TILLAGE & MANURE TIMING TO MINIMIZE PHOSPHORUS LOSSES

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Introduction

- Timing of manure applications and tillage can influence risk of P loss.
- These effects are important for:
  - Minimizing water quality effects
  - Phosphorus-based nutrient management planning

Outline

- Tillage and manure timing effects on P losses studied in recent experiments
- Results used to develop Wis. P index
- Summarize:
  - Results from runoff experiments
  - P loss estimates from P index
  - Seasonal guidelines for applying manure

How do tillage and manure affect runoff P losses?

- Manure applications reduce runoff volumes and soil loss.
- Incorporating manure increases sediment loss (erosion) but lowers soluble P losses in runoff.
- Surface manure provides residue cover and decreases sediment P losses.
- Unincorporated manure increases soluble P losses.

How do tillage and manure affect runoff P losses?

- High soil P and manure applications usually increase soluble P losses
- Tillage often increases sediment /particulate P in runoff.
- Spreading manure on no-till or alfalfa fields in fall and winter increases soluble P losses.
- Rain soon after manure application or winter spreading can lead to large P losses.

Wisconsin Datasets used for P Index Development

Simulated rainfall runoff:

- Alfalfa – 20 events
- Corn – 267 events, 4 sites

  Varying:
  - Tillage
  - Manure applications
  - Timing
  - Soil test P

Natural rainfall runoff:

- Alfalfa – 24 plots
- Corn- 36 plots

Research ongoing. Datasets growing.

SPRING MANURE TREATMENTS

- Tillage
  - No-till
  - Chisel plow
- Manure (spring applied)
  - None
  - 32 tons/acre (dairy manure)

Tillage and spring-applied manure effects on residue cover and runoff volume. Arlington, 1999

Tillage/ manure	Residue cover		Runoff volume	
	Spring	Fall	Spring	Fall
	----- % -----		----- mm -----	
No-till -	79	47	11	17
No-till +	99	74	1	5
C. Plow -	26	16	4	29
C. Plow +	50	23	1	14

Tillage and spring-applied manure effects on sediment and phosphorus in runoff. Arlington, fall, 1999.

Tillage/ manure	Runoff volume	Sediment load	Runoff Phosphorus	
			Soluble	Total
	mm	kg/ha	------ g/ha ------	
No-till -	17	855	4	325
No-till +	5	125	8	31
C. Plow -	29	2223	11	481
C. Plow +	14	1065	8	144

Tillage and spring-applied manure effects on sediment and phosphorus in runoff. Lancaster, May, 2000.

Tillage/ manure	Runoff volume	Sediment load	Runoff Phosphorus	
			Soluble	Total
	mm	kg/ha	------ g/ha ------	
No-till -	16	153	32	107
No-till +	14	60	207	277
C. Plow -	39	3019	44	1145
C. Plow +	24	1461	68	573

Fall Manure Treatments

- Manure :
  - None (control)
  - Semi-solid (32 tons/a), broadcast
  - Liquid/Slurry (19,000 gal/a)
    - Broadcast
    - Injected (6-inch depth)
- Tillage : Fall chisel plowing or no-till


