United States Department of Agriculture

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT

CODE 590

(ac)

DEFINITION

Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE

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

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by- products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

CRITERIA

General Criteria Applicable to All Purposes

All planned activities shall be consistent with federal, state, and local regulations including but not limited to US Code, Reference 40 CFR, Part 503 and ADEM Rule 335-6-7-26. A nutrient budget for nitrogen, phosphorus, and potassium must be developed that considers all potential sources of nutrients including, but not limited to, residual amounts in the soil, commercial fertilizer, compost, animal manure, organic by- products (any organic material applied to the land as a nutrient source), biosolids, waste water, green manures, legumes, crop residues, organic matter, soil biological activity, and irrigation water. All application of nutrients must be according to the principles of the 4 R's (Right Source, Right Time, Right Rate, and Right Placement) and the applicable nutrient risk assessment tools (Alabama P Index and Alabama N leaching Index) to minimize nutrient loss without sacrificing the cropping system goals.

Erosion/Runoff Control

Erosion, runoff, and water management practices shall be installed, as needed, on fields that receive applications of nutrients. NRCS conservation practices shall be established and/or maintained to protect water quality. Fields adjacent to water bodies, water supplies, or have concentrated flow areas that convey runoff into these water bodies and water supplies without treatment shall require treatment.

Conservation practices such as Filter Strip (393); Riparian Forest Buffers (391); Grass Waterway (412); Water and Sediment Control Basin (638); Critical Area Planting (342); Conservation Cover (327); Prescribed Grazing (528); Residue and Tillage Management, No-Till (329) or Mulch Till (345) and/or Cover

Crops (340) shall be planned singly or in combination, as needed, to avoid, control, trap and/or treat nutrients transported with sediment and runoff water.

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

Nutrient planning must be based on current soil test results and recommendations developed in accordance with Alabama Cooperative Extension System (ACES) guidance or other ACES recognized industry practice. Tissue testing may be used to supplement soil, manure, and organic by-products test results or used as a diagnostic tool for midseason adjustment to the nutrient management plan. Follow ACES guidance for sample collection and sufficiency ranges. Current soil tests are those that are no older than 3 years. Soil samples shall be collected and prepared according to the ACES guidance. Where a conservation management unit (CMU) is used as the basis for a sampling unit, all acreage in the CMU must have similar soils, cropping history, and management practice treatment. One sample can represent only one soil condition.

Soil test analyses shall be conducted by Auburn University Soil Testing Laboratory or other laboratories that are accepted in The North American Proficiency Testing Program (Soil Science Society of America) http://www.naptprogram.org/ program and accepted by ACES.

The soil and tissue tests must include analyses pertinent to monitoring or amending the annual nutrient budget, e.g., pH, phosphorus, potassium, or other nutrients. Follow ACES guidelines regarding required analyses. Manure and any other organic by-products shall be analyzed prior to land application to establish nutrient content and application rates. Samples must be collected, prepared, stored, and shipped, following ACES guidance or industry practice.

Manure and any other organic by-products analyses must include, at minimum, total nitrogen (N), total phosphorus (P or P_2O_5), total potassium (K or K_2O), and percent solids (percent moisture) or follow ACES guidance regarding required analyses. In addition municipal and industrial sources of organic nutrients shall be analyzed for heavy metal content. For all manure and any other organic by-products use table 1 to determine plant available N from total N, application rates shall be based on plant available N and not total N. Manure, and any other organic by-products, samples must be collected and analyzed at least annually or more frequently if needed. Chemical analysis of these organic by-products varies due to moisture, temperature, feed sources, amount and kinds of bedding, number of batches consecutively reared, and conditions under which the manure and any other organic by- products was stored and handled prior to spreading. To account for these operational changes impacting nutrient concentrations different samples, risk assessments and rates may be required for different types of waste (e.g. fresh manure/litter, stored manure/litter, compost). Less frequent manure testing is allowable where operations can document a stable level of nutrient concentrations for the preceding three consecutive years. When the stable level has been documented analysis shall be conducted at least every three years. If a stable level cannot be documented, an average value of the tests that best represents the current material shall be used.

