

ADDRESSING THE SOIL COMPACTION PROBLEM

A photograph of a green combine harvester and a red tractor working in a cornfield. The combine is on the left, and the tractor is on the right, both moving through the corn. The background shows a line of trees under a clear blue sky.

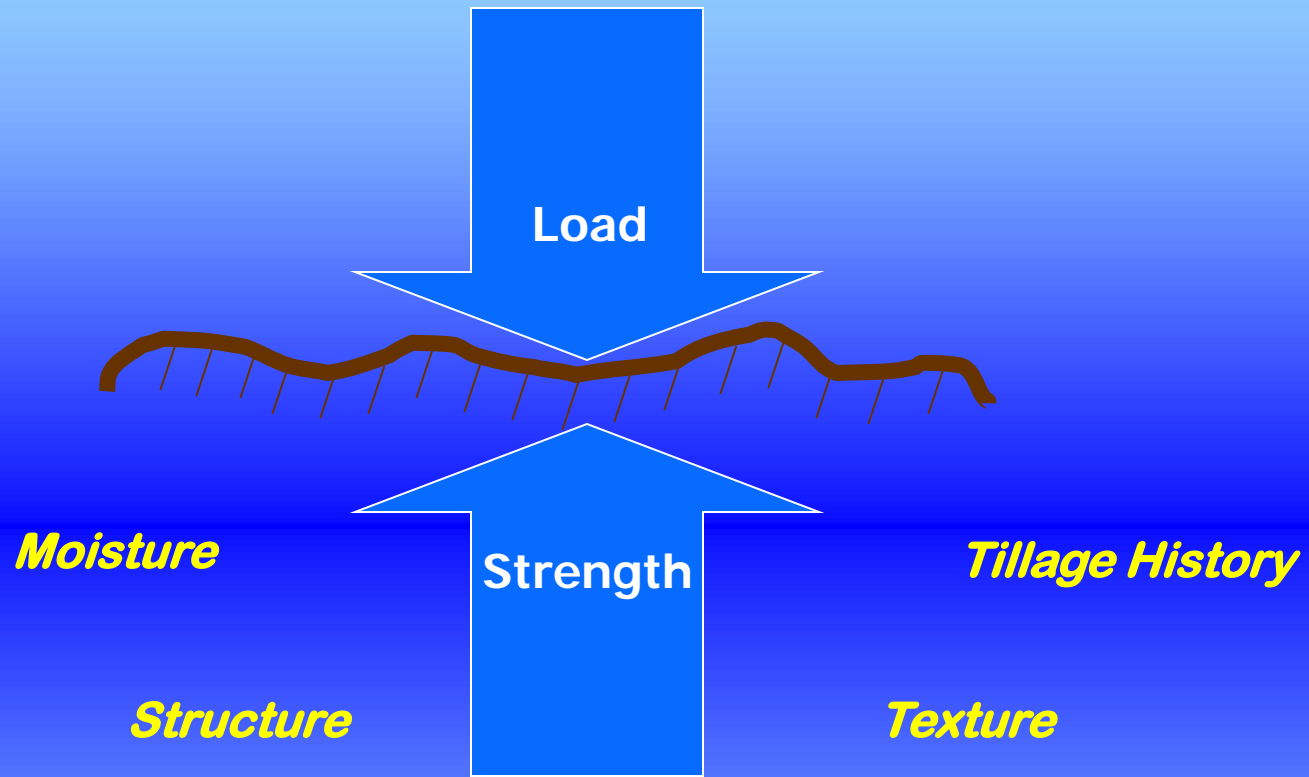
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EXTENSION SOIL SCIENTIST
UNIVERSITY OF WISCONSIN**

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**

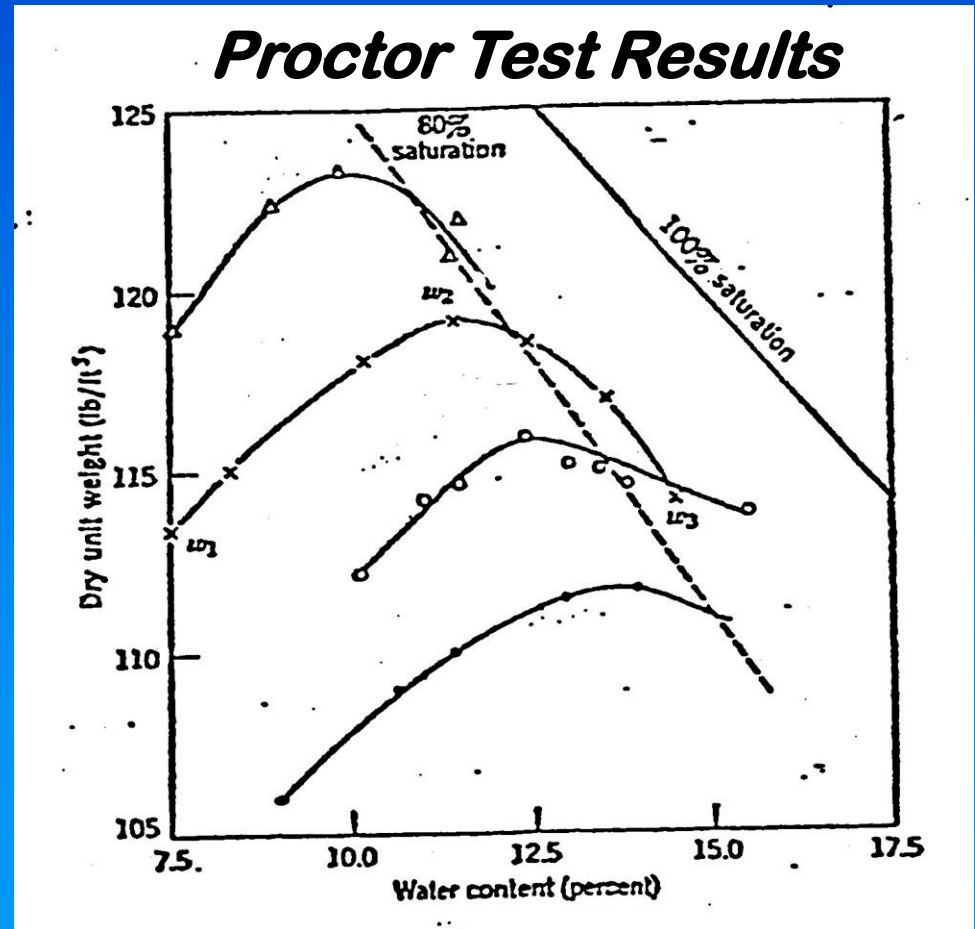




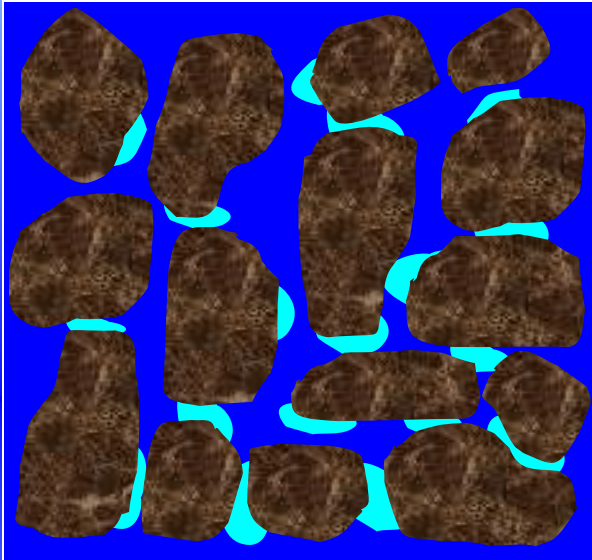
Soil compacts when load-bearing strength of soil is less than load being applied.

