ADDRESSING THE SOIL COMPACTION PROBLEM

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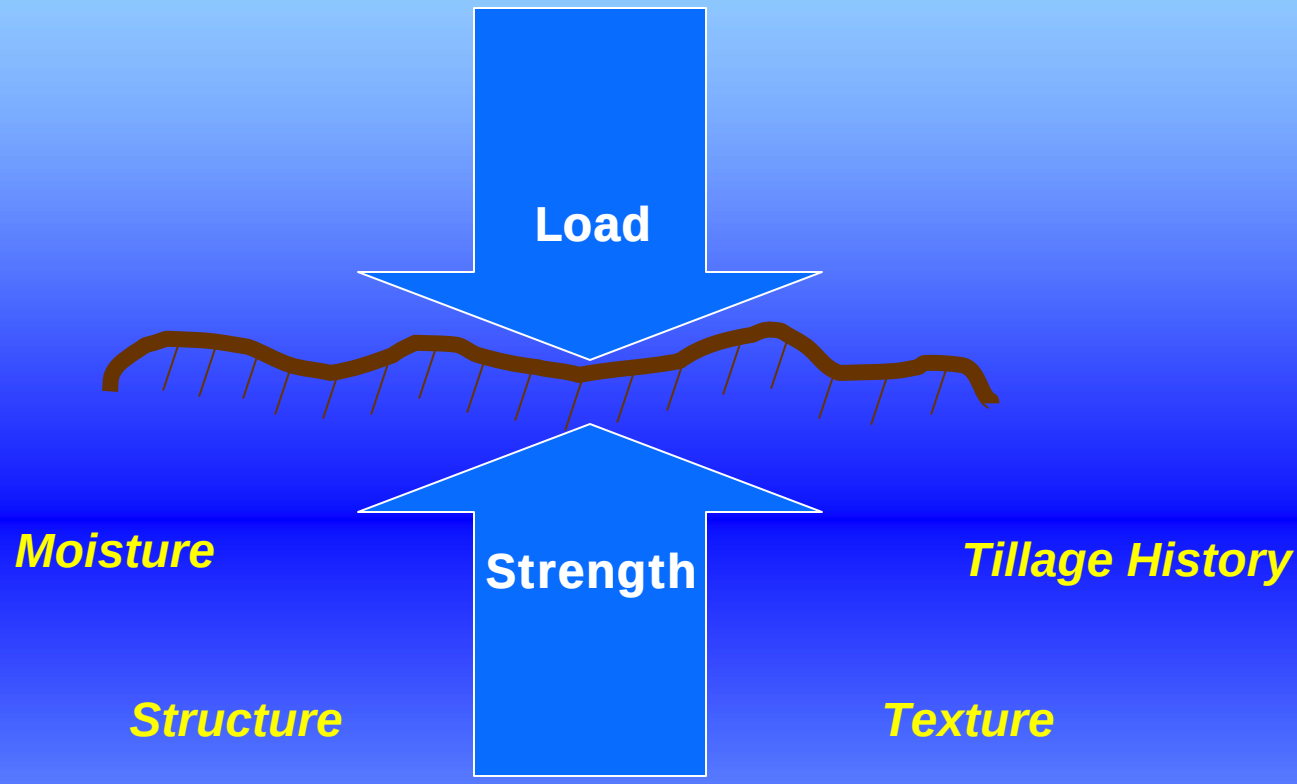
SOIL COMPACTION DEFINED

Compression of the soil from an applied force that first re-arranges and then destroys aggregates increasing bulk density and reducing porosity

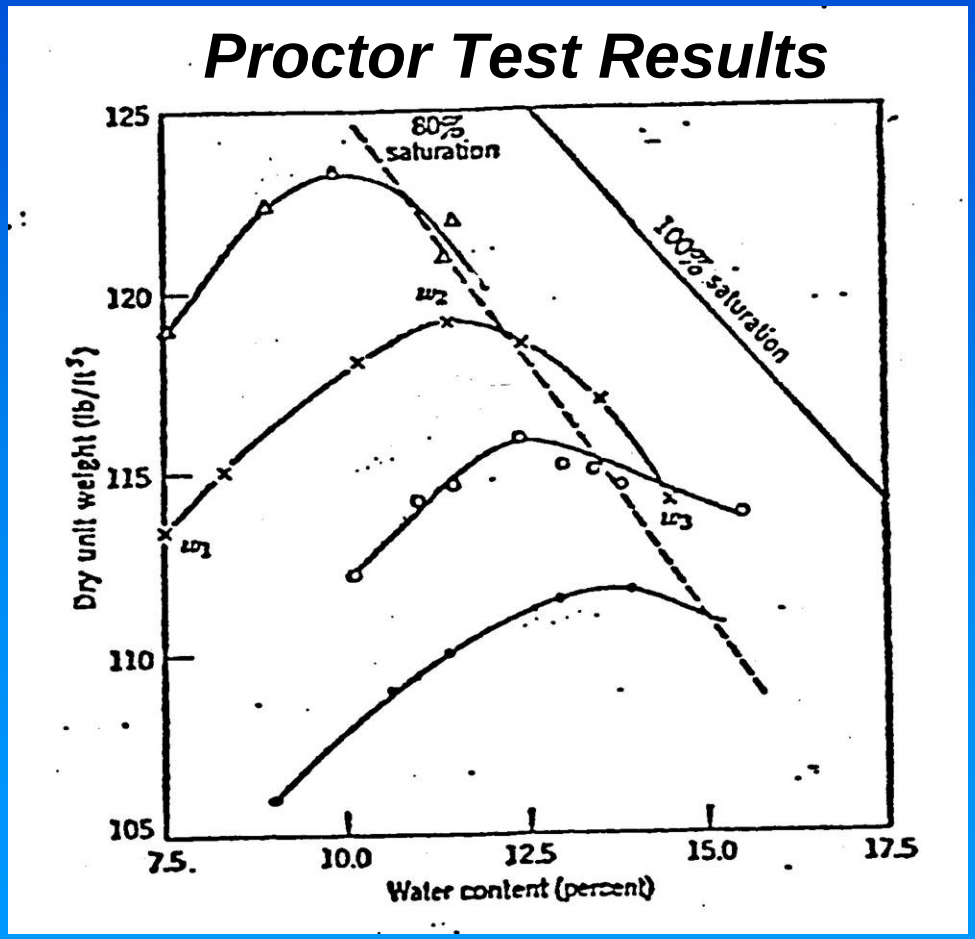
- **Wheel traffic from field operations**
- **Tillage**
- **Livestock**



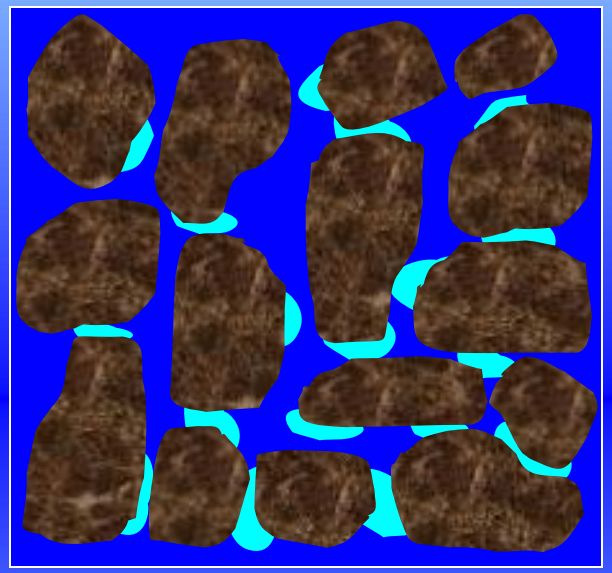
Soil compacts when load-bearing strength of soil is less than load being applied.

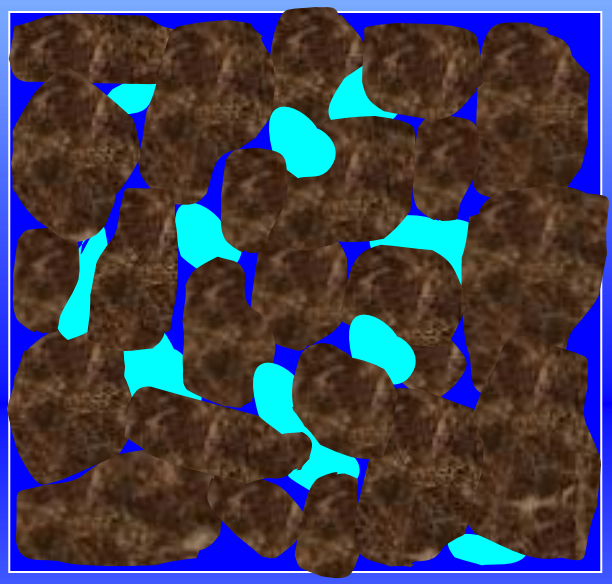
"COMPACTABILITY" INFLUENCED BY WATER CONTENT

