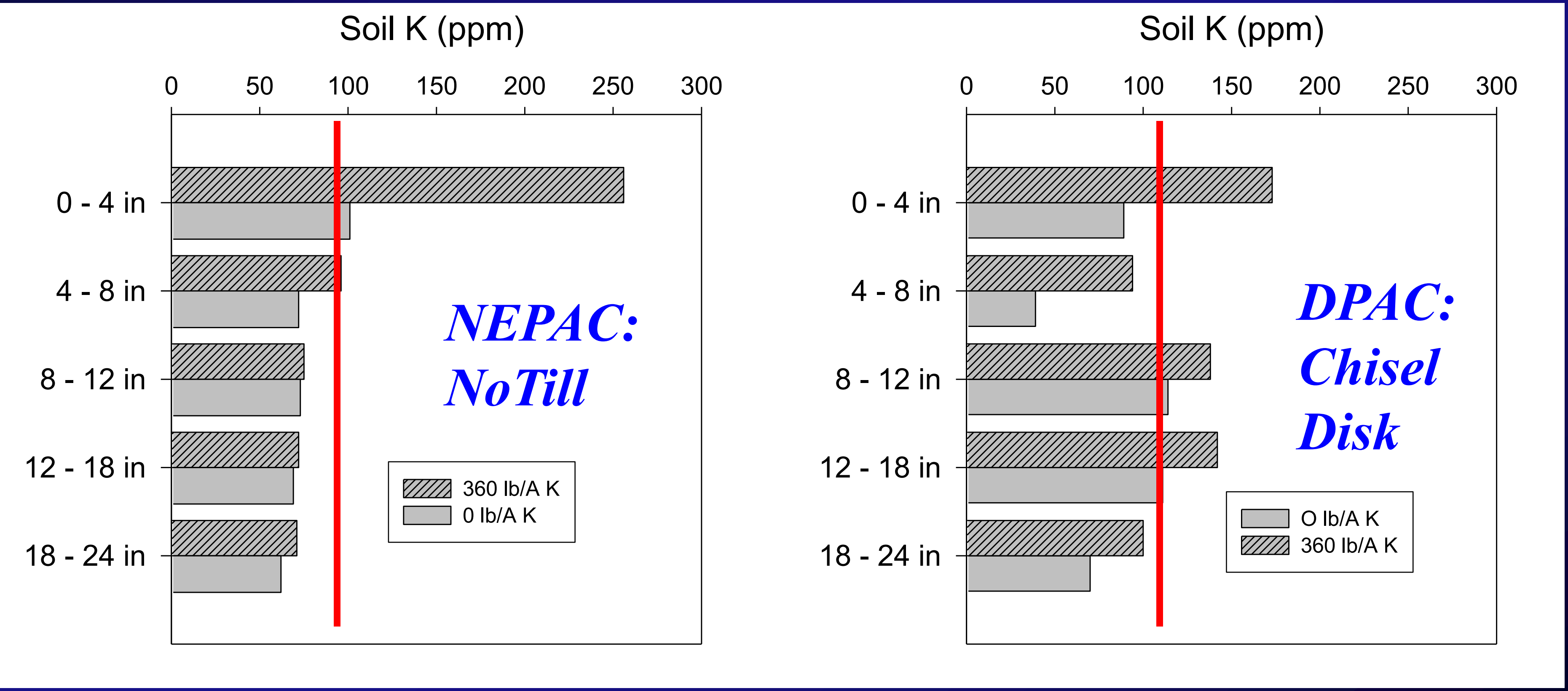


- Permits use of longer season hybrids at a any given planting date.
- Economic advantage of reduced dryer costs.

