UNIVERSITY OF MINNESOTA EXTENSION

A lot of Soil Topics all in One Presentation

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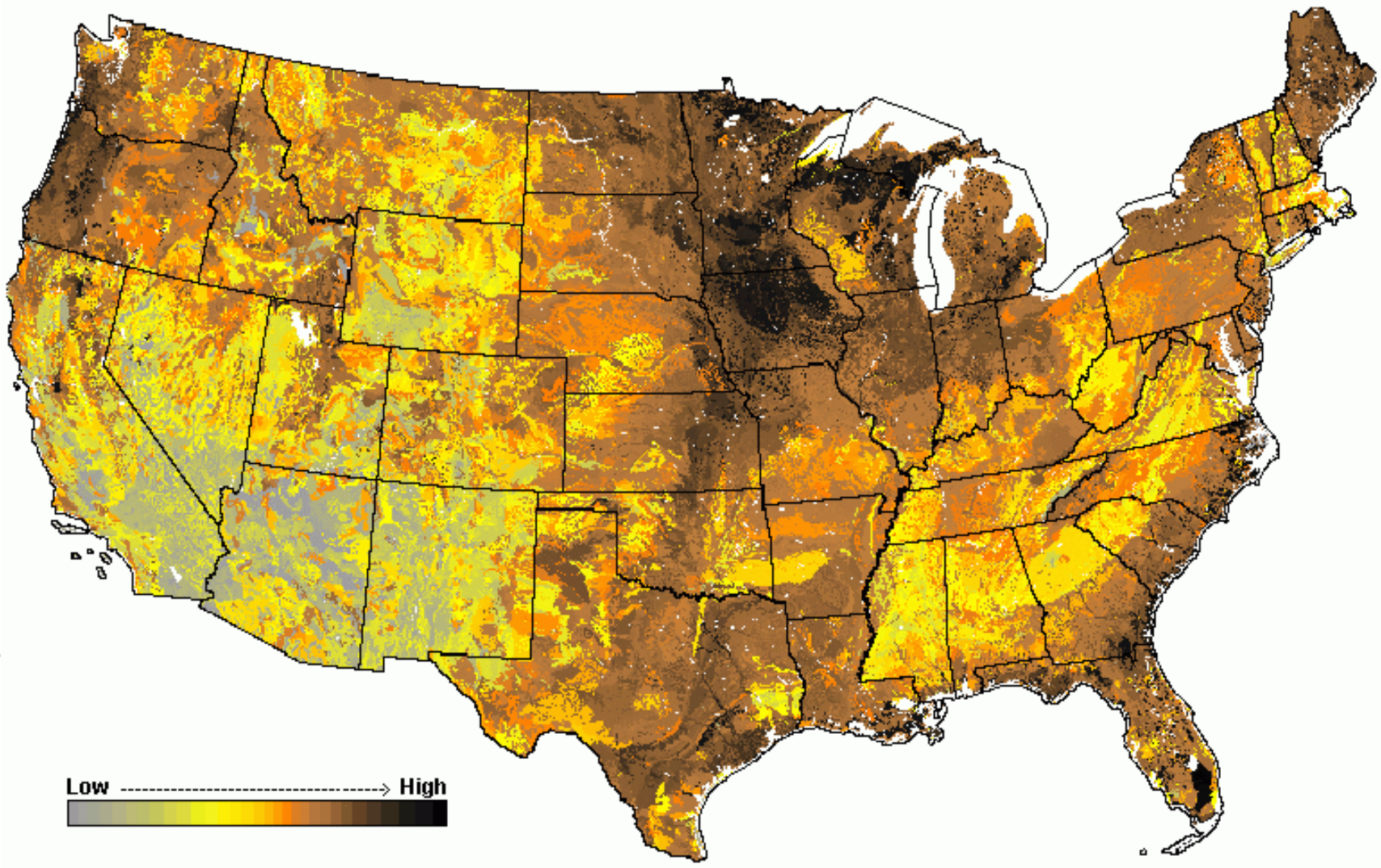
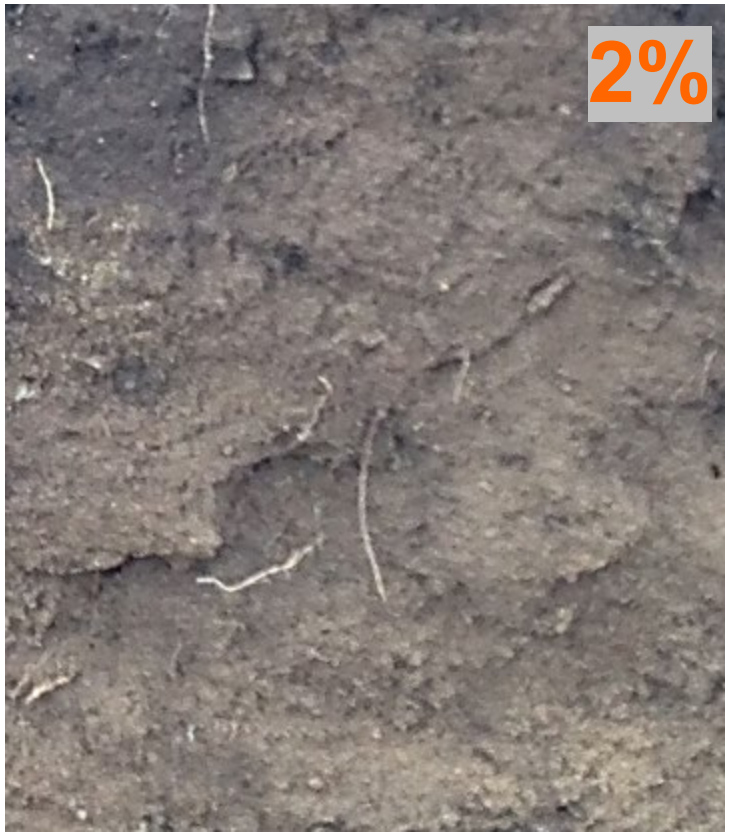
Soil Organic Matter in the US

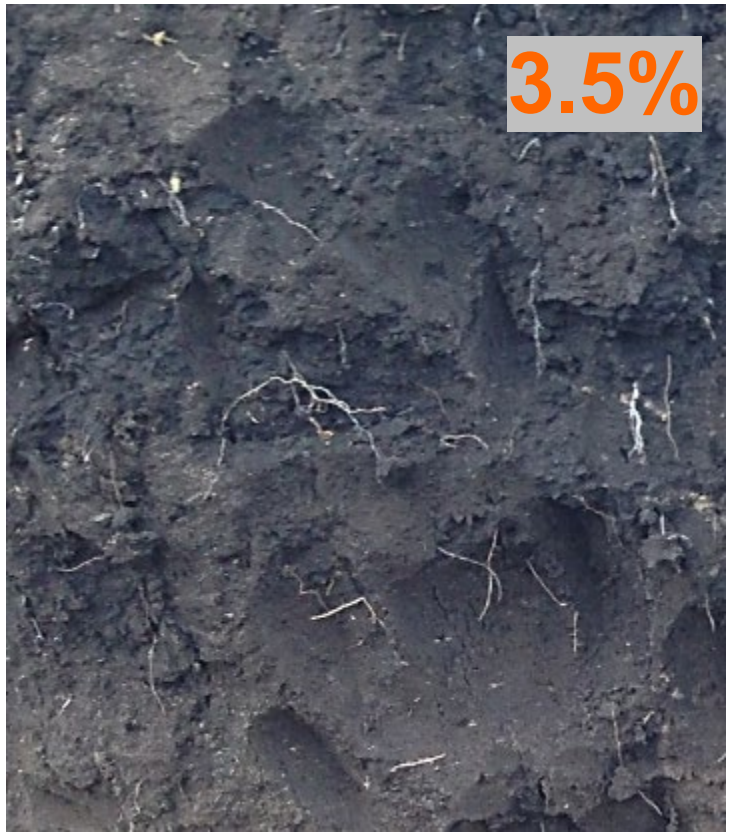


Hargrove and Luxmoore

Organic Matter is ~58% Carbon

- May hear soil organic carbon used interchangeably with soil organic matter
- Builds resiliency in your fields



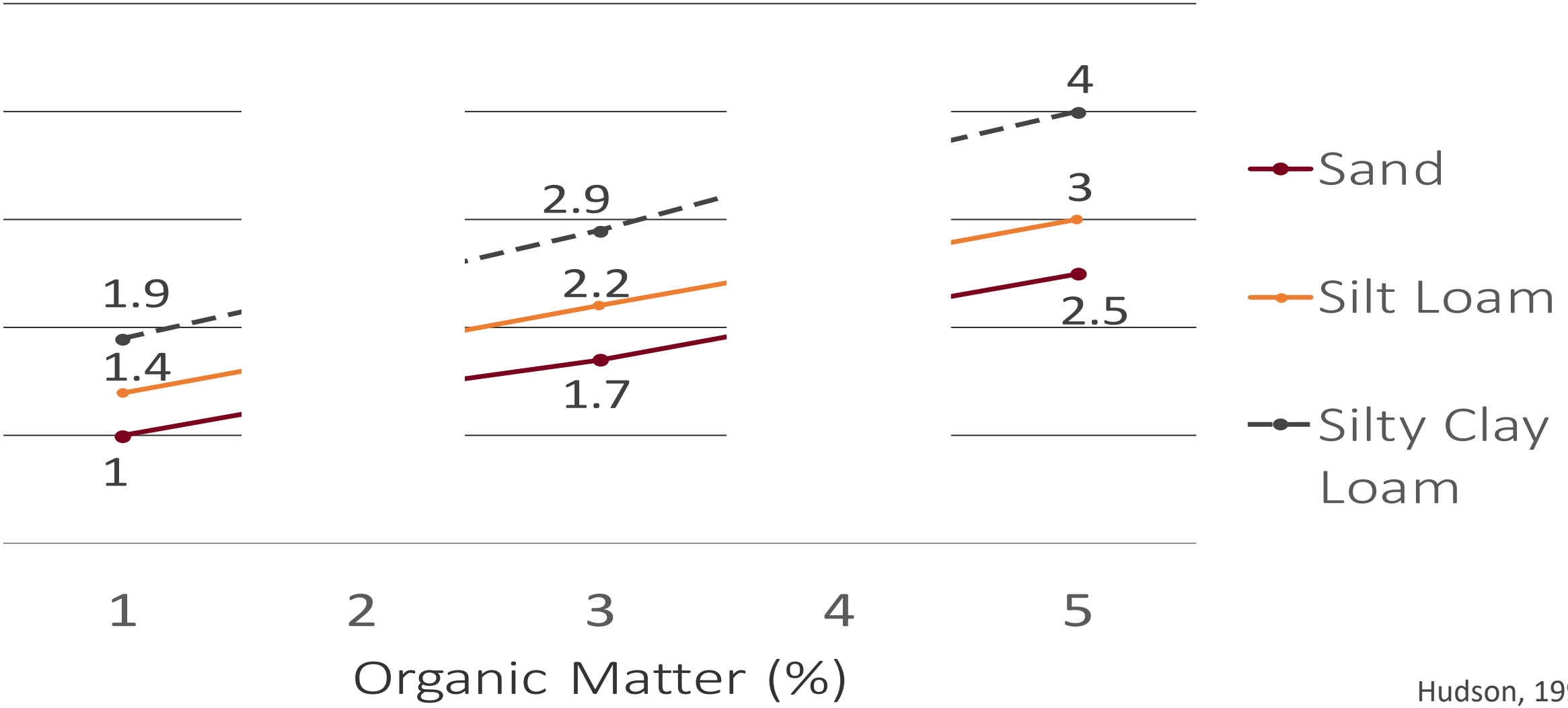


You can see carbon in the soil

Dynamic

We can change organic matter (ie carbon) with management

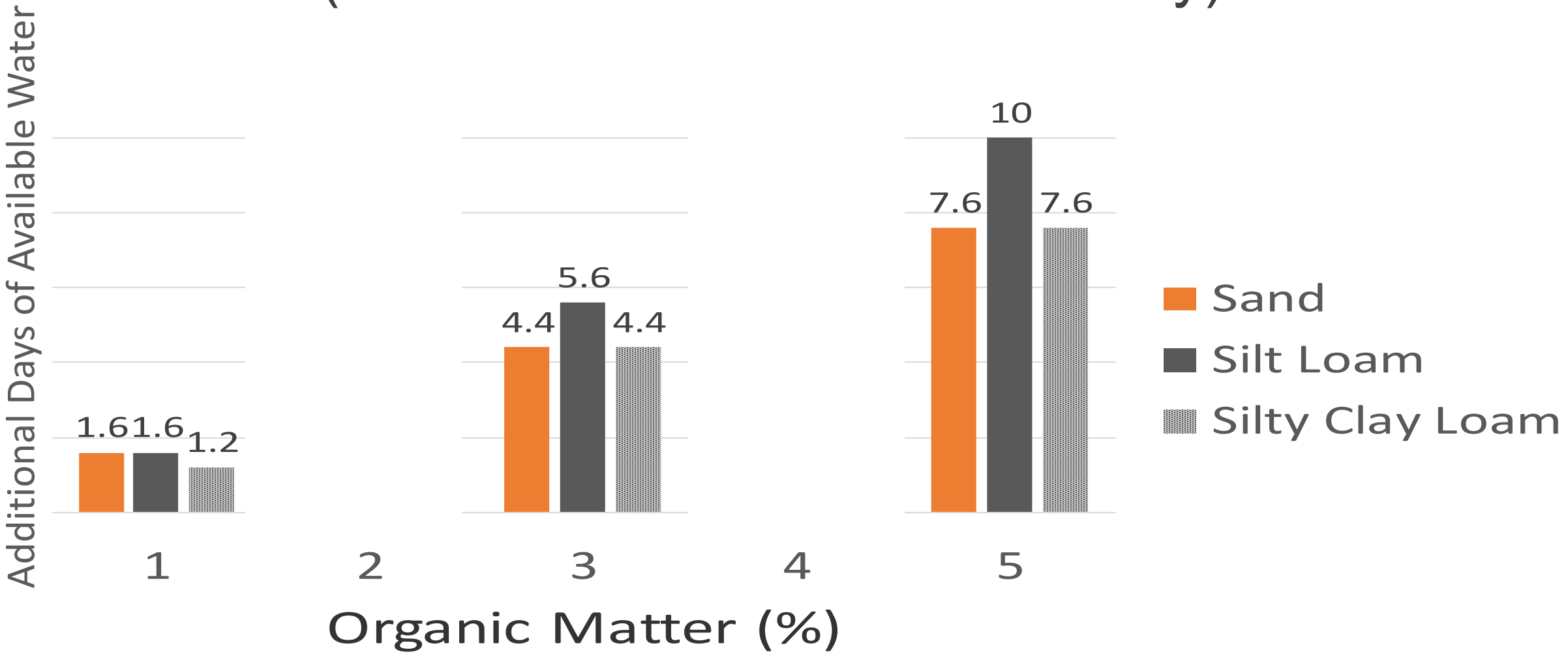
Available Water Content (inches)



Hudson, 1994

Additional Days of Available Water

(based on corn use of 0.25”/day)



Hudson, 1994

OM Helps Build Soil Structure

Goal

Water Stable Aggregates

25 yrs of conventional corn

Photo Ray Weil

20 yrs of bluegrass, then 5 yrs conventional corn

Is Water Stable Structure Important?

#1 Natural Defense Against Soil Compaction

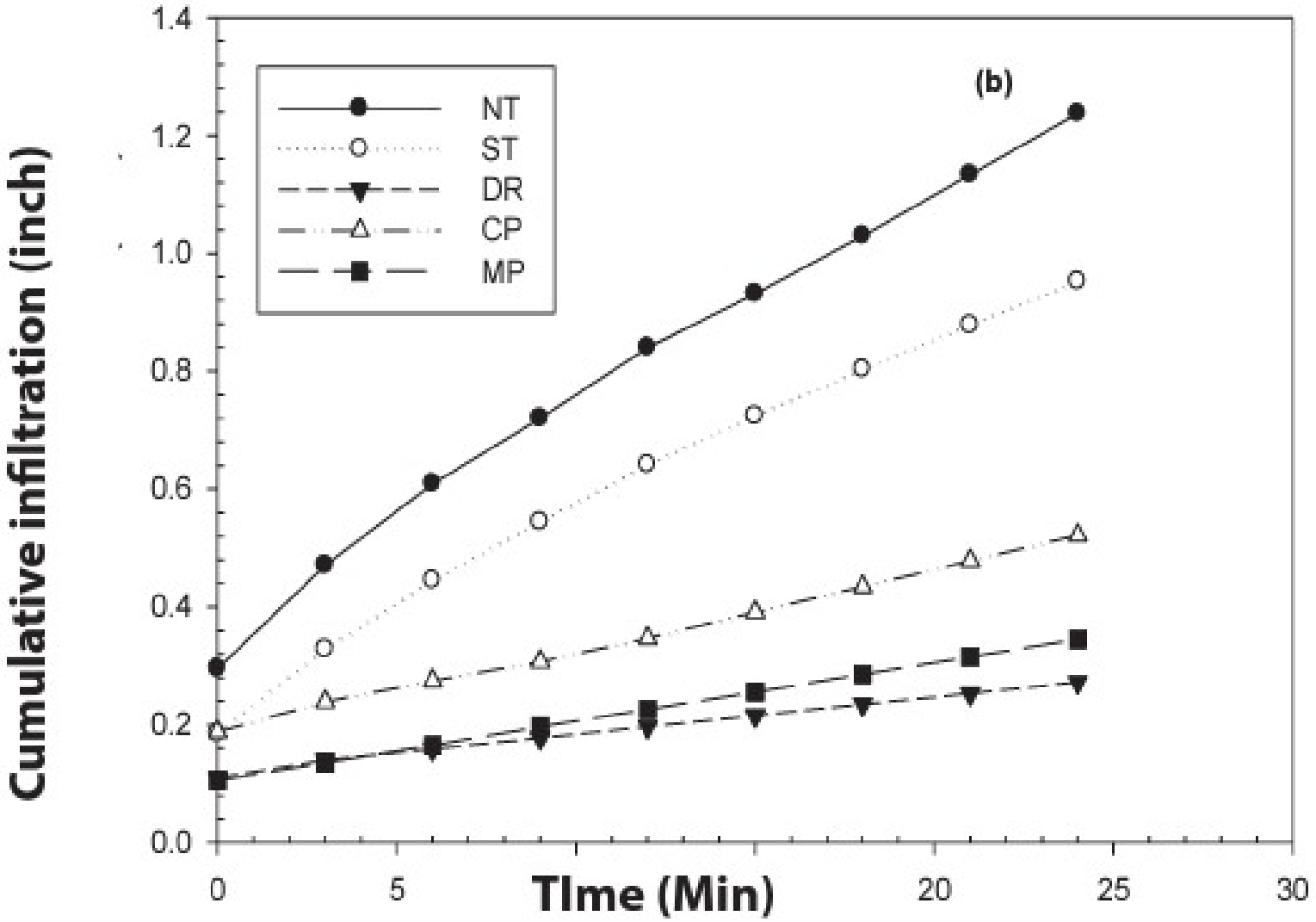
Tillage Destroys Structure

Tillage Depth and Aggressiveness

- Breaks up aggregates
- Leaves the soil unprotected
- Leads to clogged pores and crusts the soil surface

