Next Generation of Residue and Compaction Management Tools: Vertical Tillage and Strip Tillage

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EXTENSION
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Erosion

- Length of flat field (wind)
- Steepness of slope (water)
- Intensity of tillage
- Residue levels

Courtesy of Dorian Gatchell

The next day

Residue

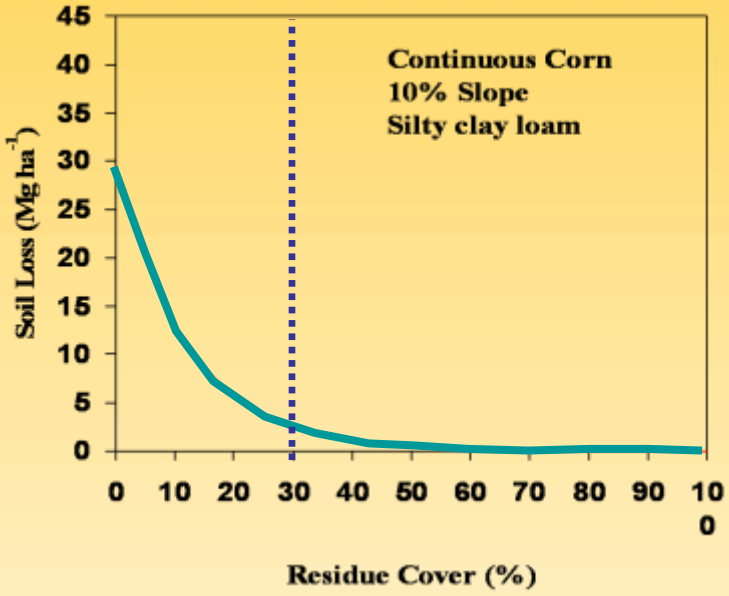
- Residue is the single most important factor influencing soil loss!

- Residue Coverage
  - protects soil from raindrop impact
  - decreases soil detachment
  - decreases soil crusting and sealing
  - decreases velocity of surface water
  - increases infiltration

How Much Residue is Enough?