“COMPACTABILITY” INFLUENCED BY WATER CONTENT

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

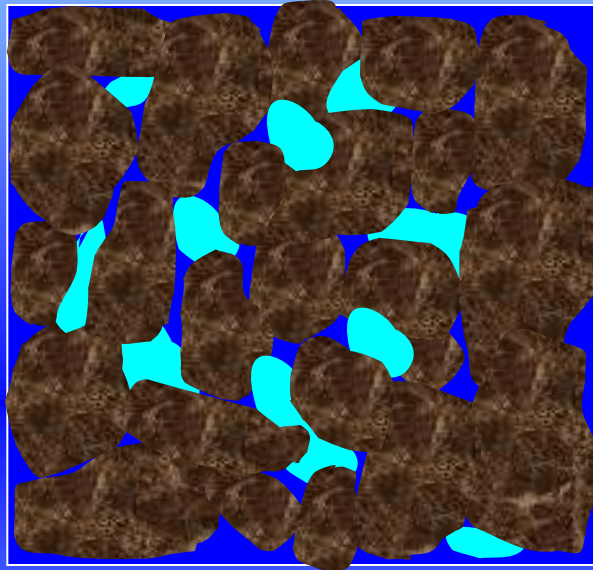


COMPACTION IS A PROCESS



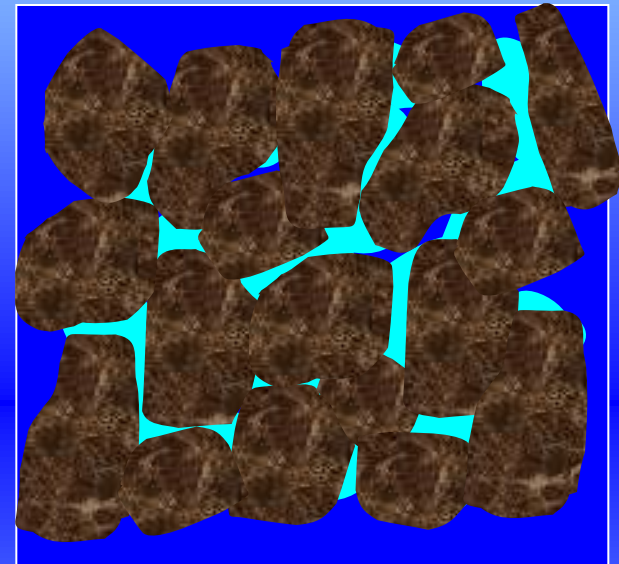
$D_b = 1.0$

- 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

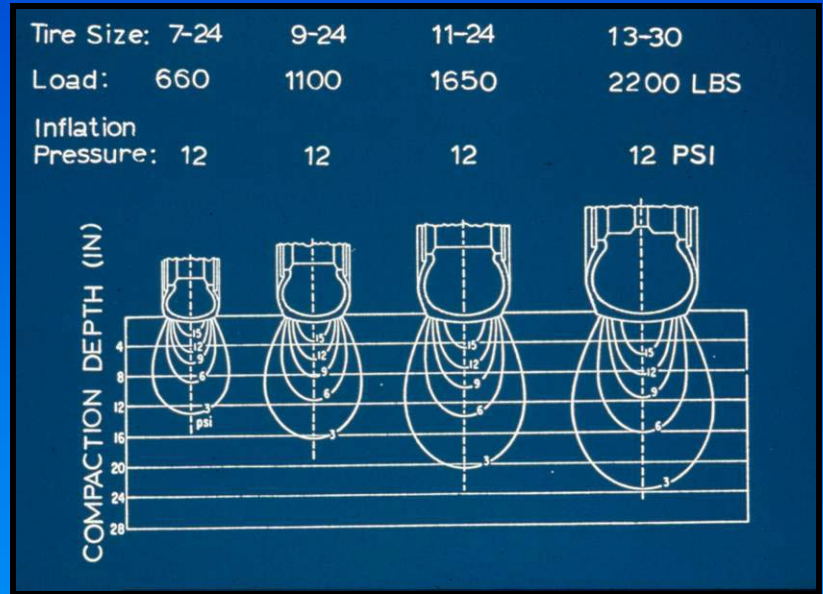


Will more tires spread weight ... or allow operations in wetter conditions and compact a greater soil volume ?

WHICH IS WORSE – PRESSURE OR LOAD?



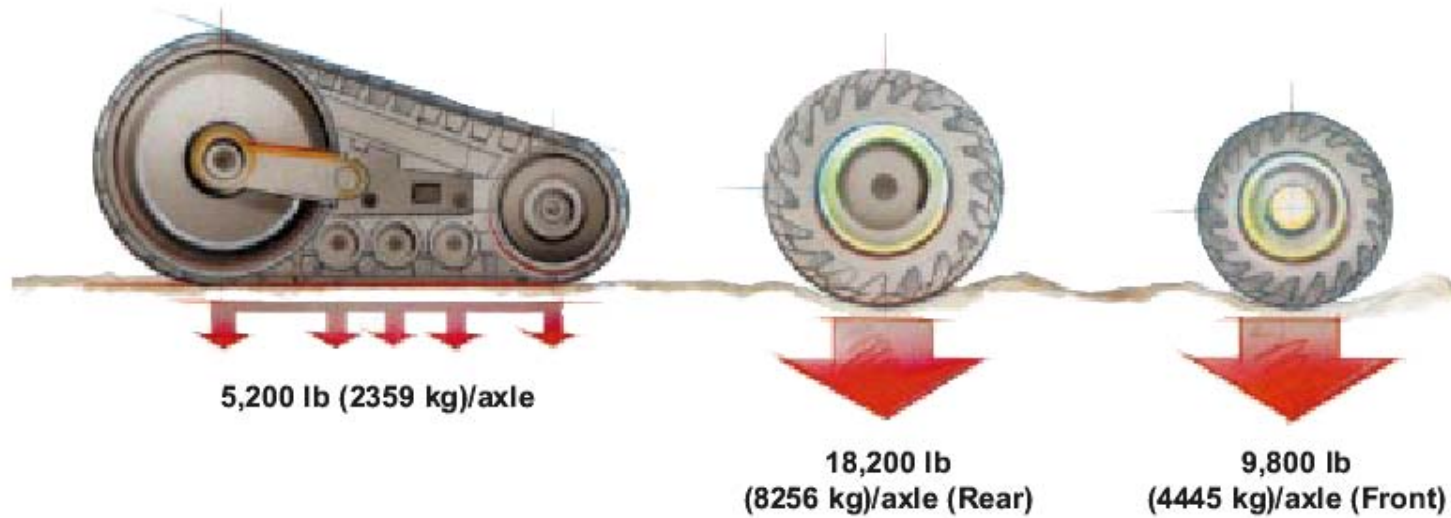
High PSI, but small load



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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WIDE



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

*Chasing the combine
is an old habit*

SOIL SURVEY

Greeley County, Kansas



***CONTROL PHEASANTS
COMPACTION BY
UNLOADING IN HEADLANDS***



MANAGING COMPACTION WITH CONTROLLED TRAFFIC FARMING



CONTROLLED TRAFFIC FARMING CONCEPTS

- Recognizes random traffic-induced compaction is bad
- Adapts machinery and organizes operations to have trafficked and non-trafficked zones
- Creates permanent “wheelways”
- Utilizes wide-span implements and GPS guidance
- Requires careful planning and

CONTROLLED TRAFFIC FARMING

- Practiced extensively in Europe and Australia
- Modified 3 m width tractor
- GPS guidance
- Preserves soil quality between lanes
- Why not?
 - Variety of operations
 - Equipment cost
 - Field shape