Standing residue acts like straws

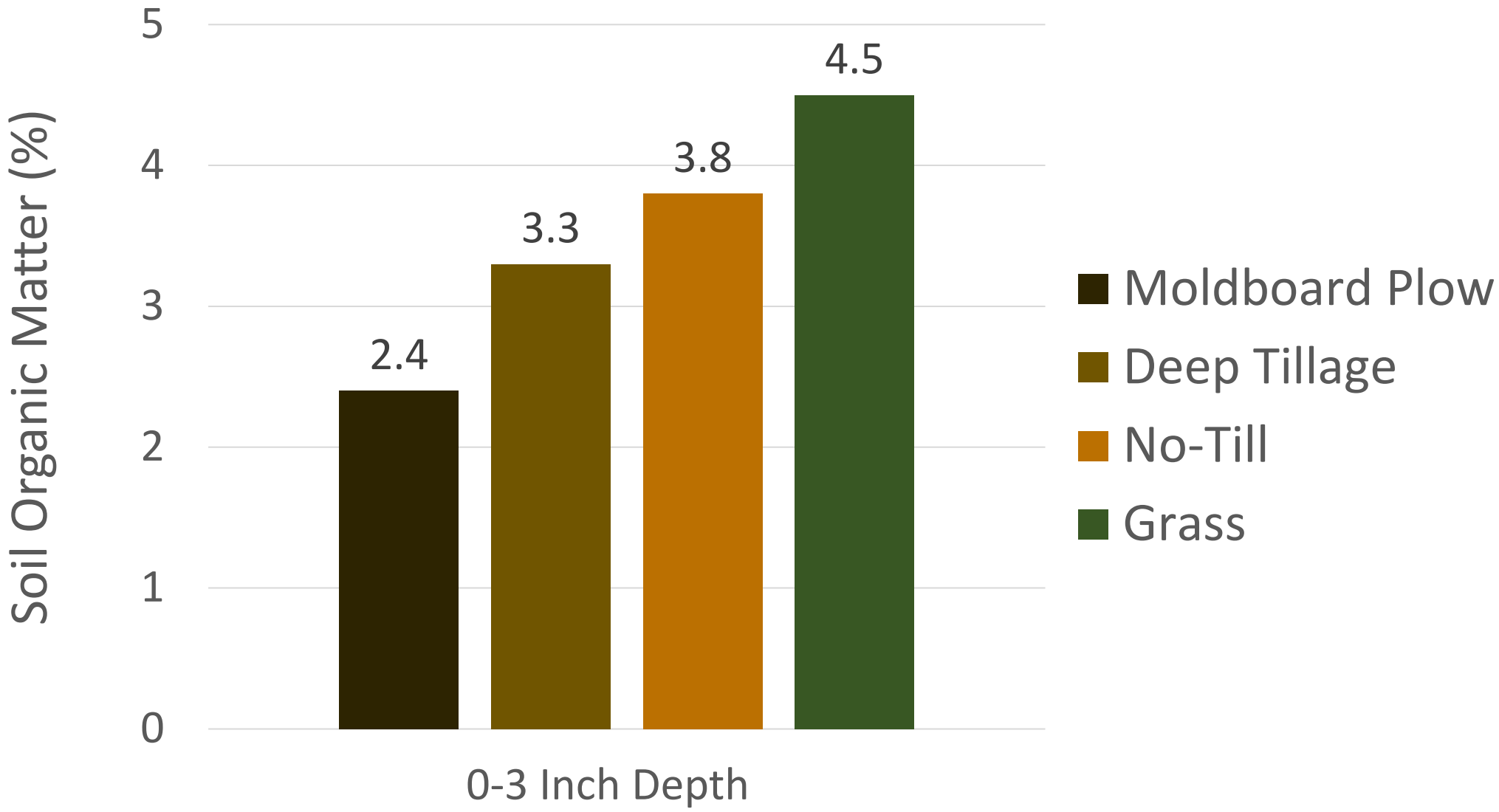
Tillage Impacts on Infiltration



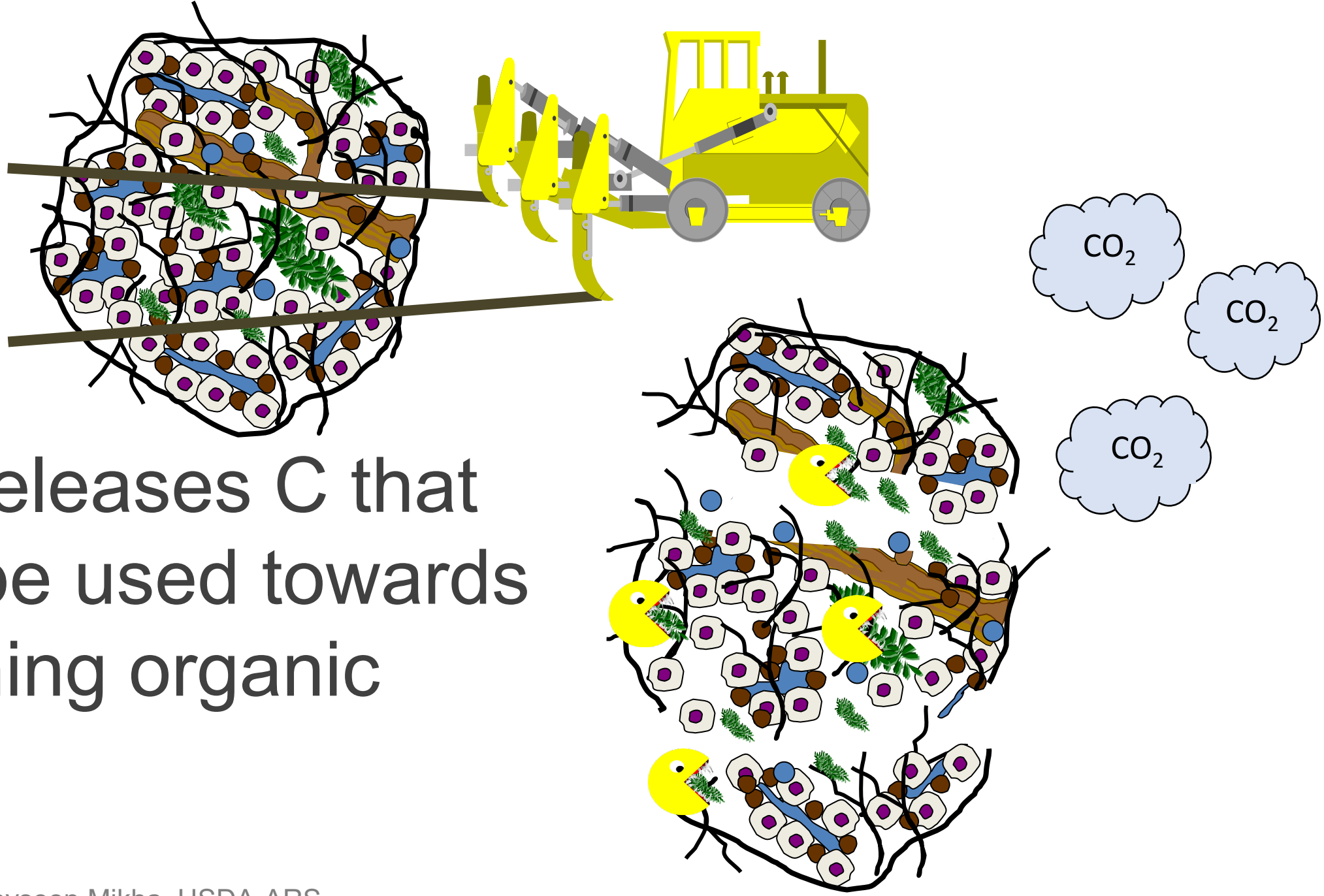
NT and ST increased water infiltration by 50-70% over conventional tillage systems.

Al-Kaisi, 2013

Less Tillage = More Organic Matter (C)



G. Hoyt, 2005



Tillage releases C that cannot be used towards maintaining organic matter.

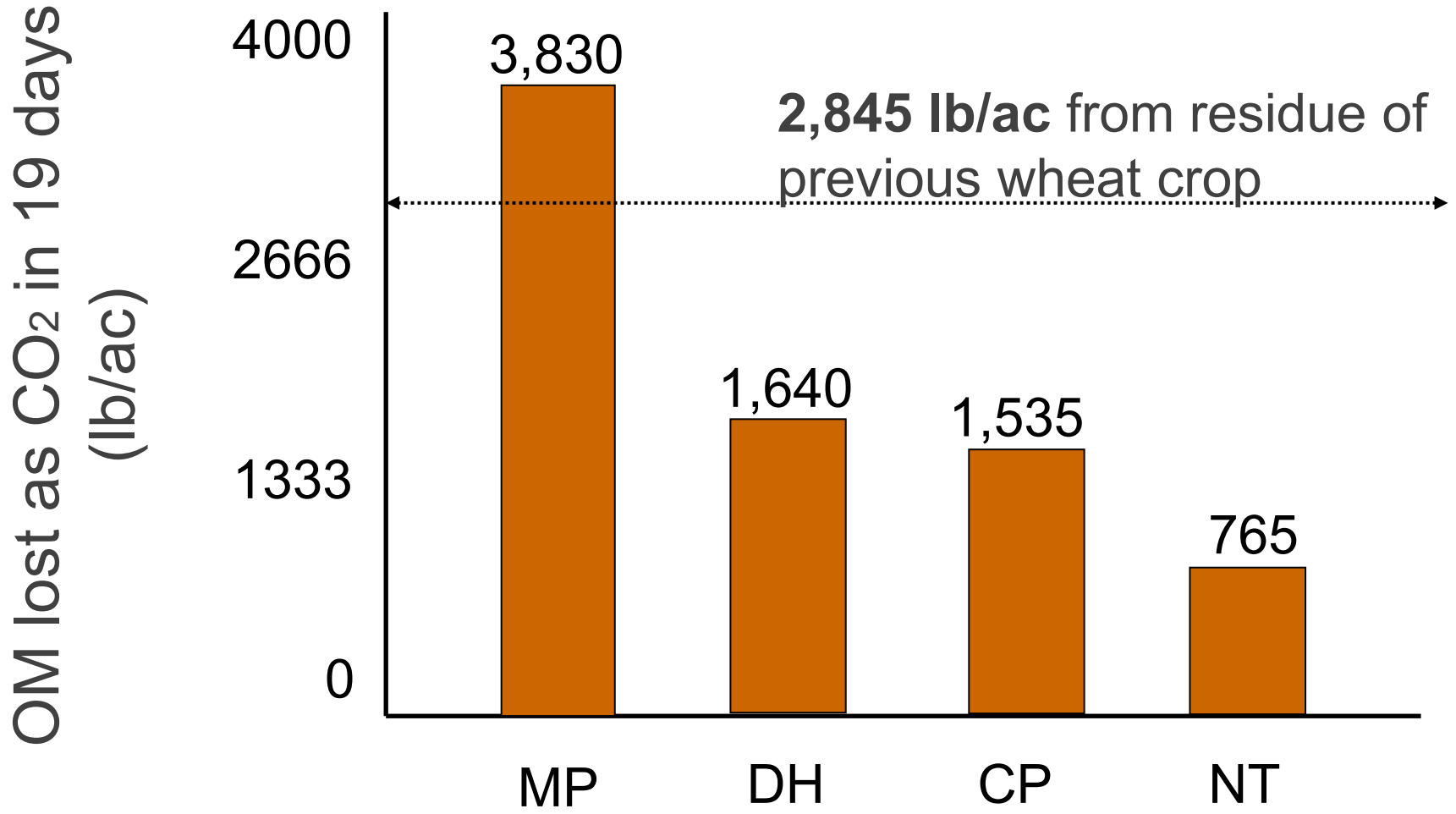
Figure courtesy of Maysoon Mikha, USDA-ARS

How do you measure CO_2 (carbon) loss?

with MR. GEM

USDA-ARS Morris, MN

MN Tillage-Carbon Study



Reicosky and Lindstrom, 1993

Shallow Tillage Implements (1-4”)

can be used in fall or spring

Points and Shanks

- Lifts and separates the soil
- Less destruction of soil structure

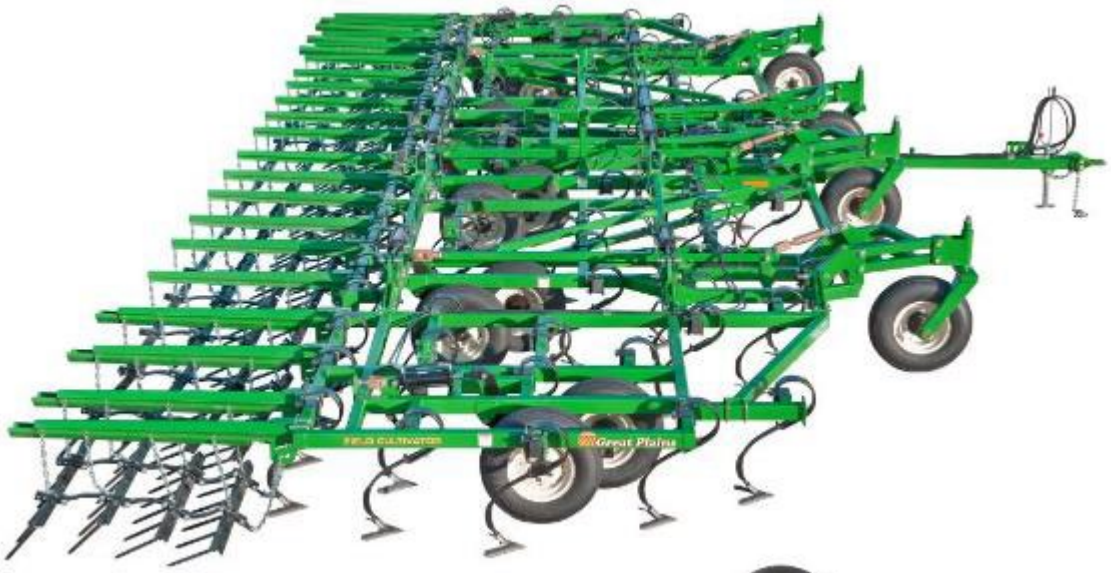
Field Cultivator

Shallow (3-4’)

Staggered rows

Turns soil over

Works well in dry soil



Sweep

Point

Photos from Google

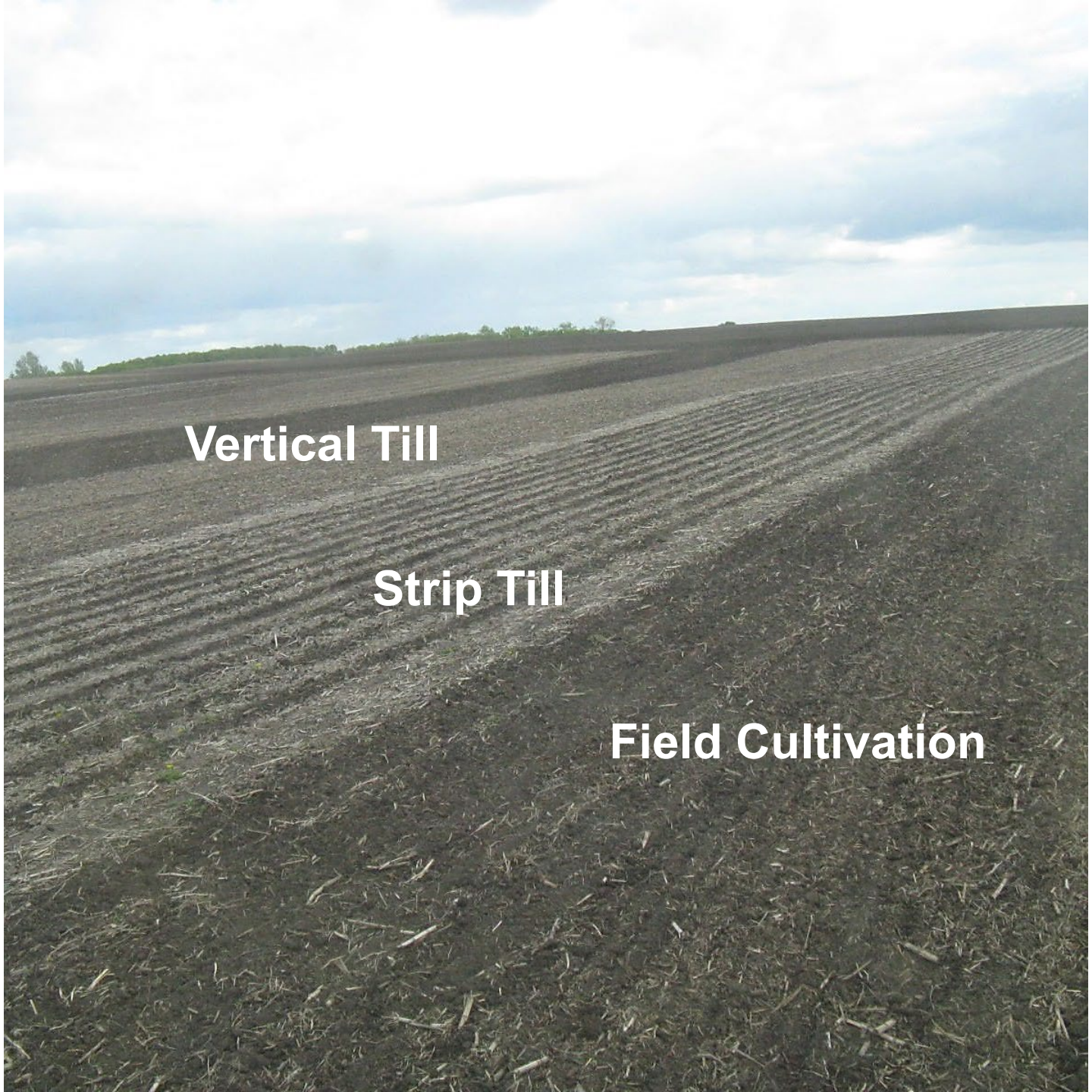
3-4” Depth

Even Mixing of Soil

Good Fertilizer and Weed Incorporation

Even Seed Bed Prep

Challenges: <30% residue remaining



Potential for smearing in a wet soil

Vertical Till

Shallow (1-3”)