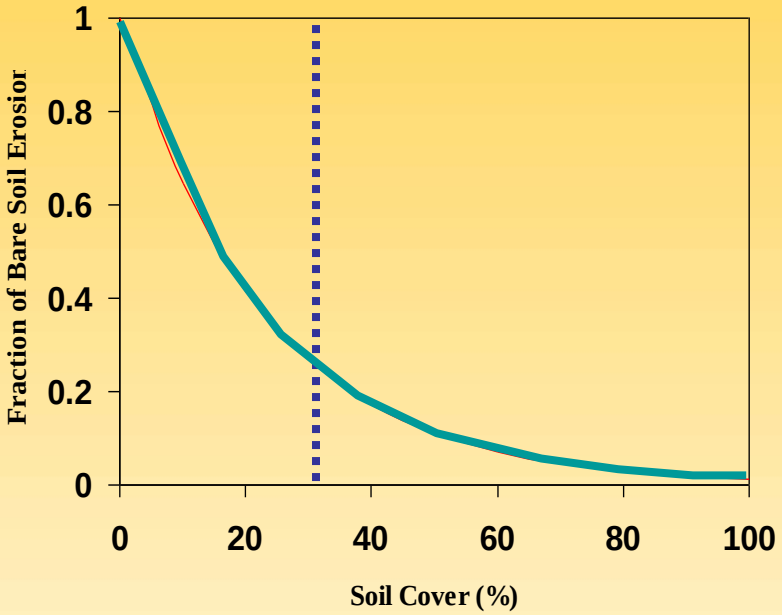
Water Erosion

Adapted from Dickey at al., 1984



Wind Erosion

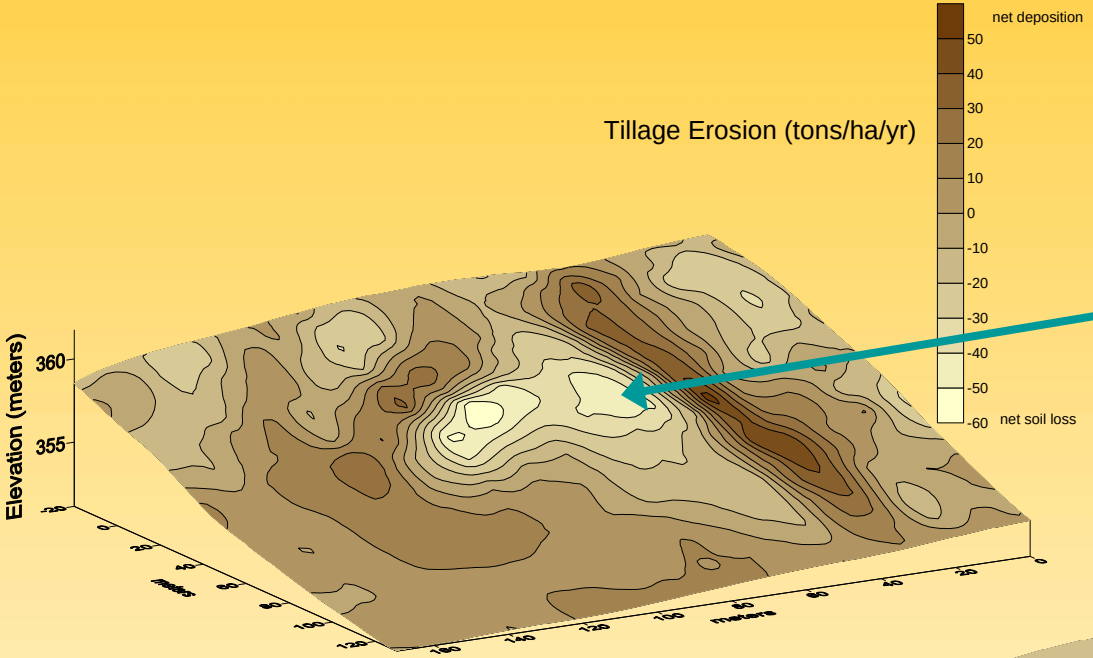
Adapted from Bilbro and Fryrear, 1994



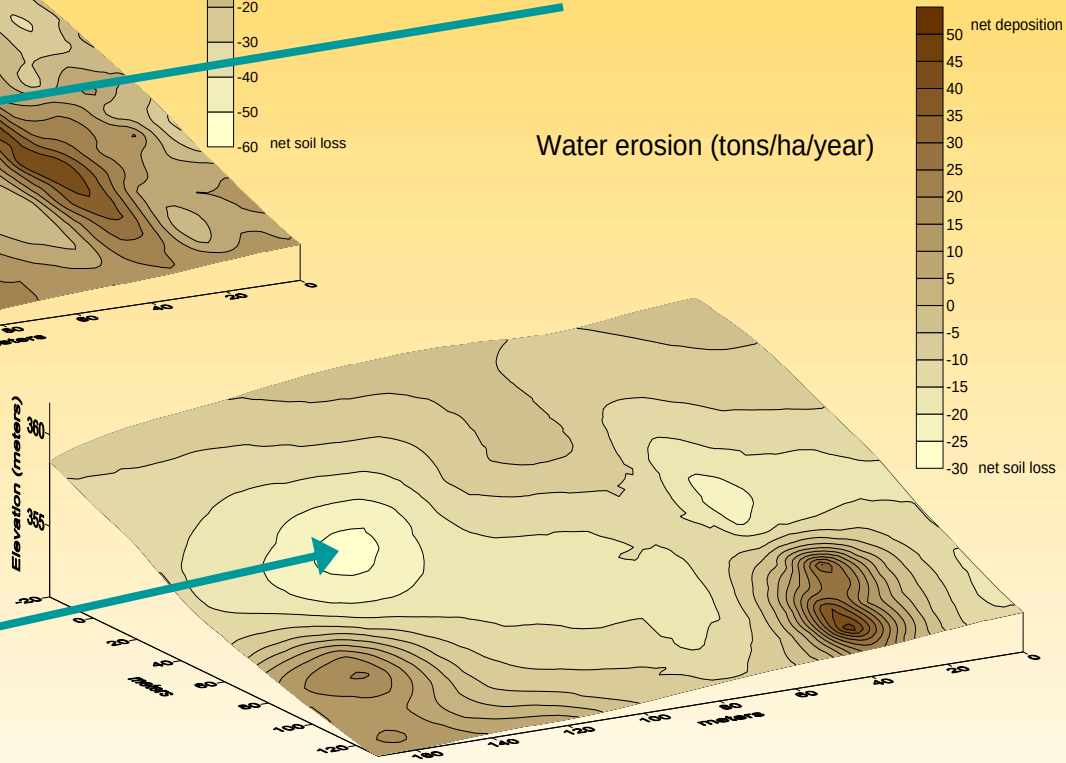
Skogstad Fields – Cyrus, MN

- Looking at water, wind and tillage erosion
  - Long term MBP field

Erosion at Skogstad Site

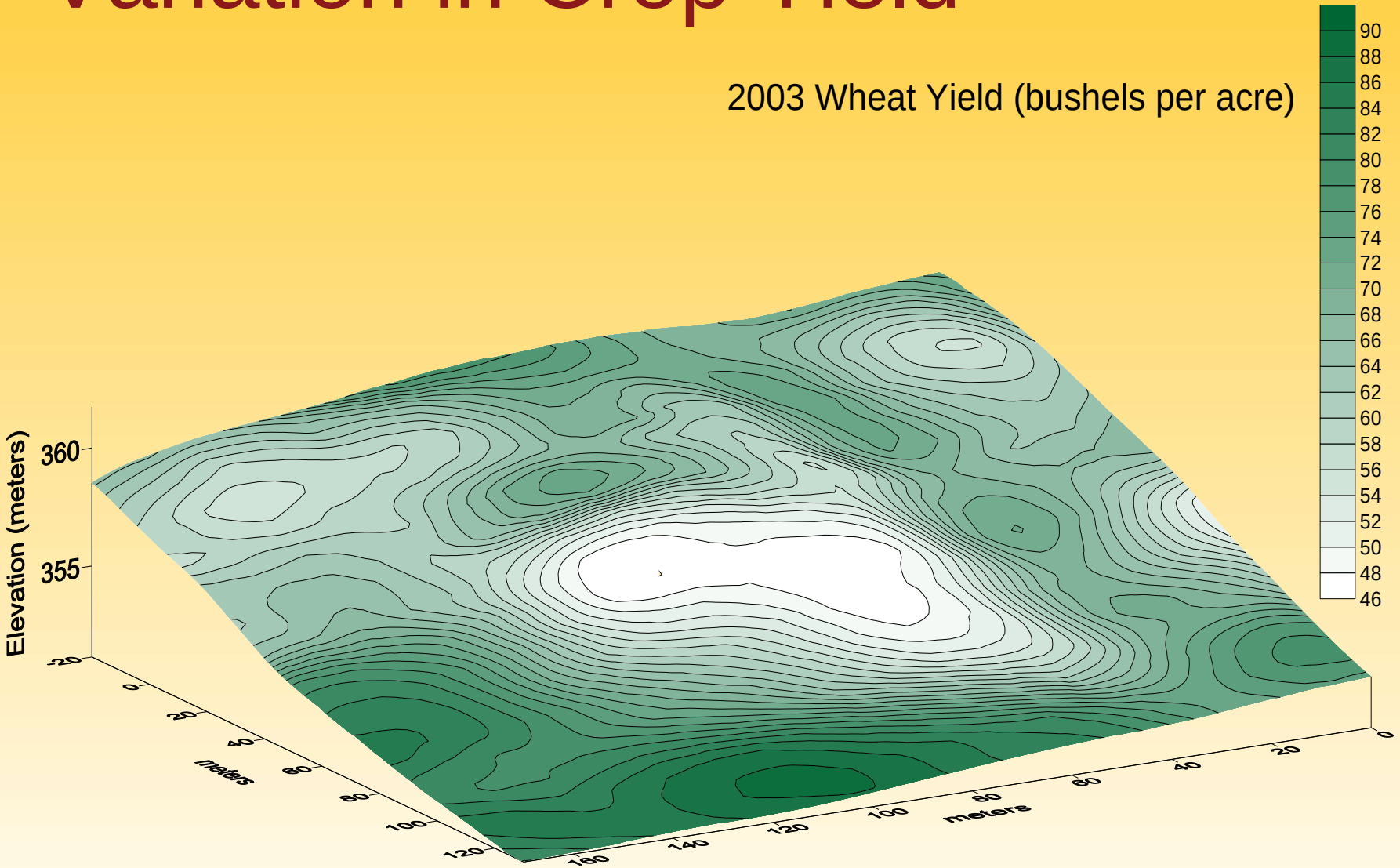


Net soil loss by tillage erosion exceeded 27 T/ac/yr

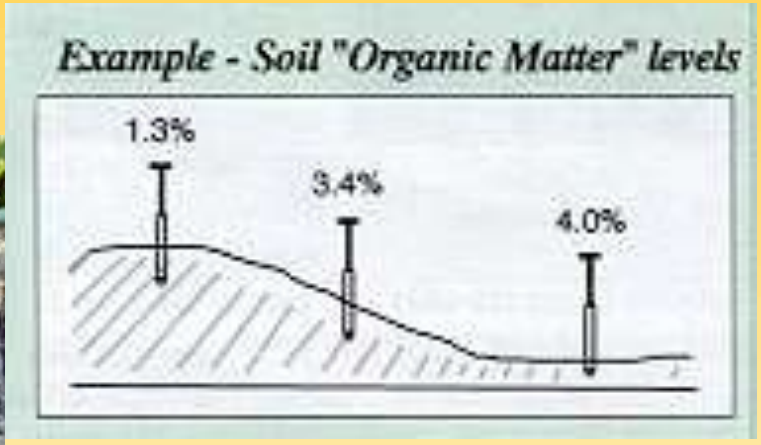


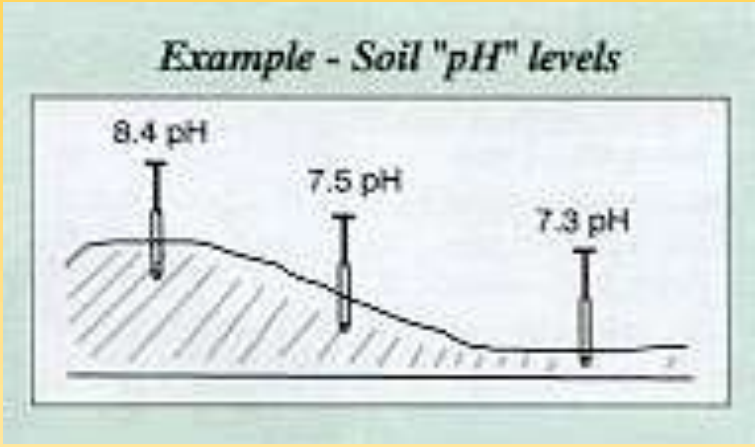
Water erosion resulted in net soil loss <9 T/ac/yr

