Technical Standards For
West Virginia Concentrated Animal Feeding Operation Nutrient Management Planning
Draft July 2011

DEFINITION

This document outlines guidance required for managing the amount, source, placement, form and timing of the application of nutrients and soil amendments for West Virginia Concentrated Animal Feeding Operations.

CRITERIA

General Criteria Applicable to All Purposes

The term of Nutrient Management Plan (hereinafter referred to as NMP's) will be three years unless a significant change in operation occurs; i.e., greater than 20% increase in animal numbers and/or manure production, significant change in manure analysis, etc. NMP's will be revised at time of the change.

Persons who review or approve NMPs shall be certified by the West Virginia Department of Agriculture's Nutrient Management Certification Program.

Nutrient Management Plans will:

- Be developed using WV-Nutman 2.3 or other methods approved by the West Virginia Department of Agriculture
- Be maintained and made available on site
- Ensure adequate manure storage
- Address mortality management- (addressed by state approved method) i.e.: composting, incineration or burial
- Address appropriate storm water diversion
- Address appropriate chemical and other contaminant disposal

The following components shall be included in the NMP.

Plan Identification

- Acreage of each crop under the plan
- County and/or watershed where farm is located
- Producer's name and address
- Planner's name, address, signature and certification number

Aerial Photograph and/or Topographic Map

- Soils map
- Plan map identifying farm location and tract boundaries
- Individual field identification with acreage
- Plan map identifying unique features such as sinkholes, water courses, wet areas, etc.

Summary of Nutrient Recommendations

- Planned crop or crop rotation
- Potential alternative crops for crop rotation – for narrative approach plans
- A nutrient budget for nitrogen, phosphorus, and potassium.
- Realistic yield goals shall be established based on guidance on page 5 of this document under **Nutrient Recommendations**.
- NMP's will be developed on a field specific basis using soil test results, residual nitrogen credits, manure analysis results, and forage and crop yield potential, and pre-side dress nitrogen tests (PSNT) when applicable. PSNT should be performed in accordance with Penn State Pre-sidedress Agronomy Facts 17 found as referenced: Douglas Beegle, Richard Fox, Gregory Roth, and William Piekielek, *Agronomy Facts 17: Pre-sidedress Soil Nitrate Test for Corn* (University Park: Penn State Cooperative Extension, 1999), http://pubs.cas.psu.edu/FreePubs/pdfs/uc067.pdf.
- Amount of livestock or poultry manure applied per acre
- Lime recommendations
- Estimated quantity and type of manure produced annually- Refer to **Table 8-5**, *2005 Virginia Nutrient Management Standards and Criteria; Animal* Manure Production Rates and **Table 8-6,** Annual Liquid Animal Waste Volume Available for Land Application, **Appendix 1.**
- Utilization and disposition of manure generated in excess of crop agronomic needs will be addressed; i.e.: manure that is given away or marketed.
- Application equipment will be periodically inspected for leaks and calibrated to ensure accuracy and uniformity of manure or litter application and documented on the appropriate manure spreader calibration forms found in Penn State College of Agricultural Sciences as referenced: Gerald Martin and Douglas Beegle, *Agronomy Facts 68: Manure Spreader Calibration* (University Park: Penn State Cooperative Extension, 2008), http://pubs.cas.psu.edu/FreePubs/pdfs/uc200.pdf. Agronomy Facts 68, **Appendix 2.**
- Results of soil, plant, manure sample analysis

Phosphorus Management Guidance for Organic Nutrient Sources

All references to nutrient levels and related quantitative values are based on West Virginia University soil test results. Under 25 lbs/ac is low, 25-50 lbs/ac is medium, 50-80 lbs/ac is high, 80-120lbs/ac is very high and a value of 120+/lbs/ac would be excessive.

I. Manure or litter may be applied at the nitrogen based application rate when soil test phosphorus levels are low to medium.
II. If soil test phosphorus is high, a phosphorus application rate of up to 1.5 times the estimated crop removal rate will be used.
III. If the phosphorus level is very high, greater than 80lbs. /ac and does not exceed 120 lbs per acre, manure or litter will be applied at the crop's estimated phosphorus removal rate or the West Virginia P-Index will be utilized.
IV. If the phosphorus level is greater than 80 lbs, and does not exceed 120 lbs., a single application of phosphorus applied as manure may be made at a rate equal to the recommended phosphorus application or estimated phosphorus removal in harvested plant biomass for a maximum period of 3 years. When such application is made, the nitrogen application rate will not exceed crop nitrogen needs during the year of organic fertilizer application. Once phosphorus levels exceed 120 lbs per acre, no phosphorus applications will be made unless the Phosphorus Field Risk Assessment in the 2010 West Virginia 590 Standard is utilized. It is within the plan writer's discretion to utilize the West Virginia P-Index in place of any of the above mentioned scenarios.
    - The 2010 Phosphorus Field Risk Assessment in the West Virginia 590 Standard: http://efotg.sc.egov.usda.gov/references/public/WV/PhosphorusIndexforNutrientManagementun2010.pdf shall be used on application fields above 120lbs soil test phosphorus to address risk of phosphorus transport from fields to surface waters.
    - Due to workload issues and training, current, existing NMPs written prior to August 1, 2011, shall be valid until their expiration date or significant plan changes occur that require update. These plans are based upon 2005 Phosphorus Field Risk Assessment (Potomac Valley Conservation District). http://efotg.sc.egov.usda.gov//references/public/WV/5904-05.pdf

A record of the P-Index assessment rating for each field and information about conservation practices and management activities utilized to reduce the potential for phosphorus movement from the site shall be included in the plan.

When such assessments are completed, the results and recommendations shall be discussed with the producer during the development of the plan.

In situations where the plan is being implemented on a phosphorus standard where additional application of inorganic nitrogen may be required, N application will be based upon PSNT or estimated crop needs.

When applications are based upon crop phosphorous removal rates, planner shall utilize crop removal information identified in **Table 4-7,** *2005 Virginia Nutrient Management Standards and Criteria*: Virginia Nutrient Management Planning P_20_5 Removal table for Grain and Forage Crops, **Appendix 3.**

Soil Sampling and Laboratory Analysis (Testing)

Nutrient planning shall be based on West Virginia University Mehlich 1 results. This is expressed as pounds of elemental P per acre. Soil test results shall be less than 3 years old. Other approved laboratories include: Virginia Tech, A&L Laboratories, Brookside Laboratories, Spectrum Analytical Laboratories, Waters Agricultural Laboratories. When necessary, analysis shall be converted to West Virginia soil test results using the conversion factors listed in **Table 2-2,** *2005 Virginia Nutrient Management Standards and Criteria:* Correlation of Soil Analysis Results for Phosphorus from Mehlich III to Mehlich I in **Appendix 4.**

Soil Samples shall be collected and prepared according to West Virginia University guidance found in *West Virginia University Soil Sampling and Testing*, **Appendix *5***

Minimum parameters for soil test results shall include: pH, phosphorus and potash.

Manure Sampling

Manure sampling shall be performed annually and in accordance with guidance from West Virginia University as found in *West Virginia University Nutrient Management*: Sample Collection Procedures for Manure Analysis, **Appendix 6.**

Plant Tissue Analysis

Tissue sampling and analysis, where used, shall be done in accordance with any Land Grant University recommendation and guidance.

Nutrient Application Timing

Timing of nutrient application shall correspond with the crop nutrient uptake characteristics as defined in *2005 Virginia Nutrient Management Standards and Criteria* ***Section V****.* Crop Nutrient Needs, **Appendix 7.**

Nutrient Application Methods

Nutrients should not be applied to frozen, snow covered, or saturated soil.

On land application sites, manure, litter or processed wastewater may not be applied closer than 100 feet to any down-gradient surface waters, open tile line intake structures, sinkholes, agricultural well heads, or other conduits to surface waters. Unless one of the following compliance alternatives is utilized:

- Substitute the 100-foot setback with a 35-foot wide vegetated buffer where applications of manure, litter, or processed wastewater are prohibited.
- Alternative practices – demonstrate that a setback or buffer is not necessary because implementation of alternative conservation practices or field-specific conditions will provide pollutant reductions equivalent or better than the reductions that would be achieved by the 100-foot setback.

Nutrient Recommendations

James Thompson associate professor pedology and land use at West Virginia University has cross referenced West Virginia soils to Virginia soil productivity groups. This information is included in **Table 1-1,** *Agronomic and Environmental Management of Soils and Other Site Features,* and ***Table 1-2,*** *Estimates Yields in Bushels (Bu) or Tons (T) per Acre (A) of Various Non-Irrigated Crops for Identified Soil Productivity Groups,* **Appendix 8**. Tile drained soils information is currently under review by West Virginia University and will be made available upon completion.

Nutrient recommendations will be based upon realistic yield goal determined through the guidance found in *2005 Virginia Nutrient Management Standards and Criteria* ***Section V****.* Crop Nutrient Needs, **Appendix 7** or actual producer yield records. Actual yield records shall be an average of the best 3 out of 5 year's yield.

For new crops or varieties, industry yield recommendations may be used until documented yield information is available. Plans for nutrient management shall specify the form, source, amount, timing, and method of application of nutrients on each field to achieve realistic yield goals, while minimizing nitrogen and/or phosphorus movement to surface and/or ground waters.

Nitrogen Application

Planned nitrogen application rates shall account for all sources of nutrients applied. This is inclusive of both organic and inorganic nitrogen sources. Manure and legume residual amounts of nitrogen in the soil and crop residue shall also be accounted for to determine the nitrogen recommendation based upon a realistic yield goal or actual producer yield records. Manure and legume residuals can be found in *2005 Virginia Nutrient Management Standards and Criteria* **Tables 7-1,** Estimated Nitrogen Availability to Succeeding Crops from Legumes and **Table 8-3**, Manure Residual Factors for Previous Applications found in **Appendix 9.**

Criteria Applicable to Manure or Organic By-Products (Excluding Sewage Sludge/Bio-Solids) Applied as a Plant Nutrient Source

Nutrient values of manure and organic by-products (excluding sewage sludge/bio-solids) shall be determined prior to land application based on a West Virginia Department of Agriculture laboratory analysis or any other laboratory certified through the Manure Analysis Proficiency Program (Minnesota Department of Agriculture). The minimum parameters for manure analysis shall be NH_4, TKN, P and moisture. Manure test results used to develop a NMP shall be taken within one year prior to the development of the plan and sampled annually thereafter. Average manure test values may be used to develop a NMP for a new facility. An actual manure sample shall be taken within one year of the NMP development. If there is any significant difference in manure test results, the NMP shall be revised. Nitrogen coefficients used in the development of the NMP are based upon 2005 *Virginia Nutrient Management Standards and Criteria* **Table 8-1**, Manure Ammonium Nitrogen Availability Coefficients, **Table 8-2**, Coefficients for Organic N Availability in Manures and **Table 8-3,** Manure Residual Factors for Previous Applications, all found in **Appendix 10.**

Nutrient Application Rates for Sewage Sludge/Bio-Solids

Nutrient values for sewage sludge shall be determined by reviewing a certified laboratory analysis provided by the landowner. When more than one analysis is available, an average value will be calculated. Sewage sludge/bio-solids applications shall be made in accordance with the phosphorus management guidance for organic nutrient sources. Manure or litter may only be applied in lieu of the sludge.

Heavy Metals Monitoring

When sewage sludge is applied, the accumulation of potential pollutants (including, but not limited to arsenic, cadmium, copper, lead, mercury, selenium, and zinc) in the soil shall be monitored by the owner/client in accordance with the US Code, Reference 40 CFR, Parts 403 and 503, and/or any applicable state and local laws or regulations.

Record Keeping

Upon transfer of manure or wastewater, a current nutrient analysis must be provided to recipient. The permit holder must maintain records for five years of the date, recipient name and address and approximate amount of manure, litter or processed wastewater transferred to another person.

CAFO NMP's are required to keep the following information in accordance with **40 CFR Section 412.37,** *Additional Measures* as outlined below:

§ 412.37 Additional measures.

(a) Each CAFO subject to this subpart must implement the following requirements:
(1) *Visual inspections.* There must be routine visual inspections of the CAFO production area. At a minimum, the following must be visually inspected:
(i) Weekly inspections of all storm water diversion devices, runoff diversion structures, and devices channeling contaminated storm water to the wastewater and manure storage and containment structure;
(ii) Daily inspection of water lines, including drinking water or cooling water lines;
(iii) Weekly inspections of the manure, litter, and process wastewater impoundments; the inspection will note the level in liquid impoundments as indicated by the depth marker in paragraph (a)(2) of this section.
(2) *Depth marker.* All open surface liquid impoundments must have a depth marker which clearly indicates the minimum capacity necessary to contain the runoff and direct precipitation of the 25-year, 24-hour rainfall event, or, in the case of new sources subject to the requirements in § 412.46 of this part, the runoff and direct precipitation from a 100-year, 24hour rainfall event.
(3) *Corrective actions.* Any deficiencies found as a result of these inspections must be corrected as soon as possible.
(4) *Mortality handling.* Mortalities must not be disposed of in any liquid manure or process wastewater system, and must be handled in such a way as to prevent the discharge of pollutants to surface water, unless alternative technologies pursuant to § 412.31(a)(2) and approved by the Director are designed to handle mortalities.
(b) *Record keeping requirements for the production area.* Each CAFO must maintain on-site for a period of five years from the date they are created a complete copy of the information required by 40 CFR 122.21(i)(1) and 40 CFR 122.42(e)(1)(ix) and the records specified in paragraphs (b)(1) through (b)(6) of this section. The CAFO must make these records available to the Director and, in an authorized State, the Regional Administrator, or his or her designee, for review upon request.
(1) Records documenting the inspections required under paragraph (a)(1) of this section;

(2) Weekly records of the depth of the manure and process wastewater in the liquid impoundment as indicated by the depth marker under paragraph (a)(2) of this section;
(3) Records documenting any actions taken to correct deficiencies required under paragraph (a)(3) of this section. Deficiencies not corrected within 30 days must be accompanied by an explanation of the factors preventing immediate correction;
(4) Records of mortalities management and practices used by the CAFO to meet the requirements of paragraph (a)(4) of this section.
(5) Records documenting the current design of any manure or litter storage structures, including volume for solids accumulation, design treatment volume, total design volume, and approximate number of days of storage capacity;
(6) Records of the date, time, and estimated volume of any overflow.
(c) *Recordkeeping requirements for the land application areas.* Each CAFO must maintain on-site a copy of its site-specific nutrient management plan. Each CAFO must maintain on-site for a period of five years from the date they are created a complete copy of the information required by § 412.4 and 40 CFR 122.42(e)(1)(ix) and the records specified in paragraphs (c)(1) through (c)(10) of this section. The CAFO must make these records available to the Director and, in an authorized State, the Regional Administrator, or his or her designee, for review upon request.
(1) Expected crop yields;
(2) The date(s) manure, litter, or process waste water is applied to each field;
(3) Weather conditions at time of application and for 24 hours prior to and following application;
(4) Test methods used to sample and analyze manure, litter, process waste water, and soil;
(5) Results from manure, litter, process waste water, and soil sampling;
(6) Explanation of the basis for determining manure application rates, as provided in the technical standards established by the Director.
(7) Calculations showing the total nitrogen and phosphorus to be applied to each field, including sources other than manure, litter, or process wastewater;
(8) Total amount of nitrogen and phosphorus actually applied to each field, including documentation of calculations for the total amount applied;
(9) The method used to apply the manure, litter, or process wastewater;
(10) Date(s) of manure application equipment inspection.

