To Bale or Not To Bale?

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Sustainable Harvesting of Biomass

- Benefits
  - Renewable
  - Domestic
  - Reduces release of fossil CO_2
  - Additional farm income

The Purpose of Residue

- Erosion control
  - Buffers soil against the forces of raindrop impact and wind shear
- Input for building SOM
  - C, N, other nutrients
- Biomass removal

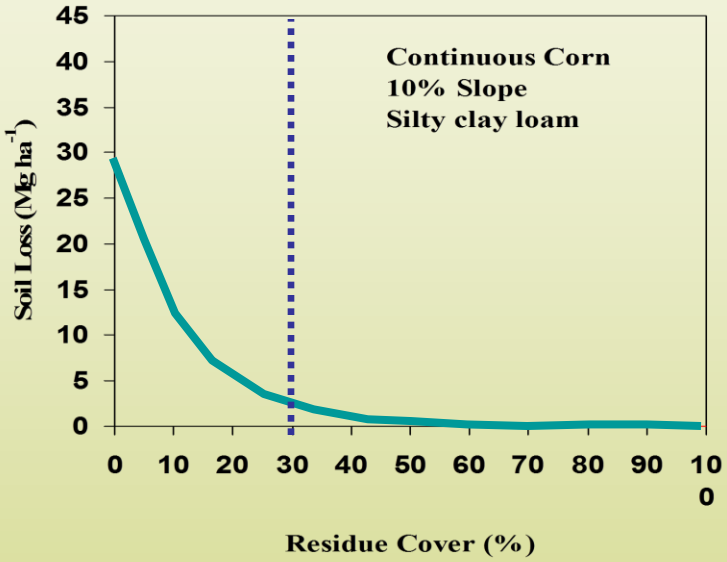
Erosion and Residue

- 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?

