NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT

(Acre)

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 conditions 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 and legume credits
- Crop residues
- Compost
- Animal manure
- Municipal and industrial bio-solids and other organic by-products
- Waste water
- Organic matter and soil nutrient availability
- Soil biological activity
- Commercial fertilizer
- Irrigation water

Enhanced efficiency fertilizers used in Kansas must be defined by the Association of American Plant Food Control Officials (AAPFCO), and be accepted for use by the Kansas Fertilizer Control official, or similar authority, with responsibility for verification of product guarantees, ingredients (by AAPFCO definition), and label claims.

When site erosion rates are greater than soil loss tolerance ("T"), a site assessment for nutrient and soil loss must be conducted to determine if mitigation practices are required to protect water quality.

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

The Natural Resources Conservation Service (NRCS) approved nutrient risk assessment for nitrogen must be completed on all sites unless the Kansas NRCS, with the concurrence of Kansas Water Quality Control authorities, has determined specific conditions where nitrogen leaching is not a risk to water quality, including drinking water.

The NRCS approved nutrient risk assessment for phosphorus must be completed when:

- Phosphorus application rate exceeds land-grant university fertility rate guidelines for the planned crop(s), **or**
- The planned area is within a phosphorus-impaired watershed (contributes to 303d-listed water bodies), **or**
- The NRCS and Kansas Water Quality Control authority have not determined specific conditions where the risk of phosphorus loss is low.

A phosphorus risk assessment will not be required when the Kansas NRCS, with concurrence of the Kansas State Water Quality Control authority, has determined specific conditions where the risk of phosphorus loss is low. These fields must have a documented agronomic need for phosphorus, based on soil test phosphorus (STP) and land-grant university nutrient recommendations.

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

On organic operations, the nutrient sources and management must be consistent with the USDA's National Organic Program.

Areas contained within minimum application setbacks (e.g., sinkholes, wellheads, gullies, ditches, or surface inlets) must receive nutrients consistent with the setback restrictions.

Applications of irrigation water must minimize the risk of nutrient loss to surface and groundwater.

Soil pH must be maintained in a range that enhances an adequate level for crop nutrient availability and utilization. Refer to KSU's documentation for guidance.

Soil, Manure, and Tissue Sampling and Laboratory Analyses (Testing)

Nutrient planning must be based on current soil, manure, and tissue test results (where used as supplemental information) developed in accordance with KSU guidance, or industry practice, if recognized by the university.

Current soil tests are those that are no older than three (3) years, unless otherwise required by federal, state, or local regulations. See the specification for "Guidelines for Soil Sampling" or http://www.ksre.ksu.edu/bookstore/pubs/mf2586.pdf. The 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, phosphorus, potassium, or other nutrients, and test for nitrogen where applicable. Follow KSU 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) and NRCS, or other NRCS approved programs that consider laboratory performance and proficiency to assure accuracy of soil test results.

Nutrient values of manure, organic by-products, and bio-solids must be determined prior to land application.

Manure analyses must include, at minimum, total nitrogen (N), ammonium N, total phosphorus (P) or P_2O_5, total potassium (K) or K_2O, and percent solids, or follow land-grant university guidance regarding required analyses.

Manure, organic by-products, and bio-solids 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 manure 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.

Samples must be collected, prepared, stored, and shipped, following KSU guidance MF 2562 "Estimating Manure Nutrient Availability" http://www.ksre.ksu.edu/bookstore/pubs/MF2562.pdf or industry practice.

When planning for new or modified livestock operations, acceptable "book values" recognized by NRCS (e.g., NRCS Agricultural Waste Management Field Handbook, Chapter 4, Animal Waste Characteristics) and KSU.

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.

Nutrient Application Rates

Planned nutrient application rates for nitrogen, phosphorus, and potassium must not exceed KSU guidelines or industry practice when recognized by the university.

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 KSU does not provide specific guidance that meets these criteria, application rates must be based on plans that consider realistic yield goals and associated plant nutrient uptake rates.

Realistic yield goals must be clearly documented for each field based on the average yield of the last five years using actual records, such as scale tickets, yield monitors, insurance yield documentation, or Farm Service Agency (FSA) certified yields plus 20%.

If actual records are not available, use the county average yields from FSA or National Agriculture Statistics plus 20%. The Soil Nutrient Assessment Program (SNAP) may be used in place of missing records. The chance of success after entering the yield goal must fall in the 50% or greater chance of success for the county and crop choice being considered.

For new crops or varieties, industry-demonstrated yield, and nutrient utilization information may be used until KSU information is available.

Lower-than-recommended nutrient application rates are permissible if the grower's objectives are met.

Applications of bio-solids, starter fertilizers, or pop-up fertilizers must be accounted for in the nutrient budget.

