Runoff and Phosphorus Issues Related to Winter Application of Manure

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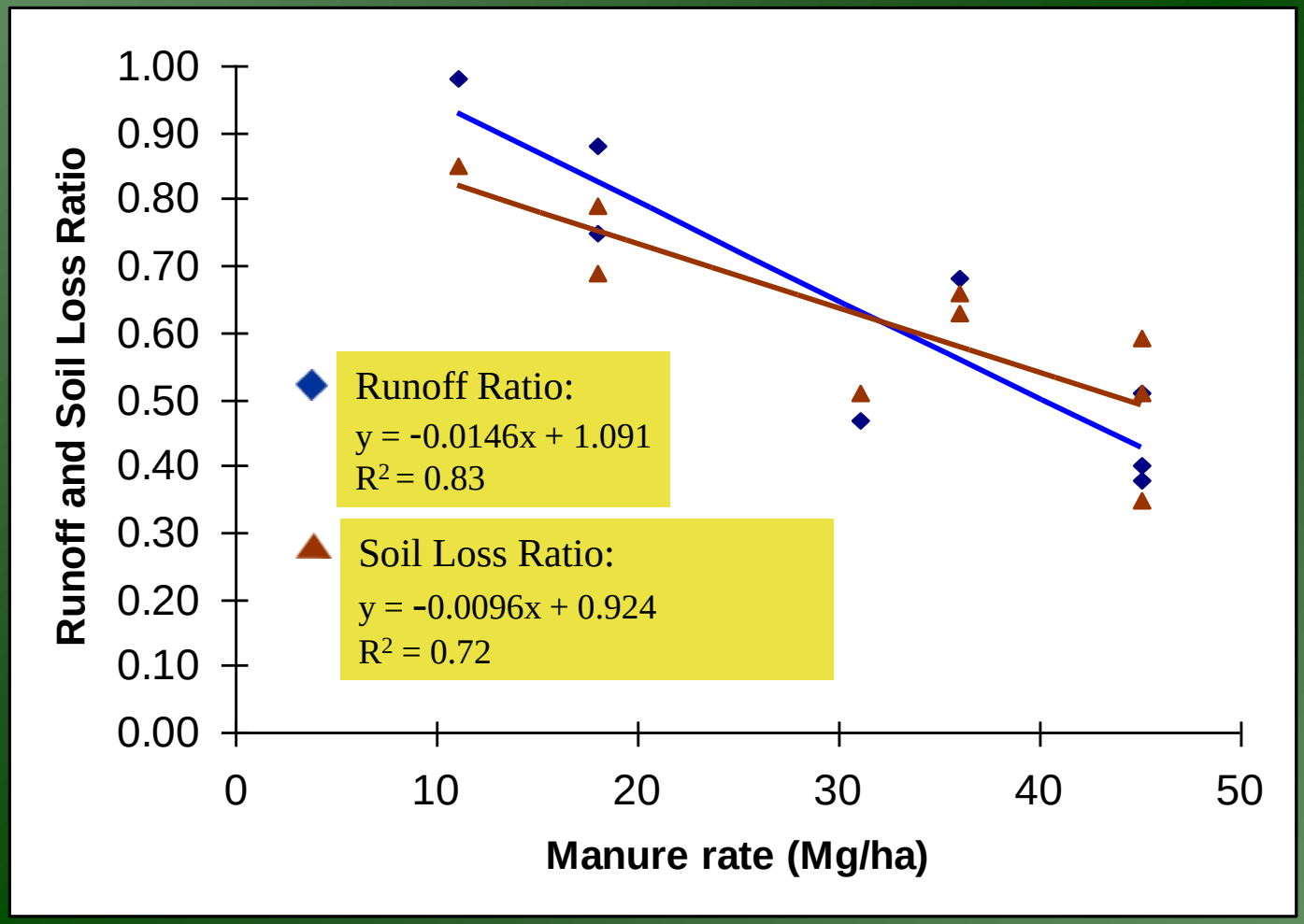
Questions to address:

- 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)

Manure characteristics & handling influences on runoff and soil loss:

- Bedding amount and type
- Loading rate
- Incorporation
- Time between application and first runoff event