MOST OF THE COMPACTION OCCURS IN THE FIRST PASS

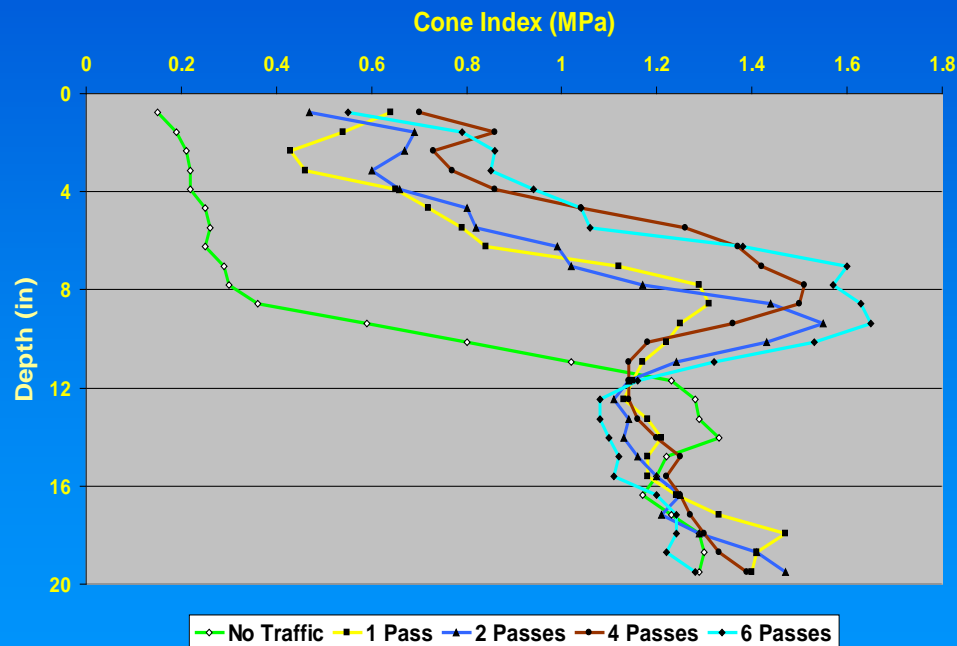
- Plano silt loam
- Soil near field capacity (34 – 38%)
- 2007 NT w. wheat
2006 NT corn silage following alfalfa
- Chisel vs. None
- No traffic or 1, 2, 4, and 6 passes with a 14.5 ton combine
- 6 measurements per treatment

Arlington Evaluation

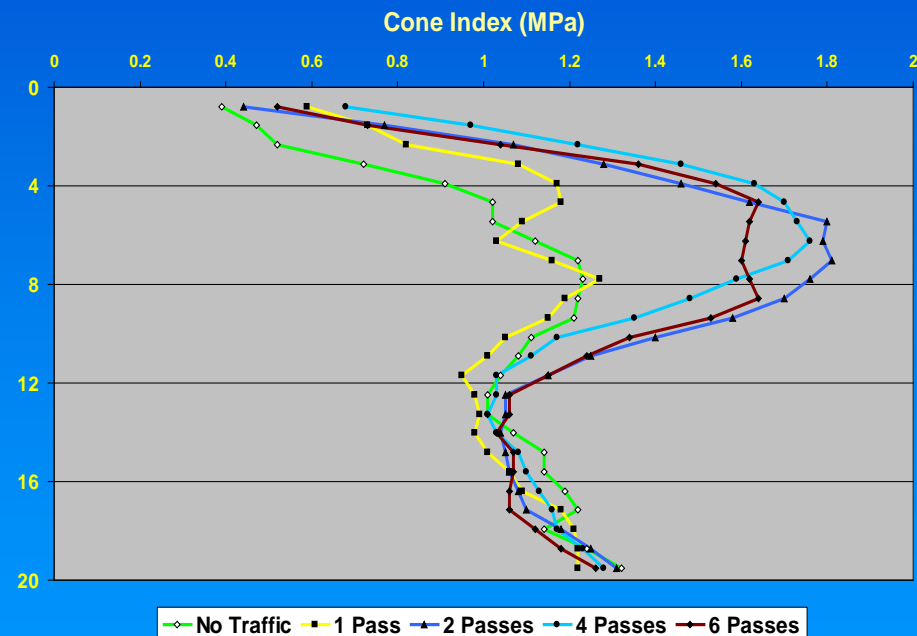


EFFECT OF NUMBER OF WHEEL TRAFFIC PASSES ON SOIL COMPACTION

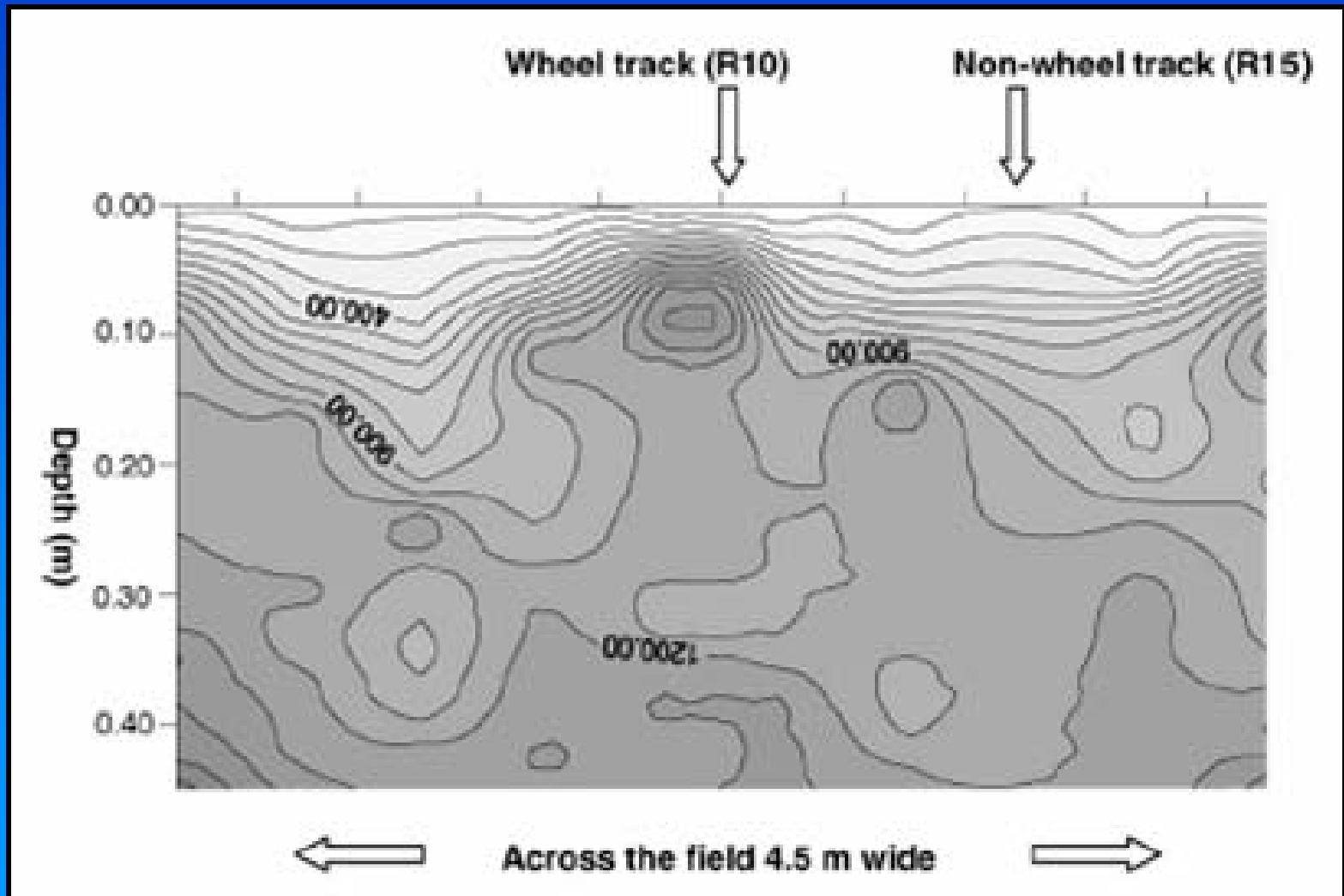
Chisel Plowed



Not Plowed



WHEEL TRACK EFFECTS ON PENETRATION RESISTANCE



TRAFFIC EFFECT ON SOIL PROPERTIES AND YIELD

	Canola		Wheat	
Measurement	WT	Non-WT	WT	Non-WT
Bulk density (g/cc)	1.58	1.29	1.50	1.25
Air-filled pores (%)	7	19	9	23
Root density (g/m ³ x 1000)	9.2	27.5	75	118
Biomass (Mg/ha)	4.7	11.8	12.0	12.6
Yield (Mg/ha)	1.1	3.2	5.5	5.3
Harvest index	22	27	43	44

