

**NATURAL RESOURCES CONSERVATION SERVICE**  
**CONSERVATION PRACTICE STANDARD**  
**NUTRIENT MANAGEMENT**

(Ac.)

**CODE 590**

**DEFINITION**

Managing the source, timing, amount (rate), and placement (method of application) 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 ground water 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 nitrous oxide) 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**

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

Nutrient applications shall be based on realistic yield goals. For new crops or varieties, industry demonstrated yield and nutrient utilization information may be used until Land Grant

University, or other refereed published information is available.

Plans for nutrient management shall specify the source, timing, amount, and placement of nutrients on each field or conservation management unit (CMU).

Only those nutrient enhancement products approved or concurred in by the Land Grant University shall be used.

The rate and placement of applied nitrogen and potassium in starter fertilizer, to avoid salt damage, shall be consistent with Land Grant University recommendations, or industry practice recognized by the Land Grant University.

Manure and/or organic by-products shall not be applied where existing phosphorus and potassium levels exceed ten times the critical soil test concentration ( the concentration at which no crop response can be expected with the addition of P and K), as established by the Land Grant University for the common crops in the planning area.

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

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

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

Applications of irrigation water shall not increase the risk of nutrient loss to surface and/or ground water.

### **Soil, Manure, and Tissue Sampling and Laboratory Analyses (Testing).**

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

Current soil tests are those that are no older than three years, or on an interval recommended by the Land Grant University or required by State code. The area represented by a soil test shall be that acreage recommended by the Land Grant University. Where a CMU is used as the basis for a sampling unit, all acreage in the CMU shall have similar soil characteristics, cropping history, and management practice treatment.

The soil tests shall 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, or other nutrients, or follow Land Grant University guidance regarding required analyses.

Soil test analyses shall be performed by laboratories successfully meeting the requirements and performance standards of the North American Proficiency Testing Program (NAPT) under the auspices of the Soil Science Society of America, or Agricultural Laboratory Proficiency Program (ALP), or other State approved program that considers laboratory performance and proficiency to assure accuracy of soil test results.

Nutrient values of manure and organic by-products, and biosolids shall be determined prior to land application.

Manure analyses shall include, at minimum, total nitrogen, ammonium N, total P or  $P_2O_5$ , total K or  $K_2O$ , and percent solids, or follow Land Grant University guidance regarding required analyses.

Manure, organic by-products, and biosolids samples shall 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.

Samples shall be collected, prepared, stored, and shipped, 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/or the Land Grant University, or analyses from similar operations in the geographical area, may be used if they accurately estimate nutrient output from the proposed operation.

Manure testing analyses shall 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 State recognized program that considers laboratory performance and proficiency to assure accurate manure test results.

**Nutrient Application Rates.** Soil amendments shall be applied, as needed, to adjust soil pH to an adequate level for crop nutrient availability and utilization. Refer to State Land Grant University documentation for guidance.

Planned nutrient application rates shall not exceed Land Grant University recommendations (and/or industry practice when recognized by the university) based on current soil test results, realistic yield goals, environmental impact, and the producer's management capabilities. If the Land Grant University does not provide specific recommendations that meet these criteria, application rates shall be based on approved plans that consider realistic yield goals and associated plant nutrient uptake rates.

Lower than recommended nutrient application rates are permissible as long as the producer's objectives are met.

Applications of biosolids, starter fertilizers or pop-up fertilizers will be accounted for in the nutrient budget.

### **Adaptive Nutrient Management**

Where adaptive nutrient management protocols and procedures have been adopted by the NRCS with the concurrence of State Land Grant University and State conservation partners, the source, timing, amount, and placement of nutrients can be adjusted from the Land Grant

University recommendations. See the NRCS Agronomy Technical Note "On-Farm Field Trials for Adaptive Management" for guidance on acceptable protocols and procedures for on-farm research activities.