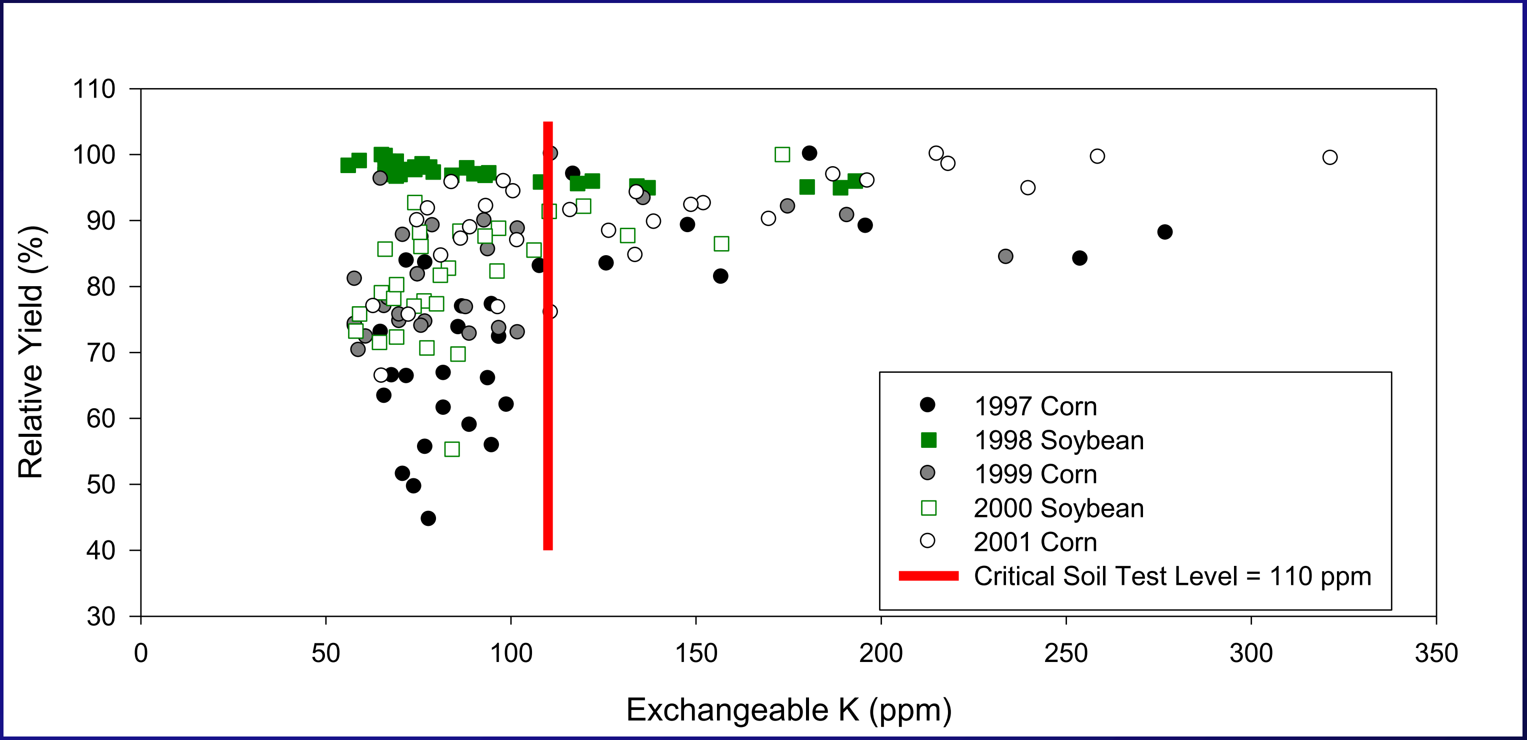
NoTill: Test K highly stratified w/ soil depth



