Tillage and Fertility Opportunities and Challenges

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Today's potpourri of issues

- Vertical tillage/subsoiling
- Crop residue management alternative
- Fertilizer placement
- Foliar feeding

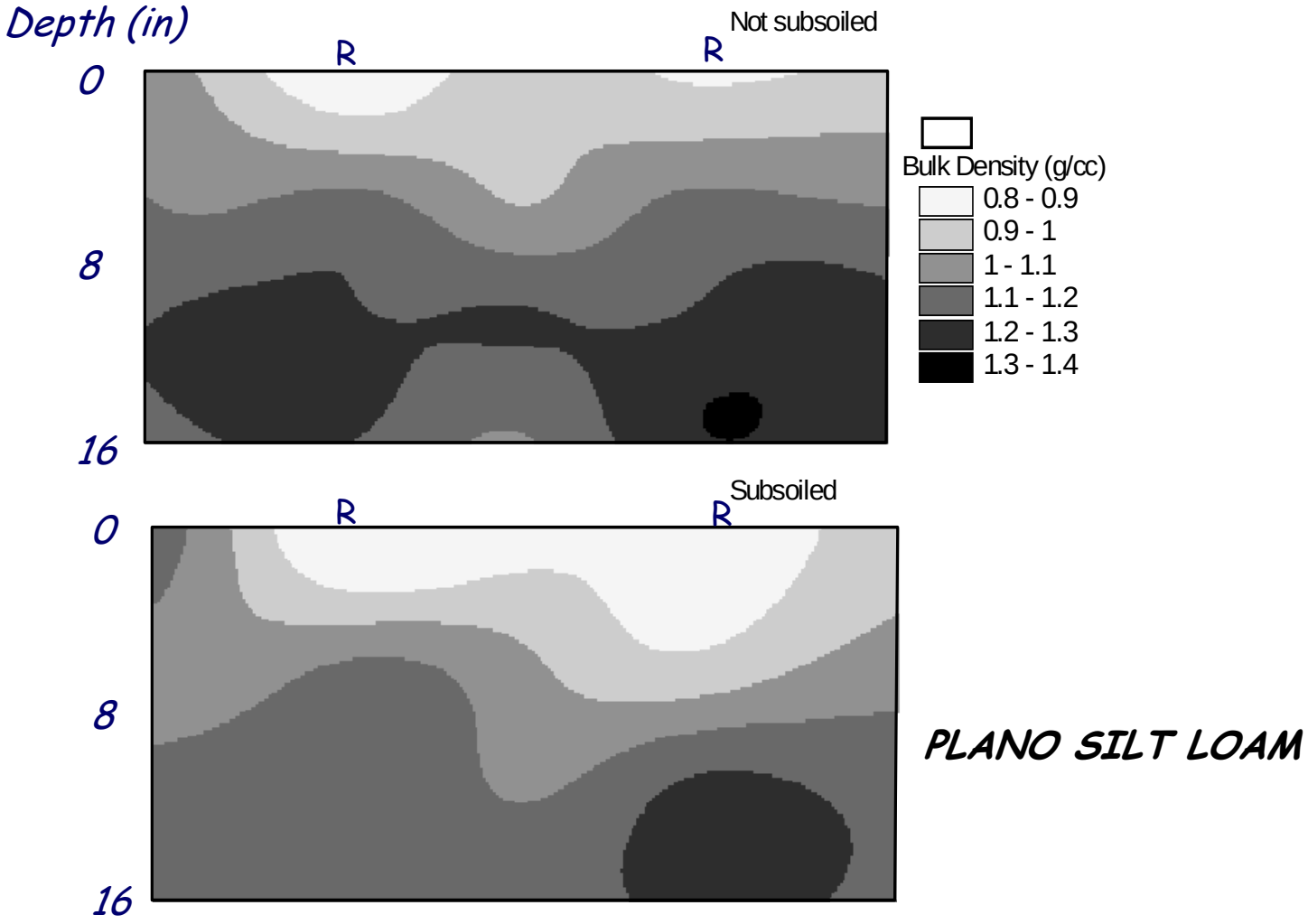
Vertical tillage

- Defined as deep tillage designed to create vertical zones by cutting a slot, shattering, and lifting the soil
  - Minimal inversion
  - Prepares seedbed
  - Various spacings
  - Fall or spring
- What is the motive for deep tillage
  - Part of a system associated with crop management programs, e.g. Zone-till™, ProfitPro™
    - Compaction not diagnosed
  - Response to poor soil condition (aka subsoiling)
    - Compaction diagnosed