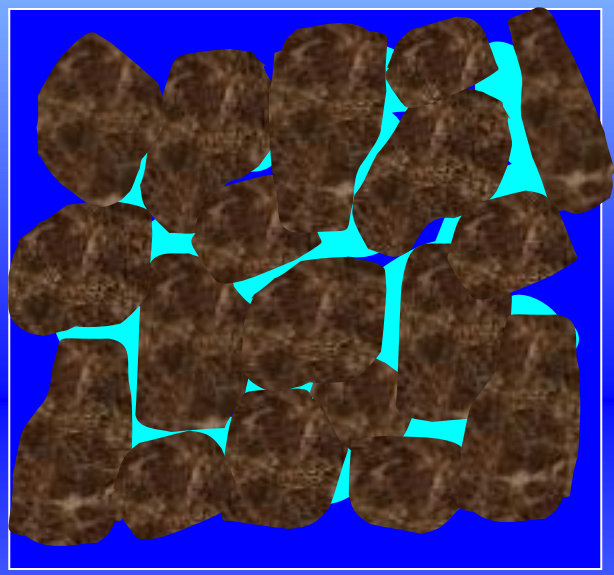
- Varies by soil
- Maximum near field capacity
- Dry soil has more strength
- Saturated soil not as compactable



COMPACTION IS A PROCESS







D_b = 1.0

- Large aggregates
- Loose condition
- Many large pores
- Well aerated
- Just after tillage

D_b = 1.3

- Firm condition
- Few large pores
- Moderate aeration
- Typical silt loam
- Following normal traffic

D_b = 1.6

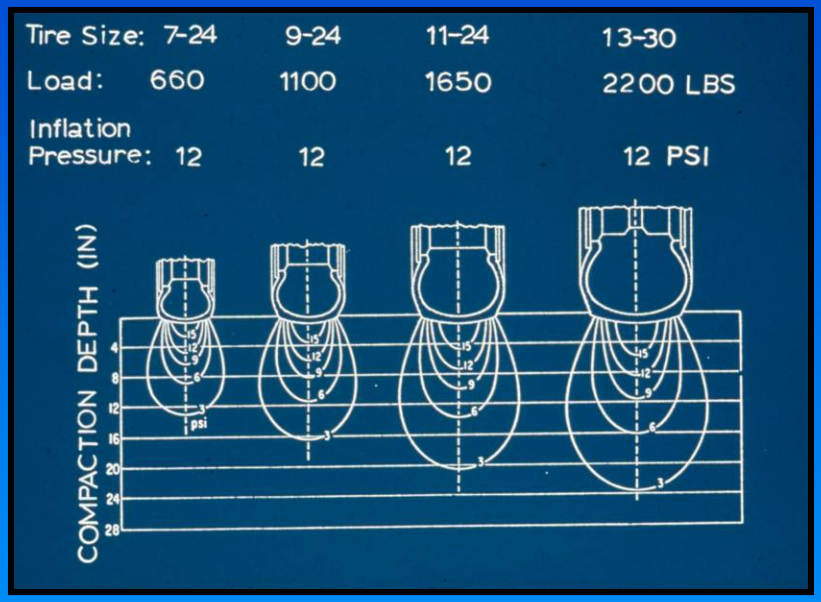
- Very tight, compact
- No large pores
- Small pores are water-filled
- Crushed aggregates

WHY IS COMPACTION AN ISSUE

- Larger equipment
- Earlier field operations
- Loss of forage in rotation
- Operations on wet soils
- Time management
- Uncontrolled traffic
- Brain cramps


Will more tires spread weight … or allow operations in wetter conditions and compact a greater soil volume ?

WHICH IS WORSE – PRESSURE OR LOAD?

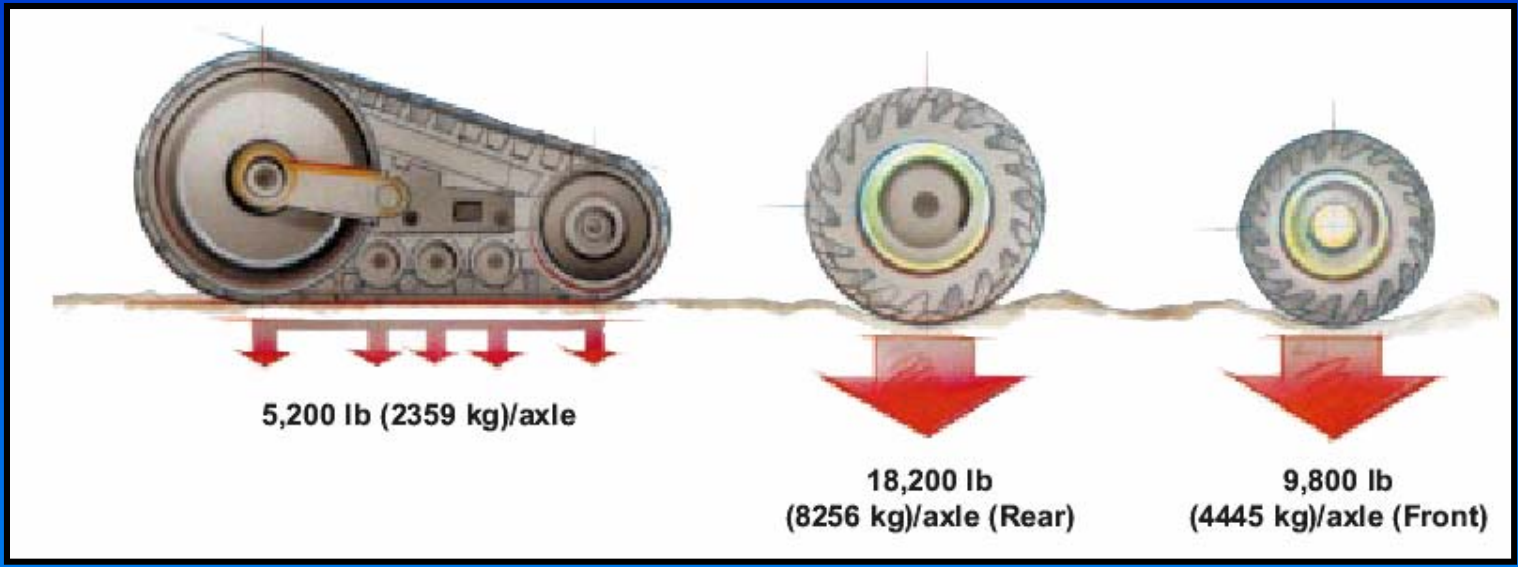


High PSI, but small load

Low PSI, but large load

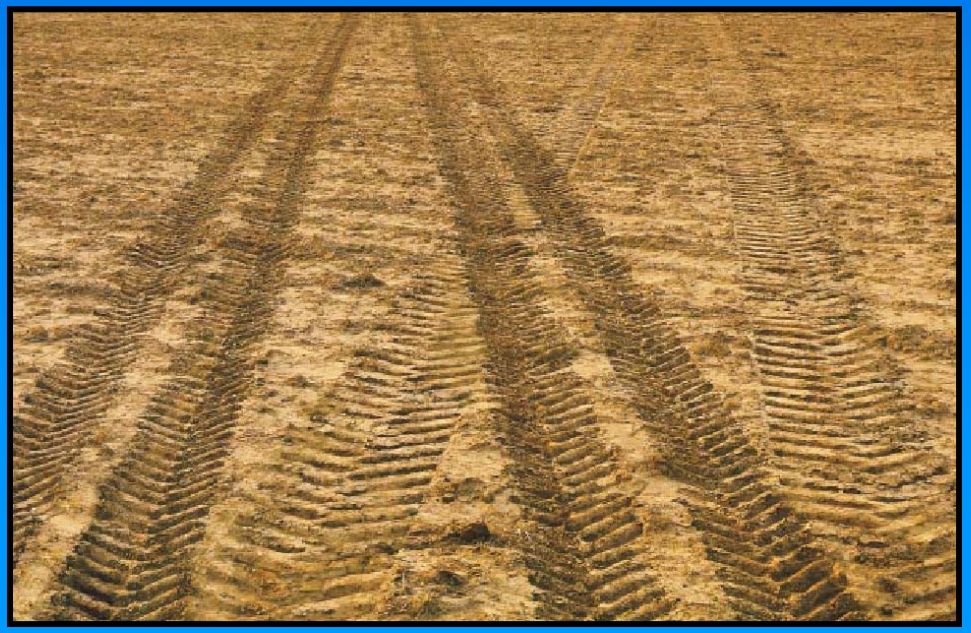
THE GREATER THE LOAD THE DEEPER THE COMPACTION EFFECT

TRACKS vs. TIRES



Compare total load per axle

Track have many axles




I'VE GOT PLENTY OF COMMON SENSE!
I JUST CHOOSE TO IGNORE IT.
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WATTERSON


There really are days you shouldn’t be in the field !

