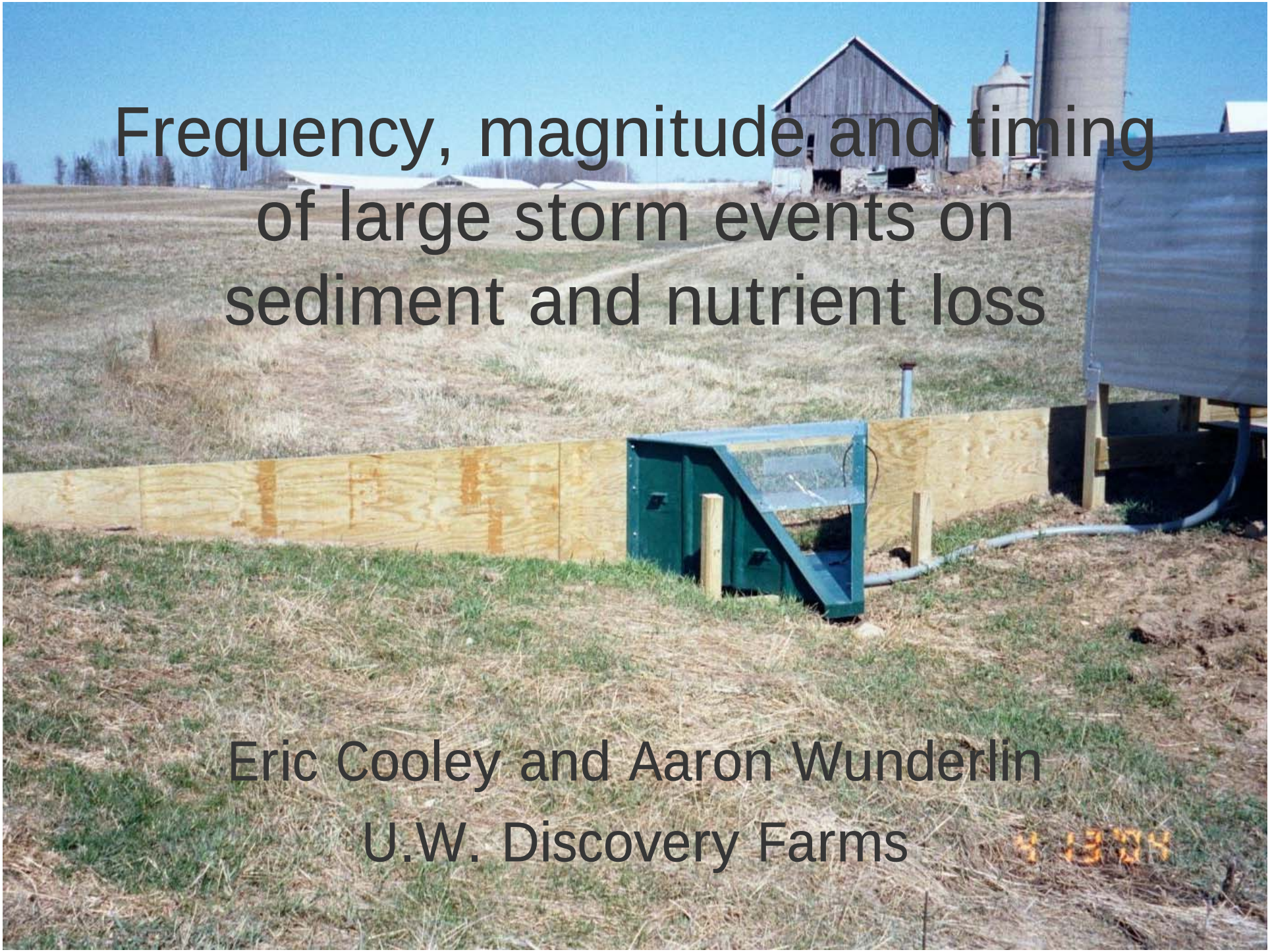


Frequency, magnitude and timing of large storm events on sediment and nutrient loss

Eric Cooley and Aaron Wunderlin

U.W. Discovery Farms

Outline

- Analysis of rain event volume, duration and frequency of occurrence
- Comparison of rain events with runoff, sediment and nutrient loss and influential factors
- Major lessons learned from rainfall and runoff data