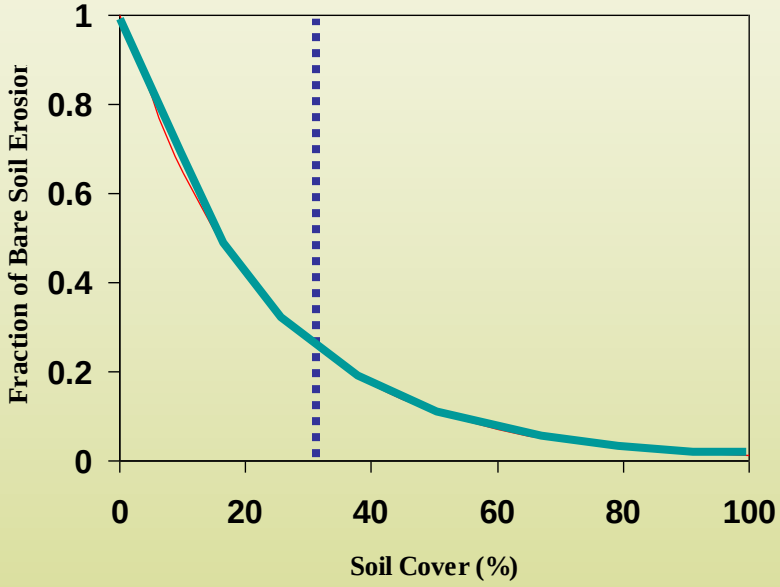
Water Erosion

Adapted from Dickey at al., 1984



Wind Erosion

Adapted from Bilbro and Fryrear, 1994



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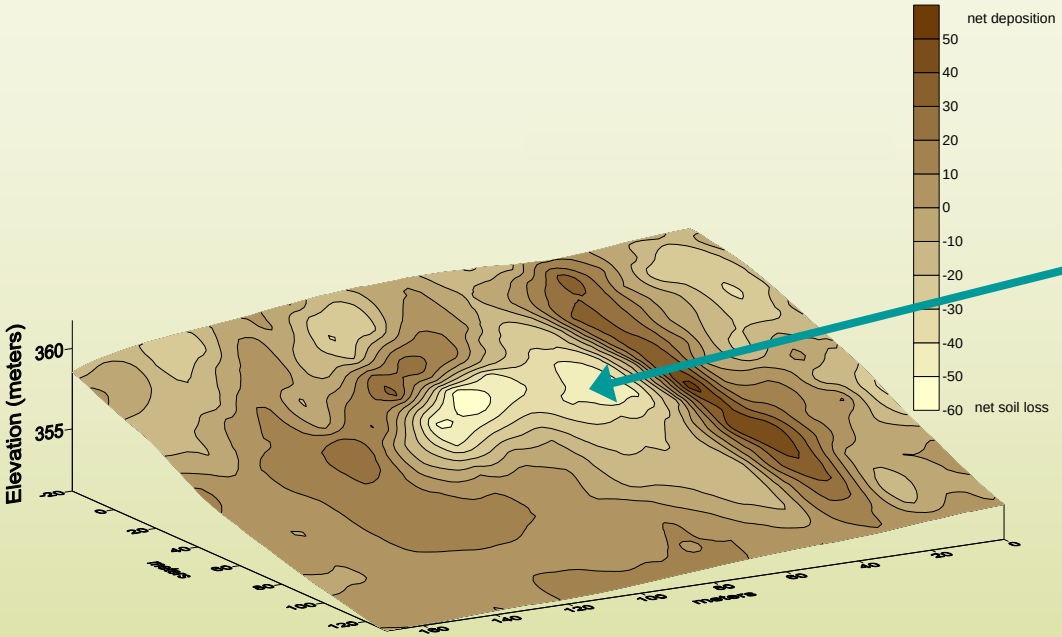
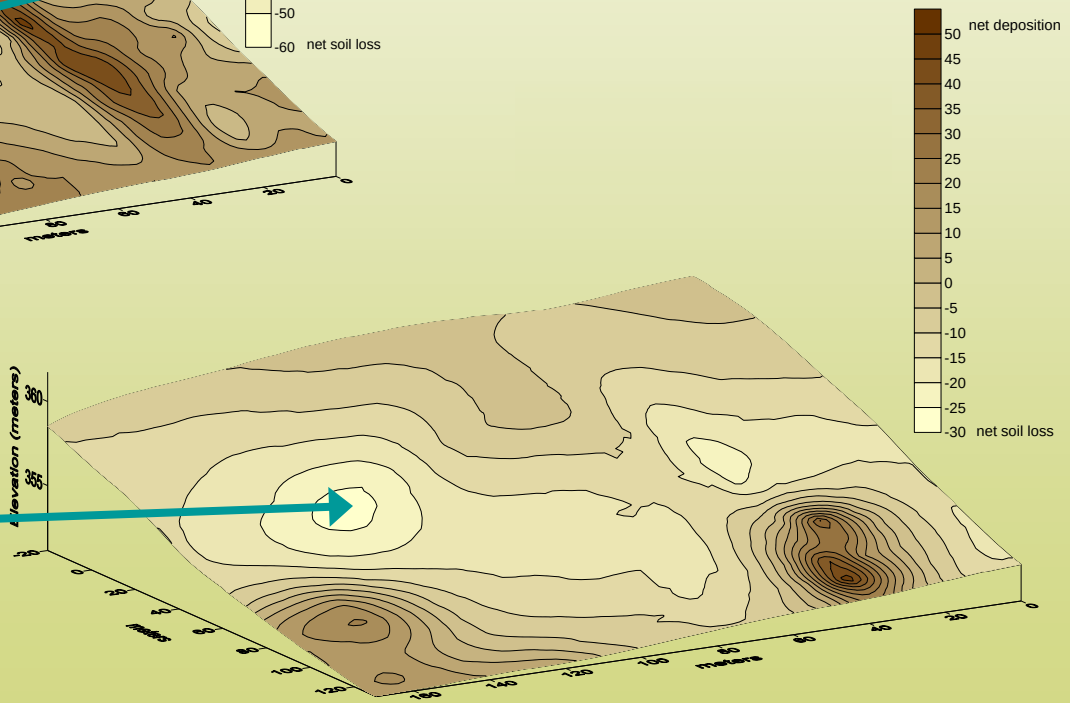