#### **Nutrient Application Timing and Placement.**

Timing and placement of nutrients shall correspond as closely as possible with plant nutrient uptake (utilization by crop plants), and consider cropping system limitations, soil characteristics, weather conditions, risk assessment results (e.g., leaching index, P index) and field accessibility.

Nutrients shall not be surface applied (except under emergency provisions in accordance with State law):

- To frozen and/or snow-covered soils
- During seasons of high runoff potential
- During periods of winter dormancy
- When the top two inches of soil are saturated from rainfall or snow melt, and there is a high risk of transport of nutrients off-site

Treatment measures shall be planned to address the movement of manure and nutrients to subsurface drainage (tile) and/or surface drained fields.

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

Current NRCS-approved soil erosion and/or nitrogen and phosphorus risk assessment tools to identify risk and treat the resource concern(s) to meet the planning criteria.

Appropriate nutrient management strategies shall be implemented to maximize nutrient use efficiency. Based on site conditions, one or more of the following nutrient management technologies shall be used:

- Slow or controlled release fertilizers
- Nitrification inhibitors
- Urease inhibitors
- Nutrient enhancement technologies
- Incorporation within 24 hours
- Injection
- Soil nitrate testing

- Other technologies that minimize surface or ground water resource concerns

#### **Additional Criteria Applicable to Properly Utilize Manure of Organic By-Products as a Plant Nutrient Source.**

Biosolids shall be applied in accordance with USEPA regulations (40 CFR Parts 403 (Pretreatment) and 503 (Biosolids) and other state and/or local regulations regarding the use of biosolids as a nutrient source.

Fields receiving animal manures shall be monitored for the accumulation of heavy metals in accordance with Land Grant University guidance and/or State law.

**Manure and Organic By-Product Nutrient Application Rates.** Manure and organic by-product application rates shall be based on nutrient analyses procedures recommended by the Land Grant University.

When manures are applied, and soil salinity is a concern, salt concentrations shall be monitored to prevent potential crop damage and/or reduced soil quality.

The total single application of liquid shall not exceed the soil's infiltration or water holding capacity.

#### **Nutrient Application Criteria**

The planned rates of nitrogen and phosphorus application recorded in the plan shall be determined based on the following guidance:

#### **Nitrogen Application Criteria**

Management activities and technologies shall be used that effectively utilize mineralized nitrogen to minimize nitrogen losses through denitrification and ammonia volatilization.

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 150 lbs available nitrogen per acre per year as calculated by the State approved nutrient planning tool.

When the nutrient management plan is being implemented on a phosphorus basis, manure or organic by-products shall be applied at rates consistent with a phosphorus limited application rate. In such situations, additional nitrogen sources may be needed, such as inorganic nitrogen fertilizer or a leguminous cover crop, to supply the recommended amounts of nitrogen in any given year.

### **Phosphorus Application Criteria**

When manures and other organic by-products are applied, the PI risk assessment shall be based on the annual soil loss value associated with the crop interval including the manure application.

The application of phosphorus applied as manure may be made 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 shall not exceed acceptable PI risk limitations and shall not exceed the recommended nitrogen application rate during the year of application or harvest cycle.

### **Additional Criteria to Protect Air Quality by Reducing Odors, Nitrogen Emissions and the Formation of Atmospheric Particulates**

In areas with an identified or designated air quality concern caused by odor, nitrogen, sulfur, and/or particulate emissions, the source, timing, amount, and placement of nutrients shall 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 within 24 hours
- Injection

Do not apply poultry litter, manure, or organic by-products of similar dryness/density when application area wind velocity is likely to blow the material off-site.

### **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, manure, or organic by-products to avoid periods when field activities will result in soil compaction and the destruction of soil structure.

Apply manure at a rate that will result in an "improving" Soil Conditioning Index (SCI) without

exceeding acceptable risk of nitrogen or phosphorus loss.

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

### **CONSIDERATIONS**

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

Use variable rate nitrogen application based on expected crop yields, soil variability, soil nitrate 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 Agronomy Technical Note # TN.190.AGR.3-Precision Nutrient Management Planning.

