NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT

(Ac.)

CODE 590

DEFINITION

Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE

- To budget, supply, and conserve nutrients for plant production.
- To minimize agricultural nonpoint source pollution of surface and groundwater resources.
- To properly utilize manure, municipal and industrial biosolids, and other organic by-products as plant nutrient sources.
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates.
- To maintain or improve the physical, chemical, and biological condition of soil.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all lands where plant nutrients and soil amendments are applied.

CRITERIA

General Criteria Applicable to All Purposes

Develop a nutrient management plan for nitrogen, phosphorus, and potassium that considers the crop requirements and all potential sources of nutrients including, but not limited to:

- commercial fertilizer
- animal manure
- legume credits and green manure,
- crop rotation
- municipal and industrial biosolids and other organic by-products
- compost
- waste water
- organic matter and soil nutrient availability
- removal of crop materials
- irrigation water.

Documents cited in this standard may be periodically updated or replaced. Use the most recent version available. Find additional technical information on nutrient management at www.agronext.iastate.edu/soilfertility.

Soil Sampling, Testing, and Analysis

Base the nutrient management plan on soil test results for, at a minimum, organic matter, phosphorus (P), potassium (K), pH, and buffer pH. Test, at a minimum, every 4 years of row crops or once during an extended rotation which includes perennial crops. For initial plans use tests no older than 2 years and account for nutrients applied at rates in excess of crop replacement since the last soil test.

Use Iowa State University's (ISU) PM-287 "Take a Good Soil Sample to Help Make Good Decisions" for soil testing guidance. For variable rate systems use NCMR-348 "Soil Sampling for Variable Rate Fertilizer and Lime Application" for additional guidance.

For soil analysis, use a lab that is certified by the Iowa Soil Testing Laboratory Certification Program, Commercial Feed and Fertilizer Bureau of the Iowa Department of Agriculture and Land Stewardship (IDALS).

To interpret the soil test results, use PM-1688 "General Guide for Crop Nutrient and Limestone Recommendations in Iowa" and PM-1310 "Interpretations of Soil Test Results."

The 4Rs
Consider the 4Rs of nutrient management – apply the **R**ight nutrient source at the **R**ight rate at the **R**ight time in the **R**ight place – to improve nutrient use efficiency by the crop and to minimize nutrient losses to the surface and groundwater and to the atmosphere.

Nutrient Application Rates
Determine the nutrient application rate to:
- Meet the crop's nutrient requirements for production
- Account for nutrient credits and rotational effects
- Account for removal of crop materials
- Conserve resources as indicated by the erosion and nutrient risk assessments, and
- Integrate the management of manure, municipal and industrial biosolids, and other waste products as crop nutrients.

Plan to meet the crop nutrient requirements for nitrogen, phosphorus, potassium, and other nutrients according to Iowa State University recommendations.

Nitrogen Application Rates
To determine nitrogen rates for corn in a continuous corn or corn-soybean rotation, use ISU's Corn Nitrogen Rate Calculator or use PM-1714 "Nitrogen Fertilizer Recommendations for Corn in Iowa."

For within season sampling to determine sidedress nitrogen application rates, follow ISU procedures for the late-spring soil nitrate test in PM-1714 or leaf chlorophyll values in PM-2026 "Sensing Nitrogen Stress in Corn."

For additional nitrogen rate information and recommendations use ISU publications:
- PM-2015 "Concepts and rationale for regional nitrogen rate guidelines for corn",
- PM-1714 "Nitrogen Fertilizer Recommendations for Corn in Iowa",
- PM-869 "Fertilizing Pasture",
- PM-1584 "Cornstalk Testing to Evaluate Nitrogen Management",
- PM-2026 "Sensing nitrogen stress in corn".

Use of the end-of-season cornstalk test especially in conjunction with on-farm field trials is encouraged to evaluate the nitrogen management program. See ISU publication PM-1584 "Corn Stalk Test to Determine Nitrogen" and NRCS Agronomy Technical Note No. 7, "Adaptive Nutrient Management Process". The corn stalk test provides post season feedback on nutrient management that can be used to adjust the nutrient source, rate, timing, and/or placement. Document how results will be reviewed and incorporated into future management.

Phosphorus and Potassium Application Rates
For P_2O_5 and K_2O requirements for most common crops, use soil test results and PM-1688 "General Guide for Crop Nutrient and Limestone Recommendations in Iowa". Use PM-869 "Fertilizing Pasture" for pasture nutrient requirements. Express phosphorus and potassium nutrient values in pounds of P_2O_5 and K_2O.

