Ruts, Rolling and Tillage

(ie Soil and Water Credit!)

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UNIVERSITY OF MINNESOTA
EXTENSION
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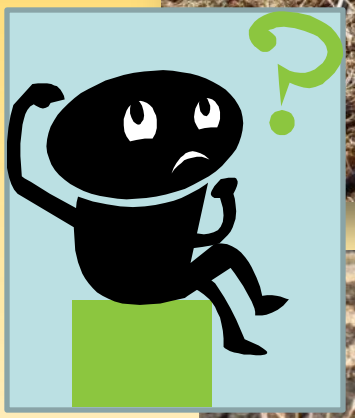
Choosing a Tillage System

- Cropping System
  - Rotation, residue removal
- Erosion Potential
  - Slope, soil type
- Long Term Productivity
- Others
  - Risk and comfort
  - Current equipment
  - Learning curve



Field Operation	Approximate % Residue Remaining
Moldboard Plow	0 - 15
Disk Ripper	20 - 45
Chisel - twisted points	20 - 35
Field Cultivator w/sweeps	30 - 50
Strip Till	50 - 70
Vertical Till	50 - 60
NH_3 w/closing disks	60 - 75

Strip Till

Chisel Plow+

No Till

Strip Tillage

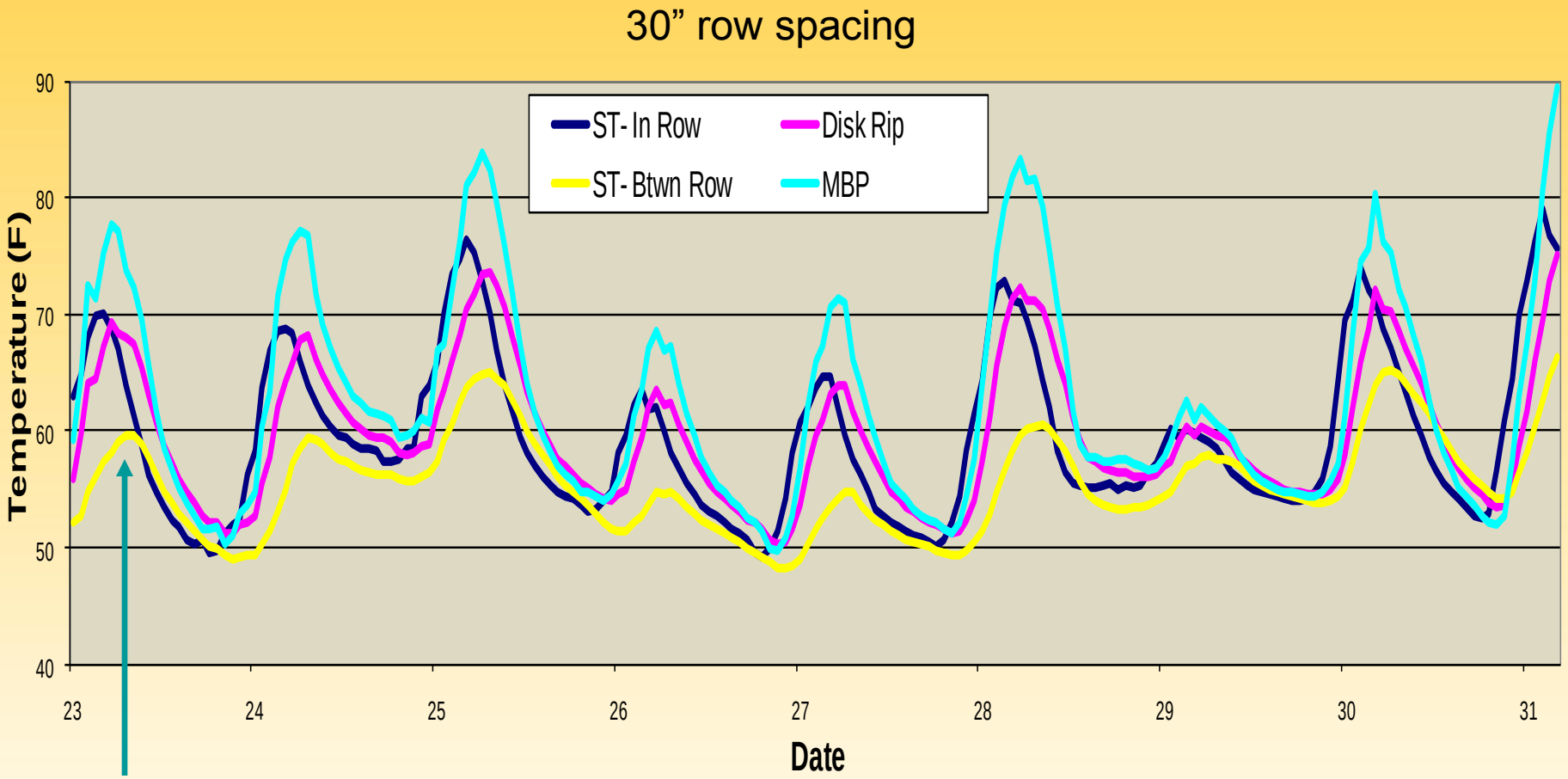
- Loosens the soil in the row 7-10” wide while maintaining residue between the rows
- Builds organic matter and soil structure
- Less energy required and less erosion than conventional systems