Reduced Tillage K also stratified

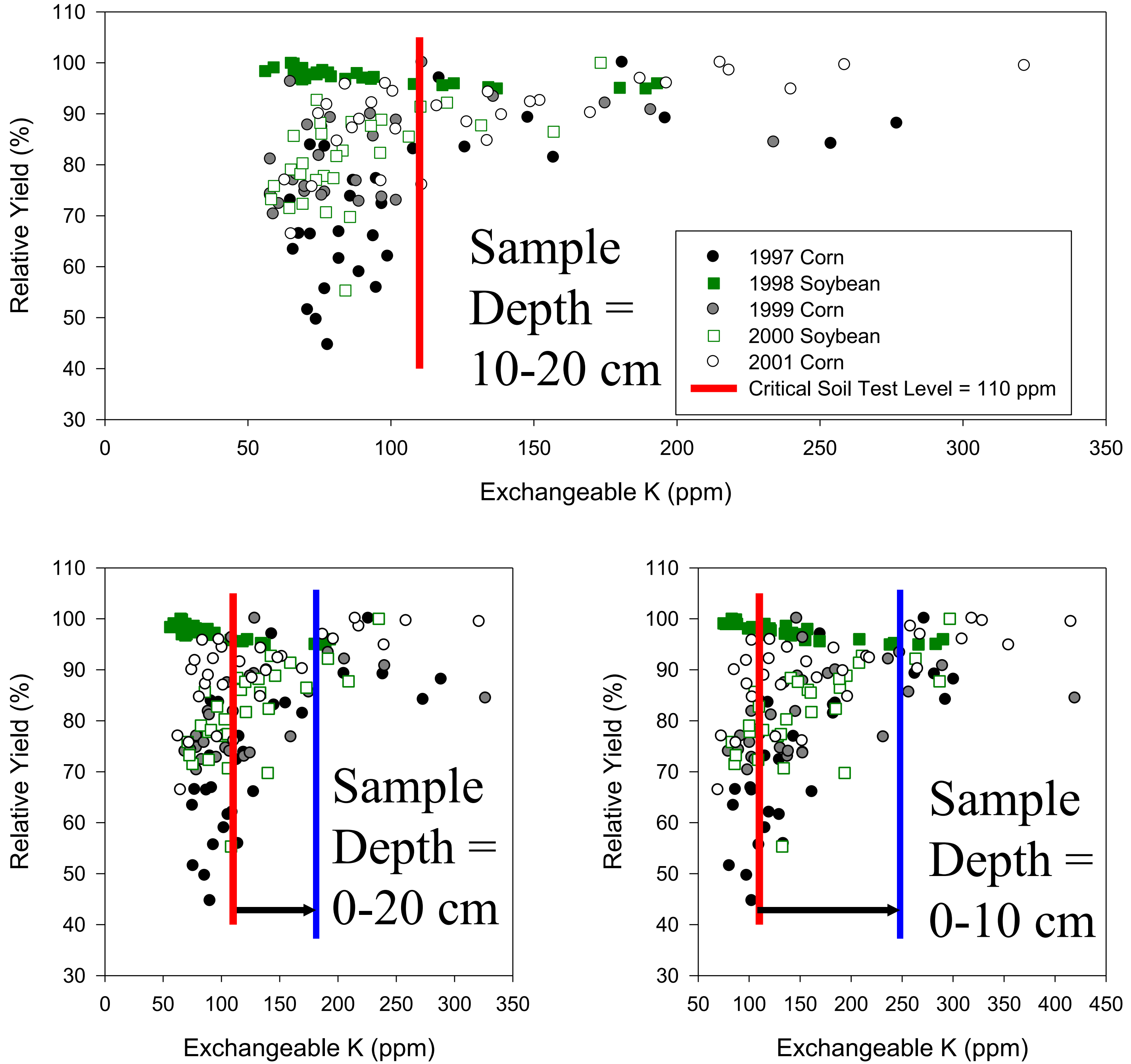


Soil Testing Issues



Problem?

