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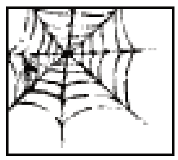

EPA promulgated regulations for Concentrated Animal Feeding Operations (CAFOs) in February 12, 2003 that expanded the number of operations covered by the CAFO regulations and included requirements to address the land application of manure from CAFOs. The rule became effective on April 14, 2003. NPDES-authorized states were required to modify their programs by February 2005 and develop state technical standards for nutrient management. On February 28, 2005, in response to litigation brought by various organizations, the Second Circuit court issued its decision in *Waterkeeper Alliance et al. v. EPA*, 399 F.3d 486 (2d Cir. 2005). EPA has updated the CAFO rule to reflect the changes requested by the Court. Visit www.epa.gov/npdes/caforule to view the 2008 CAFO Final Rule and supporting documents.

CHAPTER 6: DEVELOPING AND USING TECHNICAL STANDARDS FOR THE LAND APPLICATION OF MANURE, LITTER, AND PROCESS WASTEWATER

The CAFO effluent guidelines require Large CAFOs to develop and use site-specific nutrient application practices that are in compliance with the technical standards for nutrient management established by their permitting authority. Permitting authorities establish technical standards to minimize phosphorus and nitrogen transport to surface water. The effluent guidelines call for technical standards that establish methods and criteria for determining application rates that balance the nutrient needs of crops with the potential adverse impacts on water quality.

This chapter provides guidance on how permitting authorities may establish technical standards and other land application considerations. This chapter also presents *Manure Management Planner* as a resource for Nutrient Management Plan (NMP) development, some example calculations for determining land application rates, and NMP case studies using *Manure Management Planner*.

A. Developing Technical Standards for Land Application

Technical standards for the land application of manure, litter, and/or process wastewater must include a field-specific assessment of the potential for nitrogen and phosphorus transport from the field to waters of the U.S. In addition, the standards must address the form, source, amount, timing, and method of application of nutrients on each field to achieve realistic production goals, while minimizing nitrogen and phosphorus movement to waters of the U.S. To develop technical standards for land application, permitting authorities may use the NRCS *Nutrient Management Conservation Practice Standard*, Code 590, (see Section A.4 of this chapter) or other appropriate technical standards as guidance. It should be noted, however, that consistency with NRCS Code 590 may not by itself ensure compliance with the regulatory requirements for technical standards for nutrient management (see 40 CFR 123.36)

1. <u>EPA Recommended Technical Standards and Policies</u>

EPA has developed a “National Nutrient Management Technical Standard” to guide the permit authority (regions and states) in developing and using technical standards. The “National Nutrient Management Technical Standard” is provided in Appendix O. The purposes of the technical standards are to enable agricultural users of nutrients to:

- Minimize pollution of surface and ground water resources from agricultural nutrient sources;
- Budget and supply nutrients for plant production;
- Properly use manure, litter, process wastewater, and/or other organic by-products as a plant nutrient source;

> **Nutrient Management Definition**
>
> Planned process to protect water quality by managing the amount, source, placement, form, and timing of agricultural wastes and soil amendments utilized for the production of crop, forage, fiber, and forest products. It is supplying essential nutrients in adequate amounts to balance and maintain the soil for healthy biology and quality plants while avoiding conditions inimical to the ecosystem.

- Maintain or improve the physical, chemical, and biological condition of the soil; and
- Prevent or reduce excess nutrient concentrations in the soil.

This chapter describes how the content of NMPs are based on the technical standards, including the field risk assessment, determination of land management units, nutrient application rate development, nutrient application timing and methods, areas of special consideration, and operation and maintenance practices. This chapter also provides additional recommendations for sampling (e.g., soil, plant tissue, manure and process wastewater) and guidelines for laboratory analyses.

The Field Risk Assessment

CAFOs must perform field-specific risk assessments to determine whether manure nutrients should be applied at a nitrogen or phosphorus application rate, or whether land application should be avoided under state technical standards. CAFOs must use the state-approved method. Currently, most states have adopted one of the three field risk assessments defined in the NRCS *Nutrient Management* standards. The three field risk assessments defined in the NRCS *Nutrient Management* standards are: 1) Phosphorus Index; 2) Soil Phosphorus Threshold Level; and 3) Soil Test Phosphorus Level.

