Manure Management: 2015 and Beyond

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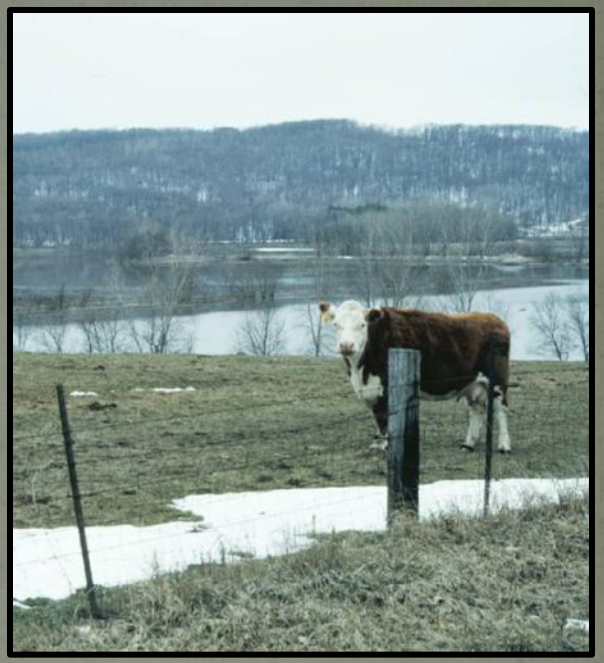
My Background

- Retired UW Extension Soil Scientist – 32 years
- Soil fertility, soil conservation, soil compaction, and land application of wastes
- Property owner in Bayfield and Ashland, Co.

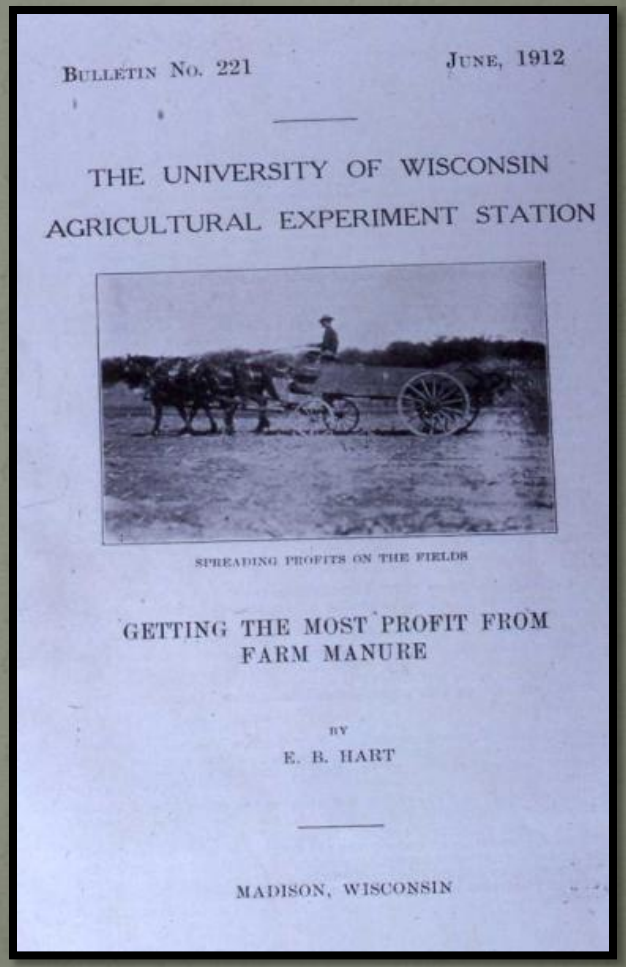
Manure Management – It's Complicated

- Conservation requirements
- Quantity and type of manure
- Storage management
- Soil conditions at application
- Potential for soil compaction
- Proper nutrient credits
- Equipment and time factors
- Tillage or injection to incorporate
- Application method to minimize loss
- Weather following application
- Making it work within a crop rotation
- Calibrated rate of application



Manure Management is a Balance

- The issue isn't new
- Recycling nutrients and organic matter to benefit crops vs. disposal need
- Potential risk for loss of nutrients to the environment does exist
- Requires planning and a commitment to "Doing it Right"



BULLETIN NO. 221 JUNE, 1912

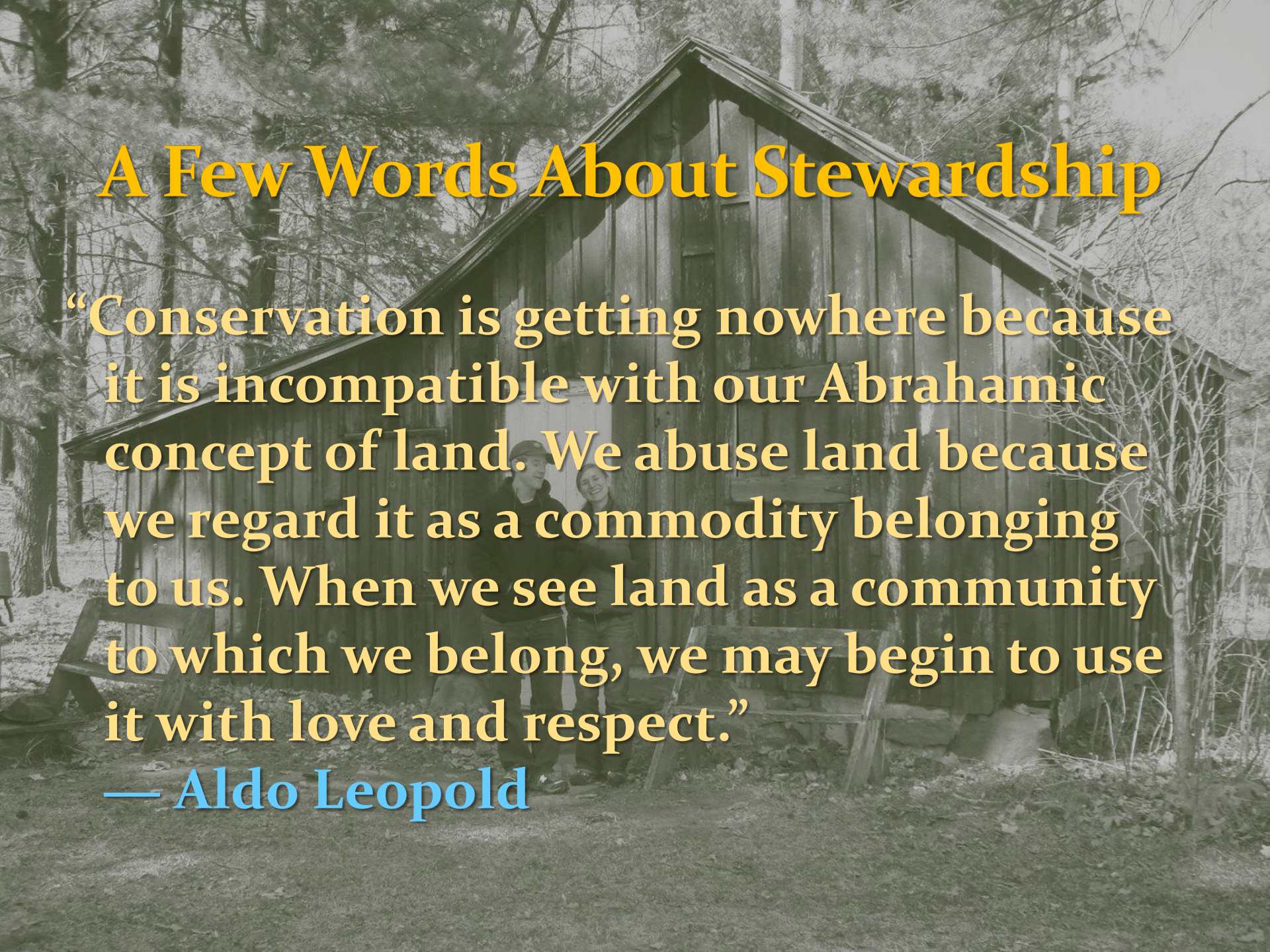
THE UNIVERSITY OF WISCONSIN
AGRICULTURAL EXPERIMENT STATION

SPREADING PROFITS ON THE FIELDS

GETTING THE MOST PROFIT FROM FARM MANURE

BY
E. B. HART

MADISON, WISCONSIN



A Few Words About Stewardship

"Conservation is getting nowhere because it is incompatible with our Abrahamic concept of land. We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect."

