When Does Runoff Occur and What Can Be Done to Reduce Impacts on Water Quality?

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Edges of Fields - Where are we at?

- 25 Water-Quality Monitoring Stations evaluated (6-640 acres)
  - 5 Discovery Farms representing a variety of landscapes and farming systems
  - Pioneer Farm
- 5 Meteorological Stations
  - Precipitation, soil temp, and soil moisture data used to understand conditions causing runoff

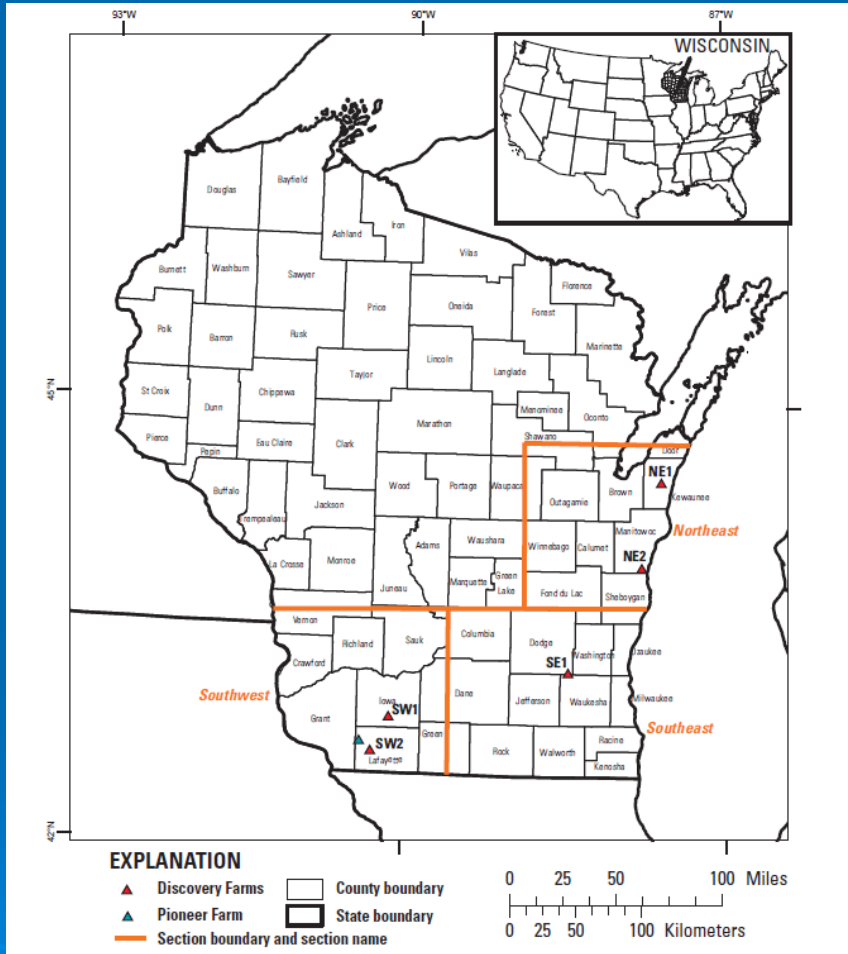


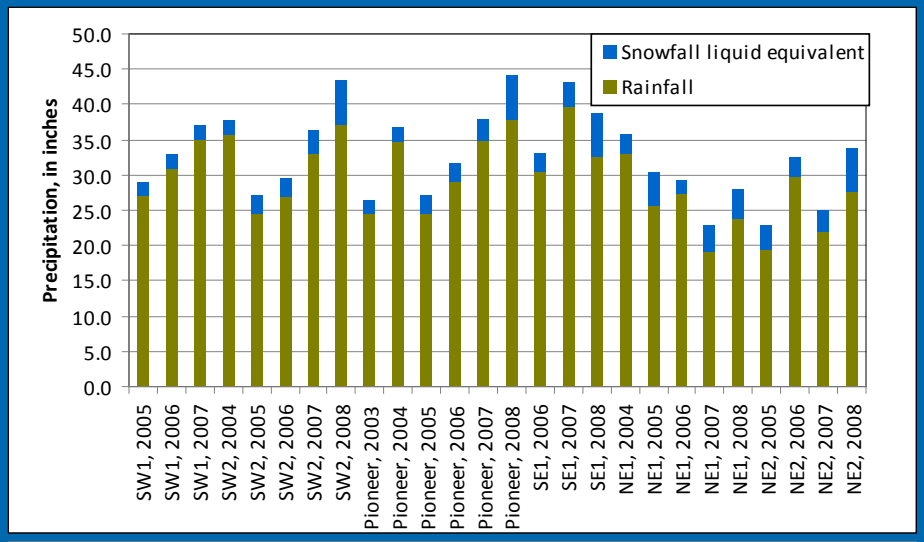
Figure 1. Map of farms

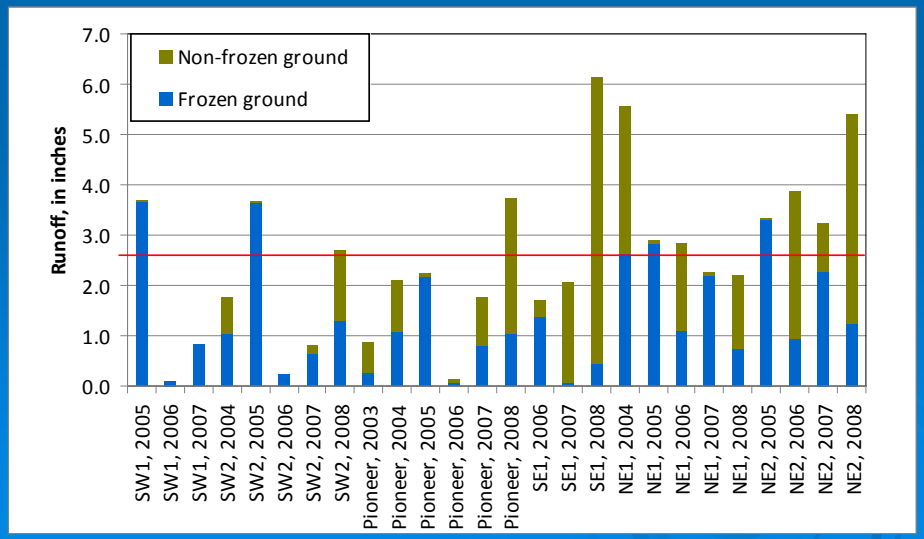
Source: Precipitation-Runoff Relations and Water-Quality Characteristics at Edge-of-Field Stations, Discovery Farms and Pioneer Farm, Wisconsin, 2003–8, publication pending

Edge-of-Field

- Edges-of-field indicate how field-management decisions can impact water quality losses
- Monitored a variety of site types
  - Flow (runoff)
  - Sediment loads and yields
  - Nutrient loads and yields
- **81 "station-years**" of data (26 "farm years") collected at 25 monitoring stations located on Discovery Farms and the Pioneer Farm from 2003-2008
