



Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT

CODE 590

(ac)

DEFINITION

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

PURPOSE

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

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

CONDITIONS WHERE PRACTICE APPLIES

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

CRITERIA

General Criteria Applicable to All Purposes

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

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

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

Follow all applicable State requirements and regulations when applying nutrients near areas prone to contamination, such as designated water quality sensitive areas, (e.g., lakes, ponds, rivers and streams,

sinkholes, wellheads, classic gullies, ditches, or surface inlets) that run unmitigated to surface or groundwater.

For nutrient management plans developed as a component of a comprehensive nutrient management plan for an animal feeding operation (AFO) follow policy in NRCS directive General Manual (GM) 190, Part 405, "Comprehensive Nutrient Management Plans." <https://directives.sc.egov.usda.gov/>. These plans must include documentation of all nutrient imports, exports, and on-farm transfers associated with the production and land application of nutrients for the specific AFO.

State specific guidance and guidelines referenced in the general criteria section of this standard as they relate to CNMP and NMP development in New York are requirements. Additional criteria are used in specific circumstances when determined applicable through the planning process.

Cornell University guidelines for field crop nutrient management and selected vegetable crop nutrient management are found on the Cornell University Nutrient Management Spear Program website at <http://nmsp.cals.cornell.edu/guidelines/nutrientguide.html>. This site contains specific 590 related guidance required for nutrient management planning in New York.

For other selected specialty crop nutrient management, access the specific crop information through the Cornell New York State IPM Program at: <https://nysipm.cornell.edu/agriculture/> or published crop specific guides at <https://cropandpestguides.cce.cornell.edu/>.

For new crops without published guidelines consult Cornell University for further guidance.

Soil and tissue testing and analysis

Base the nutrient management plan on current soil test results in accordance with Cornell University guidance. Use soil tests no older than 2 years when developing new nutrient management plans.

For nutrient management plan revisions and maintenance, soil tests must be taken at least every 3 years, not to extend beyond the spring of the fourth crop year. Any nutrient recommendations made in the spring of the fourth crop year must be based on new soil tests.

Use science-based tissue testing, when applicable for monitoring and/or adjusting the nutrient management plan in accordance with Cornell University guidance for the specific crop being grown. Tissue testing guidance from other sources can be used when referenced as an alternative by Cornell University.

Collect, prepare, store, and ship all soil and tissue samples following Cornell University guidance. The test analyses must include pertinent information for developing, monitoring or amending the nutrient plan (e.g., pH, soil organic matter, phosphorus, potassium, or other nutrients, and tests for nitrogen where applicable). Follow Cornell University guidelines regarding required analyses and test interpretations.

Soil samples will be analyzed with the Cornell Morgan test or other tests that can be converted reliably to Cornell Morgan equivalents. If a soil test conversion is used, use specific conversion equations or software tools available at the Cornell University Nutrient Management Spear Program website.

Soil tests must be performed by laboratories successfully meeting the requirements and performance standards of the North American Proficiency Testing Program (NAPT) or Agricultural Laboratory Proficiency Program (ALP).

When grid soil test samples are taken, use Cornell University guidance outlined in Agronomy Fact Sheet 106 to derive averages for P index assessments. Fact Sheet 106 is located on the Cornell University Nutrient Management Spear Program website.

Maintain soil pH within ranges which enhance an optimal level of plant or crop nutrient availability and utilization. Refer to Cornell University guidelines for recommended crop pH levels for specific crops and follow guidance for liming and pH available on the Cornell Nutrient Management Spear Program site. For

selected specialty crops follow guidelines for soil pH for the specific crop located on the Cornell New York State IPM Program page <https://nysipm.cornell.edu/agriculture/> or specific Cornell published crop guidelines <http://nmsp.cals.cornell.edu/publications/extension/LimeDoc2006.pdf>

Manure, organic by-product, and biosolids testing and analysis

Nutrient values of manure, organic by-products, and biosolids must be determined prior to land application or export. Such analyses must include, at minimum, total nitrogen (N), ammonium N, total phosphorus (P) or P₂O₅ equivalent, total potassium (K) or K₂O equivalent, and percent solids. Collect, prepare, store, and ship all manure, organic by-products, and biosolids following Cornell University guidance. Manure, organic by-products, and biosolid samples must be collected and analyzed at least once per calendar year, or more frequently if needed to account for significant operational changes (feed management, animal type, manure handling strategy, imported organic by-products, etc.) impacting manure nutrient concentrations.

