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

PURPOSE
To budget, supply, and conserve nutrients for plant production
To minimize agricultural nonpoint source pollution of surface and 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
A nutrient budget for nitrogen, phosphorus, and potassium must be developed that considers all potential sources of nutrients including, but not limited to, green manures, legumes, crop residues, compost, animal manure, organic by-products, biosolids, waste water, organic matter, soil biological activity, commercial fertilizer, and irrigation water.

Persons who approve nutrient management plans in Georgia shall be certified through certification programs acceptable to the Georgia NRCS.

Nutrient management plans should be reviewed and updated annually, or more frequently, as needed. For example, when regulations require animal feeding operations to have a plan, updated plans must be submitted for review as described in their permit. Other requirements for revising plans are described below in the Operations and Management Section.

To avoid salt damage, the rate and placement of applied nitrogen and potassium in starter fertilizer must be consistent with UGA guidelines, or industry practice recognized by UGA.

Follow the best management practices for nitrogen (and other nutrient elements) and plant a cover crop (Georgia NRCS Cover Crop Standard Code 340) after the cash crop to utilize nitrogen remaining in the soil profile as a result of the high potential for leaching nitrogen from Georgia’s agricultural soils. These nutrient management practices are also known as the 4R’s and they are applicable to the management of other nutrients (Appendix 1). Also, estimate the nitrogen available from a previous crop (Appendix 2).

Managing the rate, time and method of nitrogen application is essential for preventing the movement of nitrogen fertilizer through the soil profile. The results of plant tissue should be used to determine the need for additional applications of nitrogen to crop.
especially crops grown on Georgia’s highly leachable soils. Also, applying nitrogen from manure and organic byproducts is a strategy producers may implement to increase soil organic matter and provide crops with nitrogen later in the season.

Fields receiving phosphorous must have a documented agronomic need for phosphorus based on the results of a soil test and UGA recommendations. Use the Georgia Phosphorous Index (Cabrera et al., 2013) when the planned rate of phosphorus application rate exceeds the University of Georgia (UGA) recommended rate http://aware.uga.edu/nutrient_manage/nmp_tools/ (Cabrera, et al., 2013 ). Be sure to include any phosphorous applications since the last soil test. This tool is used to assess the risk of movement of bioavailable P to surface water where it may accelerate eutrophication in lakes and streams.

Areas contained within minimum application setbacks (e.g., sinkholes, wellheads, gullies, ditches, or surface inlets) must receive nutrients consistent with the setback restrictions. Georgia setbacks for manure application are summarized in a separate file (Appendix 3).

The specific details regarding setbacks and other requirements for obtaining permits for animal feeding operations in Georgia are described separately for swine (Swine Feeding Operations Permit Requirements, 391-3-6-.20, ftp://agp2.org/users/mlwilson/2015%20AWARE/Rules-Swine%20Operations%20More%20than%203000%20AU.pdf and non-swine (Animal (Non-Swine) Feeding Operation Permit Requirements, 391-3-6-.21 ftp://agp2.org/users/mlwilson/2015%20AWARE/Rules-Animal%20Feeding%20Operation%20Permit%20Requirements.pdf). Rules for animal manure handlers (Ga. 40-13-8), a person or entity engaged in removing animal manure from livestock/poultry production areas, transporting animal manure on public roadways, or depositing animal manure to a premise other than its point of origin are found elsewhere http://agr.georgia.gov/manure-handlers-rules-application.aspx. These requirements are also described in Appendix 3.

Applications of irrigation water must minimize the risk of nutrient loss to surface and groundwater. See the Georgia NRCS Irrigation Water Management Standard (Code 449) for details.

Soil pH must be maintained in a range that enhances an adequate level for crop nutrient availability and utilization. Refer to the results of a soil test.

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

Nutrient planning must be based on current soil, manure, and tissue test results developed in accordance with UGA guidance, or industry practice, if recognized by the university.

Soil tests for many crops in Georgia are current if they are no older than three years. However, UGA also recommends more frequent sampling under certain conditions and for selected crops. The frequency and procedures for soil testing are described in UGA’s “Soil Test Handbook”. More information may be obtained at http://aesl.ces.uga.edu/publications/soil/sth-sampling.html.

