Phosphorus Management on High P Soils

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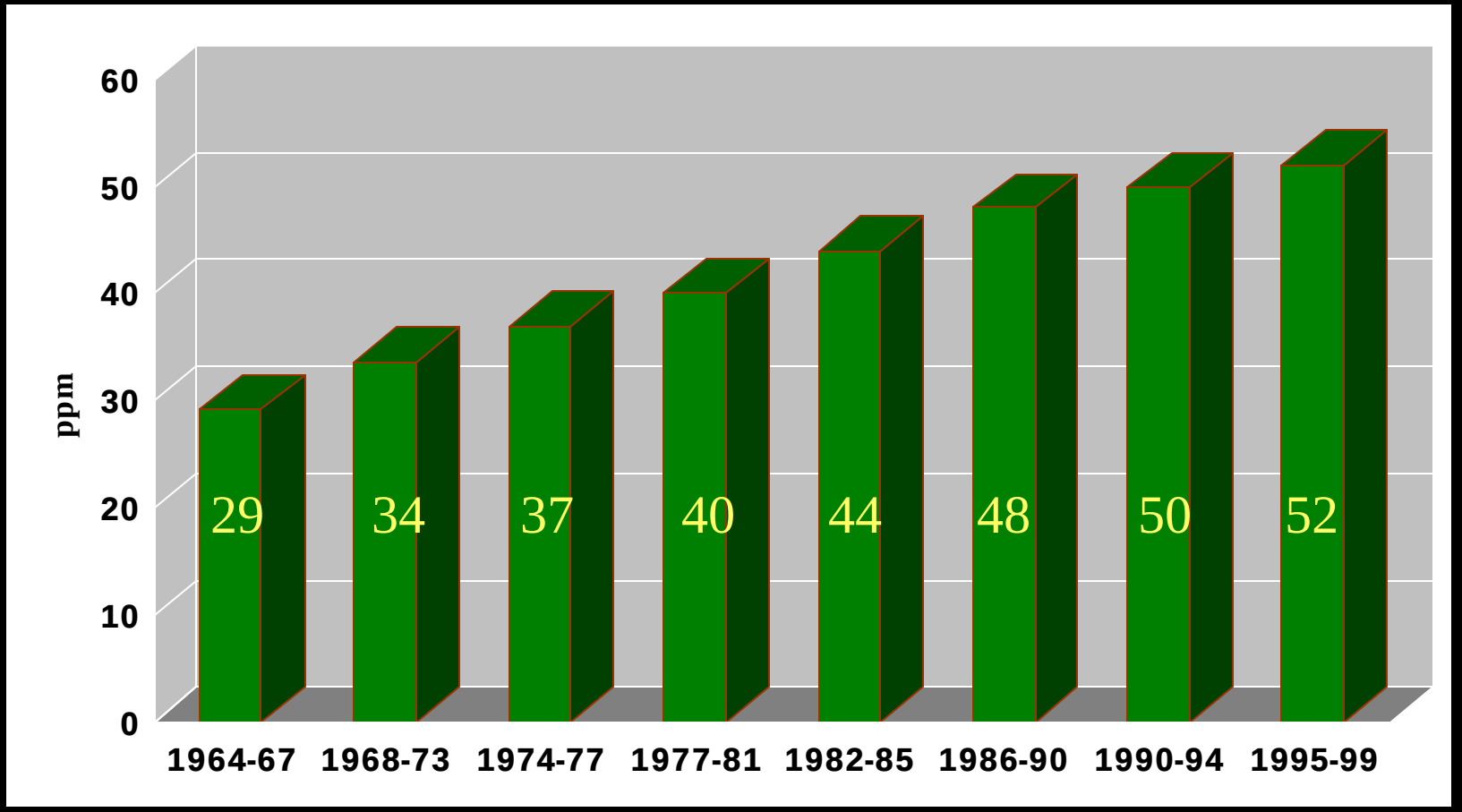
How we got into today's situation

1. Crops responded to P fertilizers

2. Applied manure to meet crops N needs
   * N to P ratio
   * Soil P build-up
   * P and water quality

Average Soil Test P in Wisconsin



P and Water Quality: Why the concern?

- No plant toxicity
- Held in soil
- Accumulates slowly
- Does not leach

Features of P-based nutrient management

Using soil test P criteria

- N-based management when soil test is < 50 ppm
- Soil test 50-100 ppm, P additions limited to crop removal or less over 4 year rotation
- Soil test > 100 ppm, limit P to less than crop removal

What options exist?