Right relationship… Wrong sample depth…



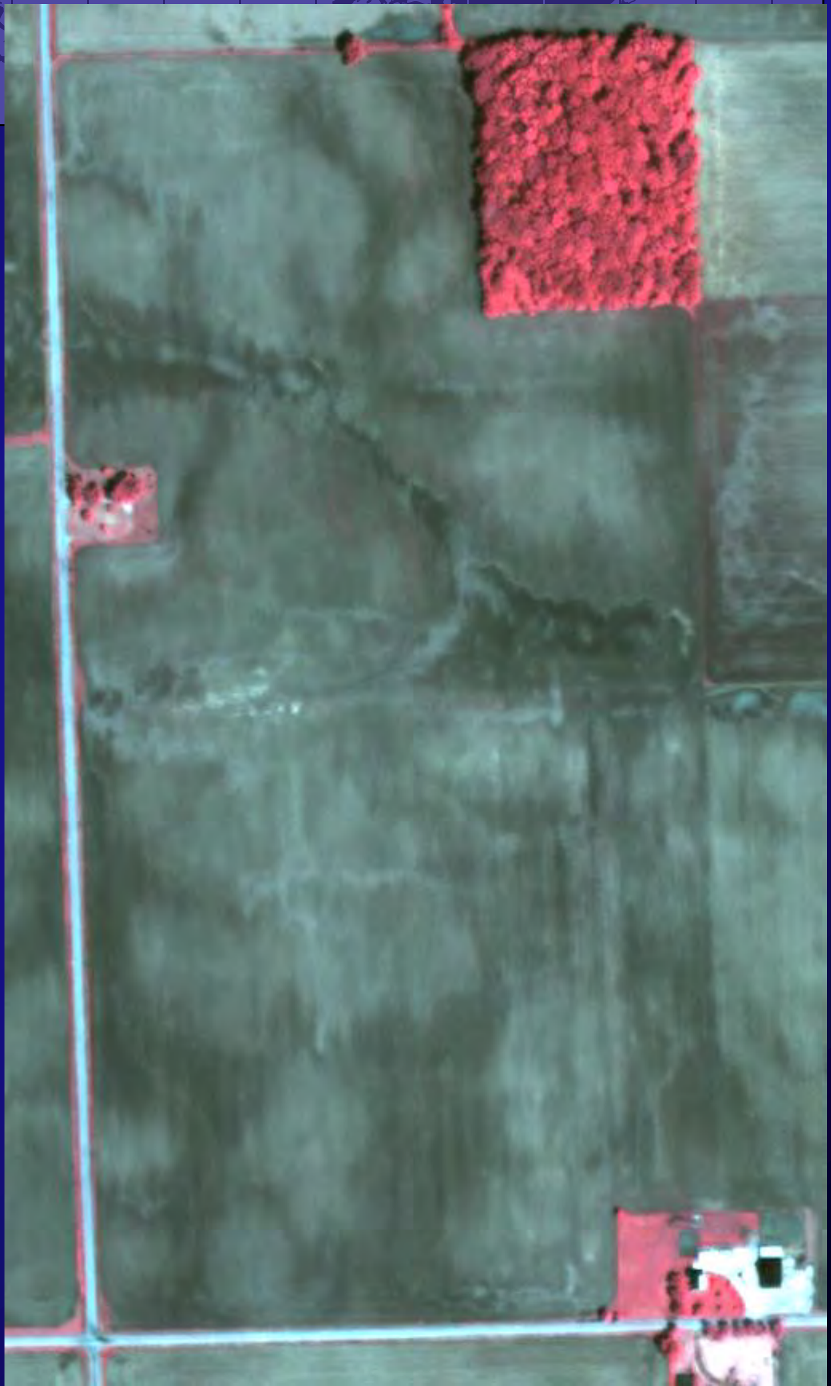
Relative Yield (%)
Exchangeable K (ppm)
Sample Depth = 10-20 cm
1997 Corn
1998 Soybean
1999 Corn
2000 Soybean
2001 Corn
Critical Soil Test Level = 110 ppm
Relative Yield (%)
Exchangeable K (ppm)
Sample Depth = 0-20 cm
Relative Yield (%)
Exchangeable K (ppm)
Sample Depth = 0-10 cm

Strategies to overcome statification

- Nutrient placement
  - Use "starter"
  - Deep banding
- Raise/build surface soil test levels to a higher sufficiency level
  - Add more P and K
  - Change test critical level

Pronounced horizontal spatial variability in soil chemical / physical properties w/in management units

- Question of the ’90s
  - Is there a yield (economic) advantage to be gained by Soil Specific or Precision Management?



Benefit / risk considerations for Precision Farming

Benefits

- Optimize yields across a variable landscape
- Optimize whole field plant nutrient / resource use efficiency
- Decrease negative environmental impacts

Risks

- Can't quantify the variability
- Can measure but can't manage the variability
- Poor return on investment

