A PROCEDURE FOR DETERMINING THE LAND AVAILABLE FOR WINTER SPREADING OF MANURE IN MICHIGAN

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Manure and Michigan Agriculture

Manure is an important resource on Michigan livestock farms. It can supply all the phosphorus (P) needed by any Michigan crop and, depending on type and amount, all of the nitrogen (N). There is the potential to pollute surface water with phosphorus, nitrogen, or organic material if applied on fields too close to streams or in the late fall on tile drained land. This procedure describes those site-specific field features to be evaluated to achieve the objectives of Michigan Right-to-Farm's (RTF) Generally Accepted Agricultural and Management) Practices (GAAMPS) for Manure Management and Utilization.

Manure collection, storage and treatment is costly. Daily hauling and spreading is the least costly method for handling manure for many livestock operations, but it is not always practical to find suitable spreading sites. Daily spreading of manure during the winter can reduce the manure storage needs of the farm, but can also contribute to non-point source pollution. Manure application, application date, and placement can not always be made to avoid any high-risk soil condition such as frozen, snow covered or saturated soils. Phosphorus is usually the limiting nutrient for developing a nutrient plan based on crop utilization and management. Long-term field research with most of the soils and crop management systems found in Michigan determines the amount of fertilizer or manure P needed for optimum crop yields.

Research has determined the most effective sources of P, timing of P application and placement methods for P fertilizers. Because of this research, successful agronomic management practices for P are available for Michigan crops.

Soil testing is the best method to determine the amount of plant available phosphorus in the soil. The Bray P1 soil test method estimates the soil P available to the crop. Michigan State University Soil Testing Laboratory uses the critical agronomic soil test levels to determine if a soil is nutrient deficient for that particular crop growth. Michigan State University Manure management sheets 1, 2, 3 and 4 (E-2344) can estimate the total available nutrients per year from a livestock operation. Also, the sheets can be used to estimate the tons of manure and pounds of N, P and K produced. These values can also be estimated using the Ohio Engineering Program for Animal Waste Management Systems. It is necessary to obtain a recent soil test (9 inches deep) to evaluate the field for winter spreading risk potential.

Manure and the Environment

Environmental concerns with nutrients in manure involve P, N, and organic material in surface water. Phosphorus from manure, contained in runoff or sediment that reaches surface water can increase **eutrophication (***defined as an increase in the fertility status of natural waters that causes accelerated growth of algae or water plants*.) In most surface waters (lakes, ponds, bays), the growth of algae or aquatic plants is limited by inadequate levels of P. Large inputs of P to surface water from non-point sources such as agricultural fields by erosion or run off can induce eutrophic conditions. This is particularly true if these fields have elevated levels of soil test P due to excessive manure

applications. Point sources of P, such as discharge from waste water treatment plants, septic systems failure, or even direct residential effluent discharge into subsurface tile drainage lines can place P into surface water and contribute to eutrophication.

Michigan State University has always supported fertilizing to meet realistic yield goals with adequate phosphorus. However, some counties in Michigan now have a high percentage of soils testing high or very high in P, and on many livestock farms, some fields, receiving manure annually, are testing above 300 lbs. available P (Bray P1) per acre. At this level, it is necessary to stop applying all sources of phosphorus including manure applications to be consistent with Right-to-Farm GAAMPS. For example, in some Michigan cropland fields and livestock farms, such as fields next to the barn, soil P levels are high enough to supply crop phosphorus for 10 years or more without any additional nutrient application.

Daily spreading of manure can contribute to non-point source pollution of surface waters, because these applications can not be timed to avoid the high risk soil conditions such as frozen, snow covered, or saturated ground. The challenge is to develop a plan to utilize the nutrients in manure and at the same time maintain agricultural profitability and environmental quality. This procedure for assessing winter spreading describes one such approach, the **Manure Application Risk Index.**

The Manure Application Risk Index

The Manure Application Risk Index is an evaluation tool that can be used to identify areas where wintertime spreading of manure may cause potential risk for runoff losses of N or P. This index uses 12 field parameters (see Table 1) for making the evaluation. Each parameter is associated with a risk for nutrients to move and be transported on the landscape. The Manure Application Risk Index assigns an individual rating to: the presence of vegetative buffers, existence of concentrated flow, the N leaching index and the rate of N applied. By either removing the risk factor or implementing appropriate management practices the index can be altered. For example: using buffer areas and spreading setbacks from the stream edge or changing the rate of N or P applied will lower the risk. By evaluating the field features on each field, this assessment method can identify the location and acreage of low, medium, and high-risk fields on a farm. Where manure production exceeds land availability, use the index to evaluate fields on other farms without livestock for their potential to serve as spreading sites. A cooperative agreement with other landowners covering sufficient land to properly utilize the manure may be necessary to sustain crop productivity levels, and avoid excessively high soil P levels. This method also can determine the manure storage needed based on the acreage available for winter spreading and the windows of opportunity for spreading.

