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 or organic by-products as a plant nutrient source
- 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. This standard does not apply to one-time nutrient applications to establish perennial crops.

CRITERIA

General Criteria Applicable to All Purposes

A nutrient budget for nitrogen, phosphorus, and potassium must be developed that considers all potential sources of nutrients including, but not limited to, green manures, legumes, crop residues, compost, animal manure, organic by-products, biosolids, waste water, organic matter, soil biological activity, commercial fertilizer, and irrigation water.

Enhanced efficiency fertilizers used in Colorado must be defined by the Association of American Plant Food Control Officials (AAPFCO) and be accepted for use by the Colorado Department of Agriculture, Fertilizer Program.

For nutrient risk-assessment policy and procedures, see General Manual (GM), Title 190, Part 402, Nutrient Management, and National Instruction (NI), Title 190, Part 302, Nutrient Management Policy Implementation.

To avoid salt damage, the rate and placement of applied nitrogen and potassium in starter fertilizer must be consistent with Colorado State University (CSU) guidelines, or industry practice if recognized by CSU.

Completion of a Colorado Nitrogen Leaching Index Risk Assessment is required for each field and soil test cycle unless the Preliminary Nitrogen Leaching Risk Screening Tool indicates that a risk assessment is not necessary.

Completion of a Colorado Phosphorus Index Risk Assessment is required for each field and soil test cycle when any of the following conditions apply.

- The planned phosphorus (P_2O_5) application rate exceeds CSU fertility rate guidelines for the planned crop, or
- The site is located within a phosphorus-impaired watershed (contributes to 303d-listed water bodies), or
- The Preliminary Phosphorus Risk Screening Tool directs the planner to complete a Phosphorus Index Risk Assessment.

For certified organic operations, nutrient sources and management must be consistent with USDA National Organic Program requirements.

Manage areas located within minimum application setbacks such as sinkholes, wellheads, gullies, ditches or surface inlets, according to applicable setback restrictions.

Manage irrigation water to minimize nutrient losses to surface and groundwater resources.

Maintain soil pH in a range that enhances crop nutrient availability and utilization. Refer to CSU Extension recommendations for specific guidance.

Soil, Manure, and Tissue Sampling and Laboratory Analyses (Testing)
Base nutrient management plans on current soil, manure, and (where used for supplemental information) tissue test results developed in accordance with CSU Extension guidance, or industry practice, if recognized by CSU.

For nutrient management plans that do not include organic nutrient applications, a current soil-test is no older than 3 years.

For nutrient management plans that include organic nutrient applications, a current soil-test is no older than 1 year.

The land area represented by a soil test must be consistent with CSU Extension recommendations.

Where a conservation management unit (CMU) is the basis for a soil-sampling unit, all acreage within the CMU must have a similar soil type, cropping history and management.

Soil and tissue tests must include analyses pertinent to monitoring or amending the annual nutrient budget, e.g., pH, electrical conductivity (EC) and sodicity where salts are a concern, soil organic matter, nitrogen, phosphorus, potassium and other micronutrients, as needed, to develop a nutrient application recommendation. Follow CSU Extension guidelines regarding required analyses.

Soil test analyses must be performed by laboratories successfully meeting the requirements and performance standards of the North American Proficiency Testing Program-Performance Assessment Program (NAPT-PAP) under the auspices of the Soil Science Society of America (SSSA), or other NRCS-approved program that considers laboratory performance and proficiency to assure accuracy of soil test results. Alternate proficiency testing programs must have solid stakeholder support and be regional in scope.

Nutrient values of manure, compost, organic by-products, biosolids and other organic amendments must be determined prior to land application.

Organic nutrient analyses must include, as a minimum, total nitrogen (N), ammonium N, total phosphorus (P) or P_2O_5, total potassium (K) or K_2O, and percent solids, or follow CSU guidance regarding required analyses.

Manure, compost, organic by-products, biosolids, and other organic amendment samples must be collected and analyzed at least annually, or more frequently if needed to account for operational changes (feed management, animal type, manure handling strategy, etc.) impacting organic nutrient concentrations. If no operational changes occur, less frequent manure testing is allowable where operations can document a stable level of nutrient concentrations for the preceding three consecutive years, unless federal, State, or local regulations require more frequent testing.

Collect, prepare, store and ship organic nutrient samples following land-grant university guidance or industry practice.

When planning for new or modified livestock operations, acceptable “book values” recognized by the NRCS (e.g., NRCS Agricultural Waste Management Field Handbook) and CSU, or analyses from similar operations in the geographical area, may be used for initial planning if they accurately estimate nutrient outputs from the proposed operation.

Manure testing analyses must be performed by laboratories successfully meeting the requirements and performance standards of the Manure Testing Laboratory Certification Program (MTLCP) 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.