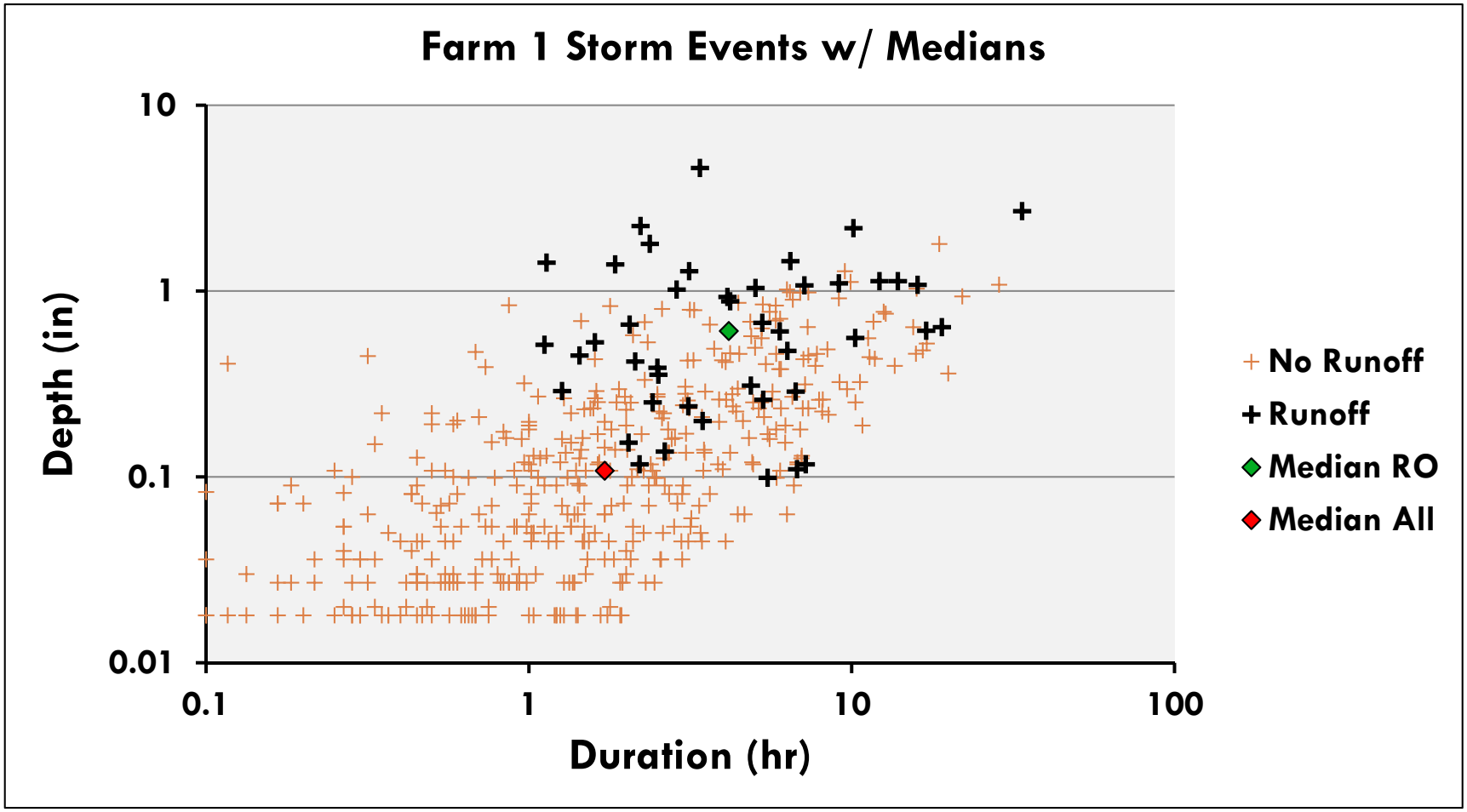
Precipitation and Runoff Monitoring

- 5 farms at various locations in WI
- Variety of farm types/practices
- Edge-of-field (27 FYrs, 59 SYrs)
- Non-frozen ground period only

Rainfall Event Data

	Years	Rain events	Runoff events	Median storm producing runoff	
				Depth (in)	Duration (hr)
Farm 1	5.5	471	44	0.61	4.16
Farm 2	4.3	399	40	0.75	4.67
Farm 3	3.3	308	27	1.03	3.86
Farm 4	6.3	639	52	1.07	2.94
Farm 5	7.5	583	83	0.90	2.90
% runoff			**10%**		