Appendix 1

Table 8-5, *2005 Virginia Nutrient Management Standards and Criteria;* Animal Manure Production Rates and **Table 8-6,** Annual Liquid Animal Waste Volume Available for Land Application

Table 8-5
Animal Manure Production Rates[1]

Animal	Daily Manure Production Per 1,000 lb weight				% Dry Matter
	Animal Size	lbs.	cu. ft.	gals	
Cattle					
Dairy	150 - 1,500	82	1.4	10.0	13
Beef	400 – 1,400	60	1.0	7.5	12
Veal	100 – 350	63	1.0	7.5	1.6
Swine					
Pigs	35 – 200	65	1.1	7.5	9
Gestation Sow	275	32	0.5	4.0	9
Sow and 8 pigs	375	88	1.4	10.6	9
Boar	350	31	0.5	4.0	9
Sheep	100	40	0.6	4.6	25
Horse	1,000	45	0.7	5.6	20
Poultry					
Poultry[2] Liquid	-	300	-	-	5
Fresh, wet, sticky and caked	-	61	-	-	25
Moist crumbly to sticky	-	32	-	-	50
Crumbly	-	22	-	-	70
Dry	-	18	-	-	85

1. Does not include bedding, wash water, runoff water and other inputs which increase manure volume.

2. Storage losses already deducted.

Broiler houses generate approximately 1.25 tons of litter per 1000 birds during each cycle. Six cycles per year is average. Houses are cleaned out at variable intervals ranging from after each cycle to once every two years.

Turkey Tom production generates approximately 10 tons of litter per 1000 birds during each cycle for 4 cycles per year. Turkey hens produce about 8 tons per 1000 birds during each of 5 cycles per year.

Complete clean outs of poultry houses should be scheduled during spring or summer, consistent with the availability of a suitable crop for uptake of N, unless covered storage is available, to minimize water quality impacts and maximize agronomic efficiency.

Table 8-6
Annual Liquid Animal Waste Volume Available for Land Application

A. Manure Production

Animal Type	Ave. Wt*		Gal/Yr		# Animals		% Confined		Volume (Gals)
Feeder Swine	_____	x	2.74	x	_____	x	____ . ____	=	_____
Sow & Litter	_____	x	3.84	x	_____	x	____ . ____	=	_____
Gestation Sow	_____	x	1.46	x	_____	x	____ . ____	=	_____
Boar	_____	x	1.46	x	_____	x	____ . ____	=	_____
Beef Cattle	_____	x	2.74	x	_____	x	____ . ____	=	_____
Dairy Cattle	_____	x	3.65	x	_____	x	____ . ____	=	_____

Subtotal Annual Manure Production _____ gallons

*Typical Weights					
	Lbs.				Lbs.
Feeder Swine	145		Dairy Cattle		
Sow & Litter	375		Mature		1400
Gestation Sow	275		Heifers	16-24 Mo	1050
Boar	350			9-16 Mo	680
Beef Cattle (Finishing)	1000			2-9 Mo	350
			Calves	0-2 Mo	150

B. Process Wastewater

Type	# Animals		Gals. Per Day		365 Days/Yr.		Total Wastewater	
Dairy	_____	x	_____	x	365	=	_____	gals
Hogs	_____	x	_____	x	365	=	_____	gals
Other	_____	x	_____	x	365	=	_____	gals

Dairy Cows Milked	Wastewater (Gal/Cow/Day)
0 - 50	5 - 8
50 - 150	4 - 6
150+	2 – 4

*** Typical Wastewater — excludes flushing systems**

Note: Most modern swine operations with lagoons use recirculated flush water for some of the production areas, therefore, when calculating process wastewater, you should consider only the clean water that is added during each flush.

C. Feedlot Runoff

$$\frac{(A \times ROF \times AnnPrec)}{12} \times 7.48 = \text{Feedlot Runoff}$$

Where: A = lot area in square feet
ROF = runoff factor
ROF for paved lot = .60
ROF for unpaved lot = .25
AnnPrec = annual average precipitation from Table 8-7
7.48 converts cubic feet to gallons

$$\frac{(_____)}{12} \times 7.48 = _____ \text{gallons}$$

D. Net Precipitation Excess Over Pit or Lagoon (Precipitation less Evaporation)

Lagoons: NPE = Rainfall - (Lake Evaporation x .9)*
NPE = _____ - (_____ x _____)
NPE = _____

Pits: NPE = Rainfall - (Lake Evaporation X .3)*
NPE = _____ - (_____ x _____)
NPE = _____

*See Table 8-7

$$\frac{(SA \times NPE)}{12} \times 7.48 = \textbf{Total NPE (gallons)}$$

where: SA = surface area of pit or lagoon at the top,
NPE = net precipitation excess as calculated above,
7.48 converts cubic feet to gallons

$$\frac{(_____)}{12} \times 7.48 = _____ \text{gallons}$$

Total Annual Liquid Animal Waste Volume Produced =
(A. Manure + B. Process Wastewater + C. Feedlot Runoff + D. Net Precipitation Excess) _____ **gallons**

Appendix 2

Penn State College of Agricultural Sciences; **Manure Spreader Calibration**: Agronomy Facts 68
Prepared by Gerald Barton, Senior Extension Associate and Douglas Beegle, Professor of Agronomy

PENNSTATE College of Agricultural Sciences CROP AND SOIL SCIENCES

Manure Spreader Calibration

Agronomy Facts 68

Manure spreader calibration is an essential and valuable nutrient management tool for maximizing the efficient use of available manure nutrients. Planned manure application rates listed in nutrient management plans must correlate with actual application rates. Calibrating the manure spreader is the only way to know actual manure application rates.

Manure spreader calibration combined with soil test recommendations and manure analysis results enable the determination of nutrient application rates that meet crop nutrient needs. The most critical and challenging aspect of both soil and manure analysis is obtaining a representative sample to submit to the laboratory. It is critical to learn and follow recommended soil and manure sampling procedures in order to obtain a representative sample and test results. The manure nutrient levels and crop nutrient requirements from test results are used to determine manure application rates that will adequately meet crop needs. Manure spreader calibration ensures that manure application rates are realistic, practical, and attainable.

Manure application rates are determined by equipment speeds and settings along with application management, such as overlaps. Manure spreader calibration can be used two ways in nutrient management planning:

Before planning—Spreaders can be calibrated to determine the rates that can be applied at typical application settings and speed. These rates are then used as the possible planned rates when the nutrient management plan is developed.

After planning—Spreaders can be calibrated to meet planned application rates by changing speeds, settings, or management. In this case, desired application rates are determined as the nutrient management plan is developed and the spreader is calibrated accordingly.

OVERVIEW OF SPREADER CALIBRATION

An application rate is defined as the amount of manure applied per unit of land area. For manure, it is usually expressed in tons per acre (solid) or gallons per acre (liquid). Generally, application rate equals the amount of manure applied (in tons or gallons) divided by the area covered (in acres).

Manure spreader calibration requires reliable estimates of both the amount applied and area covered. There are two common calibration techniques. The **swath or load-area method** involves measuring both the amount of manure in a typical spreader load and the land area covered by applying one load of manure. While this method can be used for all manures, it is the best method for liquid manure applicators. The **tarp or weight-area method** involves weighing the manure spread over a small surface and computing the amount of manure applied per acre. This method is the best method for solid manure applicators.

CALIBRATION METHODS

Below are descriptions of the two most common calibration methods.

Swath (Load-Area) Method

Liquid manure applicators used in pump-and-haul application systems are best calibrated by the swath or load-area method, which involves land applying a full load of manure and measuring the land area covered. If possible, choose an area that is typical of the land where manure will be spread. If appropriate, a relatively level area long enough for the load to be applied in a single pass makes measurements and calculations simpler. A rectangular field pattern should be used to make measuring easier. The

application rate of PTO-driven spreaders depends on ground speed. Therefore, it is important to maintain a uniform ground speed throughout the swath length. Ground-driven spreaders deliver reasonably uniform application rates regardless of ground speed.

For liquid application equipment, application rates and patterns vary depending on ground speed or PTO speed, gear box settings, gate openings, operating pressures, spread widths, and overlaps. To change the application rates, adjustments must be made in tractor/PTO speeds, spreader output settings, or application management. The calibration process should be followed for each change or combination of changes. Several calibration passes may be necessary to determine the settings required for the desired application rate.

Use the swath (load-area) method procedure and record sheet provided at the end of this publication for this calibration method.

Tarp (Weight-Area) Method

Solid manure applicators are best calibrated by the tarp or weight-area method, which involves measuring the amount of manure (weight) applied over a small measured area (tarp). The application rate is determined by dividing the amount (weight) of manure collected on the tarp by the size of the collection area (tarp).

For solid application equipment, applications rates and patterns vary depending on ground speed or PTO speed, gear box settings, gate openings, operating pressures, spread widths, and overlaps. To change the application rates, adjustments must be made in tractor/PTO speeds, spreader output settings, or application management. The calibration process should be followed for each change or combination of changes. Several calibration passes may be necessary to determine the settings required for the desired application rate.

Use the tarp (weight-area) method procedure and record sheet provided at the end of this publication for this calibration method.

Figure 1. Calculating estimated manure spreader volumes.

Solid or Semisolid

[A] Box spreader (level load)*
volume = length x width x depth

[B] Box spreader (piled load)*
volume = length x width x [depth + (stacking height** x 0.8)]

[C] Round-bottom open-top spreader (level load)
volume = length x depth x depth x 1.6

[D] Round-bottom open-top spreader (piled load)
volume = length x depth x 1.6 x (depth + stacking height**)

Liquid

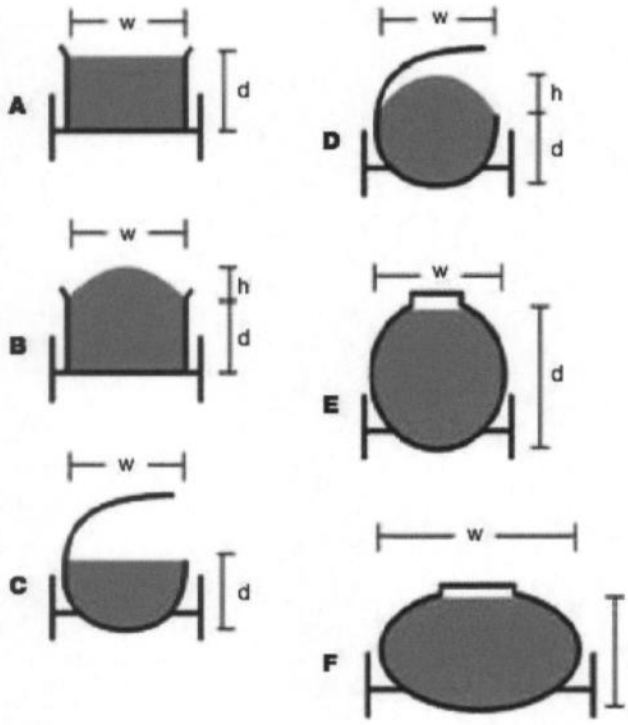
[A] Box spreader (level load)*
volume = length x width x depth

[C] Round-bottom open-top spreader (level load)
volume = length x depth x depth x 1.6

[E] Tank spreader (round)
volume = length x tank diameter x tank diameter x 0.8

[F] Tank spreader (noncircular)
volume = length x width x depth x 0.8

*For a box spreader with sloping sides, use an average width.
**Stacking height is the height of any mounded manure above level.



DETERMINING MANURE SPREADER CAPACITY

The load-area method of manure spreader calibration requires knowledge of the manure spreader's capacity. Manure spreader capacity can be determined by one of the following methods.

Manufacturer's Capacity Ratings

The rated capacity for liquid spreaders can be used directly if the spreader is typically filled to capacity. In many cases, the spreader is not fully loaded. Therefore, adjustments must be made for less than full capacity.

The rated capacity of box-type solid or semisolid spreaders must be adjusted according to the fullness of a typical load of manure. Make sure to note whether the rating specifications are for "heaped or piled" or "level" loads.

If there is any uncertainty about the rate capacity, then a more accurate method is needed to measure the actual volume of manure.

Measure Spreader Volume

Spreader volume can be estimated by using the calculations in Figure 1. All dimensions used in the following formulas must be in feet in order to obtain volumes that are in cubic feet. After calculating volume in cubic feet, convert the cubic feet to pounds and then convert pounds to tons or gallons based on manure density using the conversion factors in Table 1.

Table 1. Commonly required conversions for manure spreader volumes.