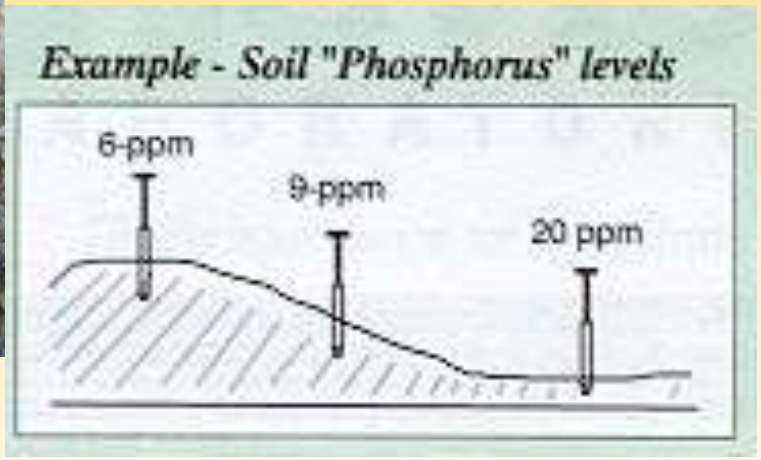
Variation in Crop Yield

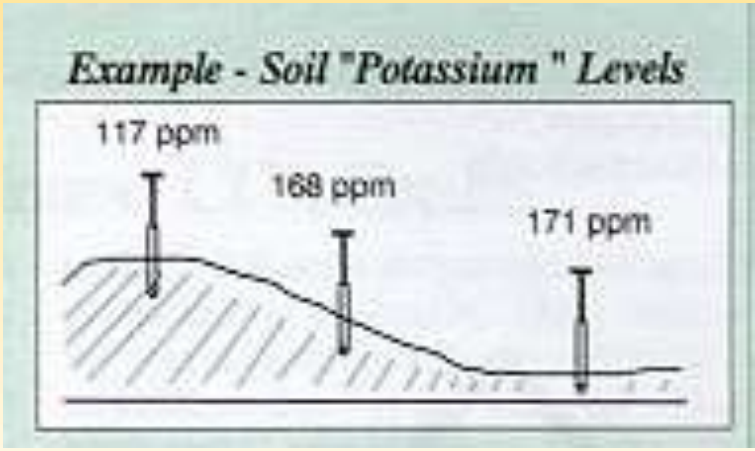


Variation in Topography







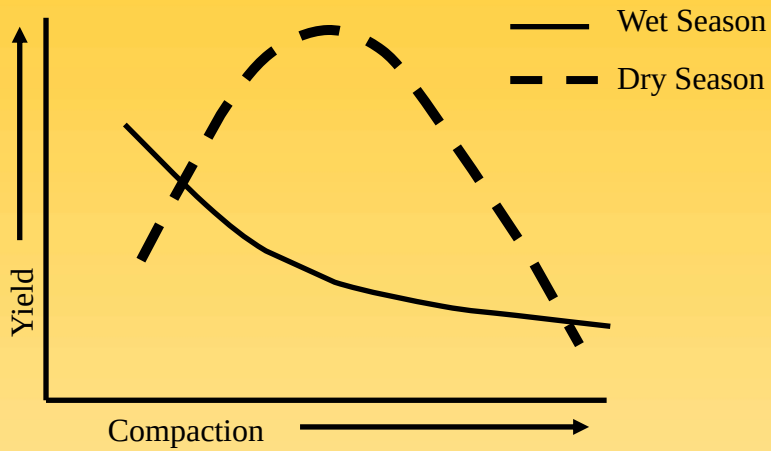


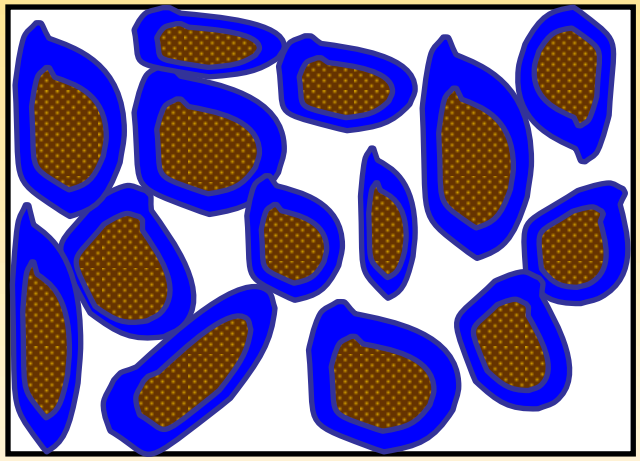
Soil Compaction

- Soil compaction occurs when soil particles are pressed together, reducing pore space between the particles

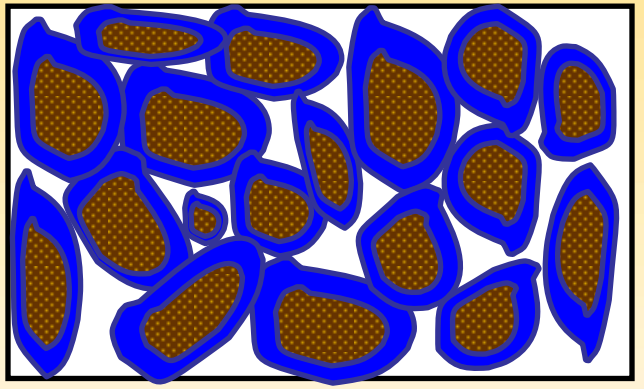
Photo courtesy of National Soil Dynamic Laboratory, USDA, Auburn, AL.

Soil Compaction





Uncompacted



Compacted

Soil Compaction - Causes

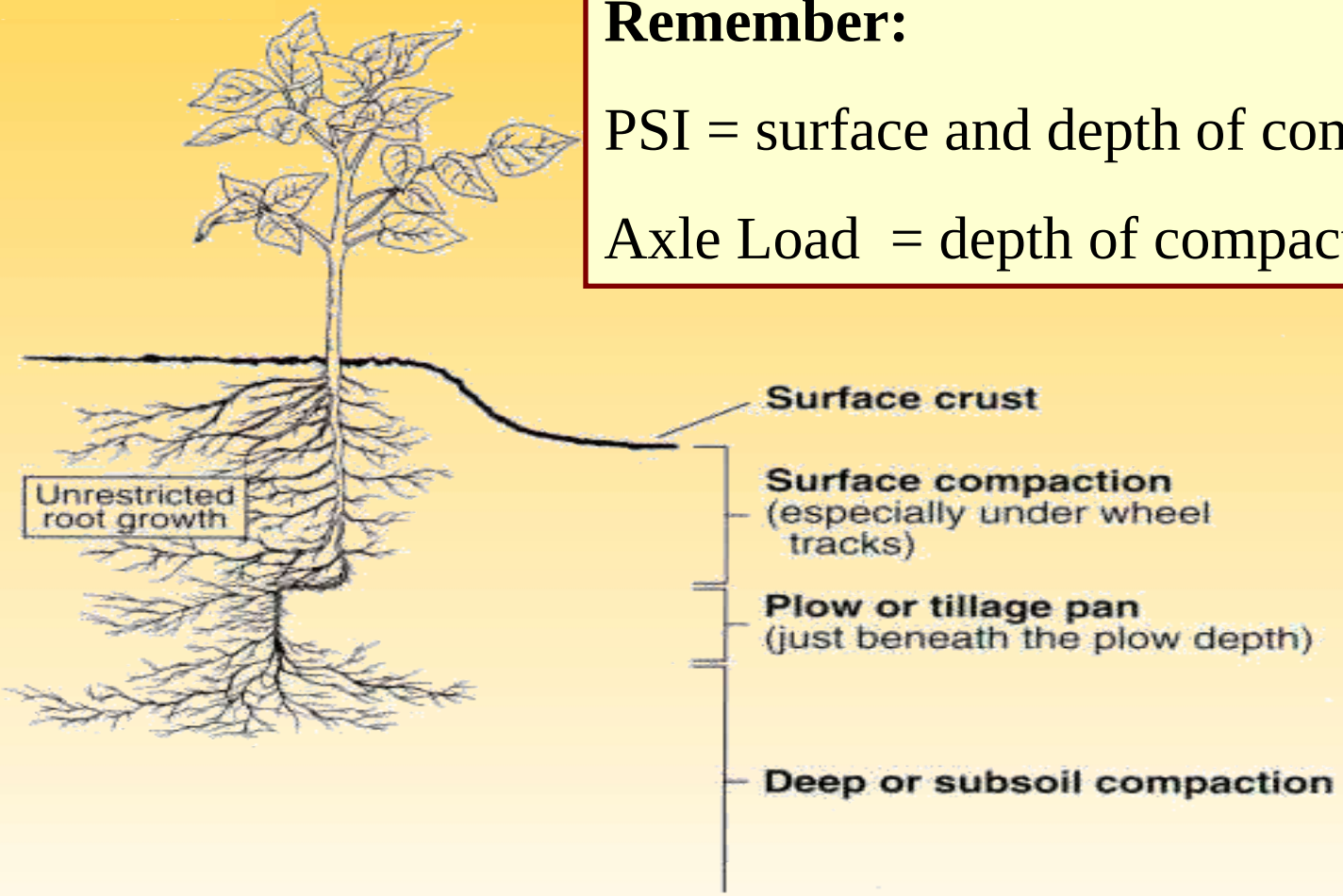
- Field equipment
- Working soil too wet
  - Water acts as a lubricant
- Livestock
- Minimal crop rotation
- Aggressive tillage

Types of Compaction

Remember:

PSI = surface and depth of compaction

Axle Load = depth of compaction



Strip Tillage

- Loosens the soil in the row 7-10” wide while maintaining residue between the rows
- Builds organic matter and soil structure
- Less energy required and less erosion than conventional systems

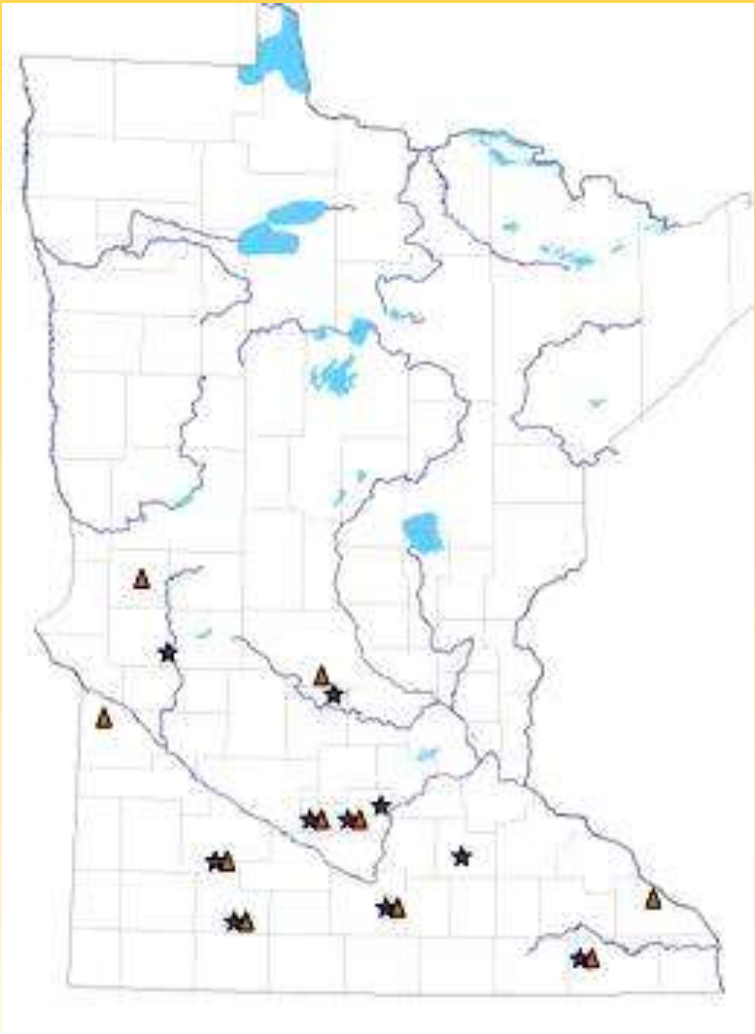
Strip Till Management

- Tile drainage is beneficial
- Have a ST rep or experienced strip tiller on speed dial
- Planting directly on the berm is essential
- Soil will ‘mellow’ in 3-4 yrs, but increased water infiltration will be immediate