When planning for new or modified livestock operations, acceptable “book values” recognized by NRCS (e.g., NRCS Agricultural Waste Management Field Handbook; ASABE D384.2 Manure Production and Characteristics) and Cornell University, or analyses from similar operations in the geographical area, may be temporarily used for a period not to exceed 12 months if they are expected to provide a reasonably accurate estimate of nutrient output from the proposed operation. In such cases, manure testing for the operation must be performed as soon as a quality sample can be taken.

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

Nutrient loss risk assessments

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

Complete the current NY Nitrate Leaching Index (NLI), for N on all fields where nutrient management is planned. The NY Nitrate Leaching Index uses specific soil properties and climatic factors to assess the potential for movement of nitrate through the soil profile and affect ground water resources. Depending on the results of the NLI, specific management strategies and/or conservation practices may need to be planned and applied on specific fields to reduce the potential for N movement through the soil profile. Detailed guidance for completing and interpreting the NLI is available on the Cornell Nutrient Management Spear Program site.

Complete the current approved NY Phosphorus Runoff Index (P-Index) on all fields where nutrient management is planned. The NY P-Index uses a field-based transport risk assessment which combined with the soil test P level and planned/applied BMPs for land-application of manure or fertilizer P, provides a risk level for P loss to surface water. The P-Index determines if manure can be applied, and if so, if rates of manure application can be N-based or should be limited to P-removal (P-based) for a specific field. Access the current NY P-Index Users Guide for detailed guidance for completing and interpreting P-Index results from the Cornell Nutrient Management Spear Program site.

Each field must be planned and managed to maintain the estimated rotational average annual sheet/rill soil erosion at or below the tolerable soil loss limit (T) for the predominate soil type in the field, as calculated by the current approved NRCS erosion prediction technology. Information regarding current water erosion prediction technology can be found in Section I of the NRCS Field Office Technical Guide <https://efotg.sc.egov.usda.gov/#/>

Stabilize areas of observable, in-field erosion caused by concentrated flows of runoff water with appropriate conservation practices.

The 4Rs of nutrient stewardship

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

Nutrient source

Choose nutrient sources compatible with application timing, tillage and planting system, soil properties, crop, crop rotation, soil organic content, and local climate to reduce nutrient loss to the environment.

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

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

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

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

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

Apply manure or organic by-products on legumes at rates no greater than 85% of the estimated N removal rates in harvested plant biomass not to exceed P risk assessment limitations. A tool for estimating crop removal rates is available on the USDA NRCS Plants Database site at <https://plants.sc.egov.usda.gov/npk/main>.

For any single application of nutrients applied as liquid (e.g., liquid manure, nutrients in irrigation water, fertigation) the rate and placement of the nutrient source must:

- Not exceed the soil's infiltration rate or water holding capacity.
- Not move deeper than the expected crop rooting depth.
- Avoid runoff or loss to subsurface tile drains.

Nutrient rate

Nutrient application rates for nitrogen, phosphorus, and potassium must not exceed Cornell University guidelines for the priority nutrient and considering applicable risk assessments. Lower-than-recommended nutrient application rates are permissible if the client's objectives are met.

At a minimum, base planned nutrient application rates on the crop/cropping sequence, crop yield potential, current soil test results, soil series, prior manure applications, soil organic matter mineralization, current year nutrient applications, the NY P-Index, the NY NLI, and any other applicable field-specific risk factors.