P_2O_5 and K_2O can be managed annually or for multiple years. Sum the nutrient requirements for all the crops in the years planned (i.e. a rotation) and apply once or split as convenient.

Phosphorus and potassium application rates may exceed the crop's nutrient requirements when manure, municipal and industrial biosolids, and other organic by-products are applied based on the N rate or need to be disposed. See Additional Criteria Applicable to Properly Utilize Manure Municipal and Industrial Biosolids, and Other Organic By-Products as a Plant Nutrient Source for management criteria.

Realistic Yield Potential
Estimate the field's realistic yield potential using:
- an average of two or more years of field yield data using producer records plus 10%, or
- the crop yield estimate for the dominant soil in the field as found in the Field Office Technical Guide, or
- PM-1268 "Establishing Realistic Yields" (1986) to calculate a more precise estimate if desired.

Nutrient Credits
To determine the nutrient application rate subtract the nutrient credits for legumes, manure, municipal and industrial biosolids, and/or other organic sources from the crop's nutrient requirements. Note that ISU nitrogen recommendations already accounts for the rotational effects and legume credit for corn following soybeans.

Legume credits can be found in ISU Publication PM-1714 "Nitrogen Fertilizer Recommendations

for Corn in Iowa". Use PMR-1003 "Using manure nutrients for crop production" to determine the 2nd and 3rd year manure credits.

Other Rate Criteria
Account for all applied nutrients including starter, in-furrow starter (pop-up), biosolids, and the N in MAP and DAP.

Consider the impact on yield of poor soil quality, drainage, pH, weather, and other factors that influence production, as well as the source, timing, and placement of nutrients before concluding that nutrients are deficient.

Nutrients and lime may be applied at lower-than-recommended rates if the grower's objectives are met.

For crops without specific ISU guidance, base nutrient application rates on university recommendations from neighboring states and/or plant nutrient removal.

Nutrient Sources
Use nutrient sources compatible with the application timing, tillage and planting system, soil properties, crop, crop rotation, soil organic content, and local climate to minimize risk to the environment.

Use fertilizers which have been verified by IDALS Feed and Fertilizer Bureau to contain the nutrients claimed on the label. For Enhanced Efficiency fertilizer products use the Association of American Plant Food Control Officials definitions for these products.

On Certified Organic or Certified Transitional Organic operations, use nutrient sources and manage nutrients consistent with the USDA's National Organic Program.

See Additional Criteria Applicable to Properly Utilize Manure, Municipal and Industrial Biosolids, and Other Organic By-products as a Plant Nutrient Source section below for criteria for these nutrient sources.

Nutrient Application Timing and Placement
Consider the nutrient source, cropping system limitations, soil properties, weather conditions, drainage system, soil biology, and nutrient risk assessment to develop optimal timing and placement of nutrients.

- For nitrogen, timing and placement should correspond as closely as practical with crop uptake.
- For phosphorus avoid surface application when the runoff potential is high.
- For anhydrous ammonia, to avoid losses during application apply when soil moisture conditions are conducive to proper injection and sealing.

Fall versus Spring Application
Corn nitrogen rate guidelines for Iowa (see the Corn Nitrogen Rate Calculator website for rates and PM-2015 "Concepts and Rationale for Regional Nitrogen Rate Guidelines for Corn" for an explanation of the method) are based on spring or sidedress N application research trials. In comparison to fall application, spring N application improves crop uptake efficiency and reduces the loss of nitrate. Fall application increases the risk for nitrogen loss and reduces nitrogen use efficiency. However, with some manure and biosolid sources, such as bedded manure, fall application increases the mineralization of organic N and improves early season N supply.

In general, plan to apply N in the spring for most nutrient sources. If for logistical or other reasons N is fall applied – such as anhydrous ammonia, manure in which > 20 lbs/acre NH_4^+-N is applied, or MAP/DAP – plan to apply late in the fall when the mid-day soil temperature, at 4" soil depth, is below 50ºF and trending colder. The actual application timing may occasionally vary due to fall weather, the weather forecast, soil conditions including vulnerability to compaction, and logistics. Do not fall apply urea and urea-ammonium nitrate solutions (UAN) due to the high risk for N loss.

For small grains planted in the fall, part of the N can be applied in the fall, typically in conjunction with phosphorus application, with the remainder applied topdress in the spring.