— Aldo Leopold

Manure Application Brings Tillage and Increases Soil Erosion Risk

- Soil Degradation
  - Fertility loss
  - Lower organic matter
  - Tilth destruction
- Water quality
  - Sediment
  - Nutrients
- Program cost
  - Cheaper to prevent
  - Still expensive
- Long-term productivity loss

Near Blue River ca. 1980

What's Changed in My 30+ Year Career?

Average WI Soil Loss	
Year	Soil Loss (t/a)
1982	4.44
1987	4.04
1992	3.49
1997	3.59
2002	3.96
2007	4.17
2010	4.43
Source: USDA-NRCS NRI	

Near Pipe, Wis.

What is the Value of Lost Topsoil?

How much cash = 3 t loss/a from a 40 a field

1. 6,000 lb x 40 acres = 240,000 lb
2. 240,000 lb/1,700 lb/yd/9 yd/truck = 16 trucks
3. 16 truckloads "leaving" the field every year
4. 240,000 lb/2,000 lb/t x $25/t = $3,000 per field

Can an eroded soil regenerate itself? (Apologies to Dr. Rick Cruse, ISU)

1. Assume a Wisconsin soil is 36 in. deep and 14,000 years old
2. 36 in./14,000 yr. = 0.003 in/yr
3. One acre-in weighs 333,333 lb
4. $\frac{333{,}333 \text{ lb}}{\text{in}} \times \frac{0.003 \text{ in}}{\text{yr}} = 1{,}000 \text{ lb/yr}$

Is "T" Tolerable?

How much soil to grow a bushel of corn

$$\frac{4.4 \text{ ton}}{\text{a}} \times \frac{2000 \text{ lb}}{\text{ton}} \times \frac{\text{a}}{162 \text{ bu}} = 54.3 \text{ lb soil/bu}$$


"You know Elyse, farmers should be able to do what they want with their land to be profitable. I see 400 bu/a corn right here in 2025."


"John, you're being silly! Let's hope people listen to folks like Grandpa who want to help us use the soil wisely and conserve it for our grandchildren."

Crop residue is still the farmer's best erosion prevention tool

- ✓**Reduced detachment**
- ✓**Hinders overland flow**
- ✓**Improved infiltration**
- ✓**Better tilth**

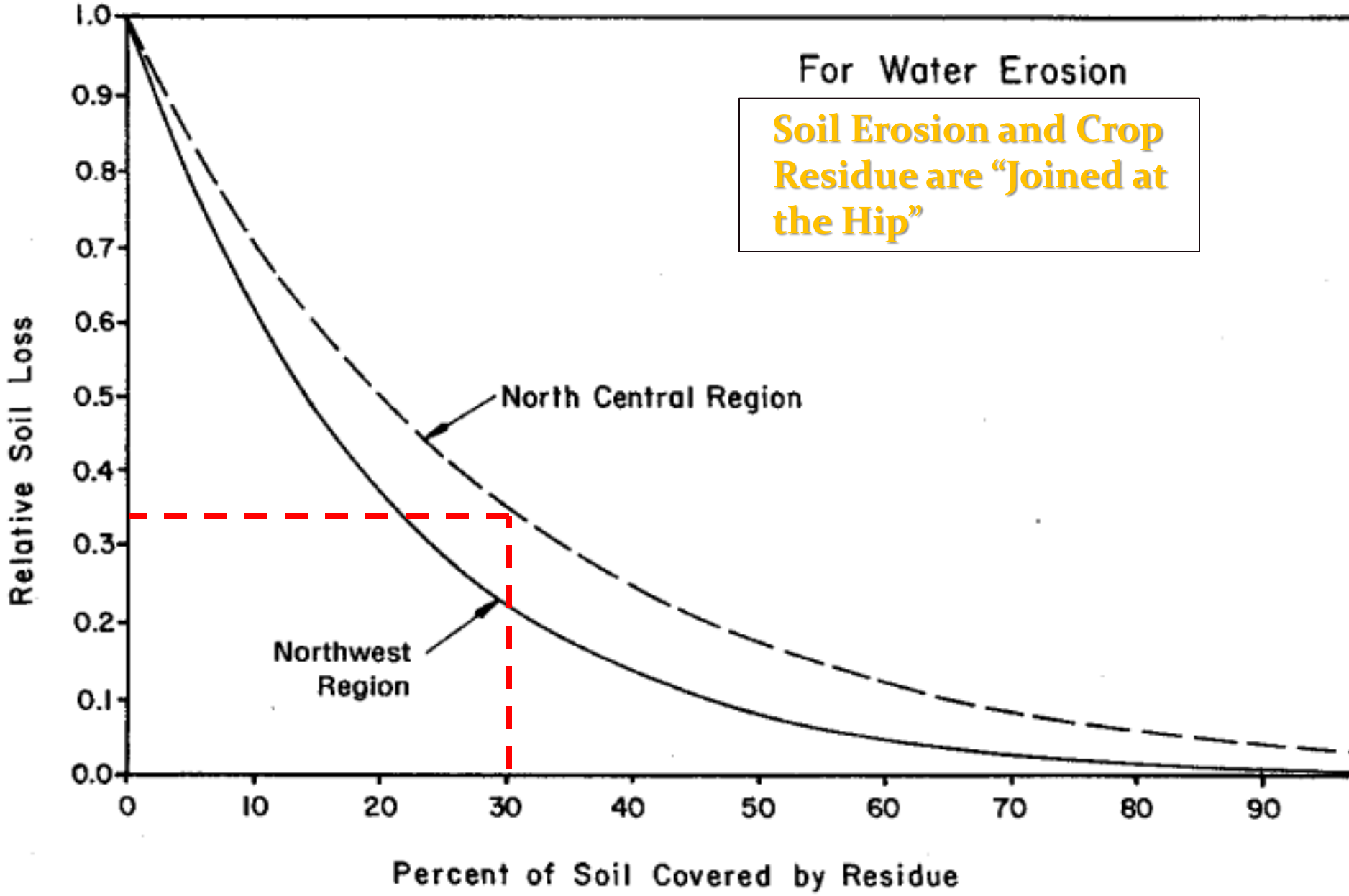
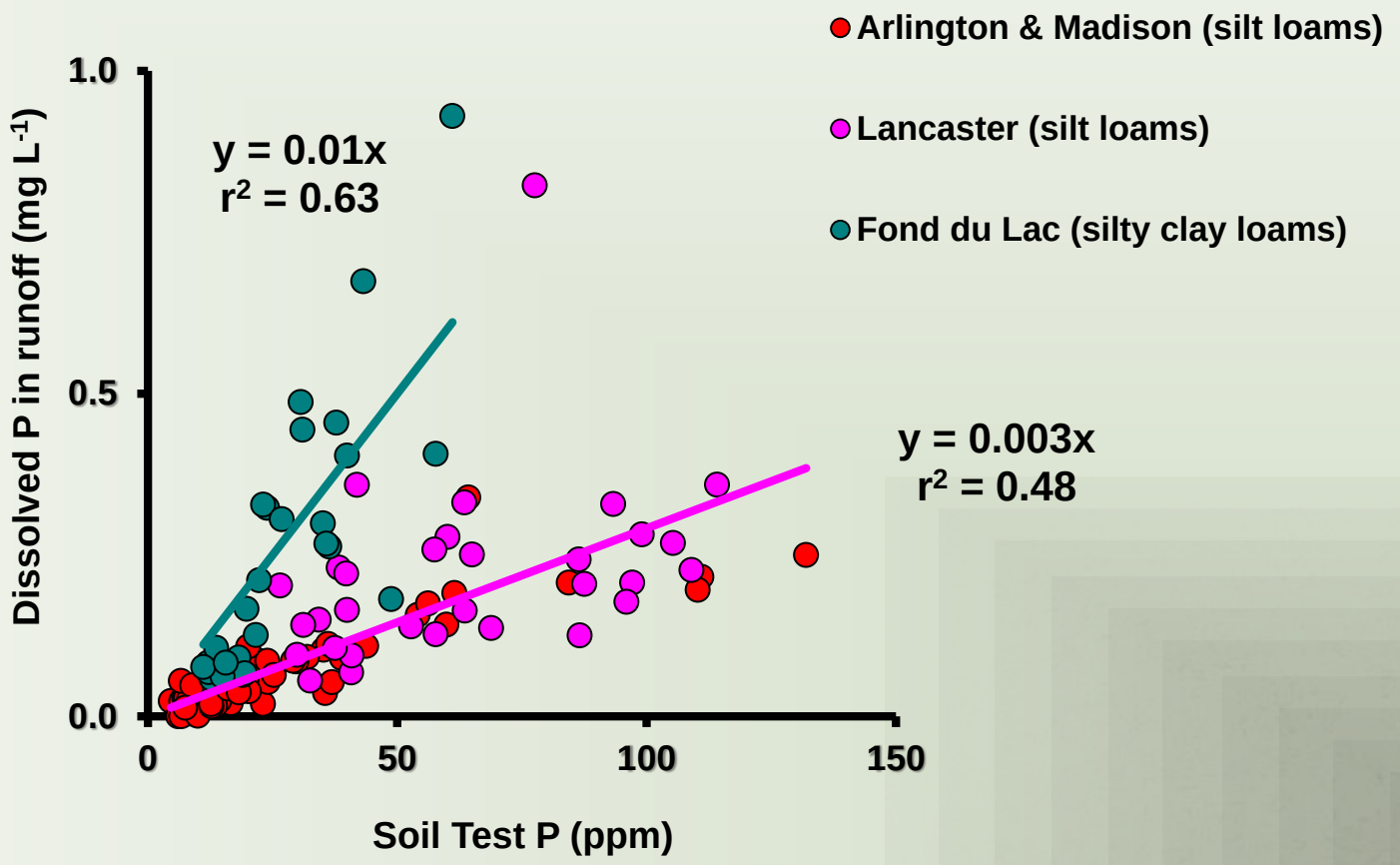