Series 1958, No. 12 Issued December 1961

Chasing the combine is an old habit

SOIL SURVEY

Greeley County, Kansas


CONTROL PHEASANTS
COMPACTION BY
UNLOADING IN HEADLANDS

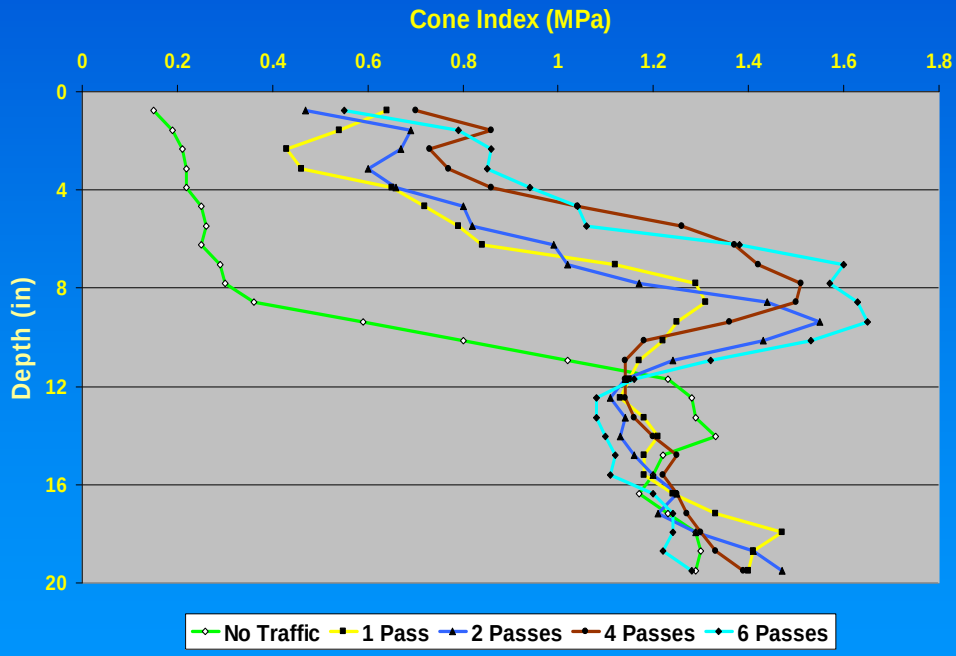
MOST OF THE COMPACTION OCCURS IN THE FIRST PASS

- Plano silt loam
- Soil near field capacity (34 – 38%)
- 2007 NT w. wheat
  2006 NT corn silage following alfalfa
- Chisel vs. None
- No traffic or 1, 2, 4, and 6 passes with a 14.5 ton combine
- 6 measurements per treatment

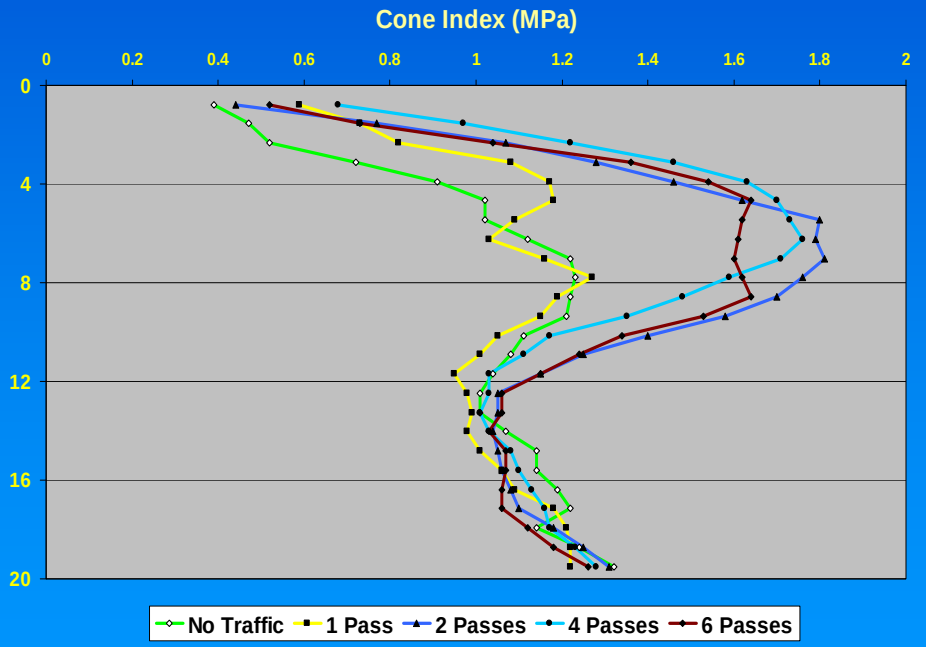
Arlington Evaluation

EFFECT OF NUMBER OF WHEEL TRAFFIC PASSES ON SOIL COMPACTION

Chisel Plowed



Not Plowed



COMMOM SYMPTOMS OF SOIL COMPACTION

SOIL:

- **Standing water**
- **Excessive runoff**
- **Structural degradation (clods)**
- **Difficult to work**

PLANTS:

- **Stunting/uneven growth**
- **Nutrient deficiency symptoms**
- **Malformed roots**
- **Reduced yield**

Pea harvest: Vegetable crop contracts often lead to soil abuse


Utility construction projects

“Cloddy” soil following corn silage harvest


Cloddiness re-defined


Stunted, uneven stand is often the first symptom


The shovel is an excellent diagnostic tool

GROWERS ARE INTERESTED IN COMPACTION MANAGEMENT

Northeast Wis. field day


Excavated
plow layer

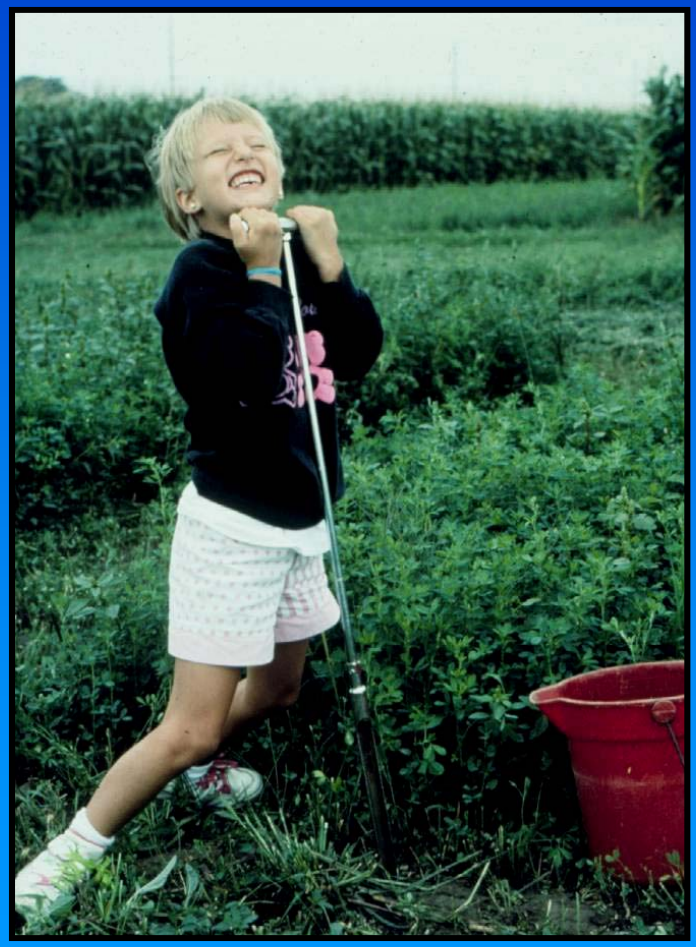

“Pancake”
root mass

QUANTIFYING COMPACTION

- **CROP AND SOIL SYMPTOMS**
- **PENETRATION RESISTANCE**
  - Moisture dependent
  - No absolute value
  - Note depth and relative force
  - Compare good and bad areas
- **BULK DENSITY**
  - Mass per volume
  - Calculate porosity
  - Texture dependent