Strip Till Management

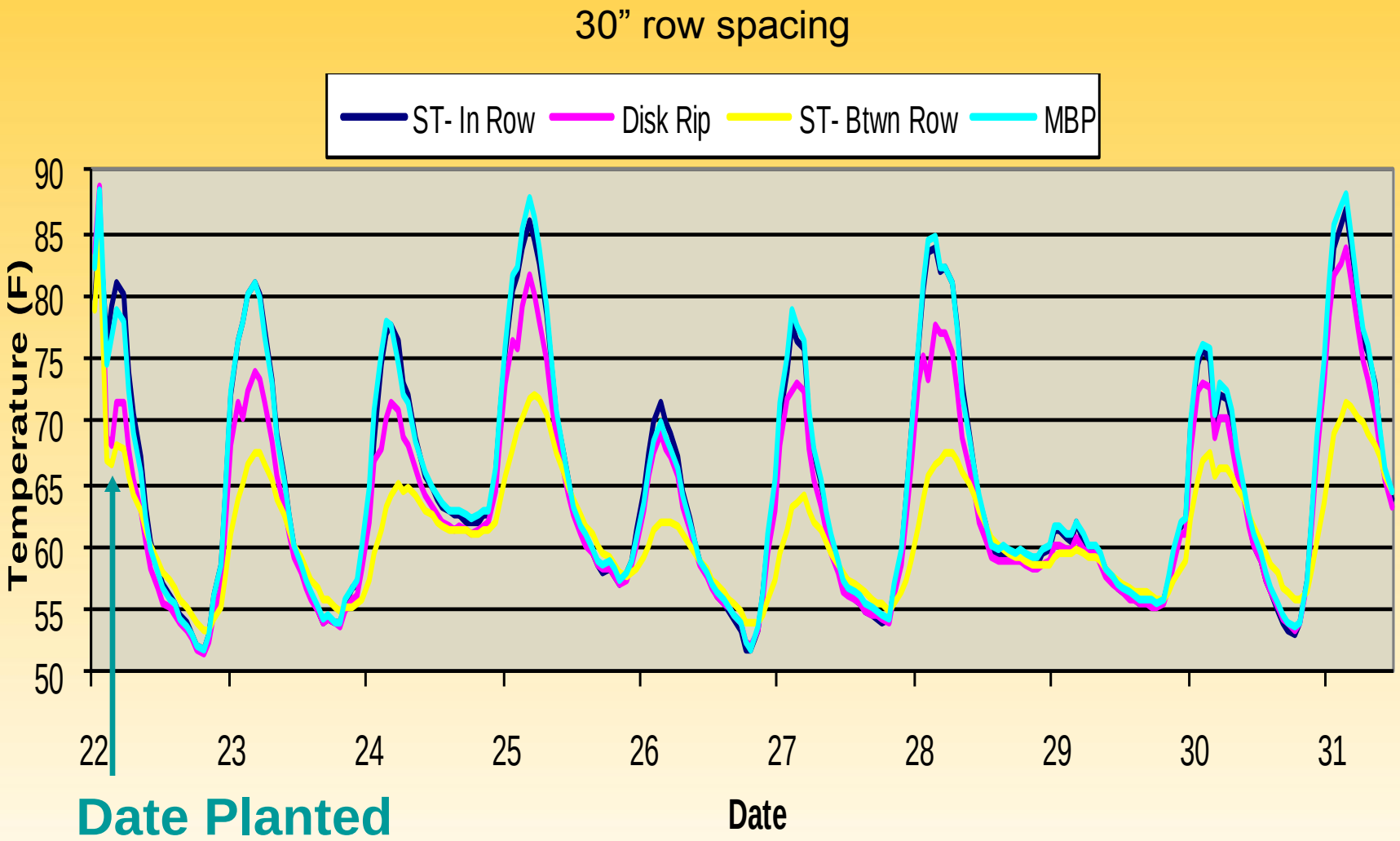
- Tile drainage is beneficial
- Have a ST rep or experienced strip tiller on speed dial
- Planting directly on the berm is essential
- Soil will ‘mellow’ in 3-4 yrs, but increased water infiltration will be immediate

Committed Sales Rep

Holloway Soil Temps - May 08



Morris Soil Temps – May 08



2006-08 Soybean Data (Jeffers, MN)

Treatment	2006	2007	2008	Residue % (average)
	---------- bu/ac ----------			
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.

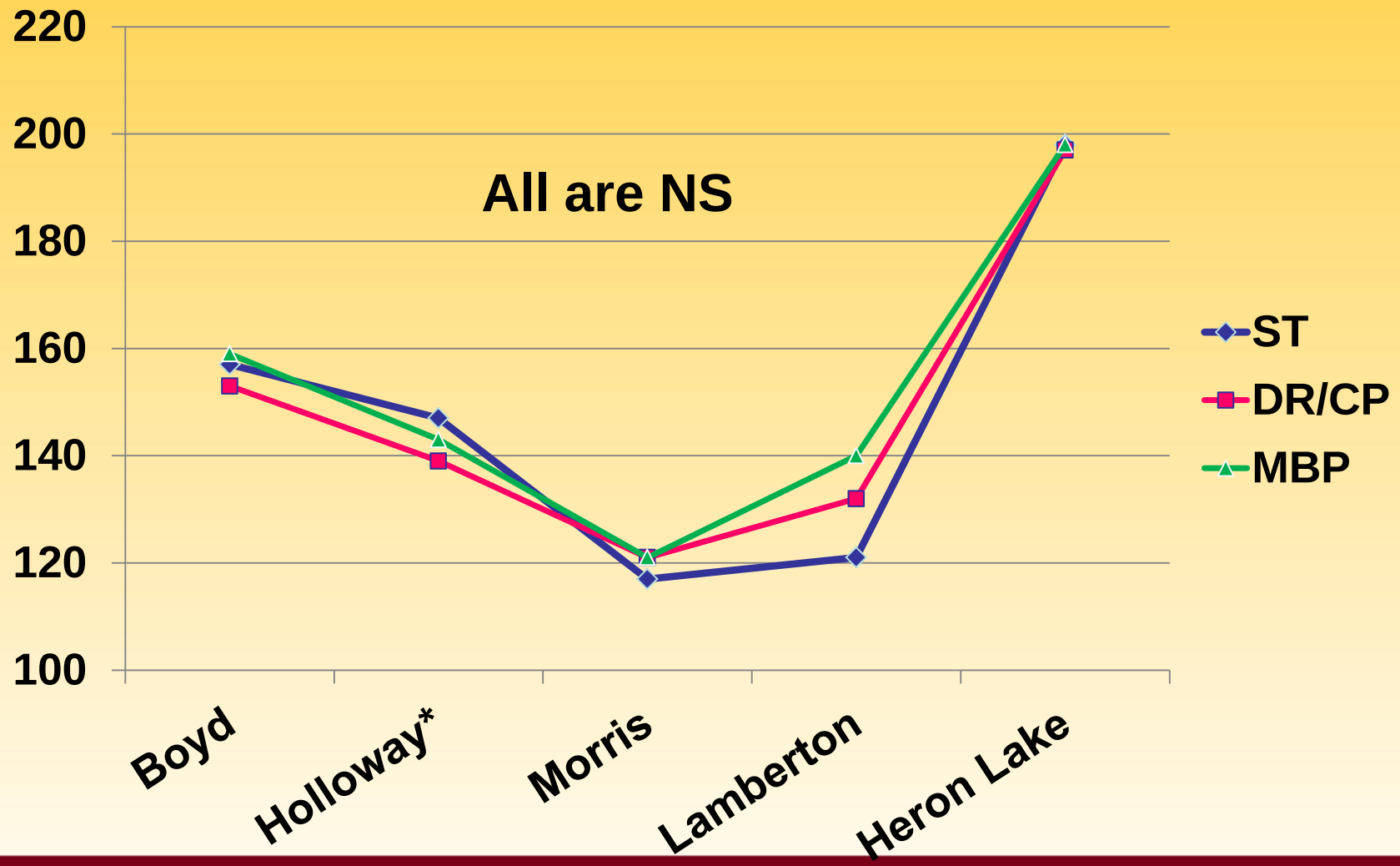
2007 and 2009 Corn Data (Jeffers, MN)

