NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD AND SPECIFICATIONS

NUTRIENT MANAGEMENT

(Acre)
CODE 590

DEFINITION

Managing the amount, source, placement, form, and timing of application of nutrients and soil amendments to ensure adequate soil fertility for plant production and to minimize the potential for environmental damage.

PURPOSES

This practice may be applied as part of a conservation system to support one or more of the following:

- Budget and supply nutrients for plant production.
- Properly utilize manure or organic by-products as a plant nutrient source.
- Minimize agricultural nonpoint source pollution of surface and ground water resources.
- 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

The application of lime and fertilizer products will meet the needs of the crop or forage to be grown to meet the landowner's objectives and protect environmental quality. These products may be applied in a balance of commercial grade products, animal manure products, and other organic by-products.

This practice shall comply with all applicable federal, state, and local laws, rules, and regulations governing pollution abatement, manure and sludge management, and health and safety.

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

Realistic yield goals shall be established based on soil productivity information, historical yield records, climatic conditions, level of management, and/or local research on a similar soil and cropping system. For new crops or varieties, industry documented yield recommendations may be used until on-farm information is available.

The form, source, amount, timing, and method of application of nutrients including any incorporation on each field will be specified. Nutrients will be applied to minimize nitrogen and/or phosphorus movement to surface and ground water resources.

Application of this standard shall recognize requirements of other conservation practices and be compatible with these requirements. Measures will be taken to control erosion within soil loss tolerance, manage runoff to acceptable levels, and provide irrigation water management (as needed) on all fields that receive nutrients.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version, contact the Natural Resources Conservation Service.

Soil Sampling and Laboratory Testing

Nutrient applications shall be based on current soil test procedures and sampling methods recommended by the University of Missouri - Columbia (UMC). Soil tests and recommend-ations shall be accepted from a laboratory certified by the Missouri Soil Testing Association Accreditation Program. A listing of certified laboratories will be accessible through the NRCS home page at http://www.mo.nrcs.usda.gov (select the following path: Services - Technical Support - Decision Support - Approved Soil Test Labs).

The soil-sampling schedule will ensure fields are soil sampled at least once every four years for pH, soil organic matter, cation exchange capacity, soil neutralizable acidity or other approved measure of soil acidity buffer capacity, and soil test phosphorus, potassium, calcium, and magnesium. More frequent sampling (every one to two years) will be required if soil test recommendations are developed using a buildup period of less than 4 years. When possible, avoid soil sampling within six months following the application of a phosphorus nutrient source.

All soil test results must be current according to the soil-sampling plan (less than 4 years old) when developing a new or revised plan. Additional soil testing to update nutrient recom-mendations may be required if phosphorus application rates have exceeded crop removal rates since the last soil test.

Additional soil tests may be required to address specific nutrient issues. Tests, such as the spring-season soil nitrogen test, may be appropriate in specific situations to assess past nitrogen management or used to adjust nitrogen recommendations for crops.

Field sampling for soil testing will be completed according to guidance from UMC Outreach and Extension. A composite sample will be collected to represent approximately 20 acres or less. Grid sampling will be accepted in lieu of composite analyses. Current soil testing will be required for all fields receiving nutrients.

The soil sampling method will be modified 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.

Tissue sampling and testing may be used to determine crop specific nutrient deficiencies. Sampling methods shall be completed according to UMC standards and recommendations. Tests such as the stalk nitrate test may be used to evaluate nitrogen recommendations for corn.

Lime

Soil amendments shall be applied to adjust soil pH to the specific range of the crop to be grown for availability and utilization of nutrients based on landowner objectives. Refer to MU Guide 9112 – "Interpreting Missouri Soil Test Results" for the desired soil salt pH ranges for Missouri crops.

Liming materials will be applied according to soil test results. Liming materials will be applied and incorporated prior to planting when inversion tillage is used to prepare a seedbed. Deep incorporation of lime will improve crop rooting depths, increase available nutrients, and improve crop yields. To establish a legume crop, lime should be applied three months prior to planting. Liming materials will be applied to established forages or no-till crop rotations as a surface application without incorporation.

Nutrient Application Rates

Nutrient application rates shall be based on soil test information. Establish a realistic yield goal for each field. Determine the need for applied nutrients within the management capabilities of the landuser by accounting for nutrients already supplied by the soil, previous crops, organic nutrient applications, and soil organic nitrogen. Applied nitrogen and phosphorus based on a nutrient budget will not exceed the planned amount by 10 percent or 10 pounds per acre, whichever is least limiting.

