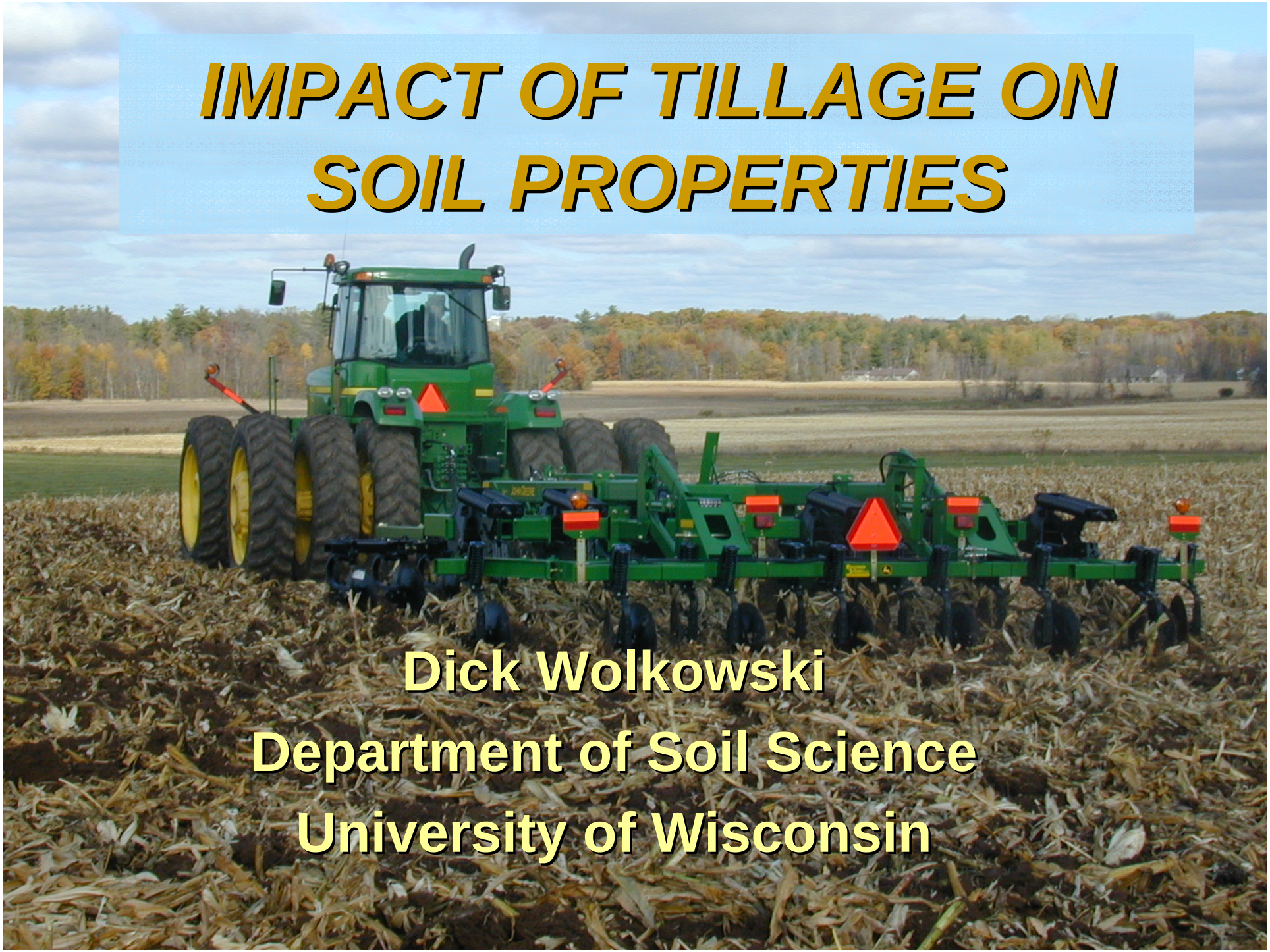
IMPACT OF TILLAGE ON SOIL PROPERTIES



Dick Wolkowski
Department of Soil Science
University of Wisconsin

WHAT IS TILLAGE

- **THE PHYSICAL MANIPULATION OF THE SOIL FOR THE PURPOSES OF:**
  - **Management of previous crop residues**
  - **Control of competing vegetation**
  - **Incorporation of amendments**
  - **Preparation of a seedbed**

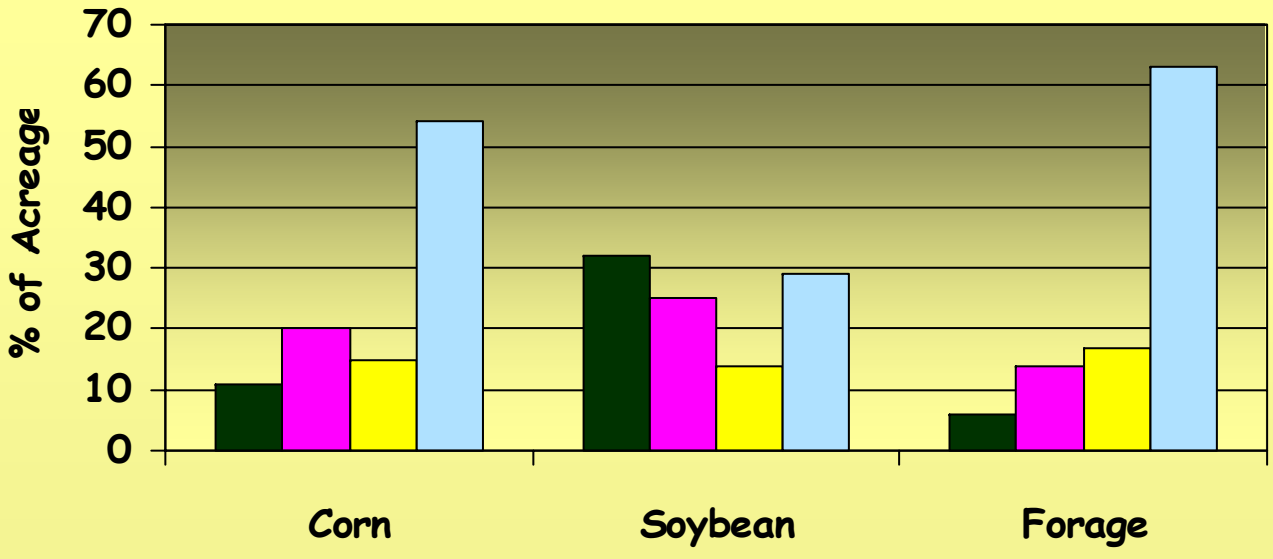
SOIL PROPERTIES AFFECTED BY TILLAGE

- Crop residue cover
- Soil test measurements
- Nutrient availability
- Structure and aggregate stability
- Water relationships
- Temperature
- Soil biology
- Strength

SURFACE CROP RESIDUE INTERACTS WITH OTHER FACTORS

- **Impact on erosion**
- **Cooler soils**
- **Conserves moisture**
- **Affects soil physical properties**
- **Affects carbon and nutrient cycling**

TILLAGE INTENSITY IN WISCONSIN VARIES BY CROP



CTIC, 2002


TILLAGE EFFECT
EROSION ON CLEAN-TILLED GROUND, DANE CO., WIS.