Classified as mulch till

Gang angle <5%

Chops and Sizes Residue

- Smooths soil
- Residue management

Primary or Secondary Tillage

Fast:
9 to 12 mph

Increased erosion potential

Similar Designs

10 hp per linear foot
(more for hills or dry soil)

Photos: Deann Pressley, KSU

Benefits of Vertical Tillage

Can get into wet fields

Leaves Some Residue Intact

Weed Pressure

Challenges for VT

~ Fertilizer incorporation

~ Stalks blowing around

Extremely Dry Soil

* 1 inch of rain in 3 months, late July to October 2011

September 2012

Shallow or High-Speed Disk

Levels and Firms the Seedbed

Great at Sizing Residue and Soil Clods

Too good

Buries more residue than other 2º tillage tools

Challenges for a Disk

- Loss of soil structure
- Crusting
- Less residue
- Hurts water infiltration
- Shallow tillage pan

Disks in Dry Soil

Pros and Cons

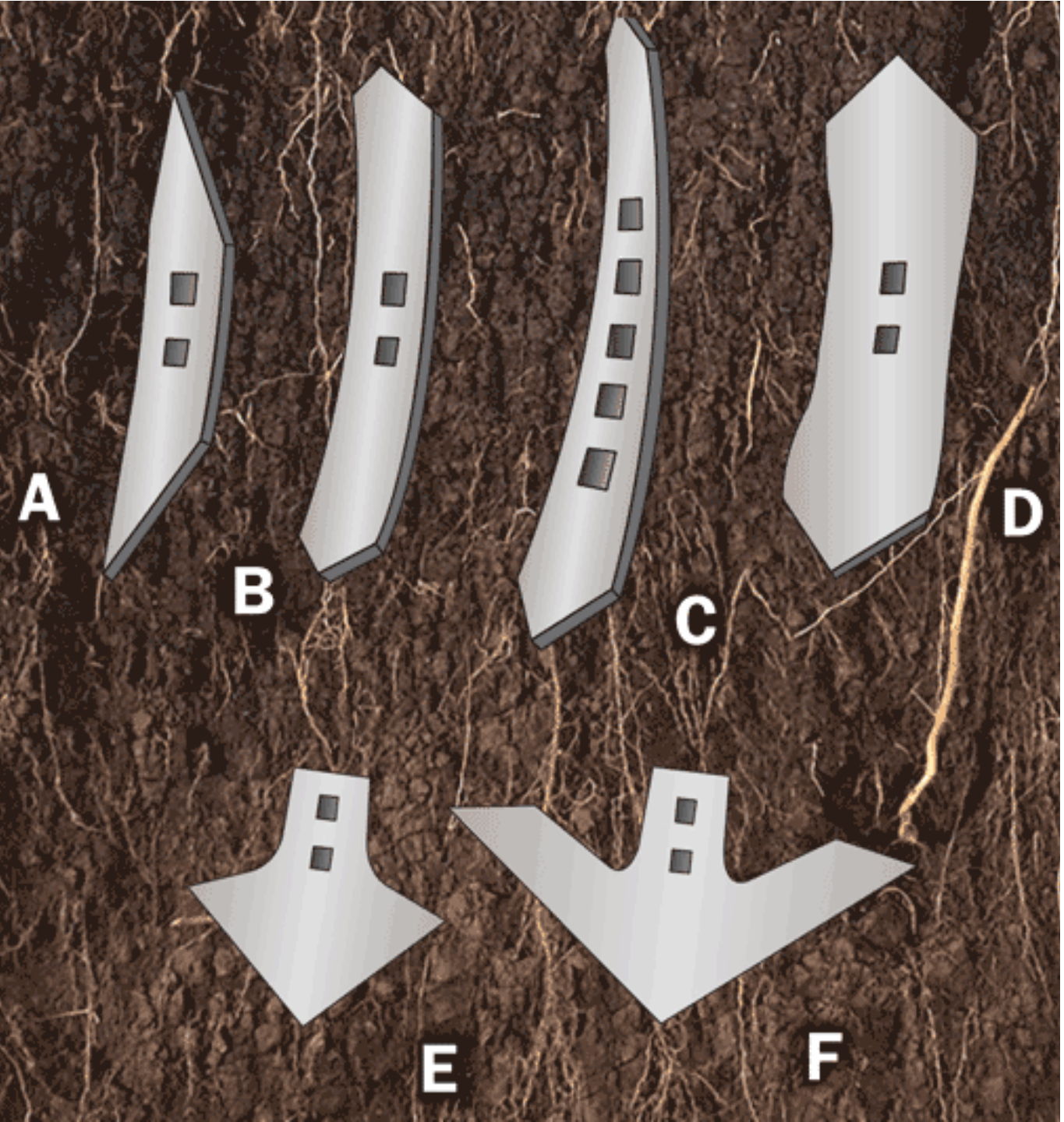
Medium Depth Tillage Implements (6-9”)

mainly used in fall, some spring purposes

Chisel Plow

- 6-9” deep
- Full field tillage
- Conventional tillage
- Varies in aggressiveness
- Slower speeds than shallow tillage

Photo courtesy of Dick Wolkowski, UW



Chisel Plow Points

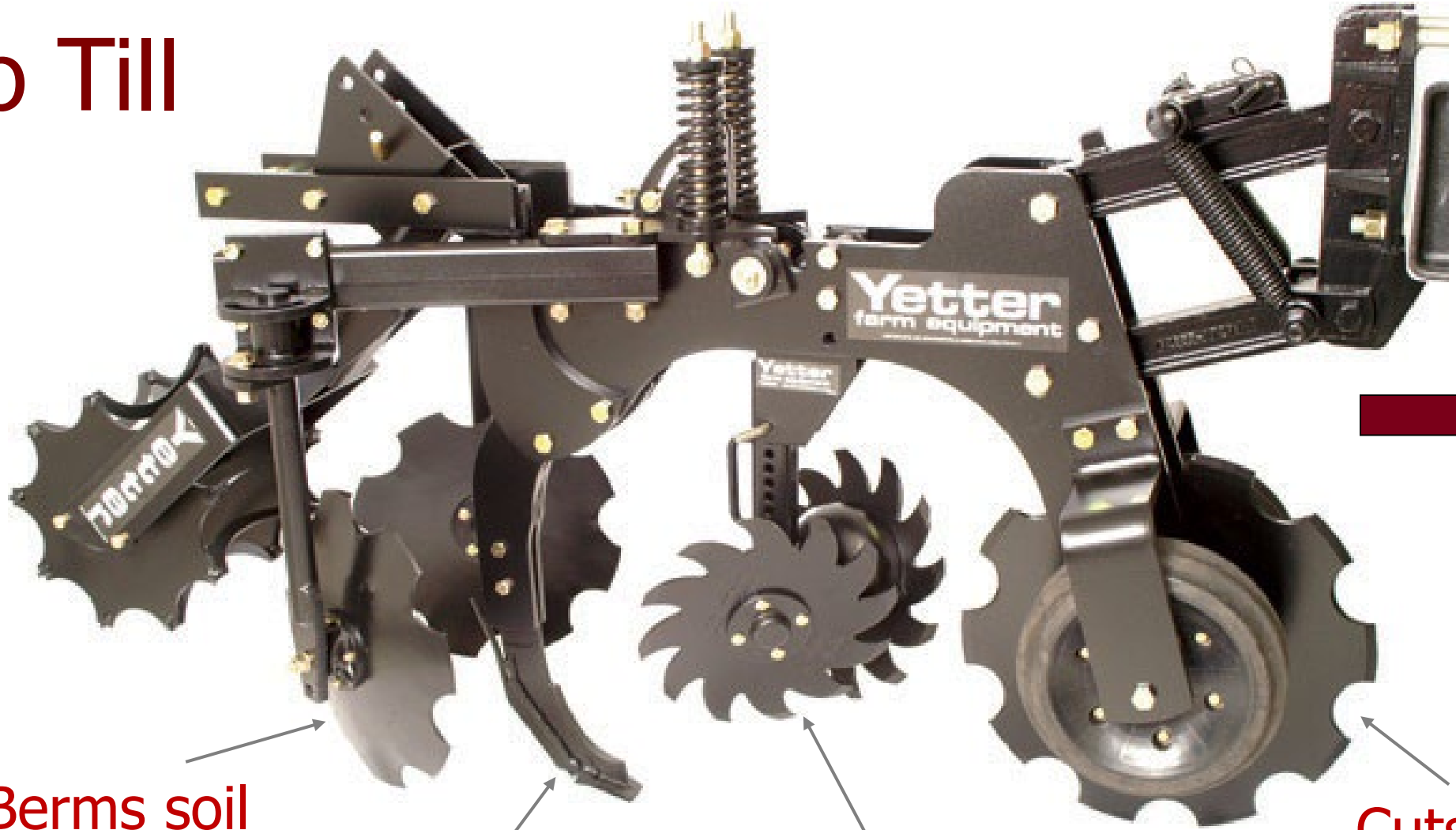
- Soil disturbance
- Depth
- Residue incorporation
- Smeared soil potential

Twisted Shovel vs. Sweep

Provided by Dick Wolkowski, UW)

Strip Tillage

Strip Till



Berms soil

Tills and injects fertilizer (6-8”)

Moves residue

Cuts residue

Disturbs only
1/3 of the soil

Plant into tilled area

P and K applied 6-8” deep with strip till pass

N can be applied w/ST, at planting, or side dressed

- Potential for one-pass across field
- Less energy and less erosion than conventional systems

Success Starts with the Combine

Even distribution of chaff and straw =

- Even temp and moisture
- Better planter performance
- Even germination

Photo: Dorian Gatchell, MN Ag Services

Deep Tillage Implements (10-20”)

used only in fall

Disks

- 8-15” deep
- More destructive forces
  - (very aggressive)
- Shears and presses soil

Where to Use a Disk

To break up clods and make a roadbed

Disk Ripper

Disk Ripper

- 10-16” deep
- Different sized shank options
- Very aggressive tillage
- Deep tillage but more residue remaining than chisel plow

Soil movement ahead of shanks

Mold Board Plow

- 8-16” deep
- Most aggressive tillage
- Highest fuel use, erosion rate, and time requirement
- Very harmful to soil biology

Long-term MBP Soil

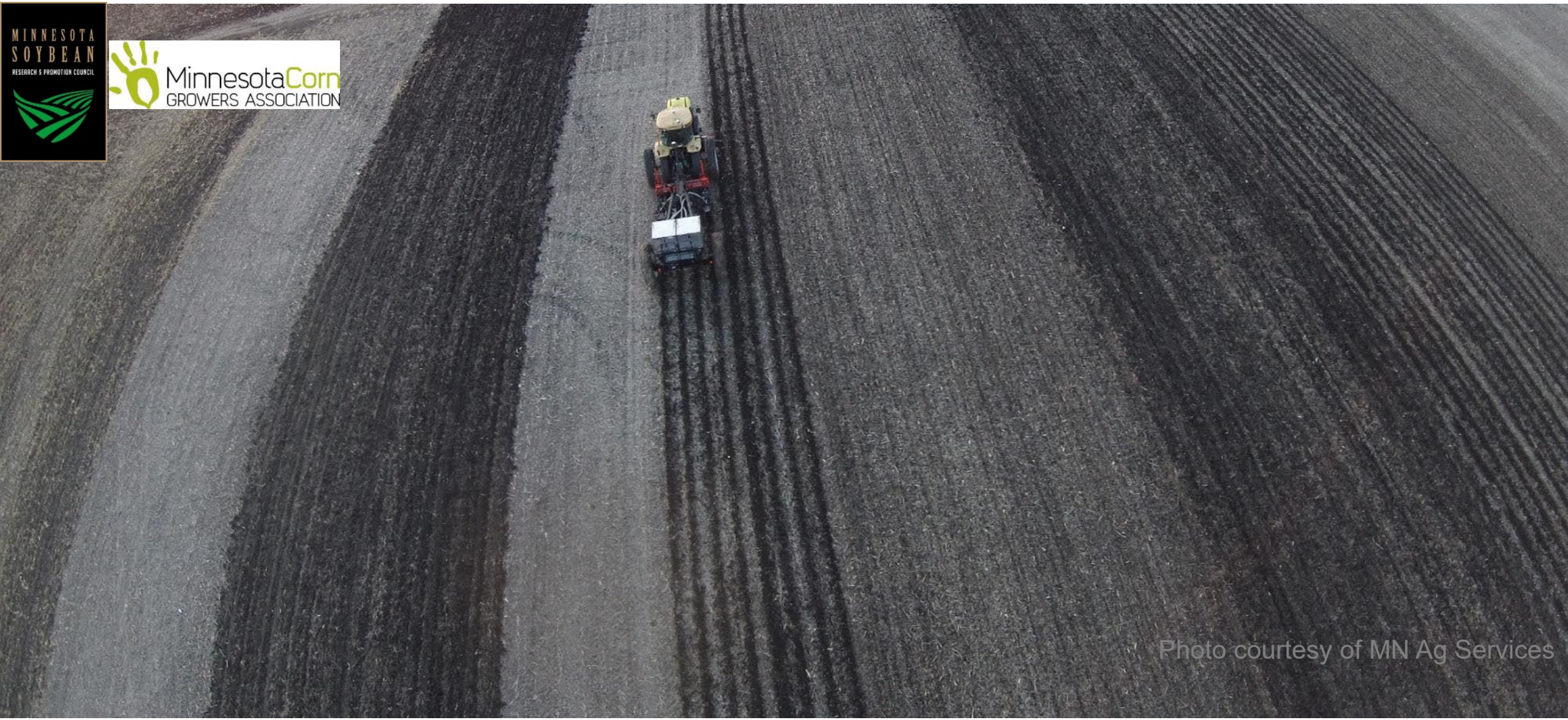
- Reduced structure – turns into a brick
- Reduced infiltration
- Prone to ponding
- More water erosion

Variable Depth Tillage!!