To convert from	To	Multiply by
bushels	cubic feet	1.24
gallons	cubic feet	0.134
gallons	pounds	8.3 (liquid)
gallons	tons	0.0041 (liquid)
cubic feet	gallons	7.48
cubic feet	tons	0.031 (liquid) or 0.0275 (solid)
cubic feet	pounds	62 (liquid) or 55 (solid)

Weigh Manure Load

The most accurate way to determine the capacity of a spreader is to directly weigh the spreader. The spreader should be weighed using drive-on scales or weigh pads.

First, weight the spreader empty and then weight at least three typical loads of manure. Obtain an average weight of the full loads and subtract the weight of the empty load to determine the weight of the manure. Convert this weight to tons or gallons.

DETERMINING MANURE DENSITY

Manure density (weight per cubic foot) varies with moisture content primarily depending on the amount of bedding. To calculate a more accurate estimate of manure density, use the procedure below.

1. Weigh an empty 5-gallon bucket. Record the weight in pounds.
2. Fill the 5-gallon bucket with a typical sample of the manure to be applied and weigh the bucket and manure. Record the weight in pounds.
3. Subtract the weight of the empty bucket (step 1) from the weight of manure and bucket (step 2). Record the weight of manure in pounds.
4. Repeat steps 2 and 3 at least six times and calculate the average manure weight (add the six weights together and divide by six). Record average weight of manure in pounds.
5. Multiply the average manure weight (step 4) by 1.5 to obtain the estimated manure density in pounds per cubic foot. Record the manure density in pounds per cubic foot.

SWATH (LOAD-AREA) METHOD CALIBRATION PROCEDURE

Obtain calibration equipment and supplies.

- Measuring wheel (available from any farm supply catalog, such as NASCO).

1. Determine manure spreader capacity.

- Use manufacturer's ratings or actual weighing of the spreader, or estimate by using spreader volume calculations described above.
- Record the capacity in gallons (liquid manure) or tons (solid manure).
- Load the spreader consistently with the capacity determination above.

2. Spread one full load of manure in a rectangular pattern. Note the details of the operating conditions (e.g., tractor gear, throttle setting, PTO speed, tractor speed, spreader settings).
3. Measure the length and the effective application width of the application coverage area.
    - Record the distances in feet.
    - An alternative method of measuring the application length is to note the ground speed and time required to make the application pass. To calculate length covered, multiply the ground speed (in mph) by the number of seconds by 1.46 feet per second.
4. Calculate the size of the coverage area.
    - Multiply the length by the width and divide by 43,560 square feet per acre.
    - Record the coverage area in acres.
5. Calculate the application rate.
    - Divide the volume of the spreader load of manure (step 1a) by the acres covered (step 4b).
    - Record manure application rate in gallons or tons per acre.
6. Repeat the calibration procedure one or two more times.
    - Repetition is necessary to increase reliability of the application rate. A certain amount of variation is inevitable. However, if there is significant variation among repetitions, check over the equipment and review your calibration procedure to try to determine the cause of the variation.
    - Repeat steps 2 through 5.
    - Calculate the average of each of the measured manure application rates.
    - Record the final calibrated rate in gallons or tons per acre.

MANURE SPREADER CALIBRATION RECORD SHEET—SWATH (LOAD-AREA) METHOD

Spreader Identification			
Date			
1. Determine the capacity of the spreader (use gallons for liquid manure and tons for solid manure).			
a. Spreader capacity			gallons or tons
2. Spread one full load in a rectangular pattern.			
Forward speed, gear, or throttle setting			
PTO speed or setting			
Spreader gate opening setting			
3. Measure the coverage area.			
	Trial 1	Trial 2	Trial 3
a. Spread area width	feet	feet	feet
b. Spread area length	feet	feet	feet
4. Calculate the area covered.			
a. Spread area (3a x 3b)	ft^2	ft^2	ft^2
b. Spread area (4a ÷ 43,560)	acres	acres	acres
5. Calculate the manure application rate.			
a. Application rate (1a ÷ 4b)			gallons or tons/acre
6. Average each of the calibration trials to determine the final application rate.			
Final calibrated application rate (average of trials in 5a)			gallons or tons/acre

Tarp (Weight-Area) Method Calibration Procedure

Obtain calibration equipment and supplies.

- Tarp or plastic (heavy) sheet approximately 100 square feet in size (9 x 12, 10 x 10, 10 x 12, etc.)
- Tent pegs or long nails
- Scales (spring-tension or platform)
- Bucket (optional to assist in weighing)

1. Measure the exact surface area of the trap or plastic sheet (length x width).
    - Record the surface area in square feet.
    - Weigh the "empty" tarp or plastic sheet. If using a bucket, weigh the tarp or plastic sheet with the bucket.
    - Record the weight (empty) in pounds. (3a)
2. Position the tarp in the field where the manure can be spread.
    - Place it far enough into the field to allow enough distance to get the spreader in gear and the tractor up to the desired speed.
    - Avoid placing the tarp where the beginning or end of the load is likely to fall.
    - Secure each corner of the tarp with a tent peg or long nail.

- Spread the first pass of manure directly over the center of the tarp.
- Operate the spreader at the speed normally driven when applying manure.
- Note the details of the operating conditions (e.g., tractor gear, throttle setting, PTO speed, tractor speed, spreader settings).
- Spread two additional passes on opposite sides of the center of the tarp.
- Apply these passes at the normal spreader overlap spacing.

3. Remove and fold the tarp.

    - Be careful not to spill any of the collected manure.
    - If using a bucket for weighing, place the manure and tarp in the bucket.
    - Weigh the tarp and manure (and bucket).
    - Record the weight (gross) in pounds (step 3b).
    - Subtract the empty tarp weight (and bucket if using a bucket) (step 3a) from the gross tarp weight (step 3b).
    - Record the weight of collected manure in pounds.

4. Determine the manure application rate.

    - Divide the amount of manure collected (in pounds) (step 3c) by the tarp area (in square feet) (step 1a).
    - Multiply this value by 21.8 (43,560 ft^2/acre ÷ 2,000 lbs/ton) to convert pounds per square foot to tons per acre.
    - Record the manure application rate in tons per acre.

5. Repeat the calibration procedure one or two more times.

    - Repetition is necessary to increase reliability of the application rate.
    - Repeat steps 2 through 4.
    - Calculate the average of each of the measured manure application rates.
    - Record the final calibrated rate in tons per acre.

MANURE SPREADER CALIBRATION RECORD SHEET—TARP (WEIGHT-AREA) METHOD

Spreader Identification			
Date			
1. Measure tarp surface area. Weigh the empty tarp and record under 3a below. Spread and secure the tarp or plastic sheet in the field.			
a. Tarp surface area:	width x	length =	ft^2
2. Spread manure over the center of the tarp and on each side of the tarp at the normal overlap spacing.			
Forward speed, gear, or throttle setting			
PTO speed or setting			
Spreader gate opening setting			
3. Fold and weigh the tarp (and weighing container) with an accurate set of spring-tension or platform scales.			
	Trial 1	Trial 2	Trial 3
a. Empty weight	lbs	lbs	lbs
b. Gross weight with manure	lbs	lbs	lbs
c. Net weight (3b – 3a)	lbs	lbs	lbs
4. Calculate the manure application rate.			
a. Application rate (3c ÷ 1a)	lbs/ft^2	lbs/ft^2	lbs/ft^2
b. Application rate (4a x 21.8)	tons/acre	tons/acre	tons/acre
5. Average each of the calibration trials to determine the final application rate.			
Final calibrated application rate (average of trials in 4b)			tons/acre

Prepared by Gerald Martin, senior extension associate, and Douglas Beegle, professor of agronomy.

Peer-review feedback provided by William Clouser, nutrient management program supervisor, State Conservation Commission; Douglas Goodlander, nutrient management program director, State Conservation Commission; Robert Meinen, senior extension associate, Penn State Cooperative Extension in Dairy and Animal Science; and Jennifer Weld, project associate, Penn State Department of Crop and Soil Sciences.

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Appendix 3

Table 4-7, *2005 Virginia Nutrient Management Standards and Criteria;* Virginia Nutrient Management Planning P_2O_5 Removal Table for Grain and Forage Crops

Table 4-7
Virginia Nutrient Management Planning P_2O_5 Removal Table for Grain and Forage Crops

Use the following table to determine the pounds of P_2O_5 removed per unit of harvest. See Note 1 for yield moisture criteria.

CROP	YIELD UNIT	LBS P_2O_5 PER YIELD UNIT
GRAINS		
Barley (cover crop)	NA	0
Barley	bushels	0.40
Barley straw (per bushel grain)	bushels	0.11
Barley-soybean dbl crop	bushels	**
Buckwheat	bushels	0.36
Canola	bushels	1.3
Corn	bushels	0.38
Oat (cover crop)	NA	0
Oat	bushels	0.33
Oat straw (per bushel grain)	bushels	0.09
Proso millet	bushels	0.39
Rye (cover crop)	NA	0
Rye	bushels	0.45
Rye straw (per bushel grain)	bushels	0.17
Sorghum	bushels	0.4
Soybean	bushels	0.89
Sunflower	tons	27
Triticale (cover crop)	NA	0
Triticale	bushels	0.39
Wheat (cover crop)	NA	0
Wheat	bushels	0.51
Wheat straw (per bushel grain)	bushels	0.11

CROP	YIELD UNIT	LBS P_2O_5 PER YIELD UNIT
SILAGE		
Barley silage	tons	5.1
Corn silage	tons	4.2
Grass silage	tons	5.7

Table 4-7
Virginia Nutrient Management Planning P_2O_5 Removal Table for Grain and Forage Crops

CROP	YIELD UNIT	LBS P_2O_5 PER YIELD UNIT
SILAGE		
Oats silage	tons	5
Rye silage	tons	5.6
Sorghum silage	tons	5.4
Soybean silage	tons	10
Triticale silage	tons	5.6
Wheat silage	tons	4.2

CROP	YIELD UNIT	LBS P_2O_5 PER YIELD UNIT
FORAGES		
Alfalfa hay	tons	14.5*
Alfalfa-grass hay	tons	14.5*
Bermudagrass hay	tons	10.4*
Bermudagrass pasture	NA	****
Birdsfoot trefoil	tons	21*
Bluegrass	tons	18*
Bromegrass	tons	13*
Bluestem species	tons	10*
Clover and grass	tons	14*
Fescue grass hay	tons	16*
Fescue grass-Ladino clover hay	tons	14*
Gamagrass	tons	11
Hay/Pasture	***	16*
Hairy vetch	tons	14
Indiangrass	tons	10
Legume cover crop	NA	0
Lespedeza	tons	10*
Millet	tons	8.4
Native/unimproved pasture	NA	****
Orchardgrass hay	tons	16*
Orchardgrass hay-Ladino clover	tons	16*
Orchardgrass/Fescue pasture	NA	****
Perennial ryegrass	tons	17*

Table 4-7
Virginia Nutrient Management Planning P_2O_5 Removal Table for Grain and Forage Crops

CROP	YIELD UNIT	LBS P_2O_5 PER YIELD UNIT
FORAGES		
Red clover	tons	10*
Red clover-grass hay	tons	14*
Reed canarygrass	tons	12*
Small grain hay	tons	10
Sorghum	tons	8.4
Sorghum x sudangrass (Sudax)	tons	10
Sorghum-sudan, millet, sudan (hay)	tons	10
Soybean and sorghum	tons	9.2
Soybean hay	tons	10
Soybean and millet	tons	9.2
Soybean and Sudangrass	tons	10
Switchgrass	tons	10*
Sudangrass	tons	10
Tall fescue hay	tons	16*
Timothy	tons	14*
Weeping lovegrass	tons	10*

CROP	YIELD UNIT	LBS P_2O_5 PER YIELD UNIT
SEED CROPS		
Crimson clover seed	pounds	0.018
Lespedeza seed	pounds	0.016
Red clover seed	pounds	0.016
White clover seed	pounds	0.030

CROP	YIELD UNIT	LBS P_2O_5 PER YIELD UNIT
VEGETABLES		
Asparagus	cwt	0.13
Beet (root)	cwt	0.092
Beet (top)	cwt	0.12
Broccoli	cwt	0.18
Brussels sprout	cwt	0.29
Cabbage	tons	1.8

Table 4-7
Virginia Nutrient Management Planning P_2O_5 Removal Table for Grain and Forage Crops

CROP	YIELD UNIT	LBS P_2O_5 PER YIELD UNIT
VEGETABLES		
Carrot	cwt	0.092
Cauliflower	cwt	0.14
Celery	cwt	0.083
Chive	cwt	0.12
Collard	cwt	0.13
Cucumber	tons	1.1
Eggplant	cwt	0.050
Endive	cwt	0.051
Escarole	cwt	0.032
Garlic	cwt	0.39
Kale	cwt	0.13
Leek	cwt	0.080
Lettuce (head)	cwt	0.79
Lettuce (leaf)	cwt	0.10
Lima bean	cwt	0.34
Mustard green	cwt	0.10
Okra	cwt	0.15
Onion (dry)	cwt	0.60
Onion (green)	cwt	0.084
Parsley	cwt	0.092
Parsnip	cwt	0.16
Pea	cwt	0.57
Pepper	cwt	0.066
Potato	cwt	0.14
Pumpkin	tons	1.7
Radish	cwt	0.064
Rutabaga	cwt	0.092
Snap bean	cwt	0.23
Spinach	cwt	0.15
Squash (summer)	cwt	0.064
Squash (winter)	cwt	0.079
Sweet corn	cwt	0.14
Sweet potato	cwt	0.12

Table 4-7
Virginia Nutrient Management Planning P_2O_5 Removal Table for Grain and Forage Crops

CROP	YIELD UNIT	LBS P_2O_5 PER YIELD UNIT
VEGETABLES		
Tomato	tons	2.0
Turnip (root)	cwt	0.065
Turnip (green)	cwt	0.14

CROP	YIELD UNIT	LBS P_2O_5 PER YIELD UNIT
FRUITS		
Apple	bushels	0.020
Grape	tons	2.0
Honeydew melon	tons	1.3
Muskmelon	tons	3.5
Peach	bushels	0.033
Watermelon	tons	0.47
Strawberry	cwt	0.043

CROP	YIELD UNIT	LBS P_2O_5 PER YIELD UNIT
MISCELLANEOUS		
Cotton (seed & lint)	tons	26
Cotton (stalk, leaf & bur)	tons	10
Tobacco (leaf & stalk - based on harvest leaf weight)	lb leaves	.009
Peanuts	pounds	.007

NOTES:
1.Yields are based on the following moisture levels: grain-corn-15.5%, wheat-13.5%, barley-14%, oats-14%, grain sorghum-13%, soybeans-14.5%; all silage-65%; all hay-15%. For all other crops, yield should be based on moisture at which, no deduction would be accessed when sold, crop can be safely stored without any additional drying, or in the case of fresh market vegetables crop has reached marketable stage of growth.