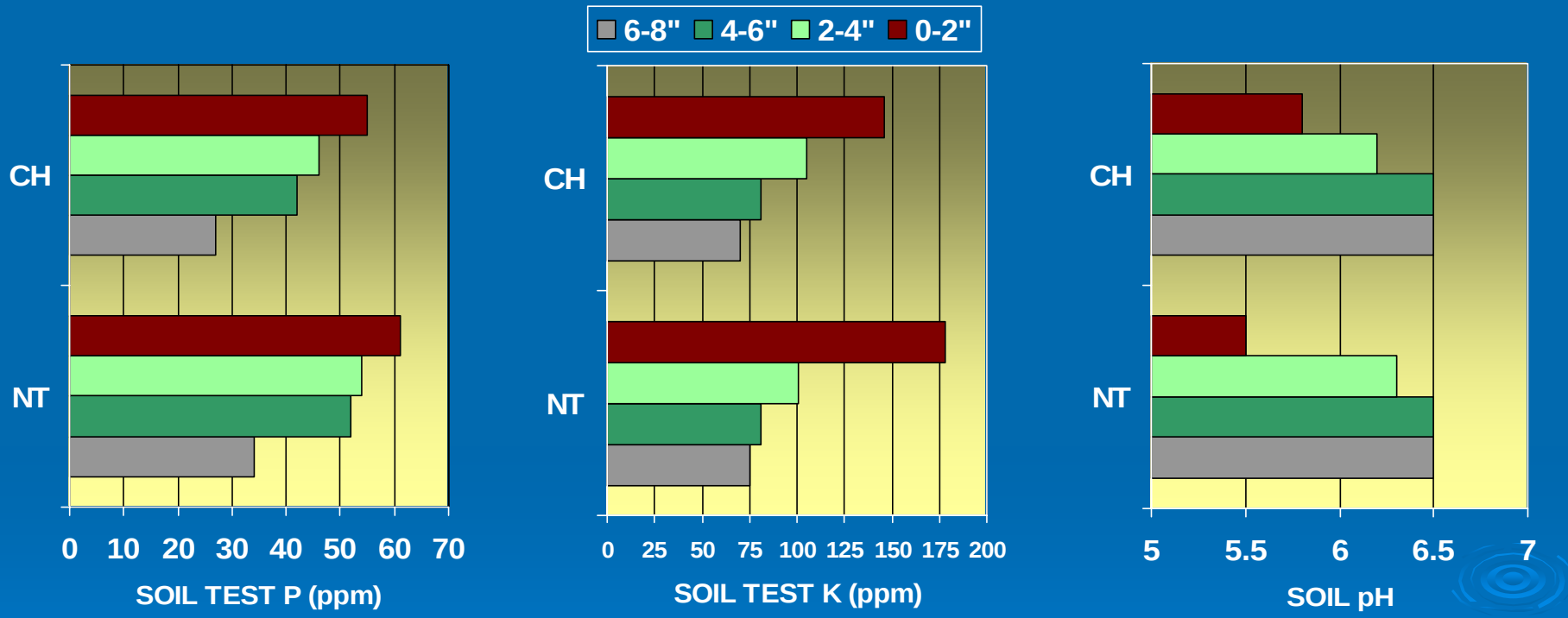

CROP MANAGEMENT EFFECT
EROSION ON CORN SILAGE
GROUND SHAWANO CO., WIS.

TILLAGE EFFECT ON SOIL TEST

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.

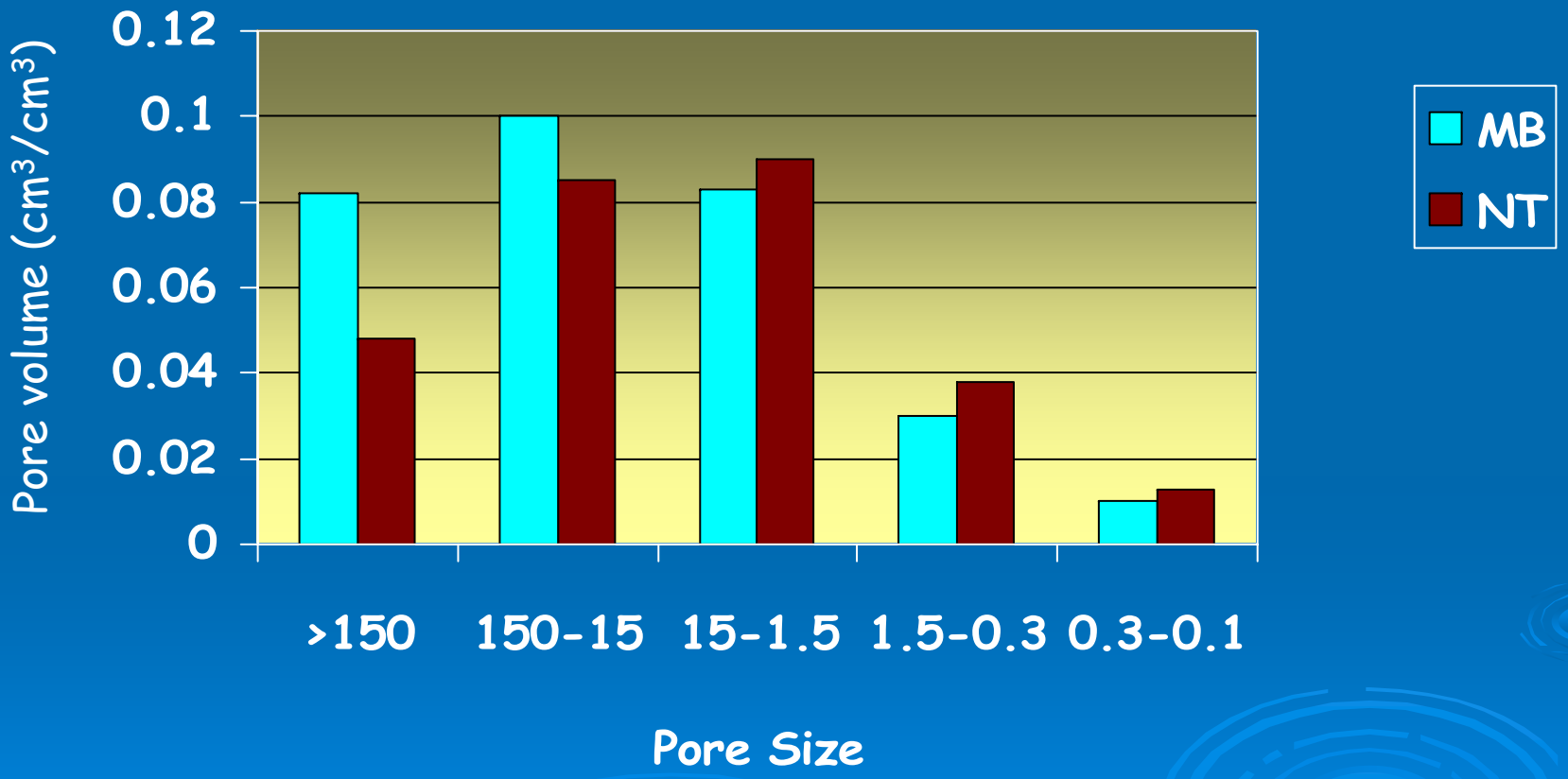


Wolkowski, 2003 (Corn/soybean rotation)

