the indicated date and shows the probability of injury or kill to alfalfa stands harvested on that date.

For example, the graph for Alma, Michigan indicates an 85% probability of reaching 500 GDD before a killing frost if cutting alfalfa on September 15 and a 20% probability of reaching 500 GDD if cutting on September 29. Waiting to cut until October 27 shows an 80% probability of reaching less than 200 GDD before a killing frost. In contrast, the graph indicates the worst probabilities of achieving either condition at approximately the 3rd of October, which occurs outside of the traditional 'no-cut' period. In general, one can see a geographical shift of the center of the adjusted no-cut period from early in the September-October period in northern areas of the state (especially those in interior sections away from the lakes) to later in the period across southern sections. Probability graphs of several locations throughout the state can be found at http://www.agweather.geo.msu.edu/agwx/articles/article-09.html.

In summary, forage quality of alfalfa changes little during September, so harvesting versus delaying cutting should be based on likelihood of winter injury or survival if the stand is to be kept. The purpose of these graphs is to give a probability of winter survival at various cutting dates in the fall so that farmers can determine the risk associated with harvesting at various dates.

References

1. Dhont, C. et al. 2004. Crop Sci. 2004 44: 144-157.
2. Bélanger, G. et al.1999. Can J Plant Sci 79:57-63.

Environmental Management

Spreading Manure on Frozen, Snow Covered Fields

Natalie Rector
MSU Extension Manure Nutrient Specialist

Dann Bolinger
MSU Extension Dairy Agent

One bad apple does spoil the whole bunch. Every incident of winter manure application that causes a runoff to surface water during spring thaw is one more reason for the public and the regulators to consider restricting this practice. Maine and Vermont already have banned all manure applications between December and April. In Michigan, restrictions on winter spreading for Concentrated Animal Feeding Operations (CAFO) (greater than 1000 animal units) farms are imminent. Some CAFOs may see these restrictions this winter, others within the next year or two, depending when coverage under a National Pollutant Discharge Elimination System permit begins. As CAFOs experience greater regulation, smaller producers should be alert to a likely trickle down of the rules to smaller farms and take the initiative to be excellent stewards of the land and to avert further regulation.

Being proactive with regard to winter spreading sounds like a cliché but needs to be seriously heeded. Preplanning to designate which fields will be utilized for winter spreading will avoid being the bad apple that brings attention to manure applications on frozen and snow covered fields in Michigan.

For many dairy producers and other livestock farmers, surface-spreading manure during the winter is necessary. In some dairy producing areas of the state, it is estimated that up to 90% of producers have some manure to be spread during the winter. There are still many producers in Michigan that do not have 6 months of manure storage for the milking herd. Winter surface spreading of manure comes with inherent risks of variable weather conditions, and ultimately the snow will melt, and the ground will thaw. The timing of all these weather factors is unpredictable, and the environmental consequences are potentially significant.

The risks of winter surface application can be averted. There are times and locations in the state where producers have knifed in manure all winter. Many producers report that they can inject manure through up to 4 inches of upper layer soil frost. So do not rule out injecting or incorporating manure during the winter. Although unreliable, some winter weather conditions facilitate lower risk. When winter temperatures fluctuate gradually allowing the soil to thaw briefly, manure can soak into the soil, which prevents its runoff to surface waters.

The least desirable winter conditions are when there is rapid snowmelt before the ground has the opportunity to thaw. In this instance, the snow turns to water and has two options before it can infiltrate into the soil—- either runoff or pond. These situations need to be prevented. A discharge of manure nutrients to surface waters is a violation that can be enforced by the Department of Environmental Quality (DEQ) and a circumstance, that all producers want to avoid.

The best plan of action regarding runoff and ponding from winter manure application is prevention. Winter application management begins before cold weather even arrives. Utilize the fall to consider options to minimize, prioritize, and strategize for manure applications that will occur on frozen and snow covered fields.

Minimize

Minimize the amount of manure and wastewater that needs to be hauled and spread during the winter. This can begin by assessing the farmstead and decreasing or eliminating clean water that ends up in storage or otherwise needs to be hauled. Barn roofs collect a tremendous amount of rain and snow, which is clean until it lands on a barnyard or otherwise ends

up in manure storage. Guttering roofs to divert clean water to grass areas will reduce this problem.