When assessing yield response, evaluate factors such as poor soil quality, drainage, pH, salinity, etc., rather than assuming that nitrogen and/or phosphorus are deficient.

Use legume crops and/or cover crops to provide nitrogen via biological fixation and nutrient recycling.

To improve nitrogen use efficiency consider:

- soil profile sampling for nitrogen,
- Pre-Sidedress Nitrate Test (PSNT),
- Pre-Plant Soil Nitrate Test (PPSN),
- corn stalk nitrate sampling, and
- tissue testing

Modify animal feed diets to reduce the nutrient content of manure.

Soil test information should be no 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. See NRCS Agronomy Technical Notes for details about the adaptive nutrient management process and benefits gained through use of an adaptive management strategy.

***Considerations to Minimize Agricultural Nonpoint Source Pollution of Surface and Ground Water.***

Conservation practices that slow runoff and increase infiltration, such as Filter Strip, Contour Farming, or Contour Buffer Strips, will reduce losses of nutrients in solution, such as 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, or
- banded applications of nitrogen and/or phosphorus to improve nutrient availability,
- Use drainage water management to reduce nutrient discharge through drainage systems.

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

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

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

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

Workers should be protected from and avoid 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 utilized 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.

**PLANS AND SPECIFICATIONS**

The following components shall 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: surface texture, pH, drainage class, permeability, available water capacity, depth to water table, restrictive features, and flooding and/or ponding frequency and duration,
- location of designated sensitive areas and the associated nutrient application restrictions and setbacks,
- results of appropriate risk assessment tools for nitrogen, phosphorus, and erosion losses.
- 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.
- 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 nutrient use efficiency products that will be used,
- In accordance with the nitrogen and phosphorus risk assessment tool(s), specify the recommended nutrient application source, timing, amount, and placement of plant nutrients for each field or management unit, and
- guidance for implementation, operation and maintenance, and recordkeeping.

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

- aerial imagery or site map(s) with global positioning system (GPS) located soil sampling area or management zones,
- soil test analysis(es) maps that identify variations in soil nutrients.
- GPS sampling locations map and results map of plant tissue analyses, when used for nutrient management,
- statement specifying the type of precision technology planned (variable rate for N and/or P and/or K),
- Land Grant University recommendations for the nutrient amount shall be used, based on field variability and realistic yield goals,
- specify the nutrient, source, application placement and timing, of plant nutrients for all nutrients for each field or management unit, and
- document the basis for the variable rate application(e.g., chlorophyll concentration, grid soil tests, etc.).

If increases in soil phosphorus levels are expected, the nutrient management plan shall document:

- the soil phosphorus levels at which it is desirable to convert to phosphorus based planning and/or no further phosphorus application,
- the potential plan for soil test phosphorus drawdown from the production and harvesting of crops, and
- 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 and allow for application of P at crop removal rates.

## **OPERATION AND MAINTENANCE**

Conduct periodic plan reviews to determine if adjustments or modifications to the plan are needed. At a minimum, plans will be reviewed and revised, as needed with each soil test cycle,

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changes in manure volume or analysis, crops, or crop management.

Significant changes in animal numbers, management, and/or 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 shall be maintained for at least five 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 or 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 nutrient use efficiency products that will be used,

Additional records for precision/variable rate sites shall include:

- maps identifying the variable application source, timing, amount, and placement of all plant nutrients applied,
- GPS based yield maps.

## **REFERENCES**

Agronomy Technical Note # - TN.190.AGR.3-Precision Nutrient Management Planning.

Agronomy Technical Note Adaptive Management- under development

Follett, R.F. 2001. Nitrogen Transformation and Transport Processes. pp. 17-44, In R.F. Follett and J. Hatfield. (eds.). 2001. Nitrogen in the Environment; Sources, Problems, and Solutions. Elsevier Science Publishers. The Netherlands. 520 pp.

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