In some instances phosphorus levels in soils are so high, or site-specific conditions (e.g., highly erodible soils) are such that any application of manure, litter, or process wastewaters would be inconsistent with appropriate agricultural utilization of nutrients. Such instances would lead to excessive levels of nutrients and other pollutants in runoff. EPA expects that these factors will be taken into account as state permitting authorities develop appropriate technical standards for the land application of manure by CAFOs.

To reduce a field-specific risk, CAFOs may apply conservation practices, best management practices, or management activities to their land application areas to reduce nutrient transport to surface waters. For example, a CAFO may be able to implement the conservation plan components of a CNMP to a field to reduce the field's risk rating, often resulting in increased flexibility to land apply manure.

Responsibilities

The CAFO rules require the permit authority to develop the technical standards for nutrient management. Large CAFOs have, under their permits, a responsibility to develop their NMP to meet the state technical standards and other requirements.

In developing NPDES permits, permit writers use the effluent guidelines, NPDES CAFO rule, and the technical standards for nutrient management. Development of the NPDES permit and how technical standards affect permits is discussed in EPA's *NPDES Permit Writer's Guidance Manual and Example NPDES Permit for Concentrated Animal Feeding Operations* (EPA-833-B-04-001). The NPDES regulations provide that the permitting authority must establish technical standards for nutrient management that are consistent with the requirements in 40 CFR 412.4(c)(2) (also see 40 CFR 123.36). The permitting authority must include in the technical standard, at a minimum, the methodologies necessary to address the following components of a NMP:

- Field-specific assessment of the potential for nitrogen and phosphorus transport from the field to waters of the U.S.;

- Form, source, amount, timing, and method of application of nutrients on each field to achieve realistic production goals, while minimizing nitrogen and phosphorus movement to waters of the U.S.; and

- Appropriate flexibility for CAFOs to implement the standard (e.g., multi-year phosphorus banking, 40 CFR 412.4(c)(2)(ii)).

EPA strongly encourages states to address water quality protection issues when establishing technical standards (i.e., appropriate land application practices). EPA expects that state and Tribal technical standards for nutrient management will be developed collaboratively among the respective state departments of agriculture, Tribes, NRCS state conservationists, state Land Grant Universities, and NPDES permitting authorities.

Coordination/Communication to Develop Technical Standards and NMPs

EPA expects that permitting authorities will provide guidance to CAFOs on how to implement the state technical standards, in coordination with their state agricultural agency partners. In addition, EPA believes that a well-prepared Comprehensive Nutrient Management Plan (CNMP) prepared in accordance with the CNMP Technical Guidance issued by USDA's NRCS should in most instances help the CAFO meet the NMP and minimum practice requirements of the permit, including the requirement to comply with the state technical standards (although whether a CNMP is adequate to meet these requirements is ultimately judged on a case-by-case basis).

CAFO owners and operators should seek technical assistance for developing NMPs from integrators, industry associations, and private consultants. In addition, federal agencies, such as the NRCS, as well as state and Tribal agricultural and conservation agency staff, Cooperative Extension Service agents and specialists, Soil and Water Conservation Districts, and Land Grant Universities may be able to provide technical assistance. A number of computer-based tools are being developed to facilitate the development and implementation of NMPs. For example, see *CNMP Watch* at http://www.cnmpwatch.com/ , a web site of the National Association of State Departments of Agriculture (NASDA) Research Foundation, for an update on nutrient management planning.

Nutrient Management Planning Tools

Many states, universities, and private sector companies have developed nutrient management tools that can be used (generally within a specific state) to assist livestock and poultry producers develop site-specific nutrient management plans. One example of such tools is *Manure Management Planner (MMP*), developed at Purdue University. This is a manure utilization planning tool to help develop nutrient management plans. Access MMP at http://www.agry.purdue.edu/mmp/.

NMPs are complex documents that require knowledge in a number of different areas. Therefore, CAFO personnel should undergo general nutrient management training to understand plan components and to successfully implement the plan. Free training, which lasts between one and four days, is often available from state agricultural Cooperative Extension Offices.