TILLAGE HAS A PROFOUND EFFECT ON THE SOIL PHYSICAL CONDITION

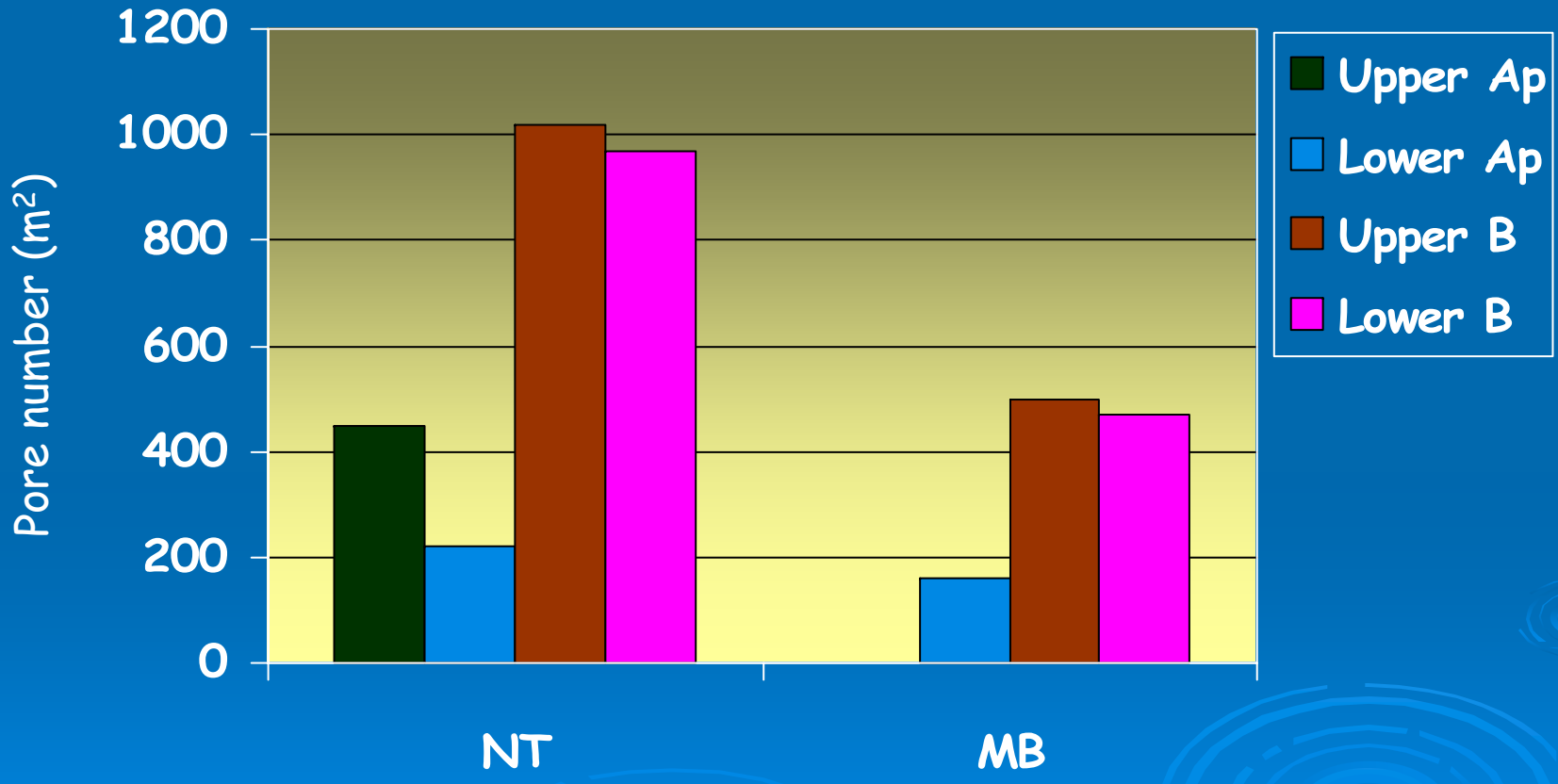
TEN BOTTOM MOLDBOARD PLOW SET AT 11”, WOOD CO., WIS.

EFFECTS OF LONG-TERM TILLAGE ON THE PLOW LAYER PORE SIZE DISTRIBUTION



Hill et al., 1985

EFFECTS OF TILLAGE MANAGEMENT ON MACRO-PORE (>0.4 mm) CONTINUITY



Lancaster, Wis.; continuous corn (Logsdon et al., 1990)

AGGREGATE STABILITY

- **INFLUENCED BY**
  - **Organic matter and organisms**
  - **Texture**
  - **Rotation**
  - **Tillage**
- **IMPORTANT FOR:**
  - **Aeration**
  - **Water relations**
  - **Productivity (Tilth)**

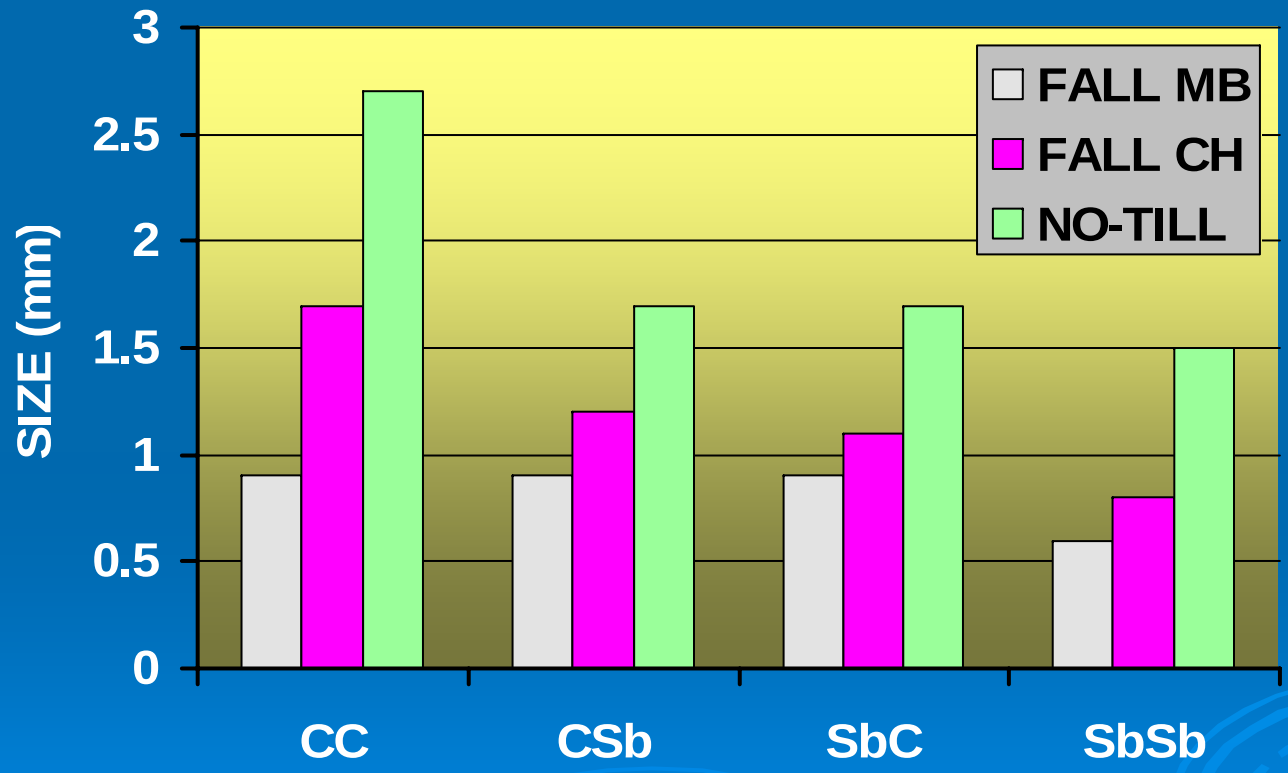

“HEALTHY” CORN ROOT MASS

TILLAGE EFFECTS ON SOIL (0-2 IN.) PROPERTIES AT LANCASTER, WIS.