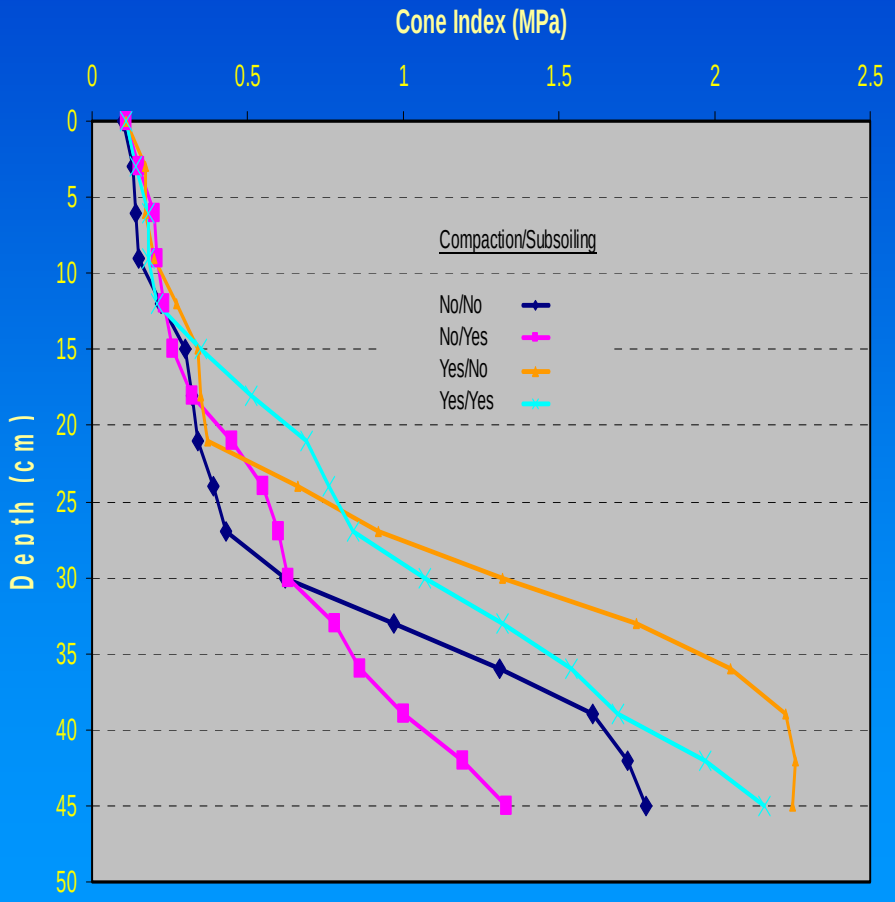
MEASURING PENETRATION RESISTANCE

Hand-held penetrometer

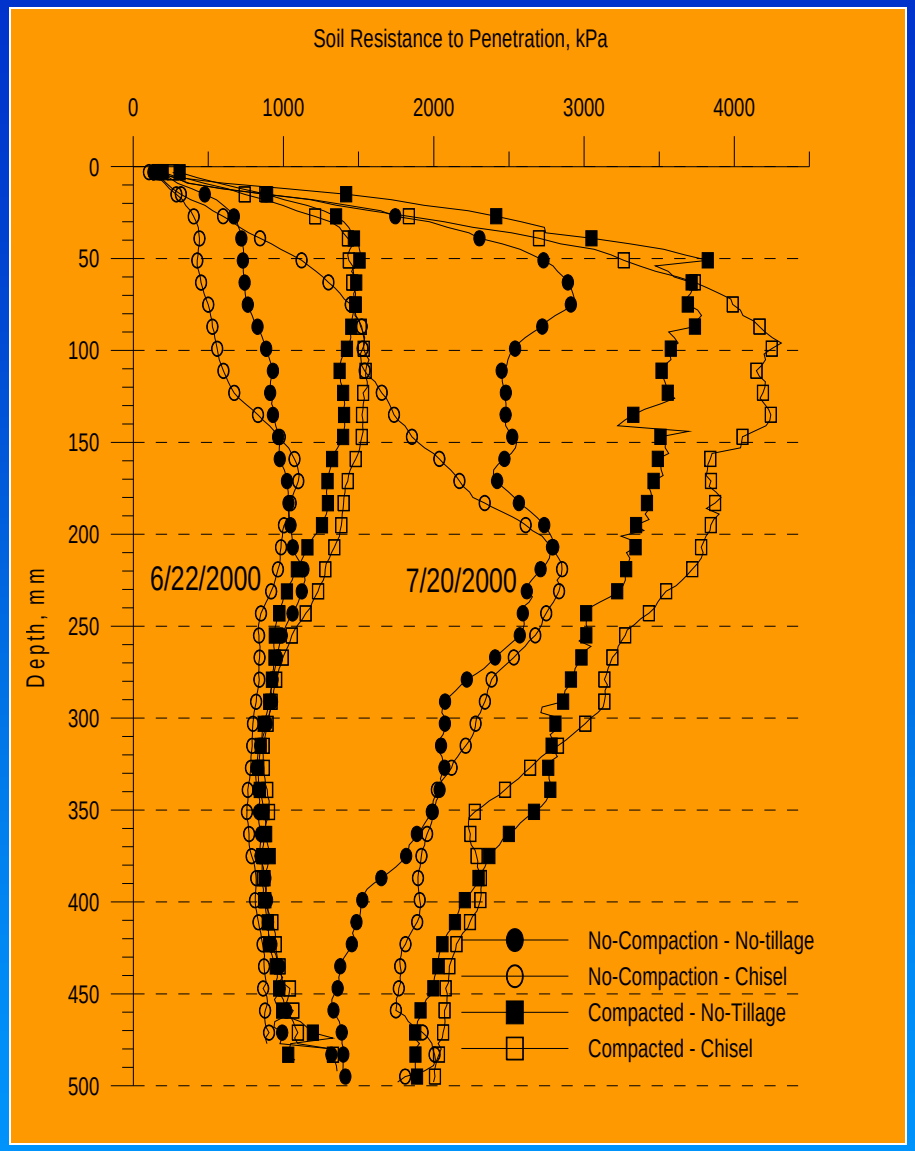


Soil probe

CONSTANT-RATE RECORDING PENETROMETER



Response of a Plainfield sand to compaction and deep tillage, Hancock, Wis.



SOIL WATER CONTENT AFFECTS PENETRATION RESISTANCE.

ARLINGTON, WIS.
PLANO SILT LOAM SOIL

6/22/2000
Avg. water content = 36 %

7/20/2000
Avg. water content = 27 %

EFFECT OF COMPACTION ON SOIL BULK DENSITY OF A PLANO SILT LOAM

DEPTH	COMPACTION	YEAR 1	YEAR 2	YEAR 3
in		---------- g/cc ----------		
0 – 6	NO	1.19	1.30	1.32
	YES	1.36	1.40	1.40
6 - 12	NO	1.31	1.33	1.31
	YES	1.59	1.50	1.52
12 - 18	NO	1.19	1.35	1.33
	YES	1.45	1.44	1.33
18 - 24	NO	1.36	1.35	1.34
	YES	1.40	1.34	1.33

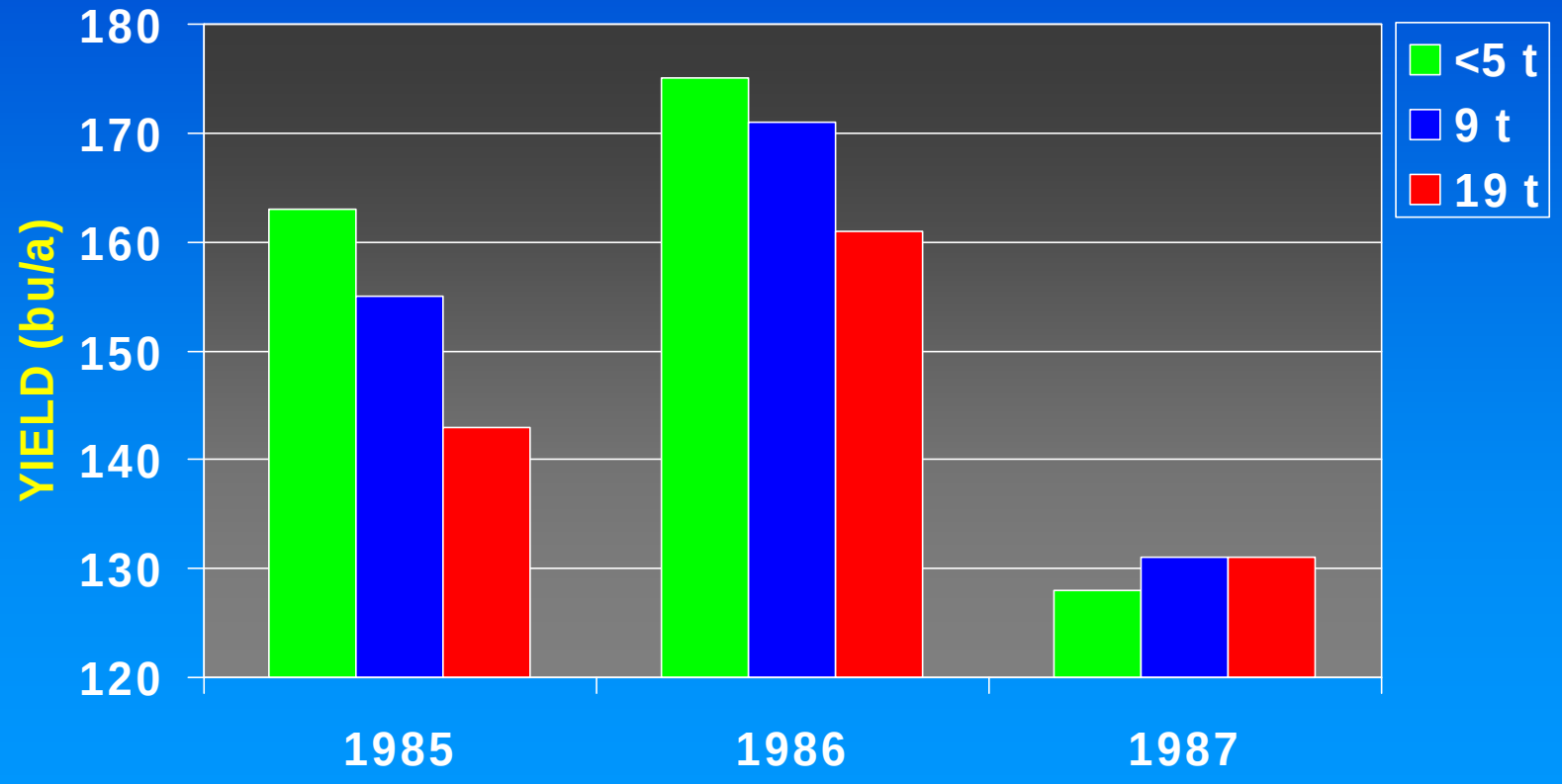
Compacted in year 1 and seeded to alfalfa