The planned rates for nutrient applications will be documented in the nutrient budget and shall be determined based on the following guidance:

Nitrogen (N) Application -

Planned nitrogen application rates shall be less than or match the annual recommended rate as closely as possible after accounting for an expected reduction in availability that may occur from manure or organic by-products. Nitrogen applications to the field will not exceed the planned

amount in the nutrient budget by 10 percent or 10 pounds per acre, whichever is least limiting. When manure or other organic by-products are a source of nutrients, see “Additional Criteria” below.

Phosphorus (P) Application -
Planned phosphorus application rates shall match the recommended rates as closely as possible accounting for availability of phosphorus in applied manure or organic by-products. When manure or other organic by-products are a source of nutrients, see “Additional Criteria” below.

Applications of phosphorus may be made for soil buildup and maintenance needs as annual or multi-year treatments. An application to meet the recommended phosphorus for multiple years in a cropping sequence may supply the calculated phosphorus need for the allowable soil test cycle. Phosphorus applications should not exceed the planned amount in the nutrient budget by 10 percent or 10 pounds per acre, whichever is least limiting.

Potassium (K) Application -
Potassium shall not be applied in situations where additional potassium results in an unacceptable nutrient imbalance in crops or forage.

Other Plant Nutrients -
The planned rates of application of the secondary nutrients shall be consistent with UMC recommendations or industry practice.

Starter Fertilizers -
Starter fertilizers containing nitrogen, phosphorus, and potassium may be applied in accordance to UMC recommendations or industry practice. When starter fertilizers are used, the nutrient value shall be included in the crop nutrient budget.

Nutrient Application Timing
Nutrients shall be applied at a time that minimizes potential movement of nutrients to surface and ground water. To reduce phosphorus and nitrogen losses in runoff, avoid surface applications on frozen, snow-covered or saturated soils and other times when runoff or flooding is likely. Additionally, apply nitrogen as closely as possible prior to crop nitrogen need unless steps are taken to adequately minimize leaching of nitrate through the soil or losses to nitrification.

Nutrient Application Methods
On irrigated farms, incorporate water management to conform to the IRRIGATION WATER MANAGEMENT (449) standard. The nutrient content of the water shall be determined by periodic water analysis and considered when balancing nutrient needs. An annual water analysis will be required when the water supply contributes 10 percent or more of the crop or forage need of at least one primary nutrient (N, P, or K).

Evaluate the capabilities of equipment to apply fertilizer products at acceptable rates. Design a system to apply fertilizer blends at rates that are efficient for the application equipment and require minimal changes or adjustments between fields.

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

Nutrient values of manure and organic by-products shall be determined annually by laboratory testing prior to land application. Acceptable “book values” recognized by NRCS may be used for the first application of organic materials from a new facility. Book values from sources listed in the “References” are acceptable.

Nutrient Application Rates
When liquid organic nutrients are applied, the application rate shall not exceed the infiltration rate of the soil, and the amount being applied shall not exceed the moisture holding capacity of the soil profile at the time of application. Organic nutrients shall not be applied to saturated, frozen, or snow-covered ground

The planned rates of nitrogen and phosphorus applications shall be determined based on the following guidance:

Nitrogen Application -
Nitrogen may be applied at rates needed to meet crop production needs or, for legumes, the nitrogen crop removal rate. When nutrient management is being implemented due to concerns with potential phosphorus losses from the field or the watershed, organic nutrients shall be applied at rates consistent with the phosphorus needs of the crop rotation. In such situations additional nitrogen applications from

non-organic sources may be required to supply the total nitrogen recommendation.

Phosphorus Application –
When organic nutrients are applied to meet the soil test recommendation or crop removal rate, the planned rates of phosphorus shall be consistent with any one of the following options:

1) Phosphorus Index (PI) Rating

Phosphorus Index Ratings, to be developed by University of Missouri and NRCS, will identify the need for management decisions that reduce the potential for phosphorus movement to surface or ground water. If the field is rated as a low to medium risk site, the application of organic nutrients may be made based on the nitrogen needs of the crop. If the field is rated as a high-risk site, organic nutrients may be applied to meet the needs of the crop rotation for phosphorus removal. If the field is rated as a very high-risk site, phosphorus applications should not be recommended for the field. Refer to Appendix A, Table 1.

2) Soil Phosphorus Threshold Values

Soil Phosphorus Threshold Values will be established for the different soil series in Missouri. These values will be used to determine the maximum phosphorus that may be applied to a soil series without causing environmental damage. When soil test phosphorus levels are below the threshold value, applications of organic nutrients may be based on the nitrogen needs of the crop. As the soil test phosphorus level approaches the soil phosphorus threshold value, organic nutrient applications are to be based on the crop removal rate of phosphorus. When the soil test phosphorus level exceeds the threshold by less than a factor of 2, organic nutrient applications are to be based on one-half the crop removal rate. When the soil test phosphorus level exceeds the threshold by a factor of 2 or more, phosphorus applications should not be recommended for the field. Refer to Appendix A, Table 2.