- Use data to determine runoff losses of sediment and nutrients and determine the "when?" and "why?" to help guide management to reduce problems if they exist

Precipitation and Runoff Amounts

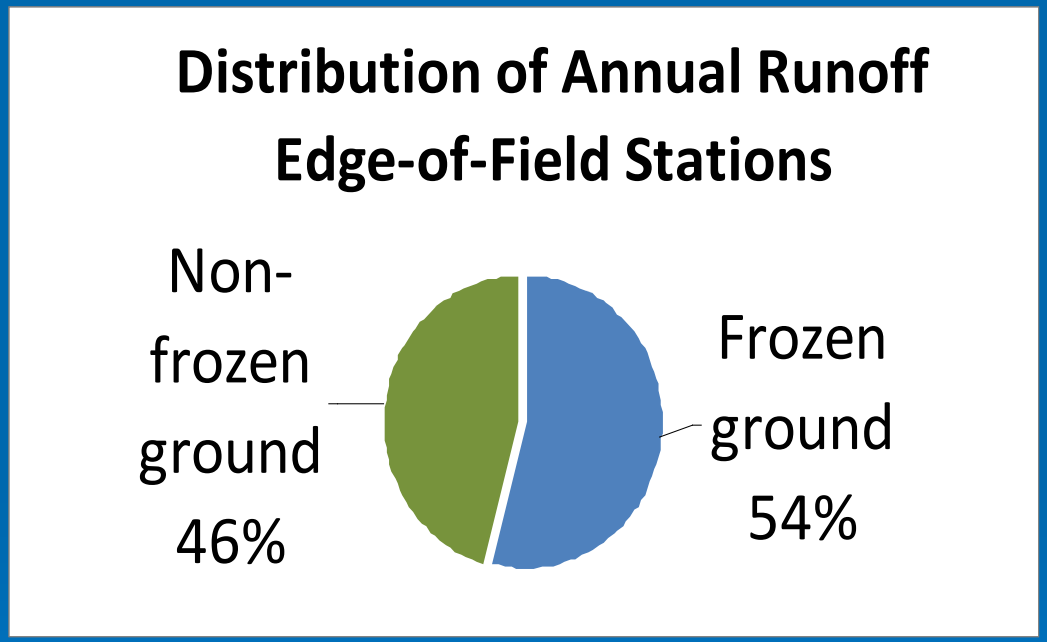




- Precipitation averaged for the entire data set was near average
- Runoff averaged 2.5 inches per year
- About 8% of precipitation was measured as runoff
- Annual precipitation was not a good indicator of annual runoff.
- Trend towards higher runoff on tighter soils in the northeast

Source: Precipitation-Runoff Relations and Water-Quality Characteristics at Edge-of-Field Stations, Discovery Farms and Pioneer Farm, Wisconsin, 2003–8, publication pending

Distribution of Runoff



- On average, runoff volumes were nearly equally distributed between frozen and non-frozen periods.
- In any one year, frozen ground contributed up to 100% of annual runoff.
- Because of this distribution, it is important to focus on causes/timing of runoff during both periods

