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HELPING YOUR LIVESTOCK CLIENTS MEET DNR'S NEW MMP AND PHOSPHORUS REQUIREMENTS

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The DNR recently revised its manure management plan (MMP) content requirements to implement the phosphorus (P) index for determination of application rates as required by Iowa law. This presentation will help you assist your clients who are required by state law to have an MMP-confine animal feeding operations with more than 500 animal units.

The P index will be phased in over time as indicated in Table 1 below. This implementation schedule will allow most producers four years to prepare for the P index-based MMP. Those producers who have four years can plan ahead. By running the P index on their fields before it is required they can determine exactly what the impact will be on their operation and anticipate any changes that might need to be made. By planning ahead, the switch from a nitrogen (N)-based to P index-based plan can be an easy one.

Table 1. Implementation dates for P index-based plans

<table>
<thead>
<tr>
<th>Implementation Date for P index-Based Plans</th>
<th>Original MMP Submitted</th>
<th>P index- Based MMP Update Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior to April 1, 2002</td>
<td>First update after August 25, 2008</td>
<td></td>
</tr>
<tr>
<td>Between April 1, 2002 and October 24, 2004</td>
<td>First update after August 25, 2006</td>
<td></td>
</tr>
<tr>
<td>On and after October 25, 2004</td>
<td>Upon submittal</td>
<td></td>
</tr>
</tbody>
</table>

† An original plan is required if you are a new owner or if you are constructing, expanding or modifying a confinement feeding operation that will be more than 500 au.

This change to manure plans based on a P index is not unique to Iowa. Changes to the Environmental Protection Agency's regulations governing concentrated animal feeding operations (CAFOs), require that all CAFOs have a nutrient management plan. This nutrient management plan must include a field-specific risk assessment to determine if manure nutrients should be applied at an N- or P-based application rate or if no manure application is appropriate. The P index is typically considered the most flexible assessment method, because it considers factors other than soil P, such as erosion, which can be reduced by management changes to reduce the risk of P loss from a field.

In the past, MMPs have been developed based on the N needs of crops (N-based rates). Due to the typical N-to-P ratio in manure, N-based manure management often results in over application of P. Over time N-based plans can increase soil P concentrations to well above levels needed for crop production. This can become a water quality issue as research in Iowa has shown that when soil P levels increase, P concentrations in surface runoff also increase (Klatt et al., 2002). However, fields with high soil P concentrations are not necessarily a risk to water quality if the P is not leaving the field. The P index was designed to consider erosion, surface runoff and subsurface drainage, along with the soil P concentration to determine the risk of P leaving the field.

The remainder of this paper will provide information about the DNR's new requirements for
implementing the P index in MMPs.

**Developing a P index-Based MMP**

The P index was designed for use on a field or a conservation management unit. Therefore, one of the first steps of developing an MMP based on the P index will likely be defining the fields. When defining fields for running the P index, the following apply:

- Fields must be contiguous and;
- Fields can’t be divided by a watersource or a public thoroughfare.

Watersource means a lake, river, reservoir, creek, stream, ditch, or other body of water or channel having definite banks and a bed with water flow. A water source does not include lakes or ponds without an outlet where only one landowner owns the surrounding property. A public thoroughfare is defined as a road, street, or bridge that is constructed or maintained by the state or a political subdivision.

When defining fields, define them as large as possible when first running the P index. That is, use the largest possible area that is contiguous and managed the same. For example, if a field is in a corn/soybean rotation, with half the field in corn and half in soybeans, consider this one field for running the P index. This will minimize the number of times the P index needs to be run. Fields can be split into smaller units if the results of the P index are higher than desired.

After defining fields for the MMP, the information necessary to run the P index will have to be gathered. The two most important inputs needed are soil P information and results of the revised universal soil loss equation (RUSLE2). The DNR has specific requirements for soil samples taken for an MMP.

**Soil Sampling**

Soil samples can be taken for the MMP by any credible sampling method. For example, grid sampling, sampling by soil type or elevation, or sampling by designated management zones within a field. Two soil sampling publications that are good sources of information are listed below. Both of these publications are available on-line.

- Iowa State University extension publication Pm-287 “Take a good soil sample to help make good decisions” available on-line at: http://www.extension.iastate.edu/Publications/PM287.pdf

Regardless of what sampling method is used, there are minimum requirements that must be met. Specifically,

- Soil samples must be taken for P and pH at least once every 4 years
- One sample must taken for every 10 acres (for fields less than 15 acres, only 1 sample is necessary)
- Each soil sample must consist of a composite of ten cores, six inches deep.