3) Soil Test Values

Based on agronomic crop needs, organic nutrients may be applied based on a nitrogen recommendation when additional phosphorus is needed for buildup and will likely increase crop yield. A soil test phosphorus rating of very low, low, or medium would allow organic nutrients to be applied at the nitrogen rate. When soil test phosphorus is high (adequate for crop production and no buildup is necessary), organic nutrients may be applied based on a phosphorus maintenance rate of one and one-half times the crop removal rate. When soil test phosphorus is very high, organic nutrients may be applied to replace the phosphorus removed in crop production. When soil test phosphorus is extremely high (exceeds crop needs), phosphorus applications should not be recommended for the field. Refer to Appendix A, Table 3.

Phosphorus Buildup for a Rotation

A single application of phosphorus applied as organic nutrients may be made at a rate equal to the recommended phosphorus need or estimated phosphorus removal in harvested plant biomass for the crop rotation (multiple years in the cropping sequence) not to exceed the allowable soil test cycle. When such applications are made, the application rate shall:

- Not exceed the recommended annual nitrogen application rate during the year of application; or
- Not exceed the estimated nitrogen removal in harvested biomass during the year of application when there is no recommended nitrogen application; or
- Not be made on sites considered vulnerable to off-site phosphorus transport unless appropriate conservation practices or management activities are used to reduce the site vulnerability.

Field Risk Assessment

When organic nutrients are applied, a field specific assessment of the potential for phosphorus transport for the field shall be completed and documented. The assessment may be done using the Phosphorus Index for Missouri or other recognized assessment tools. Include:

- A record of the assessment rating for each field or subfield, and
- Information about the conservation practices and management activities that can reduce the potential for phosphorus movement from the application site.

When field risk assessments are completed, the results of the assessment and any specific recommendations shall be discussed with the producer during the development of the nutrient management plan.

Heavy Metals Monitoring
When sewage sludge is applied, the accumulation of potential pollutants including arsenic, cadmium, copper, lead, mercury, selenium, and zinc in the soil shall be monitored in accordance with the US Code, Reference 40 CFR, Parts 403 and 503 and any applicable state and local laws or regulations.

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

In areas with an identified or designated nutrient water quality impairment, an assessment shall be completed of the potential for nitrogen and phosphorus transport from the field. The Leaching Index (FOTG Section II-(iii)-L-2), Phosphorus Index, or other recognized assessment tools will be used to evaluate potential for nutrient loss. The results of these assessments and recommendations shall be discussed with the producer and included in nutrient management planning.

Plans developed to minimize agricultural nonpoint source pollution of surface or ground water shall include practices and management activities that can reduce the risk of nitrogen and phosphorus movement from the field.

Establish and maintain minimum setback distances from sensitive areas such as losing streams, sinkholes, caves, wells, surface inlets, stream channels, and flood prone areas when applying organic nutrients. These setback distances are needed to reduce pathogen concerns. When possible, establish permanent vegetation on buffers or filters. Avoid organic nutrient applications in the buffer or filter area.

Apply only the nitrogen needed to meet the planned realistic yield goal and as close to the time of plant utilization as possible. Nitrogen fertilizer will not be applied in the fall except as a starter fertilizer for fall seeded grain crops and fall seeded forage grasses.

Use local water budgets as a guide to determine when the greatest likelihood for runoff or deep percolation will occur. Use slow-release fertilizers, split applications, and nitrification inhibitors when runoff and leaching are a concern.

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

Nutrients shall be applied in such a manner as not to degrade the soil's structure, chemical properties, or biological condition.

Nutrients shall not be applied to saturated or flooded soils when the potential for soil compaction and creation of ruts is high.

CONSIDERATIONS

Realistic yields may be based on the following:

1) Collect actual yield data on the field for five (5) or more years;
2) Ignore the highest and the lowest yield levels;
3) Calculate an average yield for the remaining years; and
4) Add 10 percent to the average yield to allow for the potential to improve yield.

Following the application of any nutrient applied at rates exceeding soil test recommendations or crop removal rates, an updated soil test should be evaluated prior to applying additional fertilizer or organic nutrients in future years.

Injection of gaseous formations or liquid products may be required to control odors and reduce losses to the environment.