Optimizing yields across spatial variability

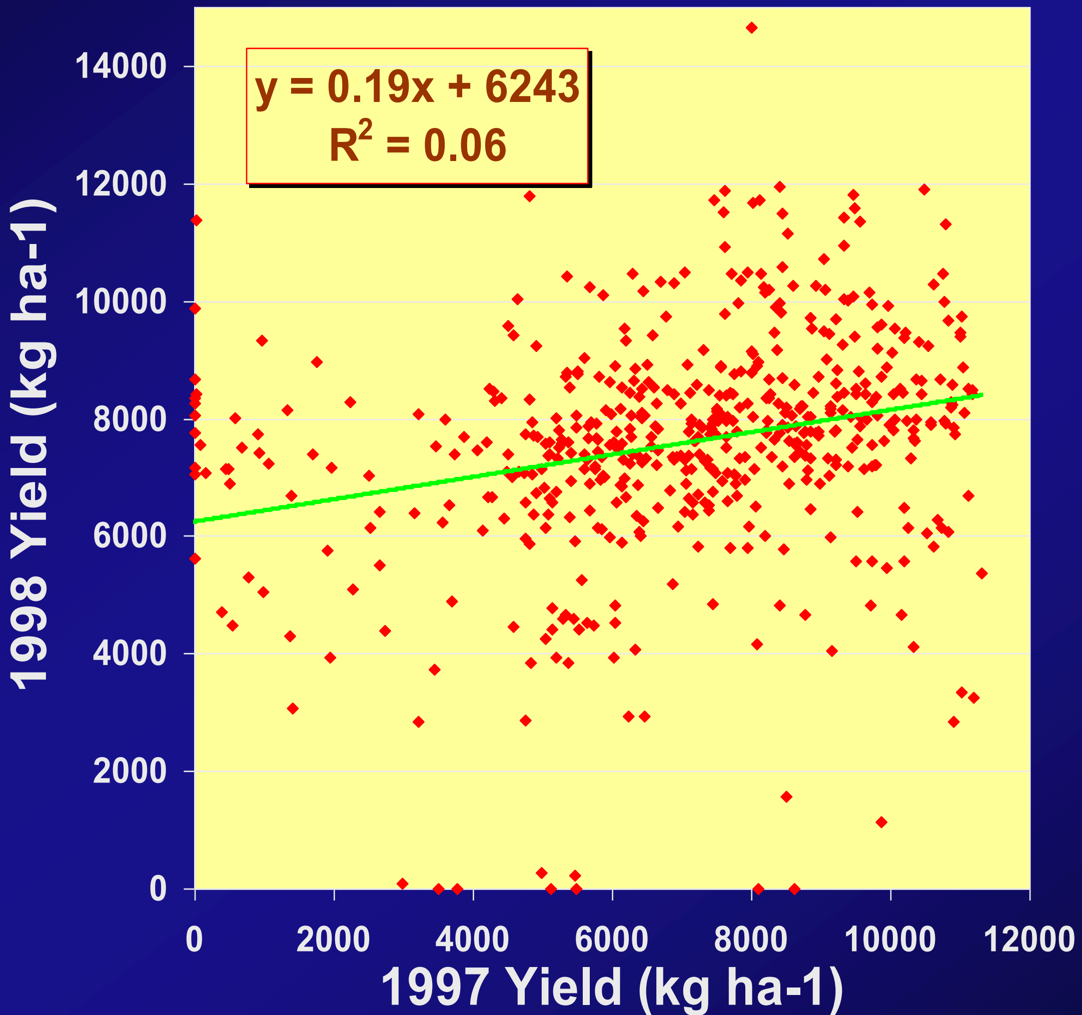
The premise of precision agriculture:

"If we can measure it we can manage it."

- What do we need to measure to manage within field variability
  - N: Yield (soil specific yield productivity potential); soil OM, residual soil N (western cornbelt)
  - P, K: Yield / crop removal soil test level relative to critical level
  - pH: active (water) and reserve (buffer) H^+ conc.