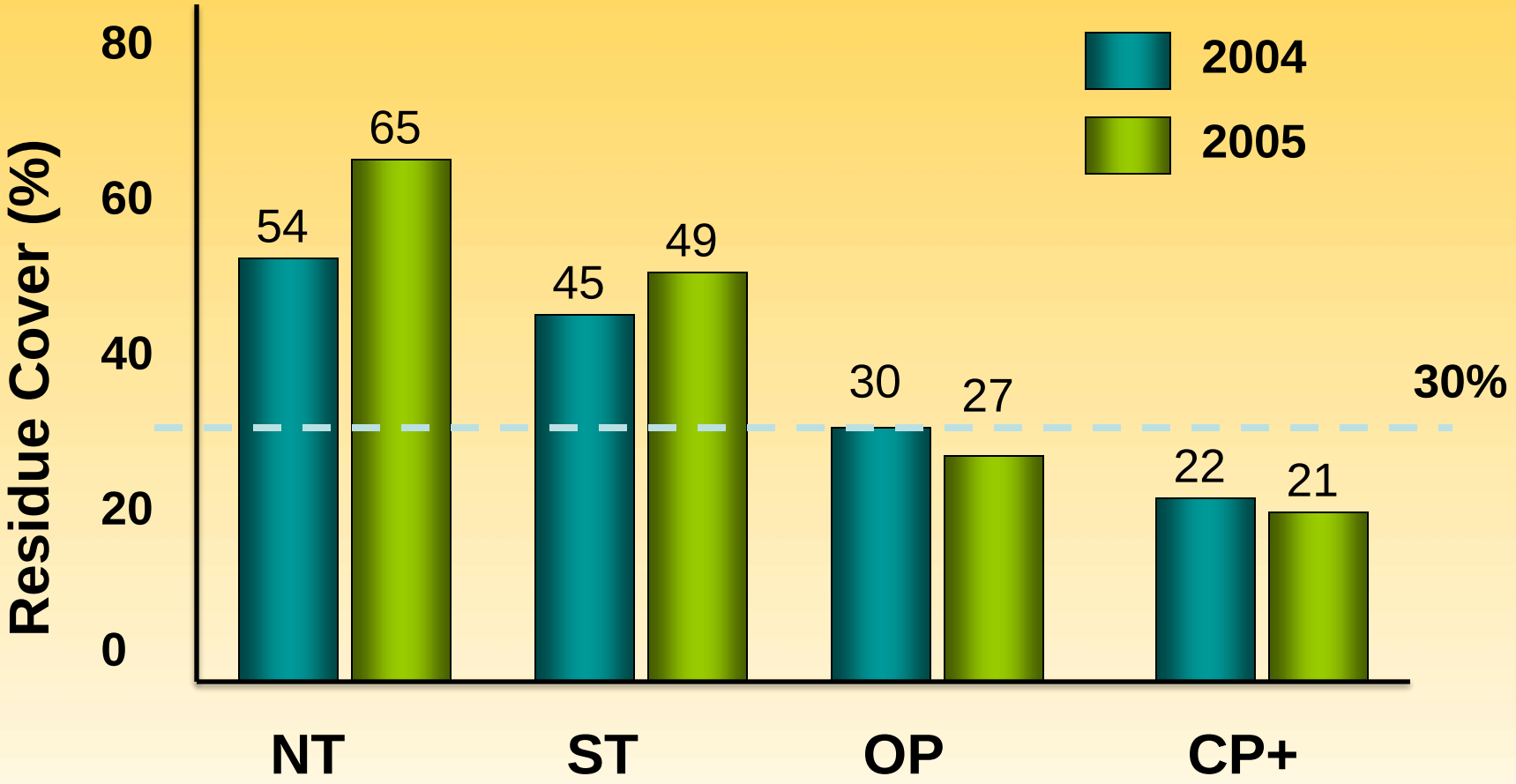
Committed Sales Rep

Tillage Comparison Study

- Three replications
- Corn following soybeans
- 10 sites in 2004 and 2005
- Four tillage treatments:
  - No Till (NT)
  - Strip Till (ST)
  - Spring cultivation (OP)
  - Fall chisel plow with Spring cultivation (CP+)



Residue Cover



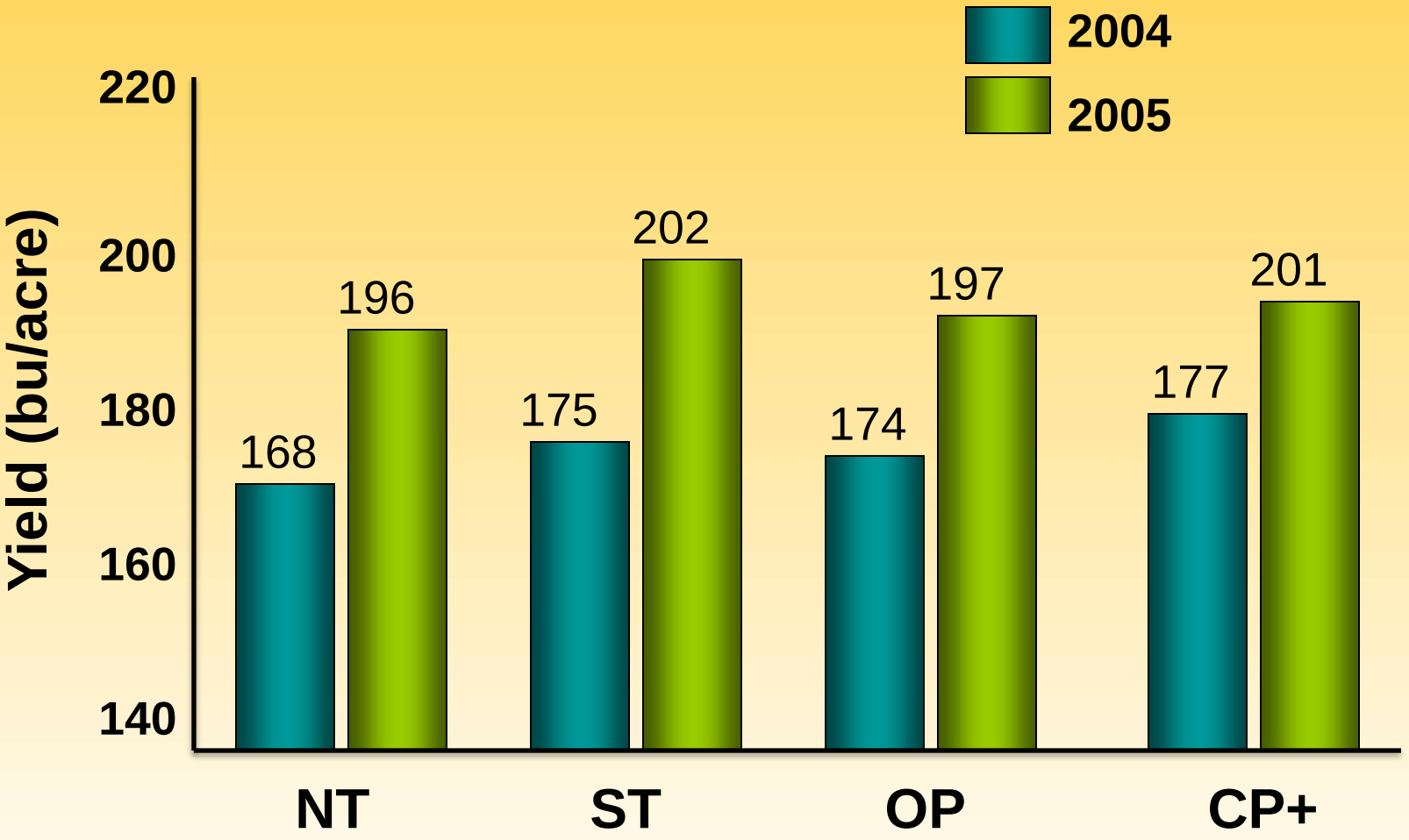
Average for UMN sites only. Residue counts taken after planting.