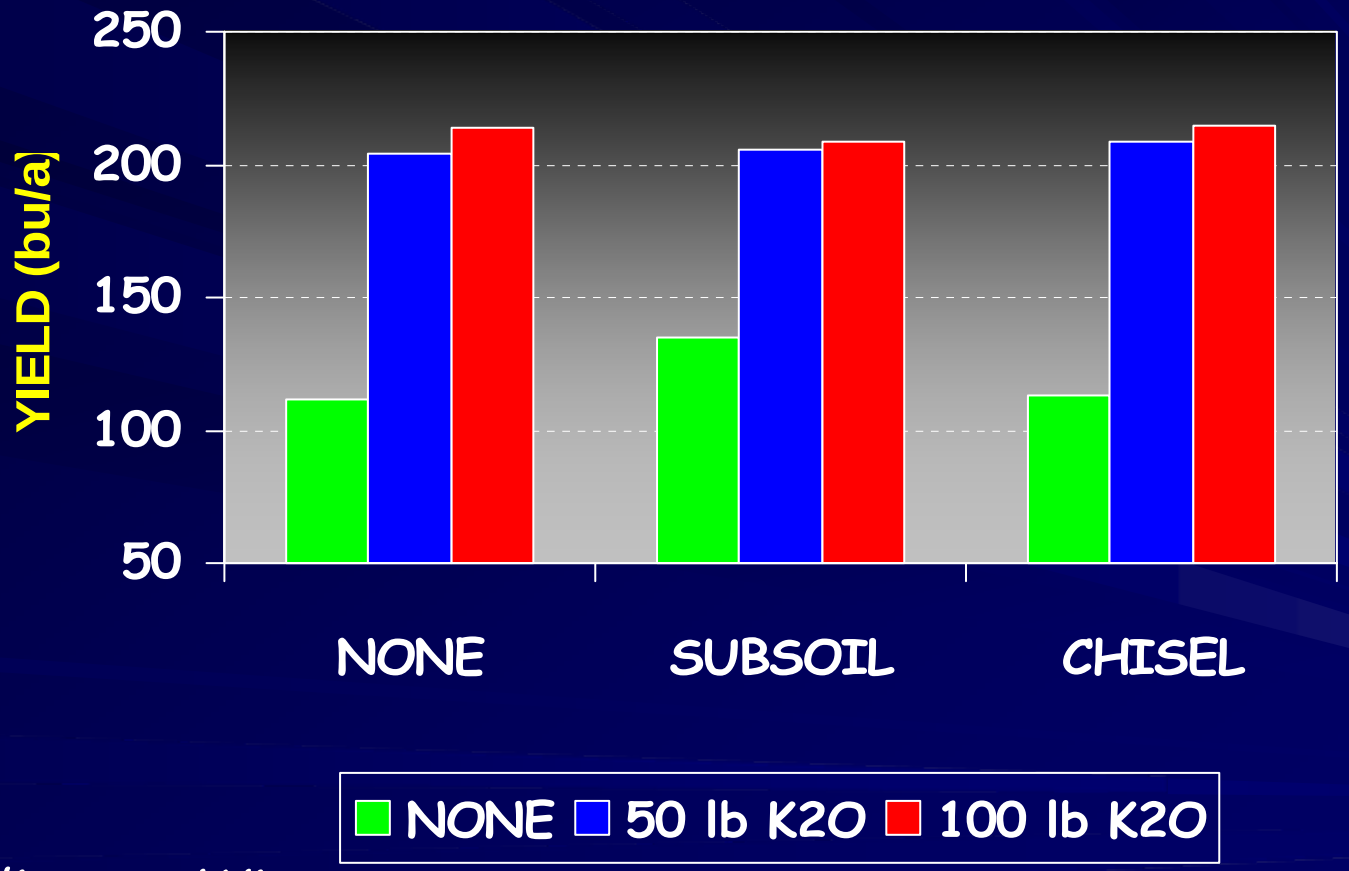
"Vertical tillage" implements

Are all situations responsive to deep tillage?

Soil bulk density profile, Arlington, Wis., 1998



EFFECT OF TILLAGE AND K FERTILIZATION ON FIRST-YEAR CORN YIELD AFTER SOYBEAN (2 yr. avg.)



Arlington, Wis.

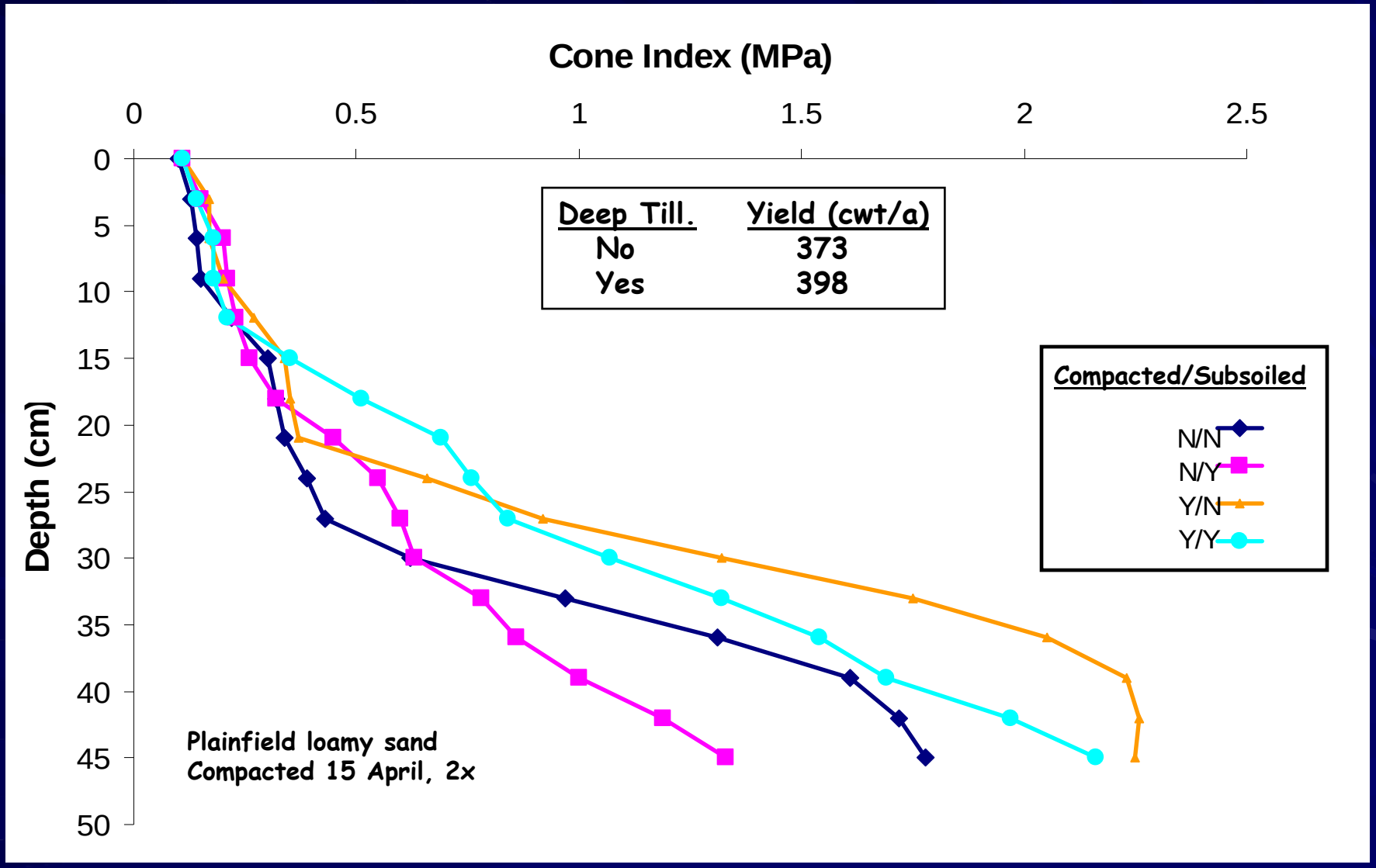
Soil abuse that causes compaction is all too common

Deep tillage can be beneficial where compaction is diagnosed

First: ID depth and strength of compaction

Sunflower tool used in Hancock deep tillage study, 2003

Cone index in a potato hill as affected by compaction and deep tillage, Hancock, Wis.