Skogstad Fields – Cyrus, MN

- 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

Lindstrom et al, USDA-ARS

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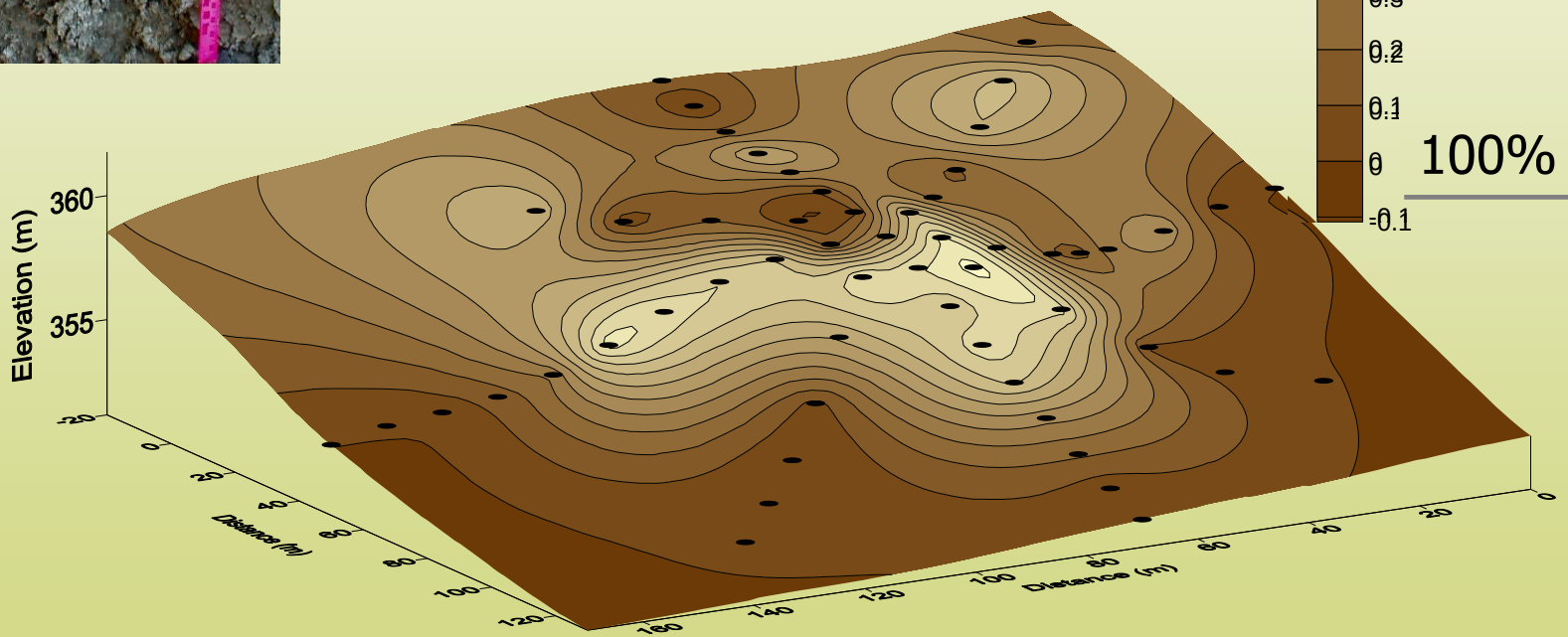
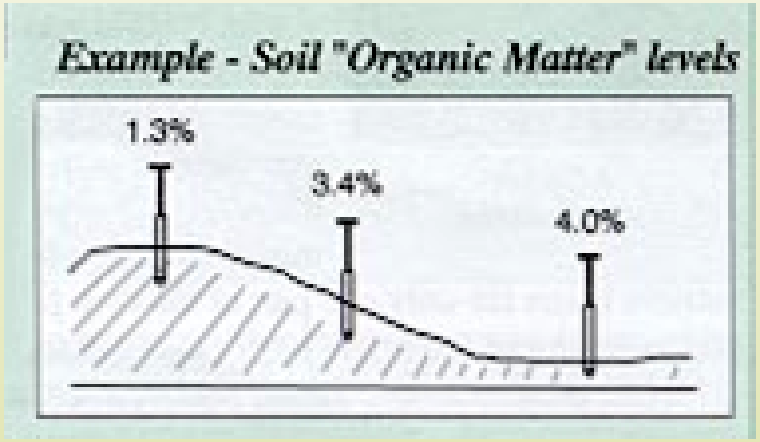
A Horizon – the good stuff