Residue Cover

Tillage	2004	2005	Range
No-till	54.1	64.7	30 - 90
Strip-till	44.7	49.1	21 - 69
One-Pass	29.9	27.4	11 - 54
Chisel+	21.7	20.6	4 - 44

- Some producers did not have residue managers on their planter
- Previous tillage was different (NT to Disc-ripped)

Corn Grain Yields



2006-08 Soybean Data (Jeffers, MN)

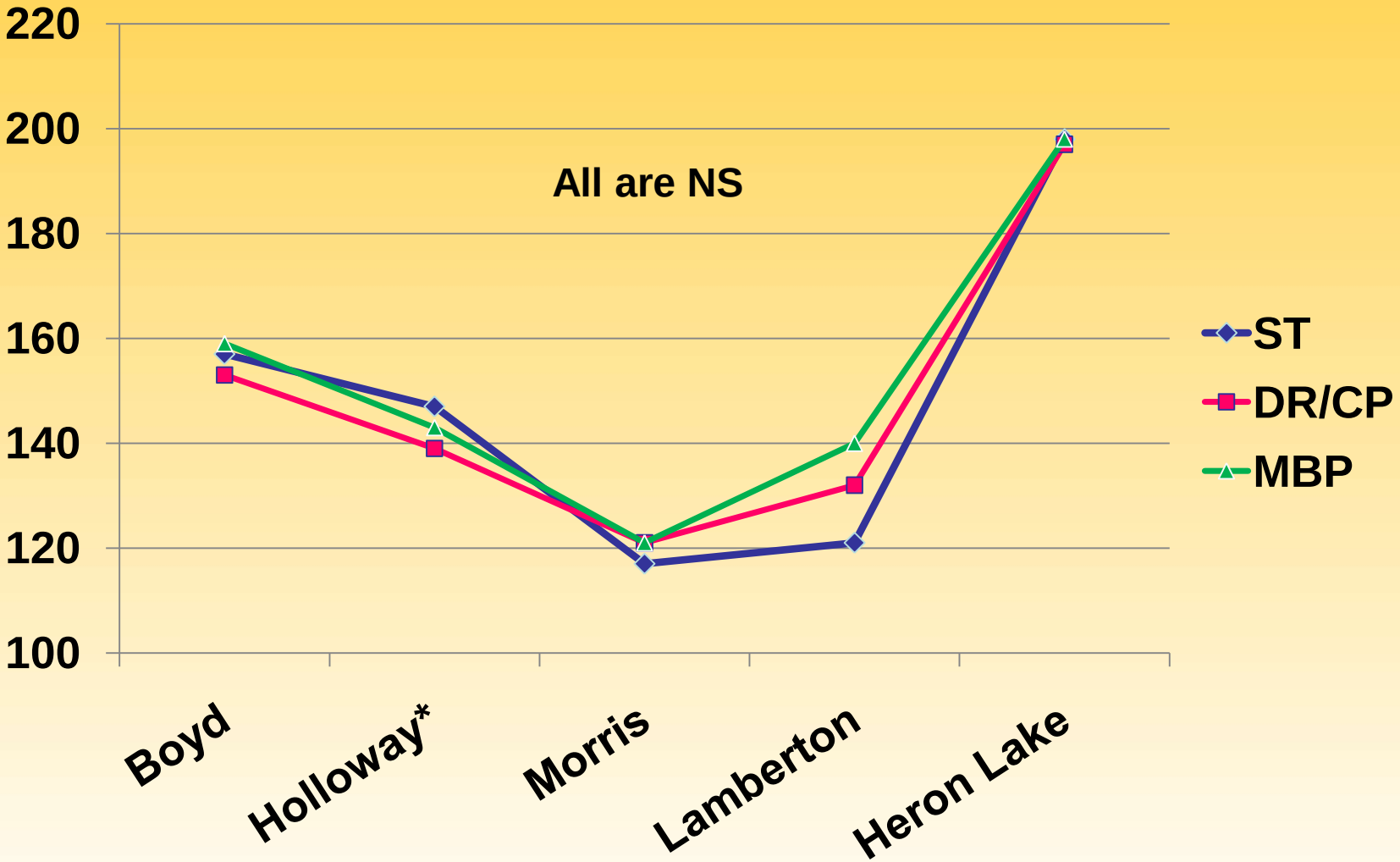
Treatment	2006	2007 (bu/ac)	2008	Residue % (average)
Chisel Plow	50.3	47.2	43.9	56%
No Till	47.8	46.8	41.6	73%
Strip Till	50.7	48.4	44.6	62%
LSD (0.05)	NS	1.7	NS	4.4%

All plots were rotated with ST corn

2007 and 2009 Corn Data (Jeffers, MN)

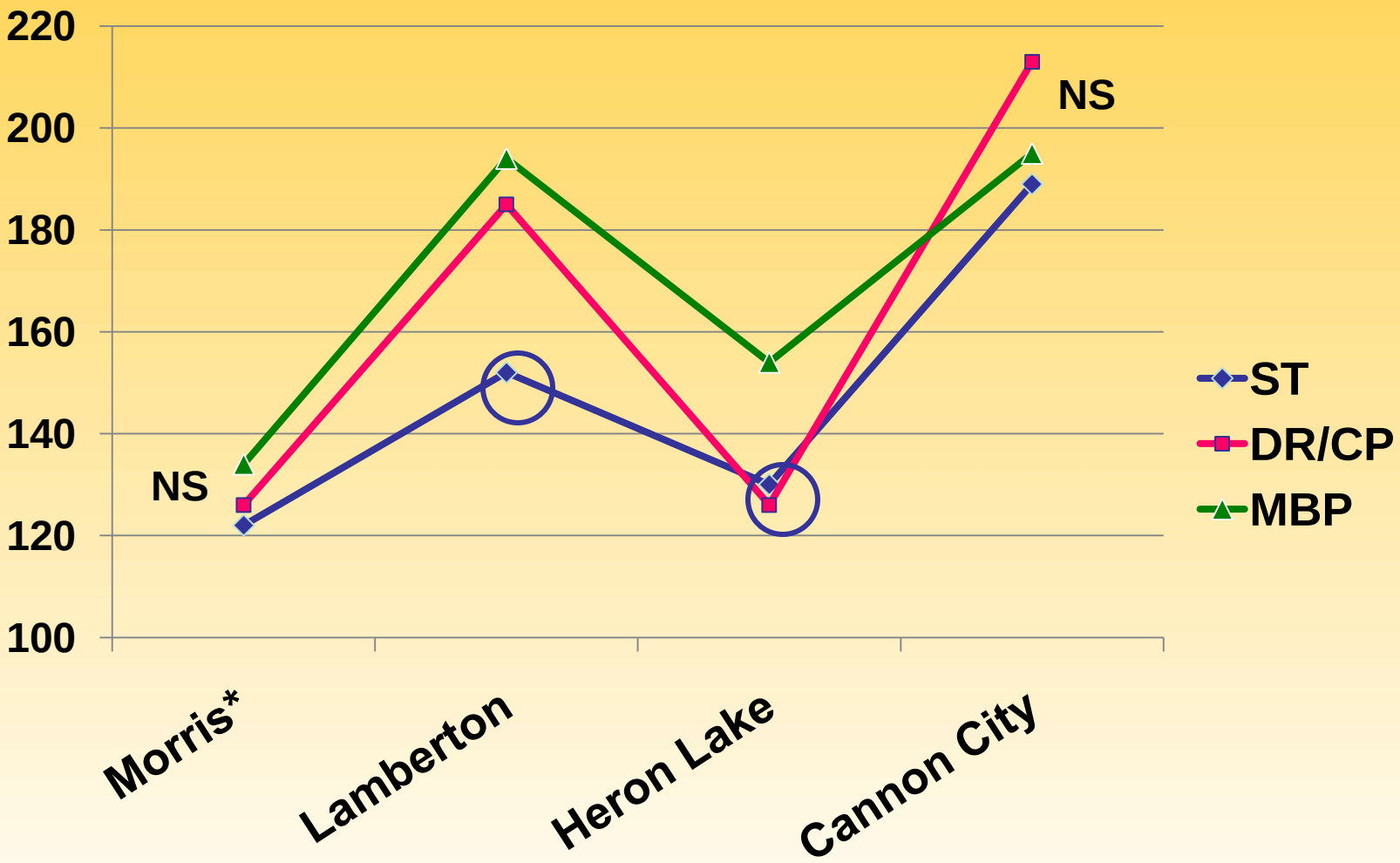
Previous Treatment	Yield (bu/ac) 2007	Yield (bu/ac) 2009	Residue Average
ST - Corn CP-SB	175.4	182.0	54%
ST- Corn NT– SB	169.4	176.7	62%
ST- Corn ST- SB	167.0	176.2	60%
LSD (0.05)	NS	NS	