Farm 1 Example



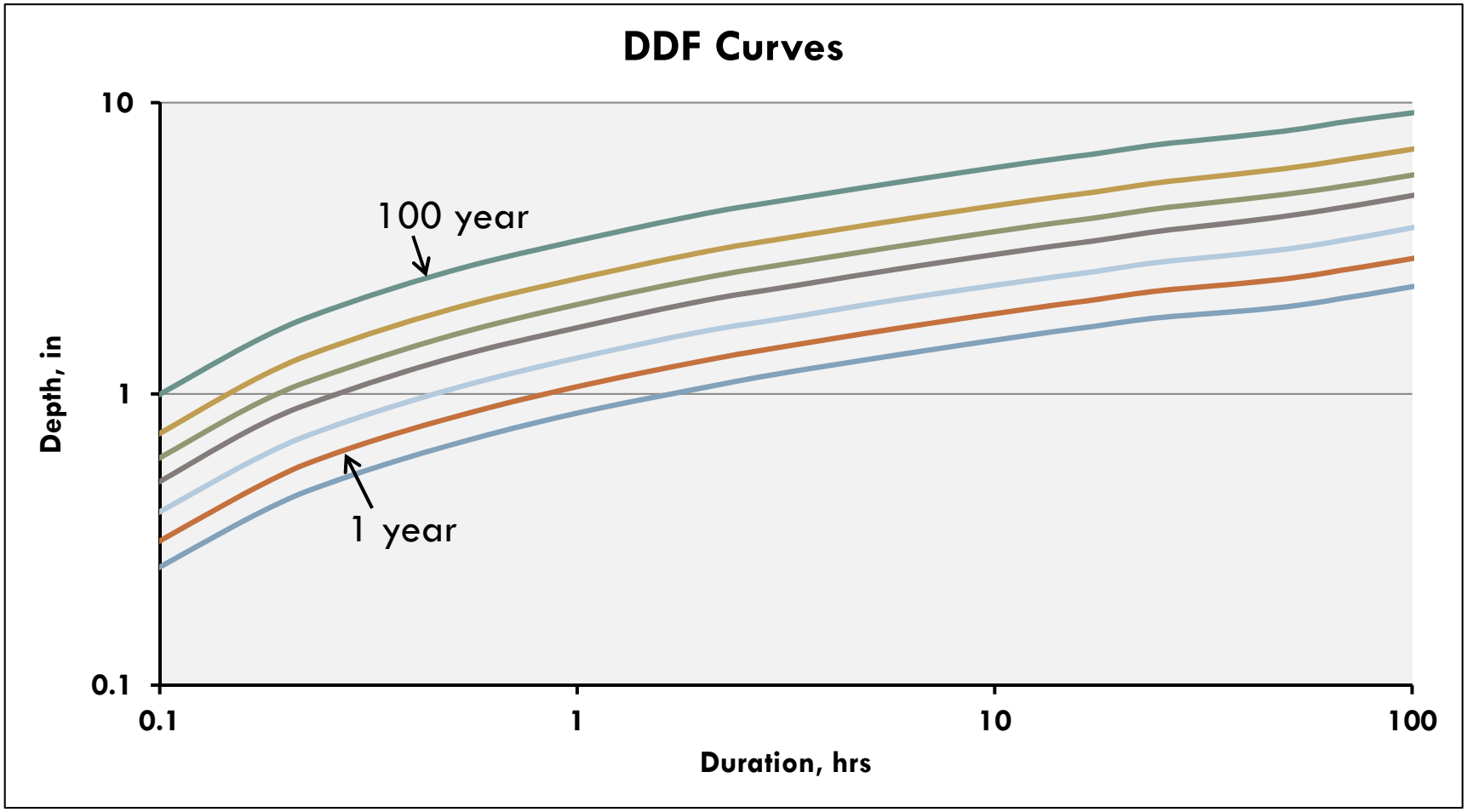
Large confinement dairy, conventional tillage, injected liquid manure, 2-6% slope