TILLAGE	STAB. AGGR.	TOTAL C	EARTH WORMS
	%	g/kg	No./m^2
No-till	46	24	78
Chisel	34	16	52
Plow	36	11	53

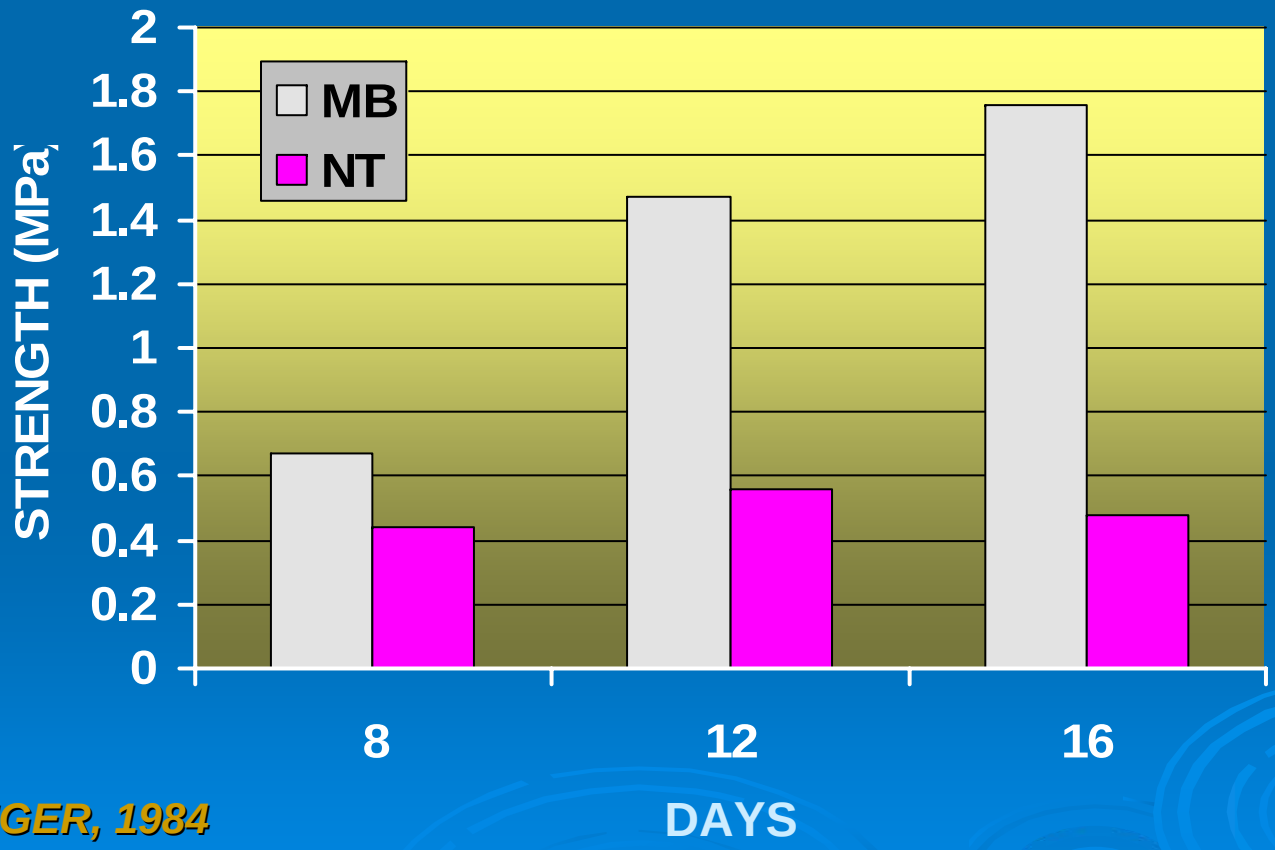
Karlen et al., 1994

WATER-STABLE AGGREGATE SIZE IN THE 0-3 IN. DEPTH AS AFFECTED BY ROTATION AND TILLAGE



Kladivko et al, 1986

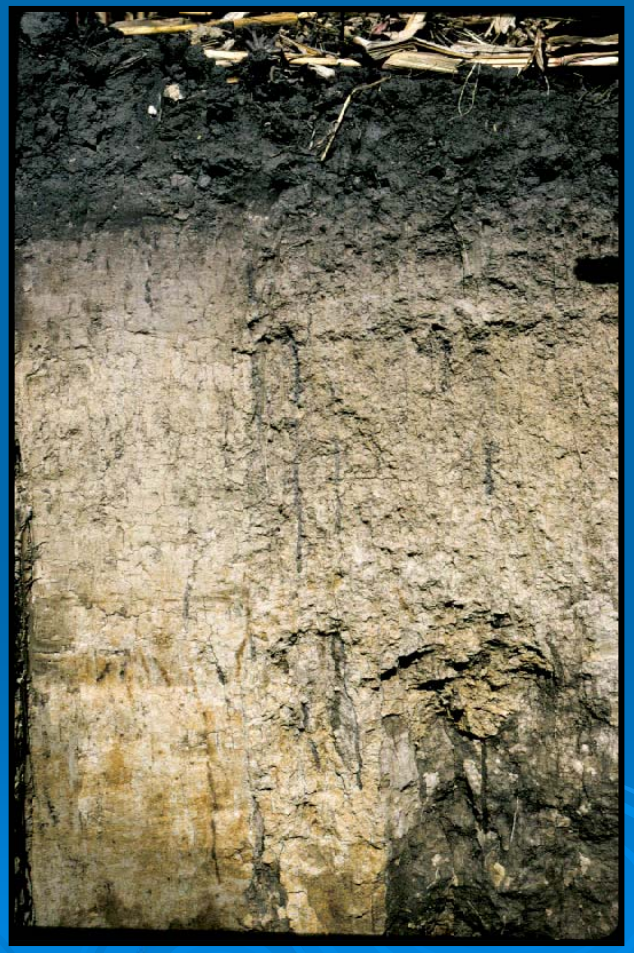
EFFECT OF TILLAGE ON CRUST STRENGTH AFTER A HEAVY RAINFALL



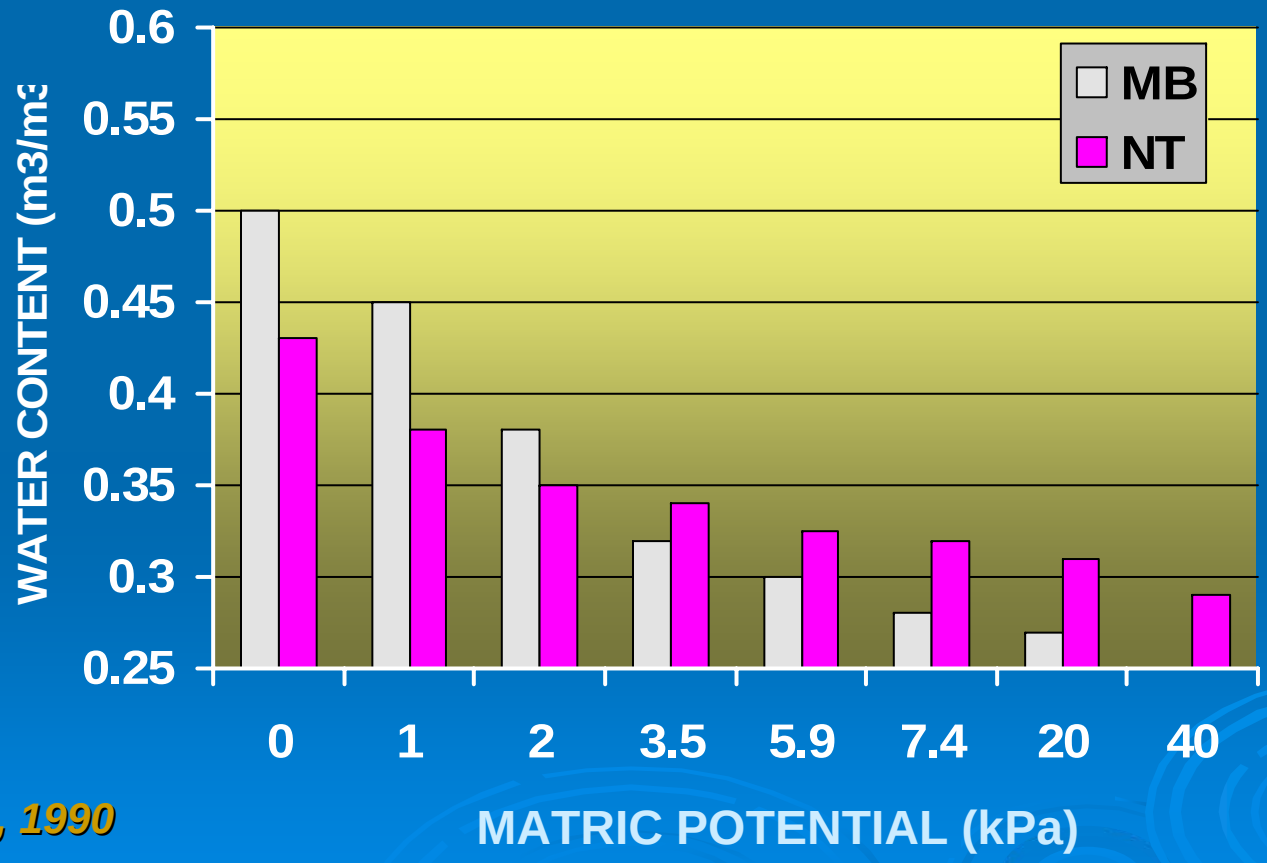
UNGER, 1984

TILLAGE EFFECTS ON SOIL WATER RELATIONSHIPS

- No-till soils tend to have lower porosity and higher water content
- Considerable variability by soil type
- Continuous channels in no-till can increase infiltration rate



RELATIONSHIP BETWEEN SOIL MATRIC POTENTIAL AND VOLUMETRIC WATER CONTENT