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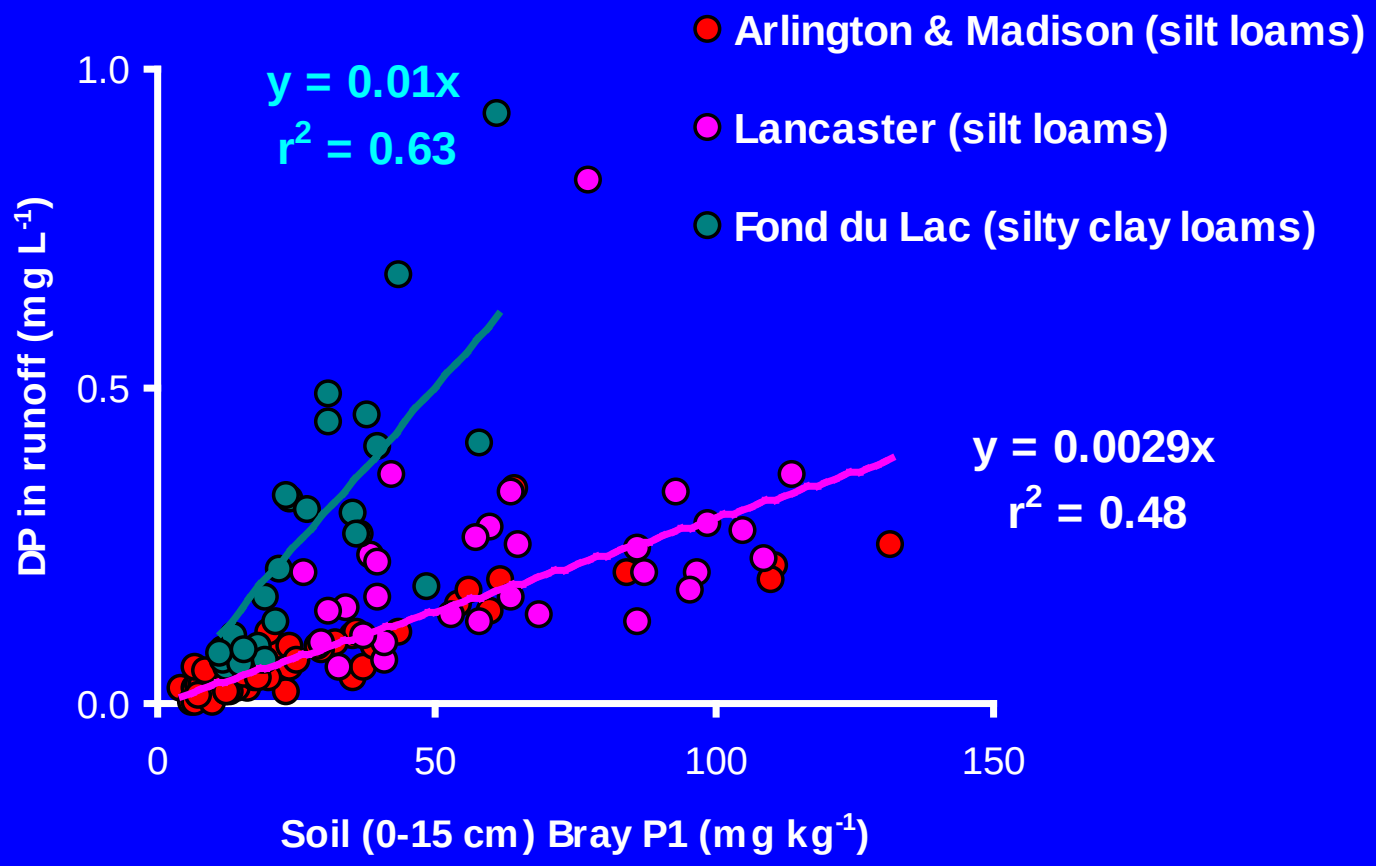
Tillage and fall-applied manure effects on sediment and phosphorus in runoff. Arlington, October, 2002.

Manure/ tillage	Runoff volume	Sediment load	Runoff Phosphorus	
			Soluble	Total
	mm	kg/ha	------ g/ha ------	
None NT	17	105	9	45
None CP	4	279	3	139
Solid NT	30	317	1396	3056
Solid CP	5	245	15	124
Liquid NT	39	568	2543	6102
Liquid CP	7	326	141	294
Liquid Inject	23	267	89	289

Runoff dissolved P can be predicted by soil test P and soil type

Simulated rainfall runoff corn plots without manure applications



Results

- Spring-applied manure often reduced P losses by reducing runoff volume and sediment loss
- Runoff volumes usually much higher in fall than spring
- Runoff lower in CP than NT in fall