If Cornell University does not provide specific guidance that meets these criteria, nutrient application rates must be based on plans that consider yield potential and associated plant nutrient uptake rates for the crop. The source of the information and application rate criteria must be documented in the plan.

A database of field corn yield potentials by soil series is provided by Cornell University for farms that do not have field-specific yield data. Farms are encouraged to use their own yield data (3 years of documented data or more). Yield potentials can be adjusted as well when implementing an Adaptive Management protocol on specific fields according to Cornell University guidelines. For specific information on the Adaptive Management process, see <http://nmsp.cals.cornell.edu/publications/files/AdaptiveManagementGuidelinesFor2018.pdf>.

Nutrient applications and other field operations conducted in appropriate areas of fields and at an appropriate scale for the purpose of planned and documented research trials may vary from the requirements of this standard.

Nutrient application timing and placement-general

Timing and placement of all nutrients must correspond as closely as practical with plant nutrient uptake (utilization by crops). Consider nutrient source, cropping system limitations, soil properties, weather conditions, drainage system, soil biology, and nutrient risk assessment results outlined in this practice standard and the supporting Cornell University guidelines. For N, time the application as closely as practical with maximum plant and crop uptake rates. For P, time planned surface application when runoff potential is low. Time the application of all nutrients to minimize potential for soil compaction.

For crop rotations or multiple crops grown in one year, do not apply additional P if it was already added in an amount sufficient to supply all crop nutrient needs.

To avoid salt damage, follow Cornell University guidelines for the timing, placement, and rate of applied N and K in starter fertilizer.

Nutrient application timing and placement-application setbacks

Setbacks from wells and down gradient surface waters, surface inlets, sinkholes, swallets, and springs must be maintained for mechanical applications of manure, litter, bio-solids, and/or process wastewater. One of the following minimum flow path distances must be maintained between applications and surface waters and surface inlets:

- a 100-foot setback; or
- a 35-foot setback, where the entire setback width is a vegetative buffer; or
- a 15-foot setback with incorporation within 24 hours of application.

The minimum manure, litter, bio-solid, and/or process wastewater spreading setback requirement for wells and down-gradient springs is:

- a 100-foot setback, unless specific evidence shows that it can be done without contamination.

The minimum manure, litter, and/or process wastewater spreading setback requirement for down-gradient sinkholes and swallets is:

- a 100-foot setback.

If operating near a public water supply (surface water or wellhead) employ additional manure setbacks as required by state and local rules.

Fertilizer applications within minimum manure application setback areas (e.g., sinkholes, wellheads, gullies, ditches, or surface inlets) must be made according to Cornell University's crop fertilization guidelines for timing, rate, source, and placement.

Nutrient application timing and placement-frozen, snow covered, and/or saturated conditions.

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

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

Exceptions for the above criterion (i.e., surface-applied nutrients when there is a risk of runoff) can be made when specified conditions are met and adequate conservation measures are installed to prevent the offsite delivery of nutrients. NRCS, in cooperation with the State water quality control authority, will define adequate treatment levels and specified conditions for applications of manure if soils are frozen and/or

snow covered or the top 2 inches of soil are saturated. At a minimum, must consider the following site and management factors:

- Climate (long-term)
- Weather (short-term)
- Soil characteristics
- Slope
- Areas of concentrated flow
- Organic residue and living covers
- Amount and source of nutrients to be applied
- Setback distances to protect local water quality
- Karst features or topography