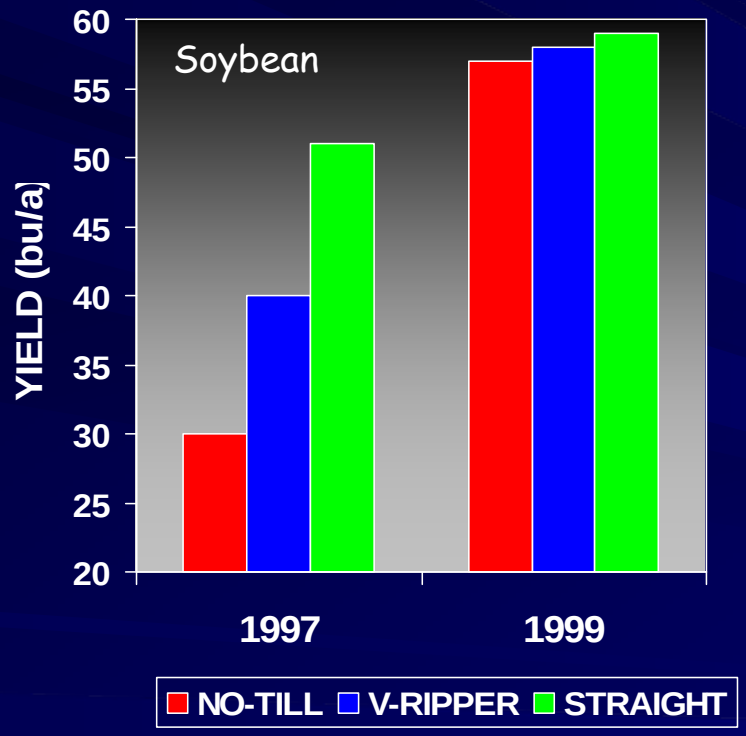


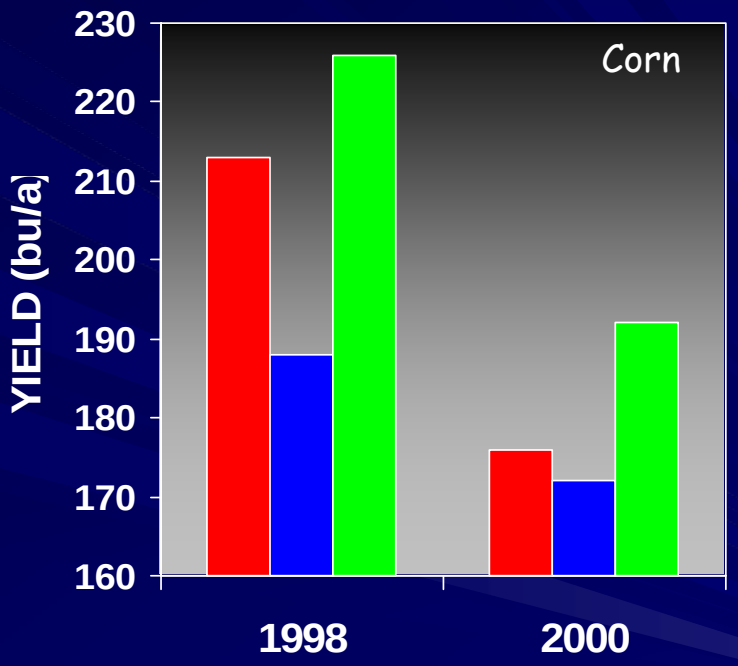
There are differences between subsoilers

"Conservation"
- Cutting coulters
- Straight shanks
- Horizontal points

"V-Ripper"
- Leading disks
- Parabolic shanks
- Winged points

EFFECT OF SUBSOILER TYPE ON SOYBEAN AND CORN YIELD ON A SILTY CLAY LOAM SOIL

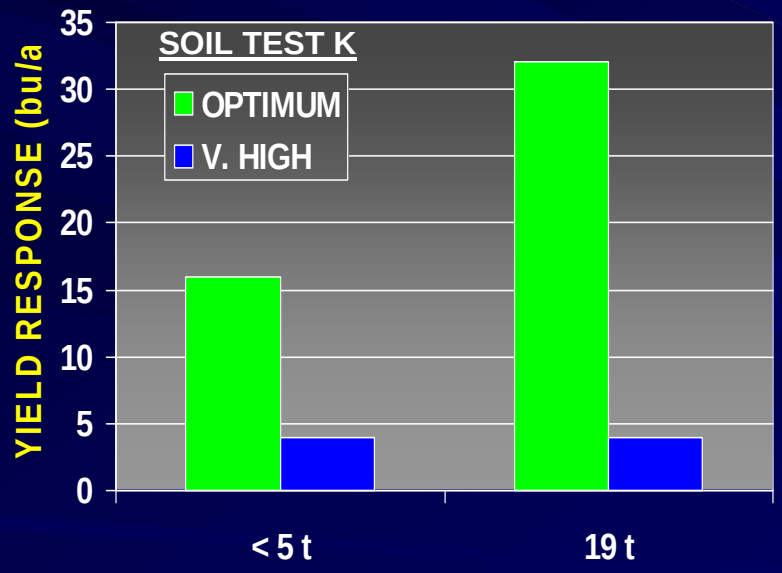




Manitowoc, Wis.