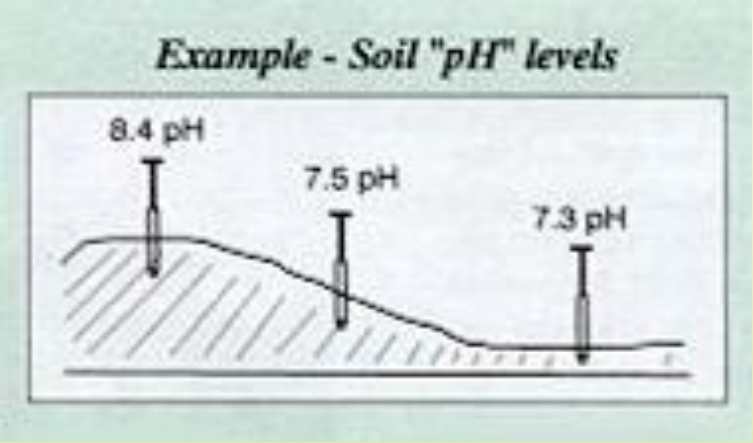
B Horizon –
Higher: pH, salts, and calcium
Lower: OM, N, P, K, structure

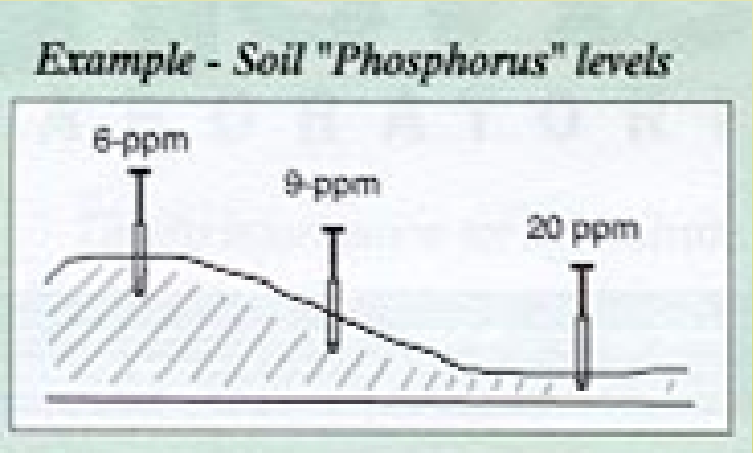


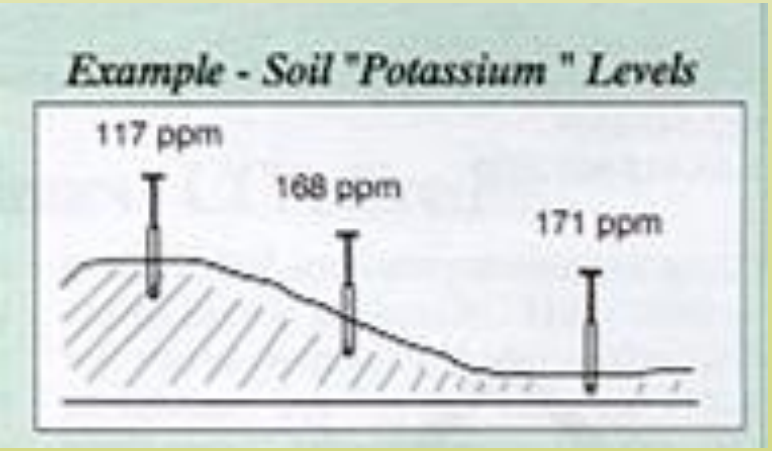
Based on inorganic carbon content

Variation in Topography

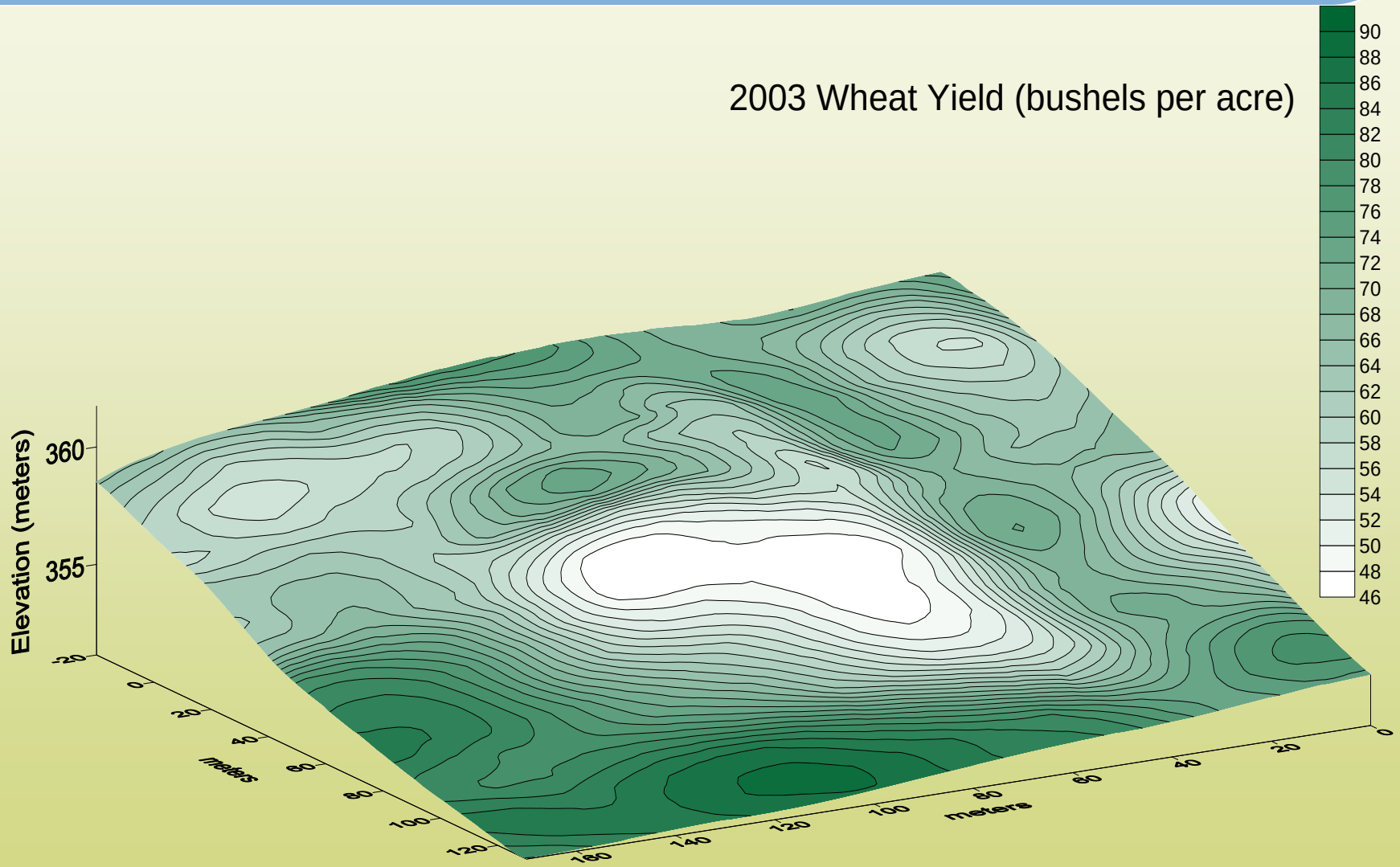








Variation in Crop Yield



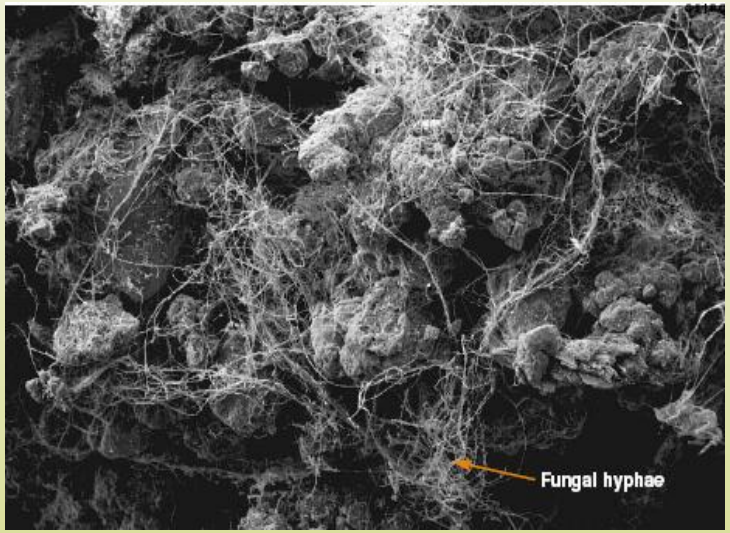
Lindstrom et al, USDA-ARS

Aggregate Stability

- Aggregate – a natural soil forming body made up of many soil particles held together

- Factors affecting aggregate formation:
  - Microbes, roots, and earthworms
  - Climate (temps and moisture)
  - Tillage

Gupta Vadakattu CSIRO group



Create Organic Matter By:

- Leaving at least 2.5 tons/ac of residue
- Increasing crop rotation
- Healthy microbial population
- Adding organic inputs
  - perennials
  - livestock and green manure
  - cover or companion crops

Crop Residue Production - MN

Crop	Crop Residue (lb/a)
Corn 160 bu/a	7,950*
Soybean 32 bu/a	1,900*
Wheat 58 bu/a	3,500*
Oats	1,600 - 2,400
Clover -cover crop	900 - 4,900
Oat/rye -cover crop	1,000 - 5,500

* Johnson, Allmaras, Reicosky - Western MN numbers

Carbon Content of Manure

Specie	Liq./Dry	Carbon
Dairy	Dry	35 #/T
	Liq.	39 #/1000 gal
Beef	Dry	30 #/T
Swine	Liq.	39 #/1000 gal
Poultry	Dry	34 #/T

1 large round bale = 1,200 lbs of residue
= 600 lbs of Carbon removed

Samples taken in 2004, AgVise Analysis

Destroy Organic Matter By:

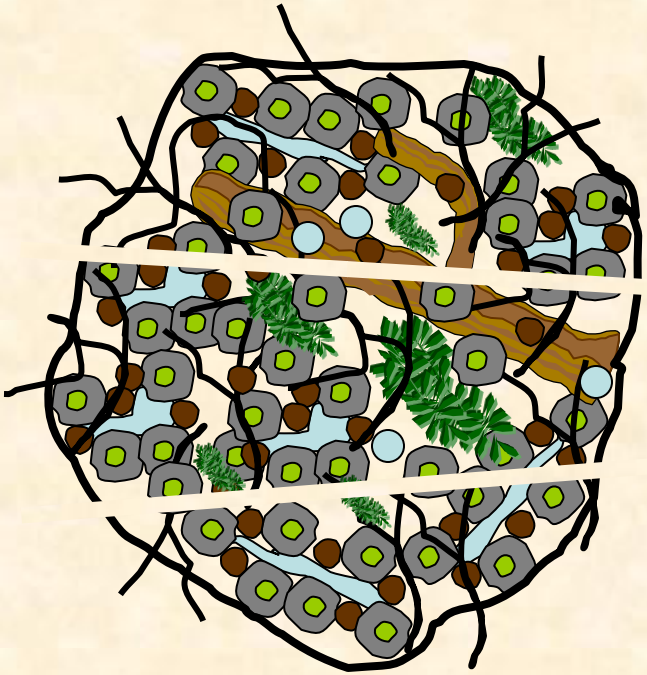
- Loss of Carbon from the system by:
  - Tillage
    - Recreational
    - Aggressive
  - Erosion
  - Fallow
  - Biomass removal

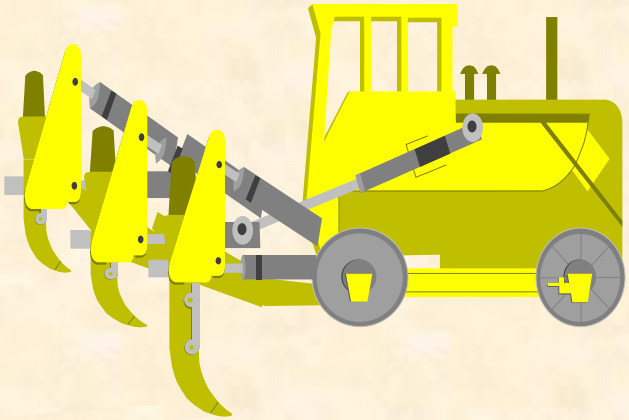
- Reduced microbial activity
  - Minimal habitat
  - Tilled too deep – loss of oxygen

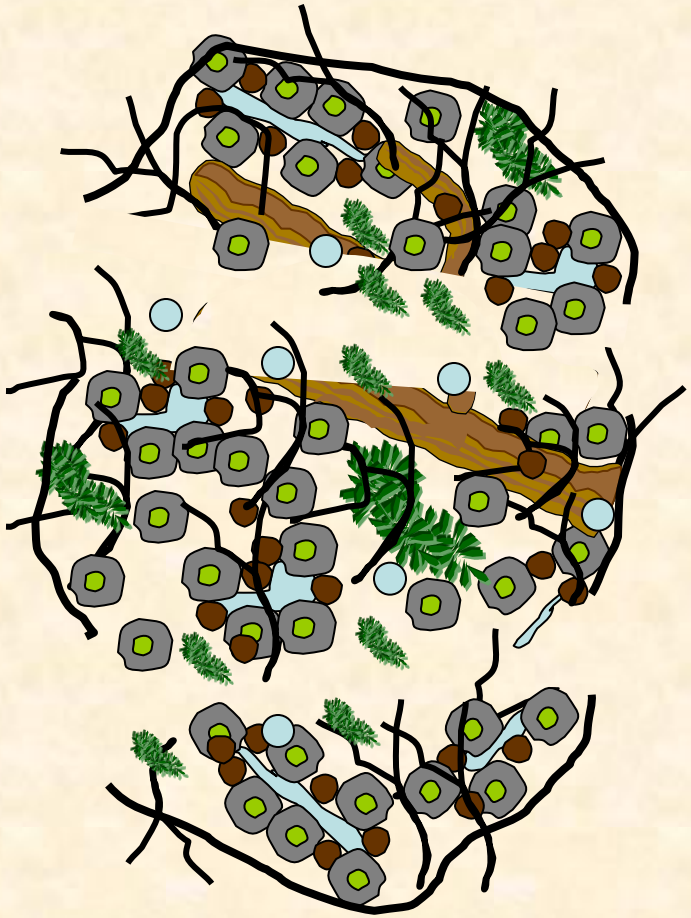
Tillage and Microbes

- Buried residue is exposed to greater microbial activity
- Decrease the density of the soil = faster warm-up
- Break-up of soil aggregates exposes organic matter to microbial activity