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	

Corn on Corn Tillage Trials

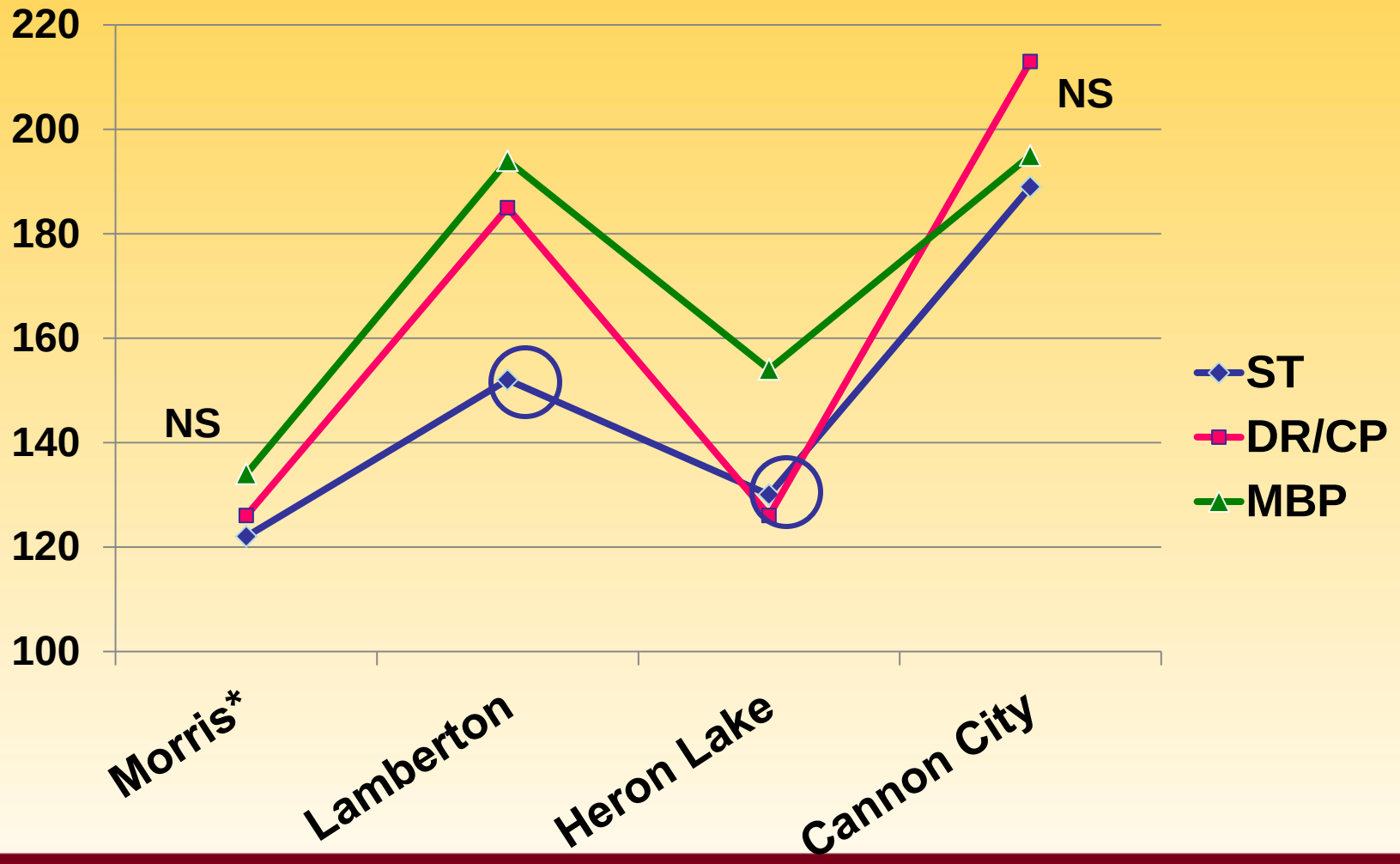
- 6 fields across Southern half of MN
- Started with corn as previous crop
- Three tillage treatments:
  - Moldboard plow
  - Disk rip or Chisel plow
  - Strip till
- Data collected:
  - % residue
  - populations
  - stalk rot, stalk lodging, root lodging
  - yield and moisture