Chan et al., 2006

EXAMPLES OF CTF SYSTEMS

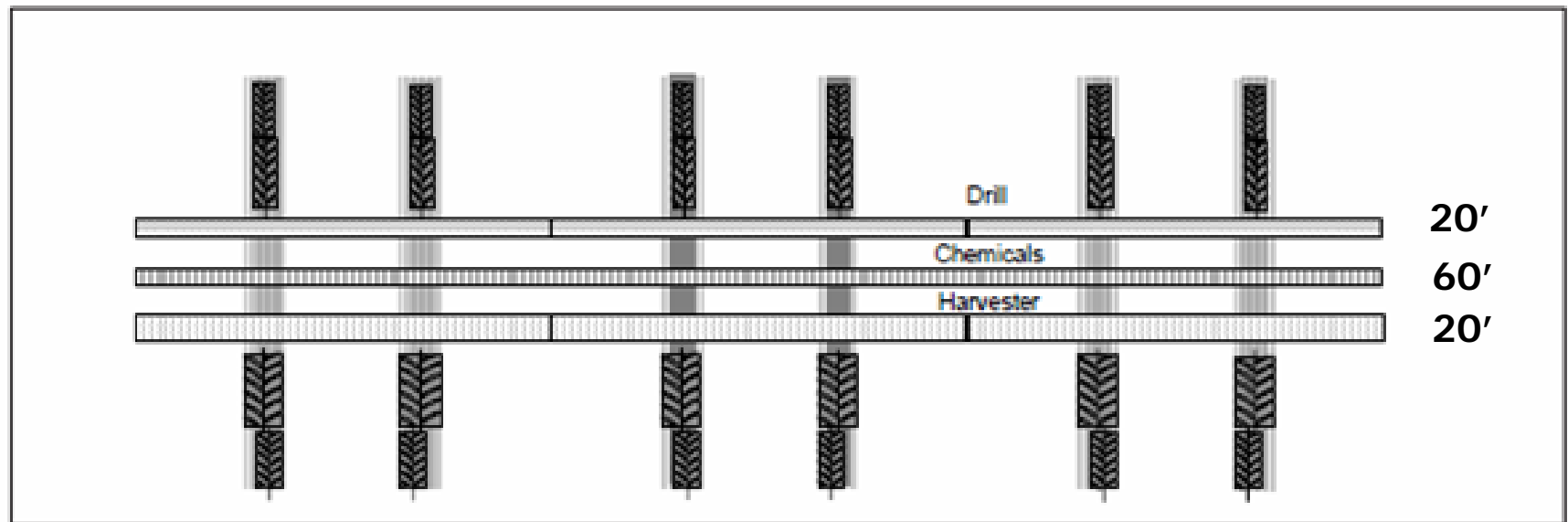
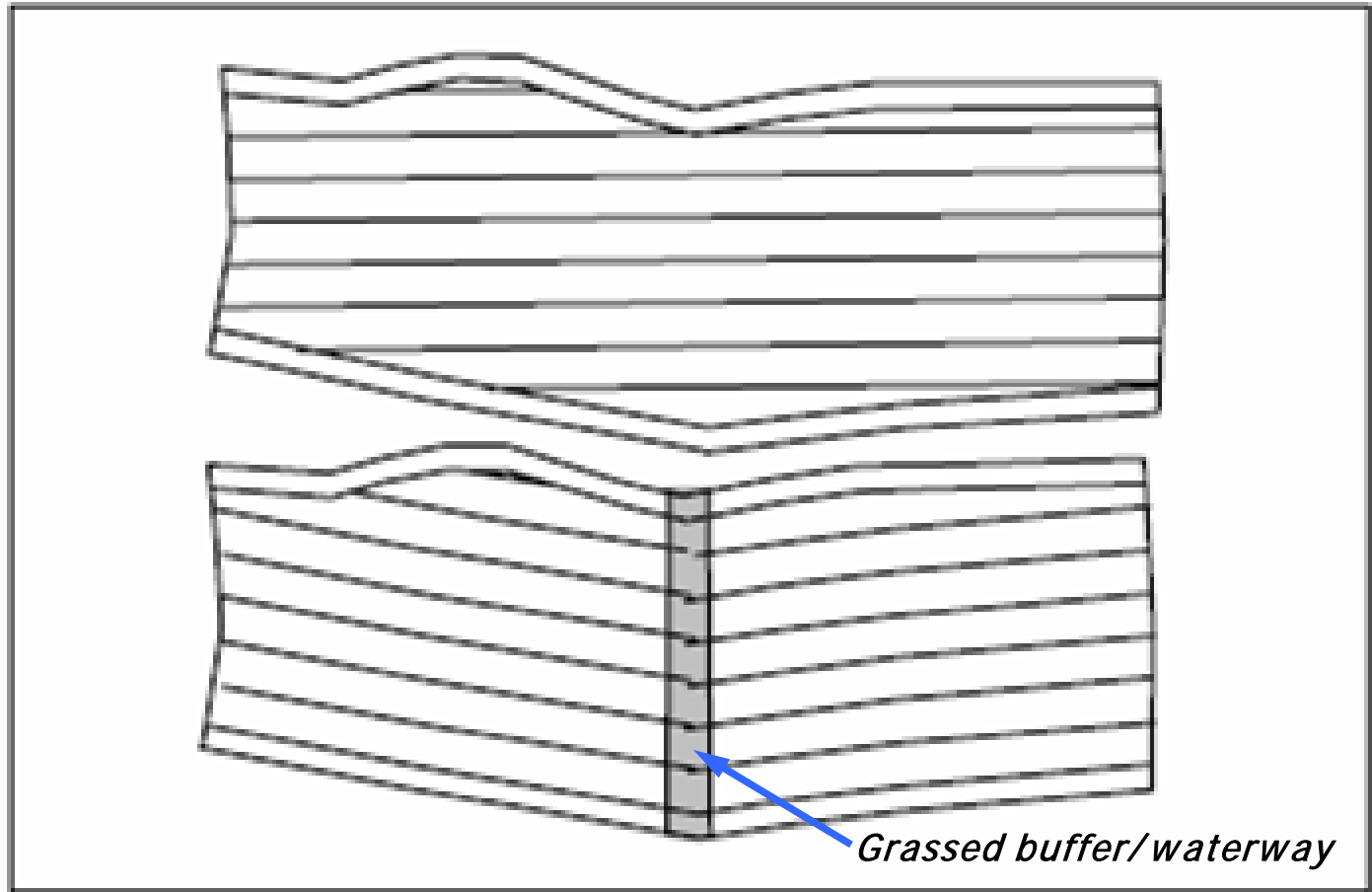


Figure 1. ComTrac. A CTF system that uses a single common track width to match the widest vehicle. Implements all have a common span or direct multiple of it.

ADAPTING CTF TO IRREGULAR AND SLOPED FIELDS



COMMON 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

A photograph of a cornfield with young plants. The plants are green and appear to be in the early stages of growth. There is a noticeable unevenness in the stand, with some plants being taller and more developed than others, indicating a stunted growth pattern. The background shows a line of trees and a clear sky.