Results – Fall Manure

- Surface manure increased runoff in NT but not with injected or CP
- No effects on sediment load
- Dissolved and total P losses were correlated with runoff volume

Summary

- Potential for P loss from fall-applied manure can be reduced by injection or chisel plowing
- The risk of P losses in runoff appears to be lower with spring applications

The Wisconsin P Index

- Based on research results from runoff experiments
- Indicates potential of a field to deliver P to surface water
- Provides one option for P-based nutrient management planning

Components of the Phosphorus Index (PI):

PI = PP + SP

PI = Total P index

PP = Particulate P

SP = Soluble P

Single-event worst-case losses from surface manure applications are added to estimated annual P delivery

Risks of manure P loss change by season of application:

- Fall
- Spring
- Winter (frozen soil)

Runoff dissolved P and particulate P from simulated rainfall event one week after a 32 ton per acre dairy manure surface application to silt loam soil in the Spring (Lancaster) and Fall (Arlington)

	DP	DP Load	PP	PP Load
	-----mg L^{-1}---	--g ha^{-1}--	-----mg L^{-1}-----	----g ha^{-1}-----
Spring				
No manure	**0.20**	**32**	**539**	**75**
Manure	**1.41**	**207**	**1009**	**70**
Fall				
No Manure	**0.05**	**9**	**336**	**36**
Manure	**4.69**	**1396**	**5069**	**1660**

The additional SP load from

- **Spring manure = 0.5 %**
- **Fall manure = 3.7 %**

of the manure water soluble P.

The additional PP load from

- **Spring manure = 0**
- **Fall manure = 2.9 %**

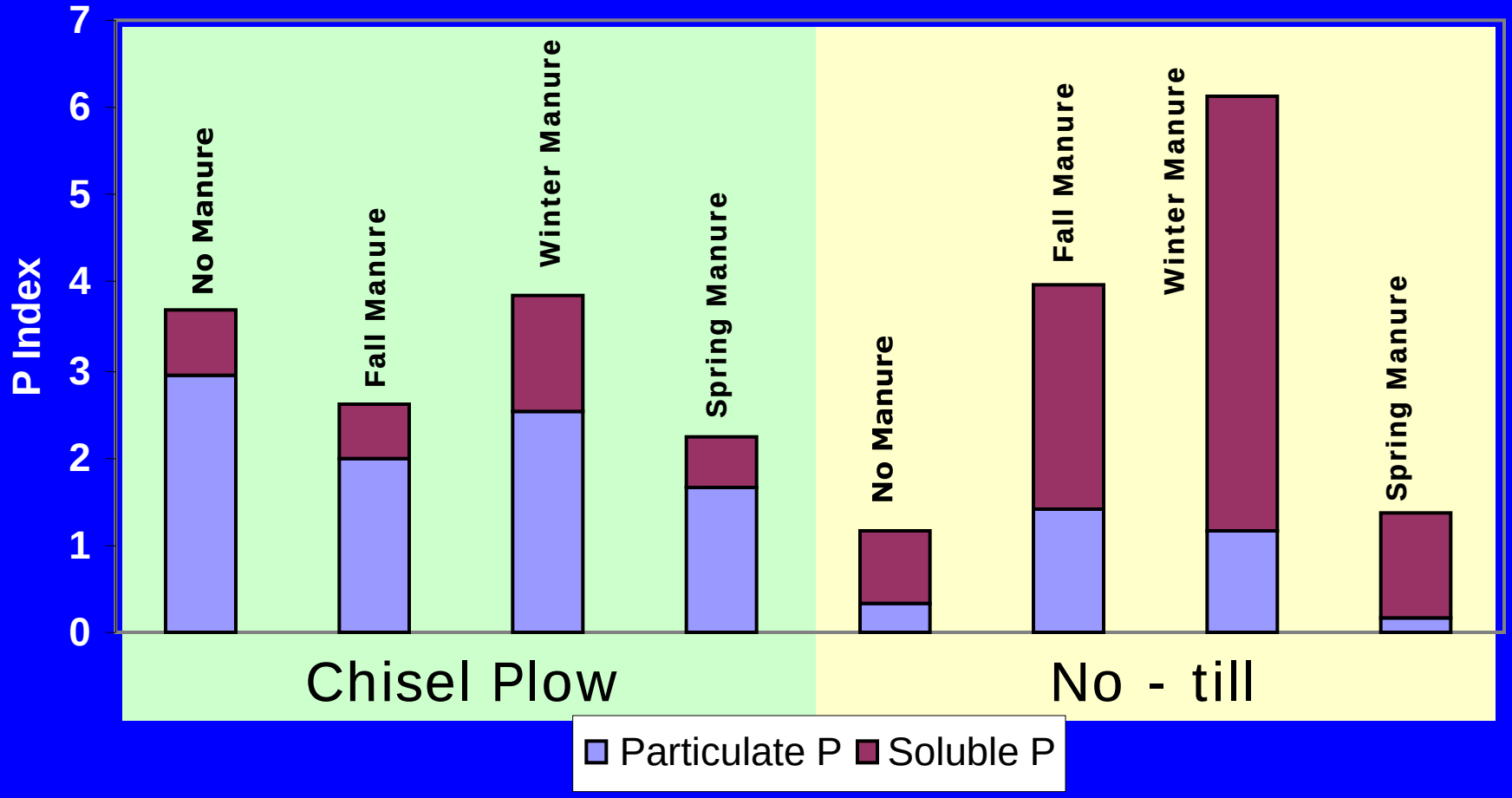
of the manure total P.

