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

State Regulations take precedence over this standard.

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. These areas shall receive no direct application of nutrients.

Soil and tissue testing and analysis
Base the nutrient management plan on current soil test results in accordance with Texas A&M AgriLife Extension Soil, Water and Forage Testing Laboratory (SWFTL) guidance, or industry practice when recognized by SWFTL. See http://soiltesting.tamu.edu/ guidance, or industry practice when recognized by the Texas A&M AgriLife Extension (SWFTL).

For nutrient management plan revisions and maintenance, take soil tests on an interval recommended by Texas AgriLife SWFTL or as required by local rules and regulations.

A current soils test will be no older than 90 days upon initiating new plans.

Soil testing for phosphorus must be Mehlich III by (ICP) inductively coupled plasma.

Collect, prepare, store, and ship all soil and tissue samples following Texas A&M AgriLife Extension (SWFTL) guidance or industry practice. The test analyses must include pertinent information for monitoring or amending the annual nutrient plan. Follow Texas A&M AgriLife Extension (SWFTL) guidelines regarding required analyses and test interpretations.

Manure, organic by-product, and biosolids testing and analysis
Collect, prepare, store, and ship all manure, organic by-products, and biosolids following Texas A&M AgriLife Extension (SWFTL) guidance or industry practice when recognized by the Texas A&M AgriLife Extension (SWFTL). In the absence of such guidance, test at least annually, or more frequently if needed to account for operational changes (e.g., feed management, animal type, manure handling strategy, etc.) impacting manure nutrient concentrations. If no operational changes occur and operations can document a stable level of nutrient concentrations for the preceding 3 consecutive years, manure may be tested less frequently, unless Federal, State, or local regulations require more frequent testing. Follow Texas A&M AgriLife Extension (SWFTL) guidelines regarding required analyses and test interpretations. Analyze, as a minimum, total N, total P or P_2O_5, total K or K_2O, and percent solids.

When planning for new or modified livestock operations, and manure tests are not available yet, use the output and analyses from similar operations in the geographical area if they accurately estimate nutrient output from the proposed operation or use “book values” recognized by the NRCS (e.g., NRCS Agricultural Waste Management Field Handbook) and the Texas A&M AgriLife Extension (SWFTL).

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.

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.” These plans must include documentation of all nutrient imports, exports, and on-farm transfers.

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

Nutrient values of manure, organic by-products, soil amendments and biosolids (sewage sludge) must be determined prior to land application or as directed by Texas Commission on Environmental Quality (TCEQ) permit requirements. Any TCEQ testing requirements take precedence over this practice standard.

At a minimum, manure analyses shall identify total nitrogen, phosphorus, potassium, and percent moisture or percent solids, as appropriate for solids or effluent.

Salt concentration in the soil shall be monitored so that manure applications do not cause plant damage or negatively impact soil health.

Manure, organic by-products, compost, and biosolids (sewage sludge) samples must be collected and analyzed at least annually, or more frequently if needed to account for operational changes (feed management, animal type, manure handling strategy, etc.) impacting manure nutrient concentrations. If no operational changes occur, less frequent manure testing is allowable where operations can document a stable level of nutrient concentrations for the preceding three consecutive years, unless Federal, State, or Local regulations require more frequent testing. If there is no prior sampling history, manure testing shall be developed and maintained until a consistent (maintaining a certain nutrient concentration with minimal variation) level of nutrient values is realized for that operation.

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. Sheet, rill and wind erosion must be managed to protect soil and water quality. Concentrated flow erosion (ephemeral and classic gully) must be managed with appropriate suite of conservation practices.

Complete an NRCS-approved nutrient risk assessment for nitrogen, see Agronomy Technical Note TX-11, "Nitrogen Leaching Index for Texas", Revised December 2012, for guidance.