Vertical Till and/or Chisel Plow

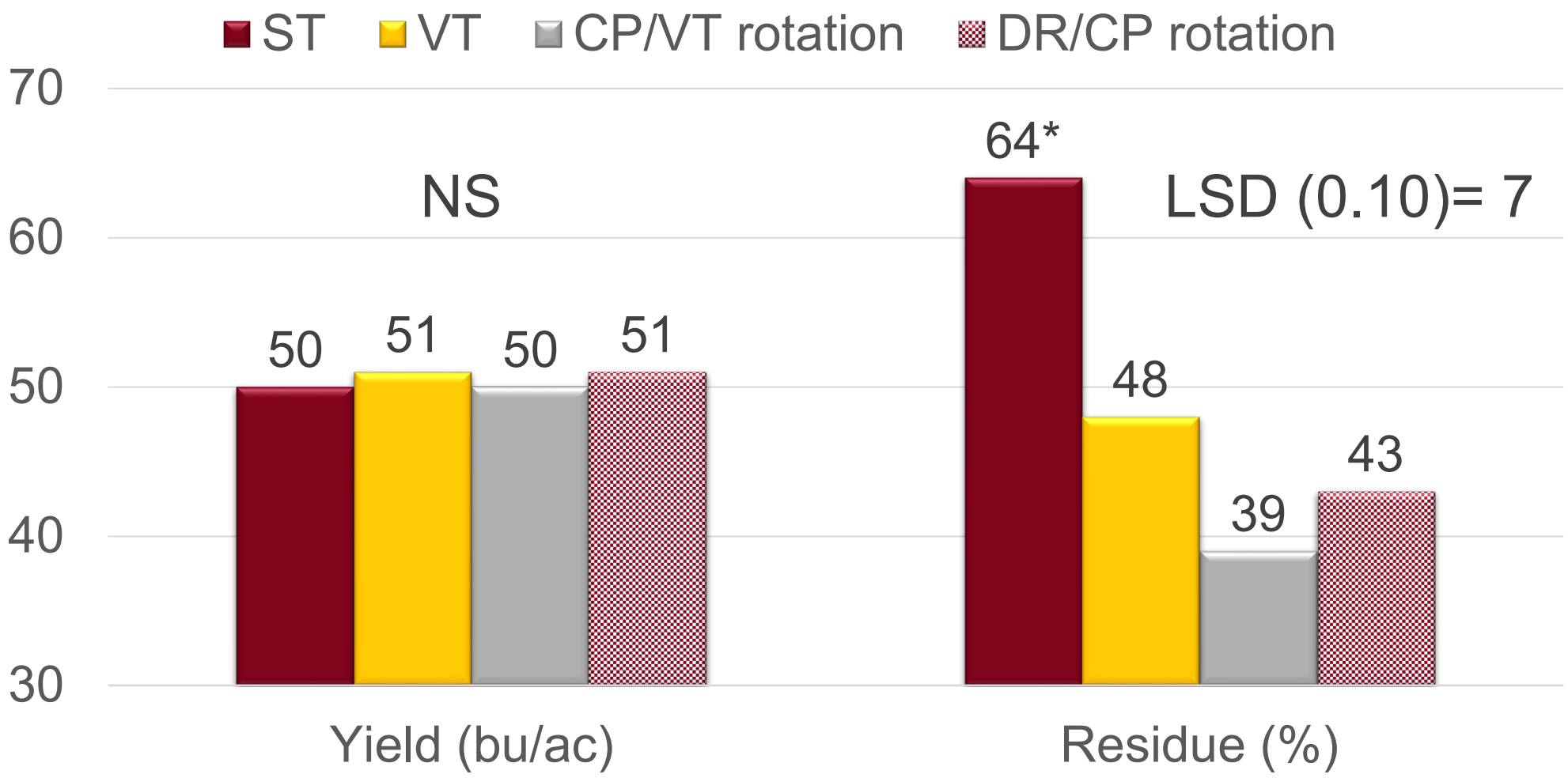
Reduced Tillage Concern

Yield Will Suffer



90% of Research Conducted in Farmer's Fields

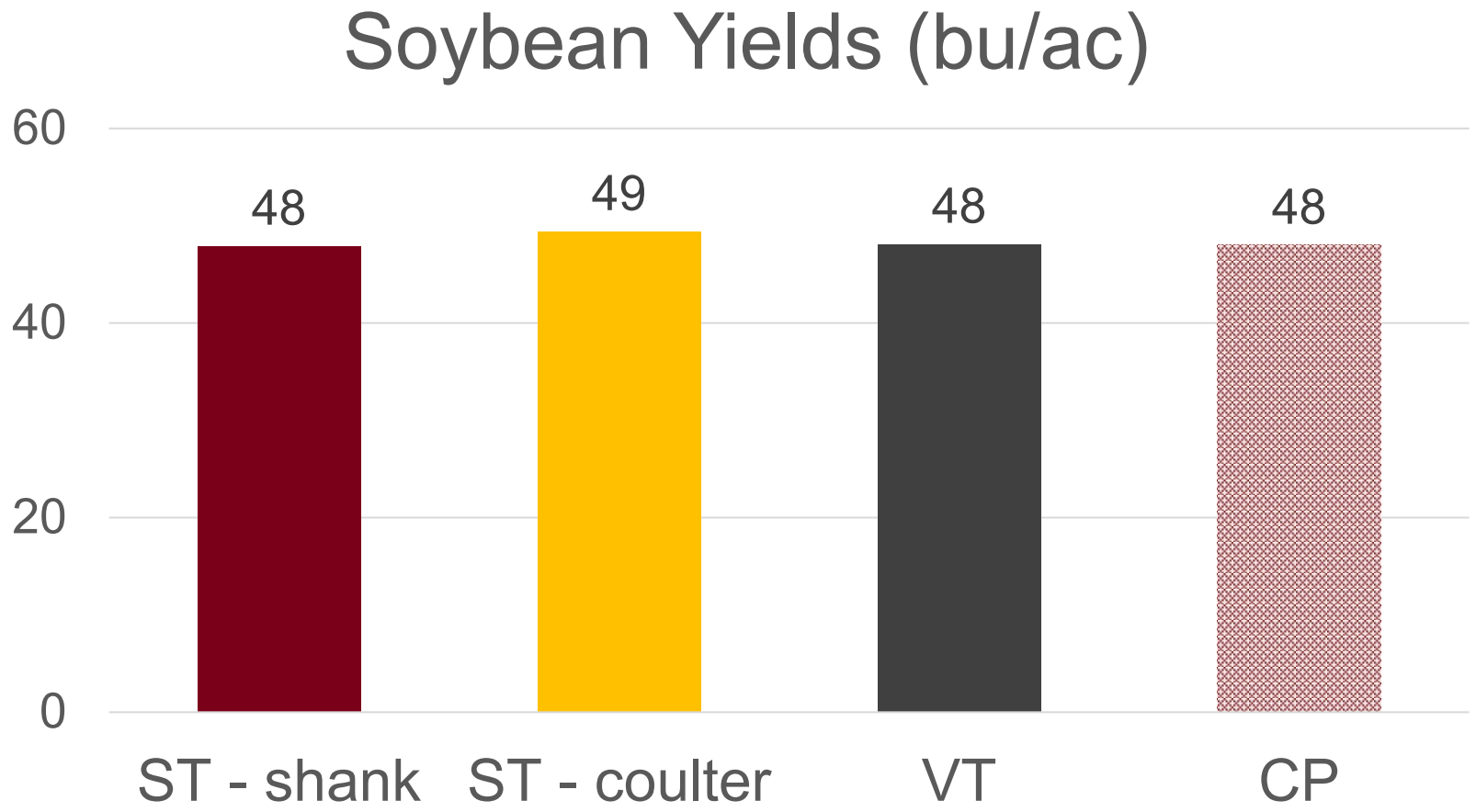
WC Soybean (2010-2012)
3-Year Yield and Residue Averages



* Yields are not statistically different from each other. Residue was significantly different with an LSD (0.10) = 7.

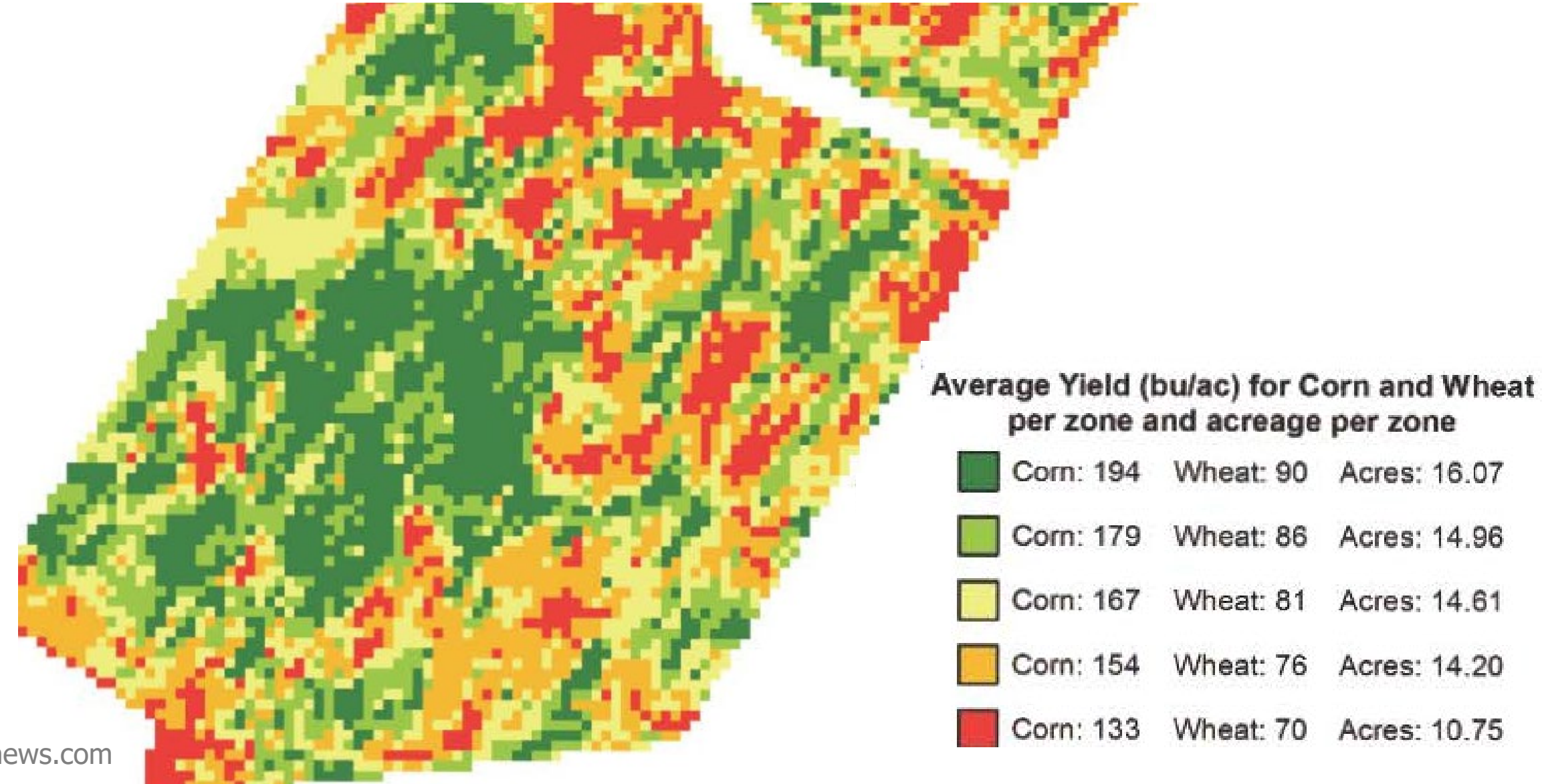
NW Soybean Yields (2016 and 2018)

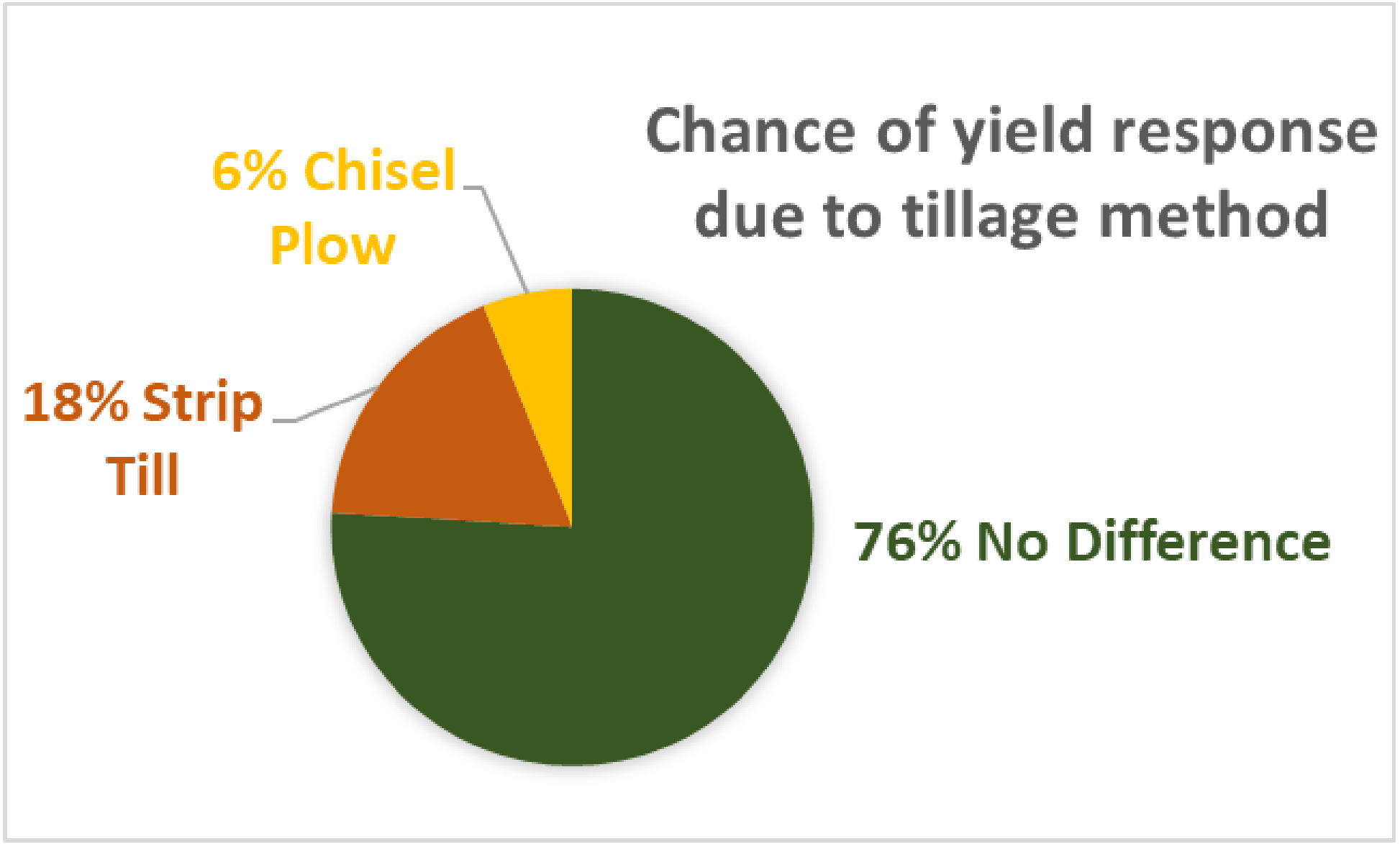
Average of 4 Site Years



No statistical difference

Yield Variability and Statistics

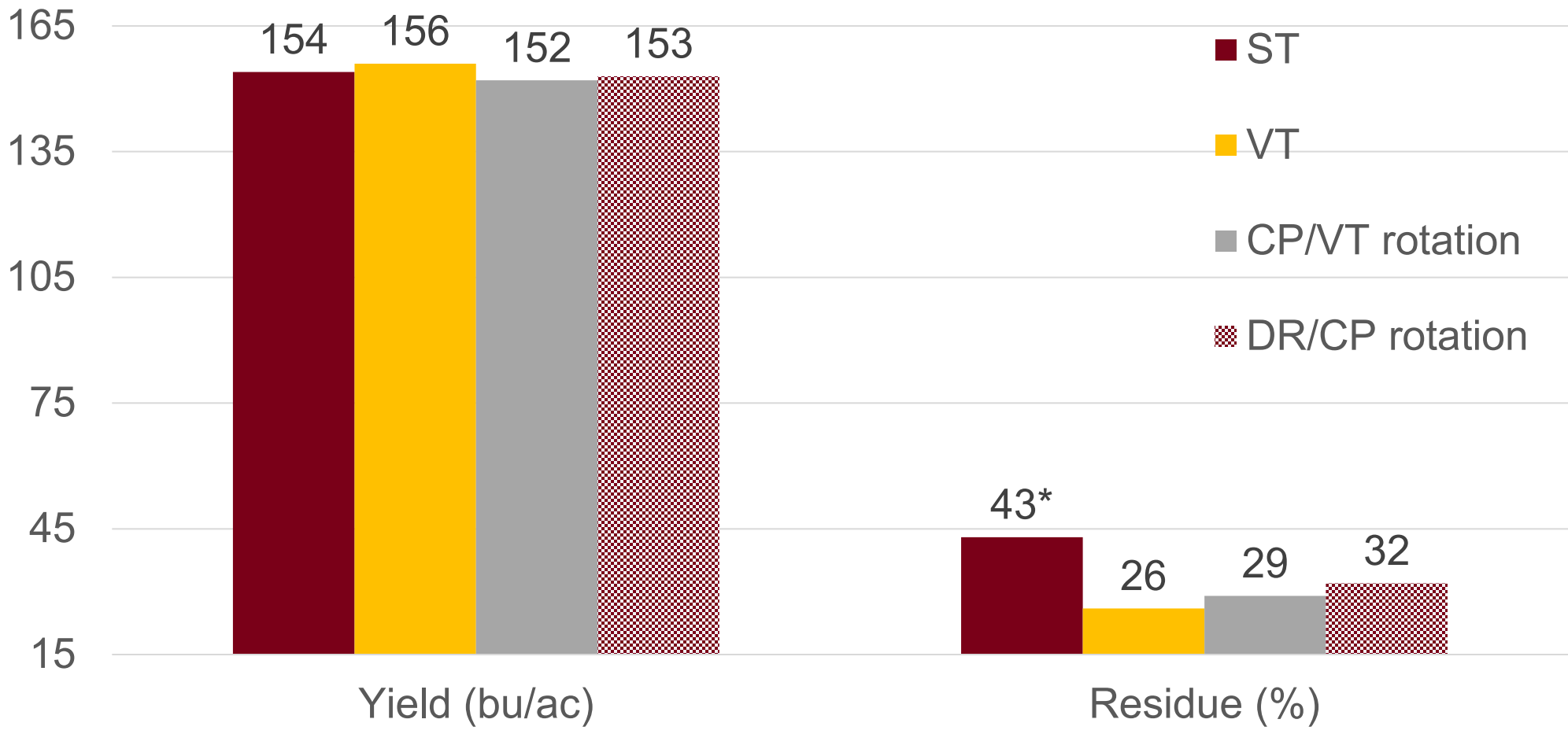




Soybean yield response to tillage for 17 site years in E. North Dakota and NW Minnesota (2005 – 2012)

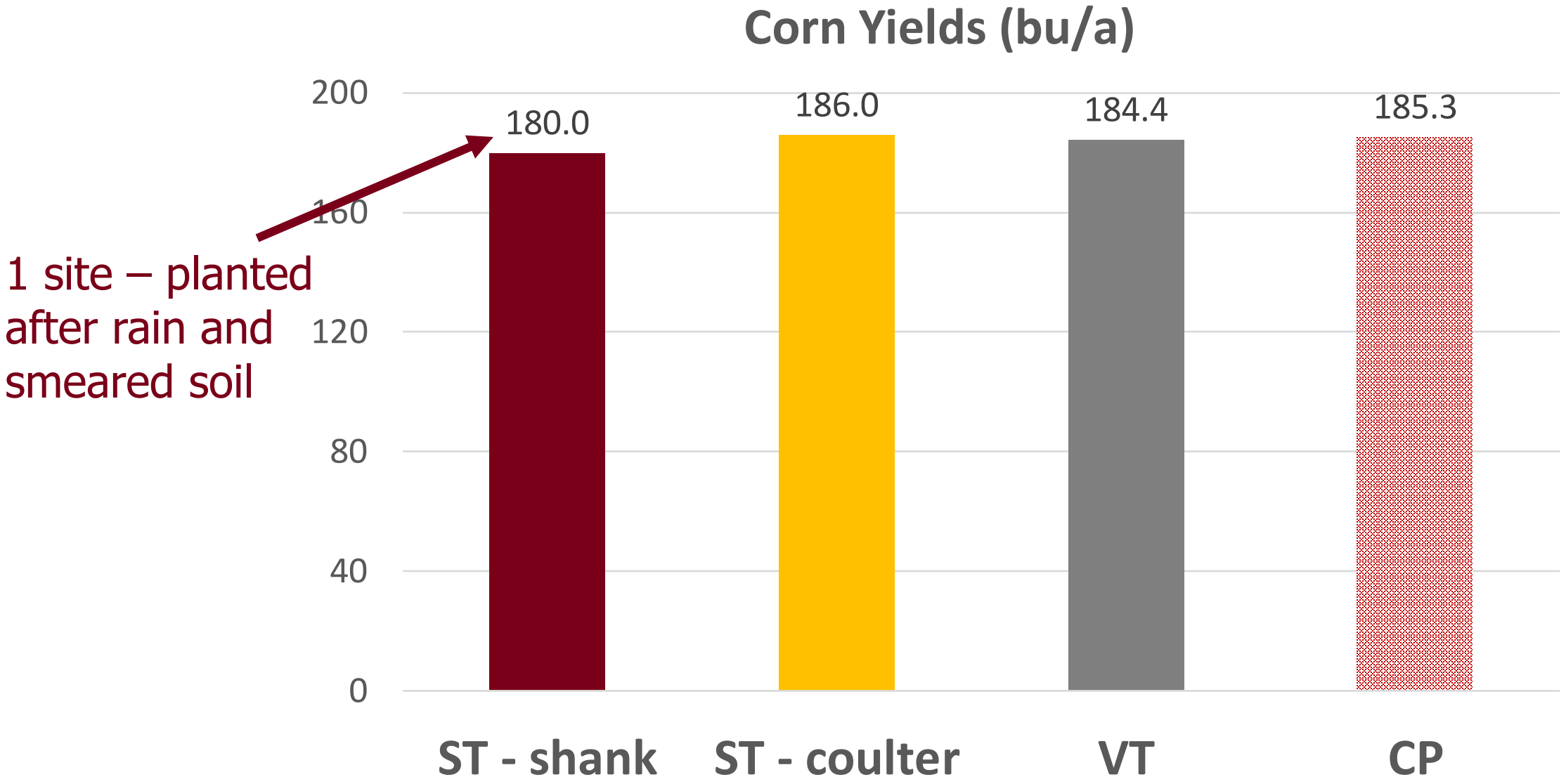
WC Corn Yields (2010-2012)

