Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT

CODE 590

(ac)

DEFINITION

Manage rate, source, placement, and timing of plant nutrients and soil amendments while reducing environmental impacts.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Improve plant health and productivity
- Reduce excess nutrients in surface and ground water
- Reduce emissions of objectionable odors
- Reduce emissions of particulate matter (PM) and PM precursors
- Reduce emissions of greenhouse gases (GHG)
- Reduce emissions of ozone precursors
- Reduce the risk of potential pathogens from manure, biosolids, or compost application from reaching surface and ground water
- Improve or maintain soil organic matter

CONDITIONS WHERE PRACTICE APPLIES

All fields where plant nutrients and soil amendments are applied. Does not apply to one-time nutrient applications at establishment of permanent vegetation.

CRITERIA

General Criteria Applicable to All Purposes

Develop a nutrient management plan for nitrogen (N), phosphorus (P), and potassium (K), which accounts for all known measurable sources and removal of these nutrients.

Sources of nutrients include, but are not limited to, commercial fertilizers (including starter and in-furrow starter/pop-up fertilizer), animal manures, legume fixation credits, green manures, plant or crop residues, compost, organic by-products, municipal and industrial biosolids, wastewater, organic materials, estimated plant available soil nutrients, and irrigation water.

When irrigating, apply irrigation water in a manner that reduces the risk of nutrient loss to surface and ground water.

Follow all applicable State requirements and regulations when applying nutrients near areas prone to contamination, such as designated water quality sensitive areas, (e.g., lakes, ponds, rivers and streams, sinkholes, public drinking water supplies, wellheads, classic gullies, ditches, or surface inlets) that run

unmitigated to surface or groundwater. Refer to 590 Practice Specification (PS) Nutrient Management for information on sensitive area setbacks.

Soil and tissue testing and analysis
Base the nutrient management plan on current soil test results in accordance with University of Missouri-Columbia (UMC) Extension guidance, or industry practice when recognized by UMC Extension. Use soil tests no older than 2 years when developing new nutrient management plans. Use tissue testing, when applicable, for monitoring or adjusting the nutrient management plan in accordance with UMC Extension guidance, or industry practice when recognized by UMC Extension.

For nutrient management plan revisions and maintenance, take soil tests every four years as recommended by UMC Extension or as required by local rules and regulations.

Collect, prepare, store, and ship all soil and tissue samples following UMC Extension guidance or industry practice. The test analyses must include pertinent information for monitoring or amending the annual nutrient plan. Follow UMC Extension guidelines regarding required analyses and test interpretations. For specific guidance on soil and tissues sampling and the current acceptable analysis methods, refer to the UMC Extension Soil and Plant Testing Laboratory at https://extension.missouri.edu/programs/soil-and-plant-testing-laboratory .

For soil test analyses, use laboratories successfully meeting the requirements and performance standards of the Missouri Soil Testing Association accreditation program. A current list of accredited laboratories can be found at the UMC Extension Soil and Plant Testing Laboratory website https://extension.missouri.edu/programs/soil-and-plant-testing-laboratory/spl-missouri-soil-accreditation-program .

Maintain soil pH within ranges which enhance the adequate level for plant or crop nutrient availability and utilization. Refer to UMC Extension Guide Sheet G9102 Liming Missouri Soils for additional guidance. Acceptable liming material are those approved by the Missouri Ag Lime Control Service (see http://aes.missouri.edu/pfcs/index.stm).

Avoid soil sampling within six months following the application of a phosphorus nutrient source or an agricultural lime application.

Manure, organic by-product, and biosolids testing and analysis
Collect, prepare, store, and ship all manure, organic by-products, and biosolids following UMC Extension guidance or industry practice when recognized by UMC Extension. Collect manure, organic by-product, and biosolids samples annually, as a minimum. Test all unique sources of manure for the following: total nitrogen, ammonium-nitrogen, total phosphorus, total potassium, and percent solids. If excessive salt concentrations are a concern, analyze the manure sample's electrical conductivity. When substantial annual variation in nutrient concentrations occurs, sample manure source more than once per year.

When planning for new or modified livestock operations, and manure tests are not available yet, use the output and analyses from similar operations in the geographical area if they accurately estimate nutrient output from the proposed operation or use "book values" recognized by the Natural Resources Conservation Service (NRCS) and UMC Extension (e.g., NRCS Agricultural Waste Management Field Handbook and Midwest Plan Service No. 18, Section 1 (2nd Edition), Manure Characteristics). Obtain and analyze manure samples within a year of beginning new or modified livestock operation.