Using the Manure Application Risk Index

The Manure Risk Index uses twelve specific field features to obtain an overall rating for each site. **There are three field features in the RTF GAAMPS that are limiting factors for winter spreading:**

1) ***Soil test P values*** *(if a soil test P is >300 lbs./ ac)***.**
2) ***Slope*** *(Application of manure to frozen or snow-covered soils should be avoided, but where necessary, (a) solid manure should only be applied to areas where slopes are six (6) percent or less and (b) liquid manure should only be applied to soils where slopes are three (3) percent 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 land where manure is applied.)*
3) ***Concentrated water flow****. (If a concentrated flow outlets into a surface water body such as a waterway,*

Watercourse, wetland, flowing stream or county drain.). Any field having any one of these three limiting factors has a very high risk of polluted effluent moving offsite; therefore, they should be the lowest priority field considered for winter spreading, if at all.

Assigned to each feature is a value rating of VERY LOW, LOW, MEDIUM or HIGH, based on the relationship between the feature and the potential for manure or P loss from a site. Each feature is assigned the appropriate rating based on field characteristics. Assigned to each feature is a *weighting factor*. Not all field features have the same influence and input because research has shown that relative differences exist in their importance to manure loss.

For example, buffer width (weighting factor = 1.5) is generally more important to manure (P) loss than the soil management group (weighting factor=1.0). Currently, these weighting factors are the professional judgment of the scientists who developed the P and manure index. The Manure Application Risk Index is based on the best scientific judgement of professionals until more field research verifies it.

Calculation of the Manure Risk Index

The current version of the Manure Application Risk Index is found in Table 2. This table, along with the Michigan Manure Application Risk Index Work Sheet is to be used in conjunction with a field visit with the farmer or farm manager. The assessment will assist the planner in determining land suitability and available for winter spreading. Also, on a particular field, the Risk Index can give planning guidance to install conservation and management practices such as buffer strips or using setbacks

First, from information gathered in the field, select a Manure Application Risk Index Rating (Value) for each field feature from the four categories: VERY LOW, LOW, MEDIUM, or HIGH. Multiply the rating value for the feature by its weighting factor to obtain the Weighted value for that feature. Sum the Weighted values for all appropriate field features to determine the Manure Application Risk Index for the field. Compare the Manure Index with Table 3 to categorize Field Vulnerability to Manure Loss. Then determine appropriate management practices for various sites based on interpretation associated with site vulnerability ratings (Table 4).

The following example illustrates the calculations used to compute the **Manure Application Risk Index** for a field. **Example Calculation:**

Field Feature	**Weight Values for Manure Risk Index**
Soil Hydrologic Group B field feature factor (low)	2 * 1.0= 2.0*
Soil Management Group 2.5c (loam) (low)	2 * 1.0 = 2.0
Per cent Slope - 1 % (v. Low)	1 * 1.0 = 1.0
Soil Test P Value 100 lb/ac (Low)	2 * 1.5 = 3.0
Concentrated Water Flow No gullies (v. low)	1 * 1.5 = 1.5
Nitrogen Leaching Index SHG Soil Hydrologic Group: B, Tile drained (low)	2 * 1.5 = 3.0
Residue, cover crops, Per. cover No tilled >40% cover (v. low)	1 * 1.0 = 1.0
Surface Water Setback (RTF) None spreads next to ditch (high)	8 * 1.0 = 8.0
Vegetative Buffer Width No buffer (high)	8 * 1.5 = 12
Manure P Application Rate 3000 gal/ac, dairy manure Liquid pit, <50 lb. P/Ac (low)	2 * 1.0 = 2.0
Manure N Application Rate 72 lb. N/Ac (low)	2 * 1.0 = 2.0
Application Method Surface applied in January, Not incorporated (v. high)	8 *1.0 = 8.0
Manure Risk Index for Field:	**45.5**

*Field feature factor (Hydrologic Group B = low =2 assigned from table 2) x weighting factor (assigned from table 1 = 1) 2 x 1 =2