A field, group of fields, or other land units with the same land use with similar treatment needs and planned management is a conservation management unit CMU (Anon. 2003). A CMU has definite boundaries such as a drainage, fence, vegetation or land use. Conservation planners may use a CMU to simplify planning activities and facilitate the development of a resource management system. Where a conservation management unit (CMU) is used as the basis for a sampling unit, all acreage in the CMU must have similar soil type, cropping history, and management practice treatment. Furthermore, when a specific risk assessment of the potential for nutrient transport from a field or a CMU shall be completed, the assessment tools must be approved by the NRCS and UGA.

The soil and tissue tests must include analyses pertinent to monitoring or amending the annual nutrient budget, e.g., pH and electrical conductivity (EC), soil organic matter,
phosphorus, potassium, or other nutrients and test for nitrogen where applicable. Follow UGA guidelines regarding required analyses.

Soil test analyses must be performed by laboratories successfully meeting the requirements and performance standards of the North American Proficiency Testing Program—Performance Assessment Program (NAPT-PAP) under the auspices of the Soil Science Society of America (SSSA) and NRCS, or other NRCS-approved program that considers laboratory performance and proficiency to assure accuracy of soil test results, such as the Agricultural Laboratory Proficiency Program (ALP). Alternate proficiency testing programs must have solid stakeholder (e.g., water quality control entity, NRCS State staff, growers, and others) support and be regional in scope.

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

Manure analyses must include, at minimum, total nitrogen (N), ammonium N, total phosphorus (P) or P2O5, total potassium (K) or K2O, and percent solids, or follow UGA guidance regarding required analyses.

Manure, organic by-products, and biosolids 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. See the O &M section for details.

Samples must be collected, prepared, stored, and shipped, following UGA guidance or industry practice. For example, sampling procedures for manure are found in pages 54-58 of the document obtained through this link http://aesl.ces.uga.edu/Feeschedule.pdf . Current procedures for sampling poultry litter are described in the following

When planning for new or modified livestock operations, acceptable “book values” recognized by the NRCS and UGA, or analyses from similar operations in the geographical area, may be used during the first year if they accurately estimate nutrient output from the proposed operation. The National Engineering Handbook, Part 651, Agricultural Waste Management Field Handbook (AWMFH), Chapter 4 - Agricultural Waste Characteristics (Anon., 1992 or current update) is currently recognized by the NRCS (Appendix 4).

For operations that do not have a prior sampling history, the manure shall be analyzed at least annually for a minimum of three consecutive years. Develop a rolling average of values until a consistent (maintaining a certain nutrient concentration with minimal variation) level of nutrient values is realized. The rolling average of the operation’s cumulative manure analyses history shall be used as a basis for nutrient allocation to fields, unless significant changes have occurred. Samples shall be collected and prepared according to UGA or industry practice.

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 other NRCS-approved program that considers laboratory performance and proficiency to assure accurate manure test results.

**Nutrient Application Rates**

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

If UGA does not provide specific guidance that meets these criteria, application rates must be based on plans that consider realistic yield goals and associated plant nutrient uptake rates, such as Chapter 6 of the AWMH or the NRCS Plants Database Crop Nutrient Tool http://plants.usda.gov/npk/main . Nutrients
removed by crops commonly produced in Georgia are provided in Appendix 5.

UGA does not consider the yield goal of the producer in its recommendations for applying nutrients to most crops. However, at a minimum, the determination of rate must be based on the crop, the 4R's (Appendix 1), a current soil test and the Georgia Phosphorus Index (http://aware.uga.edu/nutrient_manage/nmp_tools, Cabrera, et al., 2013). The rate of application is the most important factor for managing applications of phosphorous and potassium. The cropping sequence is also important due to the nitrogen provided by a previous crop or cover crop (Appendix 2).

Realistic yield goals, where applicable, are also based on historical yield data, soil productivity information, climatic conditions, nutrient test results, level of management, and local research results considering comparable production conditions.

Specific rates for applying fertilizer can be obtained through the “quick crop search” below the “Soil Test Handbook for Georgia” at http://aesl.ces.uga.edu/publications/soil/soil.html. Soil amendments should be applied to adjust soil pH to an adequate level for crop nutrient availability and utilization. Fertilizer, lime and other crop production recommendations may also be obtained through “the alphabetical or departmental list” of publications at http://www.caes.uga.edu/publications.