When planning for new or modified livestock operations, (or if there is not any representative material available to sample) use acceptable “book values” contained in Table 2 and/or in the NRCS Agricultural Waste Management Field Handbook for the plan and analyze the material, adjust rates, and risk assessment as needed before land application. To account for the site specific dilution that may affect nutrient content of the waste use the procedure outlined in the NRCS Agricultural Waste Management Field Handbook for liquid or slurry systems.

All organic by-product (manure, litter, compost, etc.) 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 other NRCS- approved program that considers laboratory performance and proficiency to assure accurate manure test results.

Nutrient Risk Assessment Tools

The nitrogen leaching index (NLI) will be used to assess the nitrogen leaching potential on sites receiving nitrogen application. Tables containing the leaching potential for soils within each county in Alabama are included in Agronomy technical note Al-73, “Nitrogen Leaching Index for Alabama”. If the leaching potential is greater than “low”, nitrogen containing material must be applied at the right rate and the right time according to ACES recommendation. See Agronomy technical note Al-73, “Nitrogen Leaching Index for Alabama” for more information and additional considerations to reduce the potential of nitrogen leaching.

The *Phosphorus Index for Alabama* shall be used to assess the potential risk of phosphorus movement into water. This applies to all fields or portions of fields that will have animal manure, poultry litter, compost or other organic by-products applied on them at a rate that is in excess of the soil test phosphorus recommendation. Additionally, in areas with an identified or designated phosphorus- related water quality impairment (303d and TMDL watersheds), an assessment shall be completed for the potential of phosphorus transport from the field. The Phosphorus Index (PI), or other recognized assessment tools will be used to assess movement potential of applied nutrients. The results of these assessments and recommendations shall be discussed with the producer and included in the conservation plan.

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

Right Application Rates

Soil amendments shall be applied, as needed, to adjust soil pH to the specific range of the crop for optimum availability and utilization of nutrients.

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

At a minimum, determination of rate must be based on crop/cropping sequence, current soil test results, realistic yield goals, nutrient recommendations and nutrient risk assessments. Agronomy technical note Al- 73, “Nitrogen Leaching Index for Alabama” contains ACES standard nitrogen recommendations. 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.

Nutrient applications rates for crops which the ACES does not have a recommendation may be based on crop need per unit of yield or industry practice when recognized by the ACES. In addition, where yield potentials (higher or lower) for crops exist, the nitrogen rate may be based on crop need per unit of yield. Agronomy technical note AL-73, “Nitrogen Leaching

Index for Alabama" contains more information that may be used to obtain these nitrogen rates. For new crops or varieties, industry- demonstrated yield, and nutrient utilization information may be used until land-grant university information is available. Lower-than- recommended nutrient application rates are permissible if the grower's objectives are met.

Starter fertilizer shall be in accordance with ACES recommendations. When starter fertilizers are used, they shall be included in the nutrient budget.

To apply fertilizer, manure or other organic by- products accurately, application equipment should be calibrated and maintained in accordance with the manufactures recommendations and/or ACES recommendations. The following will be used for determining the right application rate:

- **Nitrogen Application:** The application rates shall be within 10% of recommended rates for the field and the intended crop. When manure or other organic by- products are a source of nutrients and the application rate is based on phosphorus, an additional nitrogen application, from non- organic sources, may be required to supply the recommended amounts of nitrogen.
- **Phosphorus Application:** The application rates shall be within 10% of recommended rates for the field and intended crop except when manure or other organic by- products are the source of nutrients. Where animal manure, poultry litter, compost or other organic by- products are used, a

  field assessment for potential risk of phosphorus transport to surface water will be conducted (see Additional criteria applicable to properly utilize manure or organic by-products as a plant nutrient source). The Phosphorus Index for Alabama will be used to make this assessment of each field. A record of these assessments shall be included in the conservation plan.
- **Potassium Application**: Excess potassium shall not be applied in situations in which it causes unacceptable nutrient imbalances in crops or forages.
- **Other Plant Nutrients:** The application rates shall be applied consistent with ACES recommendations or other laboratory if recognized by Alabama Cooperative Extension System.

Right Nutrient Sources
Nutrient sources utilized must be compatible with the application timing, tillage and planting system, soil properties, crop, crop rotation, soil organic content, and local climate to minimize risk to the environment.