The Manure Application Risk Index for this field is Medium (Table 3). There is potential for runoff to transport manure into surface water from this field. Implementation of RTF GAAMPS, such as using a grass buffer along the edge of the ditch and a setback of application 150 feet

from the edge, may reduce the risk of polluted runoff entering surface water. The implementation of these management practices and their impact on the Manure Application Risk Index follows:

Manure Application Risk Index with Buffers added:

Field Feature	**Weight Values for the Manure Risk Index**
Soil Hydrologic Group (HG) B No change	2 * 1.0 =2.0
Soil Management Group No change	2 * 1.0 =2.0
Per cent Slope No change	1 * 1.0 =1.0
Soil Test P Value No change	2 * 1.5 = 3.0
Concentrated Water Flow No change	1 * 1.5 = 1.5
Nitrogen Leaching Index HG No change	2 * 1.5 = 3.0
Residue, cover crops, Per. cover No change	1 * 1.0 = 1.0
Surface Water Setback (RTF) >150 feet surface applies manure	2 *1.0 = 2.0
Vegetative Buffer Width 66 feet wide	1 * 1.5 = 1.5
Manure P Application Rate No change	1 * 1.0 = 1.0
Manure N Application Rate No change	1 * 1.0 = 1.0
Application Method No change	8 * 1.0 = 8.0

Re-evaluated Manure Risk Index for Field: 27

The Manure Application Risk Index for this field is now Low. There is less potential for runoff to transport manure into surface water from this field. Incorporation of RTF GAAMPS, such as using a grass buffer along the edge of the ditch and staying 150 feet from the edge, reduces the risk of polluted runoff entering surface water. This lowers the Manure Application Risk Index from Medium (45.5) to Low (27).

TABLE 1 Field Features and Weighting Factors Used in the Manure Risk Index

Field Features	*Weighting Factor*
Soil Hydrologic Group	1.0
Soil Management Group	1.0
Percent Slope	1.0
Soil Test P Value	1.5
Concentrated Water Flow	1.5
Nitrogen Leaching Index for Soil Hydrologic Group	1.5
Residue/Cover Crops or Perennial Cover	1.0
Surface Water Setback (RTF)	1.0
Vegetative Buffer Width	1.5
Manure P Application Rate	1.0
Manure N Application Rate	1.0
Application Method	1.0

TABLE 2 - Michigan Manure Application Risk Index				
Field Feature Factors	***Very Low (1)***	***Low (2)***	***Medium (4)***	***High (8)***
1. Soil Hydrologic Group (1.0)	A	B	C	D
2. Soil Management Group (1.0)	5.0	2.5-4.0	1.5	0-1.0
3. Percent Slope* (1.0)	0-1.9	2-3.0	3.1-6	>6
4. Soil Test P Value (lbs. /ac)* (1.5)	Medium (<79)	High (80-149)	Very High (150-300)	Excessive (>300)
5. Concentrated Water Flow* or Surface Inlet Discharge (1.5)	Ponds in flat field or no runoff	Few No direct flow offsite into surface water	Some Enters surface water through a designed buffer	Many Ephemeral channels discharges directly into surface water, no buffer
6. Nitrogen Leaching Index for Soil Hydrologic Group (1.5)	N/A	low	medium	high
7. Residue/Cover Crops or Perennial Cover (1.0)	>40% residue good perennial grass alfalfa or cover crop	30%-39% res. fair perennial grass legume, Sm. Grain	10-29% residue poor grass legume	<10% residue fall tillage or no cover
8. Surface Water Setback (1.0)	>300 ft to edge of stream	150-299 ft. to edge of stream	<150 ft. incorporates manure	<150 ft surface applies manure does not Incorporate.
9. Vegetative Buffer Width (1.5)	>100 ft. or if not applicable to the site	66-99 ft.	20-65 ft.	<20 ft.
10. Manure Application Rate $P_2 0_5$ lbs./ac (1.0)	<30	31-60	61-99	>100
11. Manure N Application Rate lbs./ac (1.0)	<60	61-130	131-200	>200
12. Manure Application Method (1.0)	Injected	Surface applied and incorporated within 48 hr.	Surface applied and incorporated within 3 month	Surface applied and unincorporated for at least 3 months.