COMPACTION AFFECTS NUTRIENT UPTAKE

Potassium Affected Most

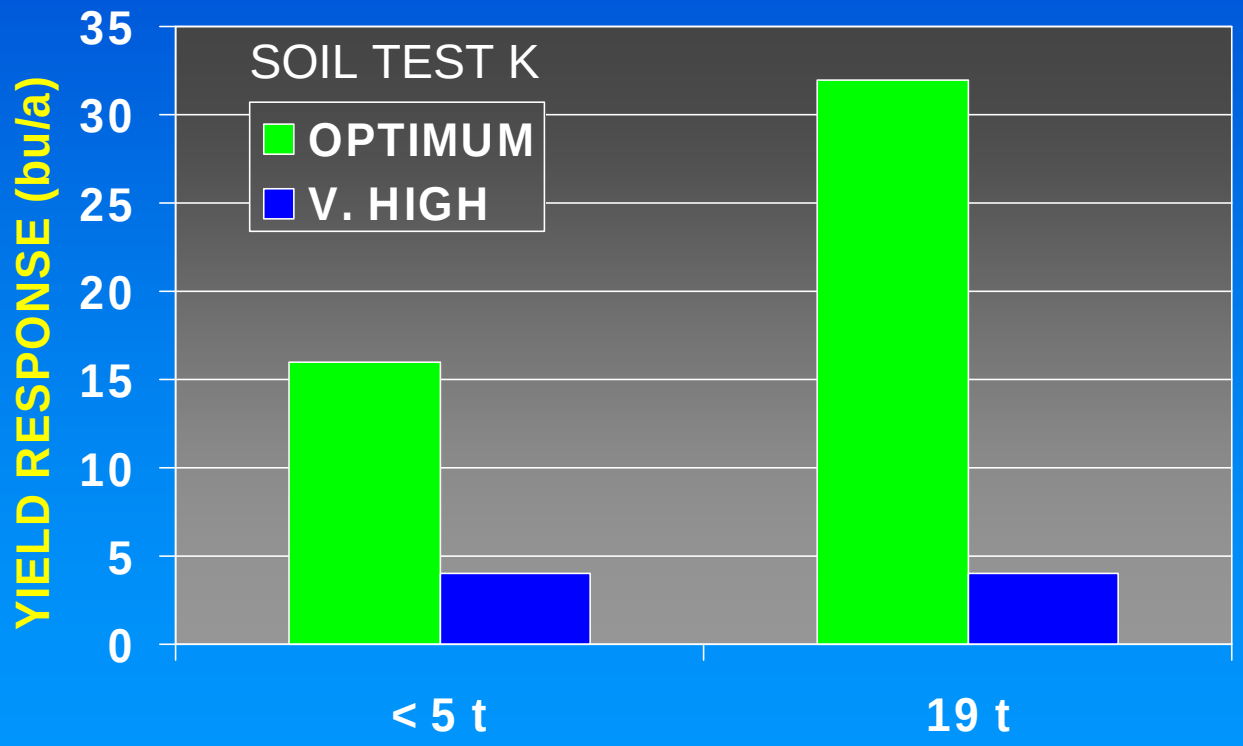
- Compaction reduces porosity
- Lowers soil oxygen
- O_2 needed for root respiration and active uptake

COMPACTION EFFECT ON CORN YIELD ON A SILTY CLAY LOAM SOIL



Oshkosh, Wis.

RESPONSE OF CORN TO ROW-APPLIED K ON A SILTY CLAY LOAM SOIL (3 yr. avg.)



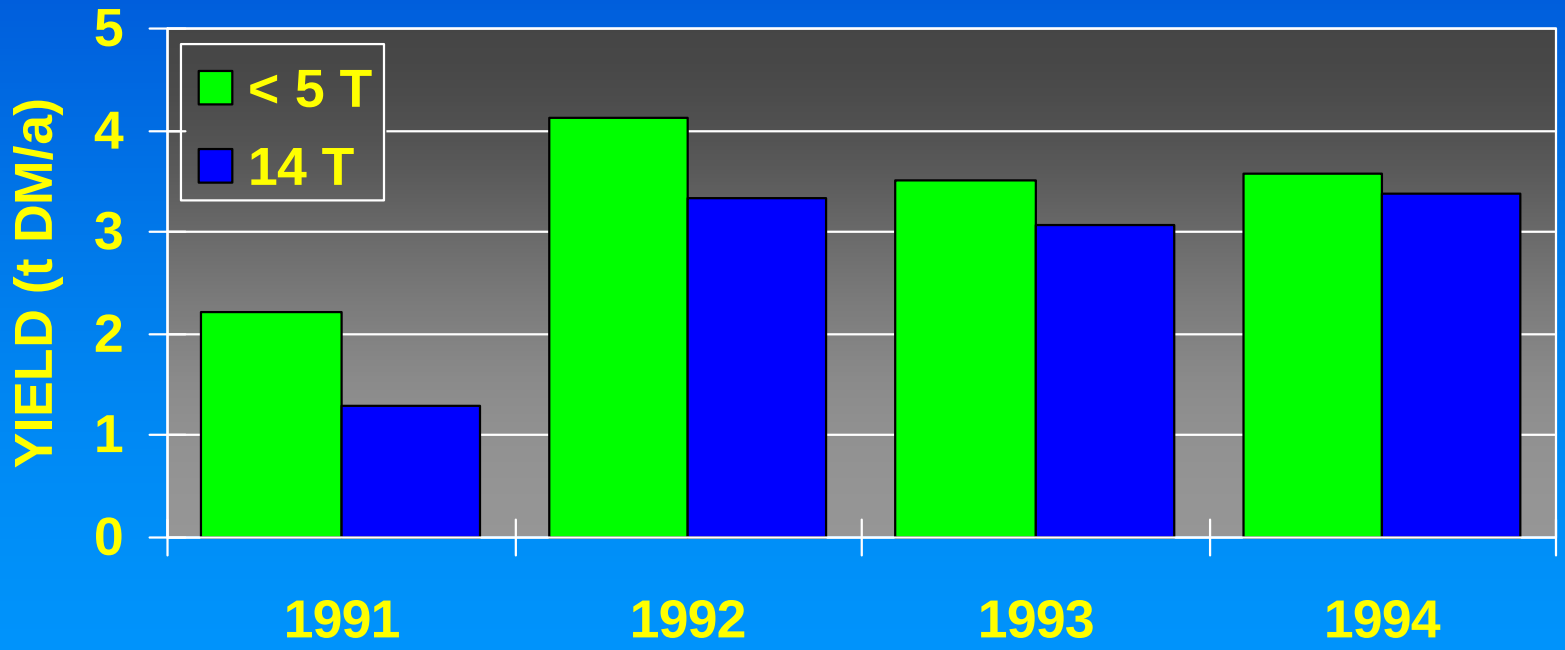
Oshkosh, Wis. (45 lb $K_2$0/a)

IS COMPACTION A PROBLEM IN FORAGE PRODUCTION

- Compaction limits growth and yield
- Potential high in forage production
  - Fertilizer and lime applications
  - Liquid manure
  - Normal management = many traffic passes
  - Harvest on wet soils
- K/compaction relationship
- Alfalfa has a high K need