**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

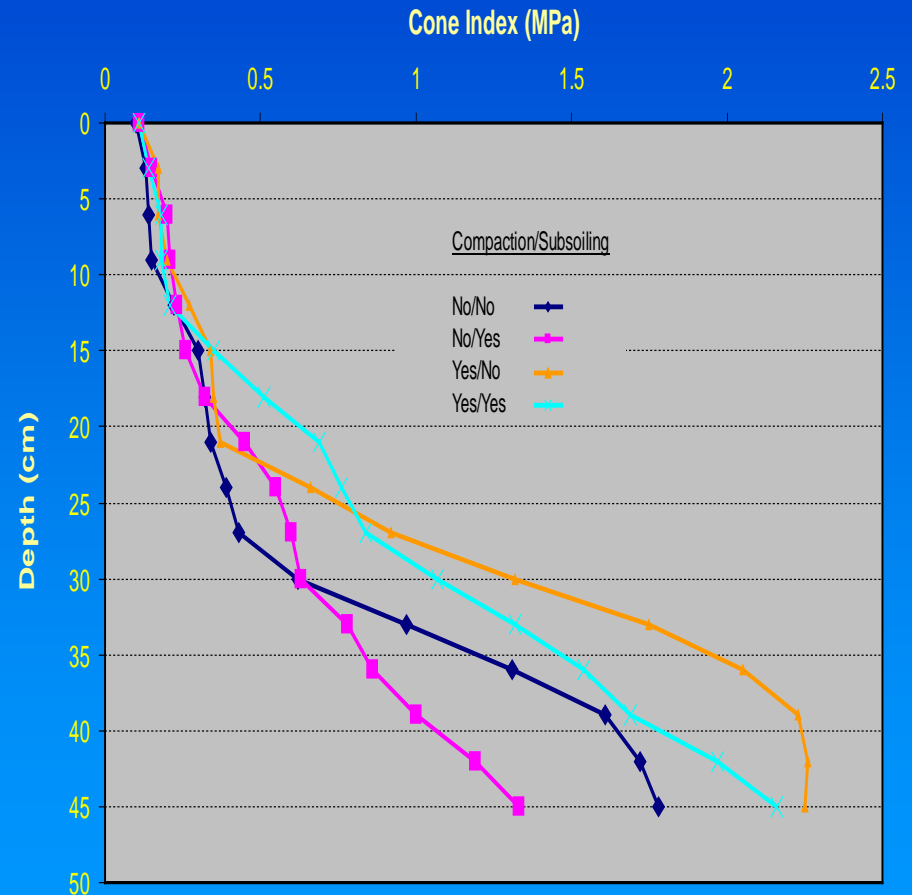


Hand-held penetrometer



Soil probe

CONSTANT-RATE RECORDING PENETROMETER



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

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

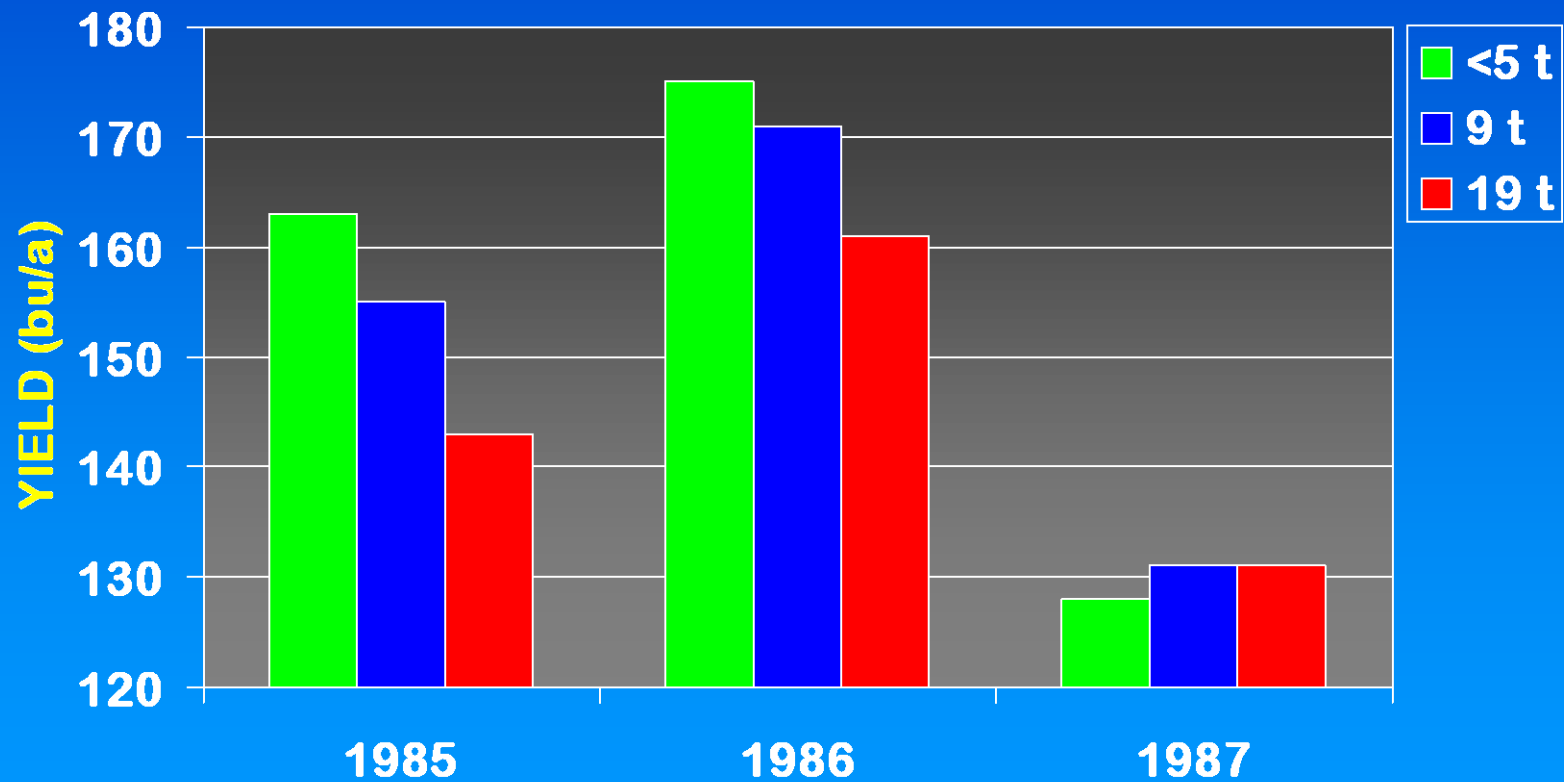
COMPACTION AFFECTS NUTRIENT UPTAKE

Potassium Affected Most

- Compaction reduces porosity
- Lowers soil oxygen
- O₂ needed for root respiration and active uptake

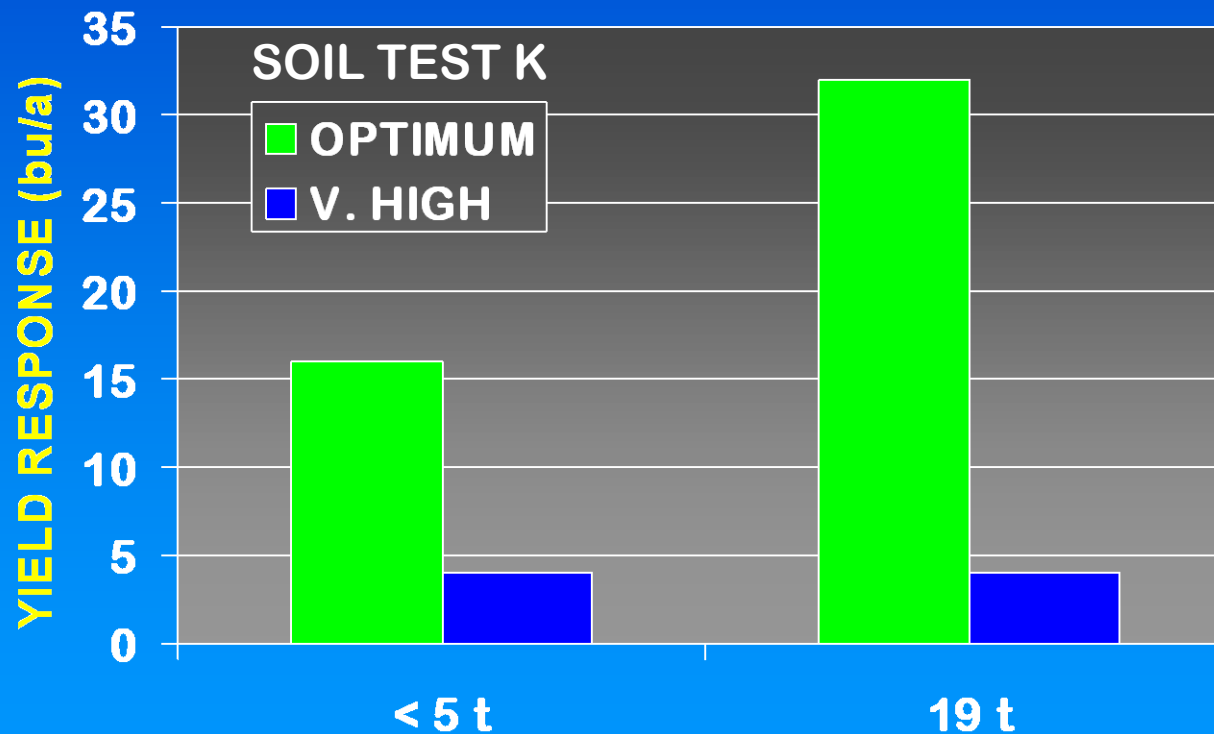


COMPACTION EFFECT ON CORN YIELD ON A SILTY CLAY LOAM SOIL



Oshkosh, Wis.