Example: A wood burning stove

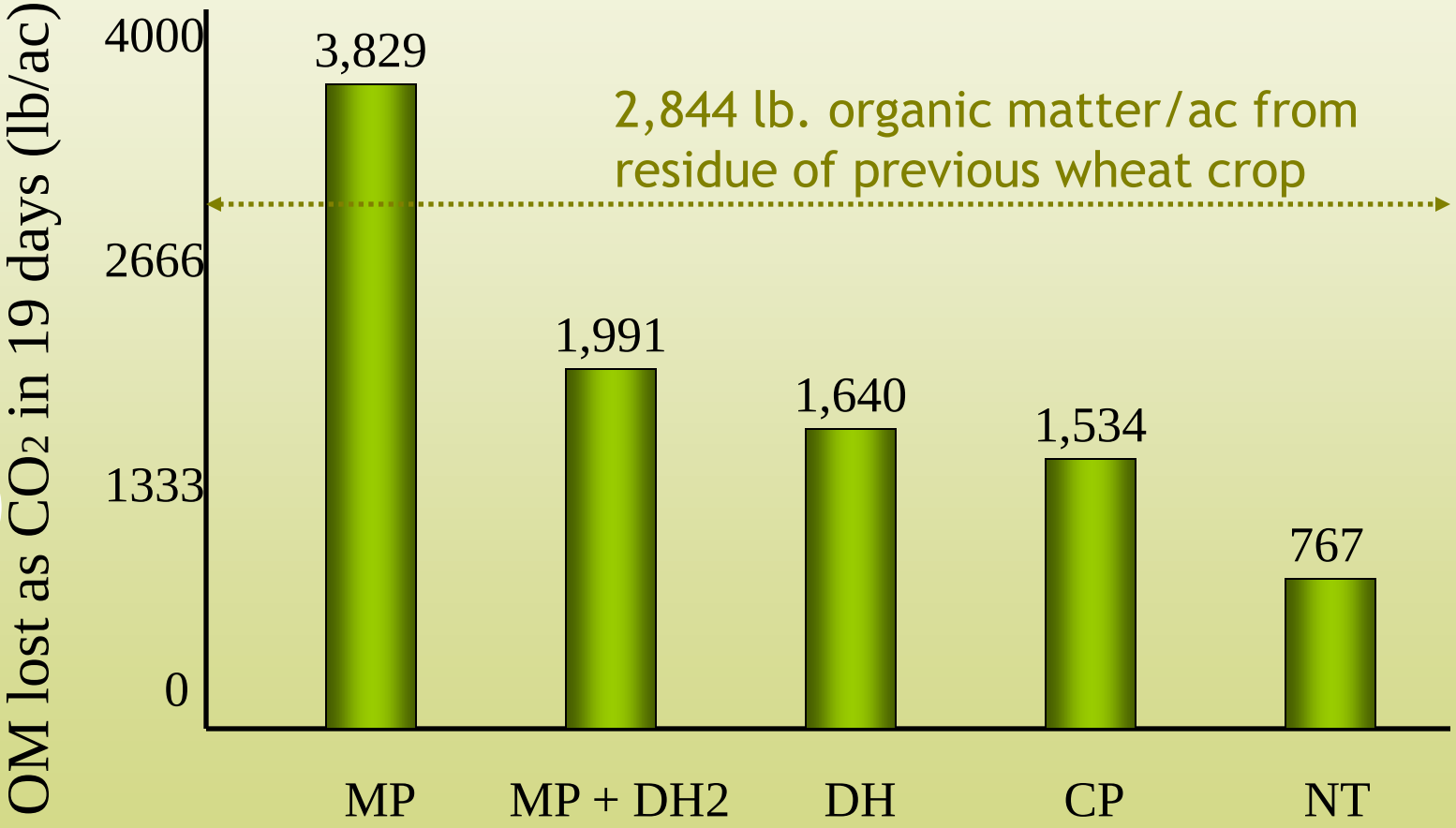






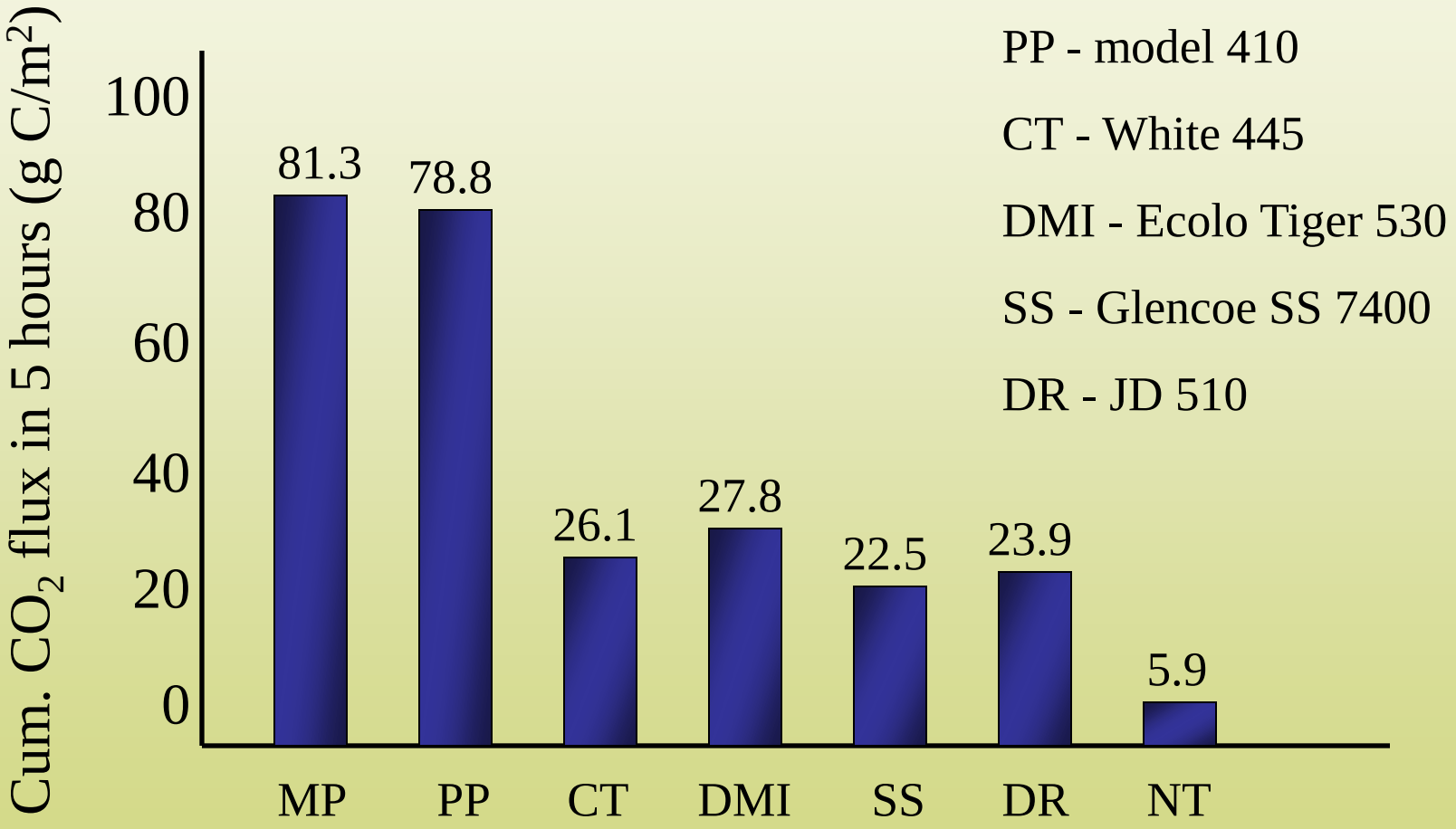
By Maysoon Mikha
Kansas State University