Figure 1. Relationship between relative soil loss from water erosion and percent of soil covered by small-grain residue (for the North Central and Northwest regions)

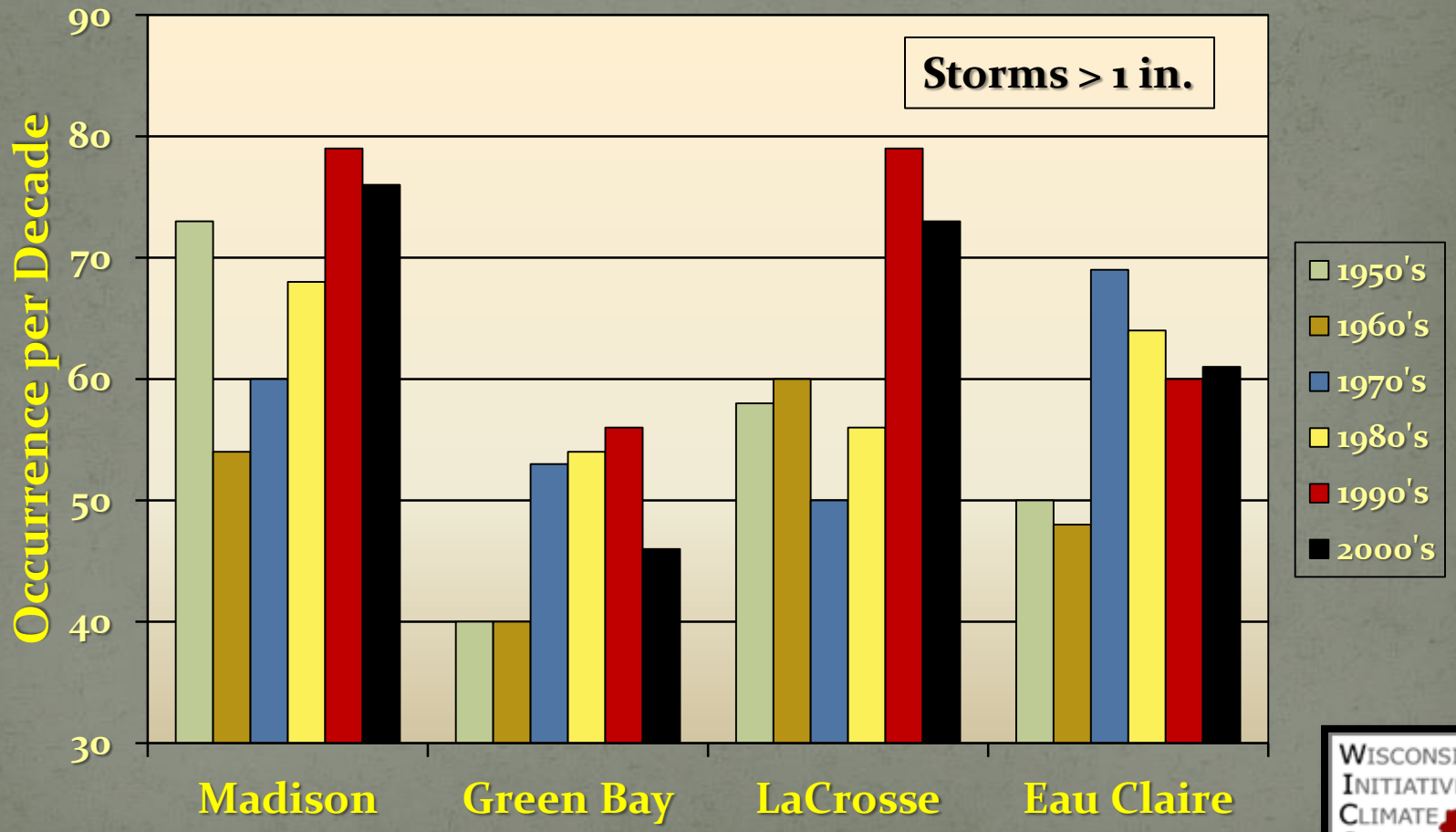

Why worry erosion and
runoff in NW Wisc. ??

Dissolved P in Runoff as Affected by Soil Type and Soil Test P



Bundy, UW Soil Science

Increased Number of Intense Storms



WISCONSIN INITIATIVE ON CLIMATE CHANGE IMPACTS

P Runoff Impacts on Green Bay

- Fox River system = 60-70% of nutrients and sediment
- 700+ tons P/yr from the Fox River watershed
- Green Bay is actually a P sink. 70-90% retained south of Chambers Island

Klump et al., 1997

Manure and Water Don't Mix

Manure Management Must Minimize Loss

- Losses begin at the farm and then in the field
- A highly value resource in terms of nutrient value and organic matter
- Nutrient crediting requires a knowledge of the manure chemical content and spreader output
- Manure is variable in storage
- Potential risk to water quality increases with poor management

Manure Nutrient Loss Pathways from Application Sites

- Aerial
  - Ammonia-N lost as a gas and re-deposited by precipitation
- Infiltration below the root zone
  - Pore structure that allows fast drainage
    - Movement through large pores to groundwater
    - Movement into tile lines, then to surface waters
- Surface runoff to water bodies
  - Soluble nutrients carried in runoff water
  - Nutrients attached to eroded soil