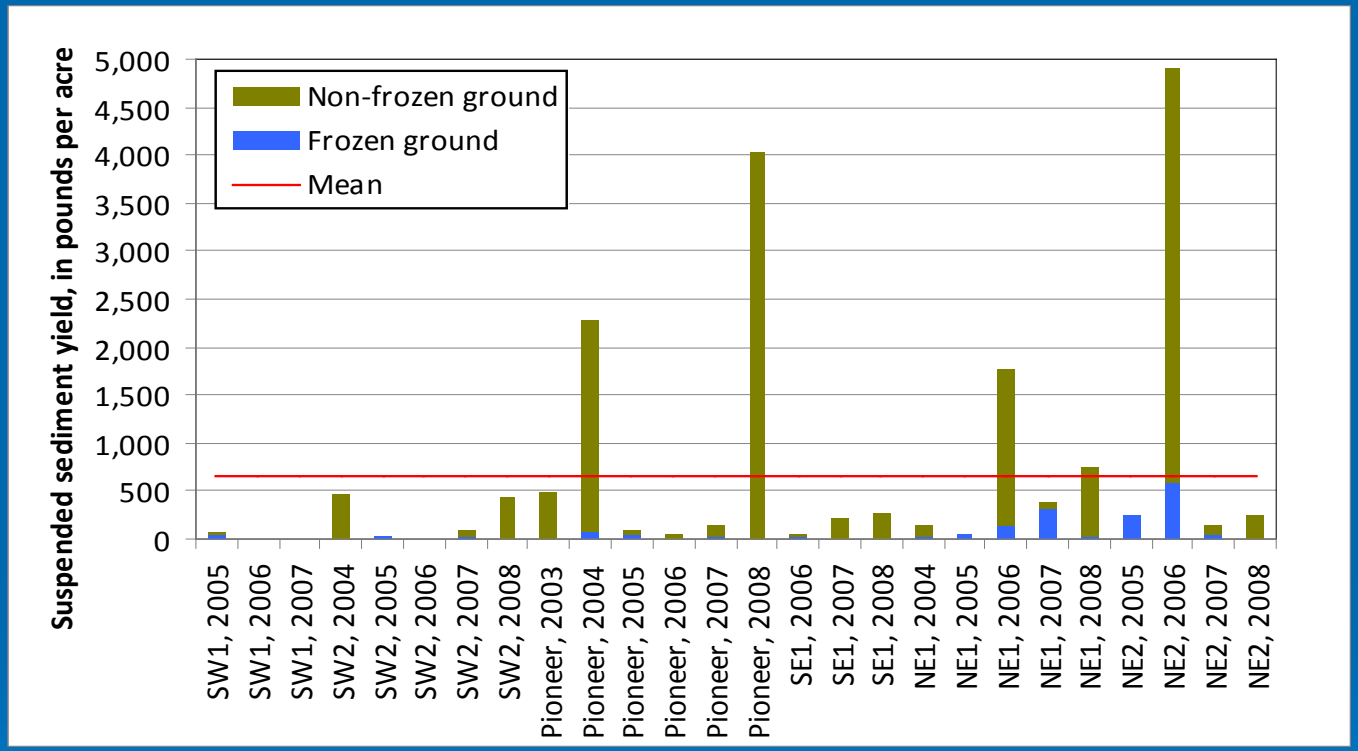
Source: Precipitation-Runoff Relations and Water-Quality Characteristics at Edge-of-Field Stations, Discovery Farms and Pioneer Farm, Wisconsin, 2003–8, publication pending

Timing of Runoff – Critical Runoff Periods

	Mean-Monthly Runoff	Mean-Monthly Runoff as a Percentage of Annual Runoff	Runoff Frequency	Total Precip	Mean-Monthly Runoff as a Percentage of Total Precip
October	0.07	3%	23%	2.32	3%
November	0.02	<1%	15%	2.22	1%
December	0.04	1%	35%	1.73	2%
January	0.10	4%	50%	1.68	6%
February	0.41	16%	58%	1.48	28%
March	0.87	34%	100%	2.22	39%
April	0.11	4%	54%	3.42	3%
May	0.32	12%	38%	3.70	9%
June	0.48	19%	42%	3.83	13%
July	0.07	3%	42%	3.90	2%
August	0.07	3%	19%	3.55	2%
September	<0.01	<1%	19%	2.76	<1%

Source: Precipitation-Runoff Relations and Water-Quality Characteristics at Edge-of-Field Stations, Discovery Farms and Pioneer Farm, Wisconsin, 2003–8, publication pending

Suspended Sediment Losses (Yields)