Rescue Nitrogen Application
Nitrogen applied at any time is subject to leaching if the fertilizer contains nitrate or converts to nitrate and excess soil wetness occurs before crop uptake. This risk increases with fall application, especially early fall application, due to greater conversion to nitrate by the springtime. If losses are suspected, use the Late Spring Soil Nitrate Test (ISU publication PM-1714, "Nitrogen Fertilizer Recommendations

for Corn in Iowa") or the crop canopy sensing technique outlined in ISU publication PM-2026, "Sensing Nitrogen Stress in Corn" to assess the loss and determine the application rate of rescue N. New in-season nitrogen assessment technologies are being developed. As they are proven, these can be chosen as alternatives.

If rescue N is needed on fields in which a full rate of N is applied in the fall, evaluate the likely causes and formulate and consider alternative nitrogen management options. Consider testing N management alternatives using strip trials over multiple years and fields. See NRCS Agronomy Technical Note No. 7: "Adaptive Nutrient Management Process" for guidance. Especially consider switching to split, spring, and/or sidedress application to reduce the loss of N from fall application.

Surface application of Nutrients to Frozen, Snow-Covered, and Saturated Soils

Design the manure and fertilizer storage and management system to avoid the need to surface apply nutrients when the risk of runoff is high, including when:

- the soils are frozen and/or snow-covered or
- the top 2 inches of the soil are saturated.

Manure may be surface applied to frozen, snow covered or saturated soils on an emergency basis if storage capacity becomes insufficient due to a natural disaster, unusual weather conditions, equipment or structural failure, or other similar events and failure to apply creates a risk of an uncontrolled release of manure.

For such emergency cases, prepare a manure disposal plan which includes the:

1) Circumstances the manure may be applied to frozen, snow covered, or saturated ground (Ex: storage capacity exceeded);
2) Rates of application;
3) Areas of application which excludes slopes greater than 5% and sensitive areas and their setbacks;
4) Which demonstrates that all other nutrient management criteria are met including the erosion and nutrient risk assessment criteria; and
5) Meets state law.

Cover Crops

Cover crops can be effective scavengers of nitrogen, immobilizing the N in the organic matter, impacting when the nitrogen will be available, and potentially preventing N leaching. However, management systems to optimize immobilization and to make subsequent agronomic N management decisions still need to be developed and tested. On-farm cover crop field trials are encouraged to test management options (species, planting method, timing of planting, timing of manure application, timing and method of killing, etc.), to estimate subsequent N availability, and to assess the impact on water quality. Variances to this standard can be made to encourage innovative work to use cover crops in the nutrient management system.

Other Timing and Placement

For pasture fertilization consult PM-569 "Warm-Season Grasses for Hay and Pasture" and PM-869 "Fertilizing Pasture" for guidance. Time nitrogen applications to pastures when crop demand is the greatest.

To avoid salt damage, follow ISU guidelines for the rate and placement of applied nitrogen and potassium in starter/pop-up fertilizers.

Additional Criteria to Minimize Agricultural Nonpoint Source Pollution of Surface and Groundwater

Use the tools below to assess the risk that the management system will impact water quality. When there is a high risk of transport of nutrients, apply conservation practices to control or trap manure, biosolids, and nutrients before they can leave the field by surface or subsurface (e.g., tile, groundwater) drainage.

Erosion and Nutrient Risk Assessment

On each field calculate the risk to soil and water resources using the:

- Revised Universal Soil Loss Equation 2 (RUSLE2) to estimate soil erosion,
- Leaching Index (LI) to determine the relative risk of N leaching to ground or surface water.

Phosphorus Index

Use the Iowa Phosphorus Index (P-Index) to estimate the risk that P will contaminate surface water. The P-Index is required when one or more of the following applies:

- The phosphorus application rate exceeds land-grant university fertility rate guidelines for the planned crop(s) in the rotation, or
- Manure, municipal and industrial biosolids, and/or organic by-products are applied, or

- Soil loss exceeds the tolerable level, or
- The average soil test phosphorus for the field is in the very high range for corn based on ISU PM-1688.

The Iowa P-Index is implemented in the Iowa Phosphorus Index Calculator and in Purdue's Manure Management Planner software. PM-2021 "Data Collection Worksheet for RUSLE2 and Iowa Phosphorus Index" provides guidance to use the calculator.

Meet the criteria of the Iowa Phosphorus Index as stated in the P-Index's "Interpretations of Site Vulnerability Ratings for the P-Index" found in the Calculator. For additional information consult "Iowa Technical Note 25: Iowa Phosphorus Index."