* Use 1/2 of the yield from VALUES if planted in the spring, 0 if planted in the fall, to calculate crop removal for the establishment year.

** For double crops, add removal for each crop

*** Use 2/3 hay yield from VALUES or use the actual yield from field records, to calculate crop removal.

**** 30 lbs P_2O_5 Removal for Productivity Group I
30 lbs P_2O_5 Removal for Productivity Group II
25 lbs P_2O_5 Removal for Productivity Group III
20 lbs P_2O_5 Removal for Productivity Group IV

Appendix 4

Table 2-2, *2005 Virginia Nutrient Management Standards and Criteria:* Correlation of Soil Analysis Results for Phosphorus from Mehlich III to Mehlich I

Table 2-2
Correlation of Soil Analysis Results for Phosphorus from Mehlich III to Mehlich I

When converting Mehlich III ppm soil test phosphorus to Mehlich I ppm soil test phosphorus, **two different formulas are used**. One is used for soil test values up to and including **205 ppm** Mehlich III phosphorus, as shown in the table below.

For phosphorus soil test values of 206 ppm Mehlich III and greater, use the formula shown under the heading Mehlich III Phosphorus (206 ppm and greater) Conversion to Mehlich I. When converting the soil test phosphorus values from labs using the Mehlich III procedure, be sure to use the appropriate formula.

Mehlich III (0-205 ppm) Conversion to Mehlich I

Mehlich III			Mehlich I		
P_2O_5 #/ac	P #/ac	P ppm	P #/ac	P ppm	Fertility Rating
0	0	0	0	0	L-
46	20	**10**	2	1	
53	23	12	4	2	L
74	32	16	8	4	
83	36	18	10	5	L+
92	40	**20**	12	6	M-
138	60	**30**	20	10	
143	62	31	22	11	M
184	80	**40**	30	15	
193	84	42	32	16	M+
212	92	46	36	18	H-
230	100	**50**	40	20	
276	120	**60**	48	24	
313	136	68	56	28	H
322	140	**70**	58	29	
368	160	**80**	66	33	
414	180	**90**	76	38	
460	200	**100**	86	43	H+
506	220	**110**	94	47	
552	240	**120**	104	52	
584	254	127	110	55	VH
598	260	**130**	112	56	
644	280	**140**	122	61	
690	300	**150**	130	65	
736	320	**160**	140	70	
782	340	**170**	150	75	
828	360	**180**	158	79	
874	380	**190**	168	84	
920	400	**200**	176	88	
943	410	**205**	181	90.6	

For soil test values not shown in the table above, use the following formula to convert Mehlich III to Mehlich I and select the closest fertility rating for the Mehlich I ppm from the table above:
Mehlich III Phosphorus less than or equal to 205:

[Mehlich III (205 ppm P or less) X 0.458] - 3.26 = Mehlich I ppm

Mehlich III Phosphorus (206 ppm and greater) Conversion to Mehlich I

Mehlich III Phosphorus Soil Test Conversions to Mehlich III Phosphorus ppm

P_2O_5 #/ac. (Mehlich III) X 0.22 = P ppm (Mehlich III)
P #/ac. (Mehlich III) X 0.5 = P ppm (Mehlich III)

Conversion Formula for Mehlich III Phosphorus ppm to Mehlich I Phosphorus ppm

To calculate the Mehlich I ppm, if not expressed on the soil test report, use the following formula. Mehlich I ppm phosphorus must be used when determining the Applied Fertilizer Dissolved Reactive Orthophosphate factor in a P-Index calculation.

[Mehlich III (206 ppm P or greater) X 0.945] - 103.5 = Mehlich I P ppm

The table below shows a sample of soil test values converting Mehlich III to Mehlich I. The Mehlich I upper limit, above which no phosphorus shall be applied to a field, based on either the Threshold Method or the P - Index and the associated physiographic region are shown in bold.

Mehlich III			Mehlich I		
P_2O_5 #/ac	P #/ac	P ppm	P #/ac	P ppm	**Phosphorus Procedure/Physiographic Regions**
948	412	206	182	91	
1164	506	253	270	**135**	Threshold/ Eastern Shore & Lower Coastal Plain
1168	508	254	272	**136**	Threshold/Middle & Upper Coastal Plain & Piedmont
1293	562	281	324	**162**	Threshold/Ridge and Valley
1380	600	300	320	180	
1610	700	350	454	227	
1840	800	400	550	275	
2070	900	450	644	322	
2332	1014	507	750	**375**	P- Index/ Middle & Upper Coastal Plain & Piedmont
2737	1190	595	916	**458**	P-Index/ Eastern Shore & Lower Coastal Plain
3064	1332	666	1050	**525**	P-Index/ Ridge and Valley

Table 2-3
Correlation of Soil Analysis Results for Potassium from Mehlich III to Mehlich I

A & L Laboratories:

A & L Potassium ppm X 0.71 = Va Tech - K ppm

Brookside Laboratories:

Brookside K lbs/acre X 0.36 = Va Tech - K ppm

Spectrum Analytical Laboratories:

Spectrum Available Potassium (K) lbs/acre X 0.31 = Va Tech - K ppm

Waters Agricultural Laboratories:

Waters Potassium (K) lbs/acre X 0.53 = Va Tech - K ppm

Appendix 5

West Virginia University Extension Service; Soil *Sampling and Testing, Ed Rayburn and Tom Basden, Extension Specialists, June 2011*

West Virginia University
Extension Service

Nutrient Management

Soil Sampling and Testing

Ed Rayburn and Tom Basden, Extension Specialists
June 2011[1]

Why soil test

Plants need adequate mineral nutrients to grow at their optimum rate. They obtain these nutrients by root uptake from the soil. This may be direct root uptake or through a symbiotic relation with mycorrhizal fungi that help extract nutrients from the soil.

When soils contain adequate levels of a plant nutrient no addition of that nutrient is needed for maximum plant growth. However, when the concentration of a nutrient in the soil is below a critical value that nutrient will limit plant growth. When a soil is low in a nutrient, adding adequate amounts of the proper fertilizer can increase the soil content of that nutrient. When crops are removed from the land plant nutrients are removed and over time soil nutrient content will decrease, if not replace through fertilization with mineral or organic fertilizers containing that nutrient. To maintain soil fertility replacement of plant nutrients equal to the crop removal rate is recommended for soils near the critical level for that nutrient.

Soil testing is a tool that provides an index of a soil sample's plant nutrient content and pH. By correlating soil test index values with plant growth and health we learn how to properly lime soils and add plant nutrients to achieve and maintain optimum plant growth. When a soil contains an adequate amount of a plant nutrient adding more by fertilization is a waste of money. Also, applying more nitrogen or phosphorus than can be used by the plants will result in poor water quality as these nutrients move into the ground and surface water. Excess nitrogen can show up as toxic levels of nitrates in well and spring water used in homes or for watering livestock. Excess phosphate can cause algae blooms in surface water that are detrimental to aquatic life in streams, lakes, and bays.

The WVU Soil Testing Lab's basic soil test measures the extractable soil phosphorus (P), potasium (K), calcium (Ca), and magnesium (Mg) as well as the soil acidity (pH) and lime required to bring the soil pH to 6.5. Other tests can be requested at an additional cost (soil

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organic matter, copper (Cu), zinc (Zn)). Soil testing is a chemical analysis and does not evaluate a soil's physical properties such as poor drainage, droughtiness, or impervious layers due to hardpans or compaction.

The soil sample sent to the laboratory represents a much greater volume of soil in the field, lawn or garden. A one pint soil sample, which weighs about one pound, taken from a one acre field or lawn (an area 209 feet square) represents about 2 million pounds of soil in that area. The soil sample must be representative of the area or the results will be meaningless. To ensure that the sample represents the soil that the plants are growing in make sure that the soil sample:

1. represents a uniform area of land,
2. is not contaminated with lime or fertilizers in dirty sampling containers,
3. is not contaminated with soil from a small atypical area such as where manure or lime was piled or spilled,
4. is not contaminated with course plant material such as leaves or roots,
5. is taken to a depth reflecting previous tillage practices,
6. is taken when the soil is moist but not when it is excessively dry, wet, or frozen,
7. is not dried in an oven or hot sun,
8. is of adequate size, about 1-2 cups (0.5-1.0 pint) in volume.

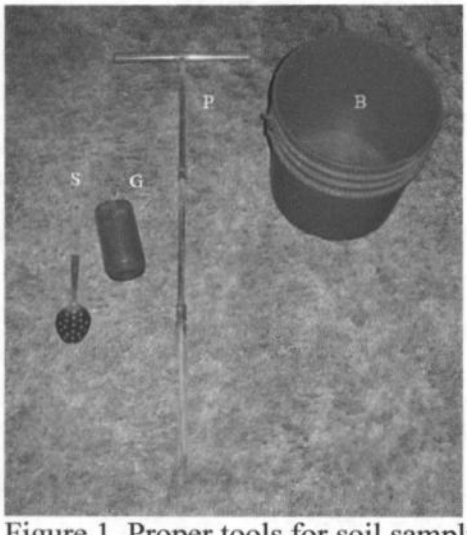


Figure 1. Proper tools for soil sampling make the work easier: soil core sampler or probe (P) for taking soil cores, clean bucket (B) for collecting the soil cores, plastic glass (G) for grinding the cores, and a slotted spoon (S) for removing small rocks and course organic matter from the soil.

Use the right tools to take the sample

The best tools for taking a soil sample are the soil core sampling tube or auger (Figure 1). These tools are pushed (tube) or twisted (auger) into the soil to the proper depth to extract a small core of soil. A number of these cores are combined to provide a soil sample. Other tools such as a shovel or trowel can be used but require more time and effort. If using a shovel cut a "V" shaped hole to the desired depth in the soil. Then take a 1-inch slice down one side of the hole to the desired depth. Cut off the sides of this slice leaving a 1 by 1-inch column of soil as long as the desired depth. In a roto-tilled garden use a garden trowel to take several small samples to the depth of tillage to represent a bed in the garden.

Pulling the soil core

Before pulling a soil core, move aside any organic surface debris to expose the mineral soil. Push the soil sampling probe (or twist the sampling auger) into the soil to the desired sample depth (Figure 2). Pull the probe out and put the soil core into a clean sample bucket or plastic bag. When sampling a lawn, pasture, or hay meadow and the sod is too tight to see mineral soil, take the sample through the sod. There will be a cap of sod and roots on the top of the core. Do not remove this sod cap until crushing and preparing the sample (see below).

Sample to the proper depth

Lime and fertilizer applied to the surface requires many years to move down into the soil. This movement of lime and fertilizer into the soil depends upon the amount applied, the activity of earth worms in the soil, the amount of frost action affecting the soil in winter, and how much time has elapsed since application. Lime and fertilizer can be physically incorporated into the soil by disking (shallow incorporation) or plowing/roto-tilling (deep incorporation). The depth that soil cores are taken to should be based on the crop and tillage management (Figure 2).

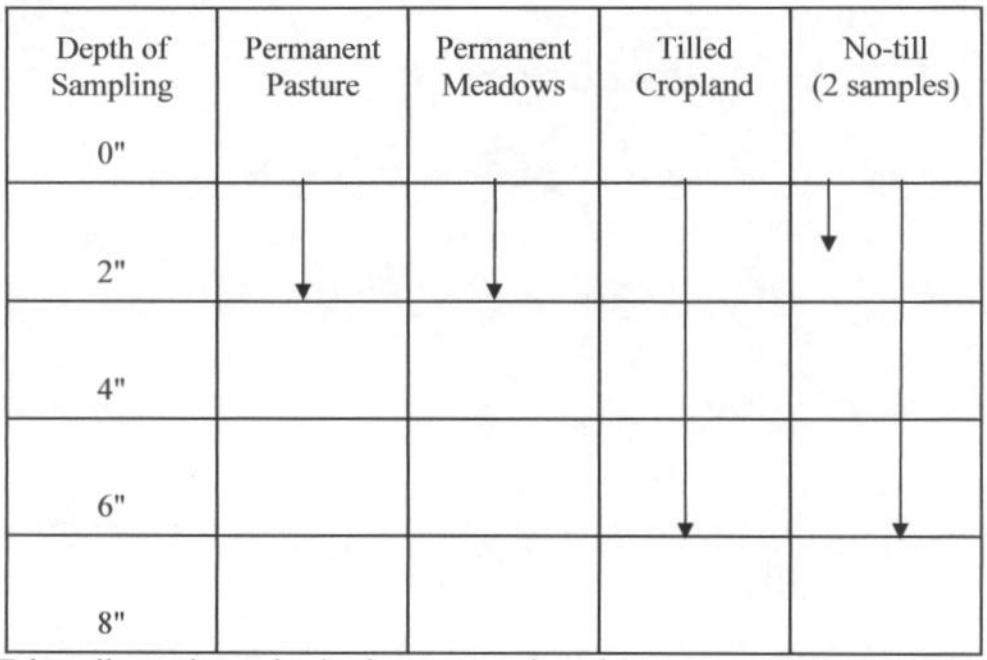


Figure 2. Take soil samples to the depth representative of tillage management practices used in the field. Pastures and permanent meadows that are not tilled should be sampled to a 2-inch depth since fertilizer and lime are not incorporated into the soil. Tilled cropland should be sampled to a 6 to 8-inch depth while no-till crop land should be double sampled, one sample to a 1 to 2-inch depth and a second sample to a 6 to 8-inch depth.