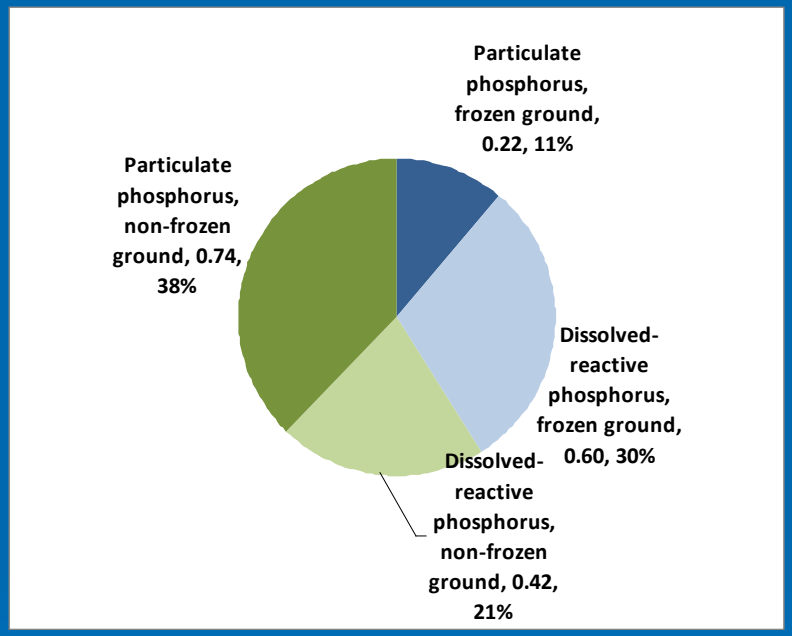


- Average across all farm years of data was 670 lb/acre
- Nearly all sediment loss occurred during non-frozen ground periods
- The same farm typically had both low and high sediment losses during the monitored period

Source: Precipitation-Runoff Relations and Water-Quality Characteristics at Edge-of-Field Stations, Discovery Farms and Pioneer Farm, Wisconsin, 2003–8, publication pending

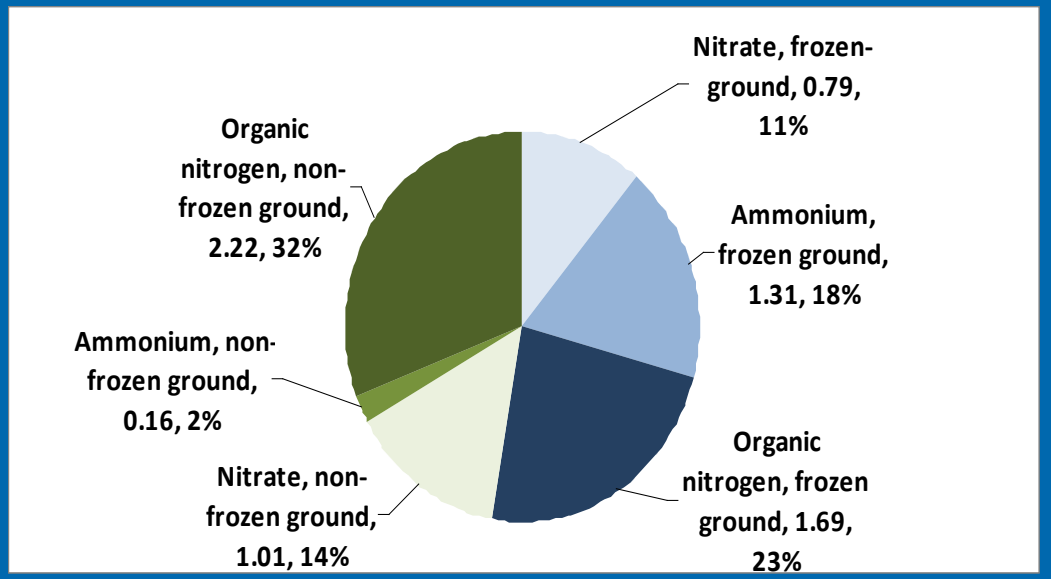
Nutrient Losses

Total Phosphorus



- Most P lost during the non-frozen ground period
- Average loss was 2 lb/acre/year
- About ½ of P loss was dissolved

Total Nitrogen



- Most N lost during the frozen-ground period
- Average loss was 7 lb/acre/year
- Most N losses were from Organic N
- Note ammonium losses from frozen ground

Source: Precipitation-Runoff Relations and Water-Quality Characteristics at Edge-of-Field Stations, Discovery Farms and Pioneer Farm, Wisconsin, 2003–8, publication pending

Lessons Learned

- In addition to the conservation practices and nutrient management plans that were already in place, consideration of
  - critical runoff periods,
  - field conditions (soil moisture, frozen soil),
  - and the timing of field-management activities (manure applications) in relation to these periods and conditions

  could have significantly reduced runoff of nutrients from edges of fields.

In other words: Day-to-day decisions can be very important!

Decisions Matter!

2 Adjacent Fields.

- Liquid dairy manure applied to 1 field (above)
- No manure applied to the other field (below)

When and Why?

- Management tools that focus on when and why and help guide decisions and planning can potentially decrease field-edge losses
- The timing describes periods of time that runoff is most likely to happen
- The why can describe the conditions that need to be met in order for runoff to develop
- Predicting that runoff will occur is more difficult than predicting if it is going to rain!