Municipal Well Protection

Determine if the field is in a municipal well capture zone. Water infiltrating soil in these areas is likely to flow to the wellhead in 10 years or less. There is an elevated risk that nitrogen and other products applied on this land will contaminate the public well. To reduce the pollution risk, consider additional measures listed below.

Nutrient Management Strategies to Reduce Nonpoint Source Pollution

Consider using the following nutrient-use efficiency strategies or technologies:

- include crops in the rotation and manage the crop sequence to require less added nitrogen For further guidance, see conservation practices:
  - 328 Conservation Crop Rotation
  - 512 Forage and Biomass Planting
- more efficient timing and number of applications
- incorporation or injection
- calibrate application equipment and apply nutrient materials uniformly
- coordinate nutrient applications with optimum crop nutrient uptake
- slow and controlled release fertilizers
- nitrification and urease inhibitors
- late-spring soil nitrate test and chlorophyll meters (SPAD) for in-season nitrogen evaluation and to determine sidedress rates
- end-of-season cornstalk test to evaluate nitrogen management
- other ISU demonstrated and/or accepted technologies that improve nutrient-use efficiency and minimize surface or groundwater resource concerns.

Strategies to Control and Trap Phosphorus

Use the P-Index to formulate and evaluate conservation alternatives to control phosphorus and sediment runoff and/or to trap it before it can reach surface water. Some conservation practices to consider are:

- 329 Residue and Tillage Management, No-Till/Strip Till/Direct Seed
- 345 Residue and Tillage Management, Mulch Till
- 330 Contour Farming
- 340 Cover Crops
- 393 Filter Strip
- 391 Riparian Forest Buffer
- 412 Grass Waterway
- 638 Water & Sediment Control Basin
- 600 Terrace
- 656 Constructed Wetland

Strategies to Trap Nitrogen

Agronomically appropriate nitrogen rates still often lead to surface and groundwater pollution. Consider the following conservation practices to trap the nitrogen not utilized by the crop.

- 340 Cover Crops
- 393 Filter Strip
- 332 Contour Buffer Strips
- 656 Constructed Wetland
- 554 Drainage Water Management
- 747 Denitrifying Bioreactors
- 739 Vegetated Subsurface Drain Outlet

As appropriate, prioritize in-field nitrogen management and trapping practices over edge-of-field practices.

Sensitive Area Nutrient Application Restrictions

A sensitive area is water we are trying to protect from pollution or direct conduits to that water. If a sensitive area is protected by a minimum 50 foot Filter Strip (NRCS Conservation Standard 393) then surface, unincorporated application of phosphorus and nitrogen can be made to the edge of the filter strip. Otherwise, do not apply phosphorus and nitrogen to the following sensitive areas unless injected or incorporated within 24 hours:

- Within 200 feet upslope of sinkholes, drainage wells, wells, classic gullies, drainage ditches, tile line surface and blind inlets for tile lines which run unmitigated to surface or

groundwater[1], or other direct conduits to surface or groundwater.
- Within 200 feet of lakes, ponds, streams, other perennial water bodies, or Iowa Designated Wetlands.
- Within 800 feet of state designated High Quality Water Resources. See DNR 117 "High Quality Water Resources" for listing.

Sidedress fertilizer applications, fertigation, and foliar applications may be made when the crops have emerged and there is a diminished chance of surface runoff.

Additional application restrictions may apply. See Iowa Department of Natural Resources (DNR) document DNR 113 "Separation Distances for Land Application of Manure" and DNR 117 "High Quality Water Resources."

Other Nonpoint Source Pollution Criteria
During the peak flood periods (April, May, June, July) do not apply phosphorus and nitrogen on land that floods more than once every 10 years.

Apply irrigation water and use fertigation and chemigation in a manner which minimizes the risk of nutrient loss to surface and groundwater.

Additional Criteria Applicable to Properly Utilize Manure, Municipal and Industrial Biosolids, and Other Organic By-products as Plant Nutrient Sources
Coordinate manure storage and management with the cropping system so that manure can be applied at the right time and in the right place (surface, incorporated, or injected) so that:
- the rate of mineralization releases nutrients when the crop can use them;
- the loss of N due to denitrification or ammonia volatilization is minimized; and
- P runoff is minimized.

[1] Tile line surface and blind inlets can provide a direct conduit to surface waters. Mitigating this is a challenge and potential solutions are being explored. Many tile inlets currently exist – especially as part of terrace or sediment basin structures – for which it will be difficult to install a filter strip or set back the application of solid manures. As an interim mitigation practice, surface application of nutrients (e.g. solid manures, MAP, DAP) may be made within the 200 foot setback area when, in the inlet drainage area, the soil loss is ≤ T **and**:
1. A cover crop is established, and/or
2. A no-tillage cropping system is used.