Refer to **Appendix 5, Table 1 or Table 2.**

A Nitrogen Leaching Index will be completed on CMU/fields receiving nitrogen applications, manures, organic by products or soil amendments that have gravelly, sandy or loamy sand surface textures. Appropriate measures will be planned to reduce leaching potential on sites with a leaching index greater than 2.

Complete an NRCS-approved nutrient risk assessment for P (Agronomy Technical Note Number 15 – Phosphorus Assessment Tool) must be completed when:

- Conservation Management Units receive manures, organic by-products or soil amendments.
- Inorganic forms are planned within a phosphorus impaired watershed (contributes to 303d-listed water bodies).

A phosphorus risk assessment will not be required when the NRCS, with concurrence of the State water quality control authority, has determined specific conditions where the risk of phosphorus loss is low. These fields must have a documented agronomic need for phosphorus; based on soil test phosphorus (STP) and SWFTL nutrient recommendations.

For Phosphorus risk assessment, see Agronomy Technical Note TX-15, "Phosphorus Assessment Tool for Texas", Revised December 2012, for guidance.

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 minimize risk 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 and recommended for use by Texas A&M AgriLife Extension (SWFTL).

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 the Texas A&M AgriLife Extension (SWFTL) estimated N removal rates in harvested plant biomass, not to exceed P risk assessment limitations.

Maintain soil pH within ranges which enhance the adequate level for plant or crop nutrient availability and utilization. Refer to Texas A&M AgriLife Extension (SWFTL) documentation for guidance. Refer to "Table 1 of Agronomy Technical Note TX-13 –Liming Information and Recommendations" for recommended pH ranges for common crops.

For any single application of nutrients applied as liquid (e.g., liquid manure, nutrients in irrigation water, fertigation)—

- Do not exceed the soil's infiltration rate or water holding capacity in the top 24 inches of the soil profile.
- Apply so that nutrients move no deeper than the current crop rooting depth.
- Avoid runoff or loss to subsurface tile drains. Maintain soil pH within ranges which enhance the adequate level for plant or crop nutrient availability and utilization. Refer to Texas A&M AgriLife Extension (SWFTL) documentation for guidance. Refer to "Table 1 of Agronomy Technical Note TX-13 –Liming Information and Recommendations" for recommended pH ranges for common crops.

Nutrient rate

Plan nutrient application rates for N, P, and K using Texas A&M AgriLife Extension (SWFTL) recommendations or industry practices when recognized by the Texas A&M AgriLife Extension (SWFTL). Lower-than-recommended nutrient application rates are permissible if the client's objectives are met.

At a minimum, determine the rate based on crop/cropping sequence, current soil test results, and NRCS-approved nutrient risk assessments. Realistic yield goals will be used. This applies to all nutrient applications inorganic and organic.

Realistic yield goals must be established based on historical yield data, soil productivity information, climatic conditions, nutrient test results, level of management, and local research results considering comparable production conditions. Yield goal may be determined by collecting the actual yield for the past six years, dropping the highest and lowest yields in this time frame, then averaging the yields of the remaining four years. For new crops or varieties where Texas A&M AgriLife Extension (SWFTL) guidance is unavailable, industry-demonstrated yield and nutrient uptake information may be used.

Nitrogen and phosphorus application rates shall match the recommended rates as closely as possible. If actual application rates differ from the recommended fertilizer rates, records for the nutrient management plan shall document the reason. It may be difficult to locate phosphorus fertilizer formulations that do not include nitrogen. When recommended nutrient rates cannot be matched with available formulations, it may be best to meet 100% of the phosphorus recommendation and follow-up with the remaining required nitrogen.

When agricultural manures are land applied, application rates shall be consistent with the requirements of the NRCS conservation practice standard for Nutrient Management (590) and **Appendix 5, Table 1 or Table 2**.