Sources of plant nutrients can include commercial fertilizer, livestock and poultry manure, poultry litter, compost, residual amounts in the soil, crop residues including cover and green manure crops, agricultural by- products, solids and waste water from municipal treatment plants, and nutrients recycled by grazing animals. When using commercial sources of fertilizer choose sources with the correct proportions of nitrogen, phosphorus and potassium that will meet the recommendation. Legume cover crops or green manure crops, where feasible, can provide nitrogen to the following crop. Be sure to consider these effects in the nutrient budget. Estimated available nitrogen provided by legume and cover crops is contained in Table 3.

On organic operations, the nutrient sources and management must be consistent with the USDA's National Organic Program. Enhanced efficiency fertilizers used in the State must be defined by the Association of American Plant Food Control Officials (AAPFCO) and be accepted for use by the State fertilizer control official, or similar authority, with responsibility for

verification of product guarantees, ingredients (by AAPFCO definition) and label claims.

Right Nutrient Application Time
Timing 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, and weather conditions.

For maximum efficiency and water quality benefits, nitrogen should be applied as close to the time of crop demand as practical. All applied nitrogen (commercial, animal manures or related organic by-products) shall be applied no more than 30 days prior to the beginning of the growth cycle (perennial crops) or 30 days prior to the planned planting date (annual crops). See Agronomy technical note AI-73, “Nitrogen Leaching Index for Alabama” for more information and additional considerations to reduce the potential of nitrogen leaching.

When applying nitrogen to hay, another cutting of hay should be expected during the current growing season. For pasture, another 45 days of grazing should be expected after the application of nitrogen. With stock-piled forage strategies, the length of additional grazing will depend on controlled grazing strategies being used.

Right Nutrient Application Place
Nutrient placement should keep nutrients where the crop can get to them and where nutrient use efficiency will be maximized. Crops, cropping systems, soil properties and nutrient source will dictate the most appropriate method of placement.

Nutrients must not be surface-applied if nutrient losses offsite are likely. This includes spreading on:

- frozen and/or snow-covered soils, and
- when the top 2 inches of soil are saturated from rainfall or snow melt.

Additional Criteria to Minimize Agricultural Nonpoint Source Pollution of Surface and Groundwater Evaluate water quality standards and designated use limitations that exist locally or statewide in managing nutrients to protect the quality of water resources.

Planners must use the current “Nitrogen Leaching Index for Alabama”, “Phosphorus Index for Alabama”, and “RUSLE 2” to assess the risk of nutrient and soil loss. Identified resource concerns must be addressed to meet current planning criteria.

Conservation plans developed to minimize agricultural nonpoint source pollution of surface or groundwater resources will include practices and/or management activities that will reduce the risk of nitrogen or phosphorus movement from the field.

Planning and application of conservation practices must be coordinated to avoid, control, or trap manure and nutrients before they can leave the field by surface or subsurface drainage.

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:

- incorporation or injection
- timing and number of applications
- coordinate nutrient applications with optimum crop nutrient uptake

- the use of guidance and rate control technology
- tissue testing, chlorophyll meters, and spectral analysis technologies

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

All specifications shall be consistent with federal, state, and local regulations. Unless exceptions are granted according to ADEM Rule 335-6-7-26(2) the minimum buffer distance for animal waste application shall be:

- 50 feet from surface waters of the state including, but not limited to, perennial or intermittent streams, ponds, lakes, springs, or sinkholes. ADEM Rule 335-6- 7-26(2) (c)
- 100 feet from nearest existing occupied dwelling, church, school, hospital, park, or non-potable water wells. ADEM Rule 335-6-7-26(2) (c) and (o)
- 200 feet from Outstanding National Resources W ater, Outstanding Alabama W ater, potable water wells, or public water supply. ADEM Rule 335-6-7-26(2) (c)
- 200 feet from nearest existing occupied dwelling, church, school, hospital, or park when applying a non- pumped surface application of wastewater or subsurface injection/application of wastewater. ADEM Rule 335-6-7-26(2) (p)
- 500 feet from the nearest existing occupied dwelling, church, school, hospital, or park when using aerial wastewater irrigation application or other type pumped or pressurized surface application. ADEM Rule 335-6- 7-26(2) (p)
- not applied across property lines unless the adjoining property owner consents in writing and the land application site is approved (meets the requirements of 590). ADEM Rule 335-6-7-26(2) (q)

Nitrogen and phosphorus application rates must be planned based on risk assessment results as determined by “Nitrogen Leaching Index for Alabama” and “Phosphorus Index for Alabama” risk assessment tools. If the phosphorus application rate is limited to reduce the field vulnerability rating on the Phosphorus Index, phosphorus should not be applied at a rate greater than the rate used in the assessment tool.