Nutrient Sources

Nutrient sources used must be 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.

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 consideration of 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 two inches of soil are saturated from rainfall or snow melt.

Exceptions for the above criteria can be made for surface-applied manure when specified conditions are met and adequate conservation measures are installed, to prevent the offsite delivery of nutrients, and will be authorized on a case by case basis with approval of the state resource conservationist.

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

Planners must use the current NRCS-approved nitrogen, phosphorus, and soil erosion risk assessment tools to assess the risk of nutrient and soil loss. Identified resource concerns must be addressed to meet current planning criteria. Technical criteria for risk assessments can be found in NI-190-302.

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

- Revised Soil Loss Equation 2 (RUSLE2) to estimate erosion
- Leaching index (LI) to determine the relative risk of N leaching to ground or surface water
- Phosphorus Index (PI) to estimate the risk that P will contaminate surface water. The PI is required when one or more of the following applies:
    - The phosphorus application rate exceeds land grant university fertility rate guidelines for planned crop(s) in the rotation
    - Manure, municipal or industrial bio-solids, and/or organic by-products are applied
    - Soil loss exceeds the tolerable level
    - The average soil test phosphorus for the field is in the very high range

When there is a high risk of transport of nutrients, conservation practices must be coordinated to avoid, control, or trap manure and nutrients, before they can leave the field by surface or subsurface drainage (e.g., tile). The number of applications and the application rates must also be considered to limit the transport of nutrients to tile.

For fields receiving manure where phosphorus risk assessment results equate to LOW risk, additional phosphorus and potassium can be applied at rates greater than crop requirement not to exceed the nitrogen requirement for the succeeding crop.

For fields receiving manure where phosphorus risk assessment results equate to MODERATE risk, additional phosphorus and potassium may be applied at a phosphorus crop requirement rate for the planned crops in the rotation.

When phosphorus risk assessment results equate to HIGH risk, additional phosphorus and potassium may be applied at phosphorus crop removal rates, if the following requirements are met:

- A soil phosphorus drawdown strategy has been implemented, **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 high risk requirements must have the approval of the Chief of the NRCS

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
- 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 meter (SPAD) for in-season nitrogen evaluation and to determine side-dress rates
- End-of-season corn stalk nitrate test to evaluate nitrogen management
- Other KSU demonstrated and/or accepted technologies that improve nutrient use efficiency and minimize surface or ground water resource concerns

The Four R's

Nutrients must be applied with the right placement, in the right amount, at the right time, and from the right source, 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 KSU recommended technologies that improve nutrient use efficiency and minimize surface or groundwater resource concerns

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

When manures are applied, and soil salinity is a concern, salt concentrations must be monitored 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 de-nitrification or ammonia volatilization.

Nitrogen and phosphorus application rates must be planned based on risk assessment results as determined by NRCS approved nitrogen and phosphorus risk assessment tools.

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.

Manure or organic by-products may be applied on legumes at rates equal to the estimated removal of nitrogen in harvested plant biomass, not to exceed land grant university recommendations.

Bio-solids (sewage sludge) shall be applied in accordance with EPA regulations (40 Code of Federal Regulations [CFR] Parts 403, Pretreatment, and 503, Bio-solids) as a nutrient source.

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 impact of these emissions on the environment and human health. One or more of the following may be used:

- 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, manure, or organic by-products of similar dryness/density when there is a high probability that wind will blow the material offsite.

When planning nutrient applications and tillage operations, encourage soil carbon buildup while discouraging greenhouse gas emissions (e.g., nitrous oxide [N_2O] and carbon dioxide [CO_2]).

Nutrient applications associated with irrigations systems should be applied in accordance with the requirements of Conservation Practice Standard 449, Irrigation Water Management.

When applying liquid forms of manure with irrigation equipment, select application conditions when there is high humidity, little/no wind, and/or other conditions that will minimize volatilization loss in the atmosphere.

Concentrated animal feeding operations (CAFOs) needing permits under Environmental Protection Agency (EPA) regulations (40 CFR, Parts 122, EPA Administered Permit Programs: The National Pollutant Discharge Elimination System, and 412, Concentrated Animal Feeding Operations (CAFO)

Point Source Category) should consult the Kansas Department of Health and Environment (KDHE) for additional criteria.

Additional Criteria to Improve or Maintain the Physical, Chemical, and Biological Condition of the Soil to Enhance Soil Quality for Crop Production and Environmental Protection

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.

Use of nutrient sources with high salt or sodium content relative to the nutrient value will be minimized to prevent damage to plants. Salt or sodium levels will be monitored by soil testing to see that they do not exceed the Electrical Conductivity (EC) rate for the crop to be grown. See table 13-3 in chapter 13 of the National Engineering Handbook (NEH), Part 652, Irrigation Guide, and KSU publication MF 1022 "Management of Saline and Sodic soils" http://www.ksre.ksu.edu/bookstore/pubs/mf1022.pdf.