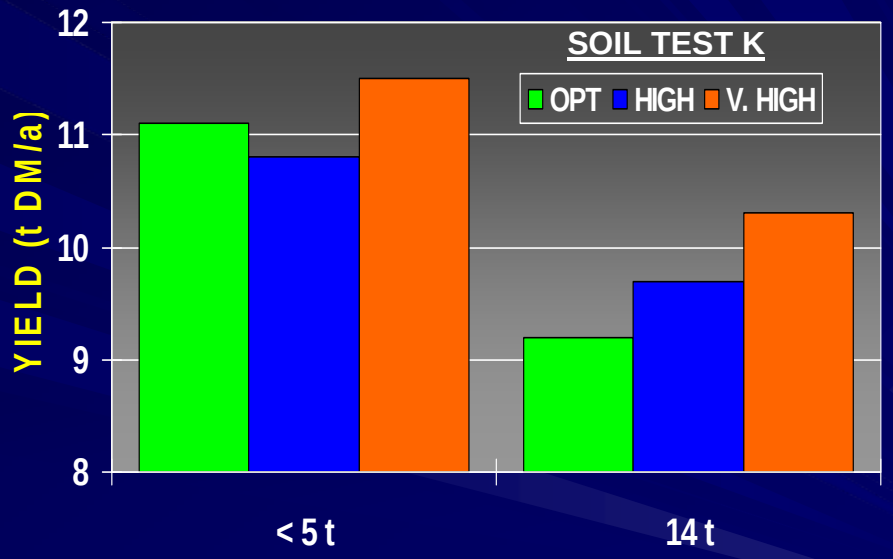
Compacted soils are responsive to K fertilization

Corn response to 45 lb $K_2$0/a in row



3 yr. avg.
Oshkosh, Wis.

Alfalfa response to soil test K

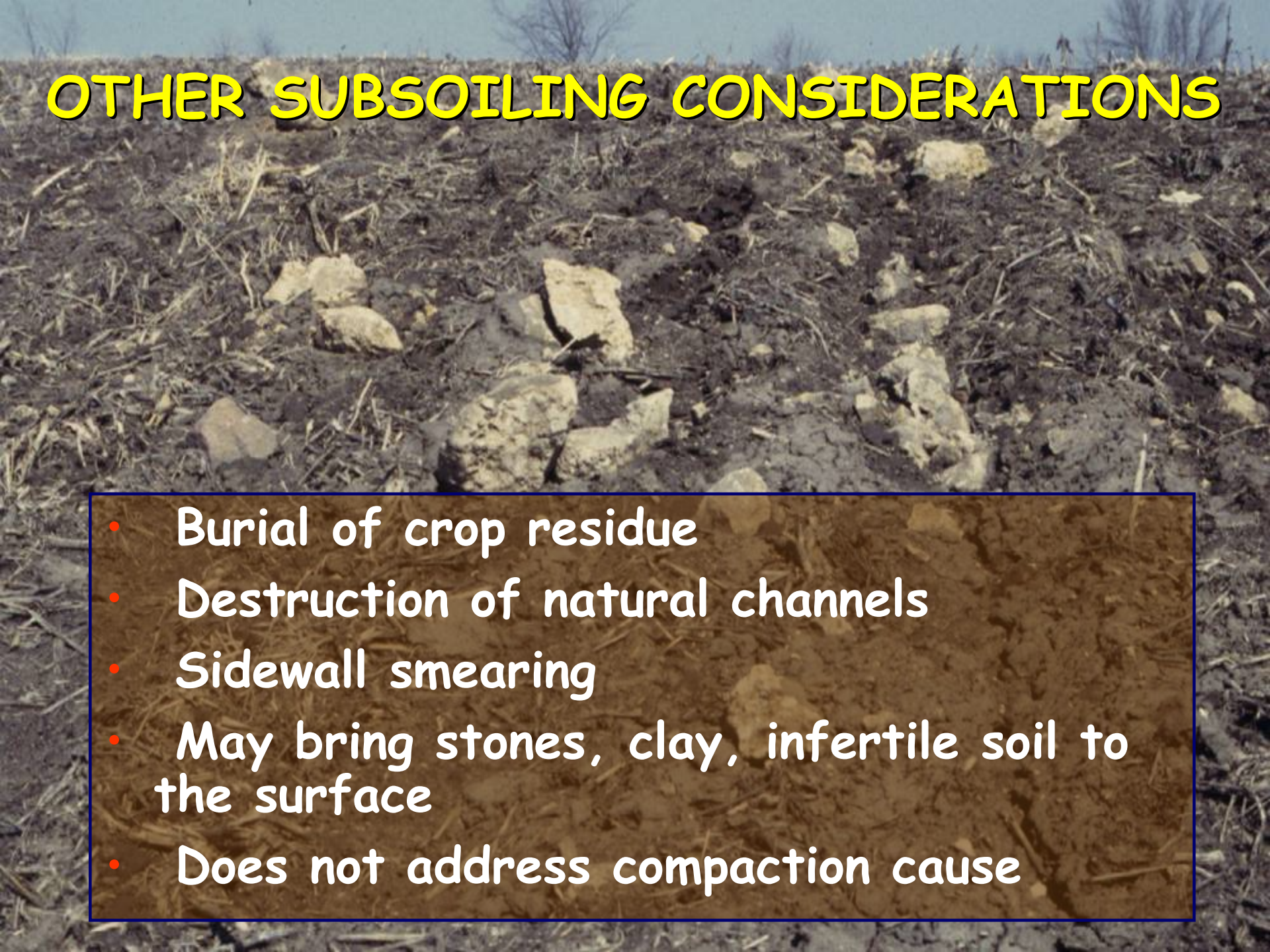


Sum of 3 hay years
Arlington, Wis.

DETERMINING THE NEED FOR SUBSOILING

- Evaluate depth and severity of compaction
- Check with penetrometer, probe, shovel
- Dig plants to examine roots
- Leave untreated strips for comparison
- Subsoiling is an expensive operation
- Subsoiling is not a cure-all, address compaction