For fields receiving manure, the phosphorus risk assessment may limit the application rate of phosphorus. Use the following table to determine the phosphorus limitation as a result of the risk assessment. In no case may the nitrogen rate be in excess of the recommendation regardless of the phosphorus limitation.

Risk Categories	Phosphorus Application Rate
Low	Nitrogen Rate
Moderate	3 x P removal by crop
Moderately High	2 x P removal by crop
High	1 x P removal by crop
Very High	No P application

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

- a strategy has been implemented that will reduce phosphorus loss risk in the future, and
- a site assessment for nutrients and soil loss has been conducted to determine

if additional mitigation practices are required to protect water quality.

Manure may be applied annually at a rate equal to the recommended phosphorus application, or estimated phosphorus removal in harvested plant biomass. As an alternative these applications may be made at one time based on recommendation or phosphorus removal for the crop rotation, or multiple years in the crop sequence not to exceed three years. 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;, and,
- no additional phosphorus must be applied in the current year and any additional years for which the single application of phosphorus is supplying nutrients.
- Use Table 4 to determine the phosphorus removal by various crops.

Animal manure, related organic by-products, or wastewater should not be applied within three days (72 hours) before a storm event having a prediction of: (1) periods of rain, (2) occasional rain, (3) rain likely, or
(4) 50% or more probability as predicted by the National W eather Service. If these conditions occur, land application can still proceed if the county is rated favorable for spreading according to the National W eather Service Alabama Animal Waste/Nutrient Land Application Map (http:/www.srh.noaa.gov/bmx/adem/farmers_map.php). If any of the above conditions exist and the county is rated not favorable for spreading on the National W eather Service land application map, land application shall not occur in order to provide reasonable assurance that nutrients in storm water runoff will be reduced

Surface applied animal manure and other related dry organic by-products will not be applied to soils in months that are subject to very frequent and frequent flooding as posted on the Web Soil Survey. This is more than a 50 percent chance of flooding in any month.

Animal manure and related organic by-products will not be applied when wind direction and velocity will cause drift onto public areas, roads, residential areas cross property lines, or offsite.

Animal manure and related organic by-products shall not be applied to root vegetable crops during the current growing season, or to other vegetable crops one-month or less before harvest because of fecal bacterial contamination concerns. Dead animal compost will not be applied to vegetable crops.

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

Waste applications associated with irrigation systems shall be applied in accordance with the requirements of the NRCS conservation practice standard, *Irrigation Water Management-449*.

The total single application of liquid manure:

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

When sewage sludge or other organic source of nutrients containing heavy metals are

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 US Code, Reference 40 CFR, Part 503, and/or any applicable state and local laws or regulations. Apply municipal and industrial sludge only to soils that are adjusted to pH 6.5 or higher and are to be maintained at pH 6.2 or higher. Refer to ACES documentation for guidance.

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.

Additional Criteria to Protect Air Quality by Reducing Odors, Nitrogen Emissions and the Forma- tion of Atmospheric Particulates

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

- incorporation
- injection
- residue and tillage management
- no-till or strip-till
- other technologies that minimize the impact of these emissions

Additional Criteria to Improve or Maintain the Physical, Chemical, and Biological Condition of the Soil to Enhance Soil Quality for Crop Production and Environmental Protection Nutrients shall be applied in such a manner as not to degrade the soil's structure, chemical properties, or biological condition. Use of nutrient sources with high salt content will be minimized in seasonal high tunnels (or other areas where rainfall is restricted) unless provisions are used to leach salts below the crop root zone.

Time the application of nutrients to avoid periods when field activities will result in soil compaction and/or tire ruts.

CONSIDERATIONS

When available use application equipment that utilizes rate controllers, GPS guidance, automatic section control or any combination of all 3 to improve application rate and placement of nutrients.

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

Develop site-specific yield maps using a yield monitoring system. Use the data to further diagnose low- and high- yield areas, or zones, and make the necessary management changes. See Title 190, Agronomy Technical Note (TN) 190.AGR.3, Precision Nutrient Management Planning.

Use legume crops and cover crops to provide nitrogen through biological fixation and nutrient recycling.