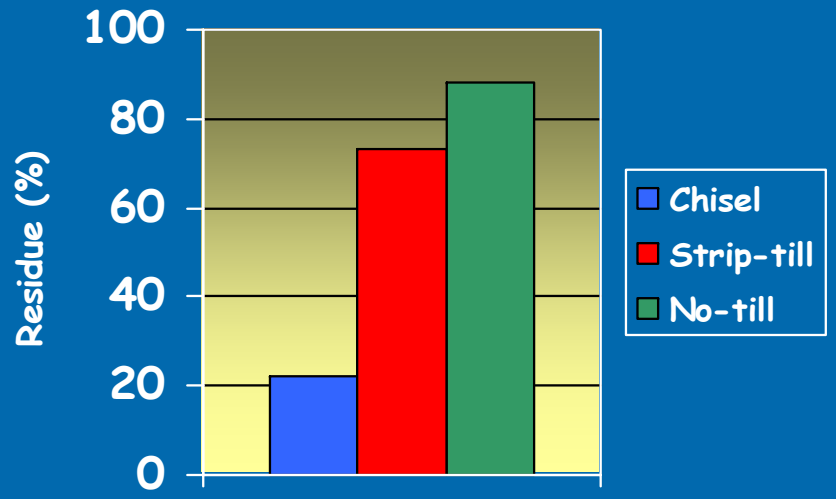
Hill, 1990

TILLAGE EFFECTS ON SOIL TEMPERATURE

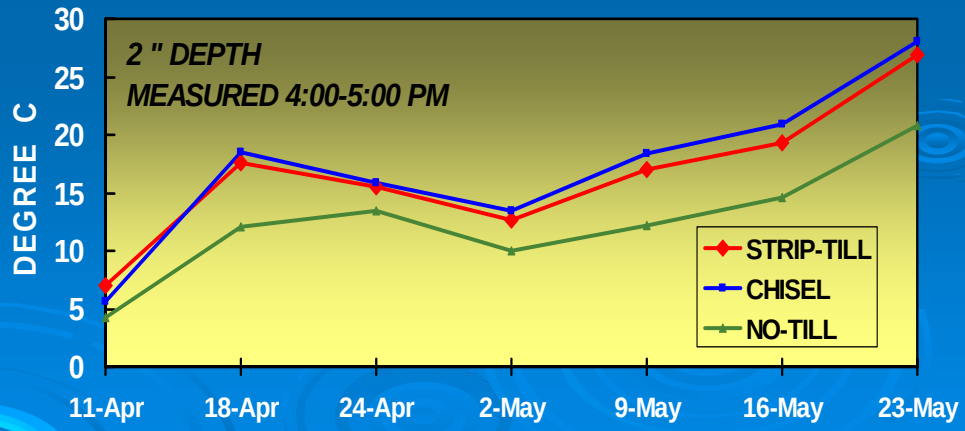
- **Cooler temperatures associated with high residue**
- **Residue buffers temperature change**
- **Emergence and early growth affected**
- **Corn on corn no-till systems have been shown to be 5-10% less productive in Wisconsin**

SOIL TEMPERATURE AFFECTED BY TILLAGE AND CROP RESIDUE

Effect on crop residue, Arlington, 1994



Effect on in-row soil temperature, Arlington, 1994



Wolkowski, 2000


STRIP TILLAGE OFFERS
AN ALTERNATIVE TO
FULL-WIDTH TILLAGE

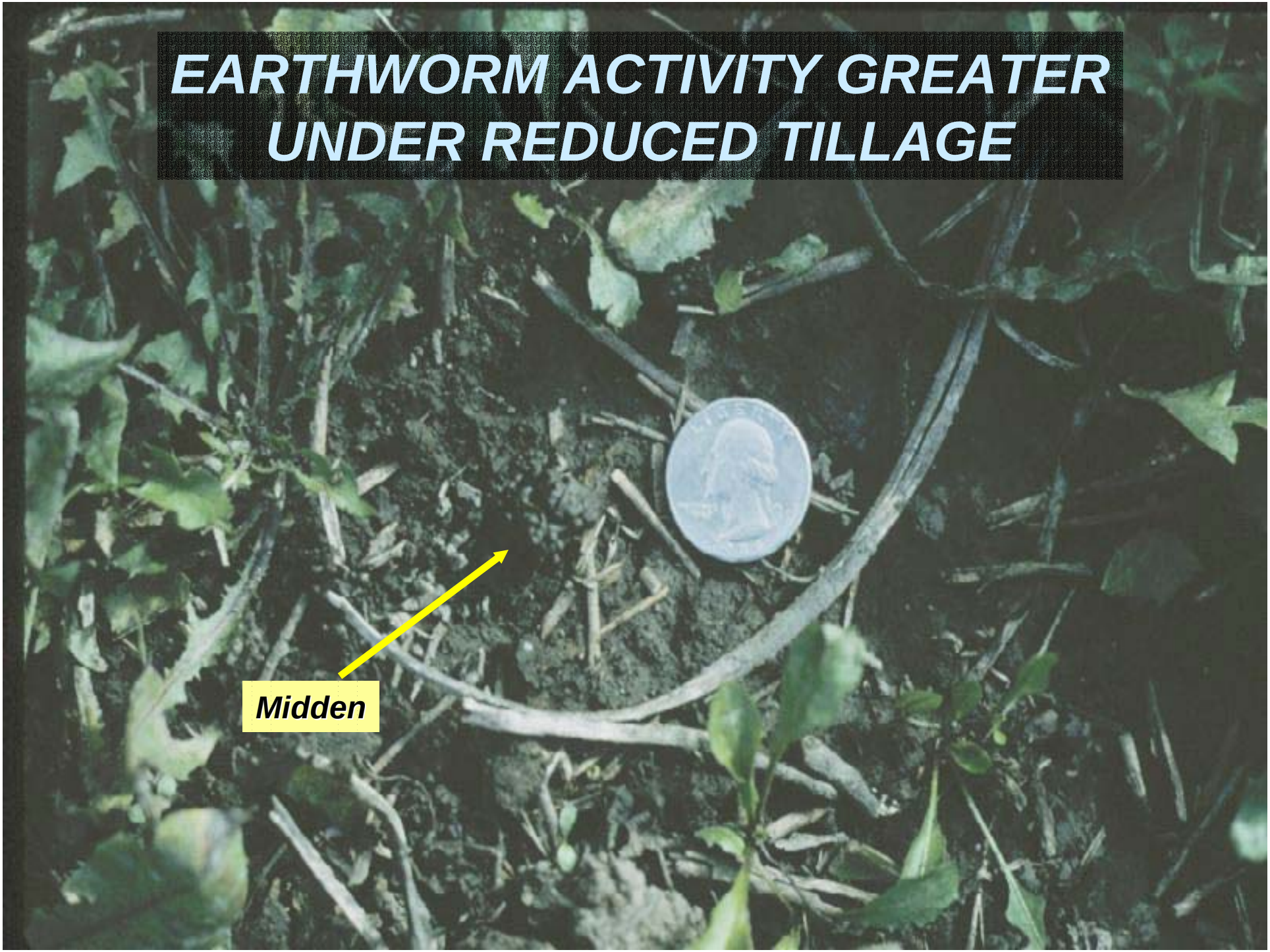
EFFECT OF TILLAGE ON THE EARLY GROWTH OF CORN, ARLINGTON, WIS.