OTHER SUBSOILING CONSIDERATIONS



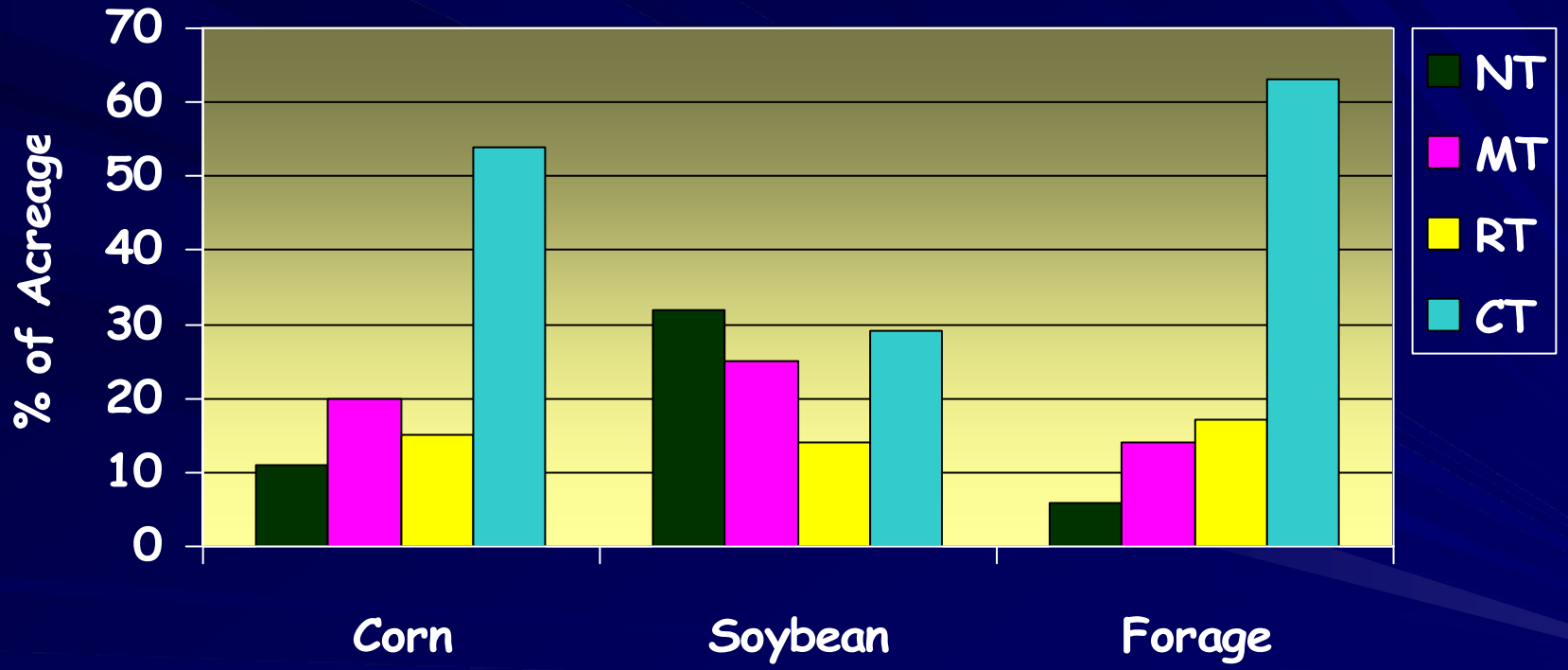
- Burial of crop residue
- Destruction of natural channels
- Sidewall smearing
- May bring stones, clay, infertile soil to the surface
- Does not address compaction cause

Crop Residue Management: Regional trend for more CT

- Eight Midwestern states:
  - 106 million acres of cropland
  - 37 percent of all U.S. cropland
- 46% of no-till acres in U.S. in the Midwest
- 2002 Midwest data
  - 17 million acres of no-till soybeans
  - 7 million acres of no-till corn
  - Forty-five million acres (42.5 %) used conservation tillage

CTIC Website (2002 data)

Wisconsin behind regional trend



CTIC Website (2002 data)

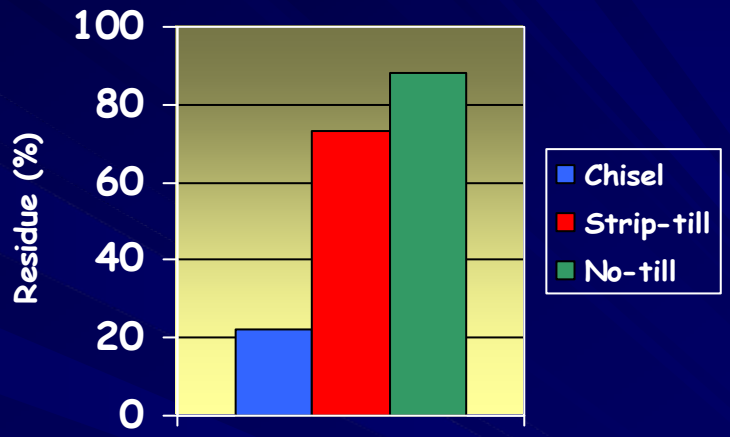
Tillage has a measurable effect on the soil condition

Direct or interactive effects

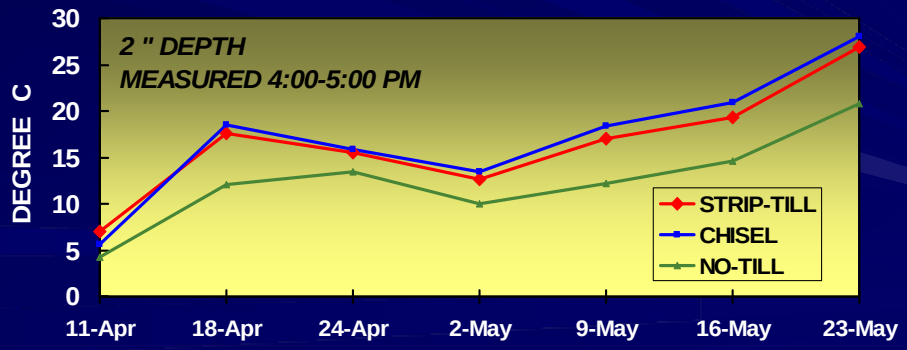
- Physical
  - Residue modifies temperature and moisture
  - Consolidation vs. loosening
- Chemical
  - Nutrient and pH stratification
- Biological
  - C distribution
  - N transformations