Nutrient Application Rates
Planned nutrient application rates for nitrogen, phosphorus and potassium must not exceed CSU recommendations or industry practice when recognized by CSU.

At a minimum, determination of rate must be based on crop/cropping sequence, current soil test results, realistic yield goals, and NRCS-approved nutrient risk assessments.

If the land-grant university does not provide specific guidance that meets these criteria, plan application rates based on realistic yield goals and associated plant-nutrient uptake rates.

Establish realistic yield goals based on historical yield data, soil productivity information, climatic conditions, nutrient test results, level of management and local research results considering comparable production conditions. CSU Extension considers a realistic yield goal as a 5-year average for the field plus 5% for above normal growing conditions.

Estimates of yield response must consider factors such as poor soil quality, drainage, pH, salinity, etc., prior to assuming that nitrogen and/or phosphorus are deficient.

For new crops or varieties, industry-demonstrated yield and nutrient utilization information is acceptable if CSU Extension fertility recommendations are not available.

Lower-than-recommended nutrient application rates are acceptable provided they meet the grower's objectives.

Account for applications of biosolids, starter fertilizers and pop-up fertilizers in the nutrient budget.

Nutrient Sources
Nutrient sources utilized must be compatible with the application timing, tillage and planting system, soil properties, crop, crop rotation, soil organic matter content and local climate, to minimize environmental risk.

Nutrient Application Timing and Placement
Timing and placement of all nutrients must correspond as closely as practical with plant nutrient uptake (utilization by crops), and consider nutrient source, cropping system limitations, soil properties, weather conditions, drainage system, soil biology, and nutrient risk assessment results.

Nutrients must not be surface-applied if nutrient losses offsite are likely. This precludes spreading on:

- frozen and/or snow-covered soils, and
- when the top 2 inches of soil are saturated from rainfall or snow melt.

As an exception to the above criteria, winter application of surface-applied organic nutrients is acceptable if a Phosphorus Index Risk Assessment for the site indicates there is a low risk of phosphorus movement off-site, and required set back distances are maintained to protect water quality.

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

Planners must use current NRCS-approved nitrogen, phosphorus and soil erosion risk-assessment tools to evaluate the risk of nutrient and soil loss, and address identified resource concerns to meet current Field Office Technical Guide, Section III, Quality Criteria.

When there is a high risk of nutrient transport off-site, conservation practices must be coordinated to avoid, control or trap nutrients before they can leave the field by surface or subsurface drainage (e.g., tile). Additionally, consider the number of nutrient applications and corresponding application rates to limit nutrient transport to drain tile.

Nutrients must be applied with the right placement, in the right amount, at the right time, and from the right source (4 Rs) to minimize nutrient losses to surface and groundwater. The following nutrient-use efficiency strategies or technologies must be considered:

- slow and controlled release fertilizers
- nitrification and urease inhibitors
- enhanced efficiency fertilizers
- incorporation or injection
- timing and number of applications
- soil nitrate and organic N testing
- coordinate nutrient applications with optimum crop nutrient uptake
- Corn Stalk Nitrate Test (CSNT), Pre-Sidedress Nitrate Test (PSNT), and Pre-Plant Soil Nitrate Test (PPSN)
- tissue testing, chlorophyll meters, and spectral analysis technologies
- other CSU Extension recommended technologies to improve nutrient use efficiency and minimize surface or groundwater resource concerns.

Additional Criteria to Properly Utilize Manure or Organic By-Products as a Plant Nutrient Source

When manures are applied and soil salinity is a resource concern, monitor manure and soil salt concentrations to prevent potential crop damage and/or reduced soil quality.

The total single application of liquid manure:

- must not exceed the soil's infiltration or water holding capacity
- be based on crop rooting depth
- must be adjusted to avoid runoff or loss to subsurface tile drains.

Crop production activities and nutrient use efficiency technologies must be coordinated to take advantage of mineralized plant-available nitrogen to minimize the potential for nitrogen losses due to denitrification or ammonia volatilization.

Plan organic nitrogen and phosphorus application rates based on risk assessment results from NRCS-approved nitrogen and phosphorus risk-assessment tools.

For fields receiving organic nutrients where the risk of phosphorus movement off-site is LOW, additional phosphorus and potassium may be applied at rates greater than crop requirements not to exceed the nitrogen requirement for the planned crop.

For fields receiving organic nutrients where the risk of phosphorus movement off-site is MODERATE, organic nutrients may be applied at a phosphorus crop requirement rate for the planned crop.

For fields receiving organic nutrients where the risk of phosphorus movement off-site is HIGH, organic nutrients may be applied at phosphorus crop removal rates if the following requirements are met:

- a soil phosphorus drawdown strategy has been implemented to remove more phosphorus than is applied, and
- a site assessment for nutrients and soil loss has been conducted to determine if mitigation practices are required to protect water quality.