What is the Distribution of Runoff for Various Soil Conditions?

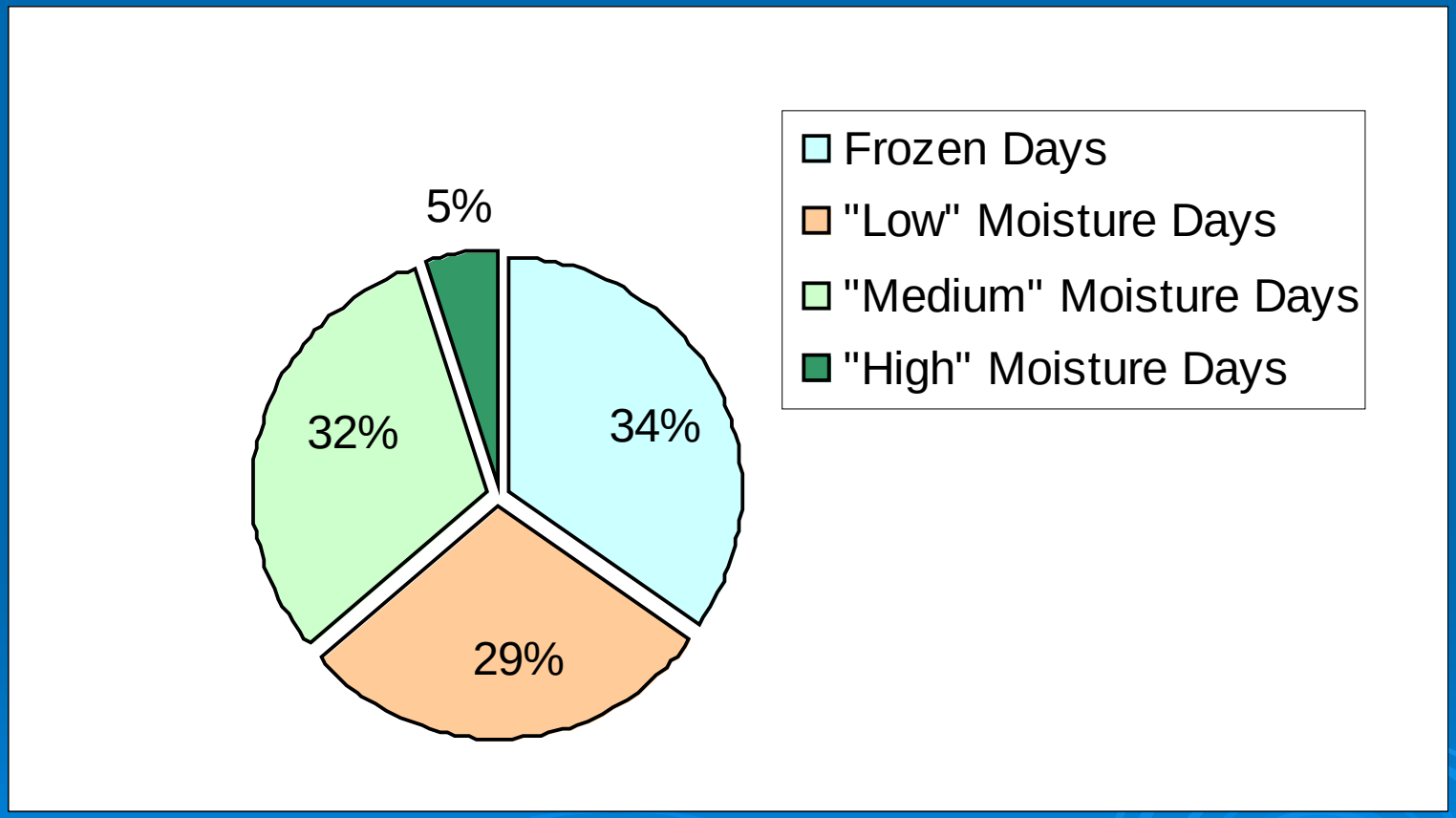
Example: No-till farm in SW Wisconsin (2003-2008)

- Frozen ground: 80%, Non-Frozen Ground: ~ 20%
  - Of the Frozen ground runoff, about ¾ has occurred in Feb. and Mar.

- Of the Non-Frozen ground runoff:
  - 83% occurred when soils were “Wet” (>35%)
  - 10% occurred when soils were “Medium” (25-35%
  - 7% occurred when soils were “Dry” (<25%)

Field Conditions

Example: No-till farm in SW Wisconsin (2003-2008)



Frozen-Ground

Example: No-till farm in SW Wisconsin (2003-2008)

- ~40% of all Frozen-Ground runoff was the result of rain or rain on snow.
- ~60% of all Frozen-Ground runoff was snowmelt only, either from warm air temperatures, solar radiation, or a combination of both.
- Looking at precipitation forecasts in the winter and making application determinations is only part of the challenge.