It is important to take soil samples to the same depth each year if the samples are to be used to evaluate the effects of a nutrient management program over time. In permanent pastures, hayfields, lawns, and no-till cropland nutrients are concentrated in the upper level of the soil and

decrease with increasing depth (Figure 3). If a 2-inch sample is taken one year and a 6-inch sample taken in another year the effect of soil depth on nutrient concentration will make it impossible to compare the samples with any meaning.

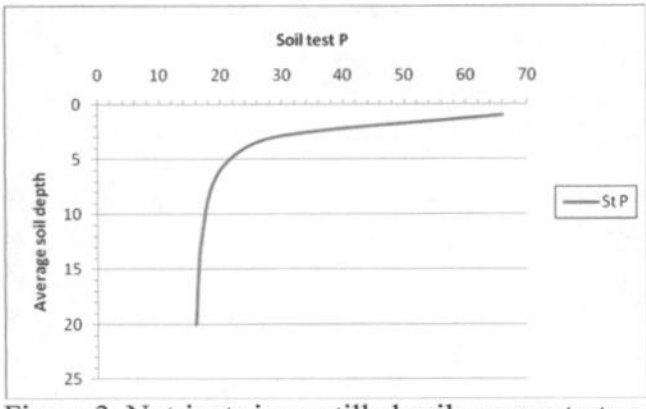


Figure 3. Nutrients in nontilled soils concentrate near the surface. To compare a field's soil samples from year to year it is necessary to sample to the same depth each time. For nontilled areas (permanent hay fields, pastures, and lawns) soil samples taken to a 2-inch depth best reflect the effect of lime and fertilizer management on soil test.

Sample management units

Soils are variable due to parent material, slope and slope position, drainage, and previous management. When taking soil samples we often think in terms of fields; however, it is best to subdivide fields (gardens or lawns) into management zones based on soil type, slope position, previous management, and expected future management (Figure 4). Areas not characteristic of a management zone should be sampled separately. For example; wet spots, eroded areas, and field edges should not be combined with soil representing the rest of the area. Do not combine soil cores from areas that were limed and fertilized recently with areas that were not treated. If the sample does not represent the area, then the lime and fertilizer recommendations will be inaccurate.

An example of the need to subdivide fields into smaller management zones is shown in Table 1. Samples 1 and 2 were taken from a slope on the north side of the field while samples 3 and 4 were taken on a level area at the foot of the slope, on the south side of the field. The slope on the north side has a higher soil pH and P status than the south side. On average the K status of north side is the same as the south side. However, the west ends have high K test while the east ends are low in K. If one average sample had been taken for the whole field these differences in soil fertility would not have been measured.

Figure 4. Soil samples should represent management zones within a field. Take different samples from areas managed differently (A vs. B) and different samples from areas that have different slopes (B vs. C). Walk across each management zone and take soil cores at random.

Table 1. Analysis for soil test pH, phosphorus (P), and potassium (K) of samples taken from four management zones based on soil slope and previous management, compared to the average sample across slope, and the average across the whole field.

Sample	pH	P	K
1 Northeast on slope	6.6	65	137
2 Northwest on slope	6.7	69	123
3 Southeast on flat	6.0	40	99
4 Southwest on flat	5.9	42	164
Avg. North side slope	6.6	67	130
Avg. South side on flat	6.0	41	132
Avg. Whole field	6.3	54	131

Grid or precision sampling

An alternative to sampling management units is grid or precision sampling. In this system soil cores are taken at across a uniform grid over the farm (Figure 5). At each sample point five soil cores are taken and the point is identified by its GPS coordinates. The five cores are processed as a soil sample. Each soil sample is analyzed and the values are entered along with the points GPS coordinates. Computer software is then used to statistically average the variation in soil fertility across the grid of sample points (Figure 6). This analysis is used to construct maps showing the varying soil fertility over the field and maps of the variable fertilizer recommendations (Figure 7) across the field. The variable recommendation maps are used by the computer of a variable application spreader truck equipped with a GPS receiver to control the application of fertilizer or lime to what is needed in any given part of the field.

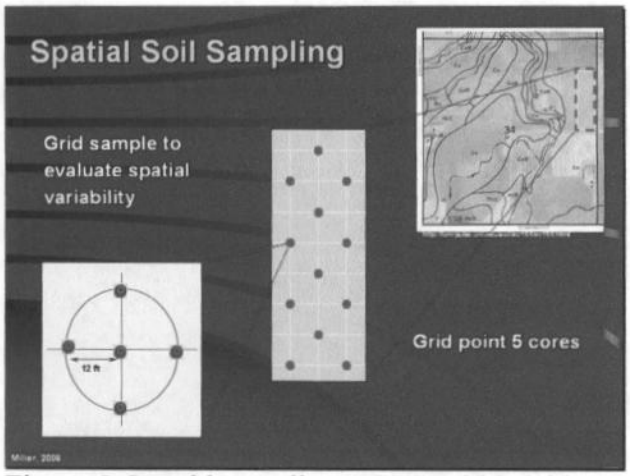


Figure 5. In grid sampling a GPS grid is laid out over the field and at each established sample point five soil cores are taken and combined to make a sample representing that part of the field.

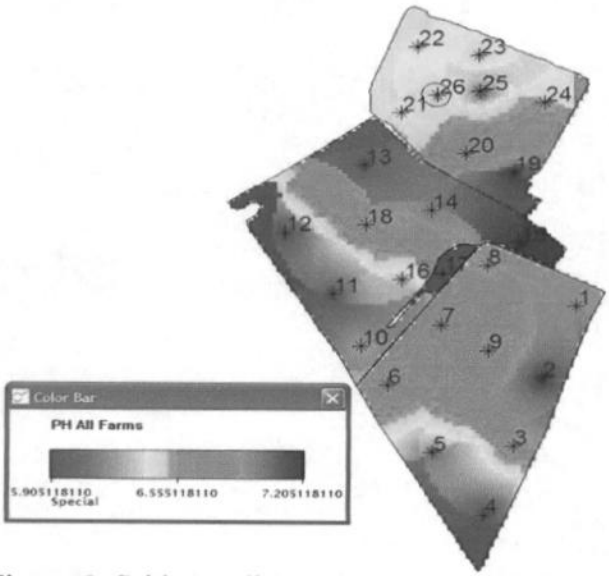


Figure 6. Grid sampling uses computer software to estimate soil fertility across the field based on the analysis of soil from each of the sample points.

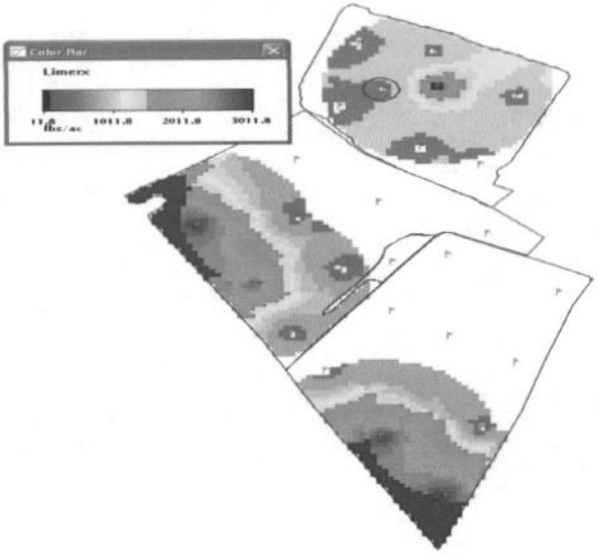


Figure 7. Grid sampling provides variable recommendation maps that allow for the precision application of fertilizer and lime across the field. This is accomplished by using spreaders that are controlled by computers and GPS receivers that tell the computer where the spreader is in the field and the application rate needed to be spread in that part of the field.

Take enough cores for each sample sent to the lab

A soil sample is composed of soil from several soil cores taken with a sampling tool, auger, or shovel. For management units less than 5-acres take 10 to 20 randomly selected soil cores. For fields approaching 10 acres, take 20 to 30 cores. When appropriate, fields larger than 10 acres should be divided into smaller management units based on soil type, yield potential, and prior management. When using precision sampling, sample grid areas of 2.5 acres and take 5 cores per sample area. For lawns and gardens take 10-15 cores for each management area.

Taking a large number of soil cores never corrects for mixing soils from areas that should be sampled separately. Any sample area should represent a uniform soil type, yield potential, and past management. For example, take a hay field that had a winter feeding area at one end. Where hay was not fed soil test K is 100. In the winter feeding area the soil test K is 400. If 15 cores are taken in the non-feeding area and 5 cores taken in the feeding area, the sample would come back indication a soil test K of 175. This is a high soil test K when most of the field has a low soil test K. This may look like an extreme example but is one found fairly frequently when doing precision sampling at the 2.5 acre scale. It only takes 2 years of concentrated winter feeding to raise the soil test K into the 400 index range.

Prepare the sample going to the lab

If the soil cores are too damp to crumble apart easily, dry them on clean paper in a cool dry place out of the sun. Do not oven or sun-dry soil samples as this will adversely affect the test results.

Once the cores are adequately dry place them into a clean plastic bucket. Gently crush and mix these soil cores using a clean hard object such as the bottom of a plastic tumbler or smooth rock. If a trace mineral analysis is going to be requested do not use galvanized tools since they will contaminate the soil sample making the analysis meaningless. Use a slotted spoon to remove stones and course organic matter from the soil sample. If the amount of soil is greater than that needed for submission, take a subsample of the thoroughly mixed soil.

When to Sample

Soil samples should be taken in late summer or early fall since these samples will better represent the nutrient status of the soil that a growing crop encounters. Do not take soil samples when the soil is wet or frozen or shortly after applying lime, fertilizer, or organic matter. Only a little fertilizer or lime in a soil sample will give a very high analysis resulting in a non representative analysis.

Soil samples should be submitted to the lab well in advance of needing the analysis. Allow 3 to 4 weeks for processing the samples. Samples sent to the laboratory between March and May take longer to process due to the number of samples being submitted to the lab at that time of year. Copies of the results are sent to local West Virginia University County Extension Agents who will be pleased to discuss the results with you.

Frequency of Sampling

The desired frequency of soil testing depends on the crop grown, when lime was applied, and the intensity of management. Land recently converted to cropland or garden may be tested every year until the proper fertility level is reached. The following testing interval is recommended:

- Permanent pastures and hay meadows- every 3 to 5 years.
- Continuous row crops and alfalfa - every 1 to 3 years.
- Crops in rotation - every 3 years or once each rotation.
- Gardens - every 2 to 3 years.
- New lawns - after topsoil has been placed and final grading completed.
- Established lawns - every 3 to 5 years.

Fill out the sample submission sheet

Fill out the information sheet as completely as possible, including your name and address written legibly. Include as much information as possible. Other additional information or questions may be included in the remarks section. If you want an analysis for soil organic matter or trace minerals list it in the remarks section. Use a separate submission sheet for each sample submitted.

Submitting the Sample for Analysis

Submit the prepared soil sample and completed submission sheet to your local county agent or mail them to:

Soil Testing Laboratory
West Virginia University
P.O. Box 6108
Morgantown, WV 26506-6108

The Soil Testing Laboratory, at no cost to West Virginia residents, will test soil samples for pH (acidity), lime requirements, and extractable phosphorus, potassium, calcium and magnesium. Upon special request for a small fee, the lab can test for other plant nutrients and soil organic matter. Contact the Soil Testing Lab for details on these services.

Acknowledgement: We would like to thank Craig Yohn and Brian Wickline for the use of their precision soil sampling figures used in this fact sheet.

Appendix 6

West Virginia University Extension Service; *Nutrient Management,* Sample Collection Procedures for Manure Analysis, Tom Basden, Extension Specialist

Nutrient Management

Thomas J. Basden, Extension Specialist
Nutrient Management

Sample Collection Procedures for Manure Analysis

The West Virginia Department of Agriculture is now offering West Virginia farmers free manure analysis at its Moorefield Nutrient Management and Water Quality Lab. A farmer can request the manure sampling kit from the county West Virginia University Extension office or Natural Resources Conservation Service field office. The manure kit contains a mailing tube, plastic jar, a litter and manure analysis submission form and this fact sheet describing the proper sampling method for types of manure. The farmer needs to have a clean plastic bucket and a hand trowel or stick to mix the manure before placing a portion of the manure in the plastic jar.

Collecting a **representative** sample is the key to an accurate nutrient analysis. If you have a history of analyzed samples and a sample comes back that is significantly different from your previous submitted samples and you have not changed your feed or storage methods, resubmit another sample and tell the lab you have received unexpected results. If farmers are to depend upon manure to supply needed crop nutrients a periodic manure sample should be taken and sent to the lab.

Sample Collection

Semi-solid Lot Manure (Dairy, Beef or Horse)

Scraped directly from lot, stall or barn into spreader:

After manure has been loaded into the spreader, collect manure from several different locations within the spreader. Thoroughly mix and fill sample container one-half full.

From Storage:

Collect a representative sample of relatively fresh manure from under the surface crust. Avoid collecting a disproportionate amount of bedding materials with the manure. Mix well and fill sample container one-half full.

Collection Tool:

Small shovel or construct a devise similar to a soil auger, using a three-foot length pipe. Sharpen the bottom end of the pipe, drill the top end so a dowel can be fitted as a handle and cut a four-foot piece of a broomstick to push manure out of the tube.

Liquid Manure Slurry

Under-slotted floor pit:

Use a length of ½" conduit that is open at each end but can be easily sealed on one end by placing a hand or thumb over the end of the conduit. With both ends of the conduit open, extend it into the manure to the pit floor. Seal the upper end of the conduit trapping the manure that has entered the lower end, remove and empty into a bucket. Collect samples from at least five locations or at least enough for a

total of 1 quart of slurry Thoroughly mix this slurry and fill sample container one-half full.