Putting it all together:

The P Index shows the relative effects of different field management practices on P loads

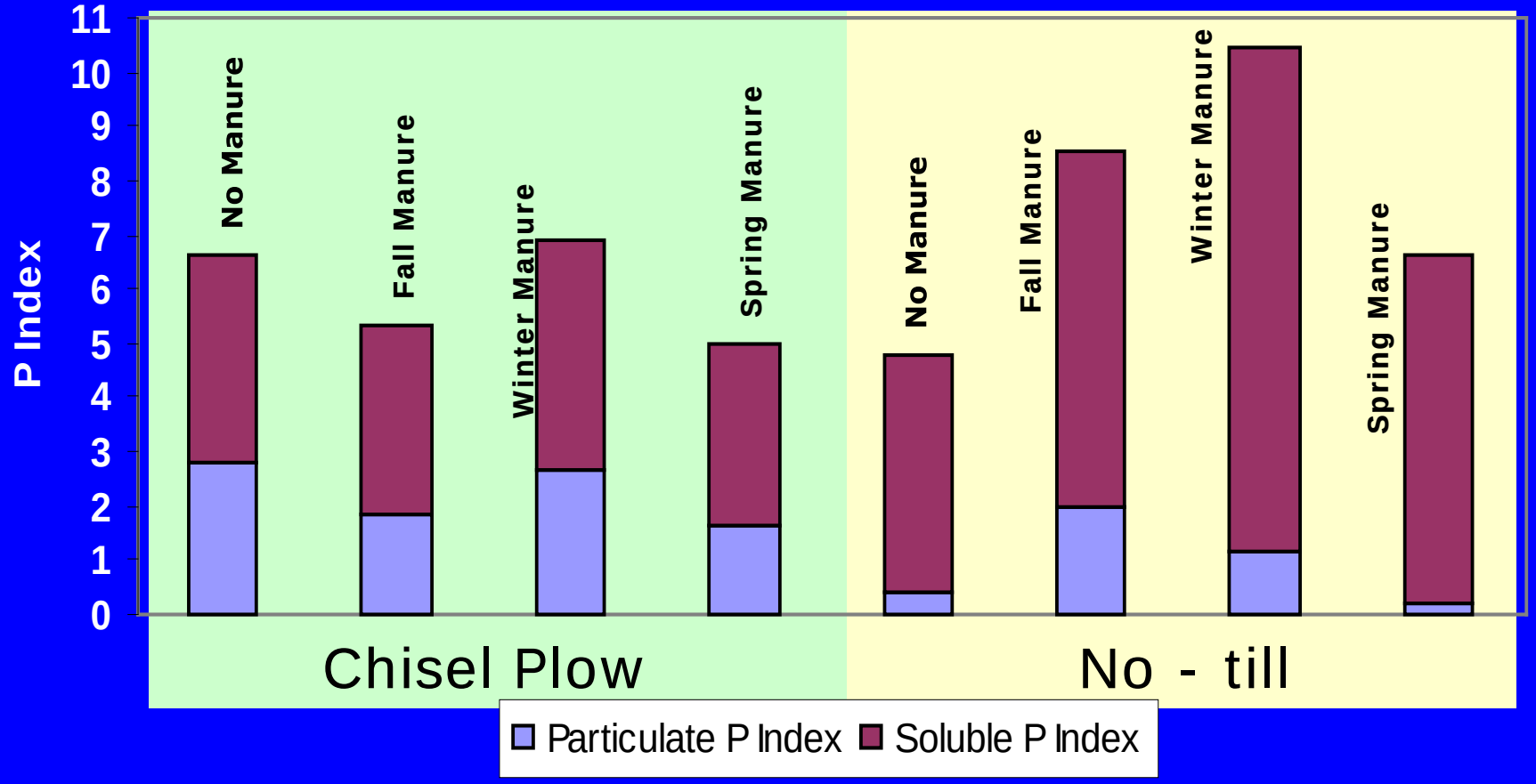
P Index Values for Grant County Corn Field