The P index requires agronomic soil samples, so these samples can also be used for making nutrient and lime recommendations. While the rule requires a sample for every 10 acres, soil-sampling requirements are reduced if P based rates are used under certain conditions (see Applying Phosphorus Based Rate section of this paper).

Soil samples that are 4 years old or less can be used for development of an MMP if they meet the above requirements. Therefore, producers who don’t need to complete a P index based MMP for two or four years could begin to soil sample for the MMP next year and could use those soil samples for developing the MMP when it was due (in 2-4 years).

For original MMPs, soil samples that do not meet the above requirements can be used if they are 4 years old or less. However, in this case, soil samples that do meet the requirements must be taken no more than 1 year after the MMP is approved.

Soil samples with a pH greater than 7.4 should not use results of the Bray-1 P soil test, as it does not provide an accurate measurement of available soil P under calcareous conditions. If the Bray-1 P test is used and the pH is greater than 7.4 in one or two samples in a field, do not include these samples in the field average for the P index. If the majority of samples have a pH > 7.4, use the Olson or Mehlich-3 soil test when samples are taken again.

Laboratories that analyze soil samples for the MMP must be enrolled in the Iowa Department of Agriculture and Land Stewardship soil testing certification program. A list of certified labs can be found at http://www.agriculture.state.ia.us/certlabs.htm. Keep the soil sampling results with the other MMP records.

**Running RUSLE2**

The RUSLE2 value is an estimate of sheet and rill erosion that is necessary to run the index. The RUSLE2 program is available for download on the Internet at http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm.

When using RUSLE2, one of the necessary inputs is soil type. When choosing the soil type for RUSLE2, use the most erosive soil type that comprises greater than 10% of the total field area. This will ensure that the RUSLE2 results will represent the dominant soil type in terms of erosion potential, which may not be the dominant soil on the landscape. See NRCS Technical Note 29, “Choosing the planning area of a field by dominant critical area” for more information about selecting a soil type and other inputs to RUSLE2.

Other inputs to RUSLE2 include slope length and slope grade. When determining these inputs, either the actual measurements or default values can be used when running RUSLE2 for the MMP. The NRCS Technical Note 29 provides information on measuring slope length and slope grade if actual measurements will be used. Default values can be obtained from the Section II of the electronic field office technical guide (http://www.nrcs.usda.gov/technical/efotg/).

Results of the RUSLE2 runs for each field should be reported with the RUSLE2 erosion calculation record, which is a reporting mechanism within the RUSLE2 software. Indicate the field designation on the RUSLE2 erosion calculation record as it is in the MMP and keep the
reports with the MMP.

**Using the P index**

The excel calculator of the Iowa P index provides a user-friendly spreadsheet that will calculate the P index with the proper inputs.

When reporting results for the MMP, use the detailed report provided in the excel spreadsheet calculator. Under “field number” in the detailed report, use the field designation from the MMP. List all fields and P index results on the same detailed report and include this report in the MMP.

For more information about the P index, see [http://www.ia.nrcs.usda.gov/technical/Phosphorus/phosphorusstandard.html](http://www.ia.nrcs.usda.gov/technical/Phosphorus/phosphorusstandard.html) for the P index calculator and Iowa Technical Note No. 25, which describes how to use the P index. Additionally, a paper written by Mallarino et al. (2002) provides more detail about how the index was developed and the supporting research used to derive the equations.

**Application Rate Requirements**

Once the P index has been run for all fields, the results must be interpreted. Running the P index results in a number that will fall into one of five risk categories (Very Low, Low, Medium, High, and Very High). Depending on the results of the P index, producers will need to use the application rates on each field that fits its P index risk category. The results of the P index may indicate that continued N based management is appropriate or may require that P based rates be used. The following application rates should be used:

1. **Very Low (0-1)**. Apply manure at or below N based rates.
2. **Low (>1-2)**. Apply manure at or below N based rates.
3. **Medium (>2-5)**. Manure may be applied at an N-based rate if current or planned soil conservation and phosphorus management practices predict the rating of the field to be 5 or less for the next determination of the phosphorus index. However, manure application can’t result in P application in excess of two times the P removed with crop harvest over the period of the crop rotation.
4. **High (>5-15)**. Manure cannot be applied until practices are adopted which reduce the P index to at least the Medium risk category. However, prior to December 31, 2008, fields with a P index between 5 and 10 may receive manure at a P-based rate if practices will be adopted to reduce the P index to the Medium risk category.
5. **Very High (>15)**. Manure may not be applied on a field with a rating greater than 15.

For exact language and requirements, see the Iowa Administrative Code 65.17(17) “f”. This rule is available on-line at: [http://www.legis.state.ia.us/Rules/Current/iac/567iac/56765/56765.pdf](http://www.legis.state.ia.us/Rules/Current/iac/567iac/56765/56765.pdf).