Focus tonight on liquid systems

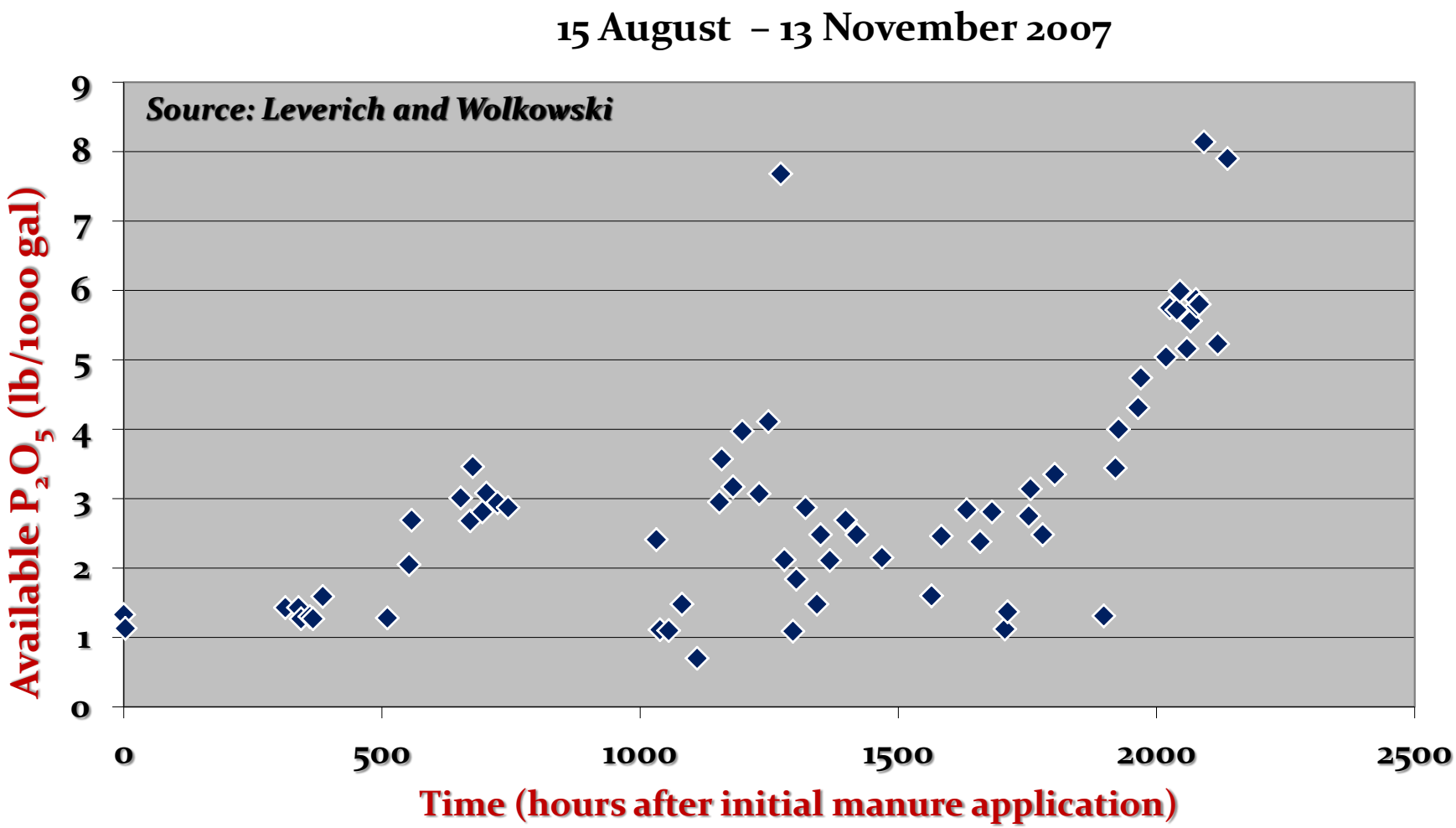
Pit agitation (mixing)

Manure Variability Sampled from a Southern Wisconsin Pit (Dairy)

(n=68)	Mean	Standard Dev.	Range
Dry Matter (%)	3.39	1.48	1.3 – 7.7
N (lb/1000 gal)	5.65	1.23	3.82 – 8.44
P_2O_5 (lb/1000 gal)	3.09	1.78	0.70 – 8.14
K_2O (lb/1000 gal)	12.68	2.98	7.27 – 21.19

Source: Leverich and Wolkowski

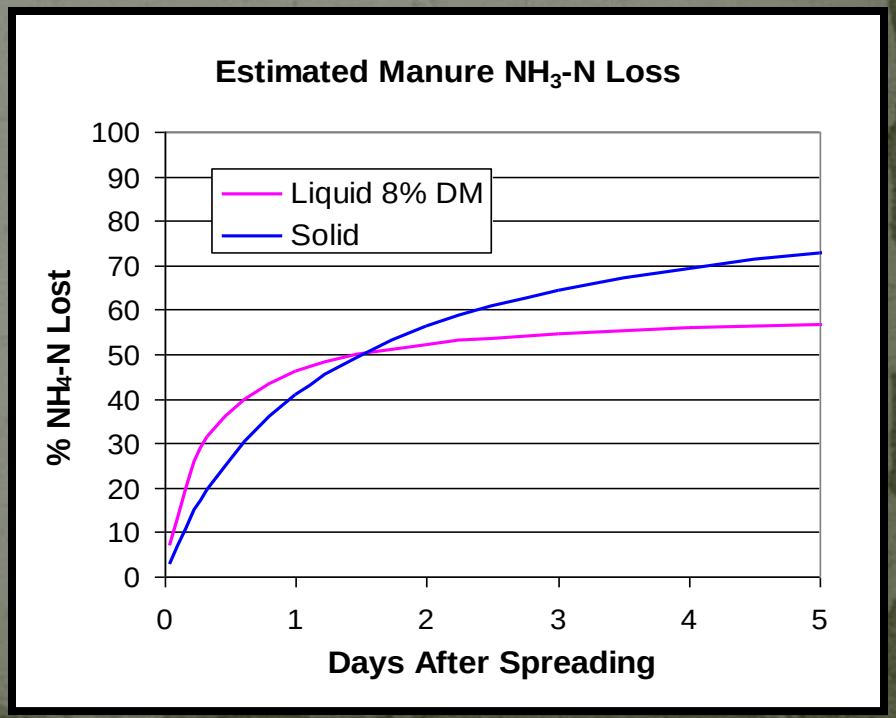
Relationship Between Time After Initial Application and Manure P_2O_5 Content



Ammonia Loss from Solid (bedded) vs. Liquid Dairy Manure

- NH_4-N content varies with dry matter content
- NH_3 loss affected by
  - Air and soil temperature
  - Soil moisture
  - Soil pH
  - Wind
- Incorporate to avoid volatilization loss
- Tillage the best option to incorporate