Reducing the outside lot area for livestock also will minimize the amount of rain and snow that becomes contaminated and ends up being hauled as manure.

Increasing storage capacity is also an option. Additional storage will not only reduce the amount of manure to handle in the winter but it will also allow more storage during the summer time when crops are growing. Additional storage provides more options for hauling when soil and weather conditions are favorable.

Maintaining freeboard is important to prevent storage systems from overflowing or breaching. Freeboard is the amount of storage that is never intended to be utilized. In general, a minimum of six inches of freeboard is required for straight-sided pits (concrete) and 12 inches is needed for sloped side-walled systems such as earthen storage structures. This freeboard PLUS the amount of a 25-year, 24-hour storm event is required at all times. The 25-year, 24-hour rain event ranges from 3.5 to 4.5 inches across Michigan. This means that the unused portion of a manure storage system should be somewhere between 9.5 to 16.5 inches, depending on circumstances, to allow for the storm event and still maintain freeboard. This freeboard should be maintained year-round, which may dictate when and how often the storage should be emptied.

Prioritize

By prioritizing fields based on level of risk associated with runoff from frozen and snow covered soil, winter spreading can be limited to fields with the least risk. Begin by figuring out how many acres are needed for wintertime spreading. This should be based on calibrated rates that deliver the appropriate nutrients per acre.

Fall is an ideal time of year to drive the perimeters of ALL fields and assess the risks each field has for wintertime spreading. First of all, know where any surface waters are and what they connect to. This can be done by drawing on your own knowledge, using soil survey maps (available free from the County Soil Conservation District) or Farm Service Agency aerial maps. These maps will be especially important when dealing with land you rent or have less knowledge of. As you drive each field, ask yourself, what would happen if manure were applied to this field and there was a rapid spring snow melt? Then ask, what could be done ahead of time to prevent or minimize risk in this situation.

Two of the most important factors in prioritizing fields for winter-time spreading are slope of the field and if there are surface waters adjacent or close enough that runoff would reach them. There is an Excel program in Michigan called the Manure Application Risk Index (MARI) that producers can utilize with or without assistance of their county Conservation District. MARI evaluates each field individually, assesses the risks, and determines a relative risk ranking for all fields. More information on MARI can be found at http://www.maeap.org/resources.htm.

There are some basic principles to follow when considering fields for winter manure application. Portions of fields that slope (especially more than 6 percent) directly to surface waters should not receive manure during the winter. Fields with slopes greater than 3 percent should receive only solid manures. Even fields with less than 3 percent slope may carry nutrient-laden water off site, potentially reaching surface waters. Surface drainage inlets represent another sensitive characteristic of some fields. Surface inlets are designed to drain water from the surface of the soil. If the water contains manure, the inlet will carry the manure to the surface water outlet. These areas of fields should be avoided during surface applications regardless of the time of year.

Strategize

Even with low risk fields, strategies need to be developed and implemented through field practices you have control over to further reduce the risk of spring-time runoff. There are several conservation and other management practices that can be part of a strategy to keep winter applied manure in the field where it belongs.

- Observe setbacks from surface waters and surface water inlets.
- Vegetated or tillage buffer strips along water courses will slow and disperse overland water flow.
- Fall tillage that leaves soils rough and better able to soak in manure may be an option for certain fields.
- Seeding a cover crop and (or) maintaining significant crop residue on the entire field will help keep the manure in place.
- Inject or incorporate manure whenever soil conditions allow.
- Reduce the rate per acre of manure applications.

As a farmer, your own knowledge of the fields and common sense are your greatest assets in identifying what fields need the most attention and in developing a plan.

Plans are of no use unless they are implemented. A key to implementing your plan for managing environmental risk associated with winter manure application is communicated with all family and farm operators. Once you have prioritized and strategized which fields will be utilized for winter spreading, be sure that the person hauling the manure is informed and aware of any areas where setbacks are needed or portions of fields that should not be spread upon at all.

Record Keeping

Another consideration is record keeping. Keeping records of field applications is not only a good idea, but necessary to receive Right to Farm Nuisance Protection and to show that you are following a Comprehensive Nutrient Management Plan – if you have one for your farm. Records also are valuable to help evaluate the effectiveness of your management practices.