Depth – Duration – Frequency (DDF) Tables

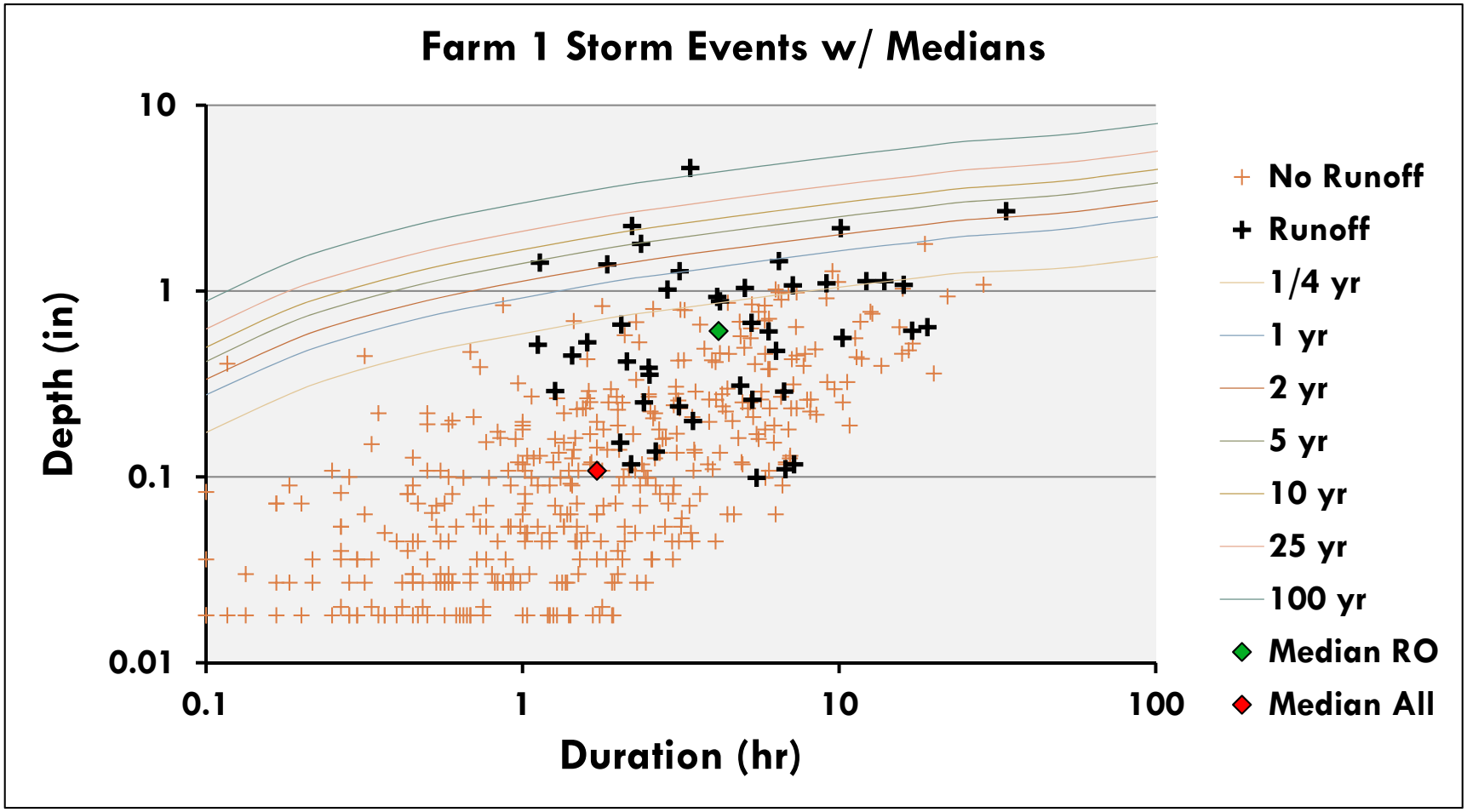
- Rainfall Frequency Atlas of the United States
  - Hershfield, 1961
- Rainfall Frequency Atlas of the Midwest
  - Huff and Angel, 1992
- Divided by regions within states

	2 mos	3 mos	4 mos	6 mos	9 mos	1 yr	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
10 day	1.85	2.23	2.57	3.02	3.48	3.78	4.88	6.19	7.16	8.45	9.49	10.6
5 day	1.56	1.87	2.11	2.45	2.82	3.06	3.92	5.04	5.91	7.22	8.29	9.52
3 day	1.4	1.65	1.86	2.16	2.48	2.7	3.42	4.43	5.23	6.43	7.49	8.68
2 day	1.31	1.53	1.7	1.98	2.27	2.47	3.12	4.05	4.82	5.91	6.88	7.95
24 hr	1.24	1.44	1.57	1.82	2.07	2.25	2.82	3.6	4.31	5.29	6.17	7.15
18 hr	1.17	1.36	1.48	1.72	1.95	2.12	2.65	3.38	4.05	4.97	5.8	6.72
12 hr	1.08	1.25	1.37	1.59	1.8	1.96	2.45	3.13	3.75	4.6	5.37	6.22
6 hr	0.93	1.08	1.18	1.37	1.55	1.69	2.12	2.7	3.23	3.97	4.63	5.36
3 hr	0.79	0.92	1.01	1.17	1.32	1.44	1.8	2.3	2.76	3.39	3.95	4.58
2 hr	0.71	0.83	0.91	1.05	1.2	1.3	1.64	2.09	2.5	3.07	3.58	4.15
1 hr	0.58	0.68	0.74	0.86	0.98	1.06	1.33	1.69	2.03	2.49	2.9	3.36
30 min	0.46	0.53	0.58	0.67	0.76	0.83	1.04	1.33	1.59	1.96	2.28	2.65
15 min	0.34	0.39	0.43	0.49	0.56	0.61	0.76	0.97	1.16	1.43	1.67	1.93
10 min	0.26	0.3	0.33	0.38	0.43	0.47	0.59	0.76	0.91	1.11	1.3	1.5
5 min	0.15	0.17	0.19	0.22	0.25	0.27	0.34	0.43	0.52	0.63	0.74	0.86