1st Year Corn Yields (bu/ac) 2008



*Holloway had a 2nd light tillage pass in the spring

2nd Year Corn Yields (bu/ac) 2009



*Morris and Heron Lake were Spring ST

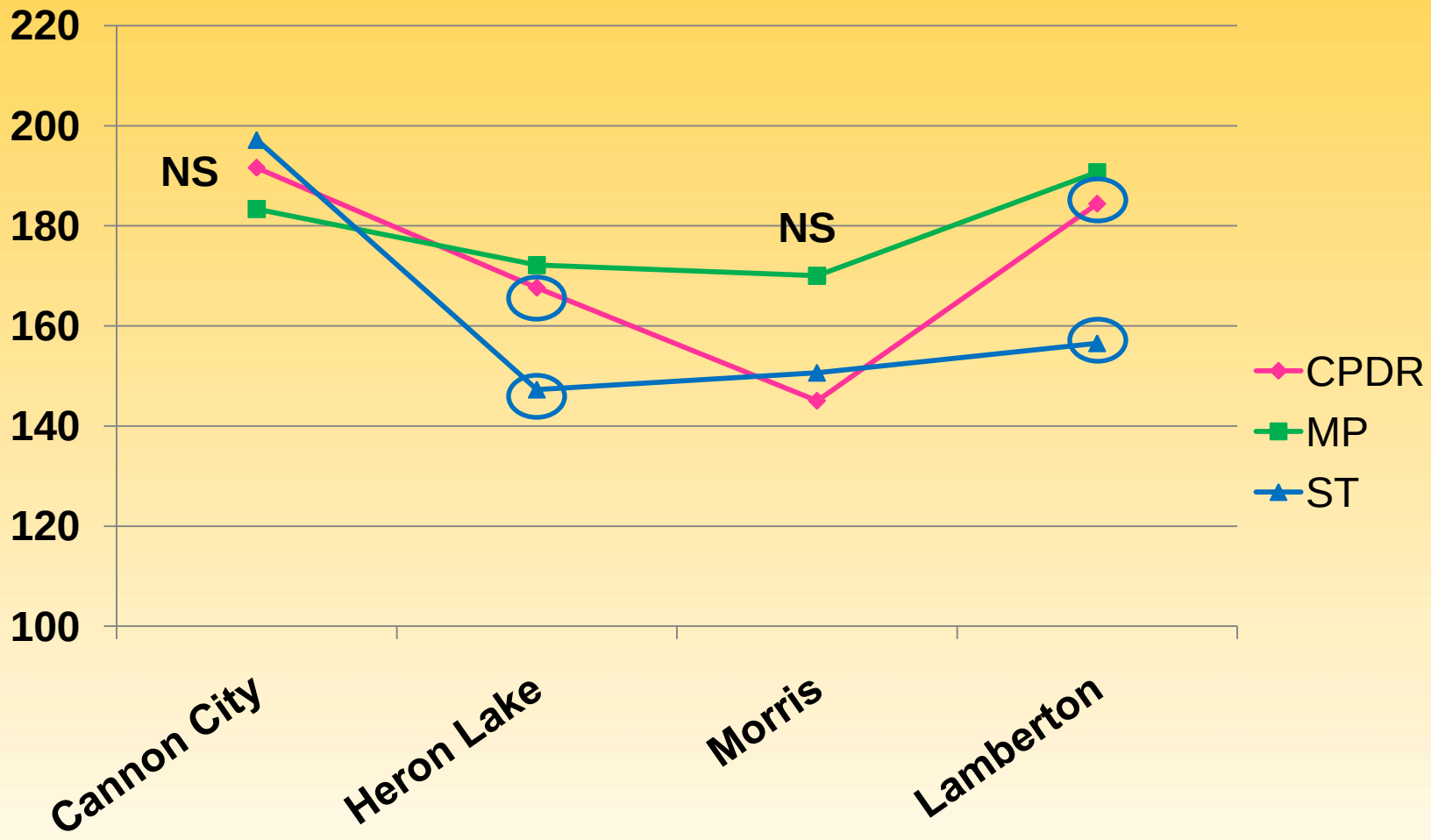
Boyd 22” Rows - Tillage Yields

	Residue (%)	Height (inches)	Population (plants/ac)	Yield (bu/ac)
Strip Till	77%	14.8 b	27,200 b	123.2 b
ST + Spring Salford RTS	54%	18.4 a	30,370 a	131.3 a
DMI + Spring Cultivation	39%	18.1a	29,240 b	----
MBP + Spring Cultivation	13%	21.5 a	32,050 a	----
LSD (0.05)	13	3.9	2,690	7.7

Planted 34,000

Salford RTS

3rd Year Corn Yields (bu/ac) 2010



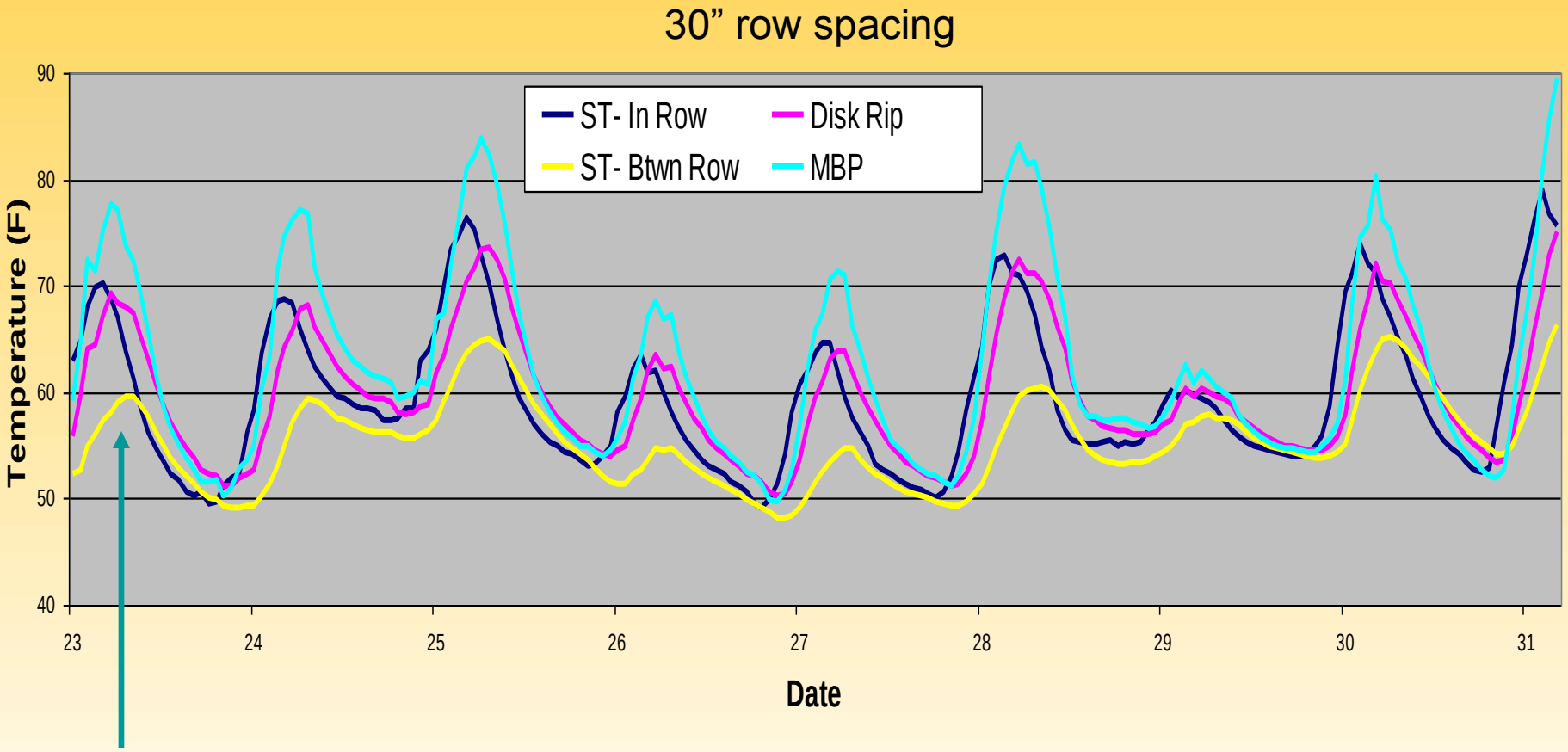
*Morris and Cannon City had secondary coulter pass

RTK and Yield with ST

Treatment	Corn Yield (bu/ac)	% from RTK
ST with RTK	221 ab	---
ST - visual	213 c	- 4
ST - 7” off center	216 bc	- 2.3
No Till	218 ab	- 1.4
Chisel Plow	221 a	---