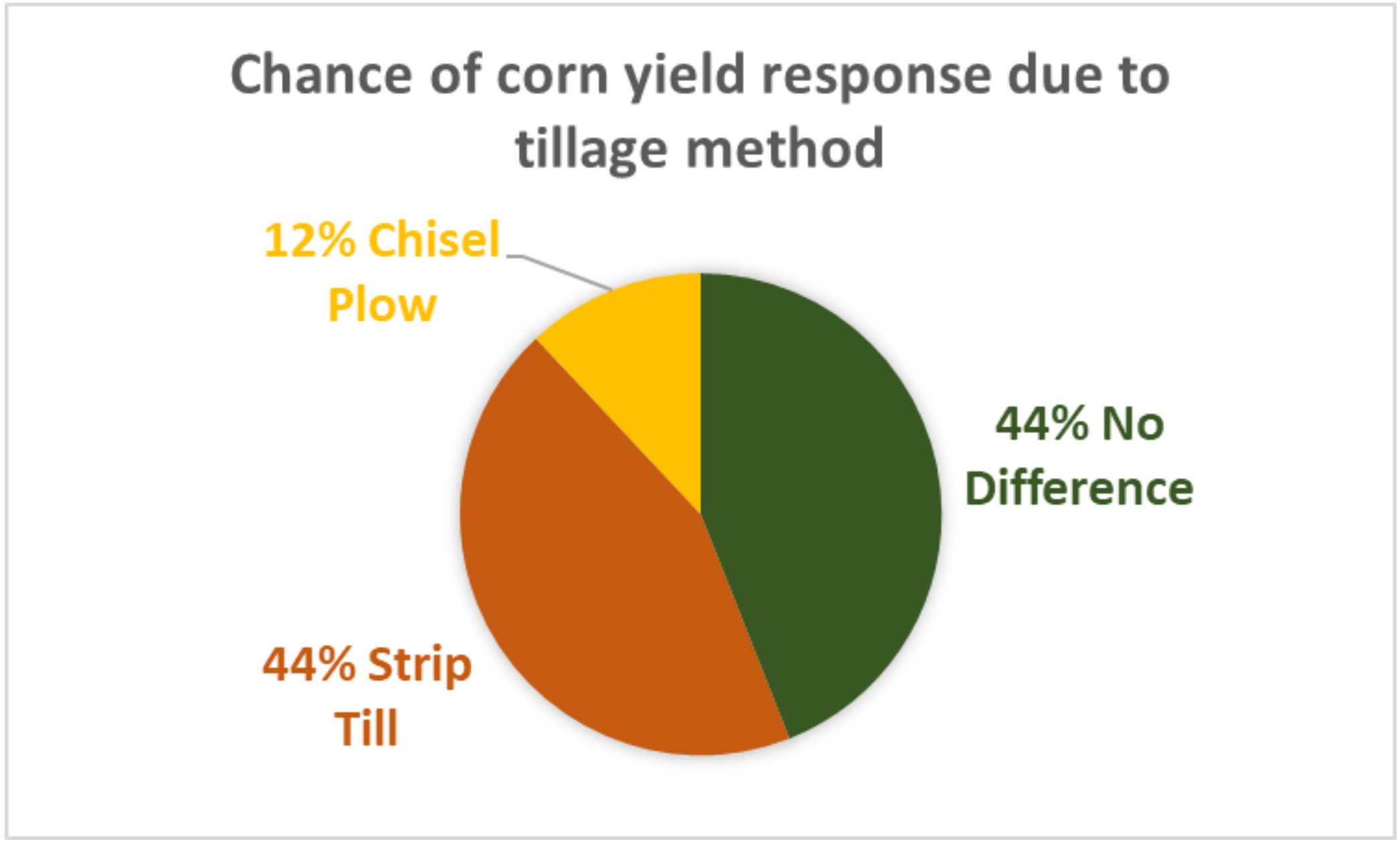
3-Year Yield and Residue Averages



* Yields are not statistically different from each other. Residue was statistically different with an LSD (0.10) = 4.

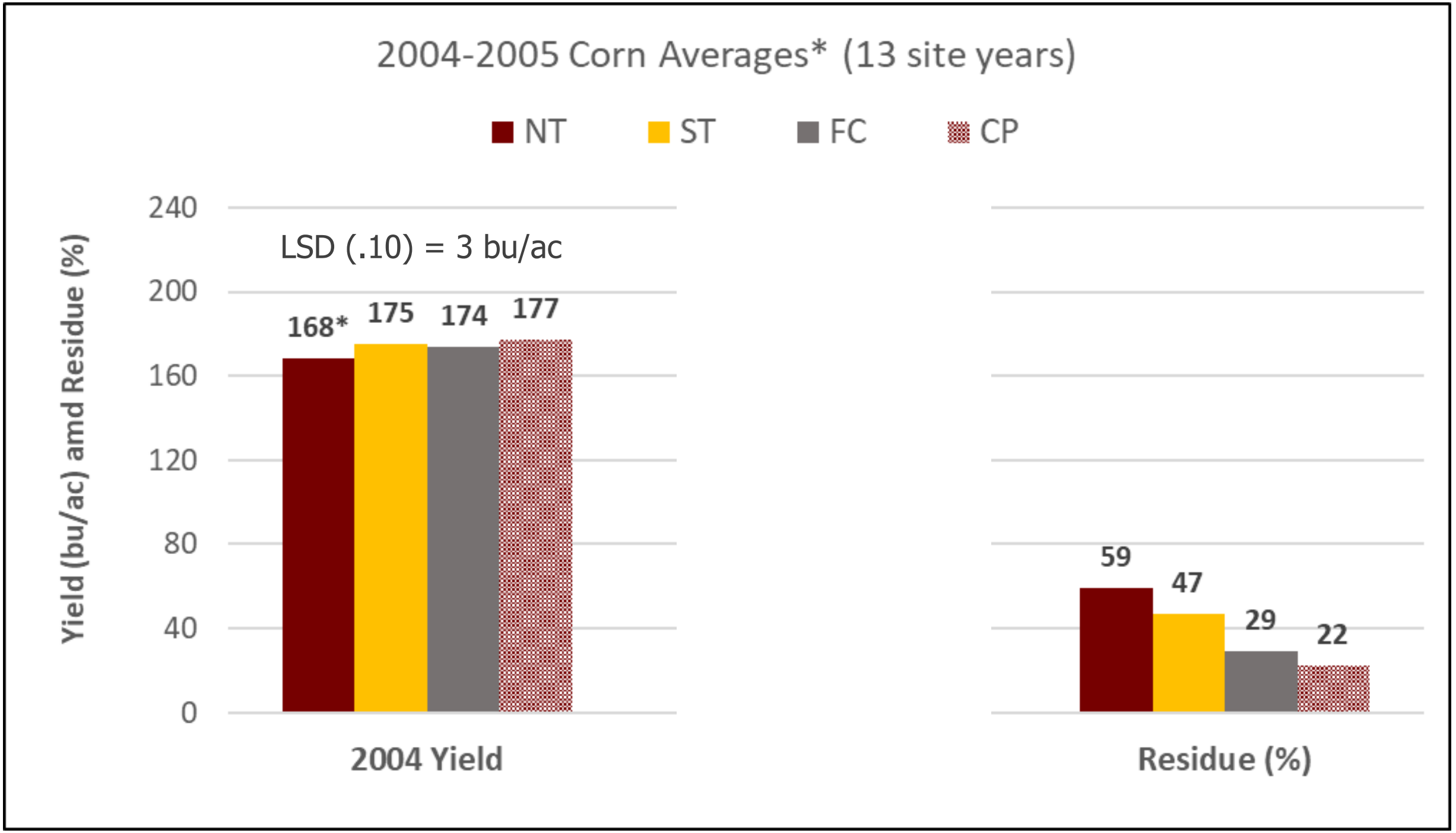
Average of 4 Site Years of Corn Yields





Corn yield response to tillage for 18 site years across E. North Dakota and NW Minnesota through 2005 - 2012.

Weather Has More Affect on Yield Then Tillage


2004-2005 Corn Averages* (13 site years)
NT
ST
FC
CP
Yield (bu/ac) amd Residue (%)
240
200
160
120
80
40
0
LSD (.10) = 3 bu/ac
168*
175
174
177
59
47
29
22
2004 Yield
Residue (%)

Tillage Costs per Acre

Assumptions:

- $2.75 diesel
- $20.00 labor
- 1,400-acre grain farm
- New tractor and implement overhead
- Not adding additional cost of chopping head
- Costs include overhead (depreciation, interest, insurance, housing and repairs), fuel and labor charges.

Source: July 2021, Farm Business Management, University of Illinois Extension

Soybean Tillage Costs

	No-till	1 pass ST	1 pass SpD	1 pass FC
First Implement	0	$17.30	$14.30	$11.10
No-till or Conventional Planter	$19.00	$19.00	$17.20	$17.20
Total cost/ac	$19.00	$36.30	$31.50	$28.30

Corn Tillage Costs

	Strip till	CP + FC	DR + FC
First Implement	$17.30	$13.60	$27.70
Liquid fert applicator (40’)	0	$ 7.70	$ 7.70
Second Implement	0	$11.10	$11.10
No-till or Conventional Planter	$19.00	$17.20	$17.20
Total cost/ac	$36.30	$49.60	$63.70

Challenges

- Learning curve
- Not everyone can do it
- Resources
- Perennial weed shifts
- Skepticism from neighbors

Changes in Soil Structure Takes Time

Remember in dry years, there is “natural tillage”

Know Your Fields

How aggressive do you need to be?

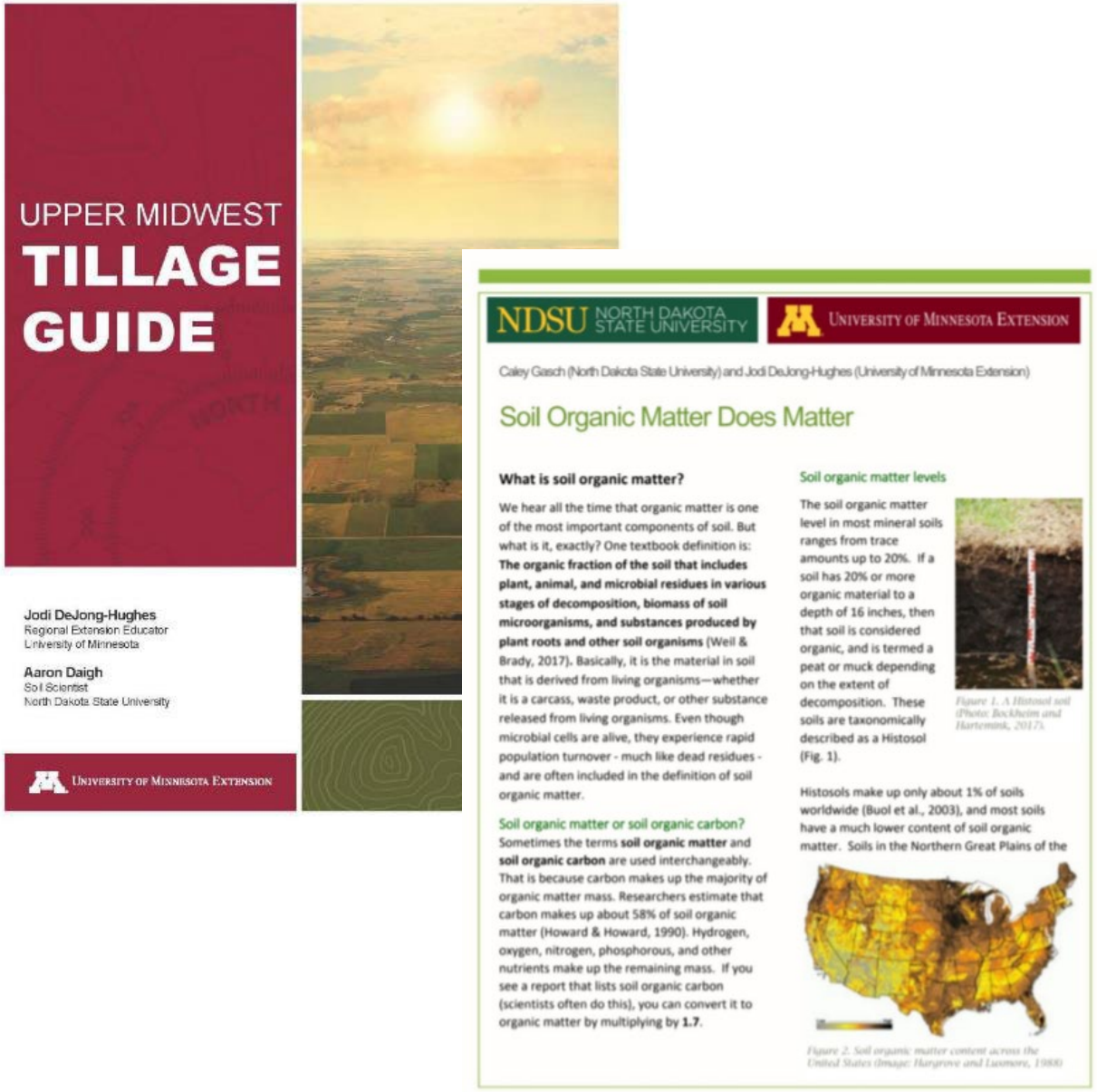
- Moisture – too much too little
- Crop rotation
- Soil type
- Topography

The Goal

Summary

- We've overestimated the importance of tillage affect on yield
- Each tillage pass costs money ($11-30/ac)
- Increases soil erosion (3 - 20 T/ac)
- Lost soil costs money ($25 per ton)

Cost per acre = $$$



Questions?

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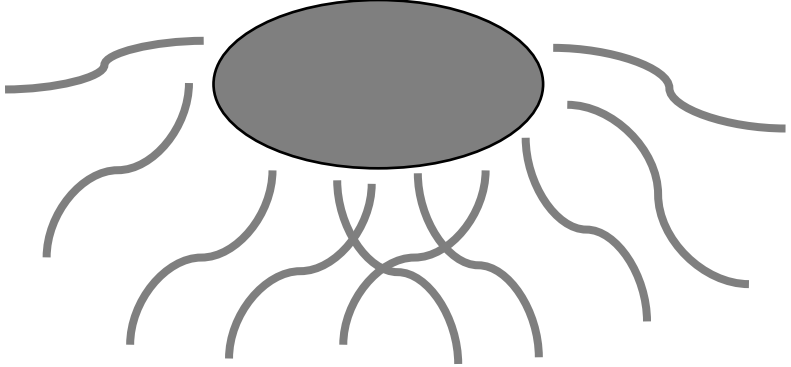
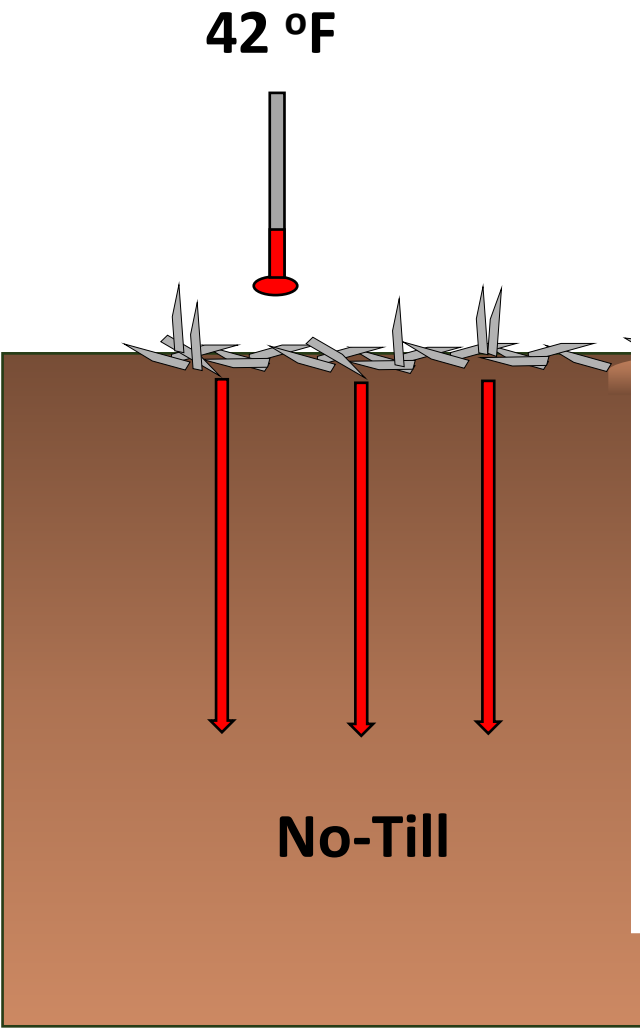
Reduced Till Planter Settings

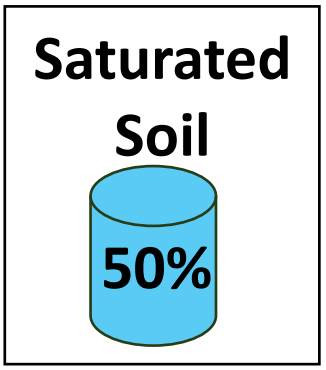
- Residue managers
- Sharp coulters/disk
- Everything in new and working order