Jokela et al., 2004



Surface Broadcast

Direct Injection with Straight Knife

Source: Jokela, USDA

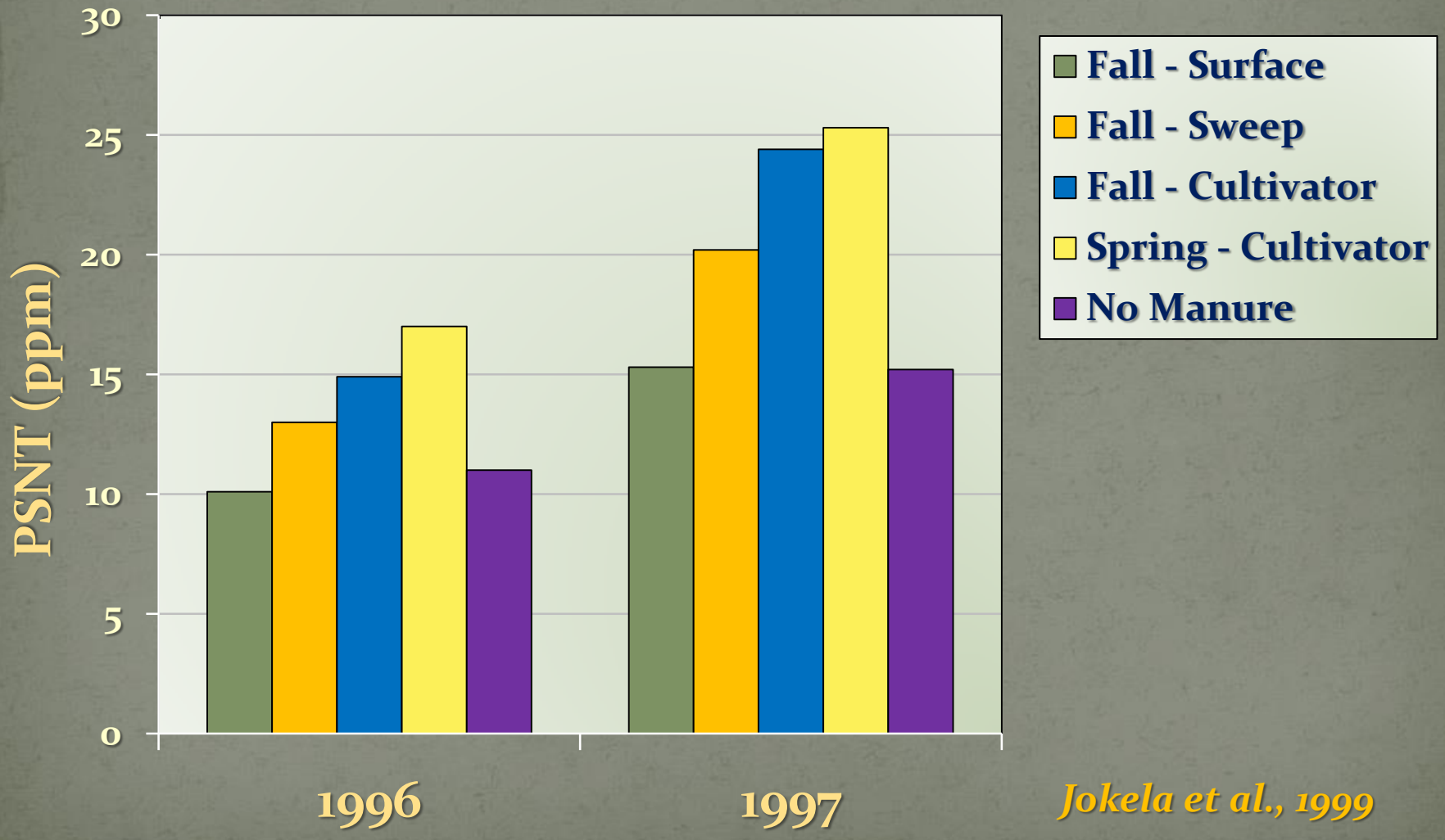
Direct Injection with Sweep

Source: Jokela, USDA

Incorporation with S-tine harrow

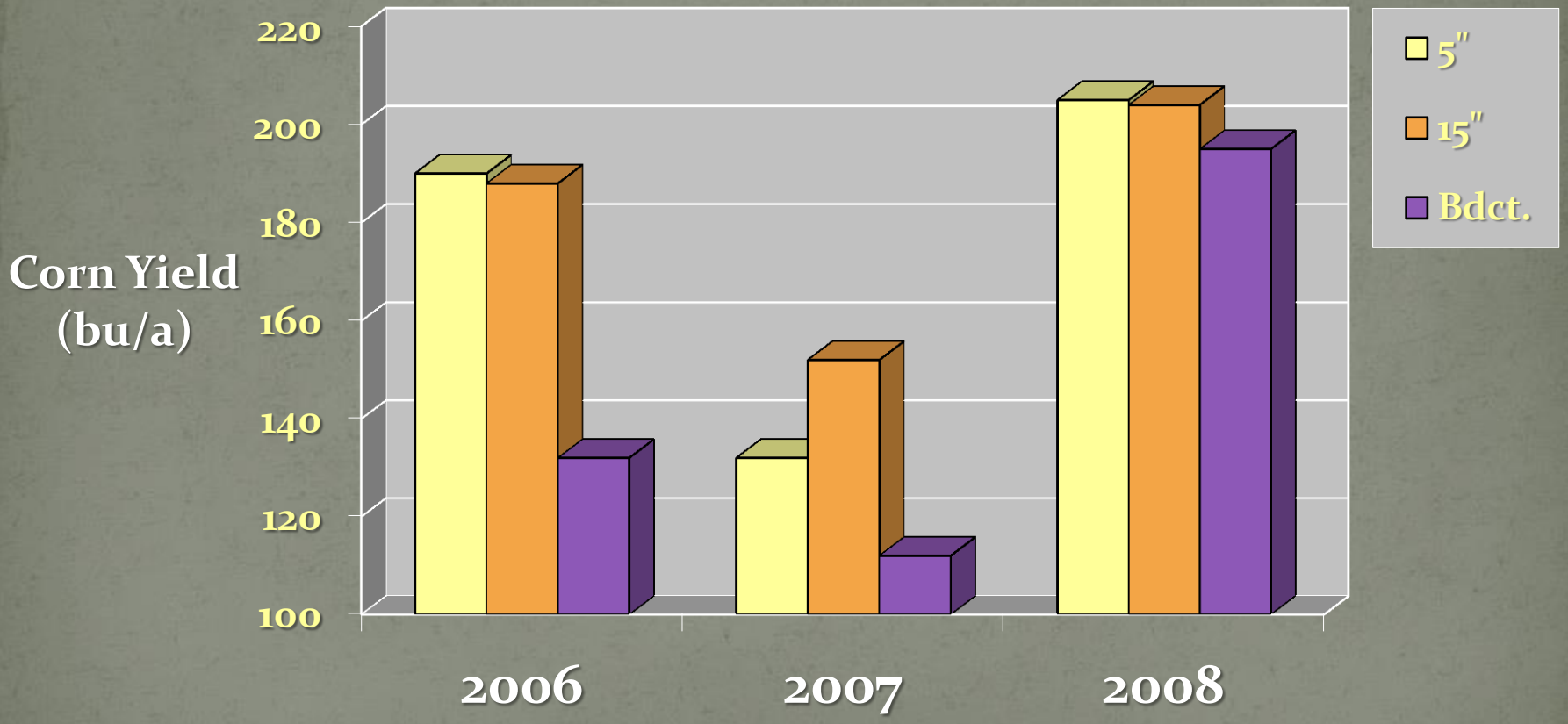
Source: Jokela, USDA

Manure Application Method and Soil N Availability (PSNT)



Jokela et al., 1999

Effect of Swine Manure Placement on Corn Yield



4,500 gal/acre

Source: Leverich and Wolkowski

Other Incorporation Methods

Aerway

Tandem disk

Source: Kevin Erb, UWEX and Bill Jokela, USDA

What About Manure Application on Grass/Perennial Forages?

Source: Jokela, USDA

Can't Incorporate on Grass

...or can you?

Source: Jokela, USDA

Blowing Smoke and Manure Application

- Blower and smoke generator attached to drain outlet demonstrates macropore connections to surface
- Potential "highway" to groundwater or tile lines
- Frank Gibbs – Ohio NRCS

Source: Mark Cain, WI-DNR

Macropore Movement in Soils

- Worm and root channels; inter-aggregate space
- Worms and roots thrive in well-aerated soil found above drain tile
- Manure or runoff flow down channels
- Greater loss with low DM manure (< 2 %)
- Continuous channels more likely after long-term hay or pasture; no-till cropping systems

Limiting Manure Nutrient Flow Down Macropore Channels

- Avoid applications when tiles flowing, heavy rain forecast, soil very wet
- Use plugs and control structures on tile system to avoid output
- Lower the rate of application
- Shallow tillage to disrupt pore openings
- Manure storage management
- Probably can't avoid some cases

Hose Drag System Can Reduce Compaction and Road Issues

Source: Kevin Erb, UWEX

Consideration for Hose Drag Systems

- Distance: Affordability and pumping
- Can move a million or more gal/day depending on application rate, field size, set up, etc.
- Overcome compaction and road weight issues
- Can pump over a mile
- "Murphy Switch": Auto-shutoff (not foolproof)
- Permission/permits to run lines over property, through ditches and culverts, right-of-ways
- Contact Kevin Erb (UWEX) or http://fyi.uwex.edu/wimanuremgt/applicators/

Frac Tanks Expand Range of Operation

Source: Kevin Erb, UWEX

- Move manure much greater distance
- Flexibility to move from field to field
- Addresses hose line "run" problems
- Still need access to tend