DDF Curves


DDF Curves
10
1
0.1
Depth, in
100 year
1 year
0.1
1
10
100
Duration, hrs

Farm Plots

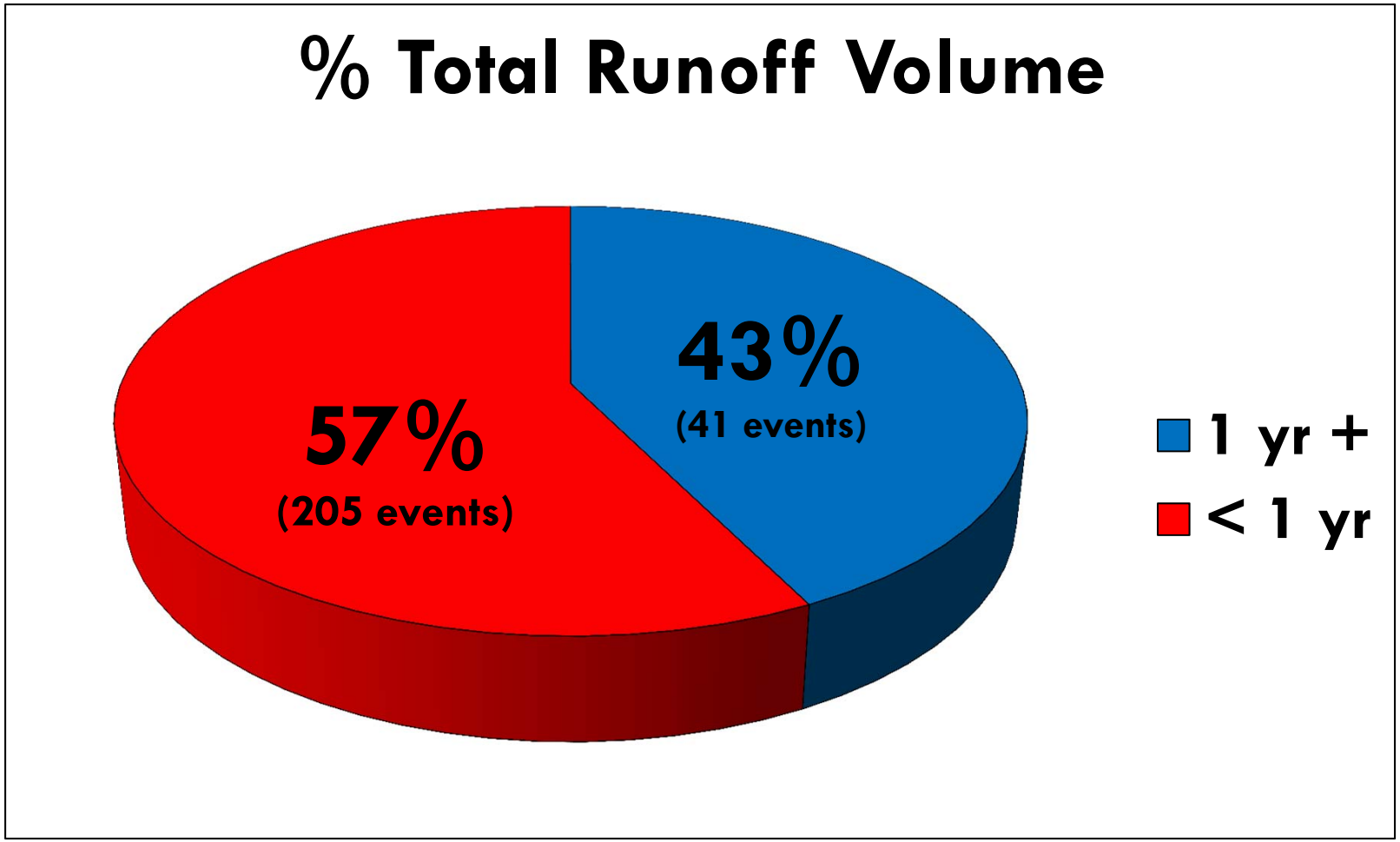


Large confinement dairy, conventional tillage, injected liquid manure, 2-6% slope