Nutrients shall be applied and managed in a manner that maintains or improves the physical chemical and biological condition of the soil.

CONSIDERATIONS

Elevated soil test phosphorus levels are detrimental to soil biota. Soil test phosphorus levels should not exceed state approved soil test thresholds established to protect the environment.

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.

Soil test information should not be older than one year when developing new plans.

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.

Use the adaptive nutrient management learning process to improve nutrient use efficiency on farms as outlined in the NRCS' National Nutrient Policy in GM 190, Part 402, Nutrient Management.

Potassium should not be applied in situations where an excess (greater than soil test potassium recommendation) causes nutrient imbalances in crops or forages.

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

Variable Rate Nutrient Management

Use variable-rate nitrogen application based on expected crop yields, soil variability, soil nitrate or organic N supply levels, or chlorophyll concentration.

Use variable-rate nitrogen, phosphorus, and potassium application rates based on site-specific variability in crop yield, soil characteristics, soil test values, and other soil productivity factors.

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.

Considerations to Properly Utilize Manure, Bio-solids, and Other Organic By-products as a Crop Nutrient Source

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 592, Feed Management.

Safety

Workers should avoid and be protected from unnecessary contact with plant nutrient sources. Extra caution must be taken when handling anhydrous ammonia or when dealing with organic wastes stored in unventilated enclosures.

Material generated from cleaning nutrient application equipment should be used in an environmentally safe manner. Excess material 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.

Consider the development of a farm/operational safety plan with emergency phone numbers, farm addresses; post near business telephones and review with employees.

Considerations to Minimize Agricultural Nonpoint Source Pollution of Surface and Groundwater

Use conservation practices that slow runoff, reduce erosion, and increase infiltration; e.g., filter strip, contour farming, or contour buffer strips. These practices can also reduce the loss of nitrates or soluble phosphorus.

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
- Banded applications of nitrogen and/or phosphorus to improve nutrient availability
- Drainage water management to reduce nutrient discharge through drainage systems
- Incorporation of surface-applied manures or organic by-products if precipitation capable of producing runoff or erosion is forecast within the time of planned application

Use the agricultural chemical storage facility conservation practice to protect air, soil, and water quality.

Use bioreactors and multistage drainage strategies when approved by KSU.

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

Odors associated with the land application of manures and organic by-products can be offensive to the occupants of nearby homes. Avoid applying manure and other by-products upwind of inhabited areas.

When applying manure with irrigation equipment, modifying the equipment can reduce the potential for volatilization of nitrogen from the time the manure leaves the application equipment until it reaches the surface of the soil.

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

Considerations to Improve or Maintain the Physical, Chemical, and Biological Condition of the Soil to Enhance Soil Quality for Crop Production and Environmental Protection

Use a baseline test, such as the Haney Test, in order to determine the soil levels of nitrogen, phosphorus, and potassium, as well as the microbial activity, soil organic carbon, and the carbon to nitrogen balance to help improve the overall soil health before adding nutrients or manure.

This baseline will help to reduce the use of unnecessary application of nutrients by getting a better understanding of the available inorganic and organic nutrients available to plants.

Also consider using SNAP to optimize fertilizer application based on soil test results, historical crop yields, and current fertilizer prices to help improve efficiency in application of nutrients.

PLANS AND SPECIFICATIONS

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, permeability, 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
- 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 during manure applications
- Results of approved risk assessment tools for nitrogen, phosphorus, and erosion losses
- Documentation establishing that the application site presents low risk for phosphorus transport to local water when phosphorus is applied in excess of crop requirement
- Current and/or planned plant production sequence or crop rotation
- Soil, water, compost, manure, organic by-product, and plant tissue sample analyses applicable to the plan
- When soil phosphorus levels are increasing, include a discussion of the risk associated with phosphorus accumulation and a proposed phosphorus draw-down strategy
- Realistic yield goals for the crops
- Complete nutrient budget for nitrogen, phosphorus, and potassium for the plant production sequence or crop rotation
- Listing and quantification of all nutrient sources and form
- 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 geographic information system (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, plans must be reviewed and revised, as needed with each soil test cycle, changes in manure volume or analysis, crops, or crop management.

Fields receiving animal manures and/or biosolids must be monitored for the accumulation of heavy metals and phosphorus in accordance with KSU 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 the nutrient application rate. When the applied rate differs from the planned rate, provide appropriate documentation for the change.

Records must be maintained for at least five (5) years to document plan implementation and maintenance. As applicable, records include:

- Soil, plant tissue, water, manure, and organic by-product 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 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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