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



Oshkosh, Wis. (45 lb K₂O/a)

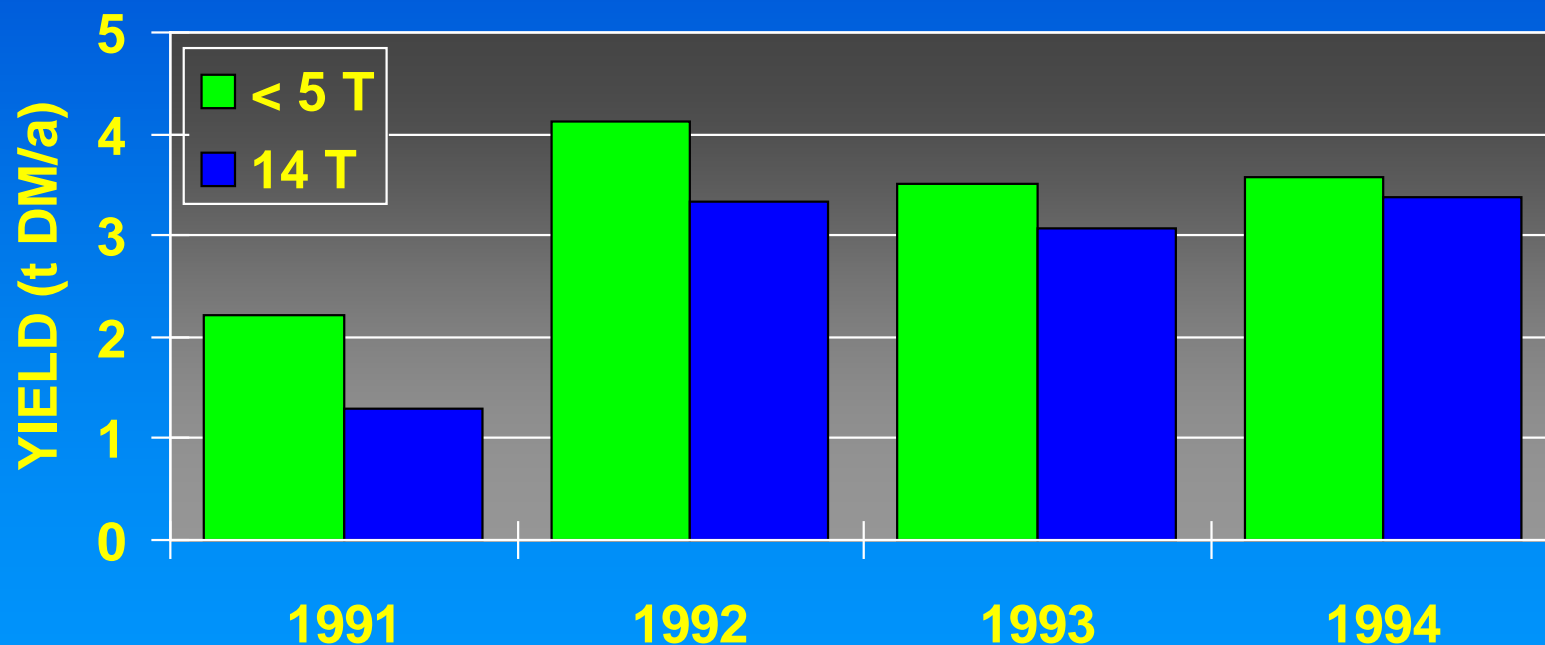
IS COMPACTION A PROBLEM IN FORAGE PRODUCTION

- **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**

A photograph of an alfalfa field showing significant winter-kill. The foreground and middle ground are covered in dry, yellowish-brown alfalfa plants. In the center, there are distinct, dark green patches of alfalfa that have survived, arranged in a pattern that suggests wheel traffic from a vehicle. The background shows a line of trees under a clear blue sky.

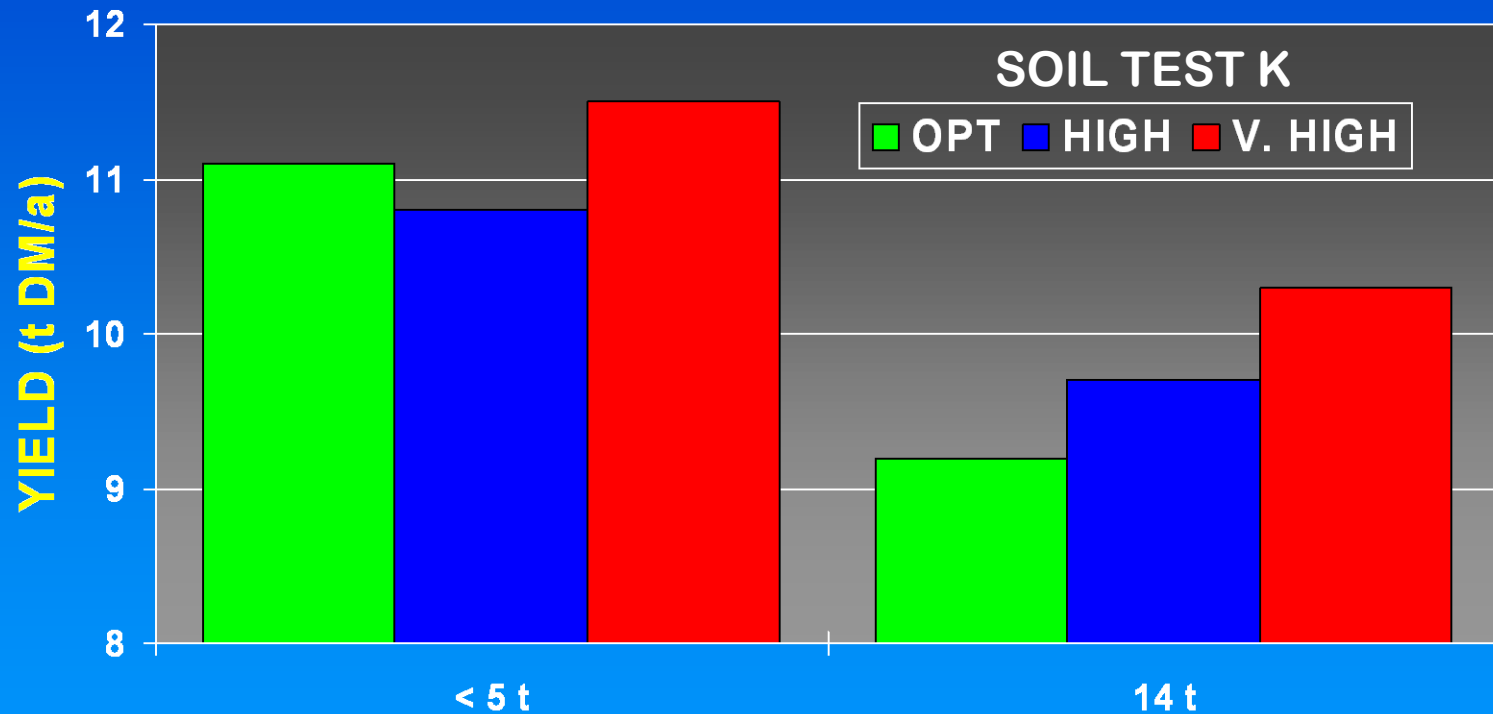
**Alfalfa winter-kill resulting from
wheel traffic**