Exterior storage basin or tank:

Make sure the manure has been well mixed or homogenized with a liquid manure chopper-agitator pump or propeller agitator. Take samples from five locations in the pit, from the agitator pump, or from the manure spreader and place in bucket. Mix well and fill the jar one-half full.

Broiler or Turkey Litter

In-house litter:

Visually inspect the litter for areas of varying quality, such as feeders or waterers, and estimate the percentage of floor surface in each of those areas. Take five proportionate samples of litter at locations that represent the different areas. At each location sample a 6' by 6' area down to the earth floor or concrete. Place in bucket and mix well. Fill sample container one-half full.

From stockpiled litter:

Collect samples from five locations around the pile at least 18 inches into the pile. Thoroughly mix and fill sample container one-half full.

Sample Preparation and Transfer

Use a zip-lock bag or request a manure sample kit from the Moorefield lab. Jars should be clean, if they are not them rinse with water and air dry. Manure **will** expand as it travels to the manure lab so never fill the jar to the top and make sure that the lid is screwed on tightly.

Complete the submission form, sample date, producer name and address, manure type and storage type. This information is important for the lab.

Mail sample as soon as collected or freeze the sample until it is mailed. Do not leave a sample at room temperature; the nutrient composition will change due to microbial action. To avoid the samples sitting in the post office over a weekend, mail samples on a Monday or Tuesday.

Send Manure Samples To:

West Virginia Department Of Agriculture
Moorefield Nutrient Management and Water Quality Lab
HC 85, Box 302
Moorefield WV 26836
/304 538 2397

References:

1) University of Maryland Cooperative Extension Service, Manure Analysis Instruction Sheet, Solid Wastes and Poultry litter. Nutrient Management Program, Reference Manual
2) Virginia Tech Extension Service, Sample Collection section of Nutrient Management Manual.

Appendix 7

2005 Virginia Nutrient Management Standards and Criteria; ***Section V.*** Crop Nutrient Needs

Section V. Crop Nutrient Needs

Phosphorus and potash soil test levels in this table are based on Mehlich I soil test results. Only soil test levels correlated to Mehlich I using methods contained in this document are acceptable.

Corn Grain Nutrient Needs*

Productivity Group	N - Nutrient Needs
IA	180
IB	170
IIA	160
IIB	150
IIIA	140
IIIB	130
IVA	120
IVB	100
V	80

***See nitrogen management recommendations for Corn.**

Soil Productivity Groups I , II

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	100-140	100-140
M	60-100	60-100
H	20-60	20-60
VH	0	0

Soil Productivity Groups III, IV, V

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	80 -120	80 -120
M	40 - 80	40 - 80
H	20 - 40	20 - 40
VH	0	0

Corn Silage Nutrient Needs*

Productivity Group	N - Nutrient Needs (a)
IA	200
IB	185
IIA	175
IIB	165
IIIA	155
IIIB	145
IVA	130
IVB	110
V	90

***See nitrogen management recommendations for Corn.**

Corn Silage Nutrient Needs (cont)

Soil Productivity Groups I , II

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	140-200	240-300
M	100-140	180-240
H	40-100	100-180
VH	0	0

Soil Productivity Groups III , VI, V

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	120-160	200-240
M	80-120	140-200
H	40-80	60-140
VH	0	0

When using documented farmer records, corn silage yield may be calculated using the following formula: Corn Grain Yield (bu/ac) X 0.0985 + 7.6964 = **Corn Silage Yield** Tons/acre.

Nitrogen Management Recommendations for Corn

On soils with a High nitrogen loss risk, at least 50% of the inorganic nitrogen applications shall be applied as a sidedress application. On Moderate and Low nitrogen loss risk soils this management method is preferred, but not required. The combination of row starter, at planting nitrogen applications and sidedress applications cannot exceed the nitrogen need listed for that crop in that field.

It is recommended that fields which contain high environmental risk soils for nitrogen loss where organic nutrient sources are used to meet most of the nitrogen need for corn should include a split application of nitrogen which is at least 33% of the nitrogen needs to be applied as a sidedress application. If no pre-plant nitrogen will be broadcast and planting conditions exist where the cold soil temperatures may be limiting mineralization of nitrogen, starter nitrogen may aid in plant establishment and early season growth. The combination of row starter, at planting nitrogen applications, plant available nitrogen supplied from organic sources, and sidedress applications cannot exceed the nitrogen need listed for that crop in that field.

For cereal silage/corn silage rotations only, 20 lbs/acre of nitrogen may be applied as part of a banded starter application at planting, in addition to the nitrogen need designated for the field. IF no starter is applied as a banded application, only the nitrogen need designated for the field shall be recommended.

To determine nitrogen needs for corn yields above those listed in Table 1-2, Estimated Yields in Bushels or Tons per Acre of Various Non-Irrigated Crops for Identified Soil Productivity Groups, use 1 lb of nitrogen per bushel for grain yields, and 1.1 lbs of nitrogen per bushel of grain yield for silage corn tonnage converted back to bushels using the formula:

$$\frac{(\text{corn silage tons/acre} - 7.6964)}{0.0985} = \text{Corn grain yield}$$

Irrigated Corn

These expected yields and nitrogen recommendations in the table below should not be used for fields where manure is applied through an irrigation system unless supplemental clean water irrigation is utilized, since manure applications should usually occur prior to the times of peak moisture demand by crops to allow time for mineralization. Irrigated nitrogen recommendations shall only be used when the water source can supply at least 6 inches of water to the entire field per growing season.

Corn Grain production using Center Pivot Irrigation *

Soil Management Groups	Expected Corn Yield, Bu/Ac	N - Nutrient Needs
A,B,D	210	210
C,E,F,G,J,K,L,M,N,O,Q,R,S,T	200	200
I,DD	190	190
V,W,X	180	180
AA,BB,II	170	170
Y	160	160
KK	140	140

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	130 - 170	130 - 170
M	80 - 120	80 - 120
H	30 - 70	30 - 70
VH	0	0

*An adjustment to irrigated grain yields is needed for traveling gun systems, because typically yield response will be highly variable depending upon management of the system. A reasonable estimate of planning yield is 90% of the above estimates for properly scheduled irrigation.

Corn Silage Production using Traveling Gun Irrigation

Soil Management Groups	Expected Corn Yield, Tons/Ac	N - Nutrient Needs
A,B,D	26.3	210
C,E,F,G,J,K,L,M,N,O,Q,R,S,T	25.4	200
I,DD	24.5	190
V,W,X	23.6	180
AA,BB,II	22.7	170
Y	21.9	160
KK	20.1	140

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	140-200	240-300
M	100-140	180-240
H	40-100	100-180
VH	0	0

Grain Sorghum

Productivity Group	Nitrogen Needs
IA	140
IB	130
IIA	120
IIB	110
IIIA	100
IIIB	90
IVA	90
IVB	90
V	80

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	80 -120	80 -120
M	40 - 80	40 - 80
H	20 - 40	20 - 40
VH	0	0

Soybeans - All Productivity Groups

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	80 -120	80 -120
M	40 - 80	40 - 80
H	20 - 40	20 - 40
VH	0	0

Small Grain Management Options: Choose nutrient needs based on the intended use of the crop by the farmer.

1. Small Grain Silage - this crop is planted for the intended purpose of harvest in early spring for silage. Similar fall tiller management practices should be applied as used in Standard/Intensive Management of Wheat and Barley.

2. Wheat and Barley: Standard/Intensive Grain Production- this crop is to be managed based on a program to maximize grain yield by planting within the window of acceptable dates according to location within the state, careful tiller management through the fall and winter months and spring split application rates of nitrogen based on tiller counts and tissue tests.

3. Cover Crop - this crop is grown for the purpose of scavenging any residual nitrogen from the previous crop due to lower than expected yield, or mineralization of organic nutrient materials applied to the previous crop is expected to occur after the crop is harvested. Cover crop may also be used to manage on farm manure storage facilities by application of low rates of manure in the fall and winter when needed.

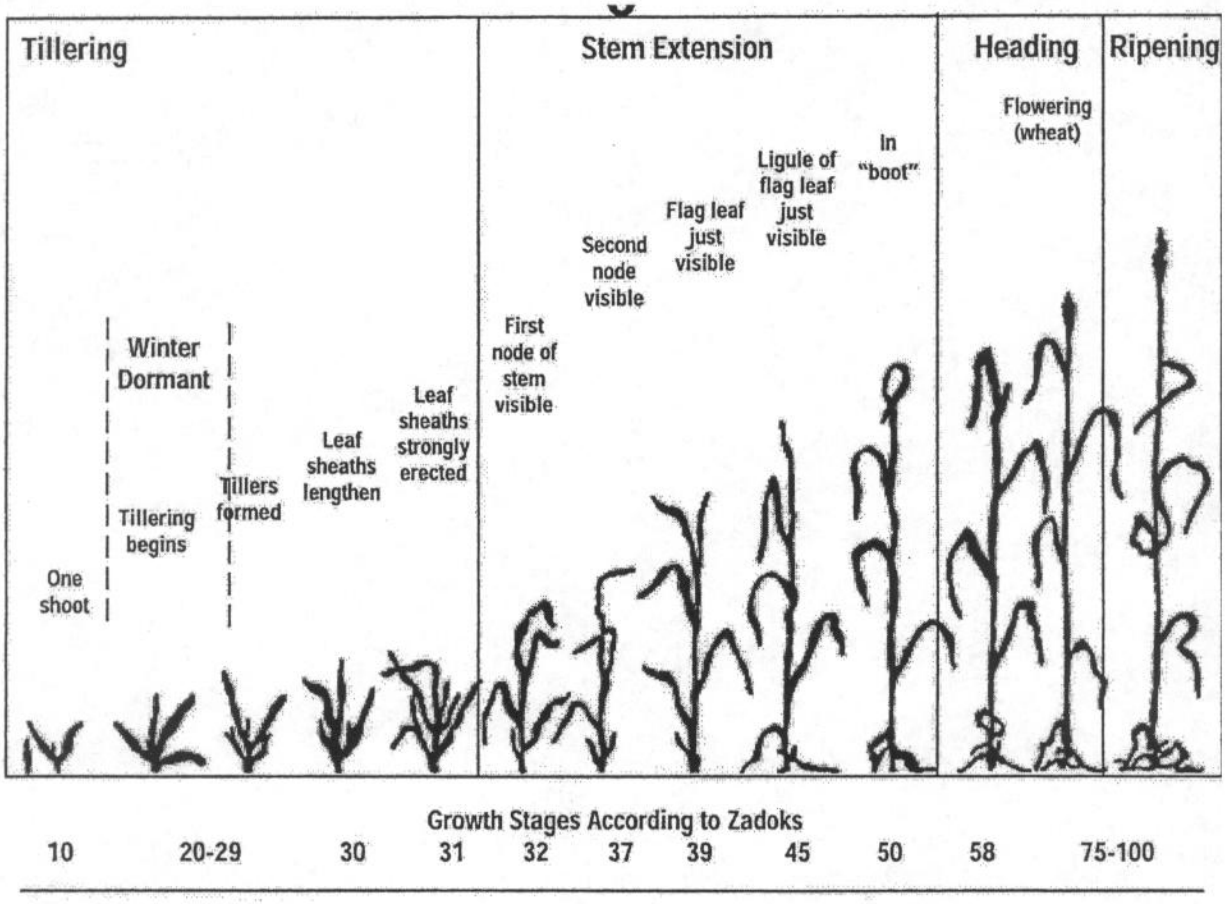
4. Trap Crop - the sole purpose of this crop is to provide fields which can receive manure, biosolids, or other organic nutrient source applications through the fall and winter months for management of limited storage facilities of these materials.

   This is a less desirable option because the nitrogen need for the following spring crop, or some part of the nitrogen need, may be used to determine rate of nitrogen for the winter application. IF the intention is to base the application rate of nitrogen on the total nitrogen need of the following spring crop, then application shall be in compliance with Timing of Organic Nutrient Sources in Section I.A and at least 30 pounds of nitrogen need must be withheld at the time of application to be used as part of a banded starter at planting. Also, all phosphorus applied though this application will be credited to the Spring crop or to the phosphorus application of the rotation.

   The only purpose of the trap crop is for the management of organic nutrient sources where limited or no storage facilities are available. Fall or winter application of a nitrogen rate based on a spring crop, commits the farmer to planting that crop in a timely manner to assure successful establishment of the intended spring crop.

Zadoks Scale of Small Grain Growth Stages

Many nutrient applications are based on timing related to the growth stage of the small grain crop. The figure below is provided as reference for planners when writing plans and explaining application times to clients.