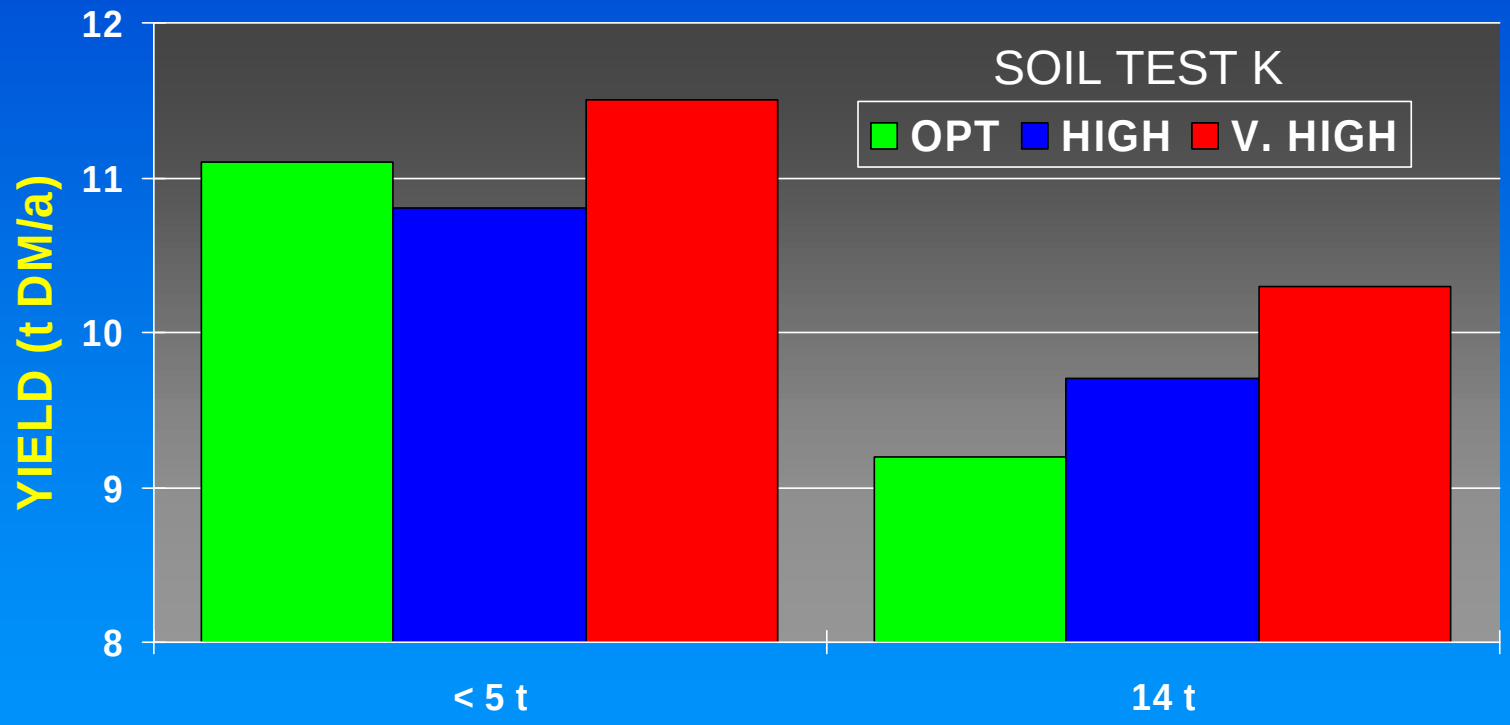

Alfalfa winter-kill resulting from wheel traffic

EFFECT OF COMPACTION ON ALFALFA YIELD ON A SILT LOAM SOIL



Arlington, Wis.

K SOIL TEST AND ALFALFA YIELD ON A COMPACTED SOIL (sum of 3 yrs.)



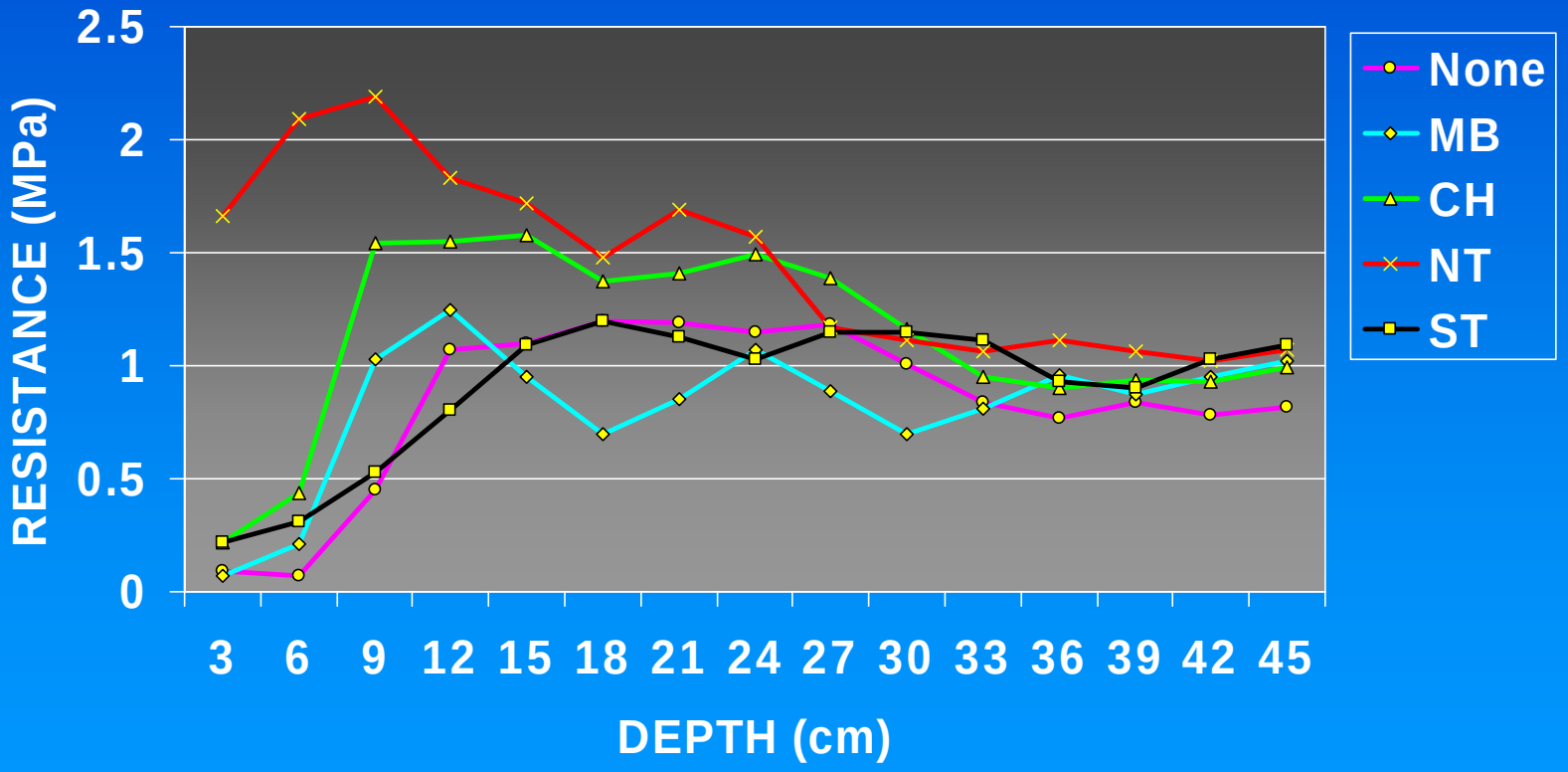
Arlington, Wis.

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 not a cure-all

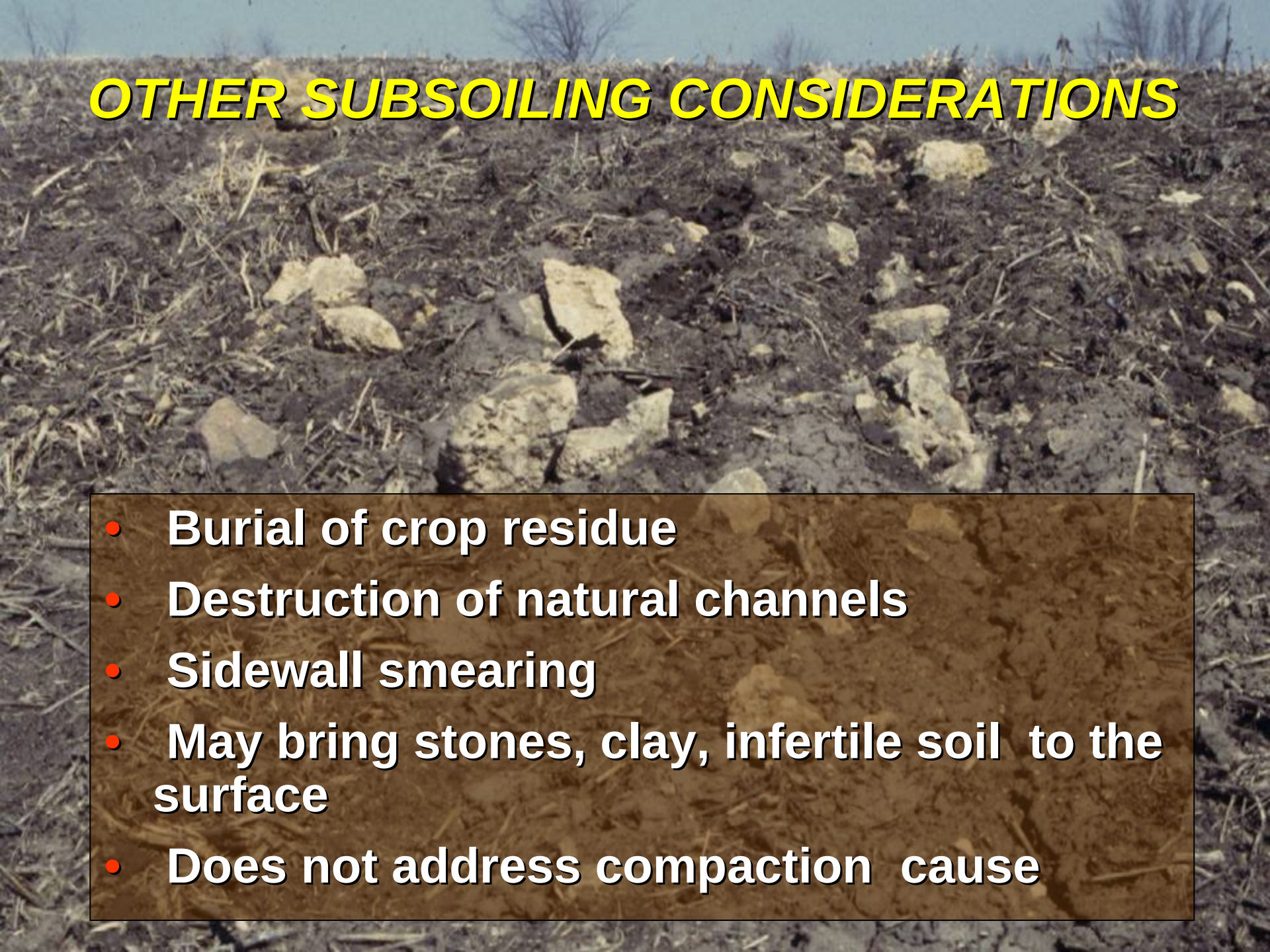
CONVENTIONAL TILLAGE CAN REMOVE SHALLOW COMPACTION