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

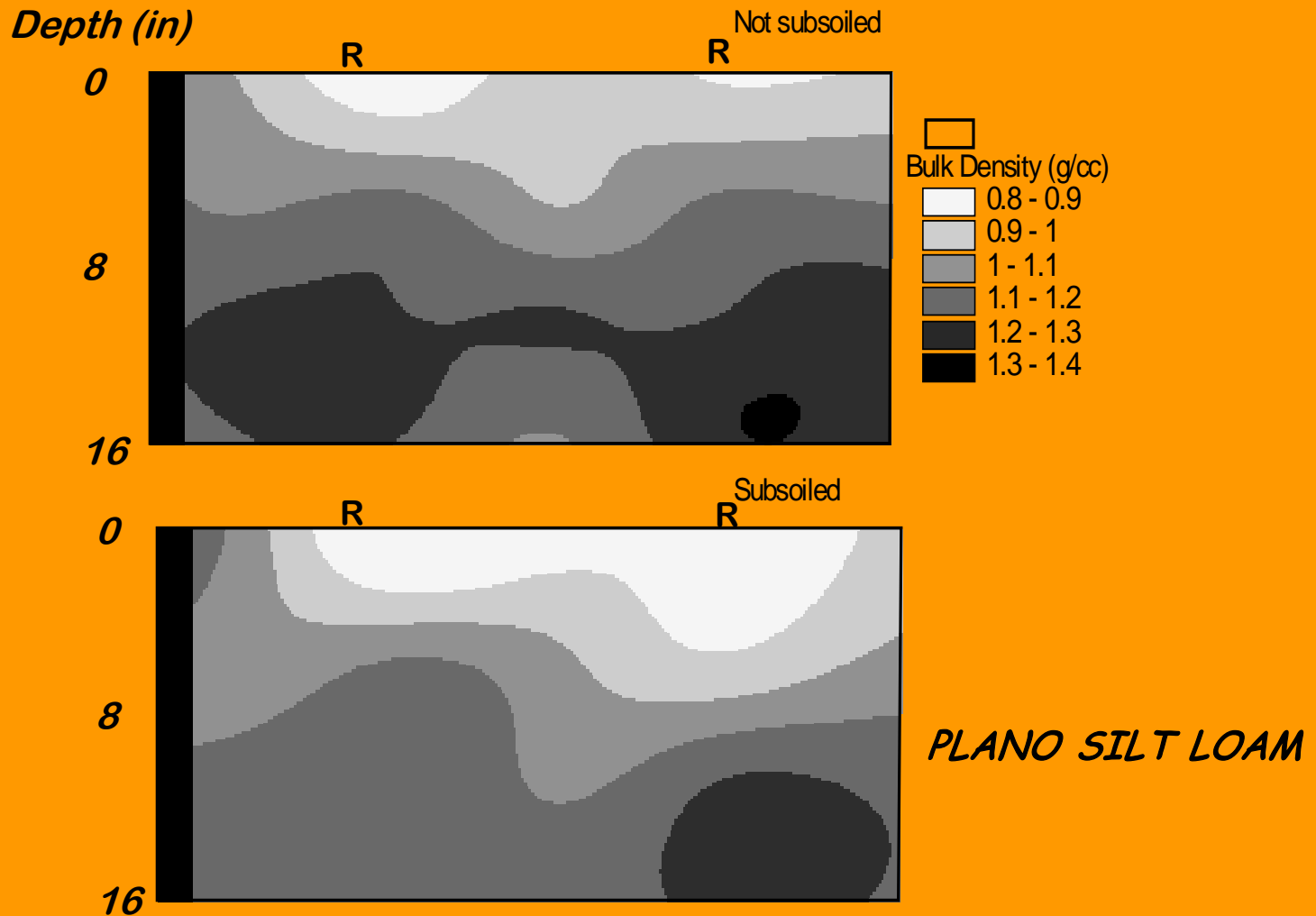


- Evaluate depth and severity of compaction
- Check with penetrometer, probe, shovel
- Dig plants to examine roots
- Leave untreated strips for comparison
- Subsoiling is not a cure-all