Nutrient Content Analysis of Manure, Municipal and Industrial Biosolids, and Organic By-products
Analyze or estimate the nutrient content of manures, municipal and industrial biosolids, and other organic by-products prior to land application. At a minimum, analyze for total nitrogen (N), ammonium N, total phosphorus (P) or P_2O_5, total potassium (K) or K_2O, percent moisture, and percent solids.

For manures, use ISU's PM-1588 "How to Sample Manure for Nutrient Analysis" for detailed guidance. To interpret the results and estimate the plant availability of nutrients use ISU's PM-3014 "How to Interpret Your Manure Analysis" and PMR-1003 "Using Manure Nutrients for Crop Production."

Test annually, at a minimum, to build a test history. If test values are stable for three consecutive years, testing can then be done every three to five years. Retest when operational changes occur (feed management, animal type, manure handling strategy, storage time, etc.) which might change the nutrient content or concentration in the manure.

Use a laboratory certified through the Minnesota Department of Agriculture Manure Testing Laboratory Certification program (MTLCP).

When planning for new or modified livestock operations, use "book values" from the NRCS Chapter 4: Agricultural Waste Characteristics in the Agricultural Waste Management Field Handbook or analyses from similar operations in the geographical area.

Municipal and, especially, industrial biosolids can be sources of heavy metals. Test, land apply, and ensure records are kept for biosolids according to state and federal law. Account for N, P, and K applied with the biosolids.

Manure, Municipal and Industrial Biosolids, and Organic By-Products Application Rate
Generally, apply manure, municipal and industrial biosolids, and organic by-products up to a rate equal to the recommended phosphorus application, or up to the estimated phosphorus removal in harvested plant biomass for the crop rotation, or up to the cumulative rate for crops over multiple years. Do not exceed the recommended nitrogen application rate during

the year of application or harvest cycle. Do not apply additional phosphorus during the years for which the rate is calculated.

However, if the **Iowa Phosphorus Index** rates the risk that P will move offsite as **Very Low** risk, **Low** risk, or **Medium** risk, the application of manure, municipal and industrial biosolids, or organic by-products may be made based on the nitrogen application rates. *Applied P may exceed crop needs and removal rates and will accumulate in the soil. This practice will not be sustainable over the long term.*

If the Iowa P-index rating is **Medium** risk, avoid accumulating phosphorus to levels that will increase the rating of the field above the medium risk category.

If the Iowa P-index rating is **High** or **Very High** risk, implement practices to reduce that risk to Medium or below. Do not apply P until the risk is reduced.

Manure Application on Legumes
Manure, municipal and industrial biosolids, and/or organic by-products may be applied on legumes at rates up to the estimated annual removal of nitrogen in the harvested portion of the crop.

Manure Application Criteria
When applying liquid manure:
- do not exceed the soil's infiltration or water holding capacity at crop rooting depth
- avoid runoff or loss to subsurface tile drains.

Additional Criteria to Protect Air Quality by Reducing Odors, Nitrogen Emissions and the Formation of Atmospheric Particulates
To address air quality concerns caused by odor, nitrogen, sulfur, and/or particulate emissions, adjust the source, timing, amount, and placement of nutrients to minimize air pollution and negative human health impacts. One or more of the following may be used:
- urease inhibitors for surface applied urea fertilizers
- incorporation
- injection
- residue and tillage management
- no-till or strip-till
- other technologies that minimize the impact of these emissions

Do not apply poultry litter – or manure, municipal and industrial biosolids, or organic by-products of similar dryness/density – when there is a high probability that wind will blow the material offsite.

Additional Criteria to Maintain or Improve the Physical, Chemical, and Biological Condition of the Soil
Manage or apply nutrients to maintain or improve the physical, chemical, or biological condition of the soil to enhance soil quality for crop production and environmental protection.

When possible, avoid applying nutrients when the potential for soil compaction and rutting is high.

Maintain soil pH at levels indicated in ISU Publication PM-1688 "General Guide for Crop Nutrient Requirements in Iowa." All recommendations are based on Effective Calcium Carbonate Equivalents (ECCE). For soil tests requiring less than 2000 pounds per acre ECCE, the lime requirement may be waived.

CONSIDERATIONS

Use nutrient management strategies such as cover crops, crop rotations, and perennials in the rotation to improve nutrient cycling and reduce energy inputs.