**Very Low and Low Risk Categories**

The Very Low and Low P index risk categories have the same application rate requirement, which is manure application cannot exceed the N-based rate. The amount of P applied with the N-based
application rate does not need to be considered in these categories. Therefore, application rates for the Very Low and Low categories can be determined identically to rates in the MMPs before the P index was implemented. However, the impact that manure applications will have on soil P should be considered, because drastically over applying P will eventually increase the P index to the Medium category.

Medium Risk Category

The language in the Medium category specifies that N-based rates can be applied “if current or planned soil conservation and phosphorus management practices” will not result with the field being in the high category the next time the P index is run on the field. Therefore, N-based applications can continue if practices are not changed to increase the P index to the high category. If practices change on a field, the P index should be run again to ensure that the field is still in the Medium category.

Additionally in the Medium category, manure cannot be applied in excess of two times the P removal rate over the period of the crop rotation. Therefore, the amount of P being applied with the manure applications must be considered when developing the MMP for fields in the Medium category. For example, for a corn/soybean rotation, if a corn crop removes 60 lbs P\textsubscript{2}O\textsubscript{5}/acre and a bean crop removes 40 lbs P\textsubscript{2}O\textsubscript{5}/acre, then the rotation removes 100 lbs P\textsubscript{2}O\textsubscript{5}/acre. Therefore, in a corn/soybean rotation, a maximum of 200 lbs P\textsubscript{2}O\textsubscript{5}/acre of manure can be applied over the two-year rotation. This is two times the P removal of the rotation.

In general, if manure is applied at N-based rates on the same fields every year, this will likely exceed two times the P removal rate. For fields that receive manure every other year, these fields will likely be receiving P at less than two times the P removal rate and therefore would not be affected by this restriction.

High and Very High Risk Categories

In the high category between >5 and 10, producers can apply manure at a P-based rate until December 31, 2008 if practices will be adopted to reduce the P index to the Medium category. Therefore, until December 31, 2008, fields with a P index between 5 and 10 can continue to receive manure, however, after this date, producers can no longer apply manure to a field with a P index greater than five.

If a field is in the high or very high categories (P index >5), you should probably advise producers that the field is having an impact on water quality and that adopting additional soil conservation practices could reduce the P index to the Medium category and allow them to continue manure application.

Applying Phosphorus Based Rates

Many producers who need an MMP may be interested in P-based rates due to the reduced soil sampling requirements for a P-based plan. If P-based rates are adopted between soil sampling periods on fields with Very Low, Low or Medium P index ratings, then soil-sampling requirements are reduced from one sample for every 10 acres to one sample for every 20 acres. So initially, soil samples must be taken at a density of one sample per 10 acres, however, if the fields receive
P-based rates after soil sampling, then the next time the fields must be soil sampled, they can be sampled at a density of one sample per 20 acres.

Applying manure at a P-based rate will replace the P removed from the field with harvest or will determine application rates based on the results of a P soil test. Producers can apply up to four years of P in a single application, if the N based rate is not exceeded for the crop receiving the application. No additional P can be applied for the period covered by the application.

This provides considerable flexibility when planning manure application rates, and a P-based rate may not be much different than a rate based on the N needs of the crop. The frequency of manure application on a given field is often more of an issue than the application rate. For instance, with liquid swine manure, N-based manure application every other year in a corn-soybean rotation is often very close to a P based rate. Table 2 illustrates P-based rates for a corn/soybean rotation using Iowa State University standard table values for manure and yields of 160 and 50 bu/acre, respectively.

Table 2 indicates that the pounds of N that would be applied with a P-based rate ranges from 98 to 142 lbs N/acre with liquid swine manure. The 142 lbs N/acre is the maximum N rate for the MMP in this example (using 1.2 lbs N/bu). Therefore, depending on the phase of production, a P based rate with liquid swine manure may supply most or all of the N that can be applied to a corn crop. Not applying manure for the soybean crop in a corn/soybean rotation makes a P based rate achievable.