Soil temperature affected by tillage and crop residue

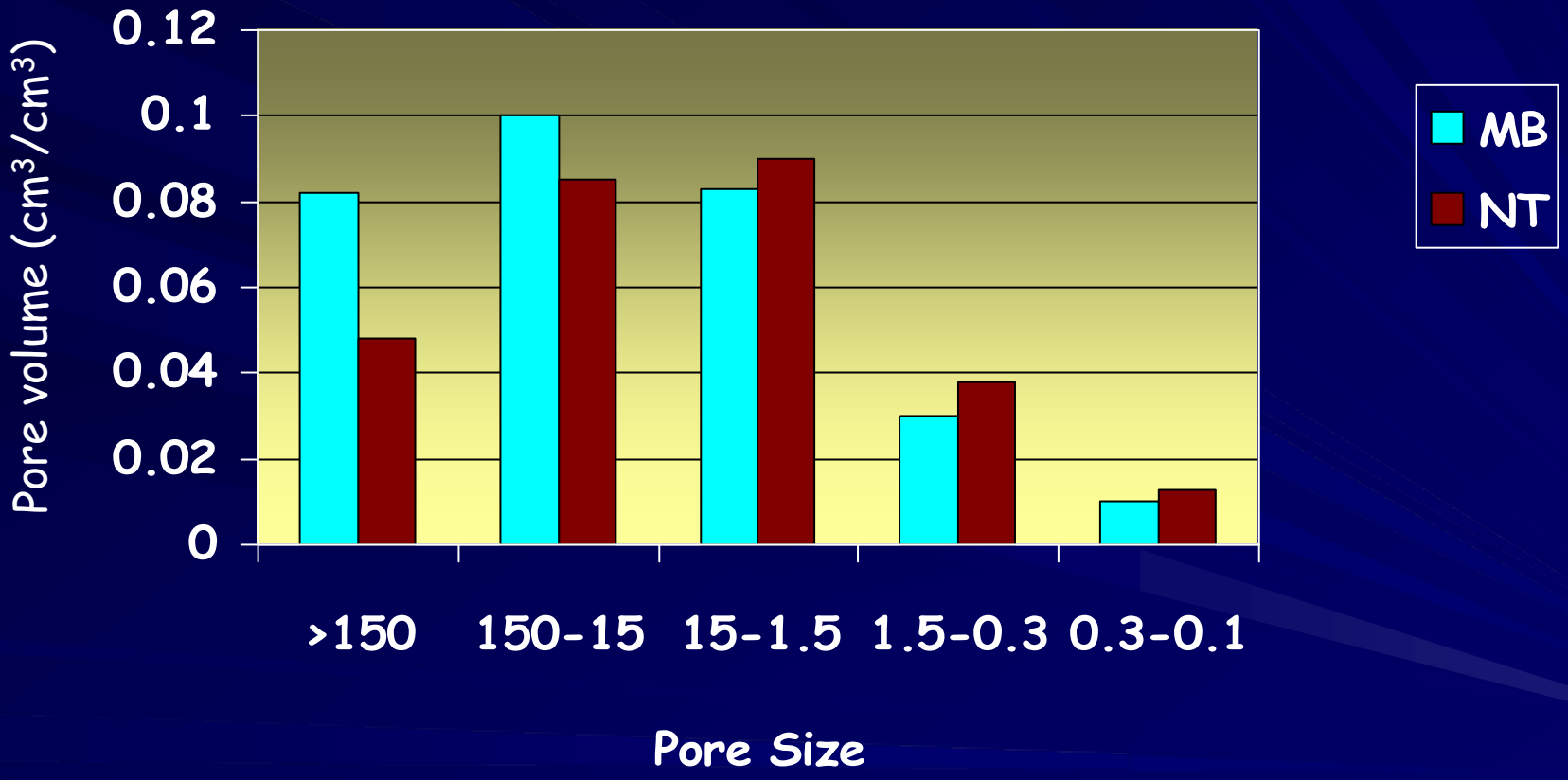
Effect on crop residue, Arlington, 1994



Effect on in-row soil temperature, Arlington, 1994



Effects of long-term tillage on the plow layer pore size distribution



Hill et al., 1985

Fertilizer placement affects corn root distribution (0-6 in.)

		Root length (km/m^3)		
Tillage	Fert. placement	Row	Untracked Inter-row	Tracked Inter-row
CH	ROW	17.1	3.0	0.8
CH	INTER-ROW	12.0	4.4	1.4
NT	ROW	19.8	2.5	0.8
NT	INTER-ROW	10.8	6.1	1.5

Kaspar et al., 1991

Controlled traffic is a key to making reduced tillage work

- Controlled traffic research, Australia
- Practiced on 2.5 million acres
- 500 GPS guided tractors
- Research shows 10-15% yield increase from controlled traffic

Strip tillage expands crop residue management

Three categories

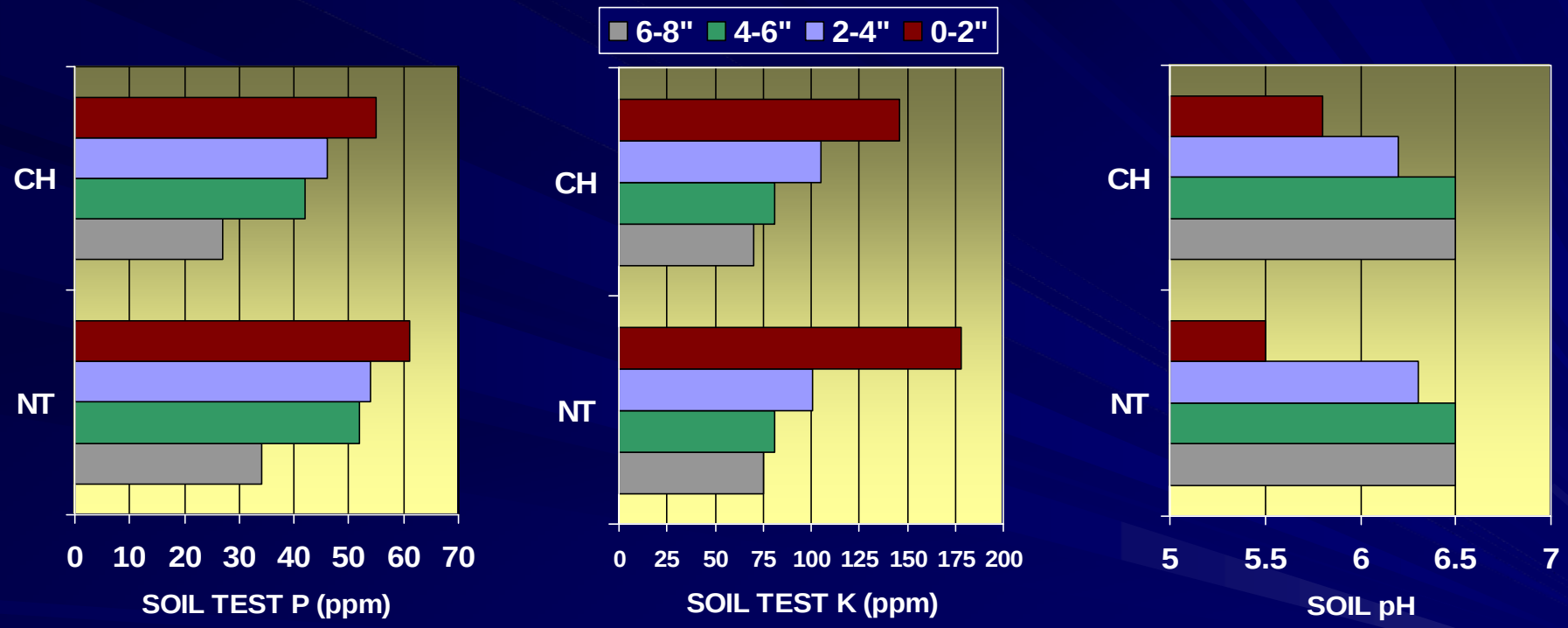
- ROW OR RESIDUE CLEARING
  - REMOVE RESIDUE
  - FINGER COULTERS, BRUSHES, SWEEPS
- STRIP TILLAGE (SHALLOW: < 6 in.)
  - MOVE RESIDUE, SEEDBED PREP., ROW FERTILIZER
  - FLUTED COULTERS, DISCS
- STRIP TILLAGE (DEEP: > 6 in.)
  - DISRUPT COMPACTION, DEEP-PLACE FERTILIZER
  - KNIVES
  - SOME WITH COULTERS TO MOVE RESIDUE OR CREATE MINI-RIDGES