The CAFO rules do not require the use of a certified specialist to develop a NMP; however, EPA encourages CAFOs to use certified planners with expertise to develop, modify, or review their NMPs. See Chapter 4 of this document for more information.

2. Factors for Developing Technical Standards

Technical standards should be developed to consider various factors for CAFOs, such as site-specific production data, watershed and jurisdictional boundaries, local environmental issues, and climate and natural resources. Permitting authorities should develop land application technical standards to address the types of crops grown, number of animals at the CAFO, nutrient concentrations in the manure, and other nutrient sources.

CAFOs may be subject to multiple technical standards if located near watershed or jurisdictional boundaries. For example, the permitting authority may develop stricter technical standards for an impaired water body. CAFOs should work with their permitting authority to determine the applicable technical standards.

Different regions of the country may need to review specific environmental issues for their area. States may develop different technical standards for urbanized vs. rural areas. Stricter technical standards may be applied to CAFOs located near impaired watersheds (e.g., the Chesapeake Bay, Gulf of Mexico).

The climate and natural resources of an area directly affect the land application of manure, litter, and process wastewater. When permitting authorities develop the technical standards (and when CAFOs develop their NMP), factors they should consider include type of soil, air quality issues that may affect management practices, and health issues (e.g., high levels of heavy metals or pathogens in the manure). For example, CAFOs located west of the Mississippi River tend to have water deficient and calcareous soils, while CAFOs located east of the Mississippi River tend to have water excess and acidic soils.

3. NRCS Standards and NMPs

Many technical standards for nutrient management have already been developed as part of implementing USDA's National Nutrient Management policy. NRCS developed a national *Nutrient Management Conservation Practice Standard* (Code 590) that serves as a basis for each state NRCS office to develop its own tailored standard. Almost all States have developed a Phosphorus Index as part of their states' *Nutrient Management Conservation Practice Standard* (Code 590). EPA expects that in most cases States have relied or will rely on these NRCS standards to form the basis for the technical standards established by the permitting authority.

The USDA's CNMP guidance contains six key elements: 1) manure and wastewater handling and storage; 2) nutrient management; 3) land treatment practices; 4) recordkeeping; 5) feed management; and 6) other manure and wastewater use options. As discussed in Chapter 4 of this document, EPA endorses the CNMP approach but cautions CAFOs that following USDA's CNMP Guidance does not guarantee that a CAFO's CNMP will adequately address all of the minimum elements that are required by the regulations for a nutrient management plan.

See the *Permit Writers Guidance* for a comparison of USDA's CNMP six elements and EPA's minimum measures.

The NRCS web site provides technical guidance to develop NMPs including a national template at http://www.nrcs.usda.gov/technical/references/. NRCS and EPA permitting authorities may have different definitions and requirements for nutrient management plans. Therefore, to meet the requirements for a NMP that complies with state technical standards, CAFOs may need to modify the elements of current NMPs or NMPs developed using NRCS standards. Appendix C includes a checklist that CAFOs may use to help ensure all requirements have been addressed in the NMP.

4. Example National Nutrient Management Technical Standards for Land Application

EPA has developed a "National Nutrient Management Technical Standard," set forth in Appendix O. EPA intends to apply this example technical standard in states where EPA is the permitting authority. States may use this technical standard as guidance in developing state technical standards for land application.

In those States where EPA is the permitting authority and required to establish the technical standards for nutrient management, this guidance recommends the use of the EPA Example Technical Standard in conjunction with the State's conservation practice for nutrient management (590) for this purpose. Upon review of the State's 590, any missing items required by the CAFO rules must be included in the terms and conditions of the NPDES permit.

5. Appropriate Flexibility in Applying Technical Standards

State regulations (including technical standards) may be more restrictive than the federal CAFO regulations. For example, the state may establish the specific conditions and criteria applicable to winter spreading of manure.