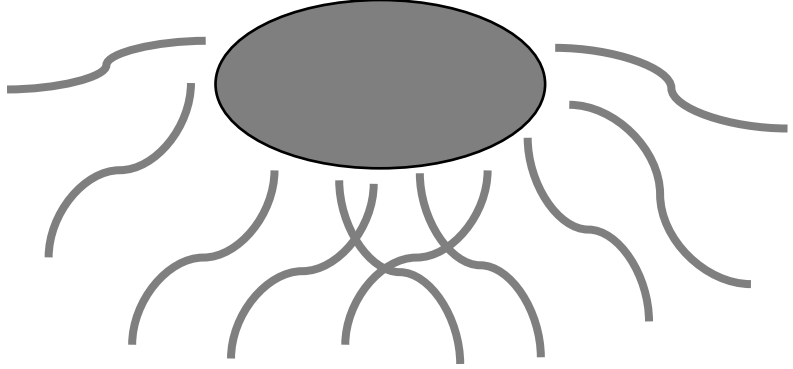


Average temperatures of the three farms

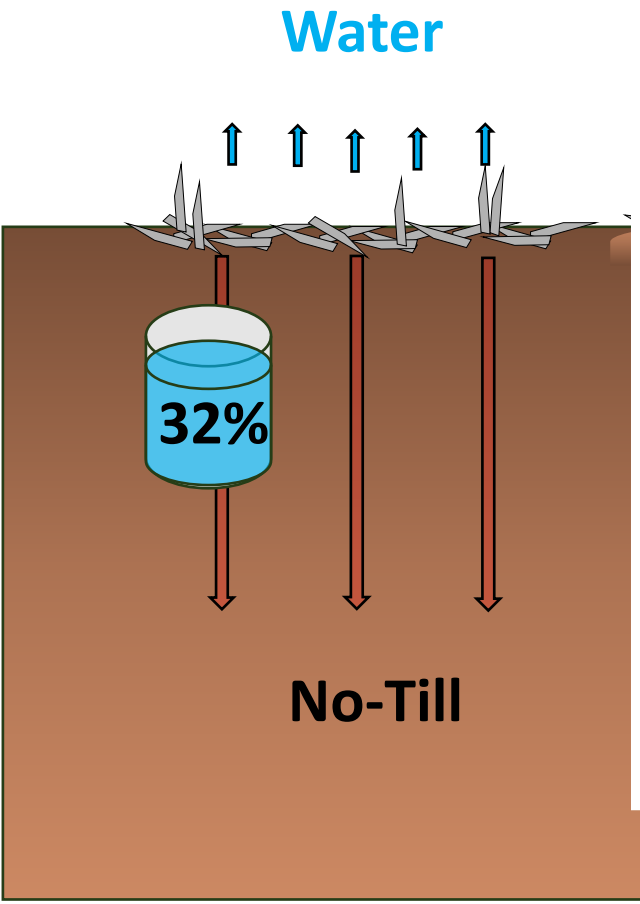


Daigh et al, 2019 NDSU





Average water content of the three farms



Daigh et al, 2019 NDSU

Option – Move Soil Back up the Hill

Study conducted in Minnesota, US and Manitoba, CA

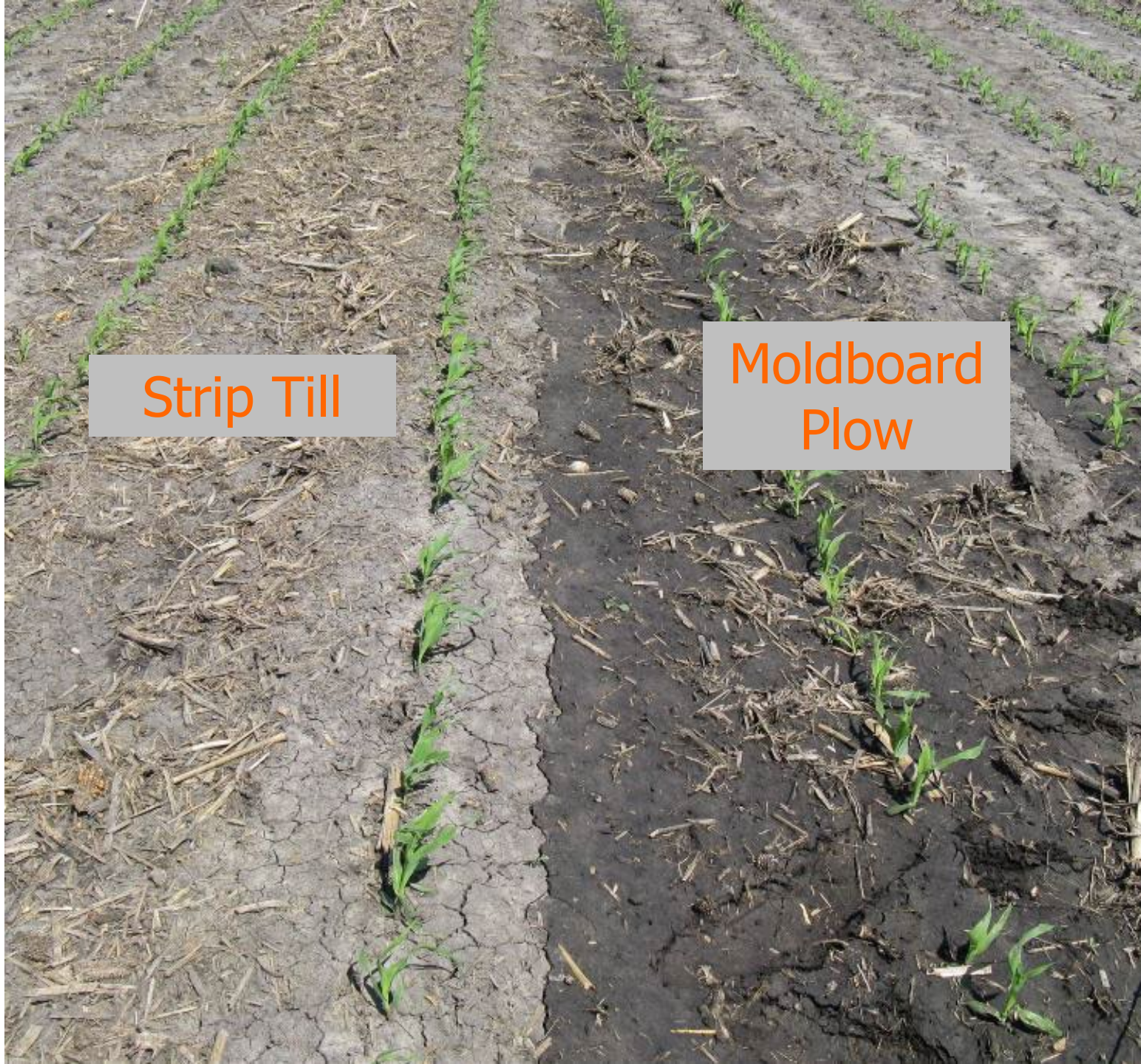
David Lobb, Treherne, Manitoba

Moving Soil **Back Up** the Hill

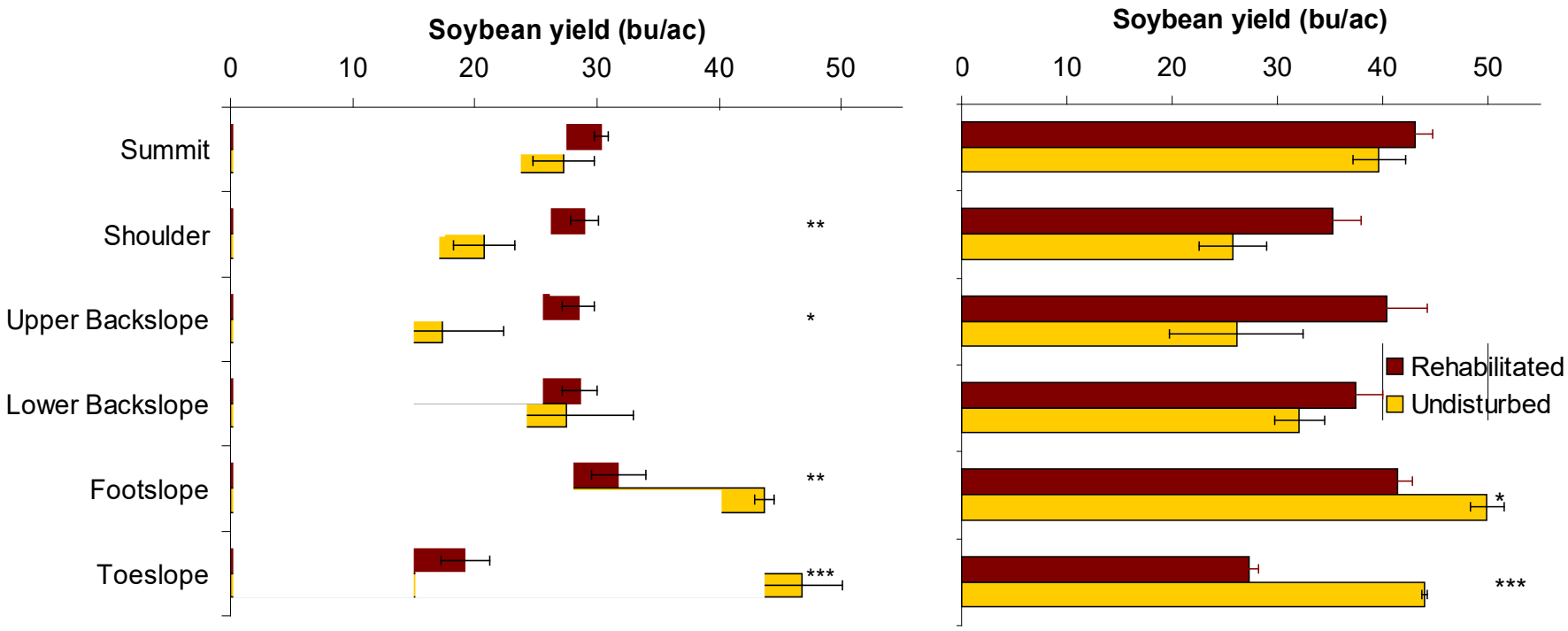
- 6-8 inches were moved back up the hill
- Yields were reduced in the lower area due to ponding and reduced soil structure
- Yields on slope were increased 24-48%

Reduced Tillage Concern #1

Reduced tilled fields won’t warm-up or dry in time for early planting



Soybean Yield: Minnesota

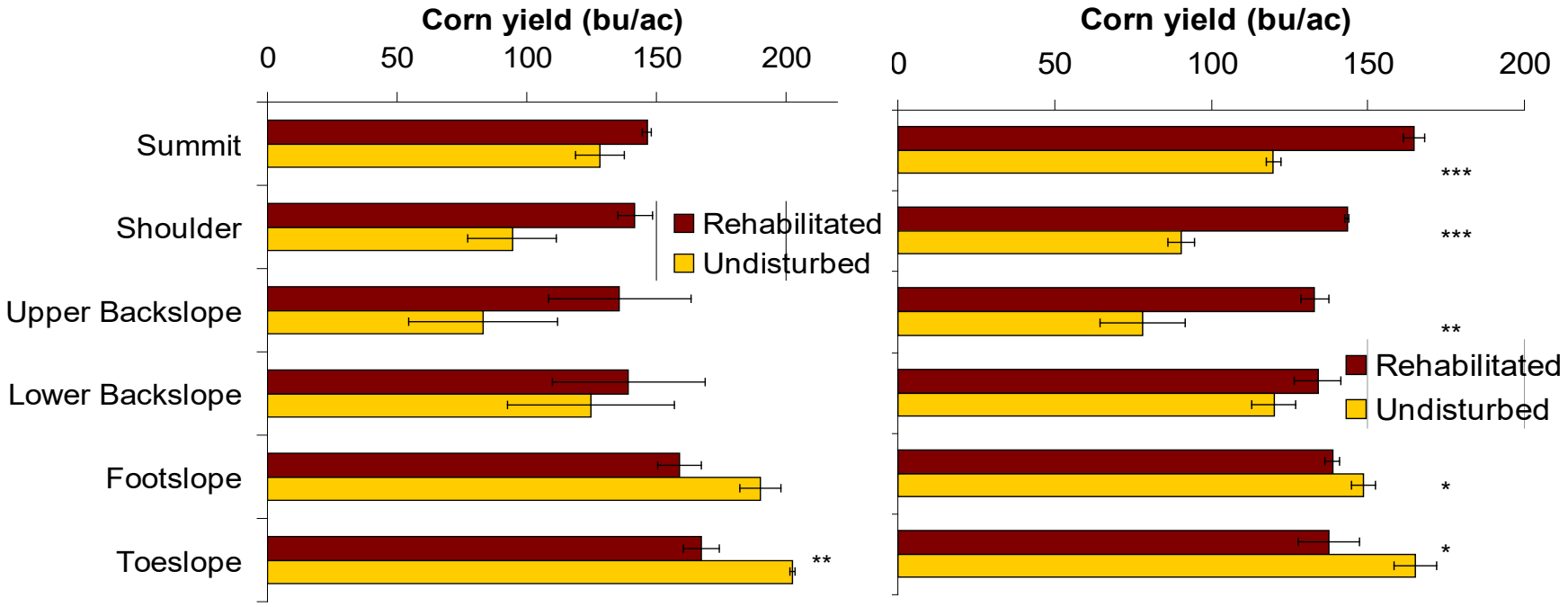


2006 2008

Yields in areas of soil addition>eroded areas

Low yields in areas of soil removal, especially in the toeslope: soil disturbance, excessive spring moisture

Corn Yield: Minnesota

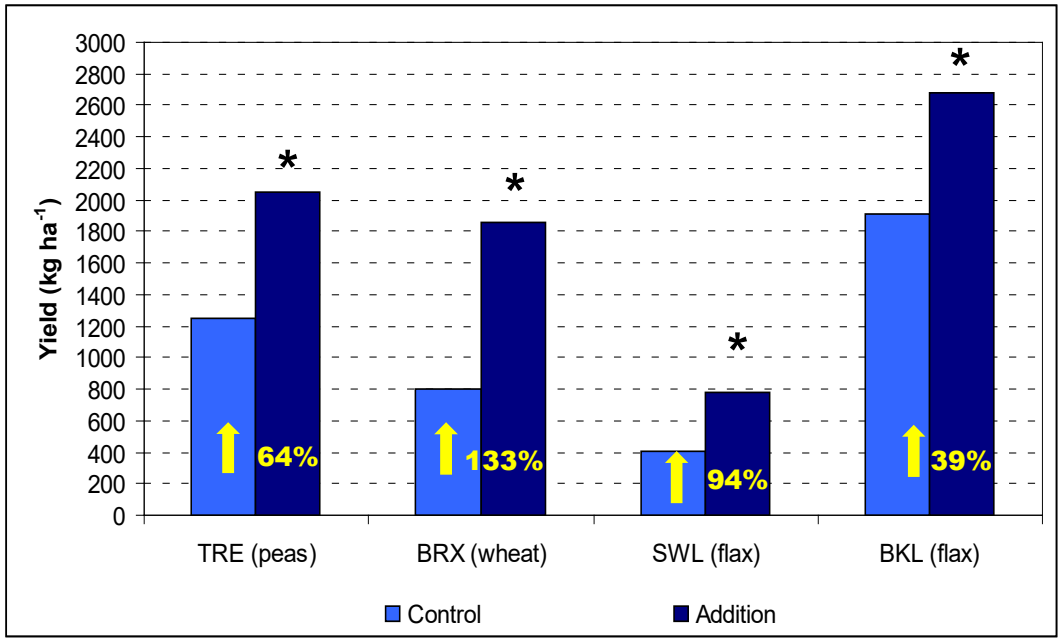


2007 2009

Yield differential in lower slope smaller than for soybean (affected by weather)

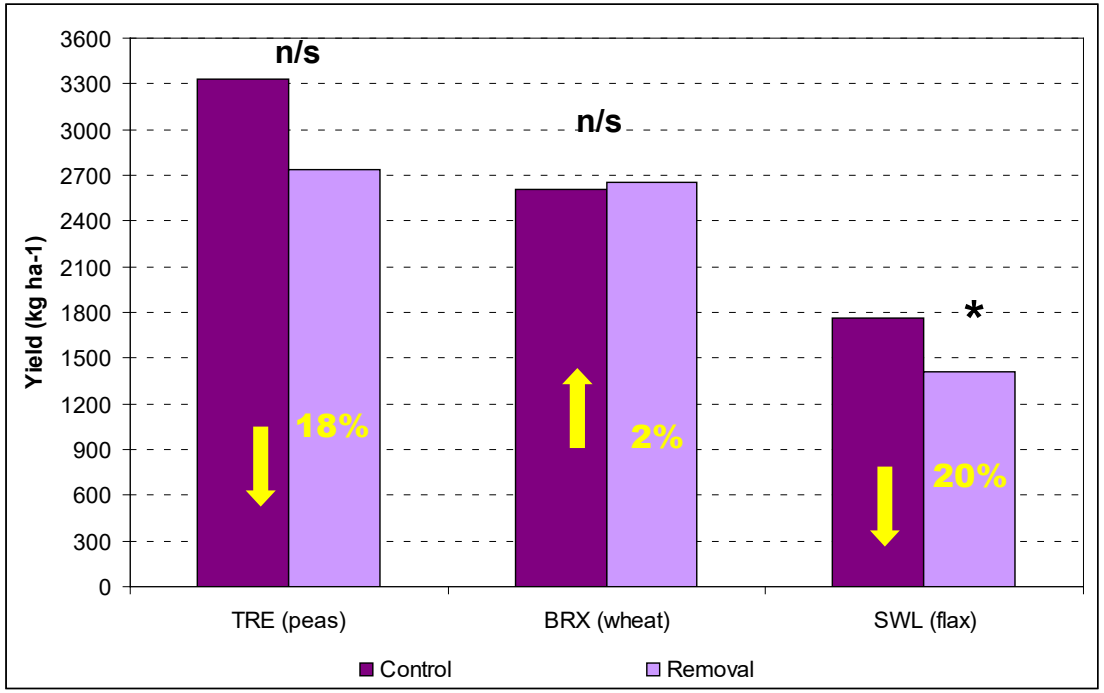
Yields in rehabilitated plots are uniform from the top to the bottom of the slope

Soil Landscape Rehabilitation: Manitoba



← *Upper Slope*

Lower Slope →



*Significant at P<0.10, **Significant at P<0.05,

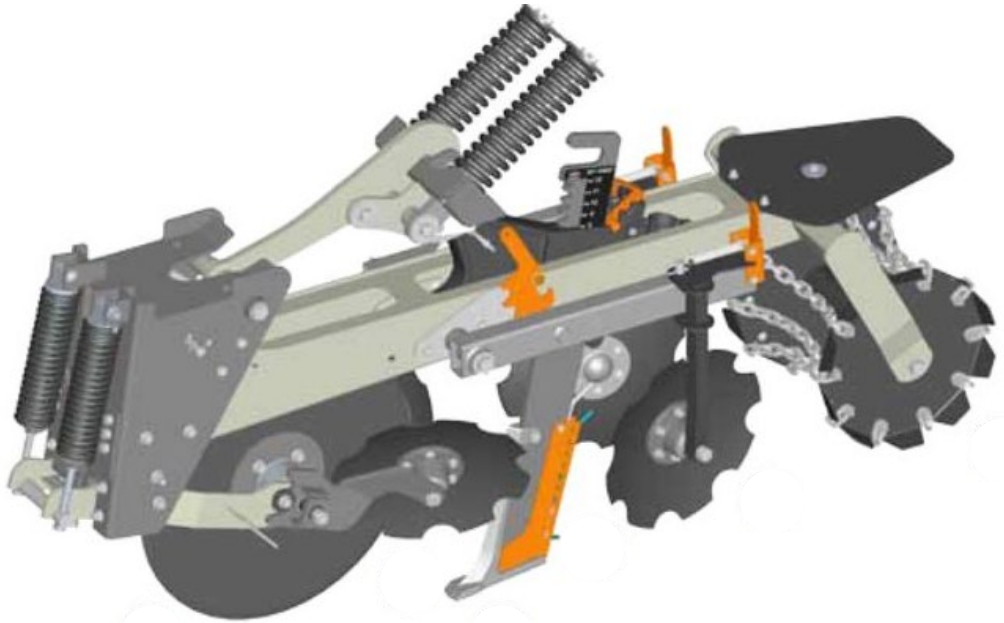
Slide from D. Lobb

Research Findings

4”of topsoil increased yields:
10 - 33% in wet years
39 - 133% in dry years

The cost of rehabilitation was recovered in 3 – 5 years.