Use no-till/strip-till in combination with cover crops to sequester nutrients, increase soil organic matter, increase aggregate stability, reduce compaction, improve infiltration, and enhance soil biological activity to improve nutrient-use efficiency.

Use legume crops and cover crops to provide nitrogen through biological fixation and nutrient recycling.

Elevated soil test phosphorus levels are detrimental to soil biota. Avoid building P in the soil to excessive levels.

Excessive levels of some nutrients can cause induced deficiencies of other nutrients, e.g., high soil test phosphorus levels can result in zinc deficiency in corn. Avoid over-applying nutrients.

If increases in soil phosphorus levels are expected from, for instance, a large application

of biosolids or manure, consider retesting the soil prior to the next nutrient application.

Use soil tests, plant tissue analyses, and field observations to check for secondary plant nutrient and micronutrient deficiencies or toxicity that may impact plant growth or availability of the primary nutrients.

Use the adaptive nutrient management learning process to improve nutrient-use efficiency on farms as outlined in the NRCS Agronomy Technical Note No. 7: “Adaptive Nutrient Management Process.”

Do not apply potassium where an excess (greater than soil test potassium recommendation) causes nutrient imbalances in crops or forages.

Avoid applying potash and other fertilizers when the risk of runoff is high, including when:
• the soils are frozen and/or snow-covered or
• the top 2 inches of the soil are saturated.
Though potassium is not considered a water pollutant, applying under these conditions can lead to the loss of the nutrient and the need and cost of re-application.

Variable Rate Nutrient Management
Use variable-rate nitrogen, phosphorus, and potassium application rates based on site-specific variability in crop yield, soil variability, soil test values, and/or other factors as proven.

Develop site-specific yield maps using a yield monitoring system. Use the data to further diagnose low- and high- yield areas, or zones, and make the necessary management changes. See Title 190, Agronomy Technical Note (TN) 190.AGR.3, Precision Nutrient Management Planning.

Safety
Protect workers from and avoid unnecessary contact with plant nutrient sources. Take extra precaution when handling anhydrous ammonia or when dealing with organic wastes stored in unventilated enclosures.

Utilize material generated from cleaning nutrient application equipment in an environmentally safe manner. Collect and store or field apply excess material in an appropriate manner.

Recycle nutrient containers in compliance with State and local guidelines or regulations.

Considerations to Minimize Agricultural Nonpoint Source Pollution of Surface and Groundwater
Use application methods and timing strategies that reduce the risk of nutrient transport by ground and surface waters, such as:
• split applications of nitrogen to deliver nutrients during periods of maximum crop utilization,
• band nitrogen and/or phosphorus to improve nutrient availability, and
• delay field application of animal manures, biosolids, or organic by-products if precipitation capable of producing runoff and erosion is forecast within 24 hours of the time of the planned application.

Use the Agrichemical Handling Facility (309) conservation practice to protect air, soil, and water quality.

Avoid surface applying manure and fertilizer to grassed waterways, ditches, and other places of concentrated water flow especially during times of the year when runoff is likely.

Nutrients applied to coarse soils and karst topography are especially at risk to leach into the groundwater. Consider additional measures to reduce the pollution risk.

Target Iowa DNR’s Outstanding Iowa Waters listed watersheds with conservation practices to protect these unique Iowa watersheds.

Considerations to Properly Utilize Manure, Municipal and Industrial Biosolids and Other Organic By-products as a Plant Nutrient Source
For animal feeding operations which apply manure more than once a year, sample manure more frequently to account for seasonal differences.

Use manure management conservation practices to manage manure nutrients to limit losses prior to nutrient utilization.

Apply manure at a rate that will result in an “improving” Soil Conditioning Index (SCI) without exceeding acceptable risk of nitrogen or phosphorus loss.

Modify animal feed diets to reduce the nutrient content of manure following guidance contained in Conservation Practice Standard (CPS) Code 592, Feed Management.

Considerations to Protect Air Quality by Reducing Nitrogen and/or Particulate Emissions to the Atmosphere

Avoid applying manure and other by-products upwind of inhabited areas.

Use high-efficiency irrigation technologies (e.g., reduced-pressure drop nozzles for center pivots) to reduce the potential for nutrient losses.

When tillage is feasible and otherwise does not cause erosion or soil quality issues, incorporate within 24 hours surface applied manure or fertilizer nitrogen formulations that are subject to volatilization (e.g., urea).

Use the National Air Quality Site Assessment Tool to explore options to improve management.