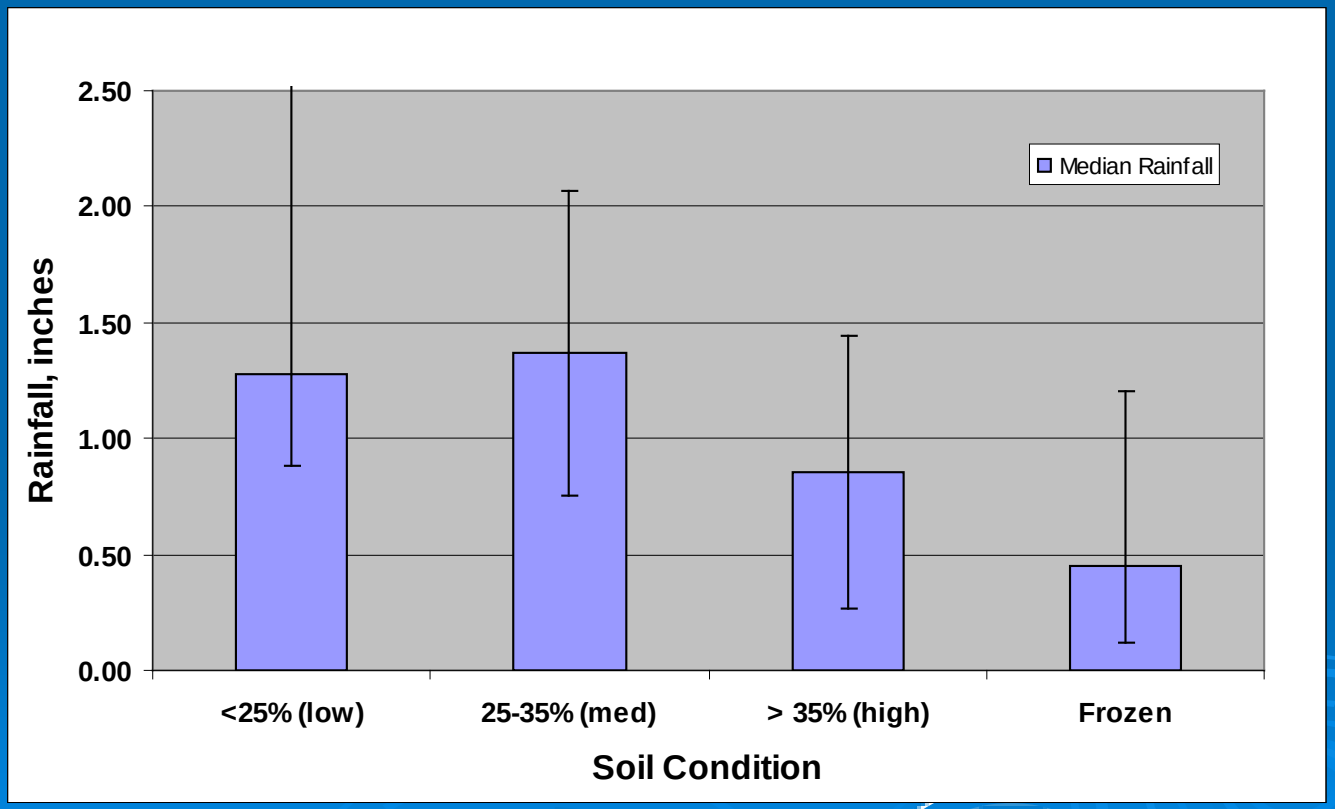
When do these soil conditions occur?

Example: No-till farm in SW Wisconsin (2003-2008)

- Frozen Ground: Average dates of persistent frost at any depth: **Nov 29 to Apr. 1**
- Non-Frozen Ground:
  - **High (>35% Soil Moisture):**
    - 47% in Spring (Apr., May, 1st ½ June)
    - 52% in Summer (2nd ½ June, July, Aug.)
    - occasionally in Fall (Sep., Oct., Nov.)
  - **Medium (25-35% Soil Moisture):**
    - 40% in Spring (Apr., May, 1st ½ June)
    - 24% in Summer (2nd ½ June, July, Aug.)
    - 36% in Fall (Sep., Oct., Nov.)
  - **Low (<25% Soil Moisture):**
    - 21% in Spring (Apr., May, 1st ½ June)
    - 46% in Summer (2nd ½ June, July, Aug.)
    - 34% in Fall (Sep., Oct., Nov.)

How much rain does it take to produce runoff for a given soil condition?

Example: No-till farm in SW Wisconsin (2003-2008)



Note that these are the actual measured rainfall amounts that caused runoff for each soil condition category. They do not necessarily represent the threshold rainfall amounts that caused runoff.