Tillage and P and K availability

Possible issues

- Nutrient stratification
  - Surface applied nutrients
  - Crop residues
  - Vertical and horizontal
- How to collect a representative sample
- Fertilizer placement considerations

Soil test stratification following five years of tillage management, Arlington, Wis.

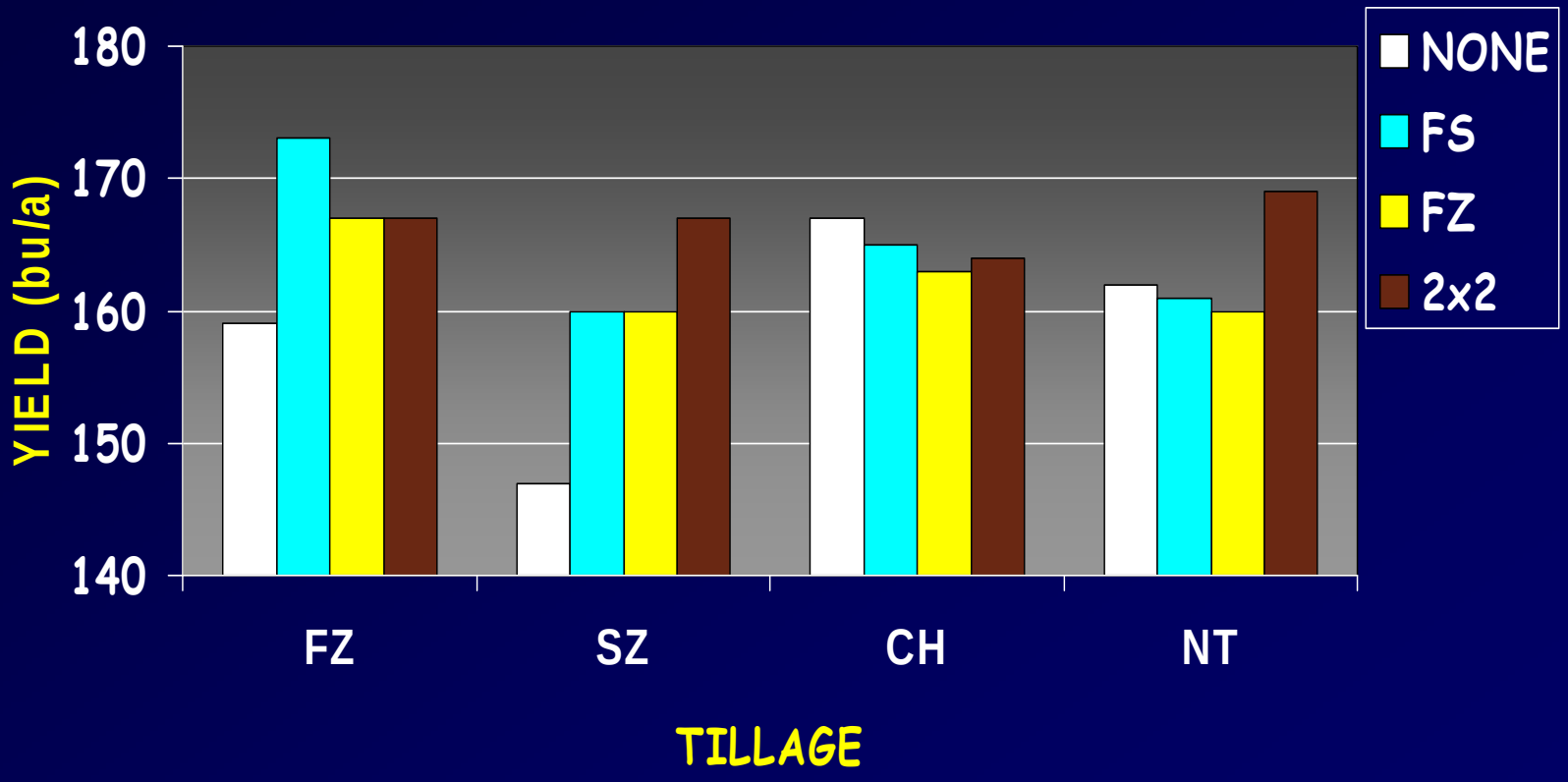


Wolkowski, 2003 (Corn/soybean rotation)

Reduced tillage is more responsive to fertilization

- Positional availability
  - Surface vs. sub-surface
  - Wheel track vs. non-wheel track effects on root distribution
- Reduced P and K fixation by the soil
- Reduced K uptake from zones of poor aeration
- Complete starter material recommended