1st Year Corn Yields (bu/ac) 2008

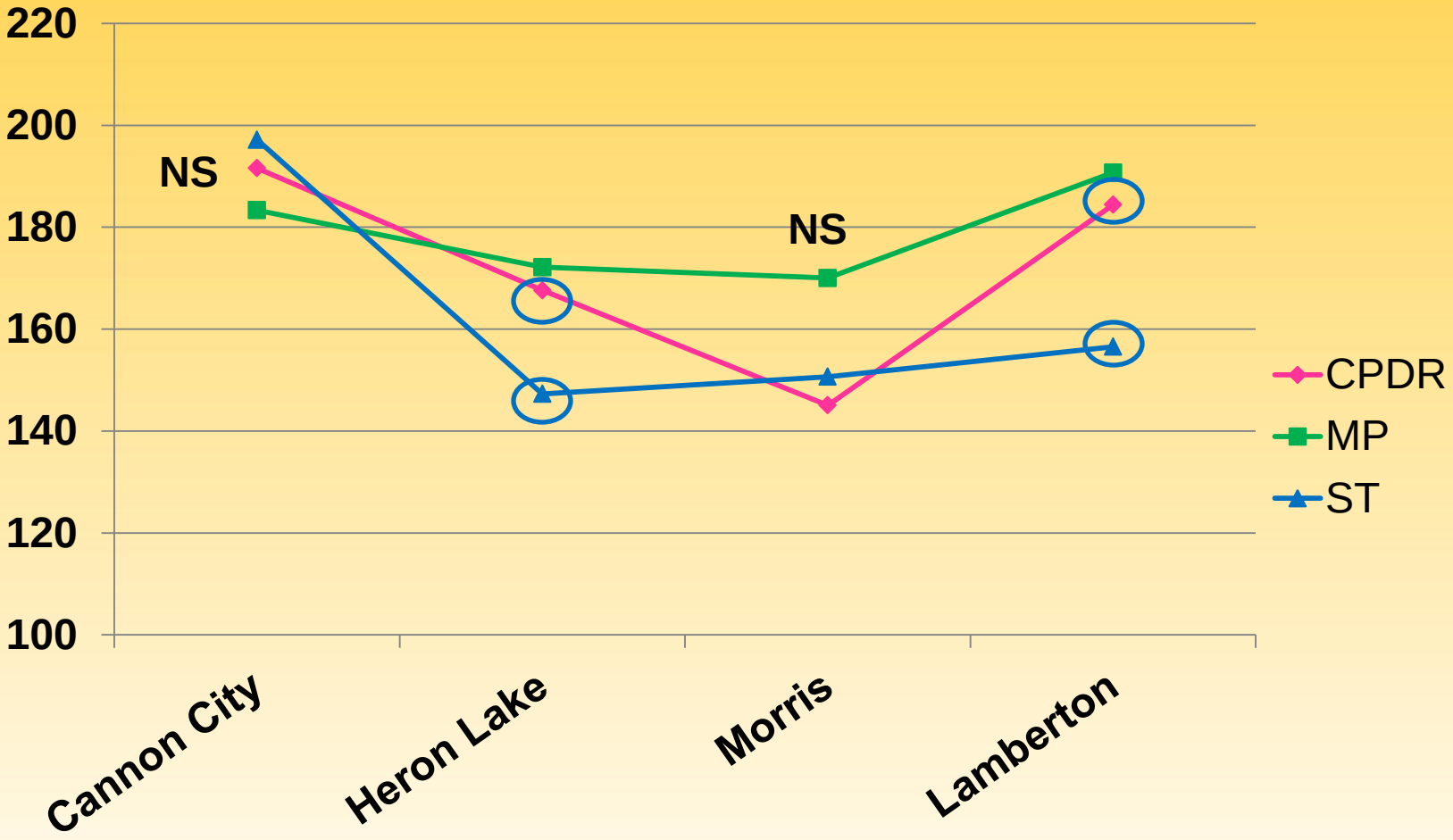


*Holloway had a 2nd light tillage pass in the spring

2nd Year Corn Yields (bu/ac) 2009



3rd Year Corn Yields (bu/ac) 2010



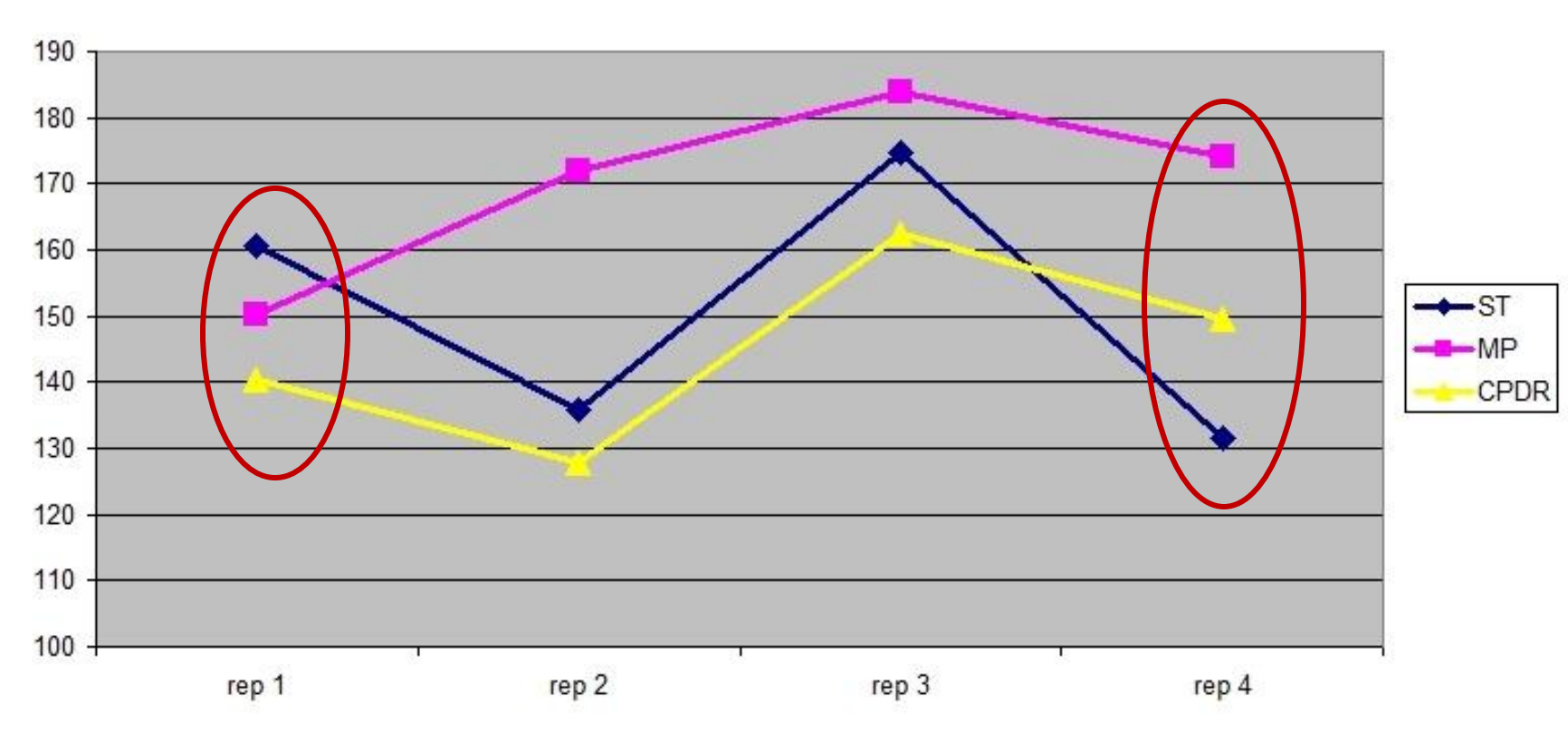
*Morris and Heron Lake had secondary coulter pass

3rd Year Corn Yields (bu/ac) 2010

Tillage	Cannon City	Heron Lake	Morris	Lamberton
CP/DR + FC	191.6	167.6	145.0	184.4
MP + FC	183.4	172.1	170.0	190.7
ST	197.2	147.3	150.7*	156.5*
LSD (.05)	NS	3.5	NS	14.1

* Secondary spring coulter pass

What Happened in Morris?



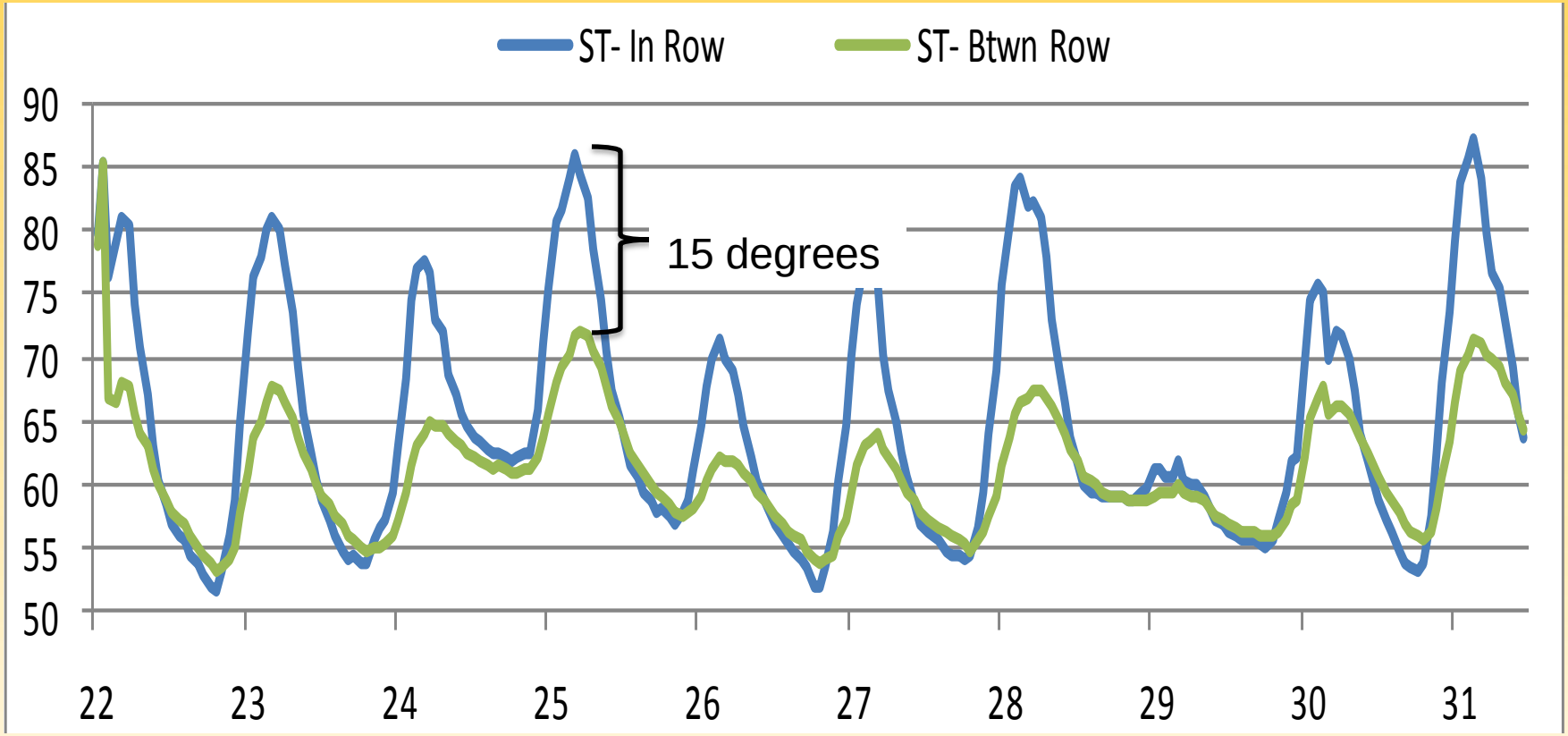
Change in soils across the research plot →

