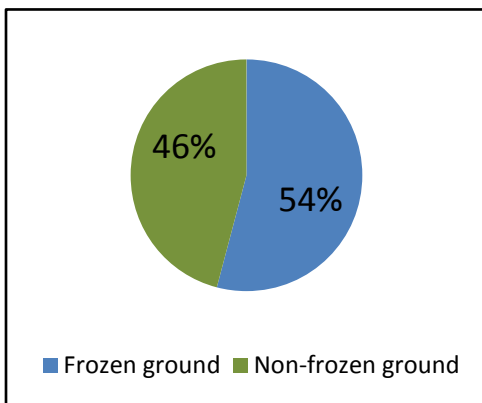


# Runoff Potential from frozen and snow-covered soils

Discovery Farms conducts on-farm research on privately-owned farms in Wisconsin to identify practices that contribute positive and negative environmental impacts and work with producers to implement practices which reduce these losses. The program is under the direction of an industry led steering committee, and we take a real-world approach to finding the most economical solutions to agriculture’s environmental challenges.

UW Discovery Farms has collected surface water runoff samples from over 25 locations around the state of Wisconsin since 2003. Data from surface water runoff samples provide valuable information on precipitation amounts, volume and depth of water leaving the fields as runoff, time period in which runoff occurred, and nutrient and sediment content of the runoff water. These data give the Discovery Farms program the unique opportunity to educate farmers and agricultural professionals about critical runoff time periods, especially when the soil is frozen and/or snow covered.



From data collected at surface water monitoring sites around the state, the frozen ground period in Wisconsin lasts, on average, from November 29 to April 1. From 7 years of data at over 25 sites, 46% of annual runoff occurred while the soil was not frozen, and 54% occurred during frozen ground conditions (Figure 1). Runoff during non-frozen time periods is triggered by very intense rain storms, or rain on soil that is at or near saturation. While annual runoff across all sites was nearly evenly distributed between the frozen and non-frozen periods, several individual sites recorded 100% of the total annual runoff during the frozen ground period. Because annual runoff can be concentrated heavily during the frozen ground period, we must focus on the causes and timing of runoff to make better management decisions.

Figure 1. Distribution of Annual Runoff: Edge of field stations

## Causes of runoff during frozen ground periods

On a no-till operation in Southwestern WI, approximately 40% of all runoff that occurred during frozen ground conditions resulted from rain or rain on snow. The other 60% of frozen ground events were caused by snowmelt from warm air temperatures, solar radiation, or a combination of both. Data from this farm also show that the average amount of rain on frozen ground necessary to create a runoff event is 0.45 inches, but runoff has been generated from as little as 0.08 inches.

## When does runoff occur?

A significant amount of the total annual runoff events occur while the ground is frozen. However, does that mean we should ban winter spreading of manure at the first sign of frost? Not necessarily.

The combined data from edge of field sites (84 site years) show that the majority of annual runoff occurs from February to June, and the months of February, March, May, and June make up 81% of the average annual runoff. During each of the other eight months of the year, less than 5% of the annual runoff volume occurs (see Table 1). Our data show that 34% of the total annual volume occurred during March, a common month for snowmelt and rain on snow.

The amount of runoff that occurs in a month is only half of the equation. The other important piece of information is how often a runoff event has been recorded in a given month in the past. The month with the highest frequency of runoff (over all 84 site years) is March, at 100%. At least once each year at every site we’ve monitored, there has been a runoff event in March, and in some cases more than one event. Table 1 shows that January through July all have an

elevated runoff frequency value (40+%). August through December have fairly low runoff frequencies, and a very low percentage of the annual runoff.

So what does this mean about our winter spreading question? Runoff is more likely in February and March than in early winter (November, December, January). However, if winter manure spreading is banned, the risk for runoff in April, May, and June is similar or greater than that of January and February, because spring rain and little plant canopy leaves soils saturated and vulnerable to runoff. Every month of the frozen ground period does not carry the same risk that March does for nutrient runoff, so managing manure and manure storage around critical time periods can be a useful tool for farmers when they are making decisions about when to spread, and where to spread (i.e. spread in November, December, even January if conditions are right).

### What about nutrient loss during frozen ground periods?

It is helpful to know when and how runoff occurs, but it is also important to consider nutrients and even sediment lost to surface water while the soil is frozen. UW-Discovery Farms data shows that a shorter time interval between a manure application and a runoff event equals a greater potential for nutrient losses.

UW- Discovery Farms data shows that the majority of nitrogen lost throughout the entire year is from frozen soils. The majority of the nitrogen lost during this time period is in the organic nitrogen form, and ammonium also makes up a fairly large fraction.

It is important to note that, in our studies, application of both liquid dairy manure and solid beef manure increased total nitrogen and phosphorus losses when manure was applied shortly preceding snowmelt. Lower concentrations and losses were observed when manure was applied in the fall and early winter.

### So what should I do to minimize my risk of nutrient loss while spreading manure in the winter?

Wintertime manure management is a challenge, since wintertime runoff can comprise a significant amount of annual surface-water runoff and nutrient losses, and coincidentally, periods which are easiest in terms of available time for producers to apply manure sometimes coincide with the periods which have the highest risk for runoff!

But, there are some strategies that could help minimize risk when spreading manure during the winter. First, work with your crop consultant or local extension or conservation personnel to outline some fields on your farm that could be classified as 'low risk during high-risk time periods'. Fields on this list could fall into several categories like low slope, low soil test values, long distance from surface water, dries out quickly, etc. It is also a good idea to work with your local resources to create a list of options when field spreading is not desirable, like designating a temporary stacking area or creating another short term storage option, even covering small sections of a field instead of the entire field could lower your risk for nutrient loss.

*For more information on runoff from frozen and snow-covered soil or the UW-Discovery Farms Program, check out our website at [www.uwdiscoveryfarms.org](http://www.uwdiscoveryfarms.org). If you have further questions, please check the website or call our office at 715-983-5668.*

	Average % of Annual Runoff	Runoff Frequency
<b>January</b>	4%	50%
<b>February</b>	16%	58%
<b>March</b>	34%	100%
<b>April</b>	4%	54%
<b>May</b>	12%	38%
<b>June</b>	19%	42%
<b>July</b>	3%	42%
<b>August</b>	3%	19%
<b>September</b>	<1%	19%
<b>October</b>	3%	23%
<b>November</b>	<1%	15%
<b>December</b>	1%	35%

Table 1. Annual Runoff and Runoff Frequency by month. 84 site years of data from edge of field sites, UW-Discovery Farms