Considerations to Maintain or Improve the Physical, Chemical, and Biological Condition of the Soil

To maintain or improve the physical, chemical, or biological condition of the soil use the concepts and technologies in the NRCS nutrient management for soil quality technical note (available soon).

PLANS AND SPECIFICATIONS

Develop the nutrient management plan to reflect the objectives and decisions of the owner/operator of the land planned. Adapt the form of the plan – from field names to equipment size – to the particular needs of the producer to facilitate plan implementation.

Specifications for All Plans

Include in the nutrient management plan:

- producer objectives
- statement of resource concerns that will be addressed in the plan
- statement of local, state, and/or federal standards and/or requirements the plan is designed to meet; tools and data sources used; and assumptions made.
- aerial site photograph(s)/imagery or site map(s)
- soil survey map of the site,
- soil information including: soil type surface texture, pH, drainage class, permeability, available water capacity, depth to water table, restrictive features, and flooding and/or ponding frequency,
- fields delineated with ID and acres, location of designated sensitive areas and the associated nutrient application restrictions and setbacks,
- for manure and biosolid applications, location of nearby residences, or other locations where humans may be present on a regular basis, and any identified meteorological (e.g., prevailing winds at different times of the year), or topographical influences that may affect the transport of odors to those locations,
- results of the RUSLE2, Leaching Index, and Iowa Phosphorus Index resource risk assessment tools,
- documentation that the Iowa Phosphorus Index's interpretations of site vulnerability ratings criteria are met,
- documentation that the conservation practices required to meet Iowa Phosphorus Index criteria are applied and/or the implementation scheduled,
- current and/or planned plant production sequence or crop rotation,
- soil, manure, municipal or industrial biosolid, organic by-product, plant tissue sample, and/or water analyses applicable to the plan,
- documentation of the realistic yield potentials for the crops and how they were derived,
- complete nutrient management plan for nitrogen, phosphorus, and potassium for the plant production sequence or crop rotation,
- specify the nutrient application source, timing, rate (except for precision/variable rate applications specify method used to determine rate), and placement of plant nutrients for each field or management unit and the source and reasoning for the choices,
- rationale for P applications in excess of crop removal when the P-Index is very low, low, or medium and soil test P is optimum or higher,
- when soil test phosphorus levels are high or very high and/or increasing,
  - ○ include a discussion of the risk associated with phosphorus accumulation,
  - ○ estimate using the P-Index when P should no longer be applied,
  - ○ propose a P stabilization or draw-down strategy to optimum soil test P, and

  - ○ formulate alternative manure management strategies to reduce application rates (i.e. use it to fertilize more land to better optimize the use of the resource), and
- guidance for implementation, operation and maintenance, and recordkeeping.

Additional Specifications for Precision/Variable Rate Plans
Include the following components in a precision/variable rate nutrient management plan:
- Document the geo-referenced field boundary and data collected that were processed and analyzed as a GIS layer or layers to generate nutrient or soil amendment recommendations.
- Document the nutrient recommendation guidance and recommendation equations used to convert the GIS base data layer or layers to a nutrient source material recommendation GIS layer or layers.
- Document if a variable rate nutrient or soil amendment application was made.
- Provide application records per management zone or as applied map within individual field boundaries (or electronic records) documenting source, timing, method, and rate of all applications that resulted from use of the precision agriculture process for nutrient or soil amendment applications.
- Maintain the electronic records of the GIS data layers and nutrient applications for at least 5 years.

OPERATION AND MAINTENANCE

Conduct periodic plan reviews to determine if adjustments or modifications to the plan are needed. At a minimum, plans must be reviewed, evaluated, and, if needed, revised, with
- each soil test cycle,
- changes in manure volume or analysis, or
- changes in crops or crop management.

Monitor fields receiving animal manures and/or municipal or industrial biosolids for the accumulation of phosphorus.

Continue to test each manure source based on PM-1558 “How to sample manure for nutrient analysis.” If feed management, animal numbers or type, manure handling strategy, storage time, etc., change significantly, re-inventory the manure resource and re-analyze the manure. The nutrient management plan may need to be revised accordingly.

Calibration of Fertilizer Application Equipment
Calibrate fertilizer application equipment at least annually to ensure proper placement or material at planned rates. Use ISU guidance PM-1941 “Calibration and Uniformity of solid Manure Spreaders” or PM-1948 “Calibrating Liquid Tank Manure Applicators.” For custom applicators or rented equipment, verify that the operator or owner has calibrated applicators.