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

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



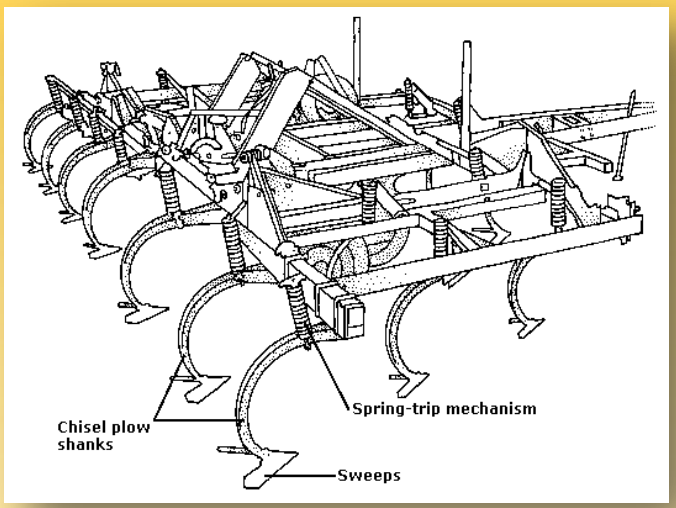
30” row spacing

Strip Till Management

- Tile drainage - important
- RTK - important (esp. if equipment doesn't line-up)
- Experienced help - important
- Look at all mgmt aspects – critical
  - Fertility
  - Weed management and shifts
  - Equipment interactions
  - Patience, flexibility, and a Plan B

Horizontal vs. Vertical Tillage

- Horizontal tillage
  - Chisel
  - Cultivator
  - Strip tiller
  - Ripper



- Vertical tillage
  - Super coulter
  - Disk

Vertical Tillage

- Shallow tillage 1-3”
- Drive 7-10 mph
- Incorporates a little residue and sizes residue
- Usually 2 passes in wet spring will get you in the field

Vertical Tillage Mgmt

- Vertical till research is still in its infancy
- Less aggressive implements have more weed pressure
- If used in wet soil or as only tillage, it may create a shallow plow pan

Tillage Trials

- Clarkfield (2) and Carlisle (1)
- Corn/Soybean rotation
- Various tillage rotations at each location
- Started Fall 2009 (1 year of data)

Equipment used at Clarkfield

2010 Soybean Data - Clarkfield

Tillage Treatment	Residue (%)	Population (plants/ac)	Yield (bu/ac)
Fall ST + Spring coulter pass	61	148,800	58.0
Salford RTS, 2x	58	153,700	59.9
Fall Wishek disk + field cultivator	41	143,300	56.7
Fall DMI + field cultivator	54	153,200	57.1
LSD (0.05)	8.9	NS	NS

2010 Corn Data - Clarkfield

Tillage Treatment	Residue (%)	Population (plants/ac)	Height (inches)	Yield (bu/ac)
Fall ST + coulter pass	36	32,200	10.6	156.6 ab
Salford RTS x 2	30	32,800	11.1	162.9 a
Fall CP + field cultivator	30	31,900	10.7	152.2 b
Fall CP + field cultivator	33	32,000	10.9	155.8 ab
LSD (0.05)	NS	NS	NS	7.1

Equipment Used at Carlisle

Gates Magnum Coulter at
0 and 7.5 degree pitch

Hiniker ST in Fall and
prototype coulter ST in spring

Why 2 passes? No breakdown that winter.

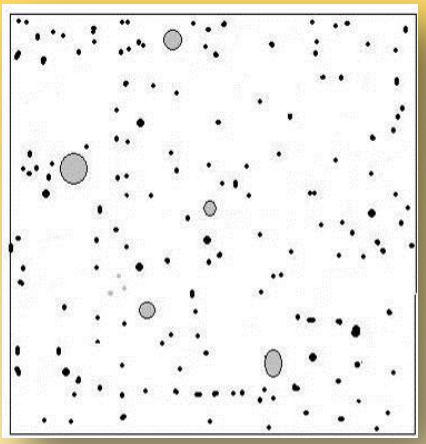
2010 Corn Data - Carlisle

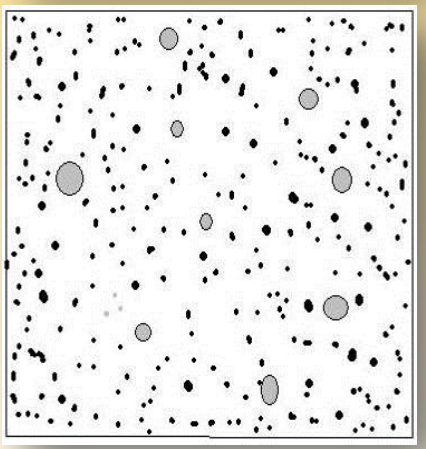
Tillage Treatment	Population (plants/ac)	Height (inches)	Moisture (%)	Corn Yield (bu/ac)
S- field cultivator	33,800	11.2 a	14.6	179.2 a
F- ST S- Coulter pass	33,200	10.7 ab	14.1	178.2 a
S- Gates Magnum Coulter – 0°	31,800	8.4 c	16.1	167.0 b
S- Gates Magnum Coulter – 7.5°	31,500	9.7 b	15.0	170.7 b
LSD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

High weed pressure in the Gates 0

Kansas State 2009 Research

- Treatments:
  - Case True Tandem 330 Turbo (vert. till)
  - Long term no-till
- Applied 6.4” of water/hour
- Infiltration rate:
  - VT 21.4 mm/hr
  - NT 44.0 mm/hr
- Bd was decreased in top 2”
- Did not incorporate P and K





Pressley et al.