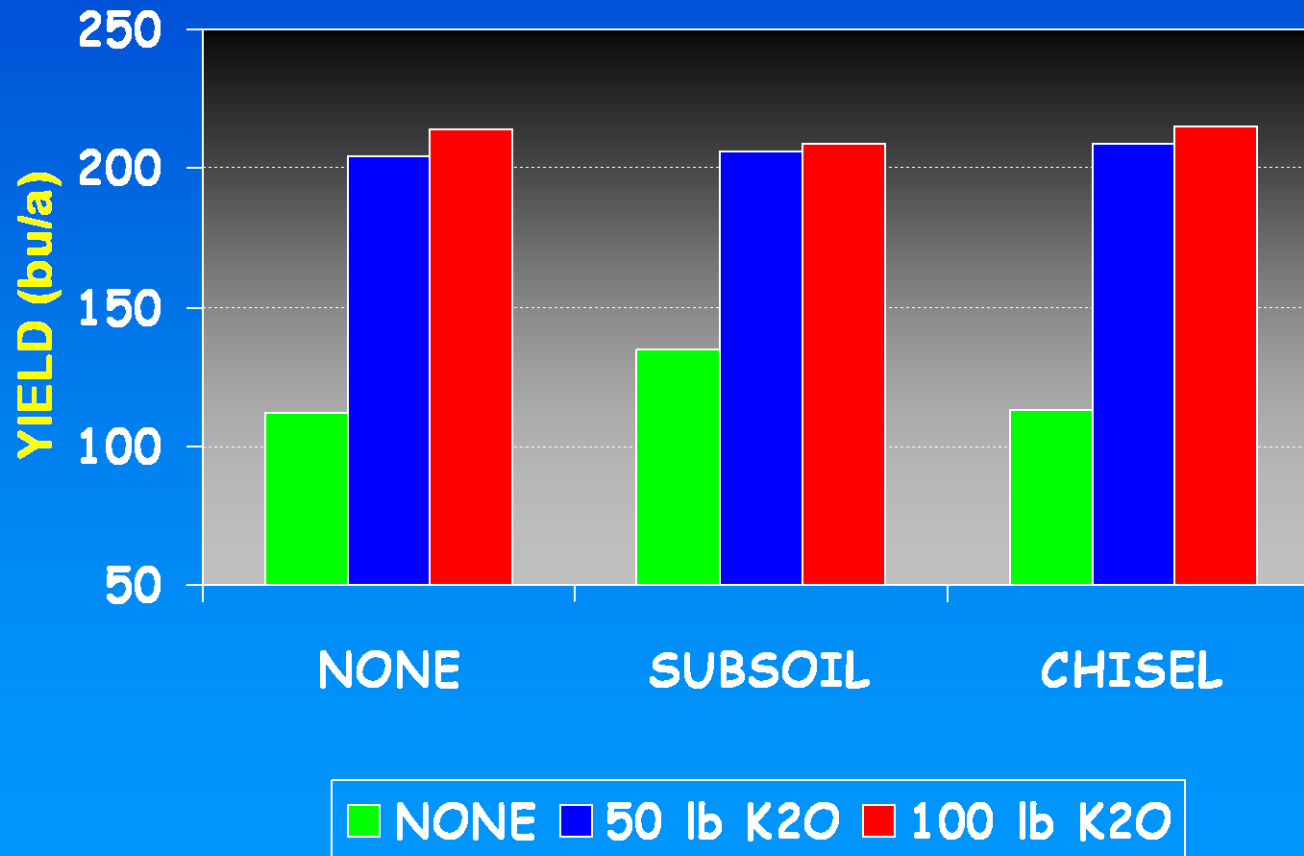
OTHER SUBSOILING CONSIDERATIONS

- **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

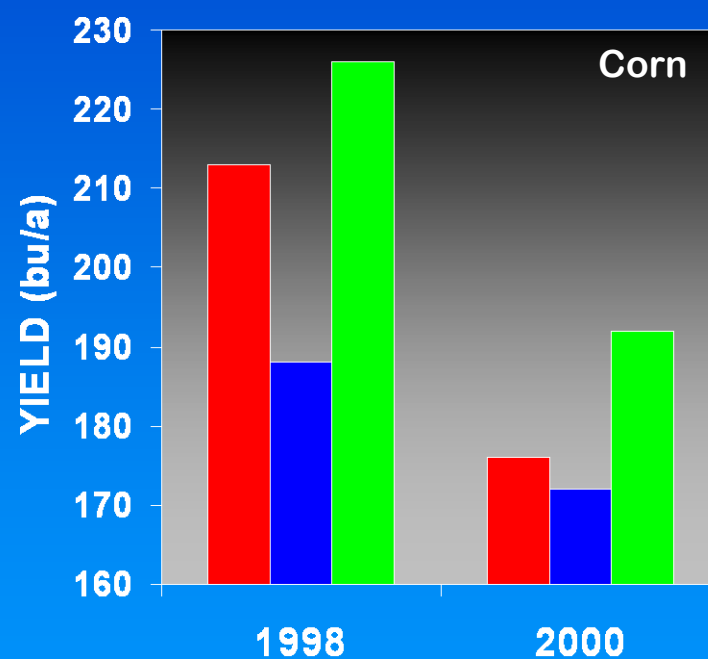
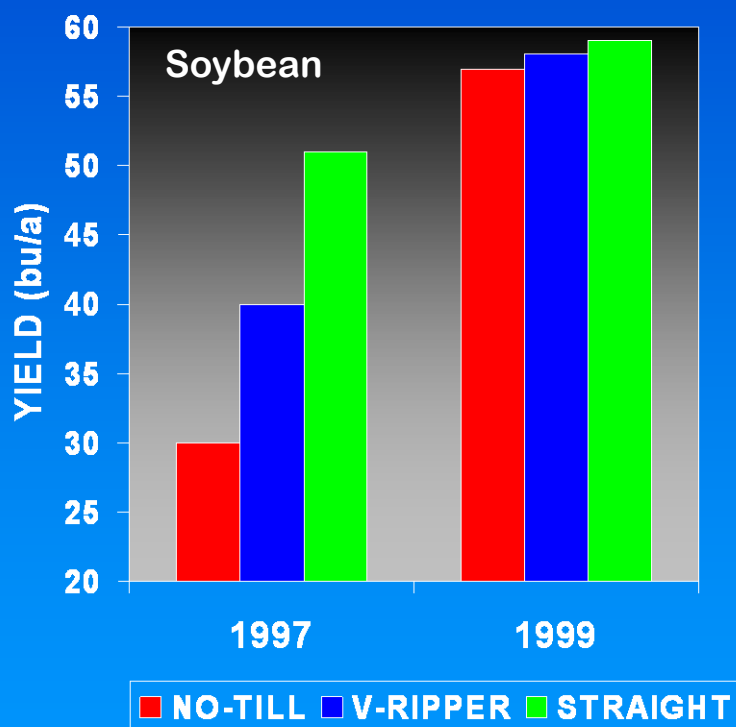


- “Conservation”**
- Cutting coulters
 - Straight shanks
 - Horizontal points

- “V-Ripper”**
- Leading disks
 - Parabolic shanks
 - Winged points

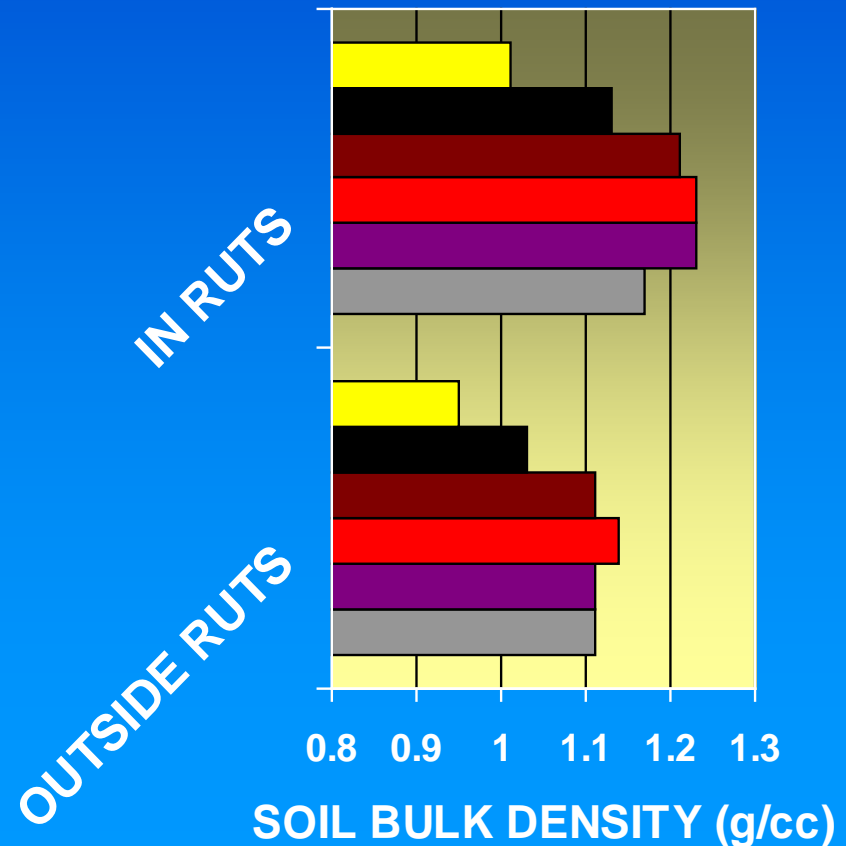
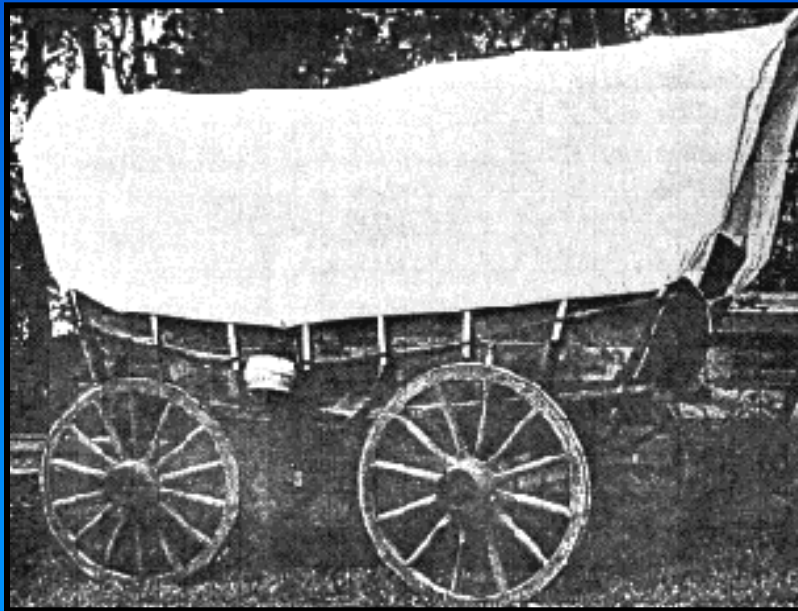
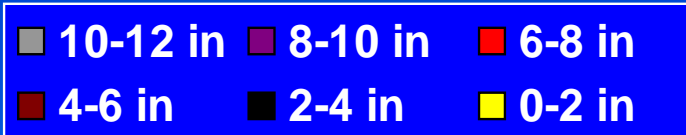


EFFECT OF SUBSOILER TYPE ON SOYBEAN AND CORN YIELD ON A SILTY CLAY LOAM SOIL



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**