Managing to prevent runoff from winter-applied manure is complicated. No single factor causes runoff and generally no set of circumstances guarantees manure won't reach surface waters. Weather changes day to day and so does the risk; reduce your risk by having a plan in place and being prepared to make day-to-day decisions on winter spreading.

Always have an emergency plan in place, for the unfortunate event of a manure release to surface waters. In such an instance, cease spreading immediately, contain the discharge if possible and report the incident to DEQ. The Michigan Department of Environmental Quality's Pollution Control hotline is: 800-292-4706 and the Michigan Department of Agriculture's spill response is 800-405-0101.

According to GAAMP

Michigan Department of Agriculture, Generally Accepted Agricultural and Management Practices (GAAMP) for Manure Management and Utilization states:

"Manures should not be applied to soils within 150 ft of surface waters or areas subject to flooding unless:

a) manures are injected or surface-applied with immediate incorporation (within 48 hr)

b) conservation practices are used to protect against runoff and erosion losses to surface waters"

"As land slopes increase from zero percent, the risk of runoff and erosion also increases, particularly for liquid manure. Adequate soil and water conservation practices should be used, which will control runoff and erosion for a particular site, taking into consideration such factors as type of manure, bedding material used, surface residue or vegetative conditions, soil type, slope, etc."

"Application of manure to frozen or snow-covered soils should be avoided, but where necessary,

a) solid manures should only be applied to areas where slopes are 6% or less

b) liquid manures should only be applied to soils where slopes are 3% or less.

In either situation, provisions must be made to control runoff and erosion with soil and water conservation practices such as vegetative buffer strips between surface waters and soils where manure is applied."

For all of the manure management GAAMPs, visit: www.michigan.gov/mda

Carbon Sequestration, What Is It in Dairy-Forage Systems?

Doo-Hong Min and Richard Leep
Dept. of Crop and Soil Sciences

Carbon sequestration is critically important to maintain tilth, enrich soils, and reduce carbon dioxide in the earth's atmosphere and is becoming a hot topic in sustainable agriculture.

1. What Is Carbon Sequestration?

Carbon sequestration is defined as a tool of storing carbon into the plants and the soil from the atmosphere. Agriculture can be a sink by sequestering carbon because crops and trees use a lot of carbon dioxide in the process of photosynthesis and store carbon in the soil over time. Carbon dioxide (CO_2) in the air is taken up by plants and incorporated into living plant matter. As the plants die or are harvested, some of the carbon-based leaves, stems, and roots decay in the soil and become a valuable organic carbon source such as humus.

2. Why Should Carbon Sequestration Be Increased?

Sequestering carbon in the soil provides for an opportunity to reduce the amount of CO_2 in the atmosphere. For example, the absence of tillage slows down the oxidation of organic matter both on the soil and in the root zone, therefore slowing the release of CO_2 back into the atmosphere. Also, no-tillage practices provide significant savings of fuel and hence lower CO_2 emissions (about 20% less carbon emissions) compared with conventional practices, because of the need for fewer field passes and lower traction requirements.

3. What Can Agricultural Producers Do to Increase Carbon Sequestration?

Reducing atmospheric CO_2 or increasing carbon sequestration can be achieved by: **1)** increasing organic carbon production (trapping carbon within plants by photosynthesis); **2)** decreasing organic carbon mineralization (managing crops and soil to reduce the conditions that break down plant residues); and, **3)** reducing soil erosion, thereby keeping carbon trapped in the soil. One of the key concepts to increase carbon sequestration is to retain the soil organic matter as much as possible. Several agricultural practices increase carbon sequestration: no-till or reduced tillage, growing cover crops, applying manure or compost, effective pasture management, buffer strips, and crop rotation.

4. What Is the Role of Soil Organic Matter in Carbon Sequestration?

Soil organic matter consists of decomposed plant and animal matter. It helps bind soil mineral particles together into clumps, called soil aggregates. Higher levels of soil organic matter leads to more stable soil aggregates, better soil infiltration capability and aeration, better water holding capacity, more resistance to wind erosion, reduced potential for soil compaction, and overall better soil fertility. Organic matter also helps hold soil nutrients in place so that they are not lost by erosion, surface runoff, or leaching. If left undisturbed, soil organic matter eventually can be transformed into long-lasting humus. However, if the soil is tilled, soil