Runoff Stats

	Farm Yrs	<1 yr	1 yr	2 yr	5 yr	10 yr	25 yr	100 yr
Farm 1	**5.5**	36	1	4	1	1	0	1
Farm 2	**4.3**	37	1	0	1	1	0	0
Farm 3	**3.3**	22	3	2	0	0	0	0
Farm 4	**6.3**	39	9	2	0	1	1	0
Farm 5	**7.5**	71	6	2	2	1	1	0
Total	**27**	205	20	10	4	4	2	1

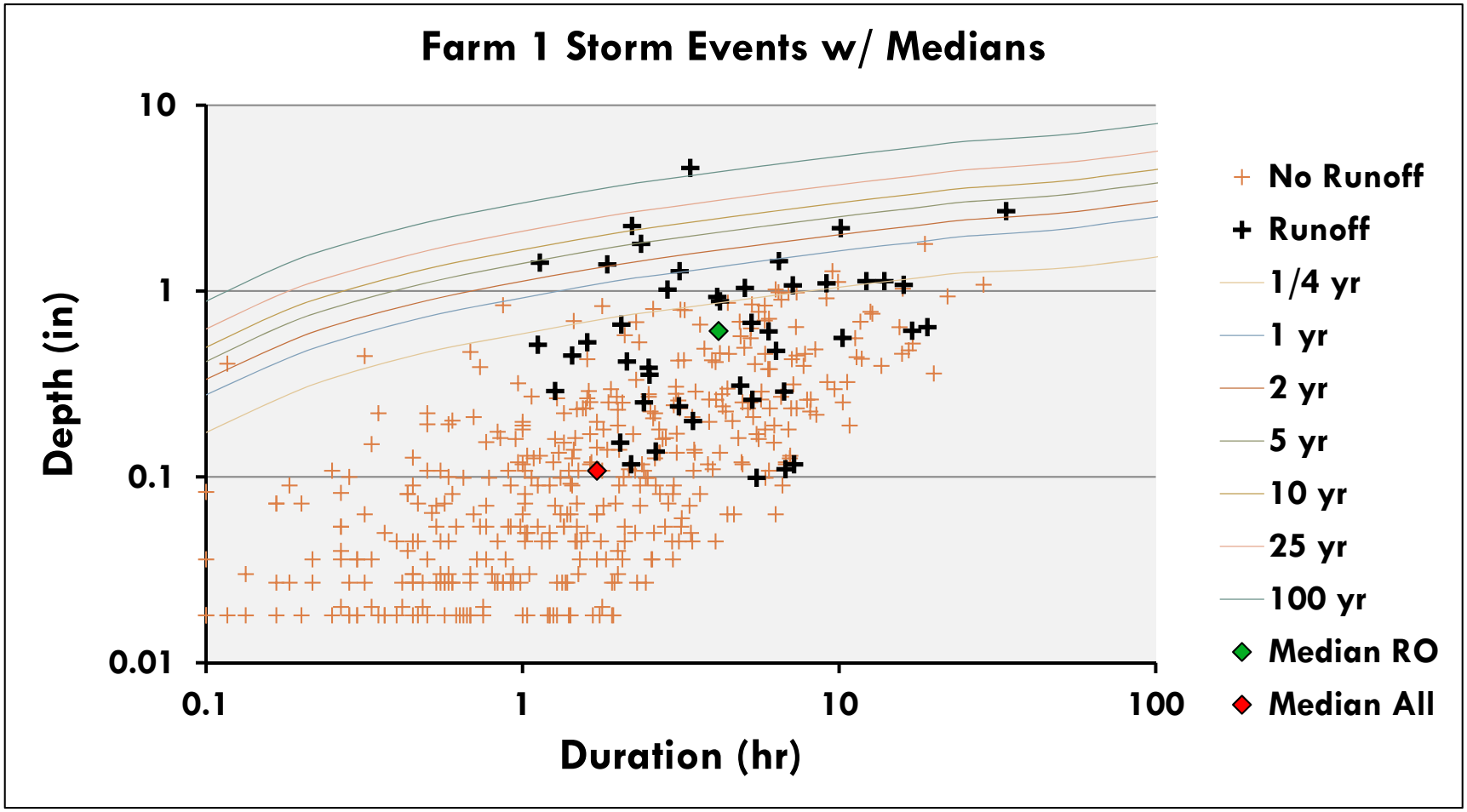
Runoff and Storm Size



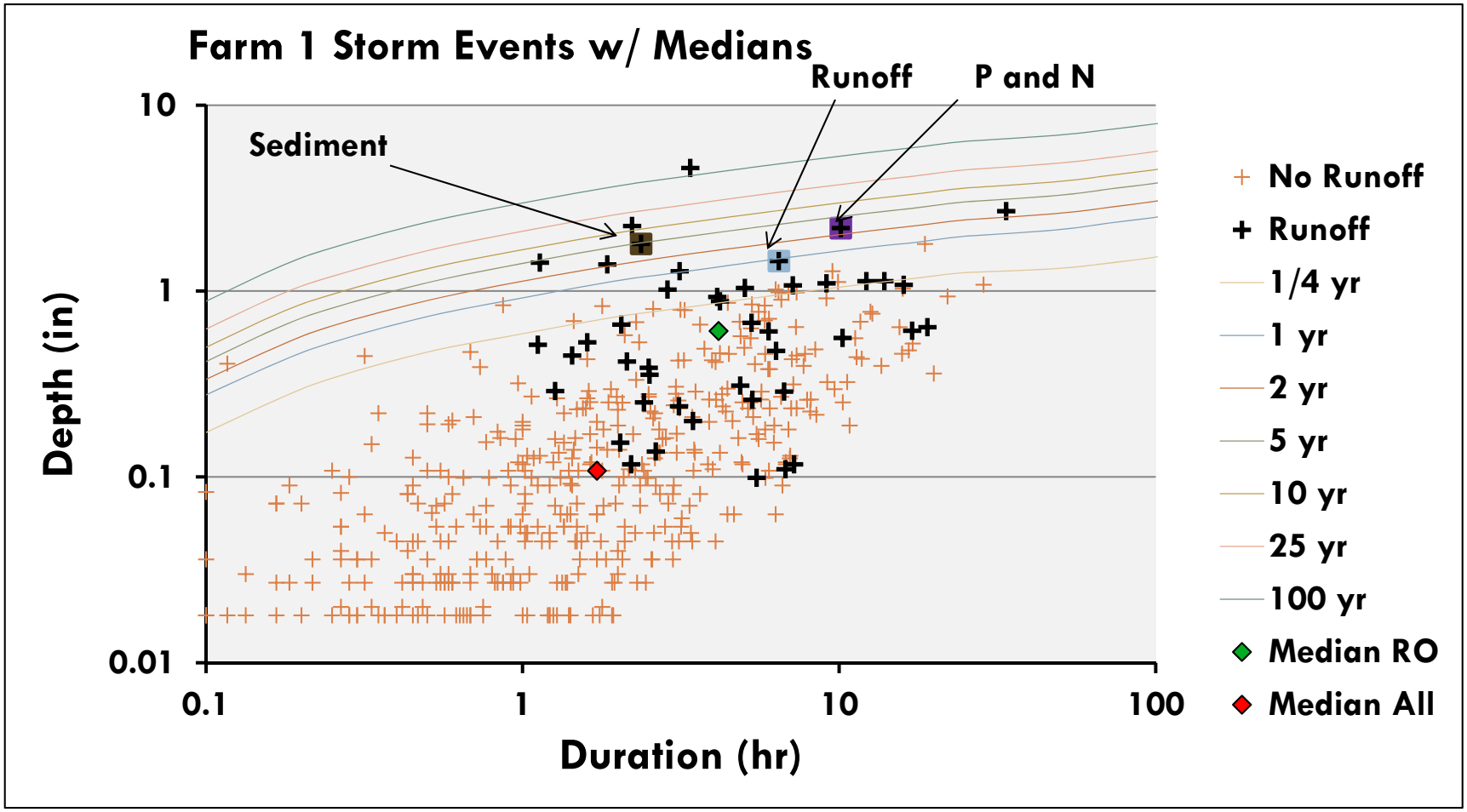
Storm size comparison to losses

- Runoff volume
- Sediment losses
- P and N losses

Farm Example



Farm Example



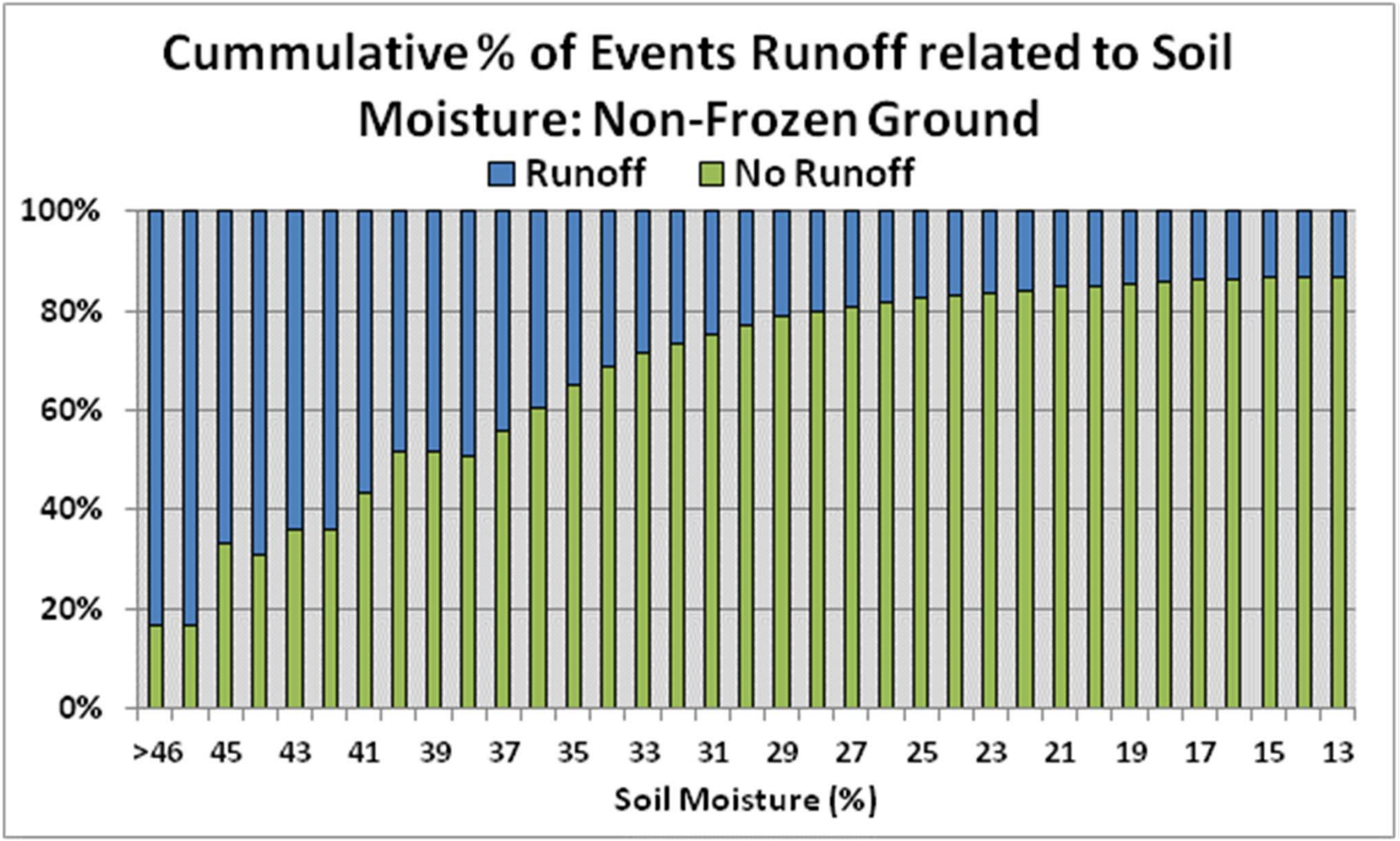
Farm Example

- Largest rainfall event (>100 yr return period)
  - 18th largest runoff event
  - 21st largest P and N loss event
  - 23rd largest sediment loss event
- Largest runoff event (1.1 inches of runoff)
  - 7th largest rainfall event