PENETROMETER RESISTANCE FOLLOWING TILLAGE OF A "LIGHTLY" COMPACTED SILT LOAM SOIL



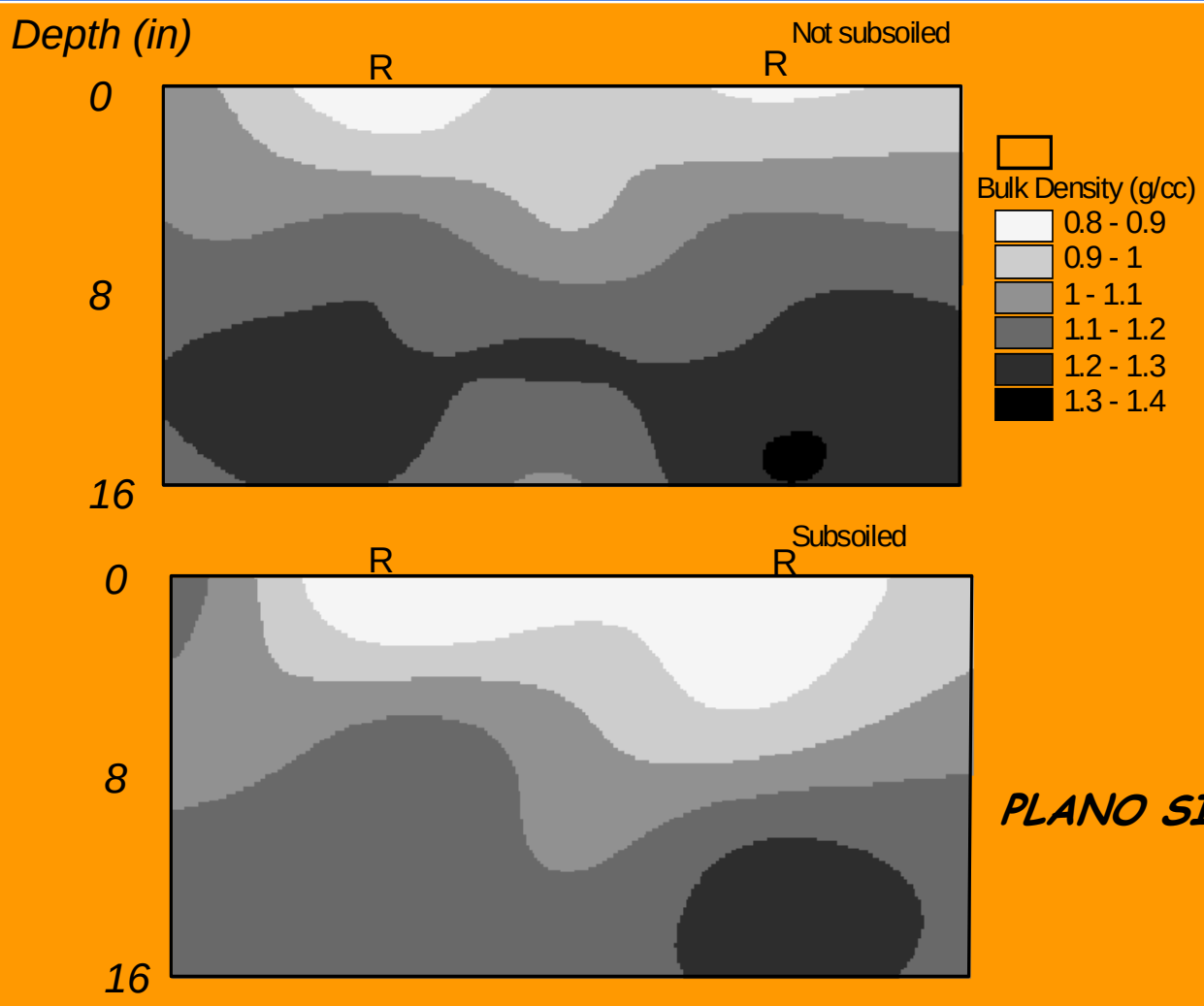
Arlington, Wis., 2002 (6 t vehicle)

OTHER SUBSOILING CONSIDERATIONS

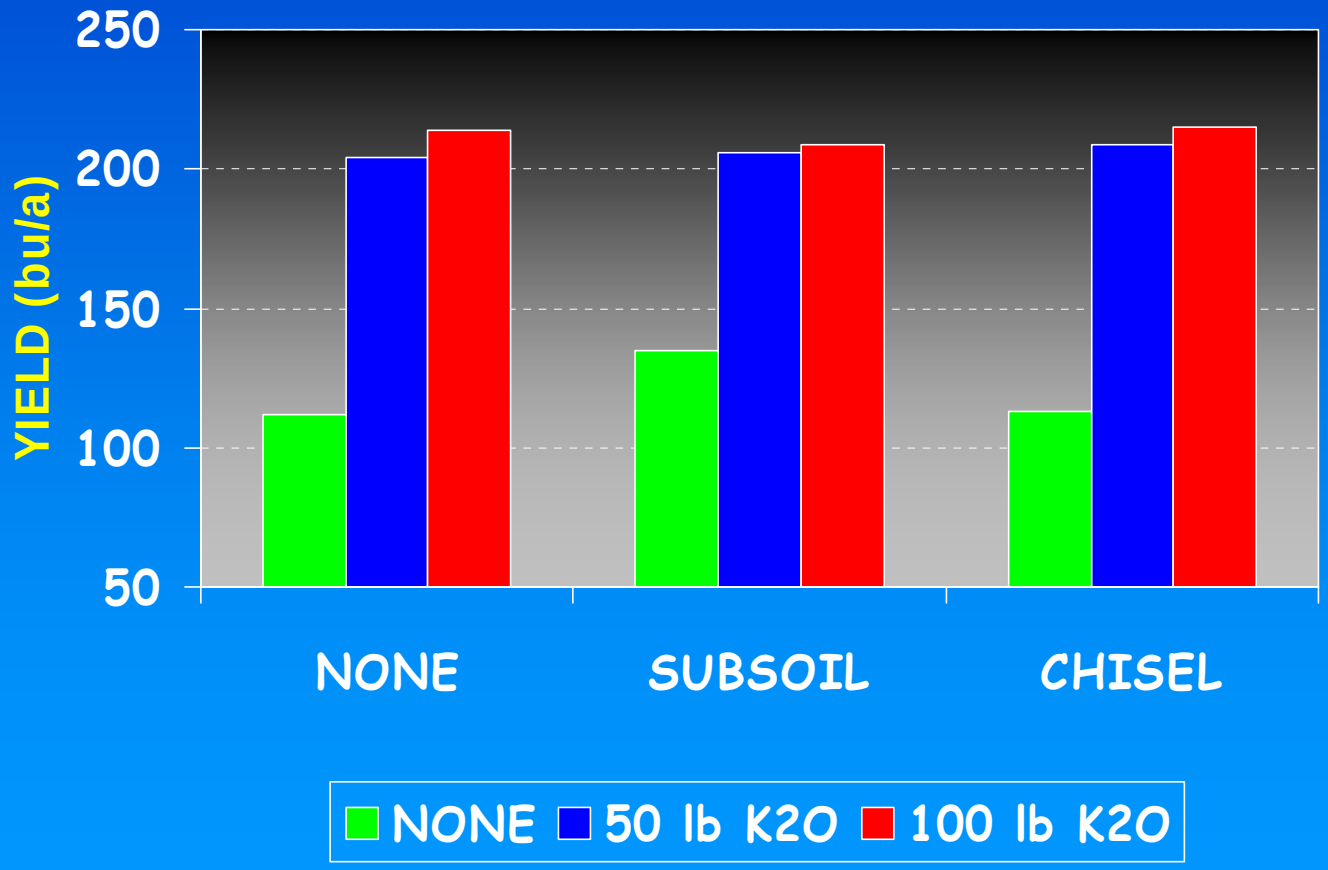


- Burial of crop residue
- Destruction of natural channels
- Sidewall smearing
- May bring stones, clay, infertile soil to the surface
- Does not address compaction cause