When creating a new plan or modifying an existing plan soil test and other needed laboratory analysis should be taken within the past year. Excessive levels of some nutrients can cause induced deficiencies of other nutrients, e.g., high soil test phosphorus levels can result in zinc deficiency in corn.

Use soil tests, plant tissue analyses, and field observations to check for secondary plant nutrient deficiencies or toxicity that may impact plant growth or availability of the primary nutrients. Use the adaptive nutrient management learning process to improve nutrient use efficiency on farms as outlined in the NRCS National Nutrient Policy in GM 190, Part 402, Nutrient Management.

Potassium should not be applied in situations where an excess causes nutrient imbalances in crops or forages. Workers should be protected from and avoid unnecessary contact with plant nutrient sources.

Extra caution must be taken when dealing with organic wastes stored in unventilated enclosures. Material generated from cleaning nutrient application equipment should be utilized in an environmentally safe manner. Excess material should be collected and stored or field applied in an appropriate manner.
Nutrient containers should be recycled in compliance with State and local guidelines or regulations.

Considerations to Minimize Agricultural Nonpoint Source Pollution of Surface and Groundwater and to Properly Utilize Manure or Organic By-Products as a Plant Nutrient Source

The conservation planner should consider appropriate use of vegetated filters and/or manure application setbacks. Vegetated filters are conservation practices designed to treat surface and subsurface runoff to reduce the risk of nutrient loss. Grass waterways, filter strips, and riparian forest buffers may be used to reduce the risk of nutrient loss at the edge of fields where runoff may occur.

Generally, a vegetated filter that meets the Filter Strip (393), Riparian Forest Buffers (391) and/or Grass Waterway (412) standard should be installed and/or maintained on the edges of the application field where runoff may occur to trap and/or treat nutrients transported with sediment and runoff water.

Application setbacks should also be considered when land applying animal manure or other organic by- products near wells. These distances should be determined after considering topography, geology, wellhead protection, and the well use. Generally, use a manure application setback of 200 feet if the application site is located down-gradient from the well and 300 feet if the application site is located up- gradient from the well. Site-specific conditions may warrant adjustments to the application distance. When land applying animal manure or other organic by-products near property lines and public roads application setbacks should be considered. Generally a recommended setback of 25 feet from property lines, 50 feet from public roads when applying waste with a spreader and 100 feet from public roads when pumped wastewater is used should be considered. However, site specific conditions on the ground should be considered to adjust these setback distances to meet the needs the conservation plan objectives.

Using conservation practices that slow runoff, reduce erosion, increase infiltration, and improve soil health will reduce the risk on nutrient loss and should be considered in the planning process. Consider managed rotational grazing systems [such as those in the conservation practice Prescribed Grazing (528)] that maintain minimum forage height, have proper stocking

rates, provide sufficient recovery time to promote the vigor of the plant community, and/or permit grazing only when soil moisture conditions support livestock traffic without excessive compaction. These systems will improve soil health and minimize the risk of nutrient loss. Use no-till/strip-till in combination with cover crops to improve soil health and soil function. This improved soil function will sequester nutrients, increase soil organic matter, increase aggregate stability, reduce compaction, improve infiltration, and enhance soil biological activity to improve nutrient use efficiency. Use nutrient management strategies such as cover crops, crop rotations, and crop rotations with perennials to improve nutrient cycling and reduce energy inputs.

Apply manure at a rate that will result in an “improving” Soil Conditioning Index (SCI) without exceeding acceptable risk of nitrogen or phosphorus loss.

Use application methods and timing strategies that reduce the risk of nutrient transport by ground and surface waters, such as:

- split applications of nitrogen to deliver nutrients during periods of maximum crop utilization,
- banded applications of nitrogen and/or phosphorus to improve nutrient availability,
- drainage water management to reduce nutrient discharge through drainage systems, and
- incorporation of surface-applied manures or organic by-products.

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

Considerations to Protect Air Quality by Reducing Nitrogen and/or Particulate Emissions to the At- mosphere

Manure application setbacks should be considered in the conservation planning process because of the odor and nuisance potential associated with animal manures and other wastes. These setbacks are separation distances between the land application site and public areas. Dwellings, churches, hospital, school, parks, public roads and property lines should be considered in determining the appropriate application setback. Additionally, trees and/or shrub screens that keep the application site from public view and influence air movement should also be a consideration when determining the setback distance.