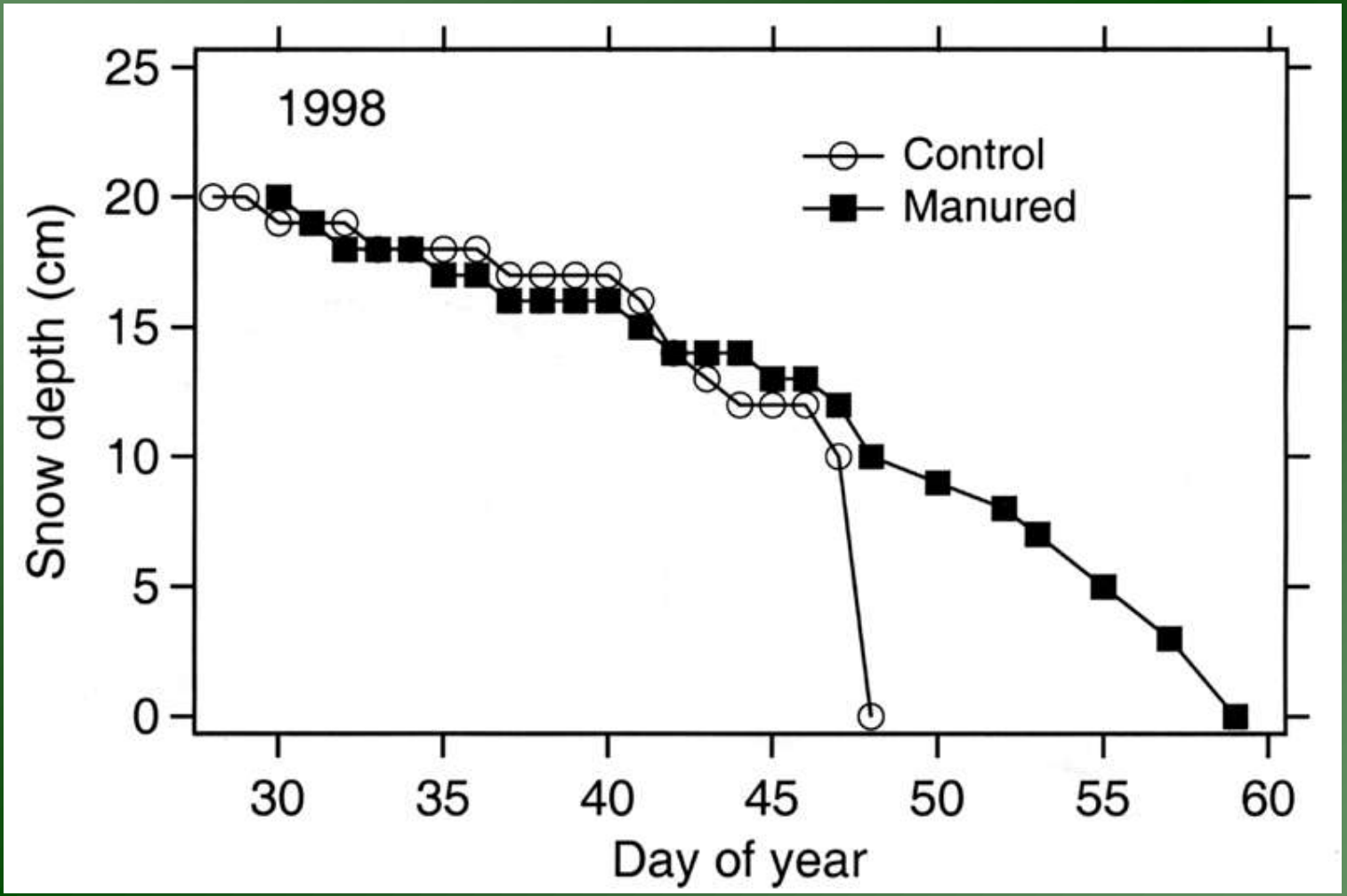
Site/soil interactions with manure on runoff and soil loss:

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

Worst-case situations:

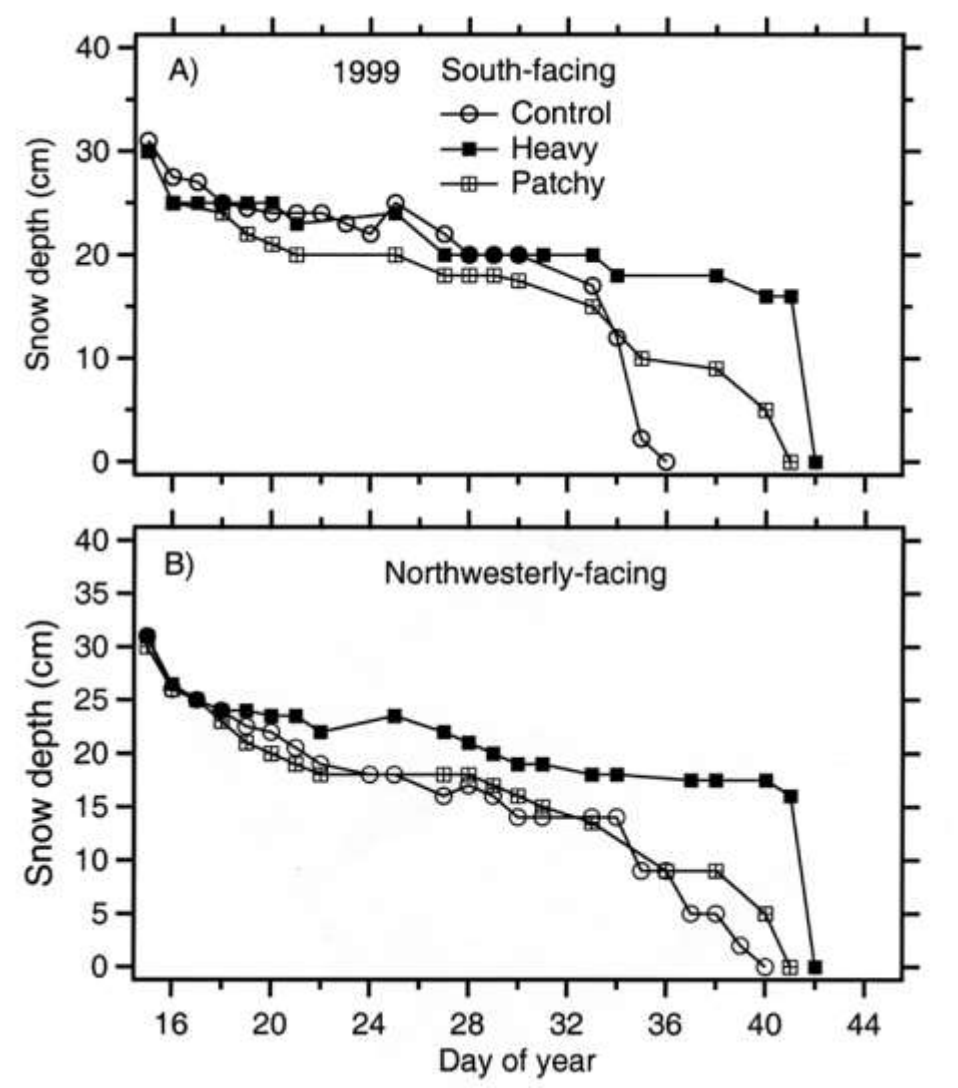
- “Concrete” frost in place
- High residue
- Smooth soil surface
- Manure at soil/snow interface
- Application during melt or immediately before rain

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



Adapted from Kongoli, 2000.

Snow depth and melting rate as affected by 45 or 100 Mg/ha dairy manure and slope aspect



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)

Estimate of total P loading to White Clay Lake from winter-spread manure:

Year	Manure P	Winter spreading	
	kg	kg	%
1974	53.4	13.2	24.7
1975	56.7	13.6	23.9
1976	178.0	46.1	25.9

(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 time of manure application to corn residue on runoff and P loss:

Manure app time	Runoff		P loss	
	1967	1968	1967	1968
	-------- mm -------		------ kg/ha --------	
None	87	143	1.00	1.60
Winter	78	115	5.66	1.13
Spring	71	105	0.73	0.90

Annual manure rate 33.5 Mg/ha; gradient 11% (adapted from Hensler et al., 1970).

Effect of annual manure rate on total soluble P losses from winter-spread manure:

Manure rate	Total soluble P		
	1972	1973	1974
Mg/ha	---------- kg/ha ----------		
0	0.82	--	--
35	0.46	0.36	<0.05
100	9.57	1.25	<0.05
200	3.66	0.89	<0.05

Gradient 2 to 4% (adapted from Klausner 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 winter manure on corn and alfalfa:

Manure application	Runoff			Total P		
	1972	1973	1974	1972	1973	1974
	---------- cm ----------			-------- kg/ha --------		
Corn: Check	16.0	0.3	3.8	0.2	T	0.1
Corn: Fall manure plowed	4.3	0.0	0.3	0.6	0	T
Corn: Fall on frozen	3.3	0.0	0.3	1.6	0	T
Corn: Spring on snow	3.3	0.0	0.5	0.6	0	0.1
Alfalfa: Check	--	8.9	8.6	--	0.1	T
Alfalfa: Fall on frozen	11.2	7.1	2.6	7.4	6.7	4.1
Alfalfa: Spring on snow	7.6	0.3	3.0	3.7	0.1	4.3

Gradient 9% (adapted from Young and Mutchler, 1976).

Summary:

- Manure improves soil physical condition and reduces runoff
- Winter-spread manure may or may not increase runoff P load
- P loading highly site- and weather-specific

Avoid high-risk environments:

- Frozen alfalfa before snow
- Through waterways
- During active melt
- Steep, long slopes

Encourage lower-risk applications:

- Inject through residue
- Level or nearly level, snow-covered, chisel-plowed fields
- Up-gradient from buffers