Consider induced deficiencies of nutrients due to excessive levels of other nutrients. Grasses are luxury consumers of potassium beyond their specific needs when excess potassium is in the soil. Mineral composition of forages should not exceed 2.5 percent potassium with a lower level of less than 1.5 percent potassium for dry cow rations.

Consider the use of nitrification and urease inhibitors when applying nitrogen prior to planting the crop.

Consider applying liming materials as far as 6 to 12 months ahead of planting sensitive crops. This is important on established forages and no-till crop rotations where inversion tillage is not used. Consider split applications of lime when the recommended rate exceeds 3 tons per acre.

Consider application methods, rates, and timing that reduce the risk of nutrients being transported to ground and surface waters. Suggestions include:

1) Split apply nitrogen to provide nutrients at the times of maximum crop use;

2) Avoid winter nutrient application for spring seeded crops;

3) Band apply phosphorus near the seed row;

4) Apply nutrients uniformly or as prescribed by precision agricultural techniques;

5) Incorporate land applied manure or other by-products immediately only when soil erosion is not a concern; and

6) Delay surface application of nutrients if precipitation capable of producing runoff forecast within 24 hours of the time of the planned application.

Consider cover crops whenever possible to utilize and recycle residual nitrogen.

Consider the potential problems from odors associated with the land application of animal manure and organic by-products especially when applied near residences and public use areas.

Consider nitrogen volatilization losses associated with the land application of organic nutrients. Volatilization losses can become significant if organic nutrients are not immediately incorporated into the soil after application.

On sites where there is a special environmental concern, consider other sampling techniques such as soil profile sampling for nitrogen; pre-sidedress nitrogen test; pre-plant soil nitrate test; or soil surface sampling for acidity and phosphorus.

Consider agronomic, nutritional, and managerial practices that reduce the amount of nitrogen and phosphorus excreted by animals. These practices include avoiding excessive dietary protein; using high quality protein sources; feeding low protein, amino acid supplemented diets; avoiding excessive dietary phosphorus; balancing diets on an available phosphorus basis; using enzyme additives such as phytase; and using feed ingredients (low-phytate grain) that possess highly available phosphorus.

Consider the potential effect of nutrient applications to National Register listed or eligible cultural resources.

PLANS AND SPECIFICATIONS

Site specifications for establishment and maintenance of this practice shall be prepared for each field or treatment unit according to the Criteria, Considerations, and Operation and Maintenance described in this standard.

Site specifications shall be recorded using approved specification sheets, job sheets, narrative statements in the conservation plan, or other acceptable documentation.

A nutrient management plan shall contain as a minimum the following:

1) Field maps and a soil map;

2) Current or planned sequence of crops or forage to be produced on each field;

3) Realistic yield goals for each crop or forage and soil type;

4) Soil test results and any special tests such as manure, water, plant tissue, or late season nitrate tests;

5) A complete nutrient budget for nitrogen, phosphorus, and potassium for the crop or forage rotation or crop sequence;

6) Quantification of all nutrient sources and losses that are to be considered in the planning process;

7) Recommended rates, methods, and timing of nutrient application including incorporation;

8) Location of sensitive resource areas when present and associated set-back areas or additional conservation treatments; and

9) Specific guidance for implementation, operation or maintenance.

If increases in soil phosphorus levels are expected due to phosphorus applications exceeding crop removal rates, the nutrient management plan shall document:

a) The soil phosphorus levels at which the producer will convert from a nitrogen based to a phosphorus based strategy;

b) The relationship between soil phosphorus levels and the potential for phosphorus to leave the field in runoff; and

c) The potential for soil phosphorus draw-down due to the production and harvesting of crops or forage.

When applicable, plans shall include other practices or management activities as determined by specific regulation, program requirements, or producer goals.

In addition to the requirements described above, nutrient management plans shall also include:

1) A discussion about the relationship between nitrogen and phosphorus transport and water quality impairment. Concerns about nitrogen should include information about nitrogen leaching into shallow ground water and potential health impacts. Concerns about phosphorus should include information about phosphorus accumulation in the soil, the increased potential for phosphorus transport in soluble form, and the types of water quality impairment that could result from phosphorus in surface water.

2) Discussion about how the plan is intended to prevent nutrients supplied for production purposes from contributing to water quality impairment.

3) A statement that the plan was developed based on the requirements of the current standard and any applicable federal, state and local regulations or policies and that changes to any of these requirements may necessitate a revision of the nutrient management plan.

OPERATION AND MAINTENANCE

The producer is responsible for the safe operation and maintenance of this practice including all equipment. Operation and maintenance addresses the following:

* Periodic plan review (recommended annually) to determine if adjustments or modifications to the plan are needed. As a minimum, plans will be revised with each soil test cycle.