The permitting authority and CAFO should look at the appropriateness of certain requirements in the technical standards in how they apply at that site. Examples include practicality of manure, litter, and process wastewater storage, allocation, and application; equipment calibration and limitations; accessibility of records (e.g., feed management component of NMP with integrator-supplied feed); and available data (e.g., crop, soil, or feed information). In

Example State Technical Standards for Winter Applications

When frozen soils prevent effective incorporation of nutrients at the time of application do not apply nutrients:
(a) within Surface Water Quality Management Areas (1,000 feet of lakes, or within 300 feet of perennial streams). Identify perennial streams using the NRCS soil survey and/or USGS 1:24,000 scale topographic map.
(b) within 200 feet upslope of wells, sinkholes, fractured bedrock at the surface, or gravel pits identified by the planner.
(c) on slopes greater than 9%, except for manure on slopes up to 12% with concentrated flow channels maintained in permanent vegetative cover. Slopes from 9% to 12% must be either contour stripcropped with alternate strips in perennial forage or contour farmed where all of the residue from the previous corn crop (harvested for grain) remains on the soil surface. Areas that do not contribute runoff to surface water or groundwater conduits may be exempted based on an in-field evaluation. Do not apply any nutrients on slopes greater than 12%.

developing the technical standards, the permitting authority shall also include appropriate flexibility for any CAFO to implement nutrient management practices to comply with the technical standards, as described above.

B. Example Rate Calculations

Large CAFOs must use the technical standards developed by the permitting authority to write a NMP. Chapter 4 of this manual discusses the aspects of the NMP in more detail. This section provides examples for calculating application rates. To properly manage manure, litter, and process wastewater, CAFOs must determine amount of manure produced, manure composition, nutrient requirements for crops, and the appropriate application rate (nitrogen-based or phosphorus-based). Throughout this section, an example dairy farm will be used to demonstrate the calculations. These examples are for illustrative purposes only.

1. Manure Production and Composition

To develop appropriate manure application rates, CAFOs must estimate the amount and composition of manure, litter, and process wastewater available for land application. The amount of manure generated at a CAFO is directly linked to the number of animals maintained. However, because the composition of manure changes as it ages, the amount collected and applied to the land is often much less than the amount generated by the animals. Therefore, CAFOs should estimate the amount of manure that will be available for land application by calculating the volume of manure, litter, and process wastewater stored on site and/or by calculating the quantity of manure removed during cleaning times.

Because the nutrient content of manure depends on many site-specific practices, CAFOs may **NOT** use book values of manure to develop NMPs. CAFOs must sample the site manure at least annually and should send the samples to an accredited laboratory for analyses of at least total nitrogen (N) and phosphorus (P). Because it is a primary essential element for plant growth, CAFOs should also sample for potassium (K). See Chapter 4, Section A.2 and Appendix E of this manual for further details on manure sampling.

Example: Calculations for a Dairy Farm

Site Description

The Dairy Farm houses approximately 800 cows on site annually. The average herd/flock size includes 500 lactating cows, 150 heifers, 100 dry cows, and 50 calves.

The Dairy Farm uses a waste storage lagoon to store process wastewater (liquid wastes) from the milking center and flush barns, runoff from the feedlot, and direct precipitation into the lagoon. The farm treats wastewater from the milking center and flush barns in a solid/liquid separator prior to discharge into the storage lagoon. The site uses a concrete slab to store solid manure and litter wastes from the dry lot, barns, and solid/liquid separator.

Calculating the Amount of Manure Produced and Collected Annually

Solid Manure: The Dairy Farm collects solid manure from the barns where the dry cows and heifers are housed and the dry lot where the calves are housed. By weighing the front-end loader before and after a load of manure is removed from the dry lot, the site calculates that approximately 8,000 pounds of manure are collected weekly. The manure is then transferred to a concrete slab for

Example: Calculations for a Dairy Farm

storage until land application.

In addition, the liquid/solids separator generates 31,000 pounds of solids daily. This quantity is also calculated by weighing the front-end loader before and after removing the solids.