Any deviation from these requirements for high-risk sites must have the approval of the Chief of the NRCS.

Manure and other organic nutrients may be applied on legumes at rates equal to the estimated annual removal of nitrogen in harvested plant biomass, not to exceed CSU Extension recommendations.

Manure may be applied at a rate equal to the recommended phosphorus application, or estimated phosphorus removal in harvested plant biomass for the crop rotation, or multiple years in the crop sequence at one time. When such applications are made, the application rate must not exceed the acceptable phosphorus risk assessment criteria, must not exceed the recommended nitrogen application rate during the year of application or harvest cycle, and no additional phosphorus must be applied in the current year and any additional years for which the single application of phosphorus is supplying nutrients.

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; the source, timing, amount, and placement of nutrients must be adjusted to minimize the negative impacts of these emissions on the environment and human health.

One or more of the following products and management strategies may be used to address air quality concerns.

- slow or controlled release fertilizers
- nitrification inhibitors
- urease inhibitors
- nutrient enhancement technologies
- incorporation
- injection
- stabilized nitrogen fertilizers
- residue and tillage management
- no-till or strip-till
- other technologies that minimize the impact of these emissions

Do not apply poultry litter, compost, manure or other organic nutrients of similar dryness/density when there is a high probability that wind will blow the materials offsite.

To minimize ammonia volatilization when tillage is an option, incorporate surface applied manure, compost, biosolids, other organic nutrients and fertilizer nitrogen into the soil within 24 hours.

When applying manure, compost, biosolids, other organic nutrients or fertilizer nitrogen to grassland, hayland, pasture or minimum-till areas, manage the rate, form and timing of application(s) to minimize volatilization losses.

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

Time the application of nutrients to avoid periods when field activities will result in soil compaction.

In areas where salinity is a concern, select nutrient sources that minimize the buildup of soil salts.

CONSIDERATIONS

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

Use nutrient management strategies such as legume cover crops and crop rotations with perennials to improve nutrient cycling and reduce energy inputs.

Variable-rate nitrogen application based on expected crop yields, soil variability, soil nitrate or organic N supply levels, chlorophyll concentration and management zones can decrease nitrogen input costs.

Variable-rate nitrogen, phosphorus and potassium application rates based on site-specific variability in crop yield, soil characteristics, soil test values, management zones and other soil productivity factors can decrease fertilizer input costs.

Site-specific yield maps developed using a yield monitoring system can help diagnose low- and high- yield areas, or zones, and make necessary management changes. See Title 190, Agronomy Technical Note (TN) 190.AGR.3, Precision Nutrient Management Planning.

Manure management conservation practices such as incorporation can limit nutrient losses prior to crop nutrient utilization.

Apply organic nutrients at rates that will increase the site-specific Soil Conditioning Index (SCI) rating, without exceeding acceptable risk of nitrogen or phosphorus losses.

Legume and deep-rooted cover crops in rotation can provide crop nitrogen through atmospheric dinitrogen fixation and recycling of nutrients lost below the rootzone of the previous crop.

Livestock feed rations can affect the nutrient content of manure. Consider a review of feed rations by a livestock nutritionist before making adjustments to decrease manure nutrient content.

Soil test information should be no older than 1 year for developing new plans for inorganic systems.

Excessive levels of some nutrients can cause deficiencies of other nutrients, e.g., high soil test phosphorus can induce zinc deficiency in corn.

Soil tests, plant tissue analyses and field observations can help identify secondary plant nutrient deficiencies or toxicities, which may adversely affect plant growth or availability of primary nutrients.

The application of adaptive nutrient management strategies may improve crop nutrient-use efficiency.

Potassium should not be applied when an excess (greater than soil test potassium recommendation) can cause a nutrient imbalance in crops or forages.

Workers should be protected from and avoid unnecessary contact with plant nutrient sources including anhydrous ammonia and organic wastes stored in unventilated enclosures.

Material generated from cleaning nutrient application equipment should be collected and stored or field applied in an appropriate manner.

Nutrient containers should be recycled in compliance with State and local guidelines or regulations.

Considerations to Minimize Agricultural Nonpoint Source Pollution of Surface and Groundwater Resources

Application of conservation practices that decrease runoff and erosion can increase infiltration and nitrate-leaching potential.

The following application methods and timing and management strategies can decrease the risk of nutrient transport to surface and groundwater resources.

- Split apply nitrogen to deliver nutrients during periods of maximum crop utilization
- Band applications of nitrogen and/or phosphorus can improve nutrient availability
- Drainage water management can decrease nutrient discharge through drainage systems
- Incorporation of surface-applied organic nutrients can decrease nutrient runoff.