TILLAGE	EMERGENCE	V6	V12	SILKING
	plt/ft	-------- g/plt --------		%
Strip-till	1.6	1.1	28	62
Chisel	1.8	1.1	29	80
No-till	0.7	0.7	18	36

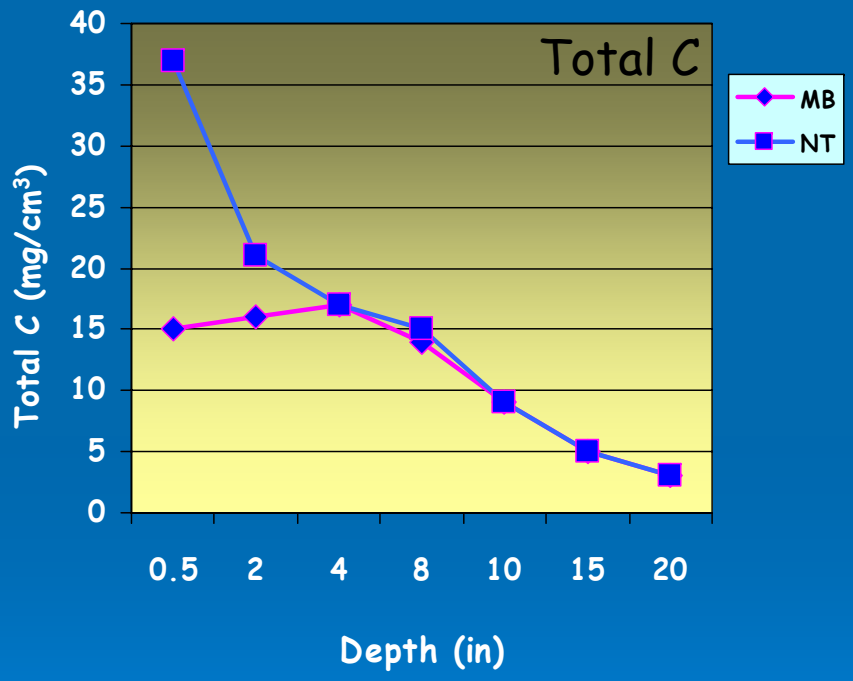
Wolkowski, 2000

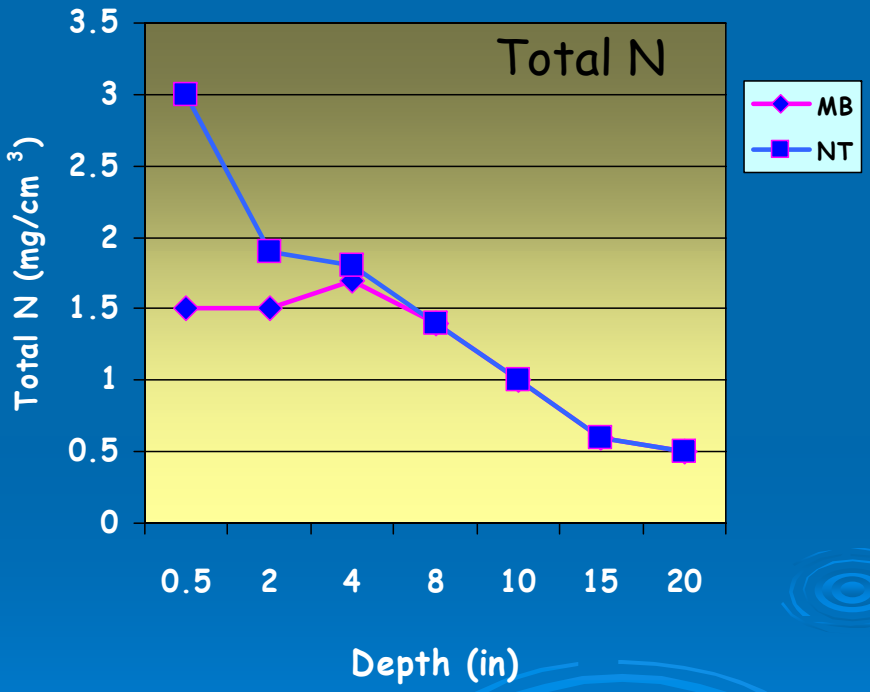
TILLAGE AFFECTS BIOLOGICAL ACTIVITY

- Cooler and wetter no-till soils
  - Slower residue decomposition
  - Nutrient immobilization
  - Greater denitrification potential
- Surface organic material promotes localized biological activity