*RTF GAAMPS limiting factors

TABLE 3 Field Vulnerability for Manure Loss	
Manure Application Risk Index for a Field 1/	***Generalized Interpretation of Manure Application Risk Index***
< 19	VERY LOW potential for manure movement from the field. If Manure is managed, there is a low probability of an adverse impact to surface water. These fields have good potential for winter spreading.
19 - 37	LOW potential for manure movement from the field. The chance of organic material and nutrients getting into surface water exists. Buffers, setbacks, lower manure rates, cover crops, and crop residue practices alone or in combination may reduce impact. These fields have good potential for winter spreading.
38-75	MEDIUM potential for manure movement from the field. The chance of organic material and nutrients getting to surface water is likely. Buffers, setbacks, lower manure rates, cover crops, crop residues, etc. in combination may reduce impact. These fields have limited potential for winter spreading and only a partial area of the field may be acceptable.
> 75	HIGH potential for manure movement from the field and an adverse impact on surface water. Winter Spreading should not be done on these fields.

Manure Management Options Based on the Manure Application Risk Index

Minimizing non-point source pollution of surface waters by manure applied to cropland, hay land and pastureland requires management practices that control both the supply and transport of manure solids, liquids and the attached nutrients. The basic objectives of environmentally sound manure management are to maintain good soil health; utilize the available nutrients; capture available nutrients; recycle N, P and K through the crops; and store nutrients in the soil for later use by the next crop. Determining the Manure Application Risk Index for soils is the first step in this process because this prioritizes the efforts needed to develop manure utilization plans that minimize runoff and manure losses. Trapping soil and manure particles enriched with nutrients N, P, and runoff containing nutrients is best accomplished with residue management, contour farming, and vegetation in buffers. Buffers are most beneficial adjacent to streams for entrapping P enriched sediments or organic material and protecting surface water quality. Implementing Right To Farm practices such as: soil and manure testing, 150 feet surface water setbacks, and evaluating winter spreading on lower risk fields all reduces the risk of impact to the environment. The higher the initial Manure Application Risk Index the bigger the management challenge to select practices that will reduce the risk. *Manure Utilization planning is very site specific*, and requires a well-planned, coordinated effort between the farmers, certified crop advisors, soil conservationists, and other nutrient management planners.

TABLE 4

Management Options to Minimize Non-Point Source Pollution of Surface Waters by Manure.

Soil testing - Have a basic MSU soil test at least every three years to monitor build-up or decline of soil P.
Residue management - Use cover crops such as rye or oilseed radish after corn silage or other low residue crops to capture residual Nitrogen and reduce erosion and runoff.
Cover crops used with or ahead of fall manure applications will help capture nitrate N in the manure and residual nitrate - N in the soil.
Crop residues or solid manure residues can reduce runoff and erosion by 50% if 30% surface cover is maintained on the soil surface. Residues increase potential for soluble surface runoff.
Calibrate manure spreaders and take manure samples to take advantage of available P in manure. Match manure rates to crop yield goals and supplement with nutrients as needed.

Surface Water Setback - RTF GAAMPS require a minimum of 150 feet distance from the edge of a stream to lower the risk. Inject or incorporate surface applied manure within 48 hours to reduce the runoff risk.
Vegetative Buffers - RTF recommends a designed permanent buffer strip to get maximum effect. Field borders, filter strips, strip cropping, riparian forest buffers and natural vegetated stream banks are acceptable buffers, if they are the proper width, density and maintained.

Slope - Apply liquid manure to frozen soils if slopes are less than or equal to 3%; solid manure to frozen soils if slopes are less than or equal to 6%. Incorporate both types of manure to meet RTF GAAMPS and prevent polluted runoff when slopes exceed these maximums. If *slopes* exceed maximum that are allowed under RTF GAAMPs for Manure Management and Utilization on frozen soils may disqualify a field with a high risk of polluted runoff from winter spreading, lack of vegetative cover, cover crops, or crop residue.
Concentrated Flow - Grass Waterways with buffers adjacent to them will assist in reducing polluted manure runoff. If winter spread manure outlets into a surface water body such as a waterway, watercourse, wetland, flowing stream or county drain without a vegetative buffer the field should not be utilized for winter spreading.
Soil Test P - Soil test P exceed 300 lb./ac. No more additional P from manure or other nutrient sources should be applied until nutrient harvest by crops reduces P test levels to less than 300 lb./acre. There is a high risk of P loss from the field

Manure Rate - Exceeds annual P or N uptake of any crop grown in Michigan, and if available, can leach N into ground water or increase P in surface runoff.