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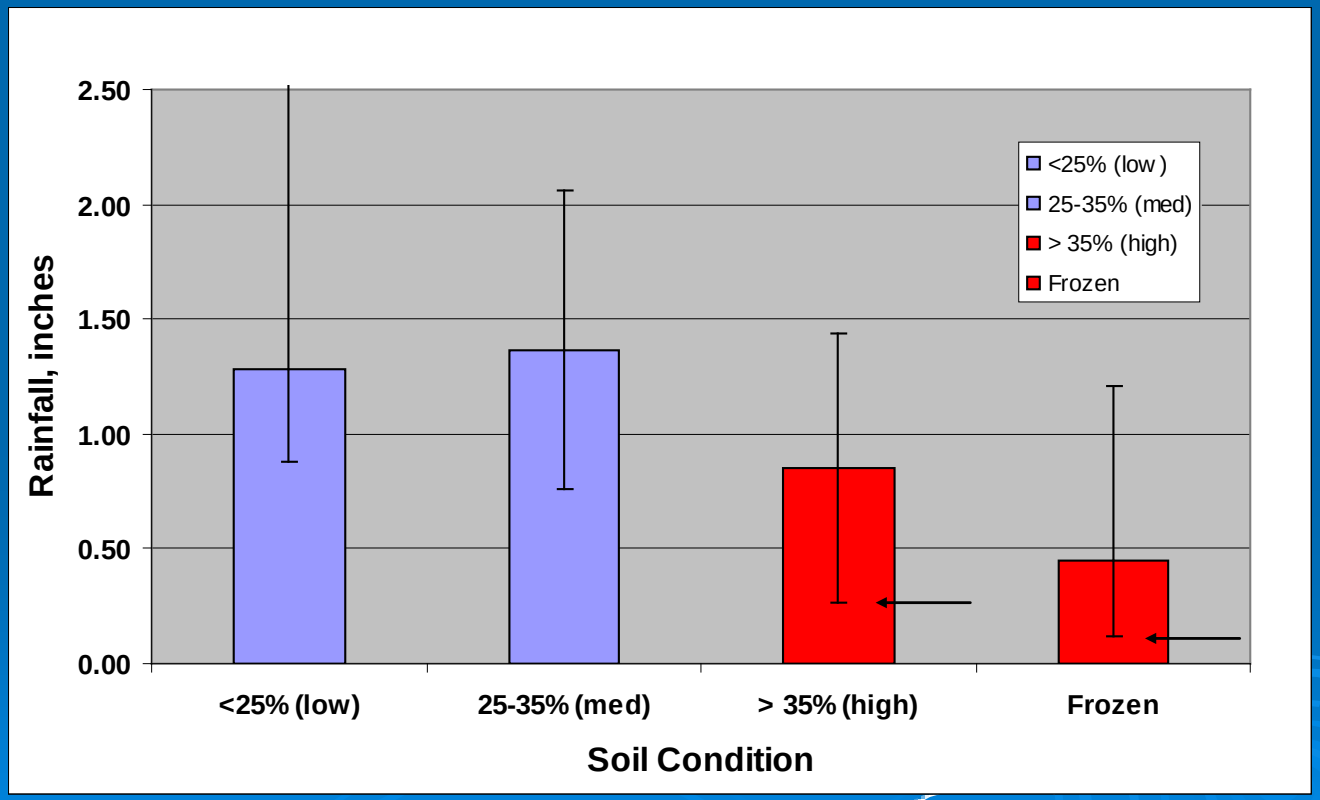
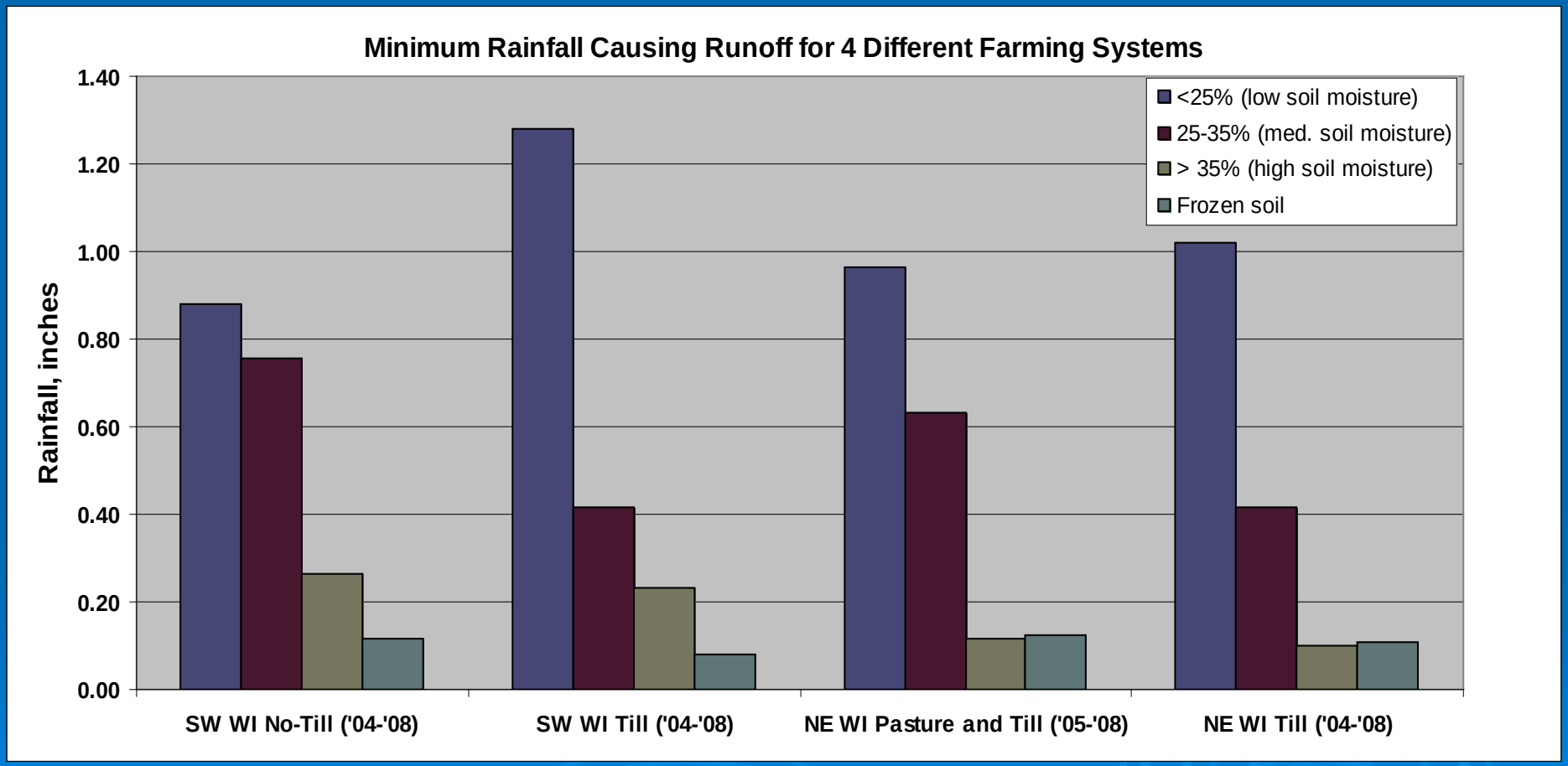