The core nutrient risk assessments required to develop the overall nutrient management plan may not adequately assess the risk of changing day to day soil conditions for manure application during winter weather conditions. For planning manure and organic by-product applications during frozen/snow covered conditions, develop and document a winter manure spreading plan as a required component of the nutrient management plan. This plan will identify fields or subfields from the developed nutrient management plan that have an inherent, comparatively lower risk of runoff. Additional risk reduction measures will be selected as applicable for these fields using site characteristics and management strategies outlined above, and those outlined in Cornell University Animal Science Publication Series No 245: Revised Winter and Wet Weather Manure Spreading Guidelines to Reduce Water Contamination Risk, located on the Cornell Nutrient Management Spear Program site. This list of fields along with the documented site characteristics and management strategies, and combined with real time or predicted soil conditions, will reduce manure application risk to frozen and/or snow-covered soil conditions to a level substantially lower than the field risk level outlined in the overall nutrient management plan. The winter spreading plan will provide the lower risk allocation of manure produced for the specific time frame anticipated when soil is likely to be frozen and/or snow-covered, and for which manure cannot be safely stored. Where storage is considered adequate to avoid adverse winter spreading conditions, develop the winter spreading plan to identify fields for low risk application in case of a storage emergency.

Do not surface apply manure, bio-solids, compost, litter, and/or process wastewater in well-defined concentrated flow channels within fields during frozen or snow-covered soil conditions.

When conditions allow, manure may be frost-injected or immediately incorporated upon application when soils are frozen and/or snow covered and in accordance with the general setback requirements, Cornell University Nutrient Guidelines, NY P Index, NY NLI, and current NRCS erosion prediction technology.

Commercial fertilizers may be applied during frozen, but not snow covered, soil conditions to fields planted to close grown crops, such as hay or small grains, and in accordance with the Cornell University Nutrient Guidelines, the NY P-Index, NY NLI, and current NRCS erosion prediction technology.

Nutrient application timing and placement-temporary manure pile areas

Areas for temporary manure piles will be identified to safely stockpile manure during conditions when manure cannot be physically applied to identified low risk fields in the winter spreading plan, or there are temporary seasonal crop constraints. Temporary manure piles areas are appropriate only for manure that is of a moisture content that allows it to be stacked. Temporary manure piles must be removed, and manure land applied according to the requirements of this standard as soon as favorable field conditions return, not to exceed 12 months from the last day of piling. Temporary manure pile areas are not intended for accumulating large volumes of manure over long durations, but rather smaller volumes during conditions not conducive for field application.

Locate temporary manure pile area(s) according to the following criteria:

- A flow path of at least 300 feet exist to the nearest down-gradient watercourse;
- Where the flow path provides diffuse overland flow;
- Where clean water runoff will be excluded from the temporary manure pile area;
- Where there is no groundwater spring, seep, or subsurface drainage in the area;
- Where access is practicable during poor weather conditions such as excessive ice, snow or muddy ground;
- Where flooding will not occur during a 25-year, 24-hour storm; and
- Outside of an aquifer recharge area.

Soils will be evaluated for their potential to leach contaminants into groundwater. Soils must be stable enough to support the unloading equipment. Grading of the area will be provided only where the ground surface slope prevents proper equipment operation and efficiency. All side slopes for any excavation and earth fill shall not be steeper than three (3) horizontal to one (1) vertical.

The temporary manure pile area will be at one or more locations and must have an adequate area to store accumulated manure. Unless there is evidence on the farm that the manure is more stackable, assume that the manure will not stack higher than 4 feet with a 4:1 angle of repose. Manure consistency and moisture characteristics need to be considered when locating and sizing the temporary manure pile areas.

Temporary manure piles are intended for use by farms with minor seasonal constraints for manure application until some degree of manure storage (NRCS Conservation Practice Waste Storage Facility – 313) is reasonable and feasible for the farm management. Temporary manure piles are not appropriate for addressing annual nutrient surpluses caused by such constraints as insufficient land base and/or repeated seasonal nutrient surpluses.

Nutrient application timing and placement- waste-storage

If storage is a component of the preferred alternative for addressing seasonal limitations for manure application, plan the storage period to store manure for the specified time to overcome the limitations (and any extra period that is needed for farm management purposes) according to the NRCS Waste Storage Facility Conservation Practice Standard (313).