- Largest sediment loss (920 lbs/acre)
  - 3rd largest rainfall event, 4th largest runoff event
- Largest P and N loss (1.6 and 5.9 lbs/acre, respectively)
  - 5th largest rainfall event, 2nd largest runoff event

Why the differences?

- Storm properties
  - Rainfall Depth
  - Intensity
- Timing, conditions and management
  - Antecedent soil moisture
  - Vegetative cover
  - Surface residue
  - Surface roughness/tillage
  - Soil texture/slope
  - Nutrient applications

Soil Moisture and Runoff



Other important findings

- A single storm can contribute the majority of annual losses of sediment and nutrients
- Many of the high sediment loss events occurred from spring rains, when soils were often void of cover
- High phosphorus loss events were common in conjunction with high sediment loss and runoff in close proximity to nutrient applications
- High nitrogen loss events were common with high runoff events and runoff in close proximity to nutrient applications

Conclusions

- Larger rain events are occurring more frequently and can result in high runoff, sediment and nutrient loss
- Soil conditions and land management are major factors in the potential for runoff - small storms can still result in runoff
- A single storm can account for the majority of the annual sediment and nutrient loss
- As larger storms become a more frequent occurrence, soil conservation practices and proper manure management will increase in importance for reducing sediment and nutrient loss

Questions?

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