19 Day CO_2 Loss From Tillage



Reicowsky and Lindstrom, 1993

Minimum Till Equipment



Reicosky et al., 1994

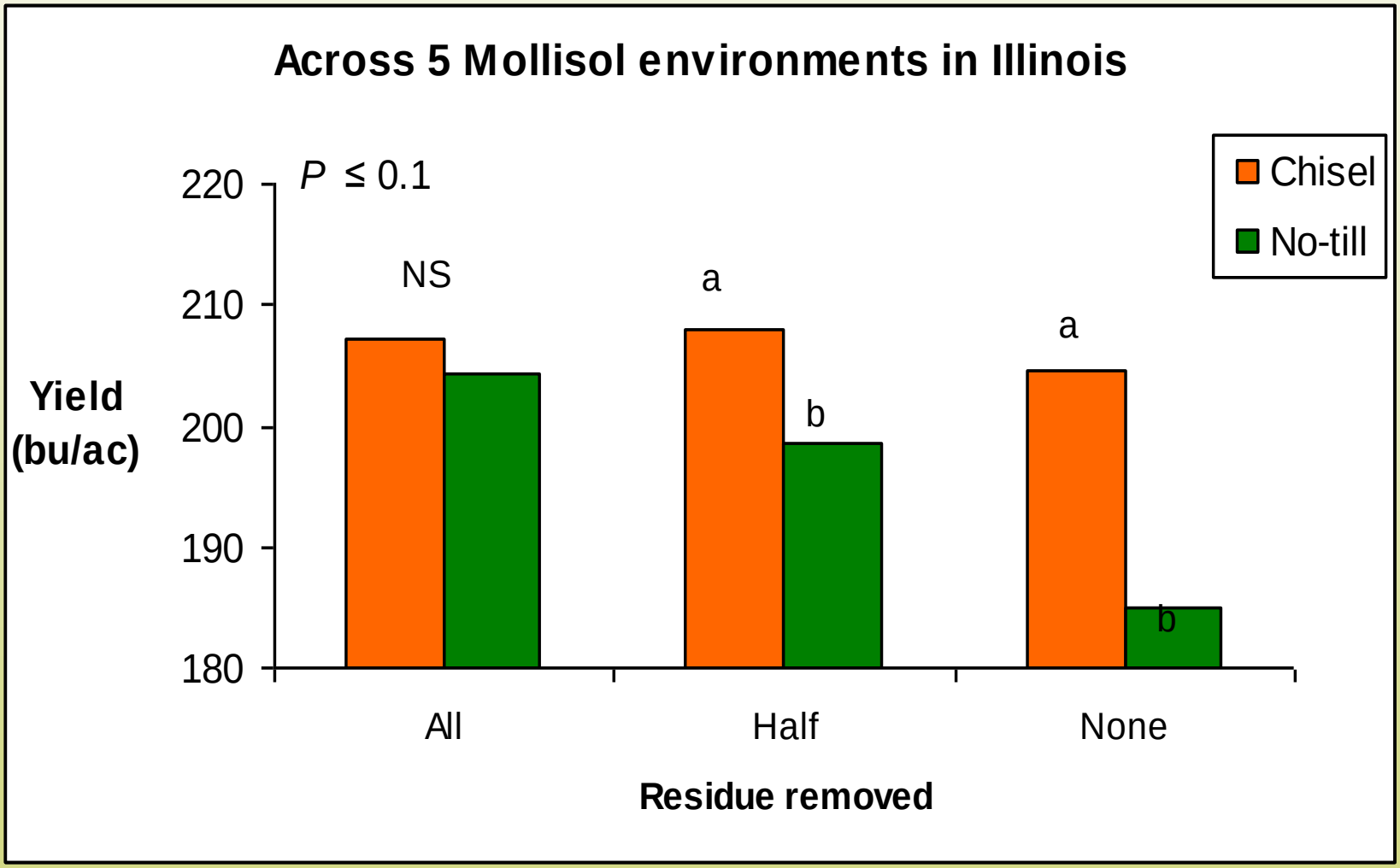
Factors of Residue Removal

Grain Yield (bu/ac)	**Corn Residue Yield**	**Cont. Corn** MBP	**Cont. Corn** CP / NT	**Corn-Soybean** MBP	**Corn-Soybean** CP / NT
	---------- Bales that Could be Harvested*----------				
100	**2.1**	**0**	**0**	**0**	**0**
125	**2.6**	**0**	**0.5**	**0**	**0**
150	**3.2**	**0**	**1.4**	**0**	**0**
175	**3.7**	**0.5**	**2.3**	**0**	**0**
200	**4.2**	**1.4**	**3.1**	**0**	**0.9**
225	**4.8**	**2.3**	**4.0**	**0**	**1.8**