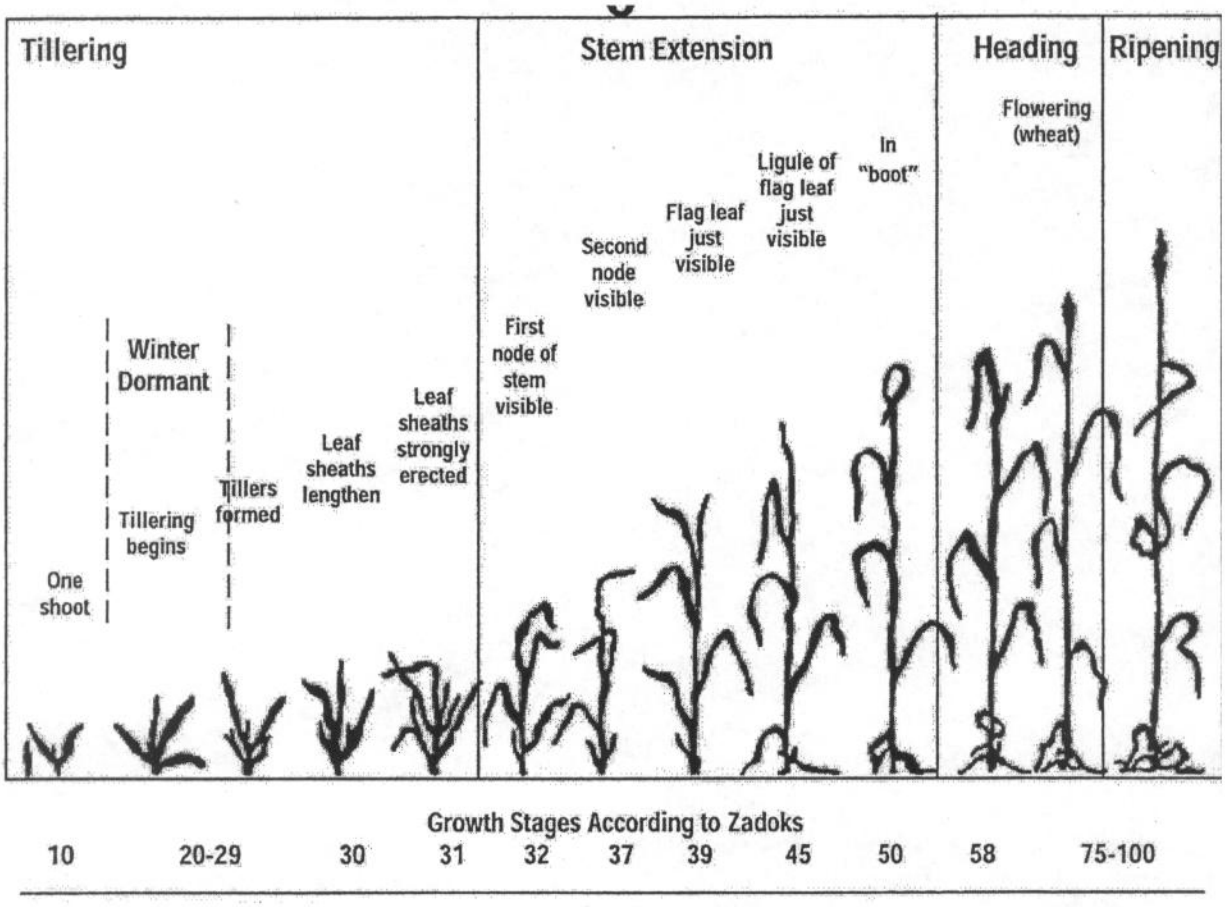
Detailed description of pertinent nutrient management program Growth Stages are:

- GS 23 - Main Shoot and 3 Tillers
- GS 25 - Main Shoot and 5 Tillers
- GS 30 - Leaf Sheaths lengthened with Erect Stems

A tiller may be counted when it has three fully developed leaves on its stem.

Zadoks Scale of Small Grain Growth Stages

Many nutrient applications are based on timing related to the growth stage of the small grain crop. The figure below is provided as reference for planners when writing plans and explaining application times to clients.



Detailed description of pertinent nutrient management program Growth Stages are:

- GS 23 - Main Shoot and 3 Tillers
- GS 25 - Main Shoot and 5 Tillers
- GS 30 - Leaf Sheaths lengthened with Erect Stems

A tiller may be counted when it has three fully developed leaves on its stem.

3. Late Winter - Early Spring Nitrogen Rates

a. Cover crop will be killed before Spring Crop is planted - No Nitrogen applied

OR

If at any time the management of this crop is changed from the original cover crop status, then the following nitrogen management recommendations shall be used. Performance and final yield of this crop may not be comparable to proper management of the specific crop outlined in other parts of this booklet.

NOTE: This change in management of the cover crop will affect eligibility for state and/or federal cost share payments.

a. Cover crop will be harvested for silage:

Triticale - Maximum of 70 lbs/ac.
Rye - Maximum of 70 lbs/ac.
Wheat - Maximum of 60 lbs/ac.
Barley - Maximum of 50 lbs/ac.

OR

b. Cover crop will be harvested for grain - Follow recommendations in table below. **Warning** - Using maximum N rates listed in table below may cause lodging of crop when a high rate of Nitrogen was applied in the Fall.

(Feb. - Early March)	Tiller Count:	N Application Program
Single Application:	<70/sq. ft.	80 lbs/acre-Feb.(Growth Stage 25)
	>100; plants dark green; tissue N levels >3.75%	30-40 lbs/acre-late March (Zadoks Growth Stage 30)
Split Application:		
February (Zadoks Growth Stage 25)	<60/sq. ft.	60 lbs N/acre
	60-100/sq. ft.	40 lbs N/acre
	>100/sq. ft. and dark green color	none; tissue test at growth stage 30
March (growth stage 30 tissue test)		No more than 120 lbs N/acre -**total of Growth Stages 25 and 30**

Trap Crop

Nutrient Needs (lbs/ac)*		
Nitrogen	P_2O_5	K_2O
0	0	0

*Specific to the Trap Crop itself.

The purpose of the following recommendations are to provide fields which can receive manure, biosolids and other organic nutrient source applications through the fall and winter months if the priority is for management of limited storage facilities, rather than achieving expected yield of future crops. Applications shall not occur before the trap crop reaches Zadoks growth stage 23 (one main shoot and 3 tillers) or greater AND having a uniform stand throughout the entire area to be spread of at least 20 plants per square foot. Application rate shall not exceed the nutrient needs described below and shall not smother the crop. Application shall only occur when the spreading equipment and associated operations will cause minimal damage to the crop during application.

Nitrogen rate for application based on Spring Crop nitrogen needs:
Nitrogen needs of spring crop to be planted minus at least 30 pounds of nitrogen to be applied as a banded application at planting.

Nitrogen rates will be calculated using Spring or Early Fall Applied coefficients for manures and Year of Application coefficient for biosolids to calculate the PAN for the organic fraction and appropriate coefficient for PAN ammonium fraction for all materials.

No more nitrogen shall be applied to the trap crop or the following spring crop using this option, with the exception of the amount of nitrogen deducted from the nitrogen needs at the time of application. This remaining nitrogen shall be applied as a banded application at planting of the spring crop. It should be noted that this program of nitrogen application may result in a lack of adequate nitrogen available to the spring crop to produce the expected yield. Less than adequate nitrogen would be due to immobilization of nitrogen by the trap crop and loss of the applied nitrogen through runoff and leaching.

All phosphorus applied though this application will be credited to the spring crop or the phosphorus application of the rotation.

Rye Grown for Grain

1. Soil productivity groups are the same as for wheat and barley

2. Nitrogen recommendations:

   a. At planting - 25-30 lbs N/acre

   b. Late winter - a single application made in February
      (1) For grain production - 45 lbs N/acre

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	80 -120	80 -120
M	40 - 80	40 - 80
H	20 - 40	20 - 40
VH	0	0

Small Grain for Silage

1. Soil productivity groups are the same as for wheat and barley

2. Nitrogen recommendations:

   a. At planting - 0-30 lbs N/acre
      - use lower rate on fields, which will be timely planted, with a history of frequent manure applications, and good growing conditions are expected 10 days after planting.

   b. Late winter - a single application made in February
      (1) Triticale, Rye, Wheat silage production - 40-90 lbs N/acre
      (2) Barley, Oats silage production - 40-70 lbs N/acre
         (a) Preferred application period would be after green-up occurs and before first joint has emerged.
         (b) Use lower rates on field which are well established, have dark green color, and a history of lodging.

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	80 -120	80 -120
M	40 - 80	40 - 80
H	20 - 40	20 - 40
VH	0	0

Wheat and Barley for Grain - Nitrogen Management Applications

Standard/Intensive

1. At planting:

   a. With NO_3^- soil test from top 6 inches measuring above 30 ppm, no nitrogen needed at planting.

   b. If soil test is below 30 ppm, apply 15-30 pounds of nitrogen.
   c. Without NO_3^- soil test results:

      (1) Conventional tillage: broadcast and incorporate 1-2 inches, 25-30 lbs N/acre during land preparation for planting. Reduce N application if high residual N levels are expected.

      (2) No-till: broadcast 30-40 lbs N/acre shortly before planting, if heavy residue (60% or greater cover) is present. Follow N recommendations for conventional planting if light residue (less than 60% cover) or no residue is present.

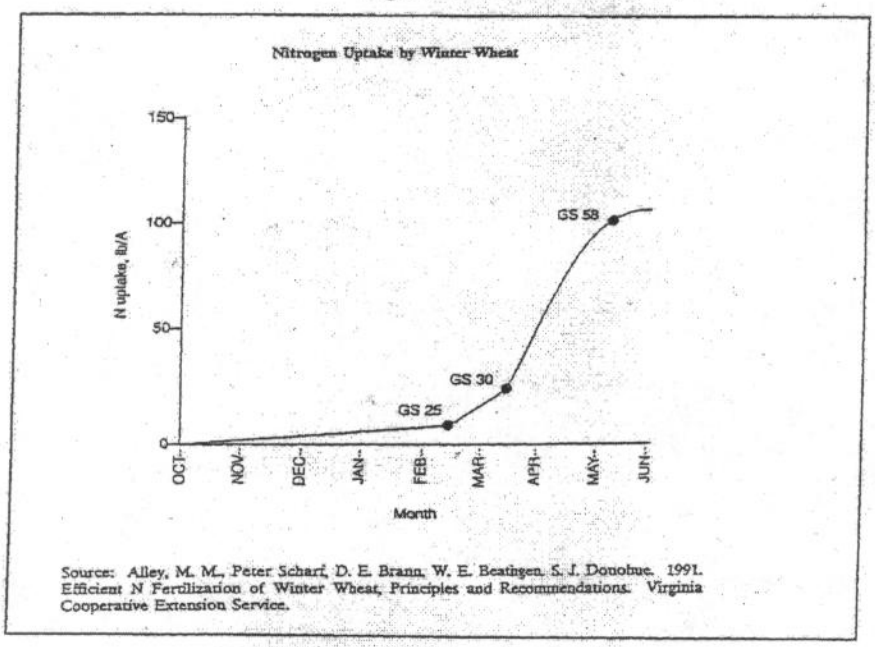
Intensive Management Only

2. Midwinter (December-January)

   If:

   a. Significant leaching rains have occurred during the October-December period, i.e., two or more rainfall events of 2.0 inches or more, and
   b. there has been very little tiller development, i.e., less than 3 tillers per plant, and the crop has a pale green color, and
   c. there is an expectation of several days during January and February when maximum daily temperature will exceed 50^0F; **apply:** 30 lbs N/acre as a topdress.

Figure 5-1



Source: Alley, M. M., Peter Scharf, D. E. Brann, W. E. Beatingen, S. J. Donohue. 1991. Efficient N Fertilization of Winter Wheat, Principles and Recommendations. Virginia Cooperative Extension Service.

Management of Spring Nitrogen

3. Late Winter (February-early March)

   a. Single Spring application of N, (Standard management):

      (1) Fields with less than 70 tillers per sq.ft., **apply** 80 lbs/acre in February. Fertilize those fields with less than 60 tillers per sq.ft. first.

      OR

      (2) Fields with 70 to 100 tillers per sq.ft., and plants are pale green and tissue test levels are lower than 3.75%, **apply:** 60 lbs/acre in February.

      OR

      (3)Fields have 70 to 100 tillers per sq.ft., plants are dark green and N tissue test levels are 3.75% or higher, **apply:** 30-40 lbs/acre in late March (Zadoks growth stage 30.)

      OR

      (4) Fields have more than 100 tillers per sq.ft., plants are dark green and tissue test levels are 3.75% or higher **apply:** 30-40 lbs/acre in late March (Zadoks growth stage 30.)

   b. Split applications of Spring N (Intensive small grain management):

      (1) February (Zadoks growth stage 25.)

         (a) Fields with less than 60 tillers per sq. ft. - apply 60 lbs N/acre.

         OR

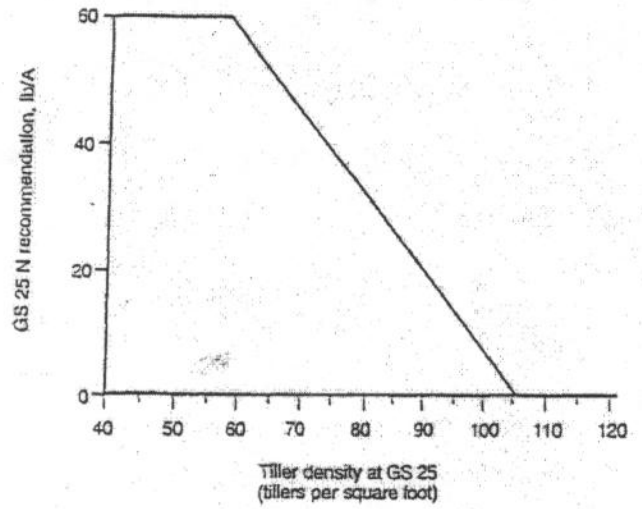
         (b) Fields with 60 to 100 tillers per sq. ft. - apply 40 lb N/acre.

         OR

         (c) Fields with more than 100 tillers per sq. ft. and the crop has a good green color - do not apply nitrogen at this time. Tissue test at Zadoks growth stage 30 to determine N application needs.

Use **Figure 5-2** for more detailed nitrogen application rates based on exact tiller counts.

Figure 5-2



Source: Alley, M. M., D. E. Brann, E. L. Stromberg, E. S. Hagood, A. Herbert, E. C. Jones, W. K. Griffith. 1993. Intensive Soft Red Winter Wheat Production. Virginia Cooperative Extension.

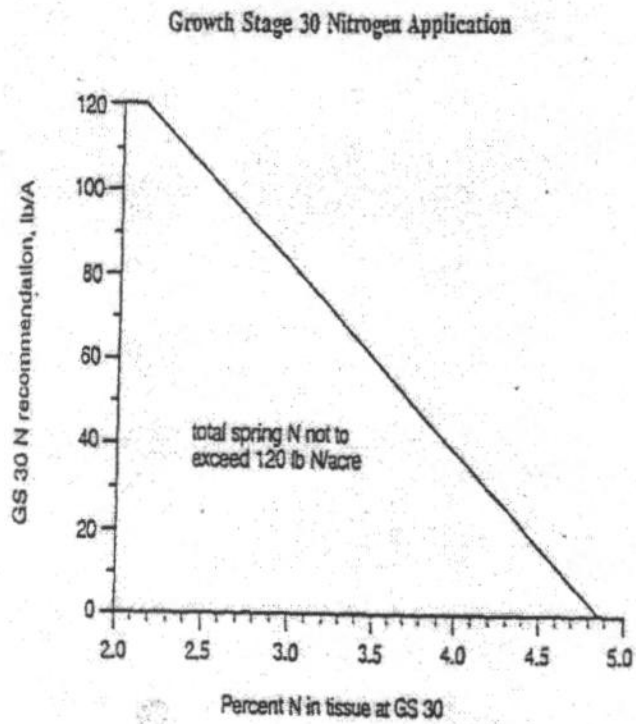
To determine the rate for the growth stage 25 application, one needs to determine the number of tillers per square foot in the field. If there are less than 60 per square foot, apply 60 pounds per acre at growth stage 25. If there are between 60 and 100 tillers, determine the rate from Figure 5-2. If there are more than 100 tillers per square foot and the crop has a dark green color, do not apply any nitrogen at this time.