Focus on the minimum rainfall amounts needed to produce runoff

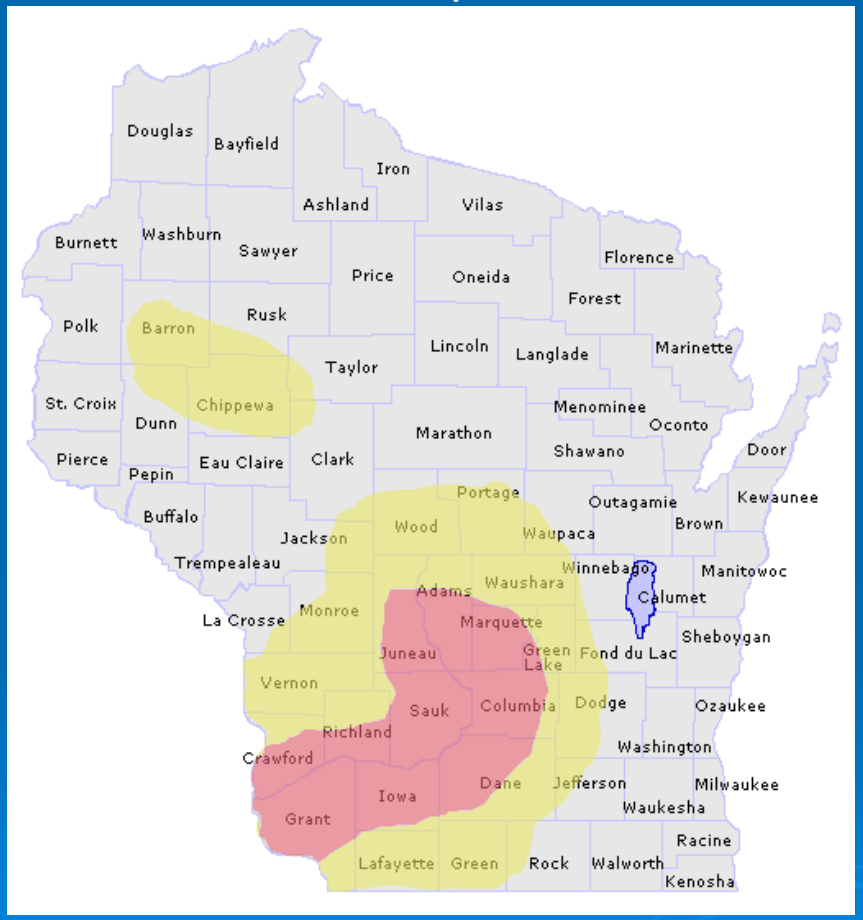
How different were the minimum rainfall amounts different among the farms?



As one would expect some differences are present between the farms. However, from a critical-period planning standpoint, they are rather similar!

The Next Steps…?

Online advisory index screening tool based on NWS predictions…



PLUS…

On the ground data and decision-making criteria

- Soil Temperature and Soil Moisture Data
- Criteria for risk of runoff based upon rainfall/runoff relations
- = Decision making tool!

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

One Potential Risk Model