For manure analyses, use laboratories successfully meeting the requirements and performance standards of the Manure Testing Laboratory Certification program under the auspices of the Minnesota Department of Agriculture or other NRCS-approved program that considers laboratory performance and proficiency to assure accurate manure test results.

For nutrient management plans developed as a component of a comprehensive nutrient management plan for an animal feeding operation (AFO) follow policy in NRCS directive General Manual (GM) 190,

Part 405, “Comprehensive Nutrient Management Plans.” These plans must include documentation of all nutrient imports, exports, and on-farm transfers.

Nutrient loss risk assessments
Use current NRCS-approved nitrogen, phosphorus, and soil erosion risk assessment tools to assess the site-specific risk of nutrient and soil loss.

Complete the Ecological Sciences (ECS) Tool Missouri Nitrogen Leaching Index (N-LI) risk assessment for nitrogen on all fields where nutrient management is planned. The ECS N-LI is located on the Field Office Technical Guide (FOTG) in Section 4 - Practice Standards and Supporting Documents, Ecological Sciences Tools.

Complete the ECS Tool Missouri Phosphorus Index (P-Index) risk assessment for phosphorus when any of the following conditions are met—

- Phosphorus application rate exceeds UMC Extension fertility rate recommendations for the planned crop(s).
- The planned area is within a phosphorus-impaired watershed.
- The site-specific conditions equating to low risk of phosphorus loss have not been determined by the NRCS in cooperation with the Missouri Department of Natural Resources (MoDNR).

Any fields excluded from a phosphorus risk assessment must have a documented agronomic need for phosphorus based on soil test phosphorus and UMC Extension nutrient recommendations.

For fields receiving manure, where phosphorus risk assessment results equate to—

- LOW risk.—Manure can be applied at rates to supply phosphorus at greater than crop requirement not to exceed the nitrogen requirement for the succeeding crop.
- MODERATE risk.—Manure can be applied at rates to supply phosphorus at greater than crop requirement not to exceed the nitrogen requirement for the succeeding crop. **The nutrient management plan must describe actions to delay or prevent accumulating soil phosphorus to the HIGH risk category**.
- HIGH risk.—Manure can be applied at rates not to exceed crop phosphorus removal rate if the following requirements are met:
  - A soil phosphorus drawdown strategy has been developed, documented, and implemented for the crop rotation.
  - Implementation of all mitigation practices determined to be needed by site-specific assessments for nutrients and soil loss to protect water quality.
  - Any deviation from these high-risk requirements that would increase the risk of phosphorus runoff requires the approval of the Chief of the NRCS.
- VERY HIGH risk. - Do not apply phosphorus from any source including fertilizer and manure.

The Missouri P-Index is located is located in FOTG Section 4 - Practice Standards and Supporting Documents, Ecological Sciences Tools.

The 4Rs of nutrient stewardship
Manage nutrients based on the 4Rs of nutrient stewardship—apply the right nutrient source at the right rate at the right time in the right place—to improve nutrient use efficiency by the crop and to reduce nutrient losses to surface and groundwater and to the atmosphere.

Nutrient source
Choose nutrient sources compatible with application timing, tillage and planting system, soil properties, crop, crop rotation, soil organic content, and local climate to minimize risk to the environment. Refer to 590 PS Nutrient Management for additional information.

Determine nutrient values of all nutrient sources (e.g. commercial fertilizers, manure, organic by-products, biosolids) prior to land application.

Determine nutrient contribution of cover crops, previous crop residues, legumes crops, and soil organic matter.

For operations following USDA's National Organic Program, apply and manage nutrient sources according to program regulations.

For enhanced efficiency fertilizer (EEF) products, use products defined by the Association of American Plant Food Control Officials as EEF and recommended for use by UMC Extension.

In areas where salinity is a concern, select nutrient sources that limit the buildup of soil salts. When manures are applied, and soil salinity is a concern, monitor salt concentrations to prevent potential plant or crop damage and reduced soil quality.

Apply manure or organic by-products on legumes at rates no greater than UMC Extension estimated nitrogen removal rates in harvested plant biomass, not to exceed phosphorus risk assessment limitations.