The annual collection of manure solids is calculated from the following equation:

Solid Manure = (8,000 lbs/week x 52 weeks/year) + (31,000 lbs/day x 365 days/year)
= 11,731,000 lbs/year ÷ 2000 lbs/ton
= 5,865 tons/year

Calculating the Amount of Manure Produced and Collected Annually (Continued)

Liquid Manure: Process wastewater collected and stored in the waste storage pond consists of flush water from the milking center (parlor, holding area, and milk room); flush water from the freestall barns where the milking cows are housed; runoff from the feedlot; and direct precipitation. An estimated total of 6.6 million gallons per year of liquid manure is produced at the operation. The following calculations are used to estimate the quantity of liquid manure produced and collected at The Dairy Farm.

Milking Center - The Dairy Farm estimates approximately 30 gallons of cleaning water is used per lactating cow each day.

= 30 gallons/cow/day x 500 lactating cows
= 15,000 gallons/day x 365 days/yr
= 5,475,000 gallons/yr

Flush Barns - Most of the water used to flush the freestall barns is recycled from the lagoon. However, one day's worth of flushing water (approximately 100 gallons per cow) is included in the total liquid waste as part of the lagoon's design capacity. Only lactating cows, dry cows, and heifers are included in this calculation; the calves are kept on dry lots.

= 100 gallons/cow/day x 750 lactating and dry cows
= 75,000 gallons/yr

Runoff - The runoff collection area totals 15 acres. The annual precipitation is approximately 5 inches, with 40% runoff from the dry lot.

= 15 acres x 43,560 square feet/acre x (5 inches/yr ÷12 inches/feet) x 40%
= 108,900 cubic feet/year

Conversion to gallons:
= 108,900 cubic feet/year x 7.48 gallons/cubic feet
= 814,572 gallons/year

Direct Precipitation - The size of the lagoon is 200 feet by 425 feet and the annual precipitation is 5 inches.
= (5 inches/year ÷ 12 inches/feet) x 200 feet x 425 feet
= 35,417 cubic feet/year

Conversion to gallons:
= 35,417 cubic feet/year x 7.48 gallons/cubic feet
= 264,919 gallons/year

Example: Calculations for a Dairy Farm

Total Liquid Manure = (5,475,000 + 75,000 + 814,572 + 264,919) gallons/year
= 6,629,500 gallons/year

The total amount of manure, litter, and process wastewater produced annually is 5,865 tons of solids and 6.6 million gallons of liquids.

Manure Sampling Analysis

Solid Manure Sampling - The Dairy Farm samples the manure stored on the concrete slab using a hand-made sampling device (similar to a soil auger). The sampling includes collecting six random samples from wastes stored on the slab and mixing all six samples together.

Liquid Manure Sampling - The Dairy Farm samples the waste storage lagoon using a plastic cup attached to a long pole. The sampling includes collecting eight random samples from around the shoreline of the lagoon and mixing all eight samples together.

Manure Sampling Results

Solid Manure: Total Kjedahl Nitrogen (TKN) - 9 pounds/ton
Total Phosphorus - 3 pounds/ton
Potassium - 6 pounds/ton
pH - 7.4

Liquid Manure: Total Kjedahl Nitrogen (TKN) - 12 pounds/1,000 gallons
Total Phosphorus - 6 pounds/1,000 gallons
Potassium - 10 pounds/1,000 gallons
pH - 7.5

2. Developing a Nutrient Budget

CAFOs must estimate the nutrient requirements of the soils where manure, litter, and process wastewater will be land applied. This includes sampling the soil, planning of the crops, and recommended crop nutrient requirements. The recommended nutrient requirements are generally provided by the local Cooperative Extension Office and based on planned crops, expected crop yields, and current soil test results.

Example: Calculations for a Dairy Farm

Site Description

The Dairy Farm owns and operates a total of 400 acres; 375 acres of cropland and 25 acres for the dairy operation. No land is currently rented. The Dairy Farm uses two fields for land application: 1) Field 1 with 250 acres; and 2) Field 2 with 125 acres.

Example: Calculations for a Dairy Farm

Soil Sampling

The soils of both fields used for land application are sampled separately. The results of the samples are below.