USE OF THE MANURE APPLICATION RISK INDEX (MARI) IN THE NATURAL RESOURCES CONSERVATION SERVICE

The MARI is a planning tool that can be used in resource management plans, for water and soil quality, nutrient management and ecosystem based planning assistance in watersheds. It is intended for the planner to communicate to the land user the relative potential for manure movement in the landscape. The NRCS does not condone or promote the use of the index for placing any restrictions on land use or other regulatory purposes that could be construed by manipulating the parameters of the index.

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MICHIGAN MANURE APPLICATION RISK INDEX WORKSHEET

Farm:		Date:	
Township		Tract(s)	

Field #										
Acres										
Field Features										
I SOIL (Map Symbol)										
1. Soil Hydrologic Group (1.0)										
2. Soil Management. Group (1.0)										
3. Per cent slope (1.0)										
II. WATER QUALITY										
4. Soil test P Value (lbs /ac) (1.5)										
5. Concentrated Water Flow or										
Surface Inlet Discharge (1.5)										
6. Nitrogen Leaching Index for										
Soil Hydrologic Group (1.5)										
III. SURFACE COVER										
7. Residue Cover/Cover Crops (1.0)										
8 Surface Water Setback (1.0)										
9. Vegetative Buffer Width (1.5)										
IV. MANURE										
10. Manure P application rate (1.0)										
11. Manure N application rate (1.0)										
12. Manure application method (1.0)										
Field Features Index Totals										
v. low risk (acres) <19										
Low risk (acres) 19 - 37										
Medium risk (acres) 38-75										
High risk (acres) >75										

FIELD FEATURE DEFINITIONS

1. **Soil Hydrologic Group** - A group of soils having similar runoff potential under similar storm and cover conditions. (NRCS FOTG Section II, Soils Database or NRCS EFM, Chapter 2, Soil Survey)

2. **Soil Management Group** - An alpha -numeric system used by MSU Crops and Soil Scientists to group soil series according to the dominant texture of the profile and natural drainage conditions. (NRCS FOTG Section II, Cropland Interpretations, Soil Survey Definitions or MSU Bulletin E-1262)

3. **Percent Slope** - Average percent of slope for the field landscape. (NRCS-Soil Survey, on site visit).

4. **Soil Test P Value** - Soil test phosphorus value based on Bray P1 soil test analysis taken at a depth of 9". (Soil Test, MSUE County Average P Value)

5. **Concentrated Water Flow or Surface Inlet Discharge** - Is there a direct flow of surface runoff water when it rains or during snowmelt via concentrated flow (through a waterway or ephemeral gully) or pond area above a surface inlet through a tile drainage system? (On site visit)

6. **Nitrogen Leaching Index** - Based on high, medium or low risk. It is the average annual water amount (in inches) expected to leach below the root zone with the potential of carrying soluble nutrients. (NRCS FOTG Section II) and Soil Hydrologic Group databases.

7. **Residue Cover/Cover Crops** - Residue cover over winter depends on tillage method, manure type, crop residue cover crops, CRP cover or hay in field. All will reduce runoff depending on kind and amount. (On site visit)

8. **Surface Water Setback** - The distance from the field border to the edge of the stream or surface water body receiving runoff from the field. (On site visit)

9. **Buffer Width** -Width of the vegetation adjacent to the surface water body to be protected. (on site visit or planned)

   Vegetative Buffers -are strips or small areas of land in permanent vegetation. Conservation buffers help control potential pollutants and manage other environmental concerns. Filter strips, field borders, grassed waterways/vegetative filters, shelter belts, riparian buffers and cross wind trap strips (streamside) buffers are all examples of conservation buffers.

10./11. **Manure Rate of P, Rate of N** - Based on the type, amount and kind of manure applied, the amount of P (Phosphorus) pounds per acre and the amount of N (Nitrogen) pounds applied per acre. (On Site Manure Application) Should include all sources of these two nutrients.

12. **Manure Application Method** - How the manure is applied to the land. Suggested symbols for method of application:
   DI - Direct Inject - Manure injected below the land level while applying.
   SI - Surface applied and incorporated - Manure broadcast applied on the land and worked in as soon as possible <(48 hours) after application.
   S<3 - Surface < 3 months - Manure broadcast applied and left on the surface, but incorporated with tillage within 90 days of application.
   S>3 - Surface > 3 months - Manure broadcast and left on the surface, but later incorporated or never incorporated greater than 90 days after application.