**Table 2.** Phosphorus-based rates using standard table values and a corn/soybean rotation.

<table>
<thead>
<tr>
<th>Management System†</th>
<th>N</th>
<th>P₂O₅</th>
<th>P-based application rate</th>
<th>P₂O₅ Applied</th>
<th>Available N Applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grow/finish</td>
<td>50</td>
<td>42</td>
<td>2400</td>
<td>100</td>
<td>118</td>
</tr>
<tr>
<td>Grow/finish (W/D)</td>
<td>58</td>
<td>40</td>
<td>2500</td>
<td>100</td>
<td>142</td>
</tr>
<tr>
<td>Grow/finish (earthen)</td>
<td>32</td>
<td>22</td>
<td>4500</td>
<td>100</td>
<td>141</td>
</tr>
<tr>
<td>Wean/finish</td>
<td>49</td>
<td>40</td>
<td>2500</td>
<td>100</td>
<td>120</td>
</tr>
<tr>
<td>Wean/finish (W/D)</td>
<td>56</td>
<td>38</td>
<td>2600</td>
<td>100</td>
<td>142</td>
</tr>
<tr>
<td>Sow and Litter</td>
<td>25</td>
<td>20</td>
<td>5000</td>
<td>100</td>
<td>123</td>
</tr>
<tr>
<td>Farrow-nursery</td>
<td>27</td>
<td>23</td>
<td>4300</td>
<td>100</td>
<td>114</td>
</tr>
<tr>
<td>Nursery</td>
<td>35</td>
<td>20</td>
<td>4100</td>
<td>82</td>
<td>142</td>
</tr>
<tr>
<td>Gestation</td>
<td>25</td>
<td>25</td>
<td>4000</td>
<td>100</td>
<td>98</td>
</tr>
<tr>
<td>Farrow-finish</td>
<td>44</td>
<td>32</td>
<td>3100</td>
<td>100</td>
<td>134</td>
</tr>
<tr>
<td>Poultry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Layer</td>
<td>35</td>
<td>80</td>
<td>2.5</td>
<td>200</td>
<td>54</td>
</tr>
<tr>
<td>Broiler</td>
<td>65</td>
<td>65</td>
<td>3.0</td>
<td>200</td>
<td>120</td>
</tr>
<tr>
<td>Turkey</td>
<td>40</td>
<td>40</td>
<td>5.0</td>
<td>200</td>
<td>124</td>
</tr>
</tbody>
</table>

† Assumed injection of liquid swine manure, and incorporation within 24 hours of poultry manure. First year N availability of liquid swine manure considered 100%. First year N availability of poultry manure of 65%. Assumes no application for remainder of crop schedule.

‡ (W/D) Wet/dry feeder
Due to the high concentration of P in poultry manure, it may be necessary to apply P-based rates of poultry manure on a three- or four-year crop schedule. Using the same yields, if poultry manure were applied for two cycles of a corn/soybean rotation in a single application, 200 lbs \( P_2O_5 \)/acre could be applied (100 lbs \( P_2O_5 \)/acre per rotation cycle). Taking the first year N availability of poultry manure into consideration (65%), manure application rates of poultry manure in Table 2 range from 2.5 to 5 ton/acre. The available N applied with poultry manure in this example ranges from 54 to 124 lbs N/acre.

One approach for making a P-based manure rate more achievable is to reduce the amount of P in the manure. Use of phytase has been shown to significantly reduce the P in manure and usually brings the N:P ratio of the manure closer to that of a corn crop. McMullen and Karsten (2001) found a 23% reduction in P in liquid manure from finishing pigs fed phytase in an Iowa study. Reduction of P concentration in the manure would be particularly beneficial if manure was being applied at an N-based rate on the same fields every year, as this is a practice that typically increases soil P levels. A lower P concentration in manure would also be beneficial where soil P levels are excessive, as this might stop the increase of soil P levels over time on these fields.

Reducing the P index Value of a Field

If a field has a higher P index risk than is desired, there are a couple ways to reduce the P index. One is through implementation of additional conservation practices. If erosion is the primary cause of the high P index, then soil conservation practices, such as reduced tillage, filter strips, grassed waterways, terraces, changing the crop rotation, contouring, or any other practice that reduces erosion or sediment delivery also reduces the P index. If practices are adopted, the P index should be reevaluated on the field, and application rates should be based on the new results.

Another option would be to split the field. Because relatively small areas are typically responsible for most P loss from a field, identifying and isolating the area that is causing the P index to be high and running the P index separately for that area is an option. This should result in a higher P index for that high-risk area and a lower P index for the rest of the field. If this is done, the two areas should be clearly marked on a map in the MMP and manure should be applied according to their respective P index results.

Conclusions

Implementing the P index into MMPs will be a challenge for producers, consultants, and agency staff. However, the phased in implementation period will provide the time needed to make the adjustment easier. By running the P index in advance of when it is required, producers and consultants can determine which fields may have a high P index and determine the best approach for reducing the P risk category if necessary. An assessment of the amount of P being applied with current manure application rates would also be beneficial to determine if over-application of P will likely increase soil P concentrations and the P index in the future. While N-based manure management will likely be continued on most fields, P-based application should be considered as a possible alternative. By switching to P-based rates, soil-sampling requirements are reduced for an MMP and soil P levels and the P index will be stabilized.
References