Nutrient application timing and placement-land base limitations

When nutrients from manure or organic by-products exceed the ability of the land base to properly recycle them through crops grown, or if constraints of the land base prevent allocation of manure and/or organic by-products according to the requirements of this standard, a strategy must be developed to properly allocate surplus manure and/or organic by-products. In order to safely use surplus manure and/or organic by-products the strategy must address identified annual nutrient surpluses through export, treatment, source reduction, and/or through additional land base availability.

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

Apply additional conservation practices to avoid nutrient loss and control and trap nutrients before they can leave the field(s) through surface runoff, leaching, or subsurface drainage (e.g., tile, karst) when there is a significant risk of transport of nutrients that cannot be adequately addressed under general criteria.

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

As applicable use the following measures to address pathogen concerns:

- Follow proper biosecurity measures as provided in NRCS directives GM-130, Part 403, Subpart H, “Biosecurity Preparedness and Response.”
- Follow all applicable Federal, Tribal, State, and local laws and policies concerning the application of manure, biosolids, or compost in the production of fresh, edible crops.

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

Additional Criteria to Reduce Emissions of Objectionable Odors, Particulate Matter (PM) and PM Precursors, and GHG and Ozone Precursors

As applicable, use the following measures to address air quality concerns:

- Adjust the source, timing, amount, and placement of nutrients to reduce the negative impact of these emissions on the environment and human health.
- Do not surface apply solid nutrient sources, including commercial fertilizers, manure, or organic by-products of similar dryness/density when there is a high probability that wind will blow the material and emissions offsite. Do not surface apply liquid nutrient sources when there is a high probability that wind will blow the liquid droplets applied from sprinklers or other applicable methods offsite.
- Reduce the potential for volatilization by applying sources subject to volatilization during cooler, higher humidity conditions or by placement that minimizes vulnerability to volatilization.
- Use enhanced efficiency fertilizer products that provide lower emission potential.
- Use manure treatment technologies that minimize emissions.

Additional Criteria to Improve or Maintain Soil Organic Matter

As applicable, use the following measures to improve or maintain soil organic matter and soil health:

- Design the plant or crop management systems so the soil conditioning index (SCI) organic matter subfactor is positive.
- Apply manure, compost, or other organic nutrient sources at a rate and with minimal disturbance that will improve soil organic matter without exceeding acceptable risk of N or P loss.
- For low residue plant or cropping systems, apply adequate nutrients to optimize plant or crop residue production to maintain or increase soil organic matter.
- Time the application of nutrients to avoid periods when field activities will result in excessive compaction.

CONSIDERATIONS

General Considerations

Develop a whole farm nitrogen and phosphorus mass balance assessment. Imports include feed, fertilizer, animals and bedding, while exports include crop removal, animal products, animal sales, manure, and compost. Follow Cornell University guidelines for developing a Whole Farm Nutrient Mass Balance Assessment located on the Cornell Nutrient Management Spear Program website at: <http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/MassBalances.html>. Use the results to benchmark the whole farm nutrient mass balance and make any necessary management changes to increase nutrient recycling efficiency on the farm.

Additional Considerations-Soil, Manure and Tissue Sampling and Laboratory (testing)

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

Use grid soil sampling to increase accuracy of soil testing and provide in field management zones in order to implement precision application technologies.

Excessive levels of some nutrients can cause induced deficiencies of other nutrients, (e.g., high soil test P levels can result in zinc deficiency in corn).

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

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

Additional Considerations-4R Risk Reduction Measures

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

- Split applications of nitrogen to deliver nutrients during periods of maximum crop utilization.
- Apply nitrogen and phosphorus fertilizer in a band to improve nutrient availability.
- Injection of nutrients below the soil surface.
- Incorporate surface-applied nutrient sources when precipitation capable of producing runoff or erosion is forecast within the time of a planned application.
- Avoid surface application of manure, bio-solids, compost, litter, and/or process wastewater in well-defined concentrated flow channels within fields.
- Slow or controlled release fertilizers.
- Nitrification inhibitors.
- Urease inhibitors.
- Tissue testing, chlorophyll meters, or real-time sensors.