Vertical Tillage Pilot Study

Physical Properties		VT mean	NT mean	p-value, t-test**
Bulk density (g cm^{-3})	0-2”	1.13	1.21	0.08
	2-4”	1.29	1.30	0.92
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”)

KSU 2010 Results: Continuous Irrigated Corn

	Residue (%)	0-2” Bd (g/cm^3)	Infiltration (mm/hr)	Yield (bu/ac)
No-till	94.8	1.21	0.49	195
Case	90.5	1.16	0.36	204
Landoll	91.4	1.16	0.18	190
Great Plains	89.3	1.13	0.54	204
LSD (0.05)	3.7	NS	NS	NS

Great Plains: Lower residue because was less anchored and more blew away, which caused lower soil moisture, trend lasted through season (not shown)

KSU 2010 Results: Continuous Corn

	Residue (%)	0-2” BD (g/cm^3)	Infiltration (mm/hr)	Yield (bu/ac)
No-till	60.2	0.96 a	0.8 b	154
Case	40.8	0.78 b	2.1 a	176
Disk	35.6	0.80 b	1.3 ab	154
LSD (0.05)	7.7	0.12	0.95	NS

At this site, tillage was done in fall, resulted in more treatment differences

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
  - Decrease residue build-up
- Leaves 50-60% corn residue = good on slopes and all soil types
- Versatile
- Shallow tillage = works well with rotational tillage

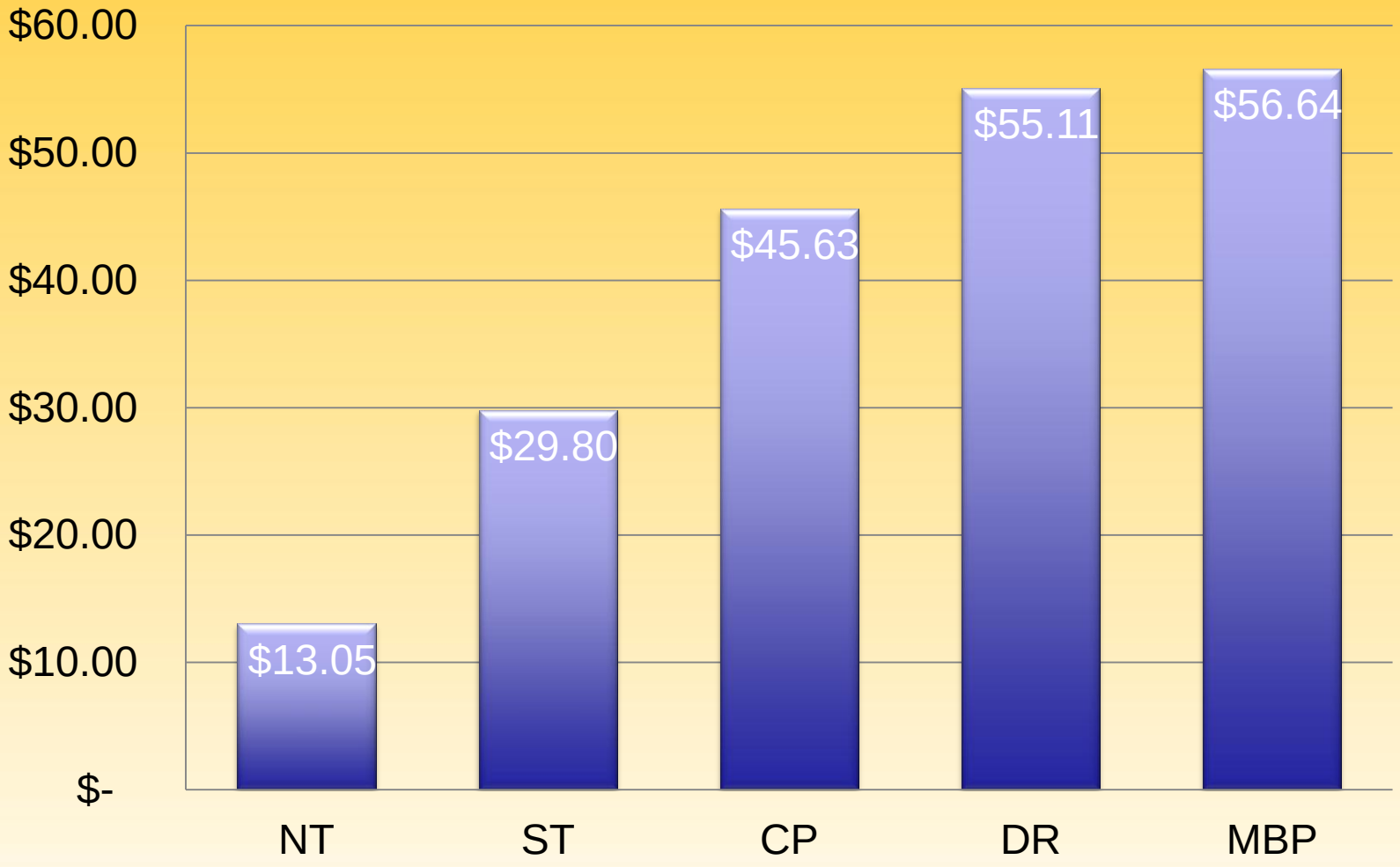
Caution When Using Vertical Till

- In long term NT fields
  - Decreased surface soil structure = decreases water infiltration
- When broadcasting N
  - Most machines will not cover N = volitalization
- Using for many years in wet conditions
  - May create hard pan