Estimates of yield response must consider factors such as poor soil quality, drainage, pH, salinity, etc., prior to assuming that nitrogen and/or phosphorus are deficient.

For new crops or varieties, industry-demonstrated yield, and nutrient utilization information may be used until UGA information is available.

Lower-than-recommended nutrient application rates are permissible if the grower’s objectives are met.

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

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**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.

**Nutrient Application Timing and Placement**

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 results.

Do not apply nutrients to the soil surface if nutrient movement to buffers or bodies of water is expected within 24 hours. This precludes spreading manure under the circumstances below:

- frozen and/or snow-covered soils
- flooded soils or 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**

Planners must use the Georgia Phosphorus Index (http://aware.uga.edu/nutrient_manage/nmp_tools/) and RUSLE2, or current NRCS-approved soil erosion risk software, to assess the risk of loss of nutrients and soil.

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.

Fertilizer nutrients, especially nitrogen, 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. As mentioned above, these
strategies or technologies are known as the 4Rs (Appendix 1).

The following nutrient use efficiency strategies or technologies must also be considered. They are listed in order of importance:

- fertigation
- incorporation or injection
- coordinate nutrient applications with optimum crop nutrient uptake
- slow and controlled release fertilizer
- timing and number of applications
- tissue testing

In areas other than cropland, state or local laws may apply under other circumstances. For example, the transportation, storage and application (Table 3) of manure from livestock and poultry operations have been defined for animal manure handlers in Georgia as discussed above (http://agr.georgia.gov/manure-handlers-rules-application.aspx).

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

Manure and organic by-product nutrient application rates will be based on nutrient analyses procedures recommended by UGA. As indicated above, “book values” may be used in planning for new operations.

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

The total single application of liquid manure:

- must not exceed the soil’s infiltration or water holding capacity and be based on crop rooting depth described in UGA’s “Easy Pan Irrigation Scheduler” (http://www.caes.uga.edu/Publications/pubDetail.cfm?pk_id=6297&pg=nn&ct=UGA%20Easy%20Pan&kt=&kid=&pid=).
- must be adjusted to avoid runoff or loss to subsurface tile drains and surface ditches based upon observation of current conditions.

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.

As mentioned above in the section applicable to all purposes, phosphorus application rates must be planned based on risk assessment results as determined by the Georgia Phosphorus Index (http://aware.uga.edu/nutrient_manage/phosphorus_tools/, Cabrera, et al., 2013). Producers must also apply nitrogen according to the principles of the 4 R’s and plant cover crops on all acres.

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 UGA recommendations, especially the requirement of the Georgia Phosphorous Index to not to exceed the “medium” risk category.

Manure may be applied at a rate recommended by UGA for multiple years in the rotation crop sequence at one time. However, there are only 2 crop rotations in Georgia for which phosphorus may be applied once for the entire crop sequence. Wheat is the first crop in each of these rotations followed by grain sorghum or soybeans. When such applications are made, the application rate must not exceed the “medium” risk potential of the Georgia Phosphorous Index and the recommended UGA nitrogen application rate during the year of application or harvest cycle. Furthermore, no additional phosphorus must be applied in the current year and any additional years for which the single application of phosphorus is supplying nutrients.

In watersheds with fecal coliform impairments (http://www.gaepd.org/Documents/gismenu.htm), plans should include best management practices such as buffers, filter strips, ponds or sediment basins to reduce impacts off-site when using manure.

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When sewage sludge (biosolids) is applied, the accumulation of potential pollutants (including arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc) in the soil shall be monitored in accordance with the US Code, Reference 40 CFR, Parts 403 and 503, and/or any applicable state and local laws or regulations. Additional information regarding the concentrations and setback requirements for the application of sewage sludge biosolids (<http://epd.georgia.gov/sites/epd.georgia.gov/files/related_files/site_page/smplasguidelines_June2006.pdf>) and septage (<http://epd.georgia.gov/sites/epd.georgia.gov/files/Issued%20Tier%201%20Operation%20General%20Land%20Application%20of%20Domestic%20Septage%20Permit%20GA%20G620000_0.pdf>) can be found on the Environmental protection Division of the Georgia Department of Natural Resources’ website (<http://epd.georgia.gov/>).