For any single application of nutrients applied as liquid (e.g., liquid manure, nutrients in irrigation water, fertigation)—

- Do not exceed the soil's infiltration rate or water holding capacity.
- Apply so that nutrients move no deeper than the current crop rooting depth.
- Avoid runoff or loss to subsurface tile drains.

Nutrient rate

Plan nutrient application rates for nitrogen, phosphorus, and potassium using UMC Extension recommendations or industry practices when recognized by UMC Extension. Lower-than-recommended nutrient application rates are permissible if the client's objectives are met.

At a minimum, determine the rate based on crop/cropping sequence, current soil test results, and NRCS-approved nutrient risk assessments. Where applicable, use realistic yield goals.

For new crops or varieties where UMC Extension guidance is unavailable, industry-demonstrated yield and nutrient uptake information may be used.

Estimate realistic yield potentials or realistic yield goals using UMC Extension procedures or based on historical yield or growth data, soil productivity information, climatic conditions, nutrient test results, level of management, and/or local research results considering comparable management and production conditions. Refer to 590 PS Nutrient Management for additional information.

Nutrient application timing and placement

Consider the nutrient source, management and production system limitations, soil properties, weather conditions, drainage system, soil biology, and nutrient risk assessment to develop optimal timing of nutrients. For nitrogen, time the application as closely as practical with plant and crop uptake. For phosphorus, time planned surface application when runoff potential is low. Time the application of all nutrients to minimize potential for soil compaction.

For crop rotations or multiple crops grown in one year, do not apply additional phosphorus if it was already added in an amount sufficient to supply all crop nutrient needs. Refer to 590 PS Nutrient Mangement for more information.

To avoid salt damage, follow UMC Extension recommendations for the timing, placement, and rate of applied nitrogen and potassium in starter fertilizer or follow industry practice recognized by UMC Extension.

Do not surface apply nutrients when there is a risk of runoff, including when—

- Soils are frozen.
- Soils are snow-covered.
- The top 2 inches of soil are saturated.

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

Apply conservation practices to avoid nutrient loss and control and trap nutrients before they can leave the field(s) by surface, leaching, or subsurface drainage (e.g., tile, karst) when there is a significant risk of transport of nutrients.

Additional Criteria to Reduce the Risk of Potential Pathogens From Manure, Biosolids, or Compost Application From Reaching Surface and Groundwater

When applicable, follow proper biosecurity measures as provided in NRCS directives GM-130, Part 403, Subpart H, “Biosecurity Preparedness and Response.”

Follow all applicable Federal, Tribal, State, and local laws and policies concerning the application of manure, biosolids, or compost in the production of fresh, edible crops.

Apply manure, biosolids, or compost with minimal soil disturbance or by injection into the soil unless it is being applied to an actively growing crop, a minimum of 30 percent residue exists, or there is a living cover that has a fibrous root system with 75 percent or more cover. Do not surface apply manure if a storm event is forecast within 24 hours.

Additional Criteria to Reduce Emissions of Objectionable Odors, PM and PM Precursors, and GHG and Ozone Precursors

To address air quality concerns caused by odor, nitrogen, sulfur, and particulate emissions; adjust the source, timing, amount, and placement of nutrients to reduce the negative impact of these emissions on the environment and human health.

Do not surface apply solid nutrient sources, including commercial fertilizers, manure, or organic by-products of similar dryness/density when there is a high probability that wind will blow the material and emissions offsite. Do not surface apply liquid nutrient sources when there is a high probability that wind will blow the liquid droplets applied from sprinklers or other applicable methods offsite.

Reduce the potential for volatilization by applying sources subject to volatilization during cooler, higher humidity conditions or by placement that minimizes vulnerability to volatilization.

Additional Criteria to Improve or Maintain Organic Matter

Design the plant or crop management systems so the soil conditioning index (SCI) organic matter subfactor is positive.

Apply manure, compost, or other organic nutrient sources at a rate and with minimal disturbance that will improve soil organic matter without exceeding acceptable risk of nitrogen or phosphorus loss.

For low residue plant or cropping systems, apply adequate nutrients to optimize plant or crop residue production to maintain or increase soil organic matter.

CONSIDERATIONS

General Considerations

Consider development of nutrient management plans by conservation management unit (CMU). A CMU is a field, group of fields, or other land units of the same land use and having similar treatment needs and planned management. A CMU is a grouping by the planner to simplify planning activities and facilitate development of conservation management systems. A CMU has definitive boundaries such as fencing, drainage, vegetation, topography, or soil lines.