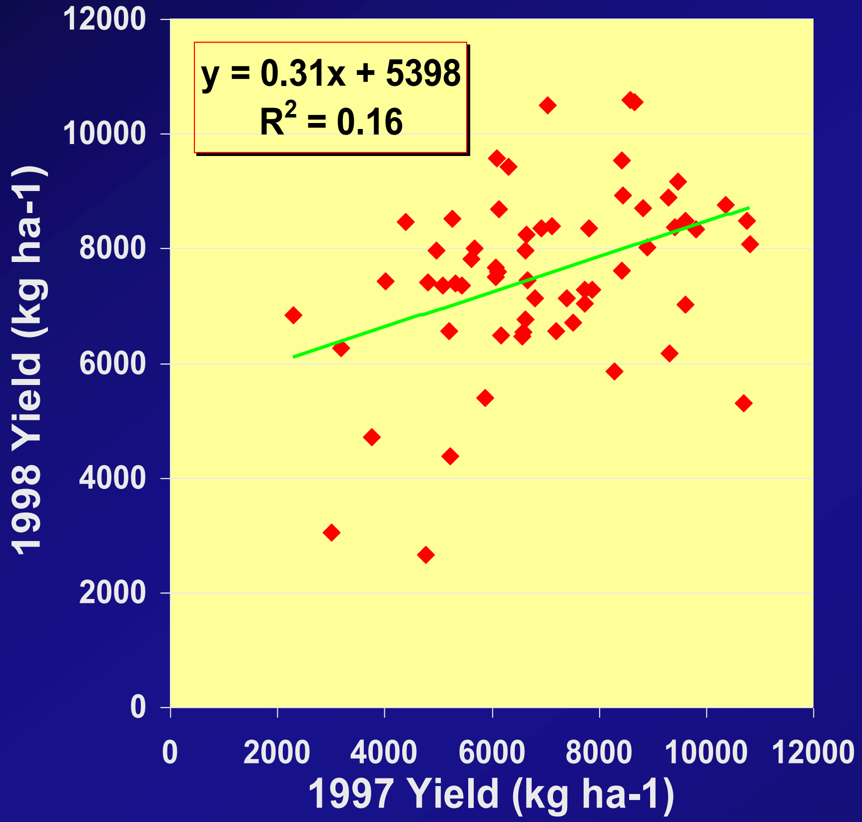
Within field variability in fertilizer N use