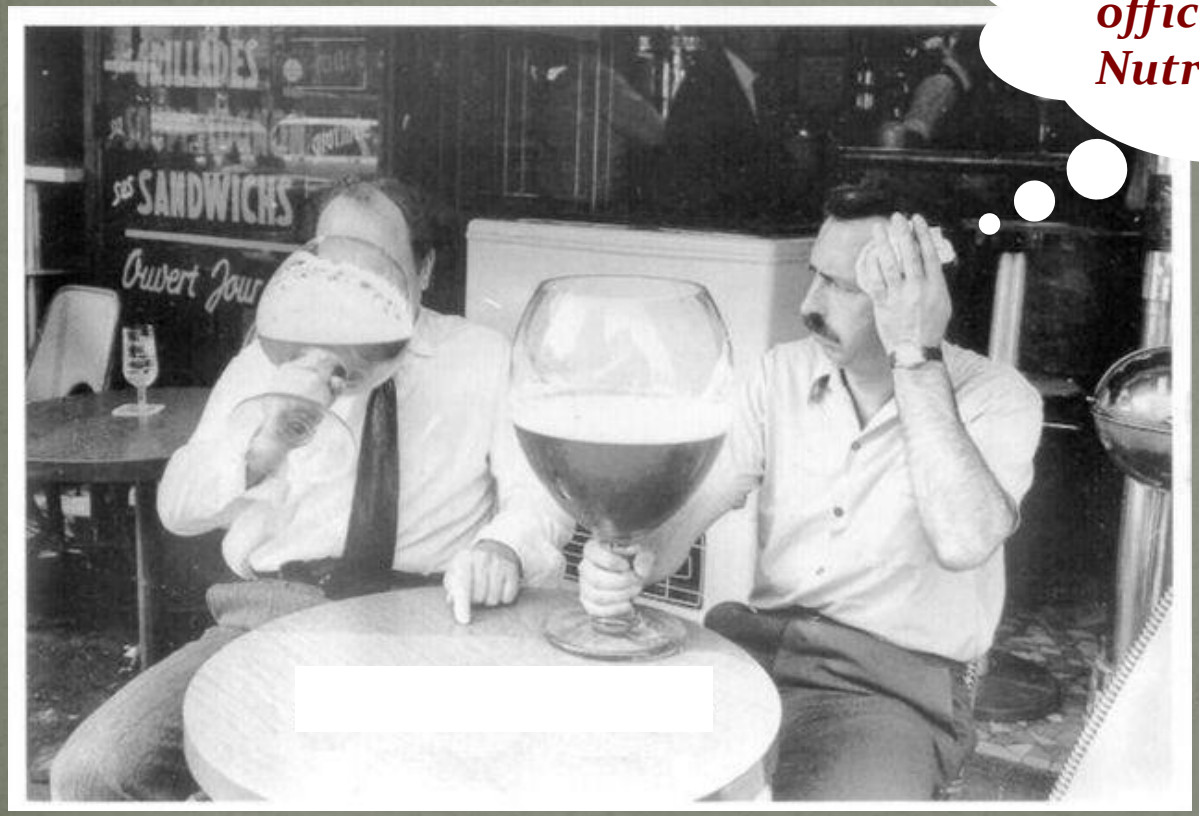
Costs for Manure Handling

MANURE SERVICES, WISCONSIN, 2013

Cost Per Hour						Cost Per Gallon (Liquid Manure only)					
Operation	Range in Rates	Statewide Averages	Regional Averages			Operation	Range in Rates	Statewide Averages	Regional Averages		
			1	2	3				1	2	3
	Dollars per hour						Dollars per gallon				
Solid Manure											
Loading	25.00-140.00	76.20	59.20	70.00	92.30						
Spreading	30.00-135.00	86.00	81.60	86.70	87.90						
Loading & spreading	20.00-245.00	109.00	95.40	129.00	104.00						
Liquid Manure						Liquid Manure					
Pumping & spreading						Pumping & spreading					
Surface	50.00-210.00	92.40	94.20	79.40	98.60	Surface	0.005-0.020	0.011	0.010	0.012	0.011
Tanker injection	95.00-150.00	124.00	-	-	128.00	Tanker injection	0.007-0.012	0.012	0.013	-	0.011
Drag line injection	240.00-350.00	292.00	-	-	-	Drag line injection	0.005-0.018	0.011	0.010	0.009	0.012
Agitation boat	45.00-200.00	140.00	100.00	210.00	146.00	Agitation boat	-	-	-	-	-

Source: 2013 Wisconsin Custom Rate Guide

Developing a Manure Application Strategy is a Lot of Work



"Better get back to the office and work on that Nutrient Management Plan"

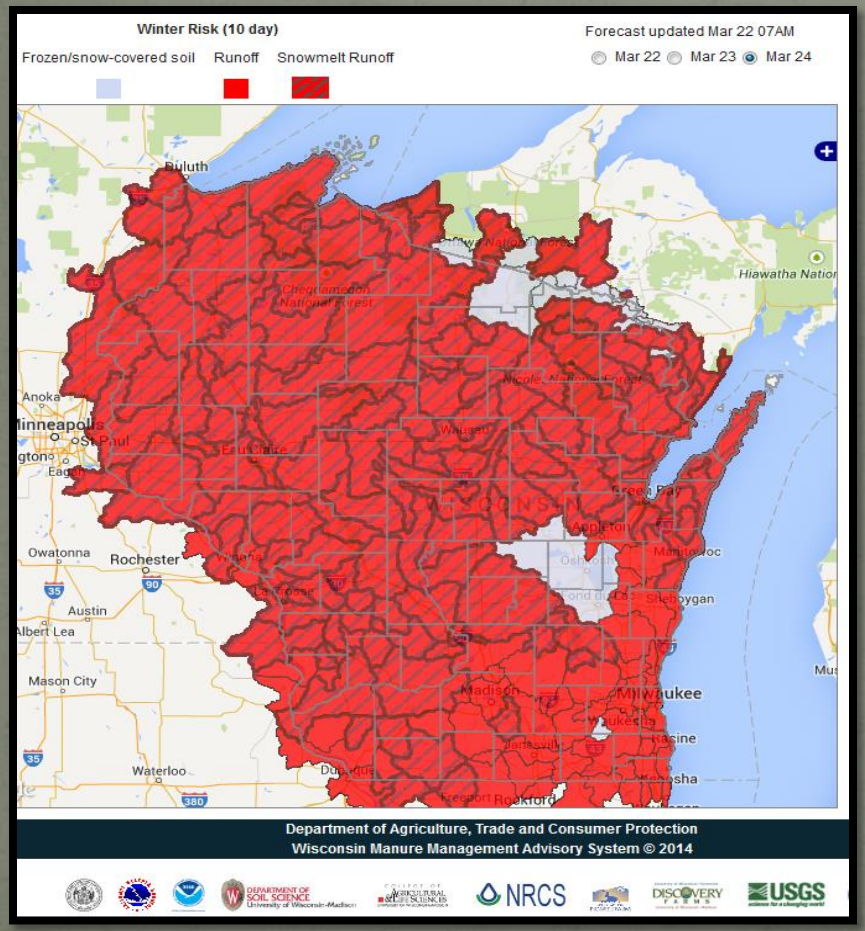
Strategy Considerations

- 4 R's (right rate, right time, right source, right place)
- Application to minimize loss over-rides nutrient benefit
- Utilize the other tools in the "Conservation Tool Box" to keep soil and nutrients in the field
- Refine your strategy (Plan A); but plans B – G better be acceptable

The Challenges of Manure Management – Use all the Tools

- Computerized management and information programs
- Weather forecasts
- Well-prepared/executed NMP
- Calibrated application equipment
- Crop residue and other in-field conservation practices
- Common sense