Nutrient application rates-frozen and/or snow covered soil conditions

Refer to all practices and strategies outlined in Cornell University Animal Science Publication Series No 245: Revised Winter and Wet Weather Manure Spreading Guidelines to Reduce Water Contamination Risk, located on the Cornell Nutrient Management Spear Program site. Document applicable practices and strategies in the required winter spreading plan as criteria.

Nutrient application rates – adaptive and precision nutrient management Techniques

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

Use the adaptive nutrient management learning process to improve nutrient use efficiency on farms as outlined in NRCS’ national nutrient policy in GM-190, Part 402 and Nutrient Management and NRCS Agronomy Technical Note (TN) 190, AGR.7, “Adaptive Nutrient Management Process”. Consider using an adaptive approach to adjust nutrient rate, timing, form, and placement as soil biologic functions and soil organic matter change over time. Guidance for implementing adaptive management techniques in New York is outlined in Adaptive Management and In-Season N Application Update - Expanded End-of-Season Evaluation Options for Corn 6-13-2018 available at <http://nmsp.cals.cornell.edu/publications/files/AdaptiveManagementGuidelinesFor2018>

Additional Considerations-Conservation Practices to Reduce Nutrient Runoff and Improve Nutrient Recycling

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

Use manure management conservation practices such as injection and incorporation to reduce the risk of nutrient loss.

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

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

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

Use conservation practices that slow runoff, reduce erosion, and increase infiltration such as contour farming, strip cropping, crop rotation, cover crops, no-till/strip till, reduced tillage, and perennial crops.

Use no-till/strip till and reduced tillage practices in combination with cover crops to reduce runoff, sequester nutrients, increase soil organic matter, increase aggregate stability, reduce compaction, improve infiltration, and enhance soil biological activity to improve nutrient use efficiency.

Use conservation practices such as filter strips, riparian forest buffers, and contour buffer strips that act as buffers to trap sediment and nutrients including soluble phosphorous and nitrates before entering surface waters.

Use NRCS Agrichemical Handling Facility Conservation Practice Standard (309) to properly store and mix agrichemicals to protect air, soil, and water quality.

Use the NRCS Drainage Water Management Conservation Practice Standard (554) to reduce Nutrient losses through drainage systems.

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

Additional Considerations-Pathogen Management

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

Use manure treatment systems that reduce pathogen content from manure.

Additional Considerations-Soil Health Management

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

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

Benchmark and track soil health levels using testing and field assessments such as the Cornell Comprehensive Assessment Of Soil Health available at <http://soilhealth.cals.cornell.edu/> or the NY NRCS Cropland In-Field Soil Health Assessment V1.2 available on the NY FOTG Section I, Assessment Tools at <https://efotg.sc.egov.usda.gov/#/>.

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

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

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

PLANS AND SPECIFICATIONS

In the nutrient management plan, document:

- Aerial site photographic imagery, or site map(s) of fields or sub-fields with attributes identified to the field or subfield level where this standard will be applied.
- Soil survey and topographic maps for all fields or sub-fields where nutrient management will be applied.
- Soil information including: soil type, surface texture, drainage class, permeability, hydrologic soil group (HSG), available water capacity, depth to water table, restrictive features, and flooding and ponding frequency.
- Location of designated sensitive areas and the associated nutrient application restrictions and setbacks.
- Location of nearby residences, or other locations where humans may be present on a regular basis, that may be impacted if odors or PM are transported to those locations.
- Results of approved risk assessment tools for N, P, and soil erosion losses. Include the evaluation and location of observable concentrated flow erosion.
- Planned practices or management strategies required by risk assessments.
- Documentation establishing the application site presents a low risk for P transport to local water if P is applied in excess of crop requirement.
- Current and planned plant production sequence or crop rotation.
- Crop rotation and manure application history required to account for nutrient credits from these sources.
- All available test results (e.g., soil, water, compost, manure, organic by-product, and plant tissue sample analyses) upon which the nutrient budget and management plan are based.
- Realistic yield goals for the crops (where applicable for developing the nutrient management plan). Document yields when yield potentials higher than those referenced in the Cornell database are used for developing the nutrient management plan.
- Nutrient recommendations for N, P, and K for each planned crop year.
- Listing of material type, quantity, application method and timing for all nutrient sources (including all enhanced efficiency fertilizer products) that are planned for application on the land base. Include documentation of all nutrient imports, exports, and onsite transfers.
- If manure or an organic by-product such as compost is to be exported, an export plan is developed that accounts for the amount to be exported, the timing of the export, the nutrient content of the exported material, and if known, the farm or entity receiving the exported material.
- Description of existing or planned waste storages (NRCS Conservation Practice Waste Storage Facility – 313).
- Manure storage durations and volumes are evaluated and planned based on the runoff and

leaching risk assessments set by this standard, seasonal constraints, plans for the efficient use of manure nutrients, and any farm management needs.

- Fields identified as acceptable for lower risk manure spreading when soil is frozen and/or snow covered according to a winter manure spreading plan. Include documentation of site conditions and management strategies for each field that reduces the risk compared to the overall nutrient management plan.
- Document the location of temporary pile areas on plan maps.
- As applicable include planned practices and management to mitigate odor concerns for nearby residences or other locations during manure application windows.
- As applicable, include planned practices and management to mitigate pathogen concerns.
- As applicable include planned practices and management to improve soil health and increase soil organic matter.
- Guidance for implementation, operation and maintenance, and recordkeeping.

For variable rate nutrient management plans, also include:

- Geo-referenced field boundary and data collected that was processed and analyzed as a GIS layer or layers to generate nutrient or soil amendment recommendations per management zone. Must include site-specific yield maps using soils data, current soil test results, and a yield monitoring system with GPS receiver to correlate field location with yield.
- Nutrient recommendation guidance and recommendation equations used to convert the GIS base data layer or layers to a nutrient source material recommendation GIS layer or layers.
- After implementation, provide application records per management zone or as applied map within individual field boundaries (or electronic records) documenting source, timing, method, and rate of all nutrient or soil amendment applications.

If increases in soil P levels are expected above an agronomic level (i.e., when N-based rates are used), document:

- Soil P levels at which it is desirable to convert to P-based planning.
- A long-term strategy and proposed implementation timeline for soil test P drawdown from the production and harvesting of crops.
- Management activities or techniques used to reduce the potential for P transport and loss.
- For AFOs, a quantification of manure produced in excess of crop nutrient requirements.
- If manure produced is in excess of crop nutrient requirements after taking into account risk assessments, plans are in place to properly address a nutrient imbalance through manure export or increased land base availability.

OPERATION AND MAINTENANCE

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

If concerns are suspected, fields receiving animal manures or biosolids must be monitored for the accumulation of heavy metals and phosphorus in accordance with Cornell University guidance and State law.

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

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

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

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

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

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

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

- All test results (soil, water, compost, manure, organic by-product, and plant tissue sample analyses) upon which the nutrient management plan is based.
- Listing and quantification of all nutrient sources (including all enhanced efficiency fertilizer products) that are planned for use and documentation of all nutrient imports, exports and onsite transfers.
- Date(s), method(s), and location(s) of all nutrient applications.
- Weather conditions and soil moisture at the time of application, the day before application, and day after the application window.
- Field specific information on type of crop, planting and harvest dates, harvest type, and any residue removal.
- Farm specific yield records when nutrient management recommendations are based on farm specific data in lieu of Cornell soil database yield values or when adaptive management applies.
- Use and management of manure field pile locations.
- Dates of plan review, name of reviewer, and recommended adjustments resulting from the review.

For variable rate nutrient management plans, also include:

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

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