INTERACTIVE EFFECT OF TILLAGE AND ROW FERTILIZER, ARLINGTON, 1994-1996

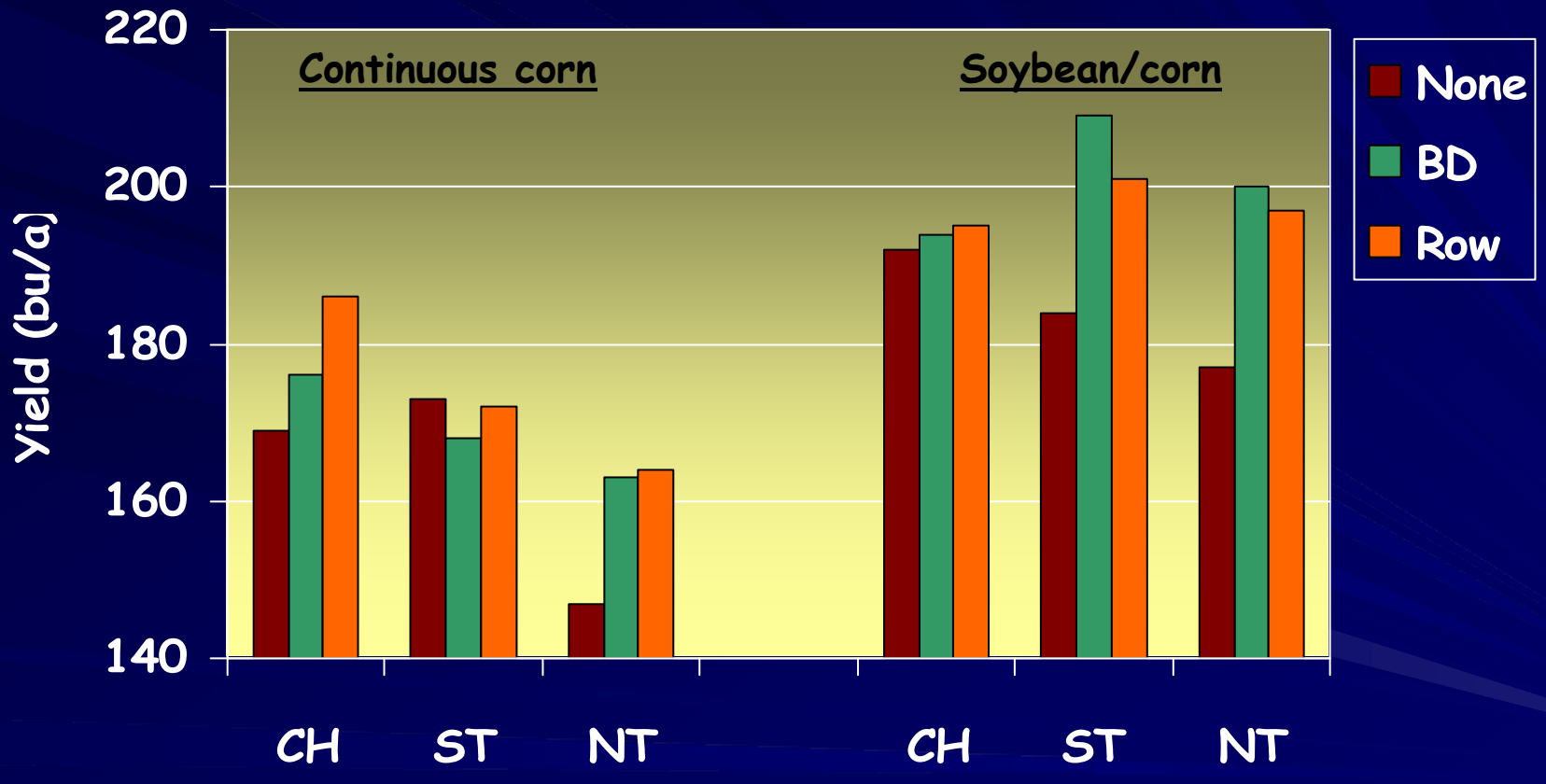


EFFECT OF ROTATION, TILLAGE, AND FERTILIZER ON TISSUE K CONCENTRATION 45 DAP, ARLINGTON, WIS., 2001

	CC			SbC		
	CH	ST	NT	CH	ST	NT
	------- % -------			------- % -------		
NONE	2.23	2.37	2.35	1.65	1.34	1.40
BDCT	2.35	2.19	2.51	2.51	2.18	1.40
2 x 2	2.85	3.26	2.31	2.46	2.58	2.16

Wolkowski, 2003

RESPONSE OF CORN TO TILLAGE AND FERTILIZER PLACEMENT, ARLINGTON, WIS. 2001-2003



200 lb 9-23-30/a

Foliar fertilization of crops

- Plants are not made to absorb nutrients through leaves
- Nutrient use by crops is substantial
- Leaf damage likely because of salt injury
- Most research with soybean (podfill)
- Micronutrients (B and Mn) for soybean under certain conditions

Response of soybean to foliar fertilization at three Minnesota locations

	Waseca	Becker	Rosemount
Treatment	---------- bu/a ----------		
Control	54	56	61
Foliar (NPKS) 4x	57	53	63

Adapted from Rehm, 1997

Summary of Midwest research for foliar B on soybean

	IL	MO	OH	WI
Treatment	---------- bu/a ----------			
Control	42.2	43.0	52.4	51.2
Foliar	43.2	43.3	53.3	51.5
Soil	38.3	42.8	52.5	51.9

Avg. of 0.25, 0.5, and 1.0 lb B/a foliar; 3 lb B/a soil

Response of soybean grown on a high pH, high O.M. soil to Mn fertilization

Treatment	Mn Rate	Yield
	lb Mn/a	bu/a
Control	--	50
Row	10	61
Row	20	64
Row	40	63
Foliar (2x)	0.5	62
Foliar (2x)	1.0	61
Foliar (2x)	2.0	59

Randall et al., 1975
2 yr. avg.

Summary

- Consider your motive and need for deep tillage
- Subsoiling more likely to be beneficial where compaction is identified
- Avoid compaction
  - Stay off wet soils
  - Watch load weight
  - Control traffic
- Tillage has a profound effect on soil properties and affects nutrient availability
  - Residue increases water content and lower temperature
  - Soil is more consolidated

Summary

- Reduced tillage has numerous benefits
- pH, P, and K stratify
- No-till (strip-till) corn is more responsive to fertilization
- Band placement often beneficial, however broadcast may be acceptable
- Foliar fertilization not recommended for NPKS
- Foliar fertilization can be useful where a micronutrient need is identified