SOIL BULK DENSITY PROFILE, ARLINGTON, WIS., 1998



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



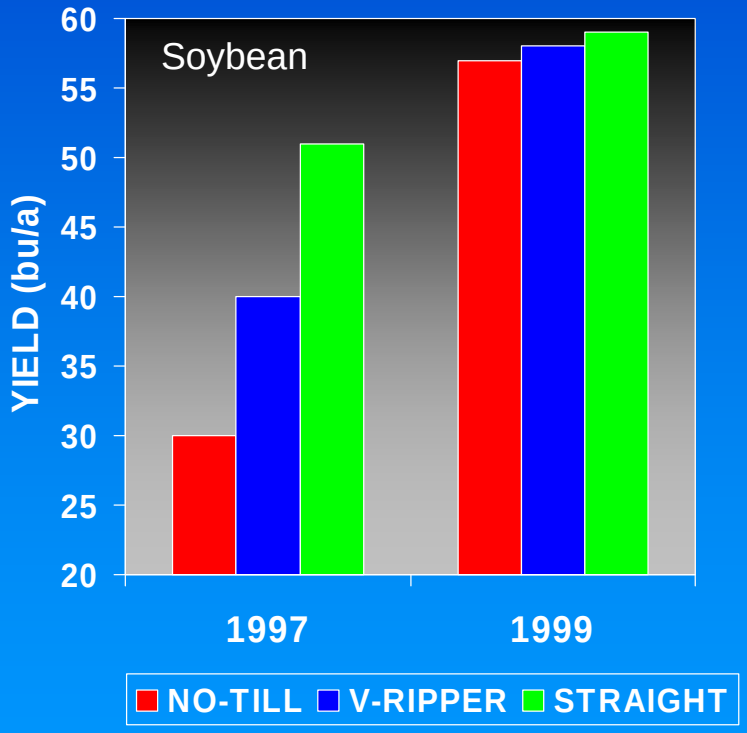
Arlington, Wis.

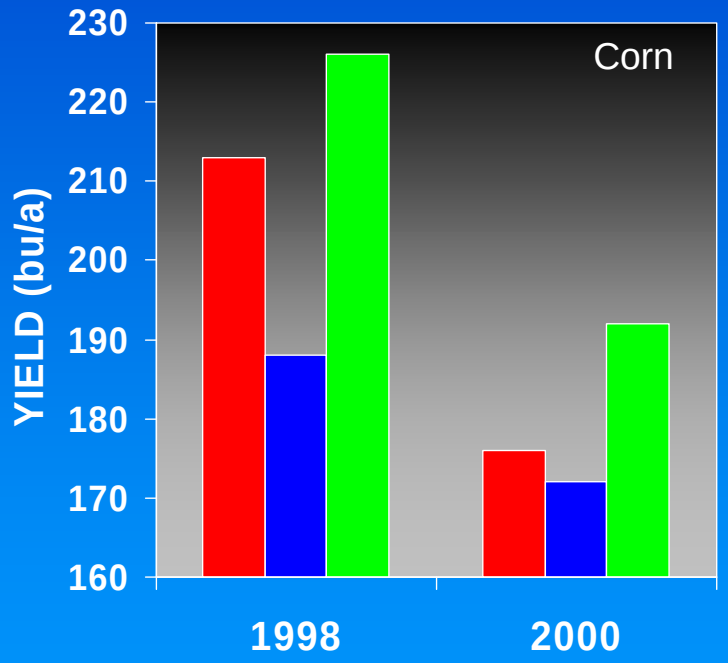
WHICH TYPE OF SUBSOILER

"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

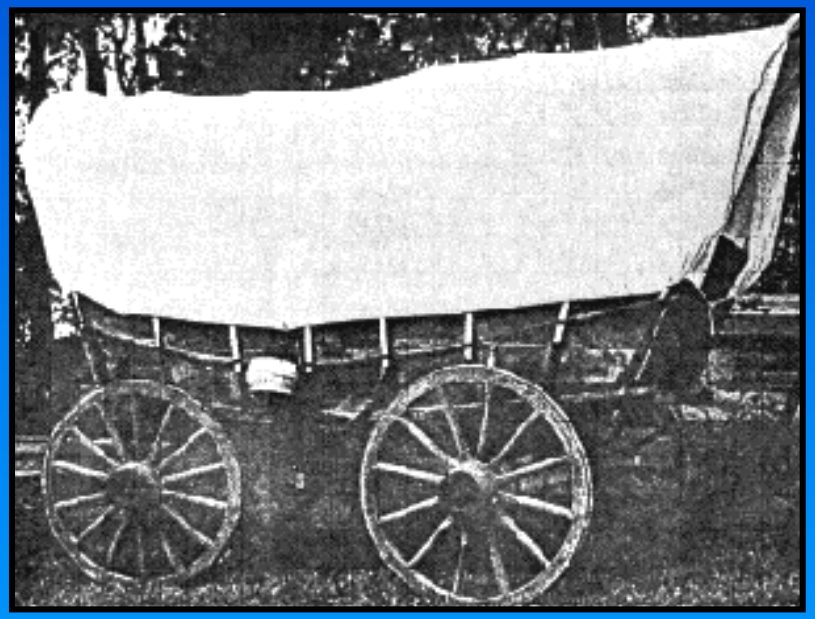


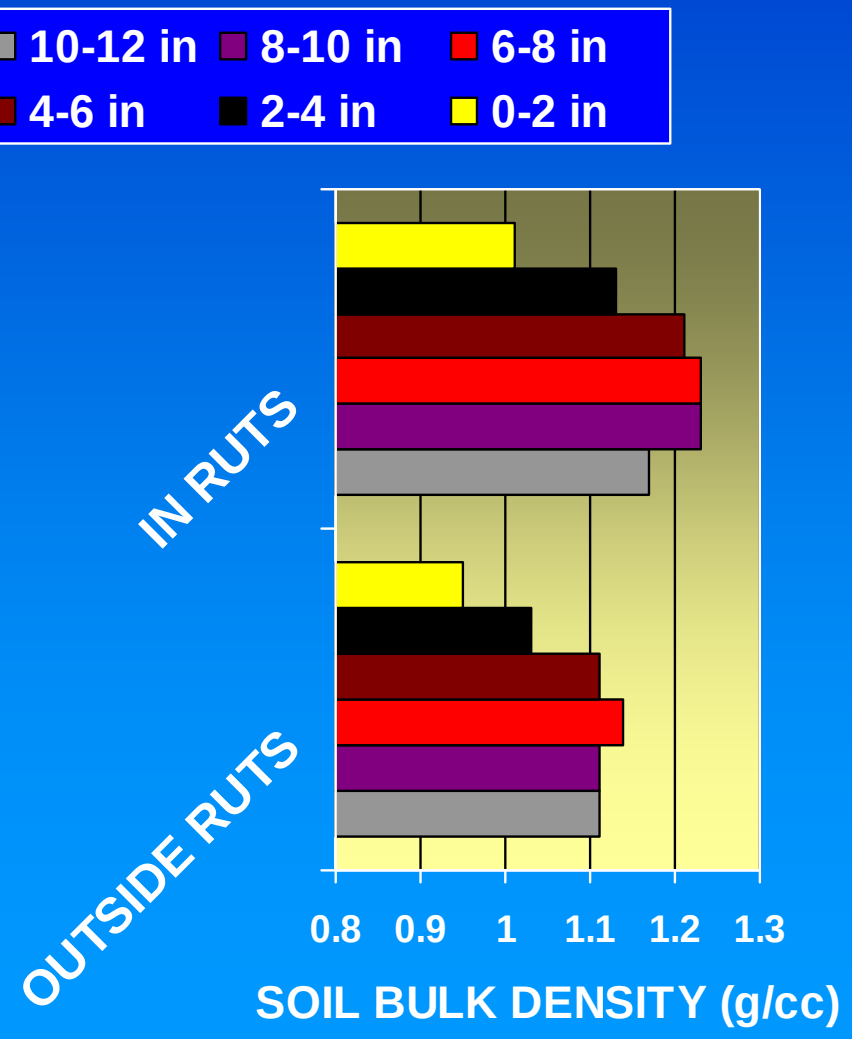


Manitowoc, Wis.

DON'T COUNT ON MOTHER NATURE TO CORRECT COMPACTION

WADSWORTH TRAIL, MINNESOTA





Sharratt et al., 1998

Guidelines for managing compaction:
1. Stay off wet soils


Get the point ?

Guidelines for managing compaction:
2. Control traffic – Unload on field edge

Guidelines for managing compaction:
2. Control traffic – No shortcuts

Guidelines for managing compaction:
3. Limit load weight – Practical considerations

Guidelines for managing compaction:
3. Limit load weight – Avoid operations with heavy loads when possible

OTHER KEYS FOR MANAGING SOIL COMPACTION

Evaluate and monitor crops and soil

- **Subsoil only if documented compaction conditions exist**
- **Use common sense**
- **Address compaction issues**
- **Factsheet A3367 currently being revised**