EARTHWORM ACTIVITY GREATER UNDER REDUCED TILLAGE
Midden

SOIL C AND N DISTRIBUTION AFTER 12 YEARS OF CONTINUOUS CORN





Karlen et al., 1994

TILLAGE EFFECTS ON SOIL STRENGTH

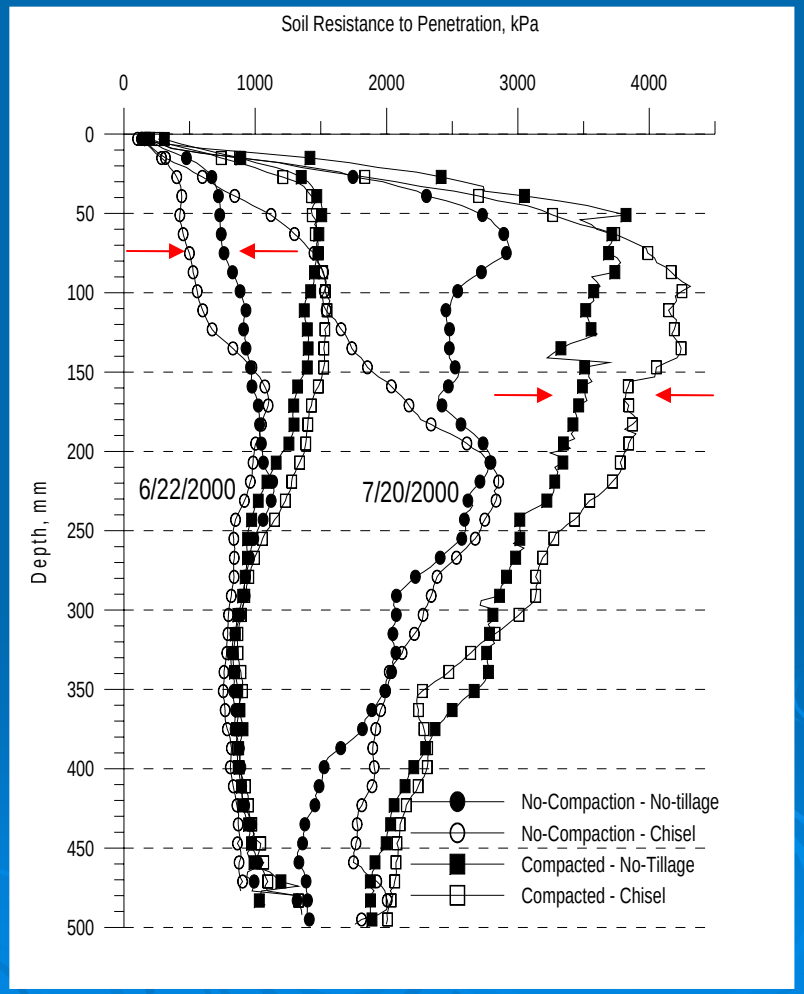
- **Reduced tillage soils have higher surface bulk density and penetration resistance**
- **Short-term response to occasional tillage**
- **Traffic management critical**
- **Subsoiling response is likely site dependent**

TILLAGE INFLUENCES RESISTANCE TO PENETRATION

- Greater penetration resistance in no-till in top 6” compared to chisel when not compacted
- Compacted chiseled soil has greater resistance than no-till
- Greater penetration resistance when soil is dry
- Compaction effects more distinct in dryer soil

  dry (36 % vs. 27 %)

Arlington, Plano silt loam



SOIL PHYSICAL PROPERTIES AND CORN YIELD AS AFFECTED BY TRACKED AND WHEELED VEHICLES

TYPE	BULK DENSITY	HYDR. COND.	AIR-FILLED PORE SPACE	YIELD
	g/cc	uM/sec	%	Bu/a
Un-tracked	1.28	26.0	17.8	166
Steel-tracked	1.38	13.0	9.7	148
Rubber-tracked	1.46	7.8	7.7	--
Wheel-tracked	1.50	2.7	4.7	139

Brown et al., 1992

Would these guys be smiling if they really knew how much pressure this grain cart put on the ground (800 bu x 56 lb = 44,800 lb)

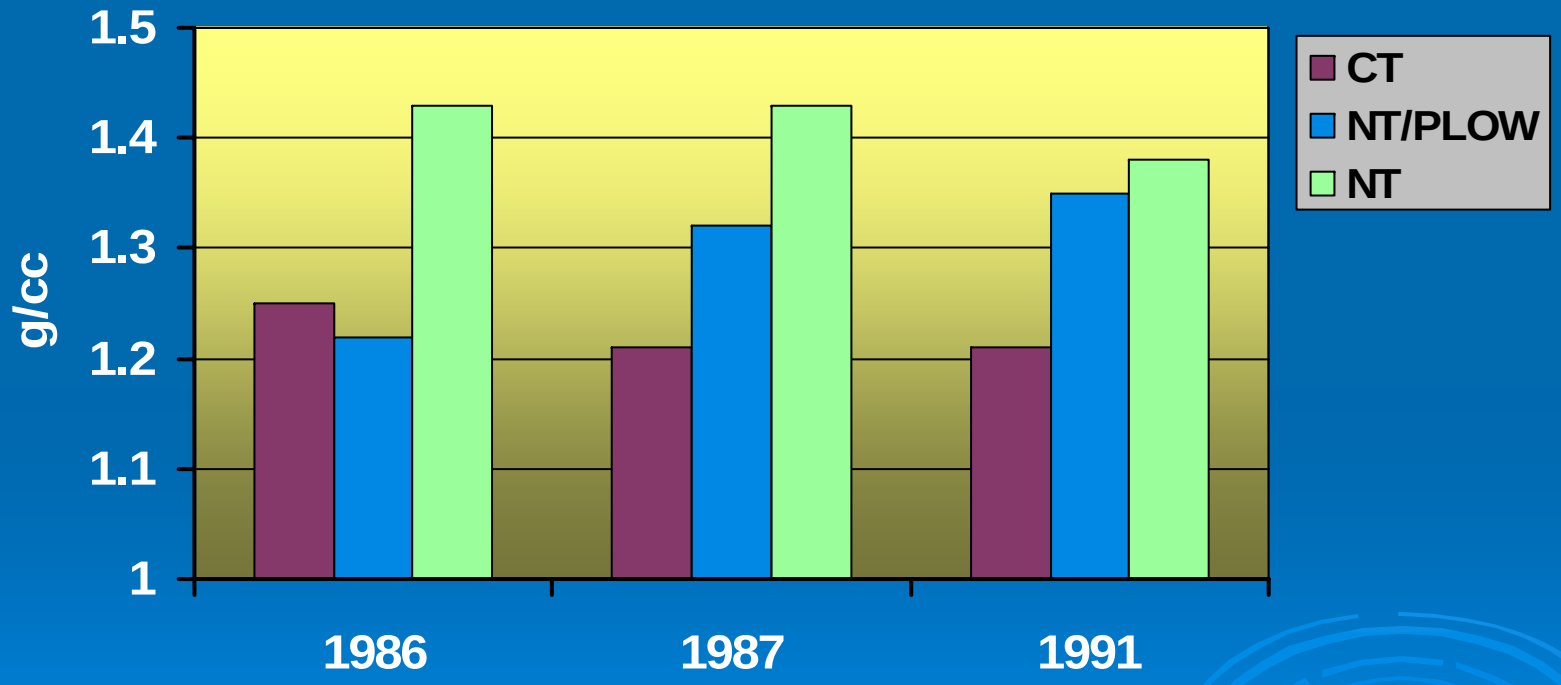
Compaction affects the soil

- structure
- porosity
- aeration
- strength

Plant growth affected

- root growth
- nutrient uptake
- water utilization

EFFECT OF PERIODIC PLOWING ON SOIL BULK DENSITY (0-3 in.)