* Assuming a 1,200 pound bale

Johnson et al. Morris USDA-ARS

Corn Yield Response to Residue Removal in Corn after Corn



J. Coulter and E. Nafziger,
Univ. of Illinois, (2006-2007)

Cost of Nutrients Removed - Corn

	Nutrient	Dry Ton	
Corn	N (16#)	$14.72	N not available the next growing season
	P_2O_5 (5.8#)	$ 3.71	
	K_2O (40#)	$17.20	
	Sulfur (3#)	$ 0.99	
Total	$36.62 (or $21.97 per 1,200# bale)		

N = $0.92, P = $0.64, K = $0.43, S = $0.33

Source International Plant Nutrition Institute

Cost of Nutrients Removed - Soybean

	Nutrient	Dry Ton	
Soybeans	N (40#)	$36.80	N not available the next growing season
	P_2O_5 (8.8#)	$ 5.63	
	K_2O (47#)	$15.91	
	Sulfur (6.2#)	$ 2.05	
Total	$60.39 ($36.23 per 1,200# bale)		

N = $0.92, P = $0.64, K = $0.43, S = $0.33

Source International Plant Nutrition Institute

Cost of Nutrients Removed - Wheat

	Nutrient	Dry Ton	
Wheat	N (14#)	$14.92	N not available the next growing season
	P_2O_5 (3.3#)	$ 2.11	
	K_2O (24#)	$10.32	
	Sulfur (2.8#)	$ 0.92	
Total	$28.27 ($16.96 per 1,200# bale)		

N = $0.92, P = $0.64, K = $0.43, S = $0.33

Source International Plant Nutrition Institute

Corn Cob Removal

- A great compromise would be to harvest only the corn cobs
  - 15-20% of the total residue
  - One pass harvest system
    - Less soil compaction
    - Less fuel
  - Consistent density/energy
  - 37% less nutrients removed
  - Minimal storage spoilage

Corn Cob Removal

The Ceres System includes:

- CleanBoot that attaches to the rear of the combine
- TopTank mounted to the top of the grain hopper
- TopCart, a hybrid


grain cart

cob collection technology tested

BY DAN LEMKE

Benson, Minn. — Specially-equipped combines chomped through several thousand acres of corn this fall — collecting cobs as well as grain.

The Chippewa Valley Ethanol Company in Benson collected cobs from its producer-shareholders to gasify and power its 47 million gallon-per-year ethanol plant. CVEC currently gasifies wood chips for power.

General Manager Bill Lee says about one ton of cobs can be collected from each acre of 200 bushel-per-acre corn. He estimates cobs from 108,000 corn acres, needed for the co-op's ethanol production, can meet 75 percent of the plant's thermal-energy needs.

Gene Pynbob, CVEC biomass collection coordinator, says the co-op held three demonstration events showcasing the cob collection. Two technologies were tested, including a self-contained unit pulled behind a combine and a system mounted on a combine. "We had a very good cross section of people who came to check out the collection — from government representatives to scientists and academics to farmers," Pynbob says. "You could tell the people who caught the vision and understood what we're trying to do."

AURI, the Minnesota Department of Commerce and Minnesota Corn Research and Promotion Council support the cob-collection project. U of M West Central Research and Outreach Center staff in Morris will analyze yields and monitor cob quality. Cobs will be gasified in the CVEC system and at a newly-installed system at the U of M Morris campus. A video and informational packet will be produced for corn farmers interested in cob harvesting. ■

PHOTO BY DAN LEMKE

During this fall's corn harvest, the Chippewa Valley Ethanol Company in Benson collected corncobs that will be gasified for power in an AURI-supported test project. Potentially, cobs from the co-op members' 108,000 corn acres could provide 75 percent of the ethanol plant's thermal energy.

Corn Cob Nutrient Removal

Nutrient	Lbs/ton Nutrient *		Cost/lb Fertilizer		Cost/ Dry ton
P_2O_5	2.1	X	0.64	=	$1.37
K_2O	12.5	X	0.43	=	$5.38
N	6.7	X	0.92	=	$6.16
	Total		**$7.75 per bale**		**$12.91 Per dry ton**
			$20.98 per corn stover bale		$36.62 per dry ton of corn stover

*Based on 160 bu/ac yield

Derived from Hanway, 2007

Residue Removal Guidelines:

- Use fields that are corn on corn
- Rotate residue harvest among fields
- Reduce tillage following residue harvest
- Add carbon back to the soil

- Consider winter cover crops

Residue Removal

- Should be based on:
  - Tillage to be used
  - Rotation
  - Economics
  - How much is to be removed
  - Whether you want to pass the land on to your kids in good condition

Disk vs. Cultivator

- Cultivator has little down pressure = less destruction of soil structure

- Disk cuts, rotates, shears and has substantial down pressure = destruction of structure

2009 Spring Management

- Soybeans can be no-till, adjust maturities accordingly
- Clay Loams and Corn:
  - Wait as long as possible
  - Chisel plow and stay shallow
  - Simply fill in ruts as best you can
  - Starters
  - Side dress

Spring Residue Management

- Bale residue and remove from field
- Burn select fields
- Preventative planting
- Hope for a dry spring

- There is not one easy answer

Questions?