Nutrient application timing and placement

Consider the nutrient source, management and production system limitations, soil properties, weather conditions, drainage system, soil biology, and nutrient risk assessment to develop optimal timing of nutrients. For N, time the application as closely as practical with plant and crop uptake. 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 Texas A&M AgriLife Extension (SWFTL) recommendations for the timing, placement, and rate of applied N and K in starter fertilizer or follow industry practice recognized by the Texas A&M AgriLife Extension (SWFTL).

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 criteria related to 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

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

Pre-plant nitrogen applications must not precede the normal planting date of the target crop by more than 120 days if incorporated within 48 hours and 30 days if surface applied.

Priority areas for land application of agricultural nutrients (organic and inorganic) should be on gentle slopes located as far as possible from waterways. When manures or effluent are applied on more sloping land or land adjacent to waterways that drains directly into the waterway, other conservation practices should be installed to reduce the potential for offsite transport of effluent or manures.

Effluent or manures will not be applied to slopes steeper than 8% with a runoff curve >80 or steeper than 16%slope with a runoff curve 70 or greater, unless applied as a component of an erosion control plan, i.e., Critical Area Planting (342), reclamation work, etc.

It is preferable to apply manures on pastures and hayland at spring greenup or soon after cutting or grazing before regrowth has occurred.

Heavy Metal Monitoring. When sewage sludge is applied, the accumulation of potential

pollutants (including arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc) in the soil shall be monitored in accordance with the TCEQ Regulations, TAC, Title 30, Chapter 312 – Sludge Use, Disposal and Transportation and any local laws or regulations.

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

Apply conservation practices to avoid nutrient loss and control and trap nutrients before they can leave the field(s) by surface, leaching, or subsurface drainage (e.g., tile, karst) when there is a significant risk of transport of nutrients.

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

Use conservation practices that slow runoff, reduce erosion, and increase infiltration, e.g., filter strip, contour farming, or contour buffer strips. These practices can also reduce the loss of nitrates or soluble phosphorus. When there is a high risk of transport of nutrients, conservation practices must be coordinated to avoid, control, or trap manure and nutrients before they can leave the field by surface or subsurface drainage (e.g., tile). The number of applications and the application rates must also be considered to limit the transport of nutrients to tile. All agricultural nutrients (organic and inorganic) shall be utilized in a manner that minimizes the opportunity for contamination of surface and ground water supplies.

When using an irrigation system for fertigation, the system shall be equipped with properly designed operating valves and components to prevent backflows into ground and surface water.

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

- soil test and tissue test
- incorporation or injection
- timing and number of applications
- soil nitrate N testing prior to planting
- coordinate nutrient applications with optimum crop nutrient uptake
- SWFTL and Texas A&M AgriLife Research and Extension recommended technologies that improve nutrient use efficiency and minimize surface or groundwater resource concerns.

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

When applicable, 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.

For multi-year nutrient budgets, the applications of irrigation water, organic by-products, effluent, manures, soil amendments, biosolids (sewage sludge), starter fertilizers, or pop-up fertilizers must be accounted for.

Biosolids (sewage sludge) shall be applied in accordance with TCEQ Regulations, TAC, Title 30, Chapter 312 – Sludge Use, Disposal and Transportation and any local regulations regarding the use of biosolids (sewage sludge) as a nutrient source.

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 storm event is forecast within 24 hours.

A 100 feet vegetated buffer will be maintained between an application area and a water of the state as directed by TCEQ Chapter 321.

The required minimum distance (setback) will be maintained from private or public drinking water supply wells. A minimum application distance for water wells used exclusively for agricultural irrigation will be planned and implemented. An exception to the full well setback zone for a private drinking water well or a water well used exclusively for agricultural irrigation may be established by a licensed Texas professional engineer or licensed Texas professional geoscientist to document that additional wellhead protective measures will be or have been implemented that will prevent pollutants from entering the well and contaminating groundwater. Additional protective measures may include a sanitary seal, annular seal, a steel sleeve, or surface slab. Refer to Texas Commission on Environmental Quality, Chapter 321 – Control of Certain Activities by Rule, the prescribed setbacks are as follows public water supply well 500 feet; private drinking well 150 feet; agriculture irrigation well 100 feet.