Rozetta silt loam soil, 6% slope, Bray P 50 ppm



P Index Values for Winnebago County Corn Field

Kewaunee silty clay loam soil, 4% slope, Bray P 50 ppm



Summary - Spring Manure

- Areas to apply
  - Prior to tillage
  - No-till corn
  - Inject manure
- Areas to avoid
  - Estab. Alfalfa
  - On snow/ frozen ground
  - Wet soils

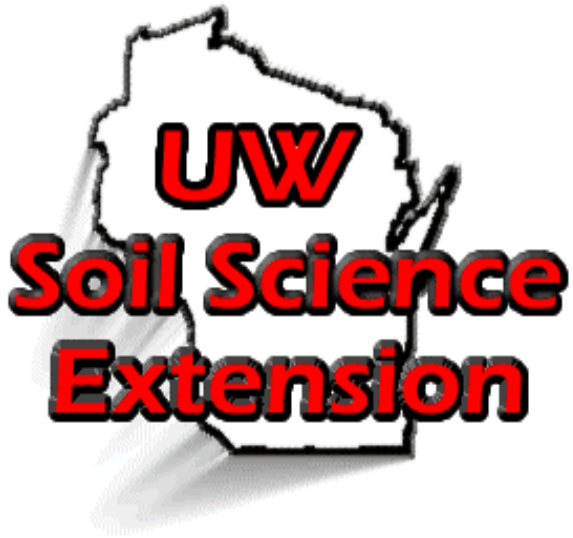
Summary – Fall Manure

- Areas to apply
  - Post-tillage to fall-plowed fields
  - Before/after tillage on fall chiseled fields
  - After silage
  - Before tillage on old hay fields
  - Inject manure

- Areas to avoid
  - Estab. Alfalfa
  - No-till corn
  - Smooth surfaces with little residue cover

Summary - Winter Manure

- Areas to apply
  - Level chisel plowed fields
  - Slopes less than 6%
  - Little upslope runoff
- Areas to avoid
  - Estab. Alfalfa
  - No-till corn
  - Slopes over 6%



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