For anhydrous ammonia, verify that the applicator is properly plumbed. See PM-1875 “Improving the Uniformity of Anhydrous Ammonia Application” for guidance. Note that other effective manifolds are now available. Verify that anhydrous ammonia is injected to the proper depth and good soil coverage is provided.

Records for All Plans
Maintain records for at least 5 years – longer if required by other Federal, state or local ordinances, or program or contract requirements – to document plan implementation and maintenance. As applicable, include:
- soil, plant tissue, water, manure, biosolid, and organic by-product analyses resulting in recommendations for nutrient application.
- nutrient sources and analyses, rates as applied, placement, timing (dates) of nutrients applied, and a summary of actual pounds of nutrients applied per acre.
- weather conditions and soil moisture at the time of application; lapsed time to incorporation; and rainfall or irrigation event,
- record of equipment calibration.
- crops planted, planting and harvest dates, yields, nutrient analyses of harvested biomass (if applicable), and crop residues removed, and
- identify variations from the nutrient management plan, evaluate why the variation occurred, and determine if a plan needs to be updated. Document decision.
- dates of plan review, name of reviewer, and recommended changes resulting from the review.

Additional Records for Precision/Variable Rate Plans

Include:

- maps identifying the variable application source, timing, amount, and placement of all plant nutrients applied, and
- GPS-based yield maps for crops where yield data can be digitally collected.

REFERENCES

Iowa State University Extension Publications

Available at County Extension Offices or at ISU Extension Online Store: https://store.extension.iastate.edu/ or at the ISU Soil Fertility website: www.agronext.iastate.edu/soilfertility.

- ISU PM-287 "Take a Good Soil Sample to Help Make Good Decisions"
- ISU PM-569 "Warm-Season Grasses for Hay and Pasture"
- ISU PM-869 "Fertilizing Pasture"
- ISU PM-1268 "Establishing Realistic Yields"
- ISU PM-1310 "Interpretations of Soil Test Results"
- ISU PM-1558 "How to Sample Manure for Nutrient Analysis"
- ISU PM-1584 "Cornstalk Testing to Evaluate Nitrogen Management"
- ISU PM-1688 "A General Guide for Crop Nutrient and Limestone Recommendations in Iowa"
- ISU PM-1714 "Nitrogen Fertilizer Recommendations for Corn in Iowa"
- ISU PM-1875 "Improving the Uniformity of Anhydrous Ammonia Application"
- ISU PM-1941 "Calibration and Uniformity of Solid Manure Spreaders"
- ISU PM-1948 "Calibrating Liquid Tank Manure Applicators"
- ISU PM-2015 "Concepts and Rationale for Regional Nitrogen Rate Guidelines for Corn"
- ISU PM-2021 "Data Collection Worksheet for RUSLE2 and Iowa Phosphorus Index**"**
- ISU PM-2026 "Sensing Nitrogen Stress in Corn"
- ISU PM-3014 "How to Interpret Your Manure Analysis"
- ISU PMR-1003 "Using Manure Nutrients for Crop Production"
- NCMR-348 "Soil Sampling for Variable Rate Fertilizer and Lime Application"

USDA-NRCS Resources

Available on the USDA-NRCS website at: http://www.nrcs.usda.gov/wps/portal/nrcs/site/ia/home/

- Iowa Technical Note 25, "Iowa Phosphorus Index"
- Phosphorus Index Calculator (Excel Spreadsheet)
- Purdue's Manure Management Planner (software)
- USDA-NRCS. 2008. Chapter 4: Agricultural Waste Characteristics. In Part 651 Agricultural Waste Management Field Handbook.
- USDA-NRCS. 2010. Agronomy Technical Note, (TN) 190-AGR-3, Precision Nutrient Management Planning. Washington, DC.
- USDA-NRCS. 2011. Title 190, General Manual, (GM), Part 402, Nutrient Management. Washington, DC.
- USDA-NRCS. 2011, Title 190, National Instruction (NI), Part 302, Nutrient Management Policy Implementation. Washington, DC.
- USDA NRCS. 2013. Agronomy Technical Note No. 7 "Adaptive Nutrient Management Process"

Iowa DNR Publications

Available on the Iowa DNR website at: www.iowadnr.gov

- Iowa DNR. 2008. DNR 113: Separation Distances for Land Application of Manure. Des Moines, IA.
- Iowa DNR. 2003. DNR 117: High Quality Water Resources. Des Moines, IA.

Other Publications

- Association of American Plant Food Control Officers (AAPFCO). 2013. Official Publication No. 66 (or latest). West Lafayette, IN.

Documents cited in this standard may be periodically updated or replaced. Use the most recent version available.