Develop site-specific yield maps using a yield monitoring system, multispectral imagery or other methods. Use the data to further delineate low- and high-yield areas, or zones, and make the necessary management changes. Use variable rate nutrient application based on site-specific factor variability. See NRCS directive Agronomy Technical Note (TN) 190, AGR.3, “Precision Nutrient Management Planning”.

Use the adaptive nutrient management learning process to improve nutrient use efficiency on farms as outlined in NRCS’ national nutrient policy in GM-190, Part 402, “Nutrient Management”. Consider using an adaptive approach to adjust nutrient rate, timing, form, and placement as soil biologic functions and soil organic matter changes over time. See NRCS directive Agronomy Technical Note (TN) 190, AGR.7, “Adaptive Nutrient Management Process”.

When developing new nutrient management plans, consider using soil test information no older than 1 year rather than 2 years.

If soil test levels have been building rapidly or if a significant application of nutrients in fertilizer or manure was made, shorten the soil test interval to less than 4 years.

Modify the soil sampling method to address special production or environmental concerns when permanent vegetative cover or long-term no-till is used in combination with surface-applied nutrients. Shallow sampling for pH and phosphorus may be warranted.

Develop a whole farm nutrient budget (nutrient mass balance), including all imported and exported nutrients. Imports may include feed, fertilizer, animals and bedding, while exports may include crop removal, animal products, animal sales, manure, and compost.

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

Provide a nutrient analysis of all nutrient source exports (manure or other materials).

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).

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

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

Use bioreactors and multistage drainage strategies to mitigate nutrient loss pathways, as applicable.

Use legume crops and cover crops to provide nitrogen through biological fixation. Cover crops with a carbon to nitrogen ratio below 20:1 can release a large amount of soluble nitrogen after being plowed or tilled into the soil when an actively growing crop is not present to take up nutrients, leading to increased risks of nitrate movement and nitrous oxide emissions. The nitrous oxide emissions often occur in high soil moisture conditions, such as when a legume cover crop is plowed down in fall or early spring. To avoid these losses, use grass-legume or grass-legume-forbs mixtures with a more balanced carbon to nitrogen ratio.

Use winter hardy grass cover crops to take up excess nitrogen after the cash crop growing season and promote contribution of the nitrogen to next plant or crop.

Use conservation practices that slow runoff, reduce erosion, and increase infiltration (e.g., filter strip, contour farming, or contour buffer strips).

Use application methods, timing, technologies or strategies to reduce the risk of nutrient movement or loss, such as—

- Split nutrient applications.
- Banded applications.
- Injection of nutrients below the soil surface.
- Incorporate surface-applied nutrient sources when precipitation capable of producing runoff or erosion is forecast within the time of a planned application.
- High-efficiency irrigation systems and technology.
- Enhanced efficiency fertilizers
    - Slow or controlled release fertilizers
    - Nitrification inhibitors
    - Urease inhibitors.
- Drainage water management.
- Tissue testing, chlorophyll meters, or real-time sensors.
- Pathogen management considerations.

When a recycled product (e.g., compost) is to be used as a nutrient source on food crops or as food for humans or animals, make sure that pathogen levels have been reduced to acceptable levels (reference the Food and Drug Administration's Food Safety Modernization Act at www.fda.gov/FSMA). When the recycled product has come from another farming operation, implement biosecurity measures and evaluate the risk of pathogen transfer that could cause plant or animal diseases.

Use manure treatment systems that reduce pathogen content from manure.

Implementing a soil health management system that reduces tillage or other soil disturbance, includes a diverse rotation of crops and cover crops, keeps roots growing throughout the year, and keeps the soils covered to reduce nutrient losses, and improves—

- Nutrient use efficiency, rooting depth, and availability of nutrients.
- Soil organic matter levels.
- Availability of nutrients from organic sources.
- Aggregate stability and soil structure.
- Infiltration, drainage, and aeration of the soil profile.
- Soil biological activity.
- Water use efficiency and available moisture.

Use targeted or prescribed livestock grazing to enhance nutrient cycling and improve soil nutrient cycling functions.

Elevated soil test phosphorus levels may lead to reduced mycorrhizal fungal associations and immobilize some micronutrients, such as iron, zinc, and copper.

Apply manure, compost, or other nutrient sources with minimal soil disturbance and at a rate that will improve soil organic matter without exceeding acceptable risk of nitrogen or phosphorus loss.