Generally, a manure application setback of 25 feet from property lines, 100 feet from public roads when applying waste with an irrigation system, and 50 feet from public roads with all other waste applications should be considered.

Soil injection or incorporation by tillage will reduce odor potential when applying animal manure and other organic nutrients Use high- efficiency irrigation technologies (e.g., reduced-pressure drop nozzles for center pivots) to reduce the potential for nutrient losses.

PLANS AND SPECIFICATIONS

The following components must be included in the nutrient management plan:

- aerial site photograph(s)/imagery or site map(s), and a soil survey map of the site,
- soil information including: soil type, surface texture, pH, drainage class, permeability, available water capacity, depth to water table, restrictive features, and flooding and/or ponding frequency,

- location of designated sensitive areas and the associated nutrient application restrictions and setbacks,
- for manure applications, location of nearby residences, or other locations where humans may be present on a regular basis, and any identified meteorological (e.g., prevailing winds at different times of the year), or topographical influences that may affect the transport of odors to those locations,
- results of approved risk assessment tools for nitrogen, phosphorus, and erosion losses,
- documentation establishing that the application site presents low risk for phosphorus transport to local water when phosphorus is applied in excess of crop requirement.
- current and/or planned plant production sequence or crop rotation,
- soil, water, compost, manure, organic by- product, and plant tissue sample analyses applicable to the plan,
- when soil phosphorus levels are increasing, include a discussion of the risk associated with phosphorus accumulation and a proposed phosphorus draw-down strategy,
- realistic yield goals for the crops,
- complete nutrient budget for nitrogen, phosphorus, and potassium for the plant production sequence or crop rotation,
- listing and quantification of all nutrient sources and form,
- all enhanced efficiency fertilizer products that are planned for use,
- in accordance with the nitrogen and phosphorus risk assessment tool(s), specify the recommended nutrient application source, timing, amount (except for precision/variable rate applications specify

  method used to determine rate), and placement of plant nutrients for each field or management unit, and
- guidance for implementation, operation and maintenance, and recordkeeping.

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

- Document the geo-referenced field boundary and data collected that was processed and analyzed as a GIS layer or layers to generate nutrient or soil amendment recommendations.
- Document the nutrient recommendation guidance and recommendation equations used to convert the GIS base data layer or layers to a nutrient source material recommendation GIS layer or layers.
- Document if a variable rate nutrient or soil amendment application was made.
- Provide application records per management zone or as applied map within individual field boundaries (or electronic records) documenting source, timing, method, and rate of all applications that resulted from use of the precision agriculture process for nutrient or soil amendment applications.
- Maintain the electronic records of the GIS data layers and nutrient applications for at least 5 years.

If increases in soil phosphorus levels are expected (i.e., when N-based rates are used), the nutrient management plan must document:

- the soil phosphorus levels at which it is desirable to convert to phosphorus based

planning,

- the potential plan for soil test phosphorus drawdown from the production and harvesting of crops, and
- management activities or techniques used to reduce the potential for phosphorus transport and loss,
- for AFOs, a quantification of manure produced in excess of crop nutrient requirements, and
- a long-term strategy and proposed implementation timeline for reducing soil P to levels that protect water quality,

OPERATION AND MAINTENANCE

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

Fields receiving animal manures and/or biosolids must be monitored for the accumulation of heavy metals and phosphorus in accordance with land- grant university guidance and State law.

Significant changes in animal numbers, management, and feed management will necessitate additional manure analyses to establish a revised average nutrient content. Calibrate application equipment to ensure accurate distribution of material at planned rates.

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

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

- soil, plant tissue, water, manure, and organic by-product analyses resulting in recommendations for nutrient application,
- quantities, analyses and sources of nutrients applied,
- dates, and method(s) of nutrient applications, source of nutrients, and rates of application,
- weather conditions and soil moisture at the time of application; lapsed time to manure incorporation;

rainfall or irrigation event,

- crops planted, planting and harvest dates, yields, nutrient analyses of harvested biomass, and crop residues removed,
- dates of plan review, name of reviewer, and recommended changes resulting from the review, and
- all enhanced efficiency fertilizer products used.

Additional records for precision/variable rate sites must include:

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

REFERENCES

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