When effluents are applied, the application rate shall not exceed the infiltration rate of the soil, and the amount shall not exceed the moisture holding capacity of the upper

24 inches of the soil profile at the time of application. Effluent application shall not result in direct runoff of effluent from edge of the field during the time of application. As guidance, refer to NRCS publication "Determining Effluent Application Rates" (December 2012) and NRCS Program Aid 1619 – "Estimate Soil Moisture by Feel and Appearance".

Effluents or manures shall not be applied to frozen, snow-covered or saturated soil if the potential risk for runoff exists. The basis for the decision to apply effluent or manures under these conditions shall be documented in the 590 Organic Nutrient Management Plan.

Manure testing analyses must be performed by laboratories successfully meeting the requirements and performance standards of the Manure Testing Laboratory Certification program (MTLCP) under the auspices of the Minnesota Department of Agriculture or SWFTL recognized program that considers laboratory performance and proficiency to assure accurate manure test results. The method of manure analyses as specified by SWFTL is found in **Appendix 3** under heading of "Biosolids".

Exceptions to Nutrient Timing and Placement criteria include a spill from an agricultural /AFO / CAFO manure/effluent storage facility is considered eminent. Any application made under these circumstances should be reported to TCEQ as soon as possible. Adjustments will need to be made to the NMP to account for this application and samples shall be collected for soils and manures as soon as sampling can be safely completed.

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

The total single application of liquid manure:

- must not exceed the soil's infiltration or water holding capacity to 24 inches
- be based on crop rooting depth
- must be adjusted to avoid runoff or loss to subsurface tile drains.

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

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

Application of all organic soil amendments will not exceed the values listed in **APPENDIX 5**, **Table 1** or **Table 2**.

Application rates under **APPENDIX 5**, **Table 2** are based on crop removal rates. A Nutrient Utilization Plan (NUP) is required where Soil Test P Level is equal to or greater than 200 ppm in non-arid areas, or equal to or greater than 350 ppm in arid areas with distance to a named stream greater than one mile, or equal to or greater than 200 ppm in arid areas with distance to a named stream less than one mile.

When phosphorus risk assessment results equate to HIGH or VERY HIGH risk and the soil test phosphorus level is greater than the critical phosphorus level for a given phosphorus index rating, additional phosphorus may be applied according to **APPENDIX 5**, **Table 1** or **Table 2** if the following requirements are met:

- a soil phosphorus drawdown strategy has been implemented, and
- a site assessment for nutrients and soil loss has been conducted to determine if mitigation practices are required to protect water quality.
- any deviation from these high-risk requirements must have the approval of the Chief of the NRCS.

There is a point above which the risk of phosphorus loss from a field is too great to warrant additional application of phosphorus for plant production. When soil test phosphorus levels are greater than or equal to 500 ppm, with a P-Index rating of "HIGH" or "VERY HIGH", there will be no additional application of phosphorus to a CMU or field.

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 SWFTL recommendations.

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

Additional practices to enhance the producer's ability to manage manure effectively include modification of the animal's diet to reduce the manure nutrient content or utilizing manure amendments that stabilize or tie-up nutrients.

Additional Criteria to Reduce Emissions of Objectionable Odors, PM and PM Precursors, and GHG and Ozone Precursors

To address air quality concerns caused by odor, N, sulfur, and particulate emissions; 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.

To address air quality concerns caused by odor, nitrogen, sulfur, and/or particulate emissions; the source, timing, amount, and placement of nutrients must be adjusted to minimize the negative impact of these emissions on the environment and human health. One or more of the following may be used:

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

Do not apply poultry litter, manure, or organic by-products of similar dryness/density when there is a high probability that wind will blow the material from the application area.