Field 1: Nitrogen - 20 pounds/acre
Phosphorus - 75 pounds/acre
Potassium - 90 pounds/acre
pH - 6.2
Soil Organic Matter: 2.2%

Field 2: Nitrogen - 25 pounds/acre
Phosphorus - 110 pounds/acre
Potassium - 110 pounds/acre
pH - 5.8
Soil Organic Matter: 2.6%

For Field 1, the phosphorus concentration is not high (defined as greater than 100 pounds per acre according to the state technical standards); therefore, the land application rate of manure may be up to and including the nitrogen-based rate. For Field 2, the phosphorus concentration is “high” (i.e., >100 pounds/acre); therefore, the land application rate of manure must be no greater than the phosphorus-based rate.

Crop Yields

The crop production history for the previous five years is used to estimate crop yields.

Field Number	Year	Crop	Crop Yield (tons/acre)
1	199920002001	Alfalfa	556
1	20022003	Corn-silage	2022
1	20022003	Winter wheat	34
2	199920002001	Corn-silage	232120
2	20022003	Alfalfa	55

Example: Calculations for a Dairy Farm

The Dairy Farm plans to plant corn-silage in both fields in April 2004 (harvested September 2004) and winter wheat in both fields in September 2004 (harvested December 2004). The expected crop yield is calculated using the average historical crop yield:

Field 1, Corn-silage Yield Estimate = (20 tons/acre + 22 tons/acre)/2
= 21 tons/acre

Field 1, Winter Wheat Yield Estimate = (3 tons/acre + 4 tons/acre)/2
= 3 tons/acre

Example: Calculations for a Dairy Farm

Field 2, Corn-silage Yield Estimate = (23 tons/acre + 21 tons/acre + 20 tons/acre)/3
= 21 tons/acre

Field 2, Winter Wheat Yield Estimate: use 3 tons/acre since no crop yield history data are available.

Recommended Crop Nutrient Requirements

The Dairy Farm uses information from the local Cooperative Extension Office, expected crop yields, and soil test results to determine recommended crop nutrient requirements.

Field Number	Crop	Nutrient Requirements (Nitrogen)	Nutrient Requirements (Phosphorus)
1	Corn-silage	180 pounds/acre	20 pounds/acre
1	Winter wheat	40 pounds/acre	30 pounds/acre
2	Corn-silage	180 pounds/acre	20 pounds/acre
2	Winter wheat	40 pounds/acre	30 pounds/acre

Example: Calculations for a Dairy Farm

Nutrient Credits

Nutrient credits for nitrogen include previous legume crops, residual nitrogen from previous manure applications, nitrogen from irrigation water, and other sources. Field 1 planting did not include a legume crop the previous year, therefore there is no nitrogen credit for legume crops. The Dairy Farm applied manure at a rate of 100 pounds of nitrogen per acre for the past two years. The residual nitrogen is calculated by multiplying the mineralization factor by the manure application rate for the previous years. The following mineralization factors, obtained from the local Cooperative Extension Office, are used for the calculation: 12% for one year ago and 5% for two years ago.

Residual Nitrogen = 0.12 x 100 lb/acre + 0.05 x 100 lb/acre
= 17 lb/acre

The Dairy Farm will apply a starter commercial fertilizer to Field 1 prior to planting the corn-silage, resulting in a nitrogen credit of 10 pounds per acre. Based on tests of the irrigation water performed by the county, only a very small concentration of nutrients are present in the water. This nitrogen concentration is assumed negligible. The local Cooperative Extension Office did not identify any other nutrient credits.

Total Nitrogen (N) Credit for Field 1 = 0 (legume crop) + 17 lb/acre (residual N) + 10 lb/acre (fertilizer) + 0 (irrigation water) + 0 (other sources)

= 7 lb nitrogen/acre

Example: Calculations for a Dairy Farm

Field 2 has no phosphorus nutrient credits.

3. Land Application Rate Calculation

Using the recommended crop nutrient requirements and nutrient credits, CAFOs can calculate the land application rate of manure, litter, and process wastewater. Land applications are typically either nitrogen-based or phosphorus-based. See Chapter 4, Section B.6 for more details. In the example below, if the phosphorus concentration in the soil is "high" (as indicated by laboratory results), or the PI rating is "high", the CAFO would use a phosphorus-based application rate.