PLANS AND SPECIFICATIONS

In the nutrient management plan, document—

- Aerial site photograph(s), imagery, topography, or site map(s).
- Soil survey map of the site.
- Soil information including: soil type, surface texture, drainage class, permeability, available water capacity, depth to water table, restrictive features, and flooding and ponding frequency.
- Location of designated sensitive areas and the associated nutrient application restrictions and setbacks including sensitive areas on adjacent properties affected by setbacks.
- Location of nearby residences, or other locations where humans may be present on a regular basis, that may be impacted if odors or PM are transported to those locations.
- Results of approved risk assessment tools for nitrogen, phosphorus, and erosion losses.
- Documentation establishing the application site presents a low risk for phosphorus transport to local water if phosphorus is applied in excess of crop requirement.
- Current and planned plant production sequence or crop rotation.
- All available test results (e.g. soil, water, compost, manure, organic by-product, and plant tissue sample analyses) upon which the nutrient budget and management plan are based.
- When soil phosphorus levels are increasing above an agronomic level, include a discussion of the risk associated with phosphorus accumulation and a proposed phosphorus draw-down strategy.
- Realistic yield goals for the crops (where applicable for developing the nutrient management plan).
- Nutrient recommendations for nitrogen, phosphorus, and potassium for the entire plant production sequence or crop rotation.
- Listing, quantification, application method and timing for all nutrient sources (including all enhanced efficiency fertilizer products) that are planned for use and documentation of all nutrient imports, exports, and onsite transfers.
- Guidance for implementation, operation and maintenance, and recordkeeping.

For variable rate nutrient management plans, also include—

- Geo-referenced field boundary and data collected that was processed and analyzed as a GIS layer or layers to generate nutrient or soil amendment recommendations per management zone. Must include site-specific yield maps using soils data, current soil test results, and a yield monitoring system with GPS receiver to correlate field location with yield.
- 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.
- After implementation, 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 nutrient or soil amendment applications.

If increases in soil phosphorus levels are expected above an agronomic level (i.e., when nitrogen-based rates are used), document—

- Soil phosphorus levels at which it is desirable to convert to phosphorus-based planning.
- A long-term strategy and proposed implementation timeline for soil test phosphorus drawdown from the production and harvesting of crops.
- Management activities or techniques used to reduce the potential for phosphorus transport and loss.
- For AFOs, a quantification of manure produced in excess of crop nutrient requirements. Determine the land required (in acres) to utilize nutrients generated by the AFO, based on the crop sequence, for both nitrogen- and phosphorus-based planning limits.

OPERATION AND MAINTENANCE

Review or revise plans periodically to determine if adjustments or modifications are needed. At a minimum, review and revise plans as needed with each soil test cycle, changes in manure management, volume or analysis, plants and crops, or plant and crop management.

Monitor fields receiving animal manures and biosolids for the accumulation of heavy metals and phosphorus in accordance with UMC Extension guidance and State law.

For animal feeding operation, significant changes in animal numbers, management, and feed management will necessitate additional manure analyses to establish a revised average nutrient content.

Calibrate application equipment to ensure accurate distribution of material at planned rates. For products too dangerous to calibrate, follow UMC Extension or equipment manufacturer guidance on proper equipment design, plumbing, and maintenance.

Document the nutrient application rate. When the applied rate differs from the planned rate, provide appropriate documentation to explain the difference.

Protect workers from and avoid unnecessary contact with nutrient sources. Take extra caution when handling anhydrous ammonia or when managing organic wastes stored in unventilated tanks, impoundments, or other enclosures.

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

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

Maintain records for at least 5 years to document plan implementation and maintenance. Records must include—

- All test results (soil, water, compost, manure, organic by-product, and plant tissue sample analyses) upon which the nutrient management plan is based.
- Listing and quantification of all nutrient sources (including all enhanced efficiency fertilizer products) that are planned for use and documentation of all nutrient imports, exports and onsite transfers.
- Date(s), method(s), and location(s) of all nutrient applications.
- Weather conditions and soil moisture at the time of application, elapsed time from manure application to rainfall or irrigation event(s).
- Plants and crops planted, planting and harvest dates, yields, nutrient analyses of harvested biomass, and plant or crop residues removed.
- Dates of plan review, name of reviewer, and recommended adjustments resulting from the review.

For variable rate nutrient management plans, also include—

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

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