Field Operations and Management Practices for Different Tillage Systems

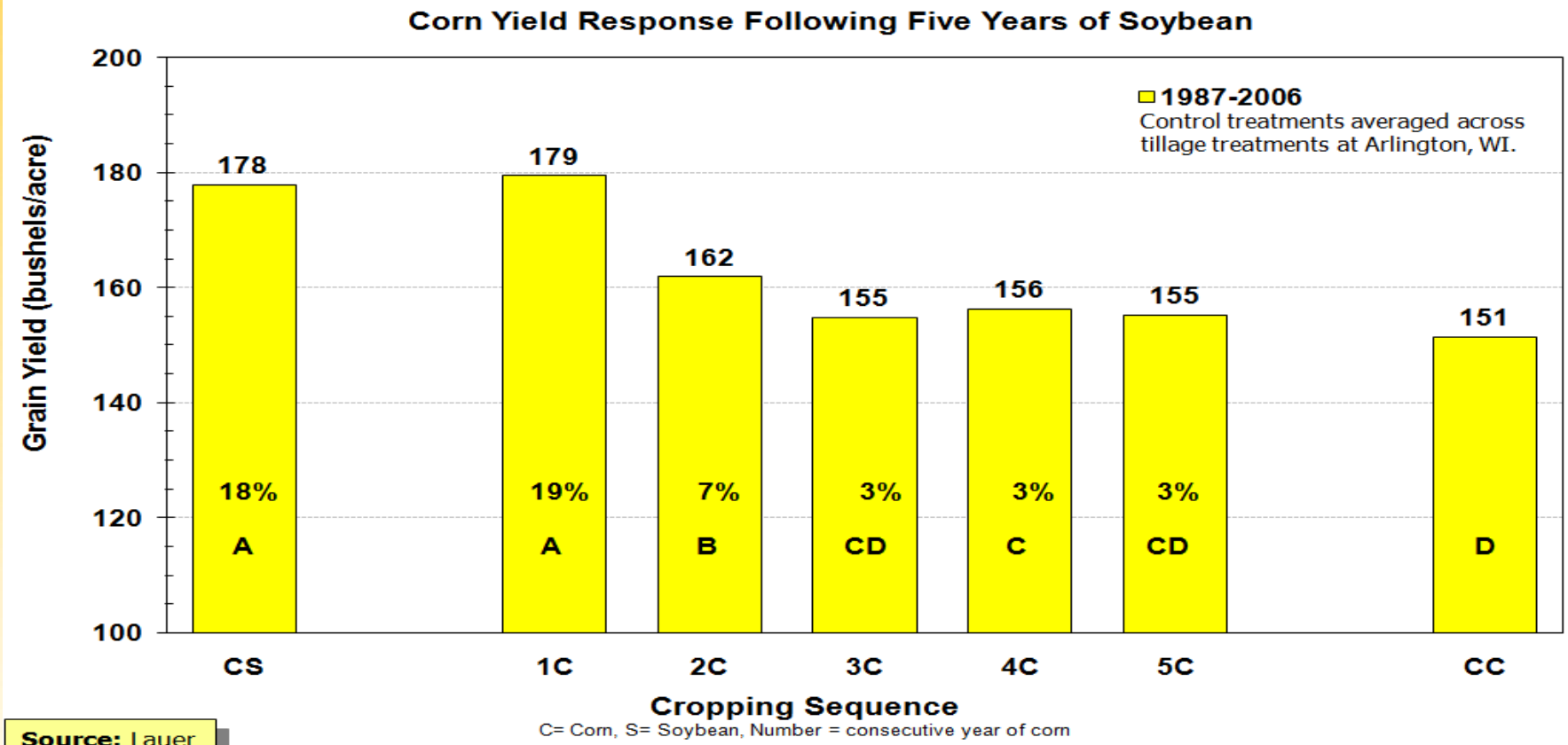
Operation	NT	ST	CP	DR	MBP
Stalk chopping			1	1	1
Primary tillage		1	1	1	1
Secondary tillage			1-2	1-2	1-2
Surface nutrient application	1		1	1	1
Planting	1	1	1	1	1
Spraying	2	2	2	2	2
Harvest	1	1	1	1	1
Total number of trips	**5**	**5**	**8-9**	**8-9**	**8-9**

Tillage Economics ($/acre)



UW Rotational Study

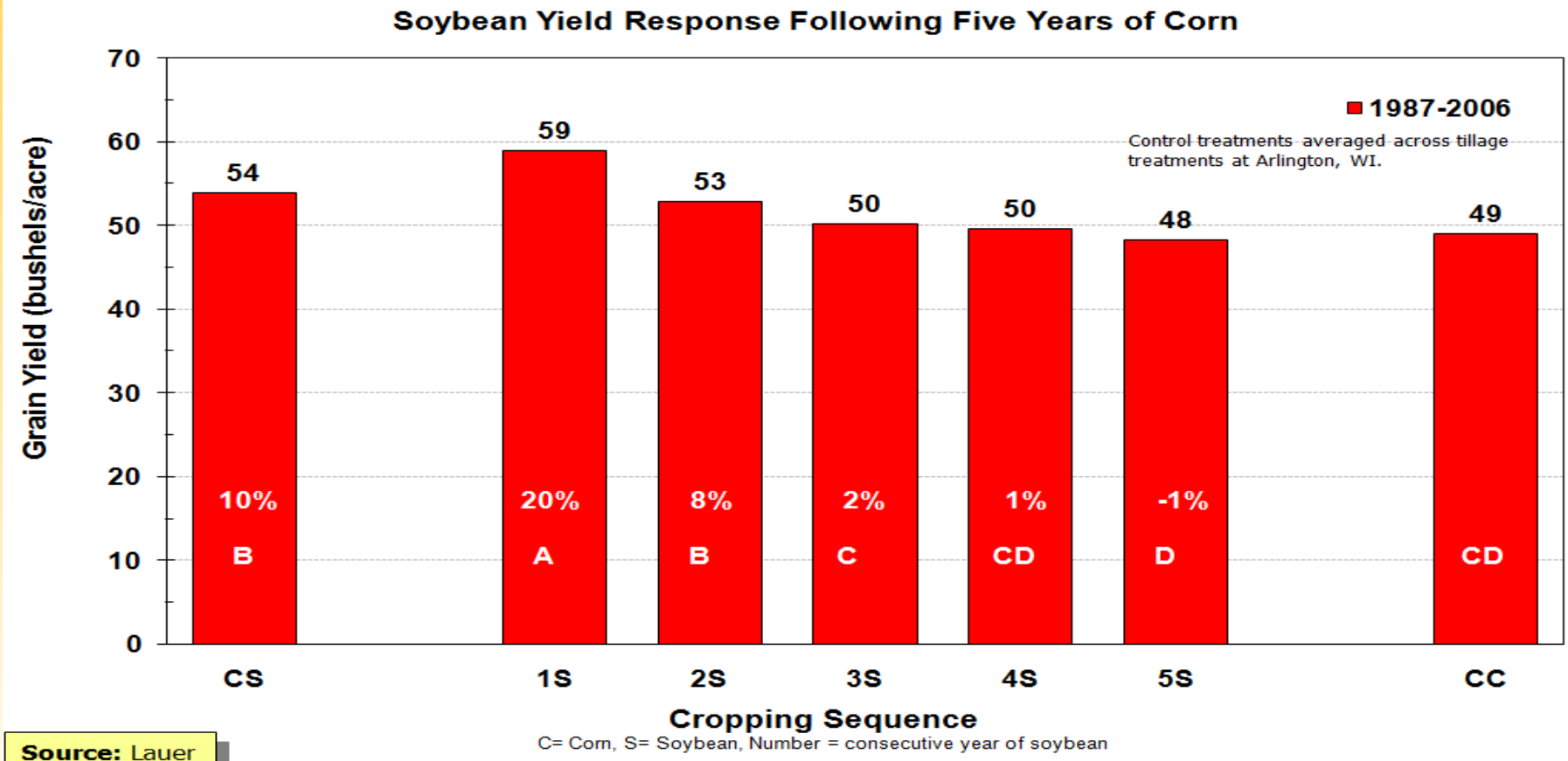
The rotation effect lasts two years increasing corn grain yield 10 to 19% for 1C and 0 to 7% for 2C ...



Source: Lauer

UW Rotational Study

The rotation effect lasts two years increasing soybean grain yield 10 to 20% for 1S and 8% for 2S ...