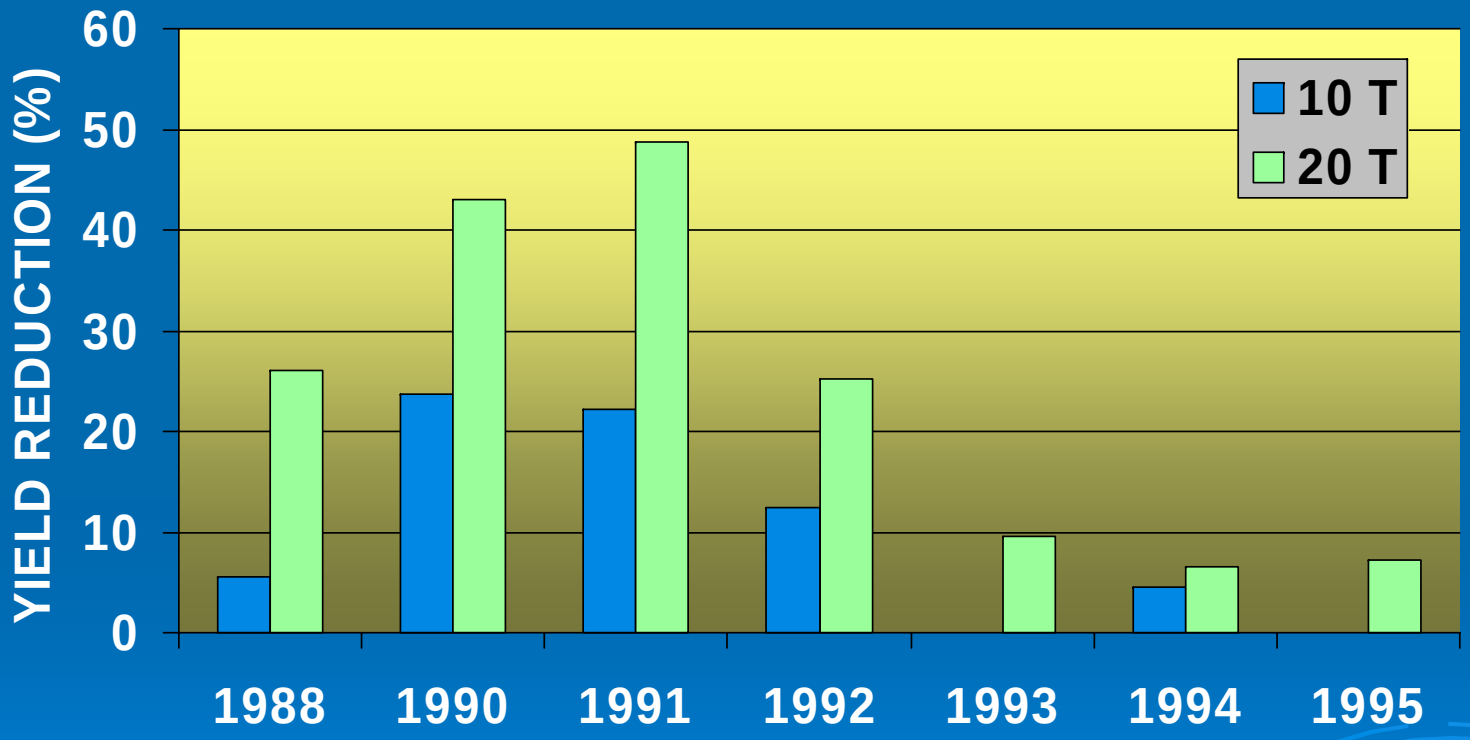
Pierce et al., 1994

CORN AND SOYBEAN YIELD AS AFFECTED BY DEEP TILLAGE, MANITOWOC, WIS.

TILLAGE	SOYBEAN 1997	CORN 1998	SOYBEAN 1999	CORN 2000
	---------- bu/a ----------			
NT	30	213	57	176
VR	40	188	58	172
ZB	51*	226*	59	192*

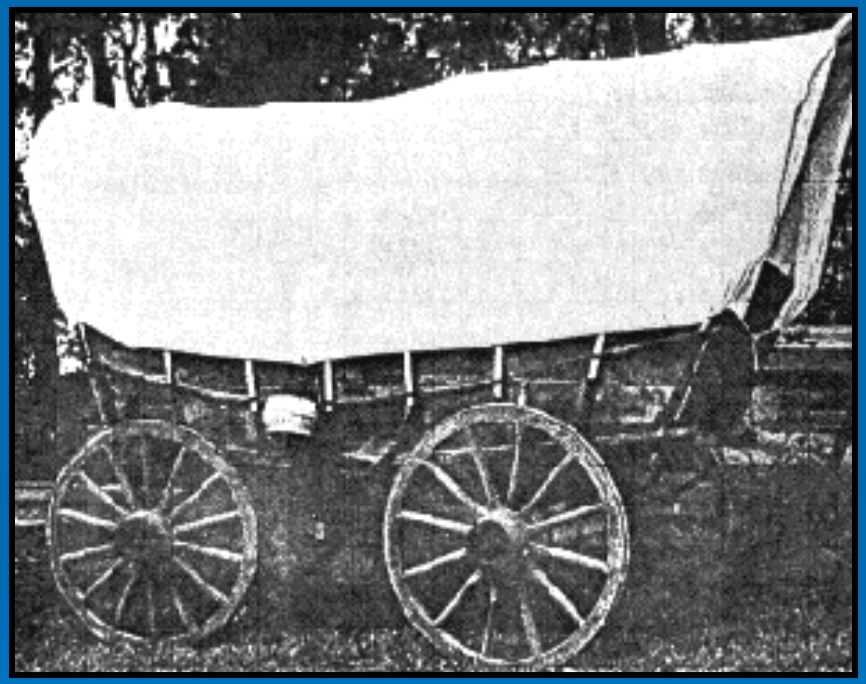
Wolkowski (unpublished)

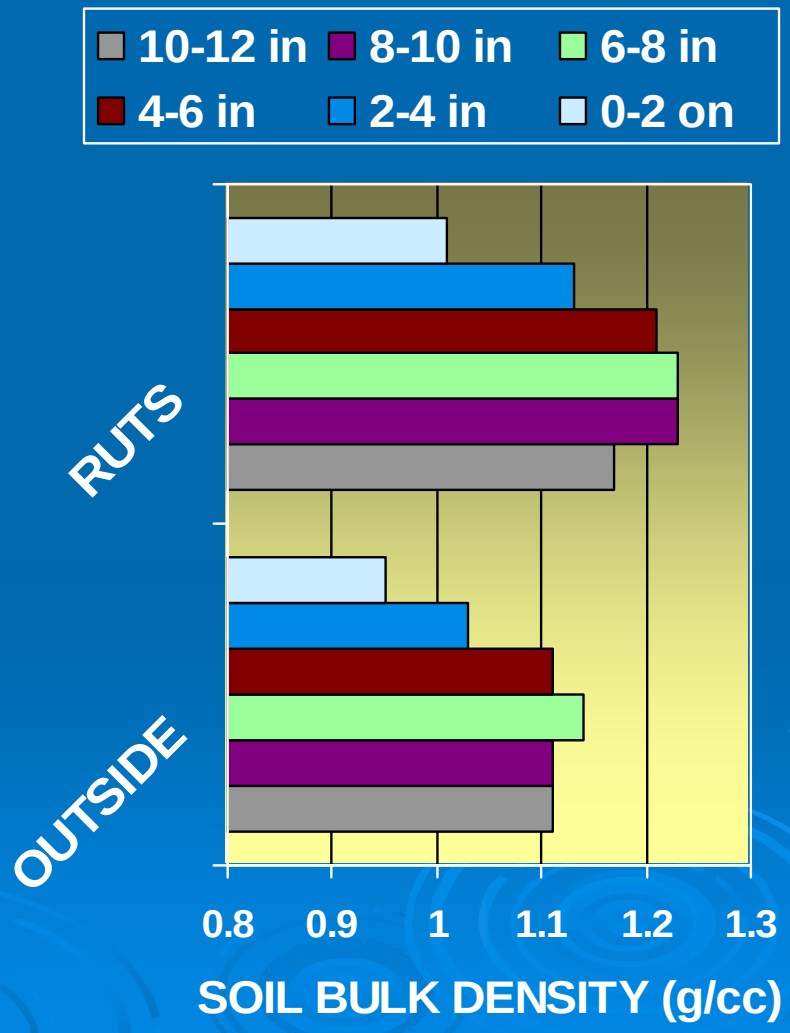
NATURAL ALLEVIATION OF COMPACTION ON A SILTY CLAY LOAM SOIL



Al-Adawi and Reeder, 1996

PERSISTANCE OF COMPACTION ALONG THE WADSWORTH TRAIL, MINNESOTA





Sharratt et al., 1998

SUMMARY

- Tillage management can greatly modify soil properties related to soil quality and crop growth
- Tillage intensity will impact residue management and soil consolidation
- Many physical, chemical, and biological properties are affected
- High residue systems need “tweaking” in Wisconsin
- Better traffic and tillage management will enhance soil quality and maintain productivity