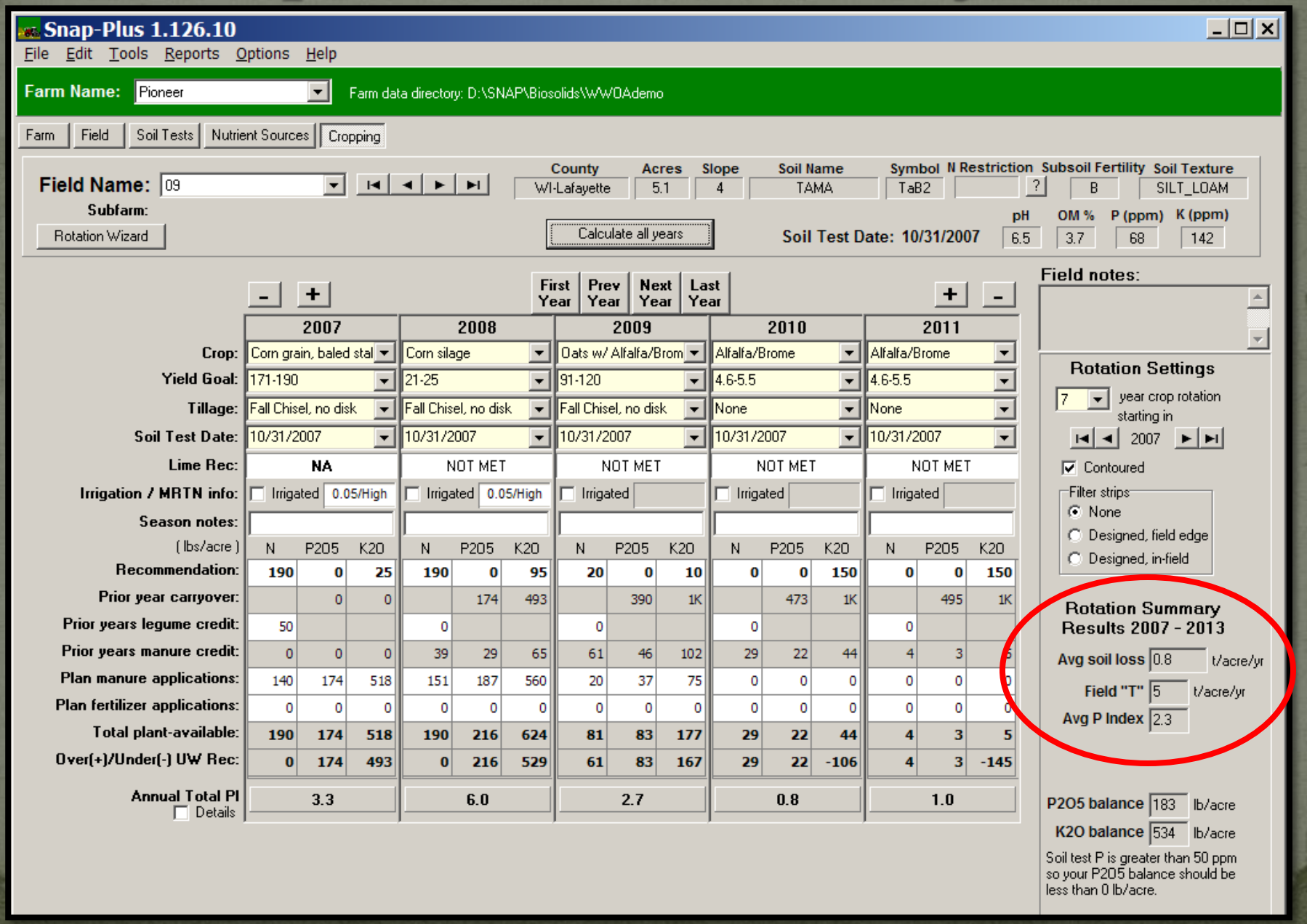
Manure Nutrient Loss – The Greatest Potential Loss Occurs in Feb - Mar



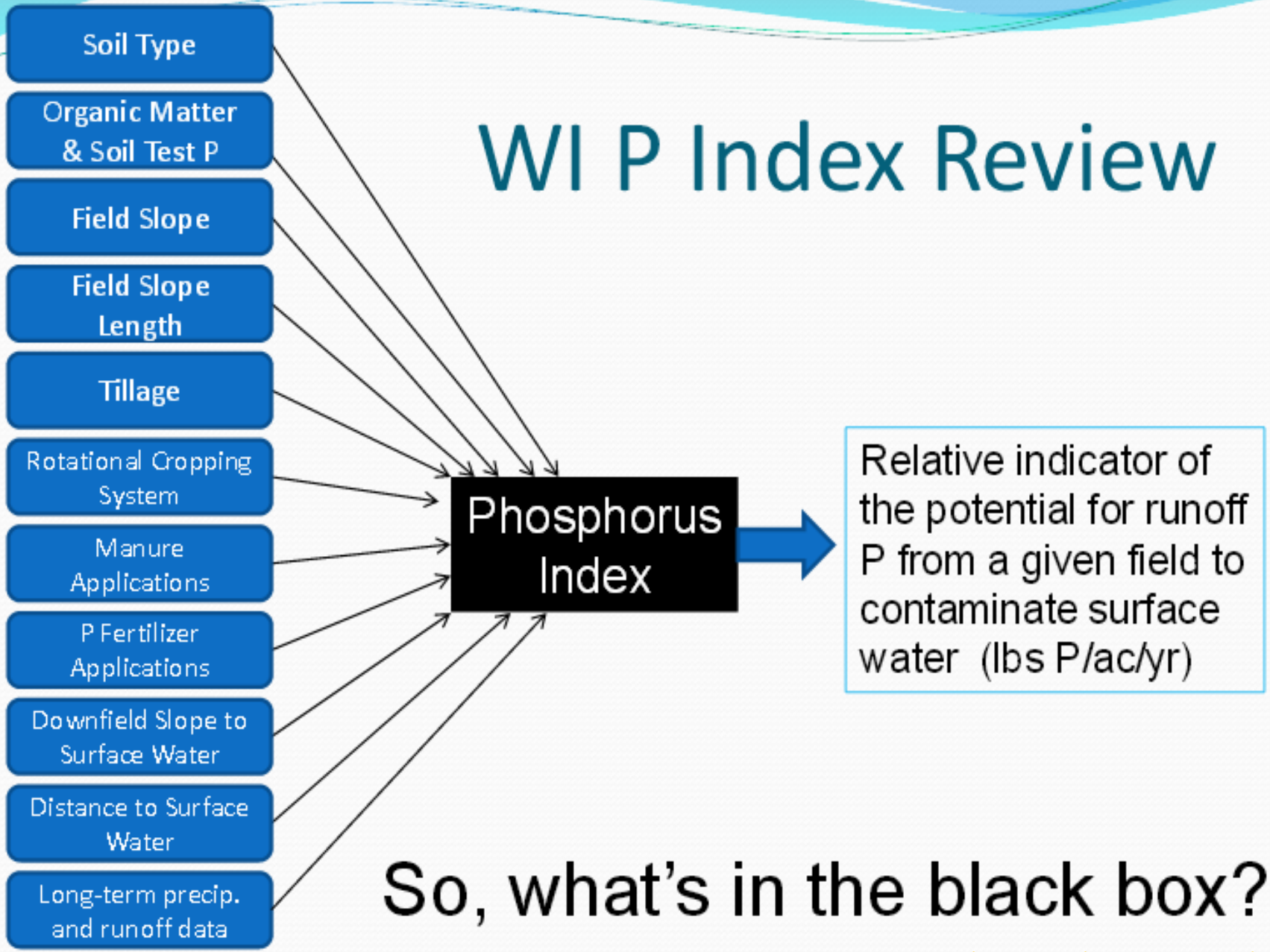
The Manure Management Advisory System helps predict the risk of nutrient loss in runoff

http://www.manureadvisorysystem.wi.gov/

Snap-Plus: UWEX NMP Software



WI P Index Review



So, what's in the black box?