Common problem: spatial stability of yields

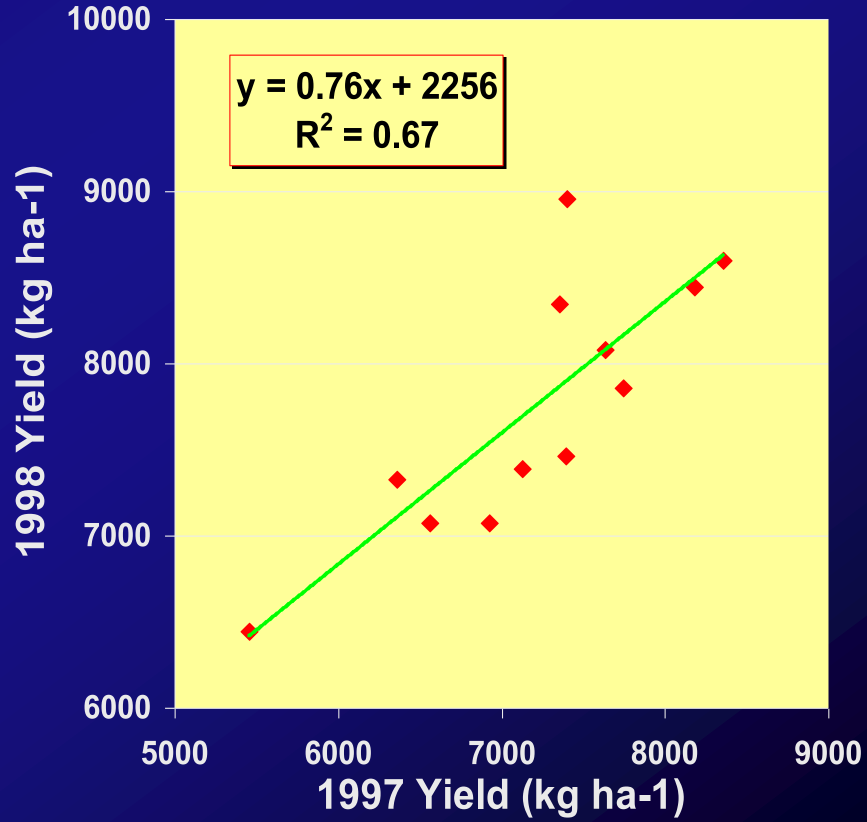


Key: Look at yield patterns on a larger scale

225 m² areas compared

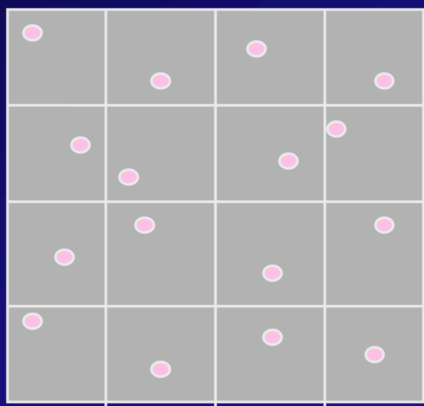


2.2 ha "moving window"

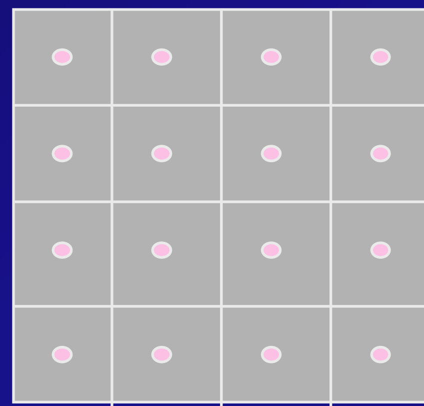


Approaches to assessment of soil P, K, pH

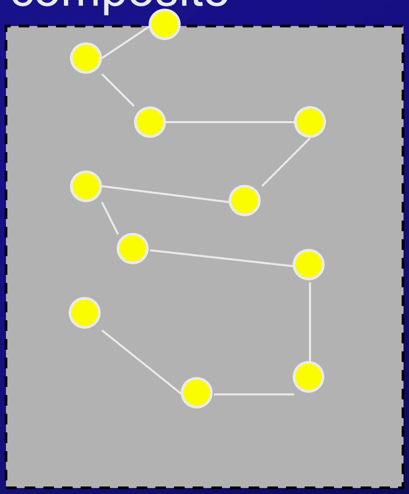
1 A random locations (georeferenced)



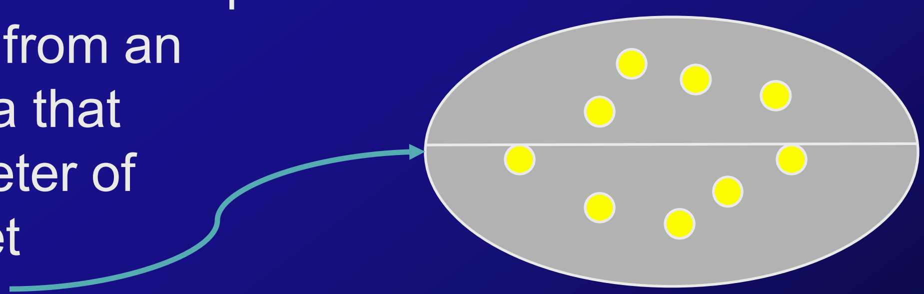
2.5 A: the grid center



2.5 A and Whole Field ~ Area composite



A composite soil sample is collected from an circular area that has a diameter of 10 to 30 feet



8 to 12 cores are collected at each point

Generating accurate maps

Case Study:

- Soil pH and management with lime

Research Issue:

- Can more intensive soil sampling strategies produce better maps for VR lime management?

Why lime and not P or K

- Soil acidity can reduce soybean yields in eastern cornbelt
- Yield penalty to overapplication

MAE = Mean Absolute Error (average wrong (+/-) application t/A)
PE = Prediction Efficiency (% “doing a better job a known points”)

	Fld D		Fld F		Fld RV		Nepac All		Nepac #1		Nepac #7	
	MAE	PE	MAE	PE	MAE	PE	MAE	PE	MAE	PE	MAE	PE
WF (area)	**0.72**	*	**0.72**	*	**0.81**	*	**1.09**	*	**1.71**	*	**0.90**	*
2.5 Ac (area)	0.72	**-14**	0.64	**14**	0.63	**33**	0.83	**34**	0.76	**72**	0.94	**-8**
2.5 Ac (CP: no math)	0.84	**-92**	0.83	**-69**	0.95	**-71**	1.10	**-38**	1.06	**24**	1.15	**-84**
2.5 Ac (CP: math)	0.74	**-13**	0.82	**-56**	0.82	**-16**	0.94	**12**	1.11	**29**	1.16	**-48**
1 Ac (CP: math)	0.70	**-6**	0.65	**-2**	0.77	**11**	0.96	**15**	1.04	**51**	1.13	**-59**
0.25/0.5 Ac (CP:math)	0.64	**20**	0.40	**59**	0.70	**19**	0.83	**35**	0.83	**68**	0.77	**14**