1. Reduce P inputs
   - feed
   - fertilizer
   - animals

2. Increase land base

3. Identify low-risk sites

Dairy Dietary P Management

Milk Production (lbs/day)	Dietary P Level (%)
55	0.32
77	0.35
99	0.36
120	0.38

Adapted from *Nutrient Requirements for Dairy Cattle*, Seventh Revised Edition, National Academy Press Washington, D.C., January 2001

Dairy Dietary P Management – Implications of a High-P Diet

Dietary-P (%)	Manure-P (lbs/cow/year)	Required Acres* (acres/cow/year)	Req. Land Inc. (%)
0.35	42	1.6	--
0.38	47	1.8	13
0.48	65	2.4	57
0.55	78	2.9	87

Acres required to meet a P-based nutrient management plan; adapted from Powell et al., 2001.

For nonruminants:

- Feed phytase
- Use high available P varieties

Reduce or eliminate P inputs

1. Follow soil test recommendations
2. Credit all nutrient sources
3. Use starter judiciously

Wisconsin “Sufficiency” Recommendations

Soil Test		Response Probability	*Phosphate Recommended
Level	Interpretation		
ppm		%	lb/a
0-4	V. Low	>90	70
5-10	Low	60-90	65
11-15	Optimum	30-60	55
16-25	High	5-30	25
>25	E. high	<5	0

*For 150 bu/a yield

Effect of soil K and hybrid RM on corn response to starter fertilizer

Variable	Category	No.	Responsive sites
			%
Soil test K	< 140 ppm	27	56
	≥ 140 ppm	73	34
Hybrid RM	< 100 day	64	33
	≥ 100 day	36	53

Adapted from Andraski and Bundy, 1999

Probability of profitable response to starter fertilizer*

Relative Maturity	Planting Date		
	4/25	5/15	5/30
	---------- probability, % ----------		
90	10	30	45
100	20	40	55
105	25	45	60
110	30	50	65

* EH Soil P and K

Increase Land Base

1. Buy land

2. Sell cows

3. Use existing land fully
   - cover all land during rotation
   - apply to rented land
   - obtain application rights

Allow P to Build on Low-Risk Sites

- Use P index to identify
- Factors considered
  - erosion
  - crop / cover
  - P level
  - fertilizer / manure practices
- Separates soluble and particulate P risks

Manage P to reduce P losses

1. Identify low risk sites
2. Time application properly
3. Use banded P applications
4. Incorporate manure only when appropriate
5. Use conservation practices / buffers

Other 590 restrictions that affect needed land base:

- Cannot spread in concentrated flow channels or buffers
- No winter spreading near lake (1000 ft), stream (300 ft) or groundwater conduit (200 ft)
- No winter spreading on slopes > 9% or 12% with RRP
- Winter application limited to P for current crop, not exceeding 7000 gal/a liquid manure

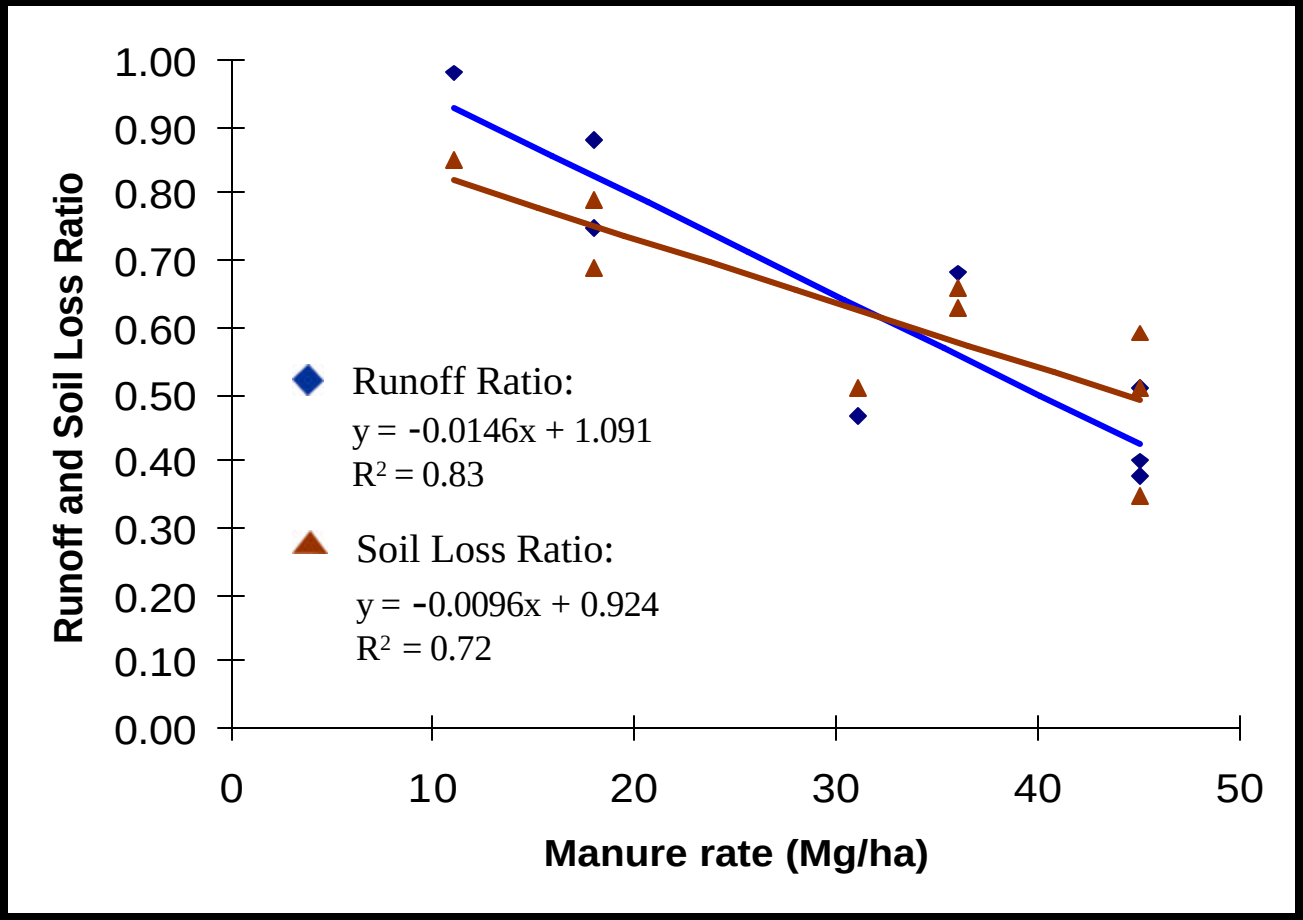
Questions to address:

- Does manure affect runoff volume?
- Does manure affect runoff quality?
- What situations are most risky?

Manure is a soil conditioner:

- Aggregation increased
- Bulk density decreased
- Water holding capacity increased
- Hydraulic conductivity increased
- Crop production increased
- Runoff/soil loss decreased

Effect of annual manure rate on runoff and soil loss ratios



adapted from Gilley and Risse (2000); slope length 20-40 m; gradient 4-13%

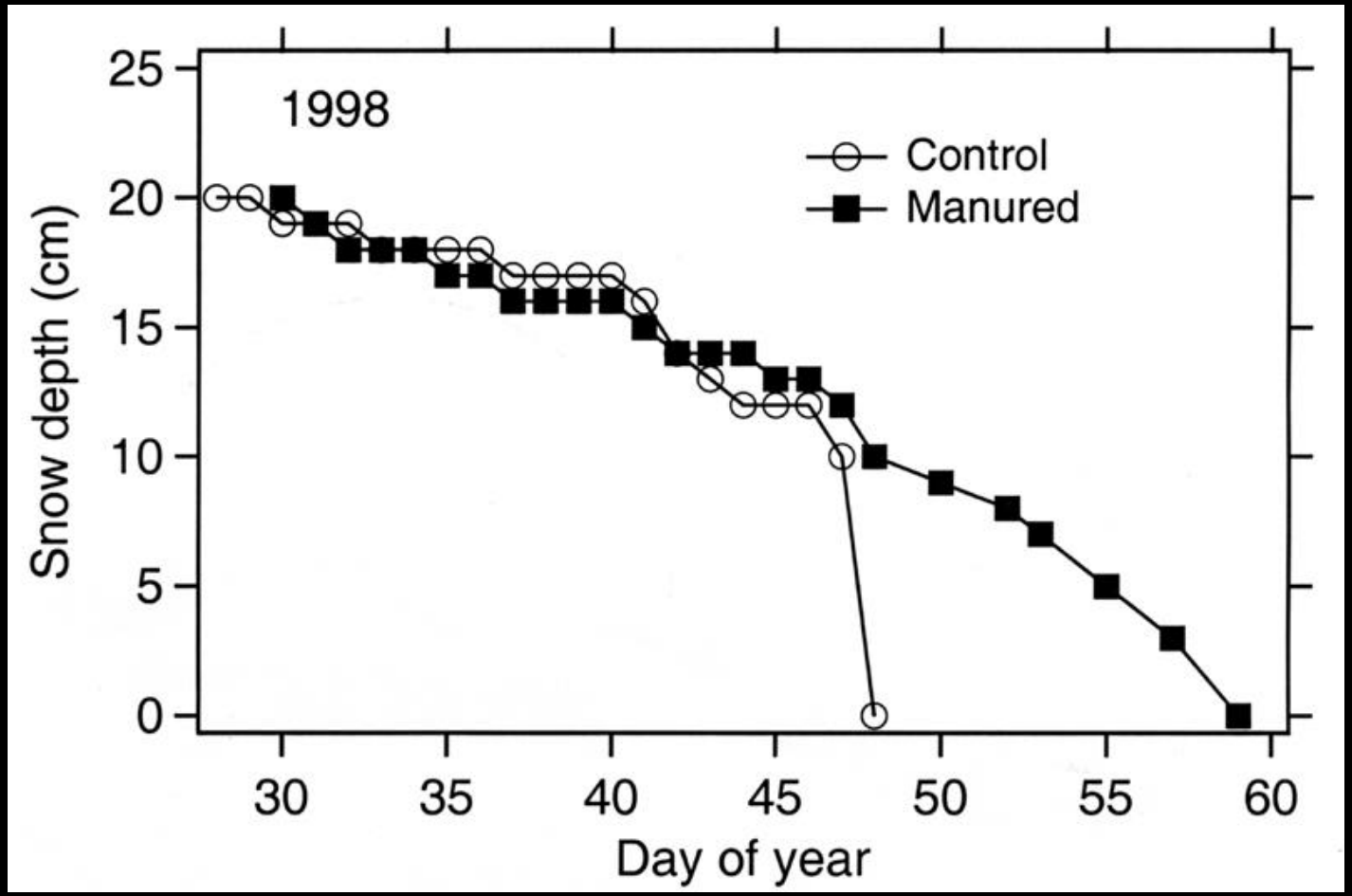
Factors influencing manure impacts on runoff volume:

- Worm population 3.5x for all times of application (Converse et al., 1976)
- Manure slows snowmelt (Kongoli, 2000)
- Mulch effect from manure (Young and Holt, 1977)

Site/soil interactions with manure on runoff and soil loss:

- Slope length
- Tillage system/surface residue
- Vegetative cover
- Frost type
- Fate of first melt water
- Position in the snow pack

Snow depth and melting rate as affected by 70 Mg/ha dairy manure



Adapted from Kongoli, 2000.

Runoff P as % P applied from winter-spread manure:

- Five studies (Vermont, Wisconsin, New York, Minnesota, & Wisconsin)
- Averages 7.58%
- Range = <0.1 to 27.4%
- (Adapted from Moore and Madison, 1985)

Effect of time of manure application to alfalfa on runoff volume and total P loss:

Manure app time	Runoff			P loss		
	72	73	74	72	73	74
	---------- mm ----------			---------- kg/ha ----------		
Check	82	142	185	0.75	0.76	2.40
Fall	52	78	90	1.24	1.20	8.09
Winter	82	103	128	0.64	0.58	6.09
Spring	67	128	150	2.39	0.55	1.81

Annual manure rate 22.5 Mg/ha; gradient 10% (adapted from Converse et al., 1976).

Effect of tillage and manure applications on snowmelt and rainfall runoff and sediment and P losses:

		Snowmelt			Rainfall		
Tillage	Manure	RO	Sediment	Total P	RO	Sediment	Total P
		mm	------ kg/ha ------		mm	------ kg/ha ------	
RT	-	23.3	62	0.50	5.1	220	0.98
	+	21.4	36	0.31	3.2	61	0.43
Mb	-	17.7	20	0.03	31.5	8579	1.57
	+	22.7	17	0.06	24.9	4307	0.58

+ Average of 2 years; manure rate 56 Mg/ha; gradient 12%
(Adapted from Ginting et al., 1998a,b).

Runoff and P loss in snowmelt from manure

Crop / Manure Applic.	Runoff	Total P loss
	in	lb/a
Corn		
None	2.64	0.1
Fall manure plowed	0.60	0.2
Fall on frozen	0.47	0.5
Spring on snow	0.50	0.2
Alfalfa		
None	3.43	0.1
Fall on frozen	2.74	5.4
Spring on snow	1.43	2.4

Average of 3 years; adapted from Young and Mutchler, 1976; 9% slope

Worst-case situations:

- “Concrete” frost in place
- High residue
- Smooth soil surface
- Manure at soil/snow interface
- Application during melt or immediately before rain

P Best Management Practices

- Balance P inputs and removals
- Check and limit P in animal diets
  - 0.40% P adequate for dairy
- Minimum P in starter
  - 15-20 lb P_2O_5/a
- Incorporate manure & fertilizer?
- Time applications to minimize runoff
  - Fall or winter apply to tilled fields
  - Spring apply to NT fields

BMP's continued

- Apply manure P on lowest fields first
- Allow soil P to build on low risk areas
- Avoid applications if soil test P >100-150 ppm
- Use conservation practices
- Cover/buffers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