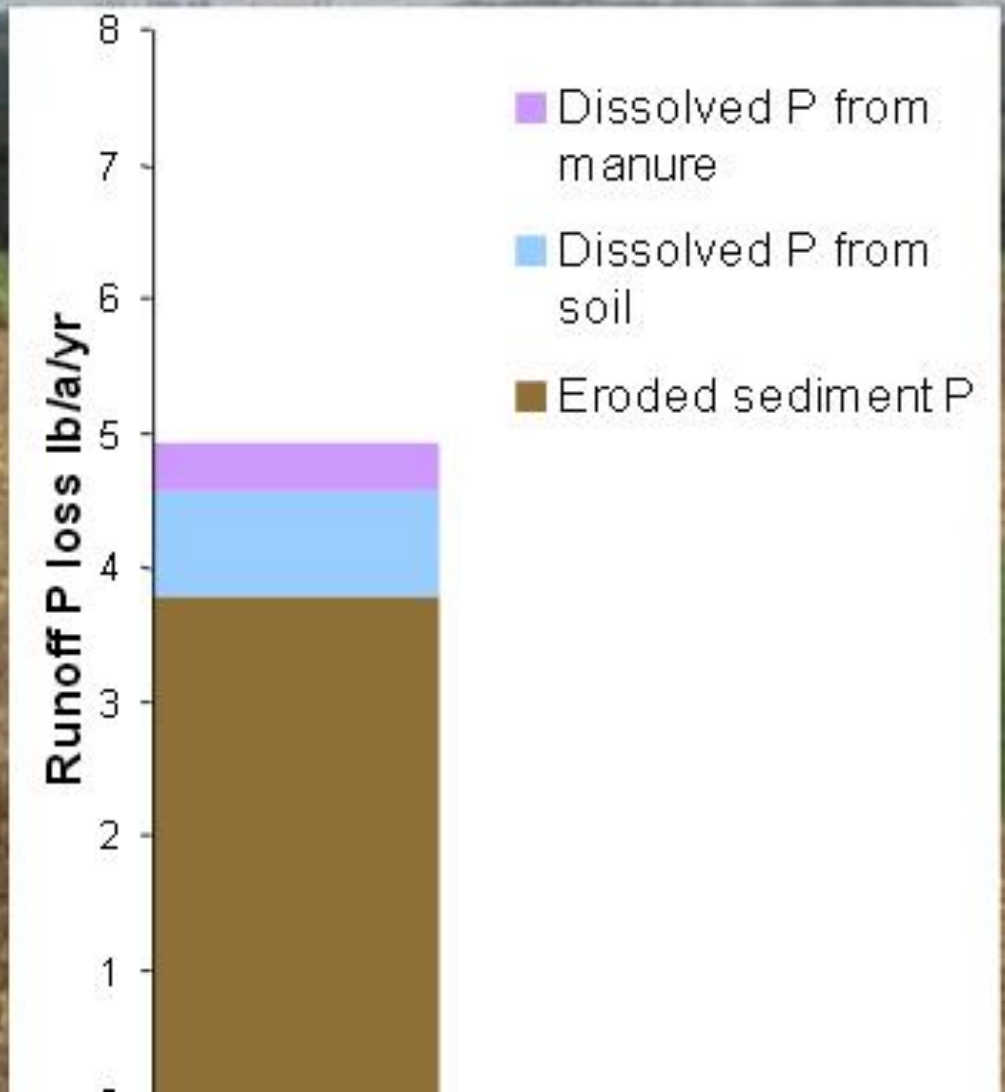
Source: Laura Ward-Good, UW Soils

Method to Develop P Index Model

Dr. Larry Bundy, UW-Soils

Example field:

3.5 T/a/yr soil loss
Bray P: 70 ppm
10,000 gallon/acre in fall before corn



Source: Laura Ward-Good, UW Soils

Tillage and Manure Effects on Sediment and Phosphorus in Runoff, Arlington (Bundy).

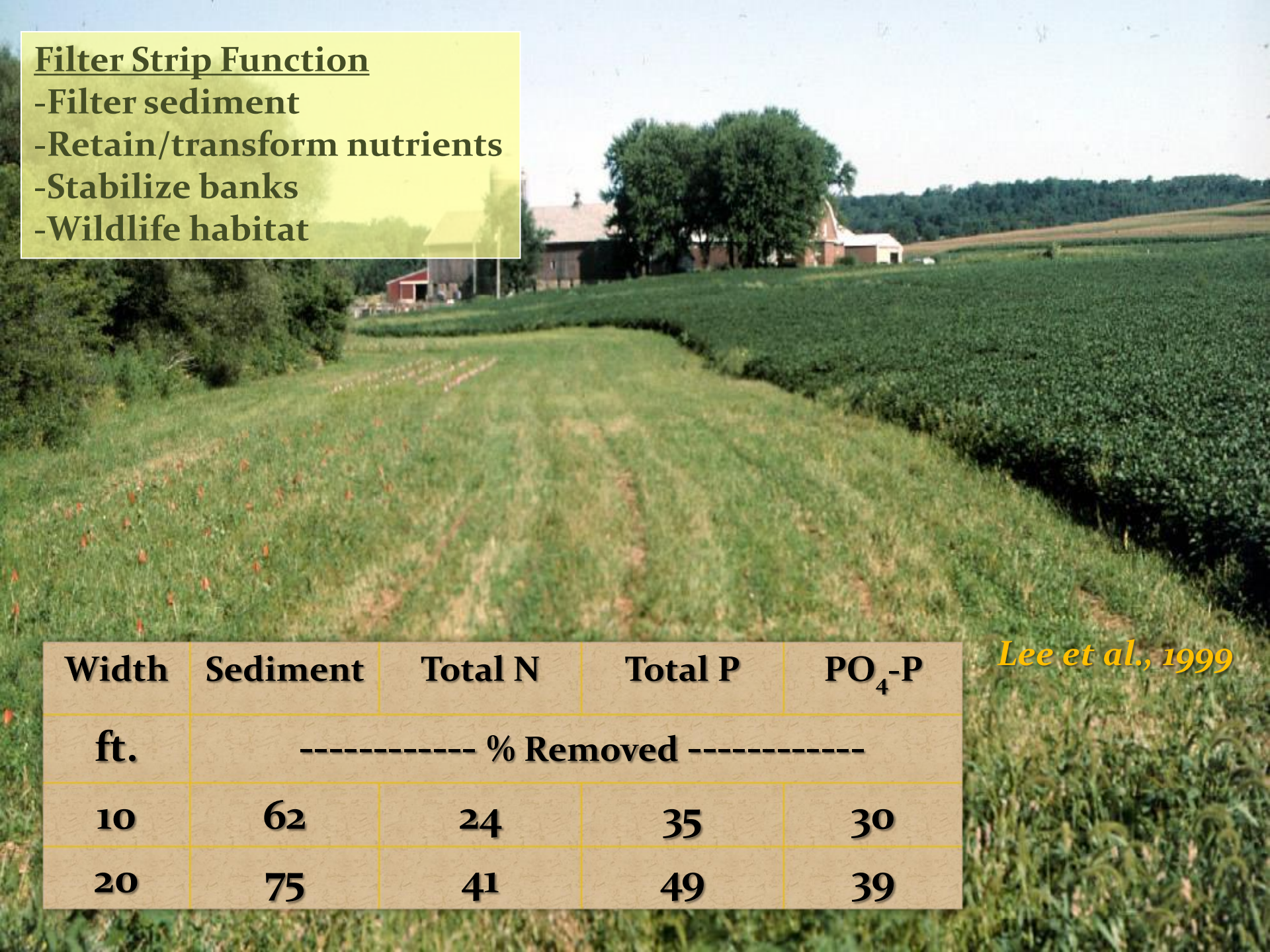
Manure/tillage	Sediment load	Runoff Phosphorus	
		Soluble	Total
	lb/a	---- lb/a ----	
None NT	93	0.008	0.04
None CP	248	0.003	0.1
Solid NT	282	1.3	2.8
Solid CP	218	0.01	0.1
Liquid NT	505	2.3	5.5
Liquid CP	290	0.1	0.3
Liquid Inj.	238	0.08	0.3

Must Manage Concentrated Flow Channels

Near Benoit, Wis.

Source: Jane Anklam, UWEX

Field Edge Protection Reduces Risk



Filter Strip Function
- Filter sediment
- Retain/transform nutrients
- Stabilize banks
- Wildlife habitat

Width	Sediment	Total N	Total P	PO_4-P
ft.	---------- % Removed ----------			
10	62	24	35	30
20	75	41	49	39

Lee et al., 1999

Where to Apply

Direct application to…

- Crops with high nutrient removal
- Grassy hay fields for summer spreading
- Low P testing soils
- Upland fields away from surface water
- Fields with conservation practices
- Level fields that don't get uphill runoff
- Medium-textured, well-drained soils
- Spring prior to tillage
- Before or after fall tillage

Where Not to Apply

Avoid application on…

- Sloping land (> 6%)
- Smooth surfaces such as killed alfalfa and no-till
- Frozen or snow-covered ground
- Wet soils
- Near surface water or concentrated flow channels
- Light textured soils
- Shallow soils (bedrock and groundwater)
- High P testing soils
- Where adequate N has been applied or exists as a forage legume credit


Thanks for listening!!