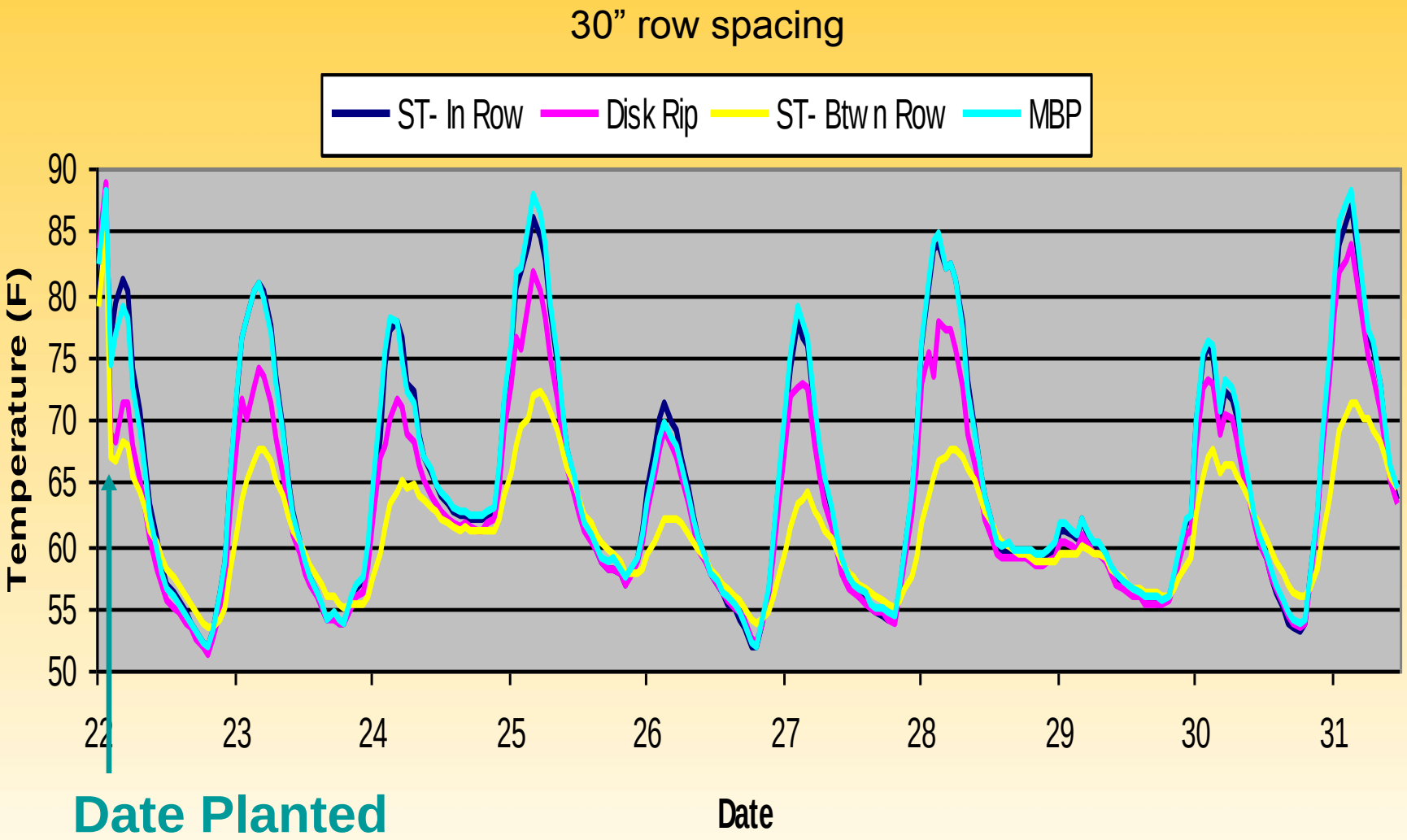
Tony Vyn, Indiana 2006

Holloway Soil Temps Corn on Corn

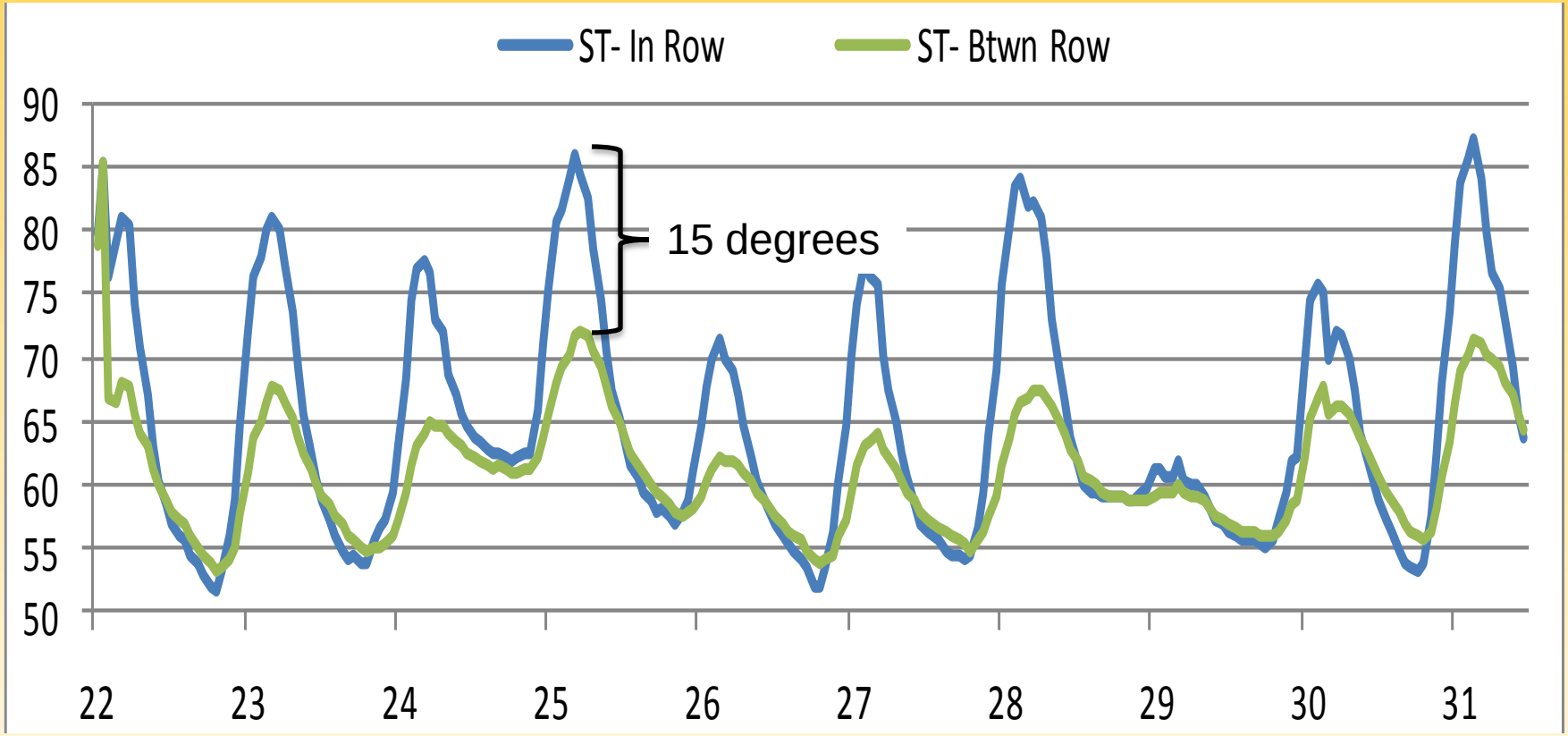


Date Planted

Morris Soil Temps Corn on Corn



Strip Till C-C Soil Temps
In-row vs. Between-the-row



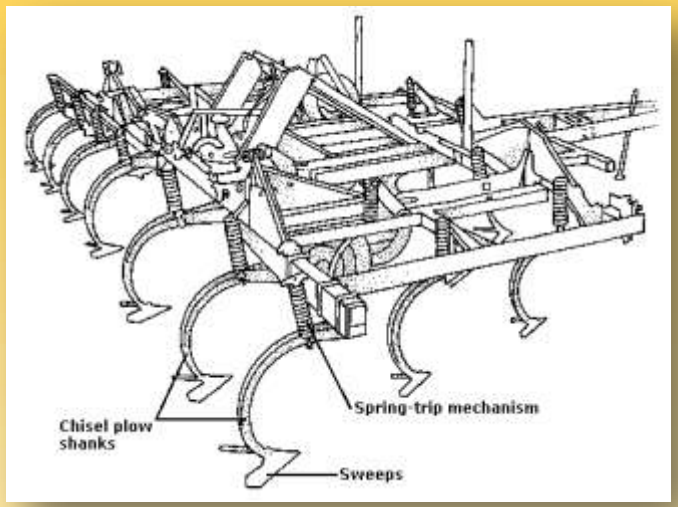
30” row spacing

Where to Try Strip Till

- Where you suspect a hard pan
- To maintain and/or build organic matter
- On well drained soil
- To improve water infiltration/structure

Vertical vs. Horizontal Tillage

- Horizontal tillage
  - Chisel
  - Cultivator



- Vertical tillage
  - Super coulter

Vertical Tillage

- Shallow tillage 1-3”
- Drive 7-10 mph
- Incorporates a little residue, nutrients, lime, and manure
- Chops and sizes residue. Prepares the seedbed.