Additional Criteria to Improve or Maintain Organic Matter

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

CONSIDERATIONS

General Considerations

Consider development of nutrient management plans by conservation management unit (CMU). A CMU is a field, group of fields, or other land units of the same land use and having similar treatment needs and planned management. A CMU is a grouping by the planner to simplify planning activities and facilitate development of conservation management systems. A CMU has definitive boundaries such as fencing, drainage, vegetation, topography, or soil lines.

Consider observing a 100 feet vegetated buffer between all nutrient application area and a water of the state.

If the area (CMU) conservation management unit represented by the soil test is extremely variable, the CMU should be separated into smaller areas where practical. Professional judgement should be used so

that the CMUs are still of manageable size. In this way, some areas of the CMU will be treated differently from others to reduce variability so that the field can be sampled and treated as a unit in the future. Variability in a field can often be noted by differences in slope, soil texture, landscape position, previous crop, manure application history, surface soil color and crop growth or yield.

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

Soil pH must be maintained in a range that enhances an adequate level for crop nutrient availability and utilization. Refer to "Table 1 of Agronomy Technical Note TX-13 –Liming Information and Recommendations" for recommended pH ranges for common crops.

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."

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, "Nutrient Management." Consider using an adaptive approach to adjust nutrient rate, timing, form, and placement as soil biologic functions and soil organic matter changes over time. See NRCS directive Agronomy Technical Note (TN) 190, AGR.7, "Adaptive Nutrient Management Process."

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

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

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

- Split nutrient applications.
- Banded applications.
- 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.
- High-efficiency irrigation systems and technology.
- Enhanced efficiency fertilizers
    - Slow or controlled release fertilizers
    - Nitrification inhibitors
    - Urease inhibitors.
- Drainage water management.
- Tissue testing, chlorophyll meters, or real-time sensors.
- Pathogen management considerations.

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 at 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.

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.

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 photograph(s), imagery, topography, or site map(s).
- Soil survey map of the site.
- Soil information including: soil type, surface texture, drainage class, permeability, 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 erosion losses.
- 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.
- 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.
- When soil P levels are increasing above an agronomic level, include a discussion of the risk associated with P accumulation and a proposed P draw-down strategy.
- Realistic yield goals for the crops (where applicable for developing the nutrient management plan).
- Nutrient recommendations for N, P, and K for the entire plant production sequence or crop rotation.
- Listing, quantification, application method and timing for all nutrient sources (including all enhanced

efficiency fertilizer products) that are planned for use and documentation of all nutrient imports, exports, and onsite transfers.
- 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.

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.

Monitor fields receiving animal manures and biosolids for the accumulation of heavy metals and P in accordance with LGU 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 Texas A&M AgriLife Extension (SWFTL) 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, elapsed time from manure application to rainfall or irrigation event(s).
- Plants and crops planted, planting and harvest dates, yields, nutrient analyses of harvested biomass, and plant or crop residues removed.
- 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.

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

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

Calibrate application equipment at least annually, to ensure accurate distribution of material at planned rates.

Document the nutrient application rate. When the applied rate differs from the planned rate, provide appropriate documentation for the change.

Records must be maintained for at least 5 years or longer if required by other Federal, State or local ordinances, programs or contract requirements, in order to document plan implementation and maintenance. As applicable, records include:

- soil, plant tissue, water, manure, and organic by-product analyses resulting in recommendations for nutrient application,
- quantities, analyses and sources of nutrients applied,
- dates and method(s) of nutrient applications, source of nutrients, and rates of application,
- weather conditions and soil moisture at the time of application; lapsed time to manure incorporation; rainfall or irrigation event,
- crops planted, planting and harvest dates, yields, nutrient analyses of harvested biomass, and crop residues removed,
- dates of plan review, name of reviewer, and recommended changes resulting from the review.
- Additional records for precision/variable rate sites must include:
    - maps identifying the variable application source, timing, amount, and placement of all plant nutrients applied, and
    - GPS-based yield maps for crops where yields can be digitally collected.

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.

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