Source: Lauer

Choosing a Tillage System

- Cropping System
  - Rotation, residue removal
  - Timeliness of field operations
- Erosion Potential
  - Slope, soil type
- Others
  - Risk
  - Current equipment
  - Comfort
  - Learning curve

Ground Rolling Research Summary

Team:

- Jodi DeJong-Hughes, Doug Holen, Phil Glogoza, Russ Severson, Jim Stordahl - UMN Extension
- MN producers, consultants, and roller manufactures
- USDA-ARS, MDA, NRCS and SWCD

Funding Provided by:

MN Soybean Research & Promotion Council

Perceived Benefits of Rolling Fields

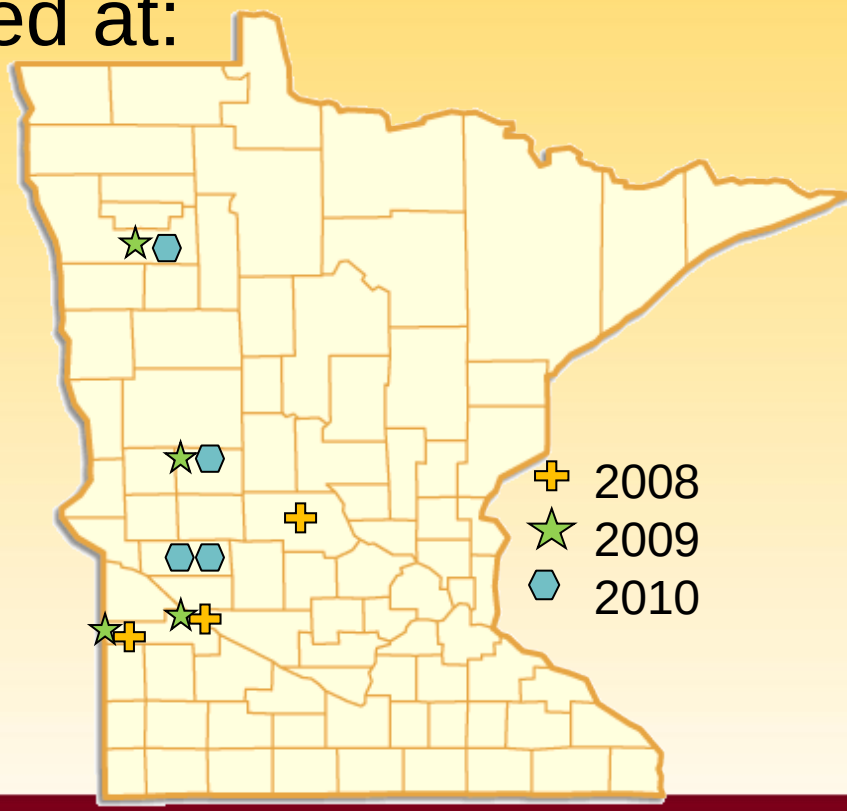
- Able to keep combine head low to the ground without picking up rocks, corn root balls, and soil
  - Harvest lowest pods
  - Decrease dockage for ‘dirty’ seed beans
  - Less wear and tear on equipment
  - Increase combine speed
  - Ease of harvest

Perceived Benefits of Rolling Fields

- Improved seed bed
- Breakup residue and corn root ball

Materials and Methods

- Three year study (2008-10)
  - 2008 was a pilot year
- Rolling treatments applied at:
  - Pre-plant
  - Post-plant
  - 50% emergence
  - V1 – 1st trifoliate
  - V3 – 3rd trifoliate
  - No rolling



Materials and Methods, con't.

- Variables observed:
  - stand, plant injury, yield, seed quality characteristics
  - residue decomposition, water infiltration and runoff (data not shown)
- Randomized complete block design with 3 reps

All Research Sites:

- Field sized equipment
- Plot width varied with roller width
- Minimum plot length 500’
- Harvest with combines and weigh wagons

Flexi-coil packer

Brillion notched roller

Riteway Smooth roller

Ave. Soybean Injury Counts

Treatment	2009	2010
	----------% Injury----------	
Pre-plant	5.7	0.3
Post-plant	7.7	0.6
50% Emergence	6.6	1.1
1st Trifoliate	11.6	4.0
3rd Trifoliate	16.4	8.2
No rolling	0	0.8
LSD (0.05)	2.2	*

*In 2010, 2 of the 4 sites had significantly greater damage for the V3 treatment.

Ave. Soybean Populations

Treatment	2009*	2010*
	------- 1,000 Plants/acre -------	
Pre-plant	158	160
Post-plant	158	160
50% Emergence	152	142
1st Trifoliate	153	151
3rd Trifoliate	150	135
No Rolling	155	154

* No statistical differences between plant populations by treatment at any locations by year.

Rolling Damage

50% Emerged V1 V3

Ave. Soybean Yield by Year

Treatment	2009*	2010*
	-----Yield in bushels/ac -----	
Pre-plant	46.6	52.1
Post-plant	46.6	51.2
50% Emergence	46.1	51.8
1st Trifoliate	45.2	51.6
3rd Trifoliate	45.3	50.0
No Rolling	44.7	51.8
LSD (0.05)	NS	NS

*Protein, oil, test weight and moisture are NS for all years

Iowa Rolling Research

Treatment	NW Iowa		NC Iowa
	2009	2010	2010
	------Yield bu/acre------		
Post-plant	64.2	58.8	57.4
1st trifoliate	65.5	58.2	58.3
3rd trifoliate	---	---	55.7
6 leaves	---	---	49.4*
No rolling	64.7	59.8	58.1
LSD (0.05)	NS	NS	5.9

Potential Problems:

- Greater risk for sealing the soil
- Increased wind and water erosion
- Cracked stem may increase disease and lodging issues

Summary

- Plant injury increased with later rolling.
- Population was not significantly affected by treatment.
- Yield was not significantly affected by treatment.
- Seed quality characteristics was not significantly affected by treatment.

Conclusion

- No yield advantage or disadvantage to rolling past emergence up to V3.
- However, risk increases with:
  - Cool, cloudy conditions
  - No-till
  - Wet soil conditions at rolling
  - Rolling direction

Fall Rut Affects on Yield

- Growers observe ~3 year affect from ruts
- 7 fields were GPS'd in Fall 2009
  - Frenchie with Crop One and 4 local growers
  - All but 1 field was CP + SFC
- Ruts vs not rutted areas were flagged-off
- Data and hand harvest w/in the flags

J. DeJong-Hughes,
J. Coulter

Spring Rut Research Data

Treatment	Ave. Ht (in.)	Early Pop. (plants/ac)	Growth (V) Stage
No Ruts	31.0	29,900	10.4
Ruts	22.5	28,900	9.1
LSD (0.05)	6.5	NS	0.7

Harvest Rut Research Data

Treatment	Final pop. (plants/ac)	Moist (%)	Yield (bu/ac)
No Ruts	29,100	14.9	158.6
Ruts	29,100	15.1	131.3
LSD (0.05)	NS	NS	11.1

Average yield drop was 17% and was very consistent.

One field had a 37% yield decrease. Ruts were on headlands = compaction + ruts (121 vs 77 bu/ac).

Husby's

Kohl's

Rutted

Not Rutted

Questions?