Vertical Tillage

- Vertical till is still in its research infancy
- Less aggressive implements have more weed pressure
- Usually 2 passes in wet spring will get you in the field

UW Discovery Farms

- Great Plains Turbo Till
  - Rolling spike harrow and reel rear attachment
- Summers Super Coulter
  - Rolling spike and reel

- 2 gangs of non-concave blades, 10” apart offset with 2nd gang

UW Discovery Farms

- 40% of soil was tilled with first set of coulters (2 out of 5”)
- 60% of soil was tilled with the rear attachments (3 out of 5”)
- Majority of old corn roots were left intact

UW Discovery Farms

- Disturbance level varied with:
  - Soil type
  - Attachments
  - Depth
  - Speed

- 2nd pass with VT was very similar in disturbance to disking with field cultivation

UMN Research

- Near Clarkfield and Carlisle MN
- Tillage research looking at the depth and aggressiveness of tillage
  - Clarkfield: Wishek, DMI, ST, and VT
  - Carlisle: VT, ST, Field Cultivation (wet fall)

DMI Ripper

Salford RTS

Elmer's ST

Wishek Disk

2010 Soybean Data - Clarkfield

Tillage Treatment	Residue (%)	Population (plants/ac)	Yield (bu/ac)
F - ST S - coulter pass	61	148,800	58.0
FS - Salford RTS	58	153,700	59.9
F - Wishek disk S - field cultivator	41	143,300	56.7
F - DMI S - field cultivator	54	153,200	57.1
LSD (0.05)	8.9	NS	NS

Only 1 year of data

2010 Corn Data - Clarkfield

Tillage Treatment	Residue (%)	Population (plants/ac)	Height (inches)	Yield (bu/ac)
F - ST S - coulter pass	36	32,200	10.6	156.6 ab
FS - Salford RTS	30	32,800	11.1	162.9 a
F - CP S - field cultivator	30	31,900	10.7	152.2 b
LSD (0.05)	NS	NS	NS	7.1

Only 1 year of data

2010 Corn Data - Carlisle

Tillage Treatment	Population (plants/ac)	Height (inches)	Moisture (%)	Corn Yield (bu/ac)
S - Field cultivator	33,800	11.2	14.6	179.2 a
F - ST S - Coulter pass	33,200	10.7	14.1	178.2 a
S - Gates Magnum Coulter – 0°	31,800	8.4	16.1	167.0 b
S - Gates Magnum Coulter – 7.5°	31,500	9.7	15.0	170.7 b
LSD (0.05)	NS	1.2	1.1	7.1

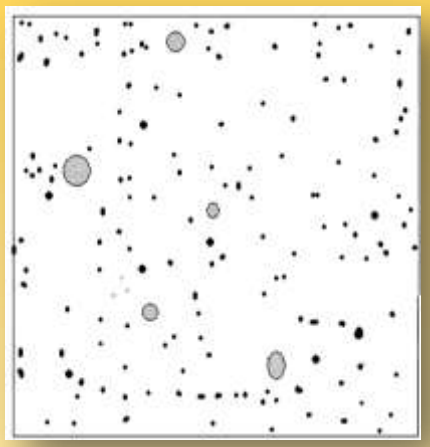
Only 1 year of data

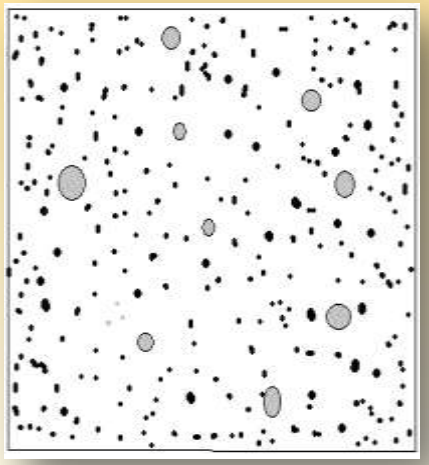
One Year Summary

- Watch your weeds
- RTK is important with ST
- Residue management starts with the combine
- We'll watch residue build-up over time

Kansas State 2009 Research

- Treatments:
  - Case True Tandem 330 Turbo (vertical till)
  - Long term no-till
- Applied 6.4” of water/hour
- Did not incorporate P and K





Pressley et al.

Vertical Tillage Pilot Study

Physical Properties		VT	NT	p-value, t-test**
Bulk density (g cm^{-3})	0-2”	1.13	1.21	0.08
	2-4”	1.29	1.30	NS
Infiltration (mm hr^{-1})*		21.4	44.0	0.04
Yield (bu/ac)		67.1	65.9	NS

This field had beautiful soil properties to begin with - NT since the 1980’s. No density increase below the depth of tillage (2”)

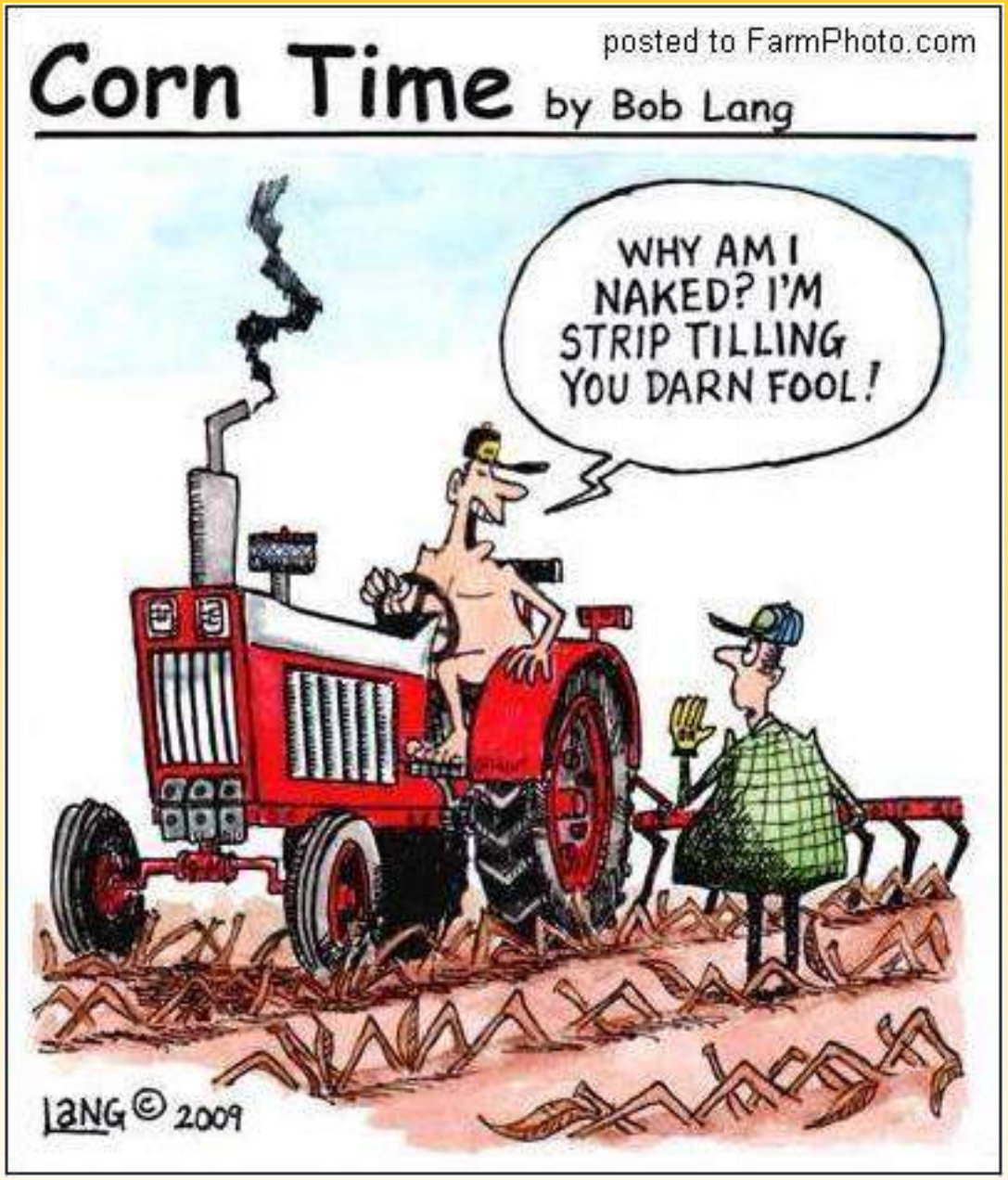
Where to Try Vertical Tillage

- Good at sizing residue and introducing air to a shallow depth
  - Wet springs
  - When fall tillage was not completed
  - Sands that need to have some tillage
  - Not beneficial on long-term NT fields
  - Decrease residue build-up
- Leaves 50-60% residue = good on slopes and all soil types
- Shallow tillage = works well with rotational tillage

Summary

- All tillage systems have their strengths and weaknesses.
  - Adjust tillage for soil type, slope, rotation, …
- Rotational tillage may work best if you have multiple soil types
- Have a Plan B

Questions?



www.extension.umn.edu/tillage/