Current thinking on approaches to VR Nutrient and lime management

Nitrogen

- Develop N management zones using inexpensive or readily available information
  - Yield maps, soil survey, topography and elevation, remotely sensed images of bare soil / early crop growth

P, K, lime

- Directed soil sampling using inexpensive / available info.
- Yield maps as proxy's for nutrient removal (P, K)
- On-the-go sensors

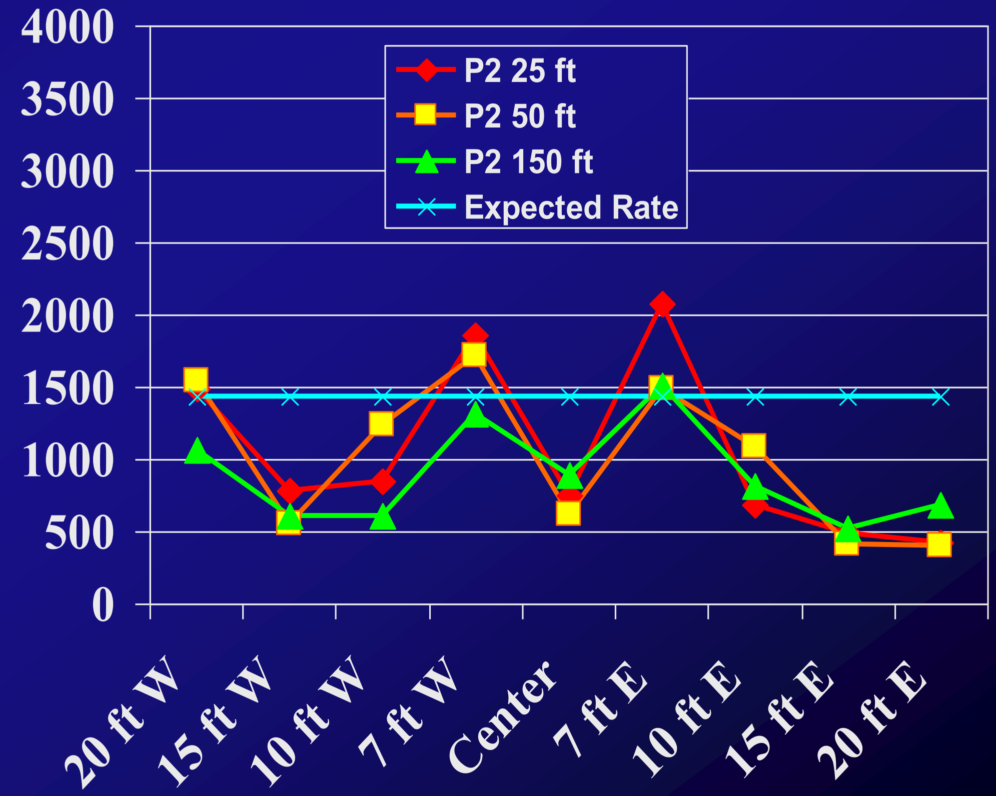
Tractor mounted pH & ISE-K

If we __can__ measure it, can we really __manage__ it?

Expected rate = 1440 lb/A

- How well can we expect variable rate application equipment to work in a production environment?

- What is realistic?



What are the characteristics of a HYSIP for corn?

- Improved water management
- Synchronous non-limiting availability of of water and nutrients throughout crop development
- Higher plant populations than currently in use

What are the characteristics of a HYSIP for corn?

- Expectation of better commodity prices or support programs related to "better management practice implementation."
- Development / implementation of informed public policy to promote both productivity and environmental stewardship on prime agricultural land.


6. 7. 2000