* Protection of fertilizer and organic by-product storage facilities from weather and accidental leakage or spillage.

* Calibration of application equipment to ensure uniform distribution of material at planned rates.

* Documentation of the actual rate at which nutrients were applied. When the actual rates used differ from or exceed the recommended and planned rates, records will indicate the reason for the differences and treatments used to prevent environmental degradation.

* Maintaining records to document implementation of the plan. As applicable, records will include:

    1) A summary of soil test results and recommendations for nutrient application;
    2) Quantities, analyses, and sources of all nutrients applied;
    3) Dates, methods, and incorporation of nutrients applied;
    4) Crops planted, planting and harvest dates, yields, and crop residues removed;
    5) Results of water and plant analyses; and
    6) Dates of plan reviews and the person

performing the review along with specific recommendations that resulted from the review.

Records will be maintained for five years or for a period longer than five years if required by other federal, state, or local ordinances or if required by program or contract requirements.

Workers shall be protected from and avoid unnecessary contact with chemical fertilizers, manure, and organic by-products. Protection should include the use of protective clothing when working with plant nutrients. Extra caution must be taken when handling ammonia sources of nutrients or when dealing with organic wastes stored in unventilated enclosures.

The proper disposal of material generated by the cleaning of nutrient application equipment should be accomplished. Excess material should be contained, collected, and stored or field applied in an appropriate manner. Excess material should not be applied on areas with a high potential risk for runoff and leaching.

The disposal and recycling of nutrient containers should be completed according to state and local guidelines and regulations.

REFERENCES

Agricultural Waste Management Field Handbook, USDA-NRCS National Engineering Handbook, April 1992.

Livestock Waste Facilities Handbook - MWPS-18, Second Edition, 1985.

Manure Characteristics, Manure Management Systems Series, MWPS-18, Section 1, 2000.

Managing Nitrogen for Groundwater Quality and Farm Profitability, Soil Science Society of America, 1991.

Soil Test Interpretations and Recommendations Handbook, UMC Department of Agronomy, Revised December 1992.

Leaching Index, Field Office Technical Guide, Section II-(iii)-L-2.

Phosphorus Index (to be developed with the assistance of the University of Missouri)

MU Guides:
9102 – "Liming Missouri Soils," (May 1992).
9107 – "Missouri Limestone Quality: What is ENM?" (December 1986).
9110 – "How to Get a Good Soil Sample," (May 1992).
9111 – "Using Your Soil Test Results," (July 1989).
9112 – "Interpreting Missouri Soil Test Reports," (December 1996).
9177 – "Preplant Nitrogen Test for Adjusting Corn Nitrogen Recommendations," March 2000).
9180 – "Phosphorus in Missouri Soils," (September 1993).
9181 – "Agricultural Phosphorus and Water Quality," (March 1999).
9182 – "Managing Manure Phosphorus to Protect Water Quality," (March 1999).
9330 – "Calculating the Value of Manure as a Fertilizer Source," (December 1997).

Missouri Water Quality Guide Sheet Series
WQ426 – "Best Management Practices for Biosolids Land Application"

Appendix A

(1) Phosphorus Index (PI) Rating –

When the phosphorus index method is used, phosphorus may be applied at rates consistent with Table 1.

Table 1. Phosphorus Index

Phosphorus Index Rating	Phosphorus Application
Low Risk	Nitrogen Based
Medium Risk	Nitrogen Based
High Risk	Phosphorus Based on Crop Removal
Very High Risk	Phosphorus Should Not Be Recommended

(2) Phosphorus Threshold Values –

When soil specific phosphorus threshold values are established in Missouri, phosphorus may be applied at rates consistent with Table 2.

Table 2. Phosphorus Threshold Values

Phosphorus Threshold Level	Phosphorus Application
< ¾ of Value	Nitrogen Based
≥ ¾ to < 1¼ of Value	Phosphorus based on Crop Removal
≥ 1¼ to < 2 of Value	Phosphorus Based on ½ Crop Removal
≥ 2 of Value	Phosphorus Should Not Be Recommended

(3) Soil Test Values –

When soil test phosphorus levels are used, phosphorus may be applied at rates consistent with Table 3.

Table 3. Soil Test Phosphorus Values

Soil Test Phosphorus Level	Phosphorus Application
Very Low	Nitrogen Based
Low	Nitrogen Based
Medium	Nitrogen Based
High	Phosphorus Based on 1½ Crop Removal
Very High	Phosphorus Based on Crop Removal
Excess	Phosphorus Should Not Be Recommended