Example: Calculations for a Dairy Farm

Field 1 Nitrogen-Based Land Application Rate

Field 1 land application will be nitrogen-based. The amount of nitrogen in the manure available to the crops during the first year of application (Plant Available Nitrogen, PAN) is 5 pounds per ton of solid manure and 5.8 pounds per 1,000 gallons of liquid manure. The following equation is used to estimate the manure application rate of nitrogen.

Manure Application Rate = Recommended Crop Nutrient Requirements - Nutrient Credits

Field 1, Corn-silage = 180 lb/acre - 27 lb/acre
= 153 lb/acre

Field 1, Winter Wheat = 40 lb/acre - 27 lb/acre
= 13 lb/acre

The Dairy Farm will apply liquid manure to Field 1 at the following rates:

Liquid Manure Application Rate (Field 1, Corn-silage) = 153 lb/acre ÷ 5.8 lb PAN/1,000 gallons
= 26,380 gallons/acre

Liquid Manure Application Rate (Field 1, Winter wheat) = 13 lb/acre ÷ 5.8 lb PAN/1,000 gallons
= 2,240 gallons/acre

Field 2 Phosphorus-Based Land Application Rate

Field 2 land application will be phosphorus-based. The Dairy Farm assumes that 100% of the phosphorus in the manure will be available to the plants. The following equation is used to estimate the manure application rate of phosphorus.

Manure Application Rate = Recommended Crop Nutrient Requirements - Nutrient Credits

Field 2, Corn-silage = 20 lb/acre - 0 lb/acre
= 20 lb/acre

Example: Calculations for a Dairy Farm

Field 2, Winter Wheat = 30 lb/acre - 0 lb/acre
= 30 lb/acre

The Dairy Farm will apply solid manure to Field 2 at the following rates:

Solid Manure Application Rate (Field 2, Corn-silage) = 20 lb P/acre ÷ 3.0 lb P/ton
= 6.7 tons/acre

Solid Manure Application Rate (Field 2, Winter wheat) = 30 lb P/acre ÷ 3.0 lb P/ton
= 10 tons/acre

C. Manure Management Planner

As far as NMP tools go, the Manure Management Planner (MMP) is probably one of the most efficient and comprehensive planning tools to use. MMP is nationally

Manure Management Planner

Developed at Purdue University, MMP is a Windows-based computer program that is used to create manure management plans for crop and animal feeding operations. The user enters information about the operation's fields, crops, manure storage, animals, and application equipment. MMP helps the user allocate manure (where, when and how much) on a monthly basis for the length of the plan (1-10 years). This allocation process helps determine if the current operation has sufficient crop acreage, seasonal land availability, manure storage capacity, and application equipment to manage the manure produced in an environmentally responsible manner. The planner can use the program with the CAFO manager to determine the most efficient utilization of manure in iterative processes, allowing the CAFO/farm manager to determine not only how and where to utilize manure, but also how to revise their own plans of crop rotation to maximize nutrient uptake and long-term land application. MMP is also useful for identifying changes that may be needed for a non-sustainable operation to become sustainable, and determining what changes may be needed to keep an operation sustainable if the operation expands.

supported by both EPA[1] and USDA-NRCS for nutrient management planning. MMP automatically calculates Extension fertilizer recommendations and manure nutrient availability automatically in accordance with state NRCS 590 standards. MMP automatically imports field data from Missouri's Spatial Nutrient Management Planner (SNMP) GIS, which is also supported nationally by EPA for nutrient management planning. MMP can be set to automatically import data from soil test labs and Customer Service Toolkit. MMP currently supports 25 states: AL, AR, DE, FL, GA, IN, IL, IA, KS, MA, MI, MN, MO, MS, MT, NE, ND, NM, OH, OK, PA, SD, TN, UT and WI.

Manure Management Planner (MMP) is freely obtained from www.agry.purdue.edu/mmp. Full technical documentation can be downloaded from www.agry.purdue.edu/mmp/MmpDocs.htm.

SNMP is also free (www.cares.missouri.edu/snmp)

[1]EPA is publishing this information in an effort to further public understanding of how a manure utilization planning tool can be used to develop nutrient management plans that can further efforts to protect our environment. The EPA does not endorse products nor does it recommend for or against the purchase of specific products.