Additional Criteria to Protect Air Quality by Reducing Odors, Nitrogen Emissions and the Formation 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:

- slow or controlled release nitrogen fertilizers such as urea formaldehyde or sulfur coated urea to reduce ammonia volatilization
- incorporation
- injection
- residue and tillage management, such as strip-till
- other technologies that minimize the impact of these emissions, such as applying irrigation water soon after nitrogen application

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 offsite.

Additional Criteria to Improve or Maintain the Physical, Chemical, and Biological Condition of the Soil to Enhance Soil Quality for Crop Production and Environmental Protection

Time the application of nutrients 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

Use no-till/strip-till in combination with cover crops to 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 crop rotations, and crop rotations with perennials to improve nutrient cycling and reduce energy inputs.

Use variable-rate nitrogen application based on expected crop yields, soil variability, soil nitrogen content.

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

Develop site-specific yield maps using a yield monitoring system. Use the data to further diagnose low- and high-yield areas, or zones, and make the necessary management changes. See Title 190, Agronomy Technical Note (TN) 190. AGR.3, Precision Nutrient Management Planning through the following link (<http://directives.sc.egov.usda.gov/default.aspx?l=182>).

Use manure management conservation practices to manage manure nutrients to limit losses prior to nutrient utilization.
Apply manure at a rate that will result in an “improving” Soil Conditioning Index (SCI) in the RUSLE2 soil loss prediction software without exceeding acceptable risk of nitrogen or phosphorus loss.

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

Soil test information should be no older than 1 year when developing new plans.

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

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

Use the adaptive nutrient management learning process to improve nutrient use efficiency, especially of cover crops, on farms as discussed in the General Criteria section of this standard and outlined in the NRCS’ National Nutrient Policy in GM 190, Part 402, Nutrient Management and in the NRCS Agronomy Technical Note No. 6.

Potassium should not be applied in situations where an excess (greater than soil test potassium recommendation) 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 handling anhydrous ammonia or when dealing with organic wastes stored in unventilated enclosures.

Material generated from cleaning nutrient application equipment should be utilized in an environmentally safe manner. Excess material should be collected and stored or field applied in an appropriate manner.

Nutrient containers should be recycled in compliance with State and local guidelines or regulations.

**Considerations to Minimize Agricultural Nonpoint Source Pollution of Surface and Groundwater**

Use conservation practices that slow runoff, reduce erosion, and increase infiltration, e.g., Georgia NRCS Filter Strip Practice Standard (Code 393), Georgia NRCS Contour Farming Standard (Code 330), or Georgia NRCS Contour Buffer Strips (Code 332). These practices can also reduce the loss of nitrates or soluble phosphorus.

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

Use bioreactors and multistage drainage strategies when approved by UGA.

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

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

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:

- as mentioned above, use the University of Georgia Phosphorous Index to establish that the application site presents low risk for phosphorus transport to local water when phosphorus is applied in excess of crop requirement,
- use the NRCS CPA-051 spreadsheet or other software recognized by the Georgia NRCS or University of Georgia for estimating the application rate of plant nutrients (Appendix 6),
- 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,

- 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 recommendations 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.

As mentioned above, factors in the Georgia Phosphorous Index that can be used to reduce the risk of the movement of P from a field to a body of water are the source, rate and placement of phosphorous and the presence (width) of a filter strip (Georgia Filter Strip Standard Code 393). Producing another crop is another strategy for reducing the risk of P movement from the field to water bodies. For example, harvesting hay will remove more P than grazing it.

**OPERATION AND MAINTENANCE**

Producers should conduct annual reviews of plans nutrient management plans (Appendix 7).
An additional manure analysis may be required to establish a revised average nutrient content before the annual update as a result of the following conditions:

- Changes in manure volume or analysis, crop rotation or management
- Significant change (10%) in animal numbers or management (additional structures or change in treatment and feed management)
- Each soil test cycle (for most crops, no more than 3 years; for some other crops, every year. However, the frequency of soil testing depends upon the crop as discussed above in the section on testing and sampling.)

Fields receiving animal manures and/or biosolids must be monitored for the accumulation of heavy metals according to Georgia law (http://www.gaepd.org/Documents/rules_exist.html) and phosphorus concentrations as indicated by the results of the UGA Phosphorous Index.

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. 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

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 IN ADDITION TO NRCS, NHCP JANUARY 2012

NRCS, GA
October 2015
(CSSA), Soil Science Society of America (SSSA). Madison, WI.