David Lobb, Treherne, Manitoba



Shanked Strip Till Units

Best for fall use
Banded nutrients
More tillage
Deeper tilled zone (6-8”)

Don’t forget to purchase rock trippers

Coulter Strip Till Units

Fall and Spring usage

Fertilizer mixed in 5” x 5”

Less aggressive tillage

Shank to Coulter option

To Chop or Not to Chop…

- Upright stalks:
  - Increases water infiltration
  - Dries out faster
  - Evenly traps snow
- Chopped stalks:
  - Decomposes faster
  - May leave mat of residue
  - Easier flow through ST machine

Spring vs. Fall ST

Fall

- Soil warming-up before planting
- Split the workload
- Chance to do more tillage in spring

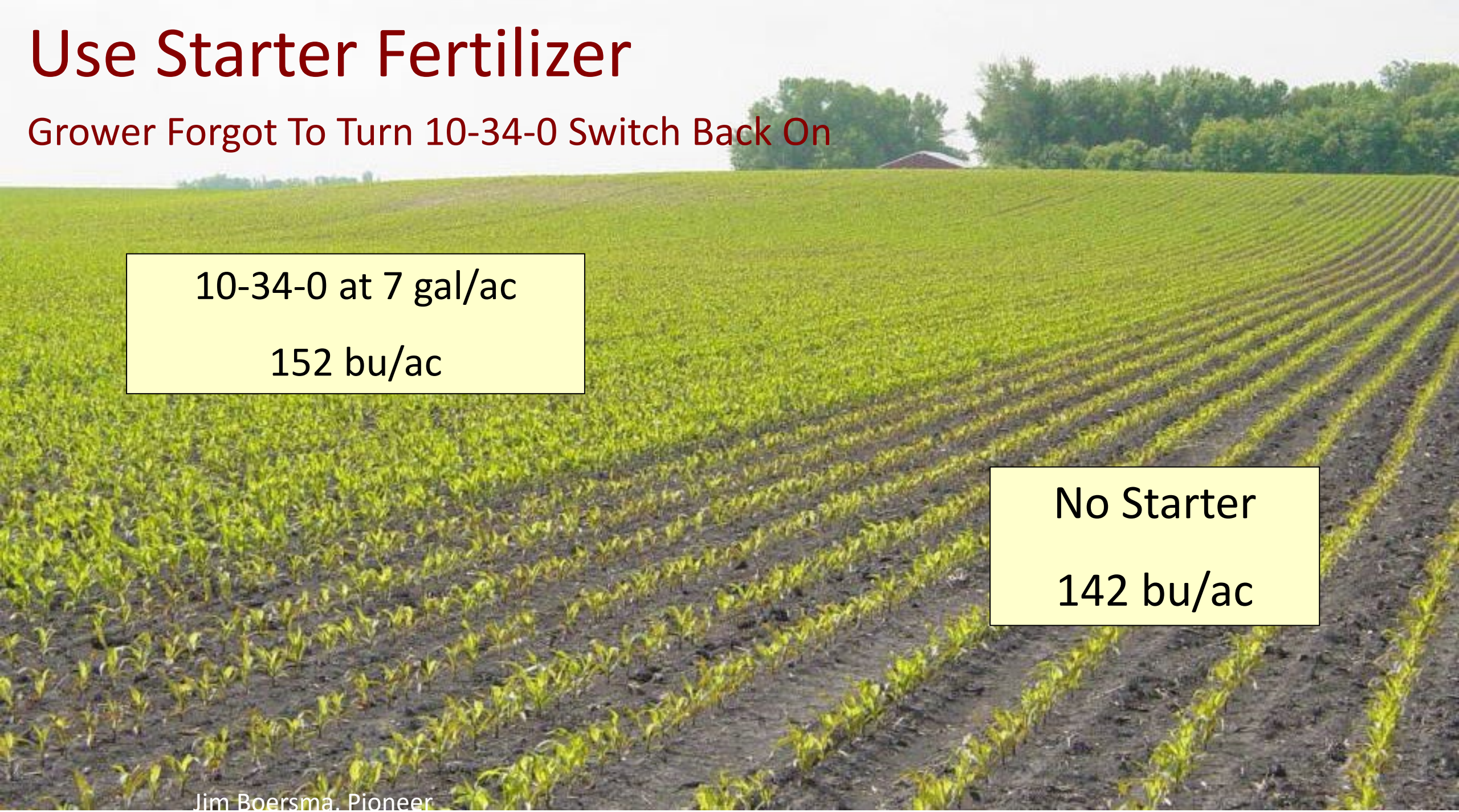
Spring vs. Fall ST

Spring

- Benefit for low rain fall or sandy soils
- Potential for cooler, wetter soil at planting, cloddy seed bed

Use Starter Fertilizer

Grower Forgot To Turn 10-34-0 Switch Back On



Adding a 2nd Tillage Pass

Used in spring to “freshen-up” the berm

Coulters

Coulters

Other Options

Lilliston Rolling Cultivator

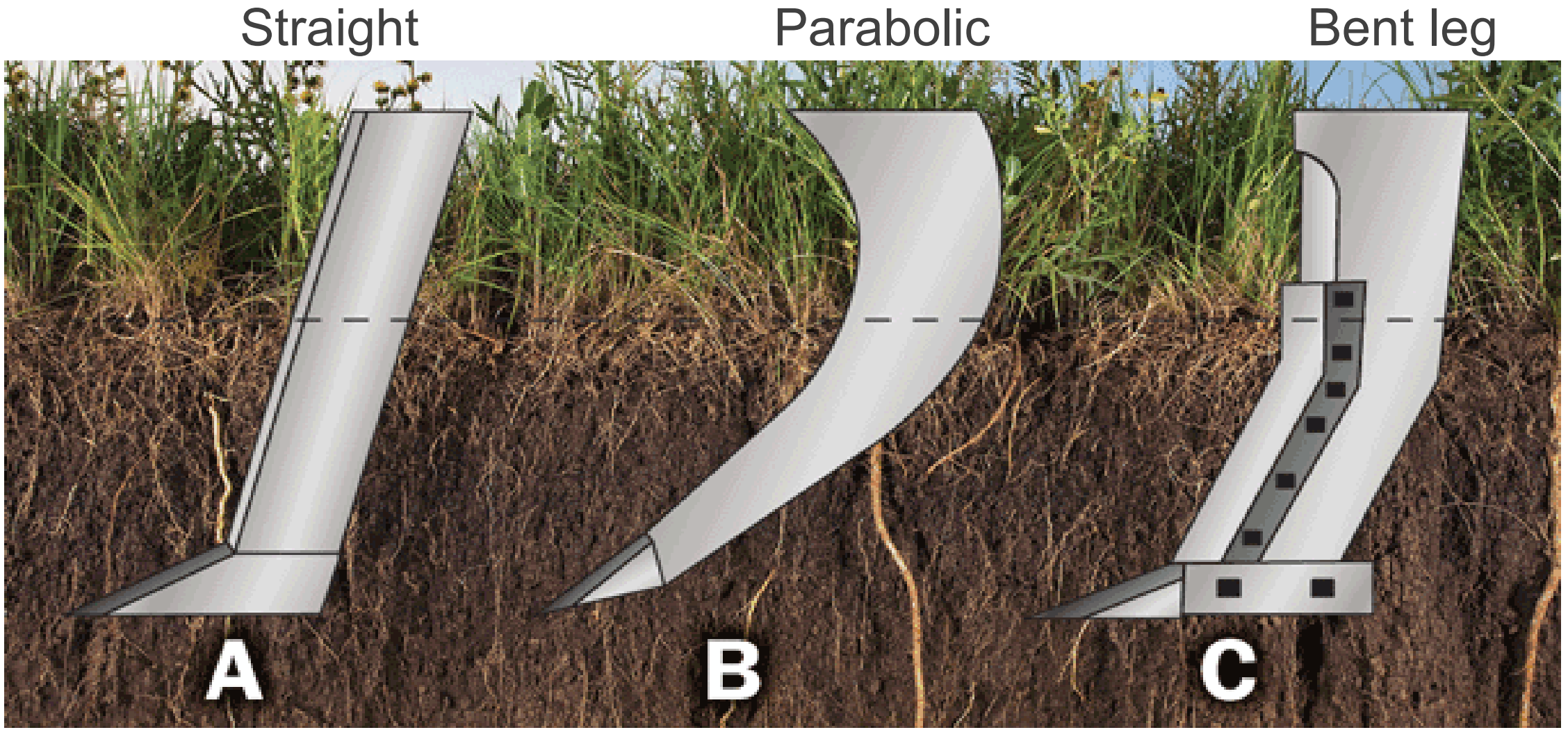
Subsoiler (Zone Till)

- 20” Depth
- In-row
- 30-50 hp per shank

Parabolic shank

Straight shank

Subsoiler Shanks

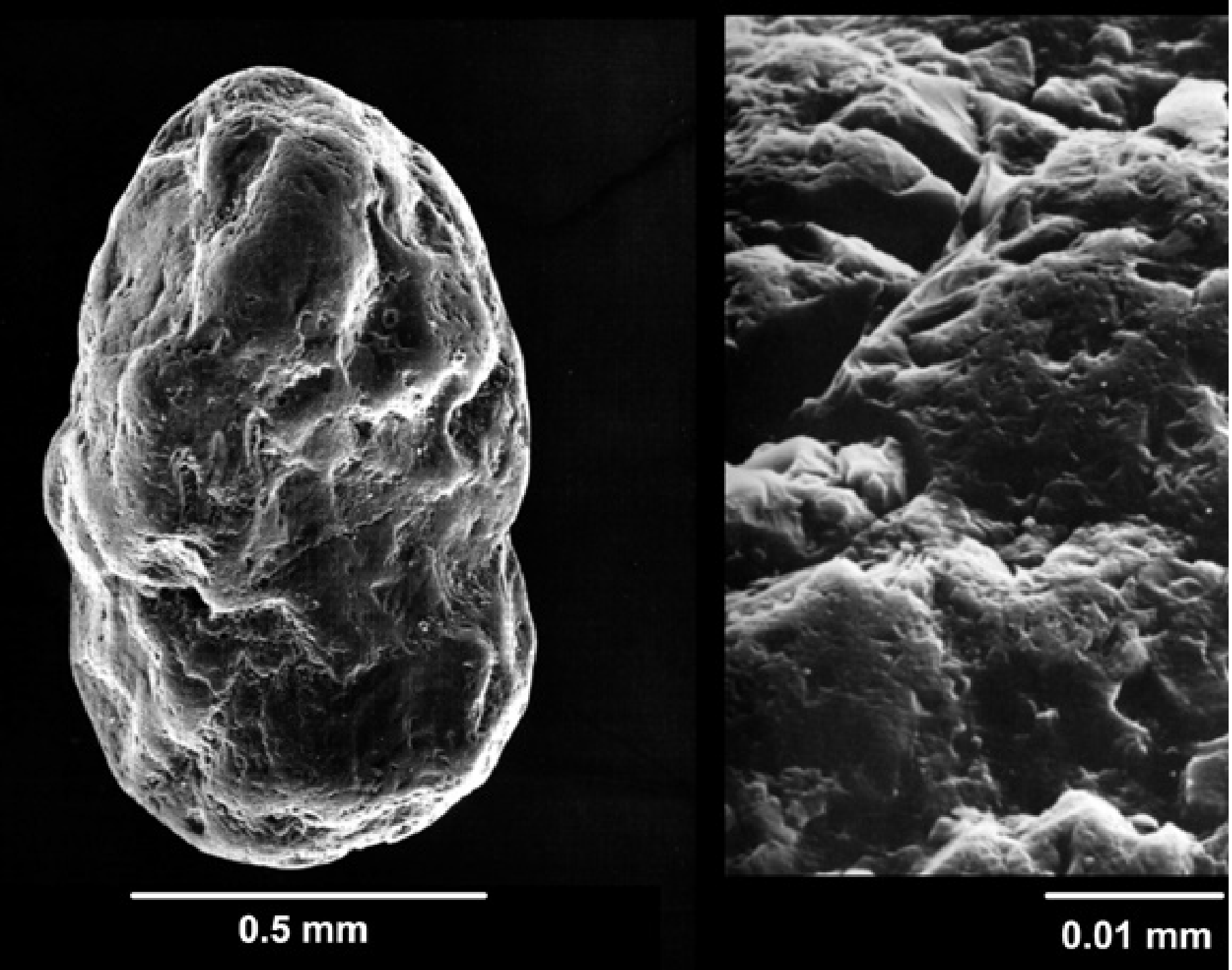


Deep Tillage Guidelines

- Work soil when dry. Soil should fracture and crumble down to the depth of shanks.
- Use most non-invasive, straight shank.
- Do not drive on ripped soil again. Use controlled traffic practices.

Tillage and Water Erosion

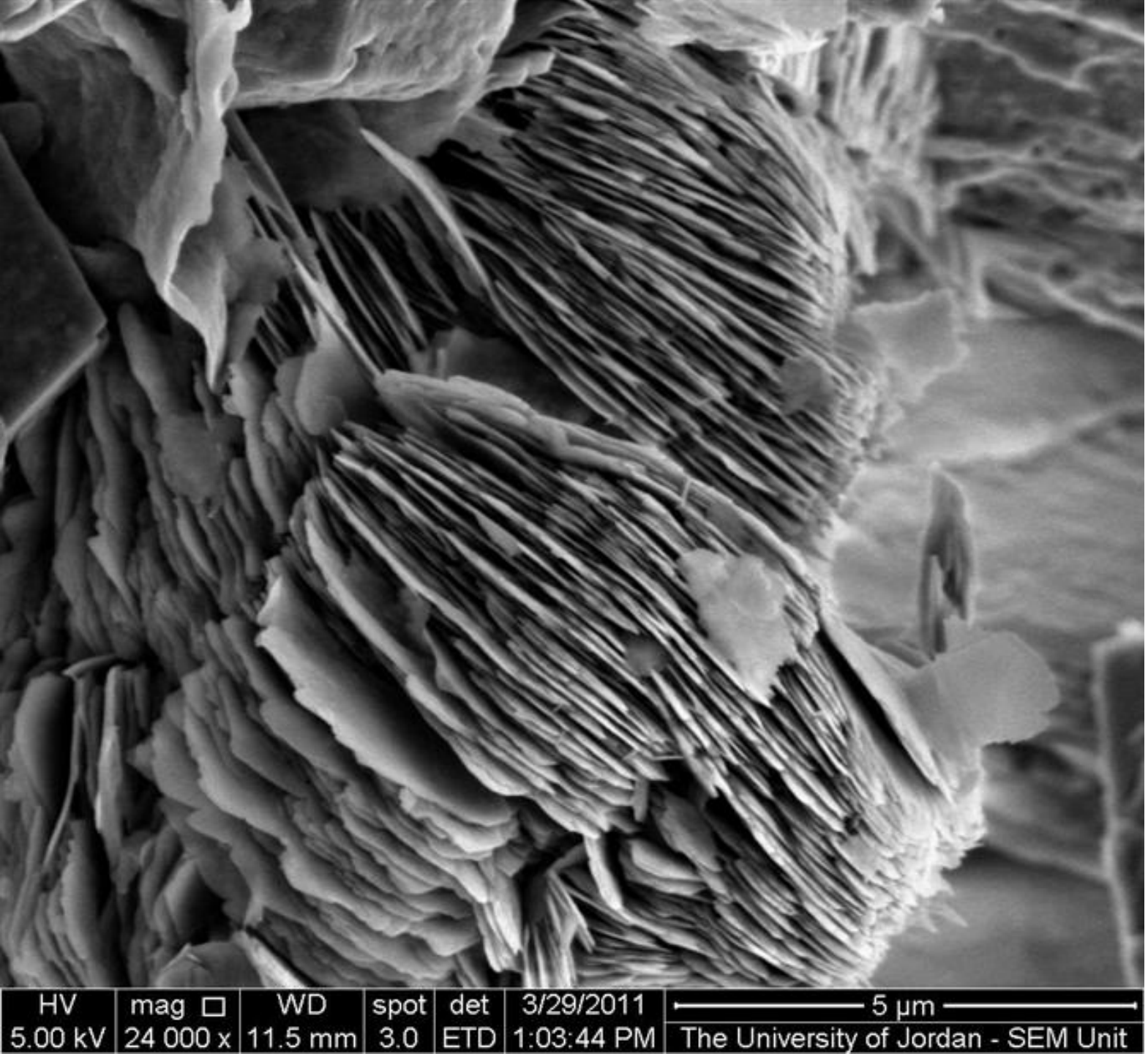
Measurements in cm



Sands

- Large pore space
- Little surface area
- Not able to hold as much water or nutrients

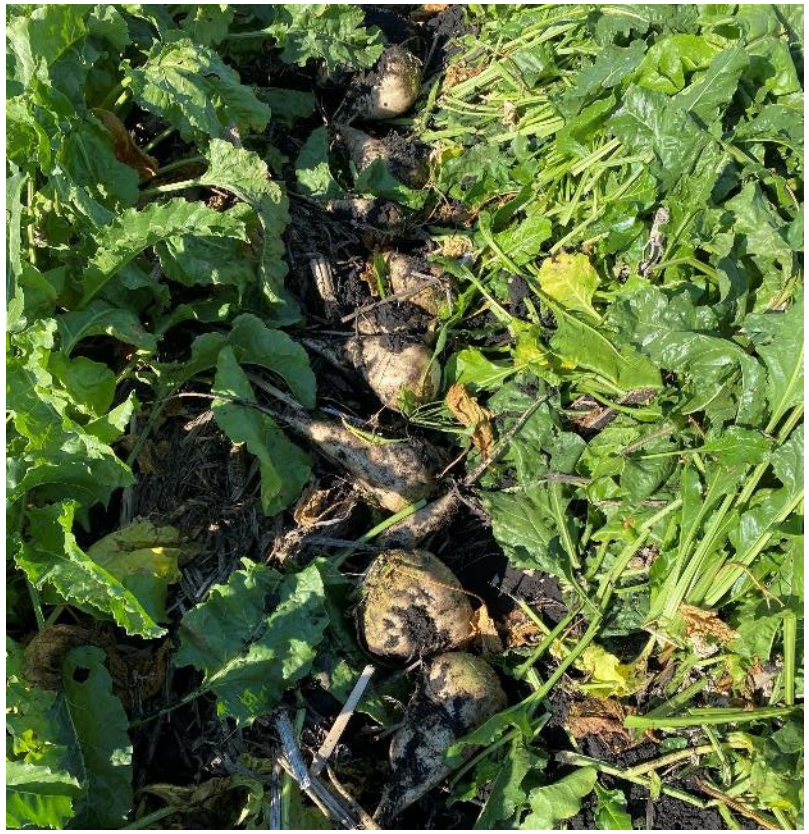
Photo - Researchgate.com

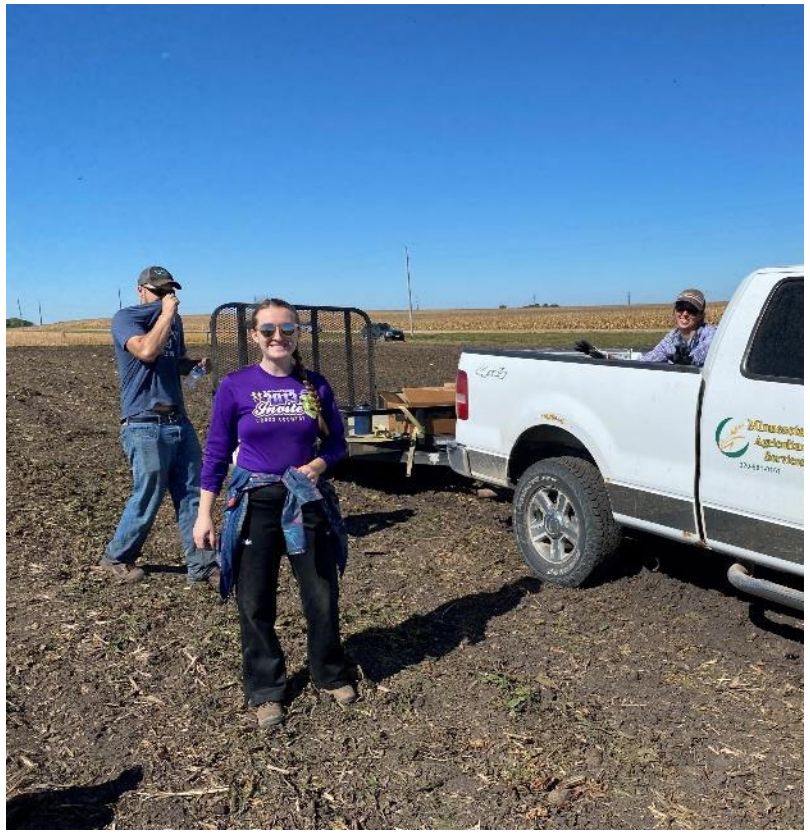


Clays

- Plate-like structure
- Negatively charged
- Huge surface area (100,000 > than sand)