Agricultural chemical storage facilities can help protect soil, water and air quality.

Consider nutrient management strategies and coordination with public water systems and governments in locally derived source water protection planning areas or drinking water supply areas, as defined by source water assessment-areas. Contact the Colorado Source Water Assessment and Protection program (SWAP) at the Colorado Department of Public Health and Environment (CDPHE) for protection planning and GIS shape file information.

Considerations to protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
For odor concerns, avoid manure applications upwind of occupied structures when residents are likely to be home (evenings, weekends and holidays).

The urease enzyme controls hydrolysis, the process of converting urea to ammonia, and urease activity is higher in plant litter than in soil. Consequently, ammonia volatilization can increase when surface broadcasting nitrogen fertilizer over no-till fields or to stubble or straw. Moving litter to the side on no-till and placing urea in direct contact with the soil or injecting fertilizer below the litter layer, can decrease ammonia-volatilization loss potential.

Ammonia volatilization potential increases with increasing temperature and wind speed.

Irrigation or precipitation following organic nutrient or urea fertilizer applications can decrease ammonia volatilization potential, but may increase nitrate leaching potential and nitrous oxide emissions.

For liquid manure or effluent applications with irrigation equipment, system modifications such as reduced pressure and drop nozzles can decrease potential ammonia volatilization from the time the material leaves the application equipment until it reaches the surface of the soil.

Application of liquid manures or effluents under a crop canopy can also decrease ammonia volatilization potentials.

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

To minimize ammonia volatilization when tillage is not an option for no-till or pasture and hayland, select liquid urea-ammonium nitrate as an N source rather than granular urea.

Incorporation of fertilizer materials into the soil to decrease ammonia volatilization can increase carbon dioxide emissions.

PLANS AND SPECIFICATIONS

Develop plans and specifications for each field or treatment unit according to the Criteria and Operation and Maintenance Sections of this standard.

Record practice specification on a Colorado Nutrient Management 590 Job Sheet.

The following components must be included in the nutrient management plan.

- Aerial site photograph(s)/imagery or site map(s), and a soil survey map of the site
- Soil information including: soil type surface texture, pH, drainage class, saturated hydraulic conductivity, available water capacity, depth to water table, restrictive features, and flooding and/or ponding frequency
- Location of designated sensitive areas and the associated nutrient application restrictions and setbacks
- For manure 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 approved risk assessments for nitrogen, phosphorus, and soil erosion

- Documentation that the application site presents a low risk for phosphorus transport when phosphorus is applied in excess of crop requirements
- Current and/or planned plant production sequence or crop rotation
- Results of soil, water, organic nutrient, and plant tissue sample analyses that are applicable to the plan
- If soil test phosphorus levels are increasing, include a discussion of the risks associated with phosphorus accumulation and a proposed phosphorus draw-down strategy
- Realistic yield goal for the planned crop
- Complete nutrient budget for nitrogen, phosphorus, and potassium
- Listing and quantification of all nutrient sources and forms
- Listing and quantification of all enhanced efficiency fertilizer products that are planned for use
- In accordance with the nitrogen and phosphorus risk assessment tool(s), specify the recommended nutrient application source, timing, amount (except for precision/variable rate applications specify method used to determine rate), and placement of plant nutrients for each field or management unit
- Guidance for implementation, operation and maintenance, and recordkeeping

In addition, the following components must be included in a precision/variable-rate nutrient management plan:

- Document the 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.
- 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.

If increases in soil phosphorus levels are expected (i.e., when N-based rates are used), the nutrient management plan must document:

- The soil phosphorus levels at which it is desirable to convert to phosphorus based planning
- The potential plan 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
- A long-term strategy and proposed implementation timeline for reducing soil P to levels that protect water quality

OPERATION AND MAINTENANCE

Conduct periodic plan reviews to determine if adjustments or modifications to the plan are needed. At a minimum, review plans with each soil test cycle and revise as needed based on changes in manure volume or analysis, crops, or crop management.

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

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.

Document applied nutrient application rates. When applied rates differ from planned rates provide appropriate documentation for the change.

Maintain records for at least 5 years to document plan implementation and maintenance. As applicable, records include:

- Soil, plant tissue, water, manure, and organic nutrient analyses resulting in recommendations for nutrient application
- Quantities, analyses and sources of nutrients applied
- Dates and method(s) of nutrient applications, source of nutrients, and rates of application
- Weather conditions and soil moisture at the time of application; lapsed time to manure incorporation; rainfall or irrigation event,
- Crops planted, planting and harvest dates, yields, nutrient analyses of harvested biomass, and amounts of crop residues removed
- Dates of plan review, name of reviewer, and recommended changes resulting from the review
- All enhanced efficiency fertilizer products used

Additional records for precision/variable rate sites must include:

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

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