Photo - www.fei.com/image-gallery/kaolinite-clay-sheets

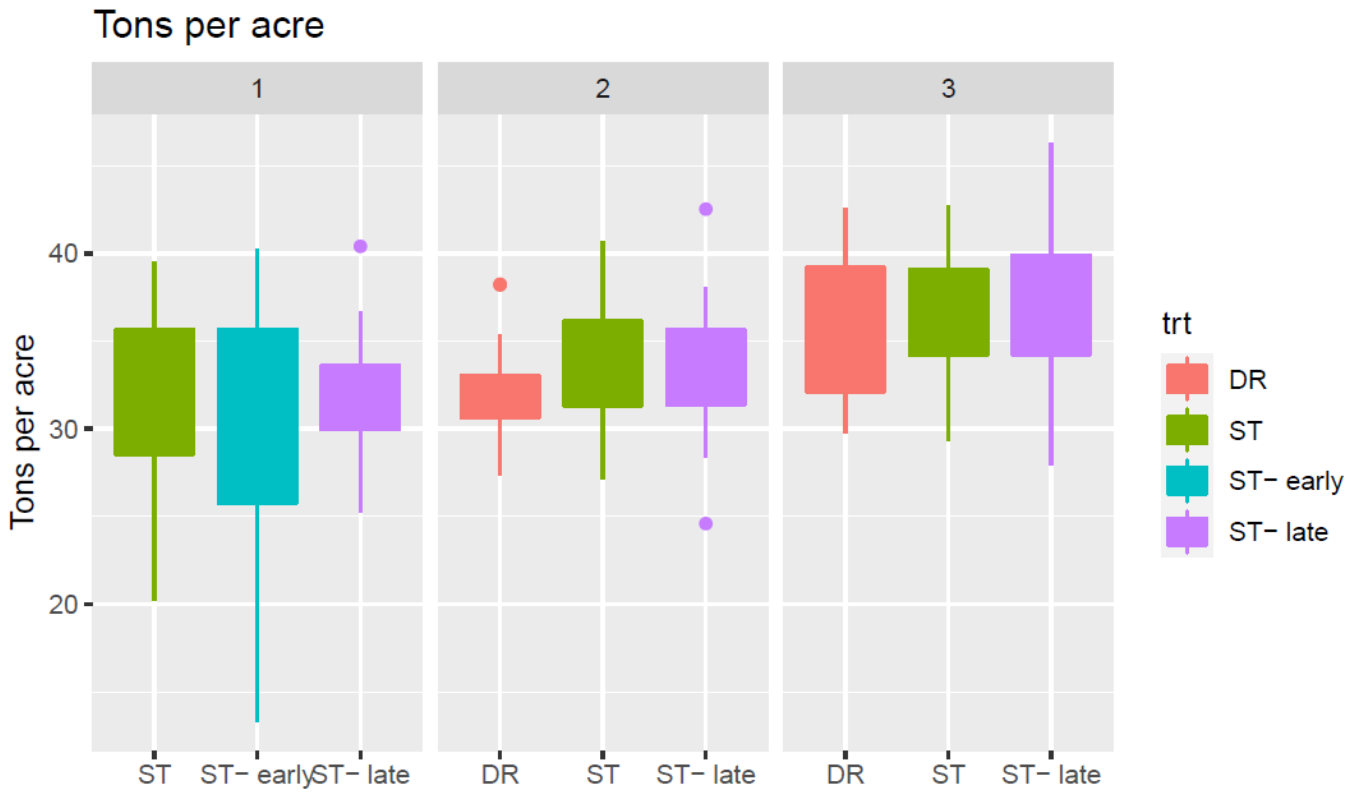




Hand Harvest

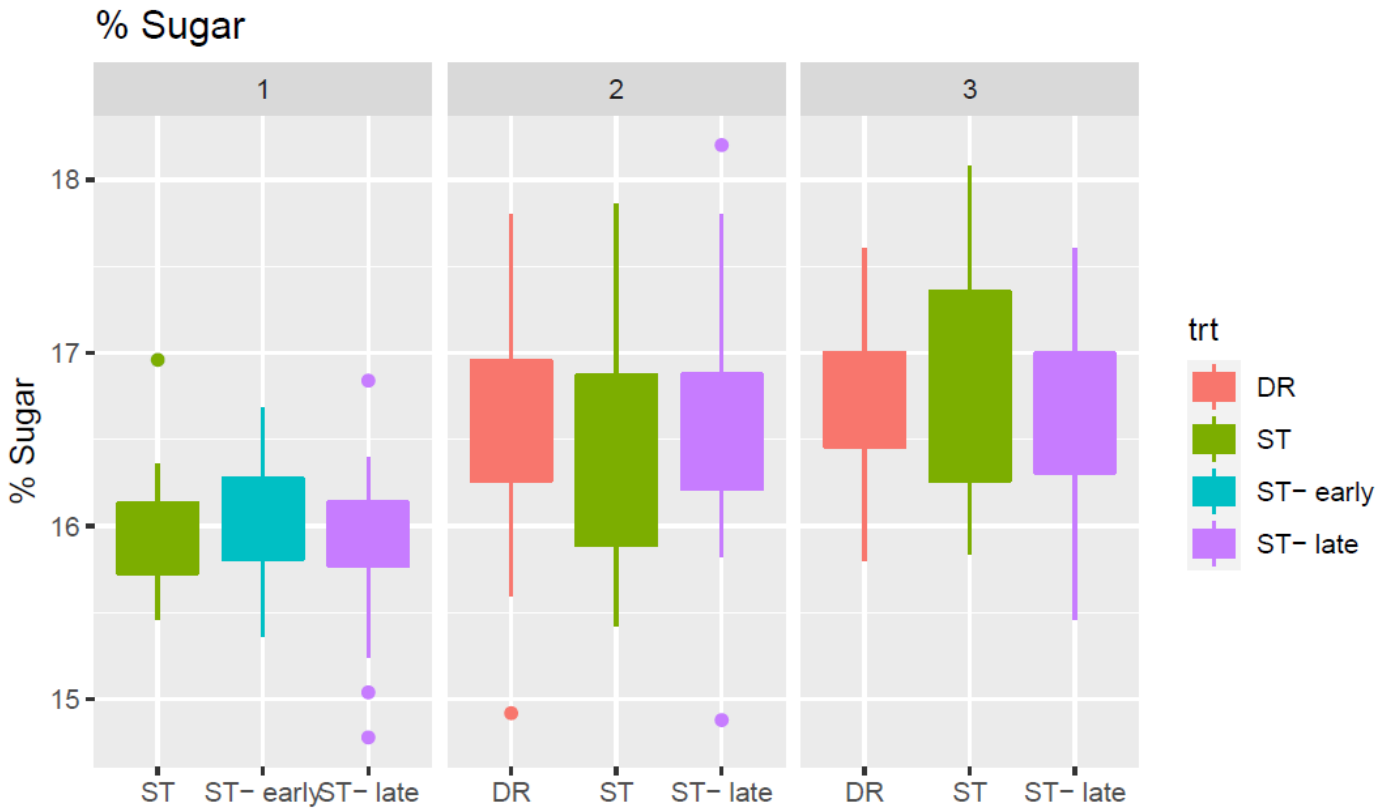
10’ of row, 6 times per treatment x 3 treatments x 3 reps
= 54 samples per field

Sugarbeet Tons per Acre



No significant difference

Sugarbeet % Sugar per Acre



No significant difference

Summary

- No differences in
  - Tons/acre
  - % Sugar
  - % Extractable Sugar
  - Extractable Sugar/Ton
  - Extractable Sugar/acre
  - Sugar/acre
  - Purity
- ST may need a light secondary pass in spring if planting zone is not fit

Fall 2021 Interesting Observation

Corn stalks from previous year

Harvested, not tilled

Harvested, tilled

More Sugarbeet Research

- Jay Gudajtes of Minto, ND - farmer
- Brian Ryberg of Buffalo Lake, MN - farmer
- Brad Brummond, NDSU Extension
- Aaron Hoppe, NDSU

Nutrients in 1% Organic Matter

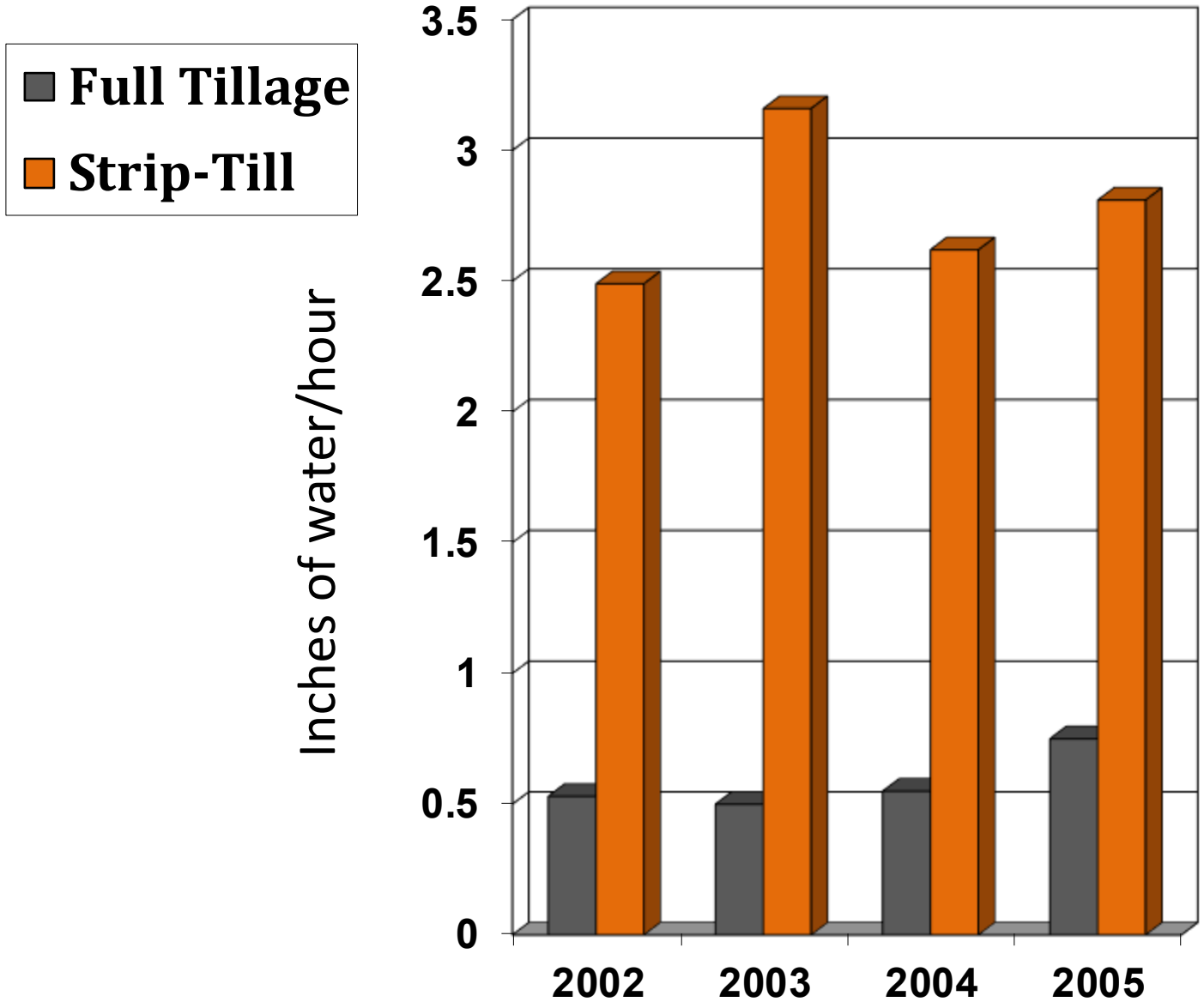
Nitrogen:	1,000 lbs x .95/lb	$ 950
Phosphorus:	100 lbs x .95/lb	$ 95
Potassium:	100 lbs x .71/lb	$ 71
Sulfur:	100 lbs x 1.54/lb	$ 154
Carbon:	11,600 lbs 30/ton	$ 174

Value of 1% SOM Nutrients/Acre **~$1,444**

Assumptions:

2,000,000 lbs. soil in top 6 inches. 1% organic matter = 20,000 lbs.

USDA-NRCS

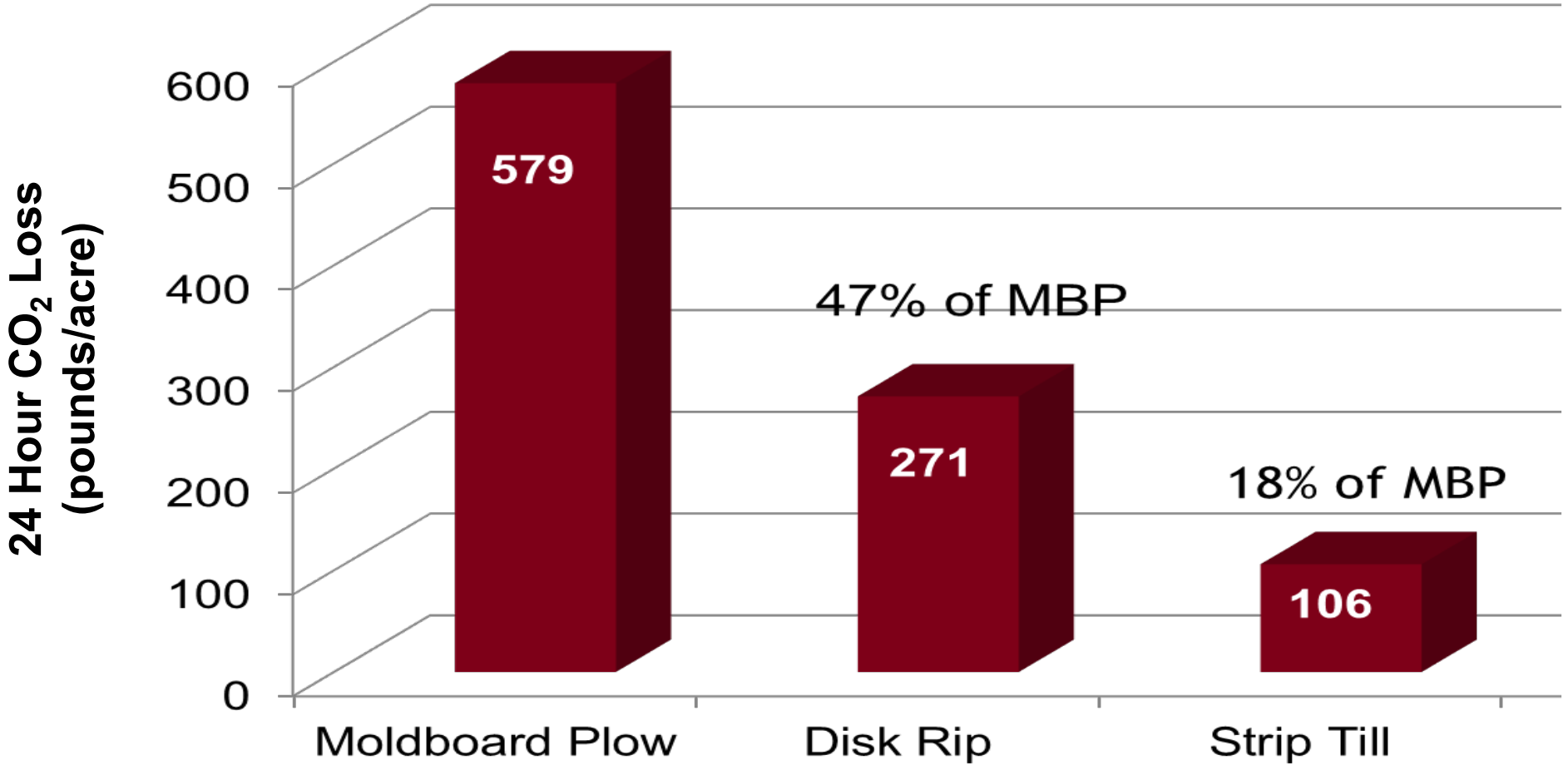


Less Tillage Improves Water Infiltration

IRF – Irrigation Research Foundation – Yuma, CO

Measurements with Cornell Sprinkle Infiltrometer on moist soil

Pounds of CO_2 Lost from Fall Tillage



Reicosky et al. 2005, Jeffers, MN

Bottom Line

We farm in a highly erodible region

~Keep the soil covered

Nitrogen Loss

Denitrification in a Saturated Soil

Can Lose **2-4** lbs of Nitrogen/ac/day

Full tillage

Strip tillage

Photo Courtesy of Dave Franzen, NDSU