(Spring N management continued on next page)

(2) March (Zadoks growth stage 30).

(a) N application rate for wheat based on the % N in a plant tissue sample taken at Zadoks growth stage 30 using Fig. 5-3. **NOTE:** Observations have shown that barley topdress rate should be decreased by 0.5% N.

Figure 5-3



Source: Alley, M. M., D. E. Brann, E. L. Stromberg, E. S. Hagood, A. Herbert, E. C. Jones, W. K. Griffith. 1993. Intensive Soft Red Winter Wheat Production. Virginia Cooperative Extension.

Nitrogen Application Recommendations for Wheat and Barley (Summary)

Season	Application Criteria	N Application Program
I. Planting	**Nitrate Soil Test**	
	>30 ppm (top 6 inches)	None
	<30 ppm (top 6 inches)	Apply 15-30 lbs/ac. N
	None	Conventional Tillage-broadcast & incorporate to 1-2 inches, 25-30 lbs/ac N; No-Till-broadcast 25-30 lb N/acre
II. Midwinter (Dec.-January)		
Precipitation	2 or more rainfalls >2.0 inches **AND**	
Tiller Development	<3 tillers per plant; pale green **AND**	
Max. Daily Temp.	>50^{0}F	**THEN:** Apply 30 lbs N/acre topdressed
III. Late Winter (Feb. - Early March)	**Tiller Count:**	
Single Application:	<70/sq. ft.	80 lbs/ac. N-Feb.(Growth Stage 25)
	>100; plants dark green; tissue N levels >3.75%	30-40 lbs/ac. N- late March (Zadoks Growth Stage 30)
Split Application:		
February (Zadoks Growth Stage 25)	<60/sq. ft.	60 lbs ac.N
	60-100/sq. ft.	40 lbs/ac. N
	>100/sq. ft. and dark green color	none; tissue test at growth stage 30
March (growth stage 30 tissue test)	Refer to Figure 5-3 for N rates based on tissue test	No more than 120 lbs N/acre - **total of Growth Stages 25 and 30**

Phosphorus and Potassium Nutrient Needs
(Standard/Intensive Small Grain Management)

Soil Test Level	Nutrient Needs (lbs/ac) P_2O_5	K_2O
L	80 – 120	80 – 120
M	40 – 80	40 – 80
H	20 – 40	20 – 40
VH	0	0

Canola

Nitrogen Fertilization:

1. Apply 30 - 40 lbs/ac. N at planting time. Broadcast and disc-in before planting.

2. Apply 90 - 120 lbs/ac. N in late February just before spring growth begins. For soils which are a High environmental risk for nitrogen loss, the late winter application should be split with the first 45 to 60 lbs/ac being applied in late February and the second 45 to 60 lbs/ac being applied 4 weeks later.

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	80 -120	80 -120
M	40 - 80	40 - 80
H	20 - 40	20 - 40
VH	0	0

Peanuts

Phosphorus and Potassium Nutrient Needs:

The phosphorus and potassium nutrient needs for peanuts can be applied at the same time the crop preceding peanuts in the rotation is fertilized. If not applied at that time, it should be plowed down before peanuts are planted.

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	100-200	80 -120
M	55 – 85	0
H	0 - 40*	0
VH	0	0

*Apply 40 lbs/ac at H-. No P_20_5 recommended at H and H+.

Apply ½ pound of elemental boron per acre per year at early bloom stage in a compatible labeled pesticide spray or dust or as a separate foliar application. (Va. Tech Soil Test Note 4).

Cotton

Nitrogen Needs:

The planned rate of total nitrogen application should take into consideration the crop that cotton will be following and the soil on which it will be grown. The following suggestions consider both:

Soil Management Groups on Which Cotton Will Be Grown		Total N Application Lbs/Acre
I.	A, AA, B, C, E, J, K	50-60
II.	F, Q, R, S, T, DD, II	60-90
III.	N, O, V, X	50-70
IV.	Soil Management Groups that are not suited for cotton production: P, Z, BB, CC, EE, FF, HH, JJ, KK, LL, MM, NN, OO, PP, QQ.*	
V.	Soil Management Groups on which cotton will not be grown: D, G, H, I, J, L, M, U, W, Y, GG.	

* **"Soils in this field are not suited for cotton production. If at all possible, select another field, but if cotton will be grown, apply 50-70 lbs of N per acre."**

Reduce the planned rate of nitrogen application by 10 pounds per acre if cotton will be following soybeans and by 20 pounds per acre if it will follow peanuts.

Timing of Nitrogen Application on Cotton

Only about 20 percent of the total nitrogen uptake will have occurred by early square formation (approximately 45 days after planting). To avoid possible stimulation of excessive vegetative growth and loss of unneeded nitrogen through leaching, apply only one third of the planned nitrogen application rate at planting. The most effective method of application of this nitrogen is in a starter fertilizer which would also supply 20 to 40 pounds of P_2O_5 depending upon P_2O_5 needs as shown by a soil test. This can be done by using either a 1:1:0 ratio fertilizer such as 15-15-0, a 1:2:0 ratio fertilizer such as 18-46-0 or a 1:3:0 fertilizer such as 10-34-0. Use of a starter fertilizer has been shown to stimulate the early growth rate and increase lint cotton yields by 60 to 100 pounds per acre, both of which are desirable.

The preferred placement of this starter fertilizer is two inches to one side of the seed and at least as deep as the seeds are planted but preferably one to two inches below seed level. Placing the starter fertilizer in the row behind the subsoiler shank while ripping under the row has also been shown to be an effective placement. However, applying the starter fertilizer in a 3 to 4 inch wide band on the soil surface in front of the press wheel has not proven to be an effective placement method in research conducted in North Carolina.

The remainder of the planned nitrogen application can be applied at first square formation (approximately 45 days after planting).

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	80 – 120	80 -120
M	40 – 80	40 - 80
H	20 – 40	20 - 40
VH	0	0

Apply ½ pound of elemental boron per acre per year in a compatible labeled pesticide spray or dust or as a separate foliar application. (Va. Tech Soil Test Note 4).

White Potatoes - All Soil Productivity Groups

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	125-150*	200	300
M	125-150*	150	200
H	125-150*	100	100
VH	125-150*	30**	50

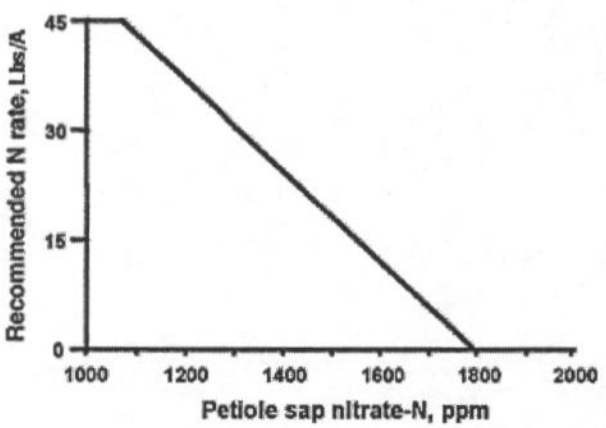
* Nitrogen recommendation for yields up to 250 cwt/acre. Split apply nitrogen with 1/3 of the rate applied at planting and remaining 2/3 to be applied 1-2 weeks after emergence.

** For phosphorus soil test levels exceeding 65% saturation as shown in Table 4-1,Section IV, or if the Phosphorus Index rating is greater than 100, no phosphorus application shall be made to the field, including starter.

When documented yields for the field (average of the high 3 yields in the last 5 years) indicate an expected yield of greater than 250 cwt/acre use .6 (six-tenths) X the expected tuber yield (cwt/ac) to determine the nitrogen recommendation. At this higher nitrogen recommendation, use a three way split as follows, 1/6 -1/3 of the total recommendation at planting, 1/2 to 2/3 of the total recommendation at emergence, and 1/6 of the total recommendation at flowering. The combination of nitrogen applications applied before flowering shall not exceed 5/6 of the total nitrogen need when using this program.

For more efficient nitrogen management application at flowering, apply the remaining nitrogen from the 3-way nitrogen split, or use the figure below showing petiole sap concentrations at flowering to adjust nitrogen application rate.

Figure 5-4 White Potato Petiole Sap Nitrate Concentration before Flowering



Note: At greater than 1500 ppm, response to additional nitrogen is unlikely.

Sudangrass, Sudan-Sorghum Hybrids and Millet Plantings

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	70*	100-120	100-120
M	70*	70-90	70-90
H	70*	40-60	40-60
VH	70*	0	0

* The N recommendation is for application at planting. If additional pasture, hay, silage production is desired, apply 40-60 lbs/A N after each cutting, or 30-40 lbs/ac. N after each grazing. Do not apply more than 130 lbs/A N per year.

Alfalfa and Alfalfa-Orchardgrass Establishment

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	150-170	150-170
M	120-140	120-140
H	50-110	50-110
VH	0	0

Alfalfa and Alfalfa-Grass Hay Maintenance, Soil Productivity Group I

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	100-120	390-450*
M	70-90	300-360*
H	40-60	40-210*
VH	0	0

* For K_2O rates greater than 200 lbs/ac, split the application, applying 1/2 in the fall and 1/2 in the spring. (Alternate recommendation where field sampled in spring - apply 1/2 in early spring, and 1/2 after the first cutting).

Apply 2 to 4 pounds of elemental boron per acre per year with a broadcast fertilizer.(Va. Tech Soil Test Note 4).

Alfalfa and Alfalfa-Grass Hay Maintenance, Soil Productivity Group II

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	100-120	280-330*
M	70-90	220-270*
H	40-60	60-200
VH	0	0

* For K_2O rates greater than 200 lbs/acre, split the application, applying 1/2 in the fall and 1/2 in the spring. (Alternate recommendation where field sampled in spring - apply 1/2 in early spring, and 1/2 after the first cutting).

Apply 2 to 4 pounds of elemental boron per acre per year with a broadcast fertilizer.(Va. Tech Soil Test Note 4).

Alfalfa and Alfalfa-Grass Hay Maintenance, Soil Productivity Group III, IV, V

Soil Test Level	Nutrient Needs (lbs/ac)	
	P_2O_5	K_2O
L	70-90	200-240*
M	40-60	160-180
H	40	40-140
VH	0	0

* For K_2O rates greater than 200 lbs/ac, split the application, applying 1/2 in the fall and 1/2 in the spring. (Alternate recommendation where field sampled in spring - apply 1/2 in early spring, and 1/2 after the first cutting).

Apply 2 to 4 pounds of elemental boron per acre per year with a broadcast fertilizer.(Va. Tech Soil Test Note 4).

Red Clover-Orchardgrass, Orchardgrass/Fescue-Ladino Clover, Orchardgrass and Fescue Establishment

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	40*	150-170	150-170
M	40*	120-140	120-140
H	40*	40-110	40-110
VH	40*	0	0

* Apply the nitrogen at the time the grass is seeded in late summer, early fall or early spring. Overseed the grass with clover the following February.

Red Clover-Grass Hay Maintenance, Soil Productivity Groups I, II

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	0	100-120	200-240
M	0	70-90	160-180
H	0	40-60	40-140
VH	0	0	0

Red Clover-Grass Hay Maintenance, Soil Productivity Groups III, IV

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	0	70-90	120-150
M	0	40-60	80-110
H	0	40	40-70
VH	0	0	0

Stockpiled Tall Fescue, Soil Productivity Groups I, II

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	60-100*	100-120	100-120
M	60-100*	40-90	40-90
H	60-100*	0	0
VH	60-100*	0	0

* Remove animals by early August and apply the N between August 1-15. Keep animals off pasture until November to allow stand to mature. Where clover makes up more than 25% of the stand, use the 60 lbs/ac. N rate. If clover is not present and you desire maximum production, apply the 100 lbs/ac. N rate.

Stockpiled Tall Fescue, Soil Productivity Groups III, IV, V

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	50-80*	40-60	60-80
M	50-80*	30	30-50
H	50-80*	0	0
VH	50-80*	0	0

* Remove animals by early August and apply the N between August 1-15. Keep animals off pasture until November to allow stand to mature. Where clover makes up more than 25% of the stand, use the 50 lbs/ac. N rate. If clover is not present and you desire maximum production, apply the 80 lbs/ac. N rate.

Orchardgrass/Fescue-Clover Pastures, Soil Productivity Groups I, II

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	0*	100-120	100-120
M	0*	40-90	40-90
H	0*	0	0
VH	0*	0	0

* If stand contains less than 25% clover, apply 50-80 lbs/ac. of N.

If additional production is needed later on, apply 40 to 60 lbs/ac. of N in late summer.

If you are planning to overseed a legume into the stand, do not apply any N.

If organic nutrient sources are utilized, up to 120 lbs/ac. of N may be applied if the application is no more frequent than once every 2 years. When applying organic nutrient sources pasture should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

Orchardgrass/Fescue-Clover Pastures, Soil Productivity Groups III, IV, V

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	0*	40-60	60-80
M	0*	30	30-50
H	0*	0	0
VH	0*	0	0

* If stand contains less than 25% clover, apply 40-60 lbs/ac. of N.

If additional production is needed later on, apply 40 to 60 lbs/ac. of N in late summer.

If you are planning to overseed a legume into the stand, do not apply any N.

If organic nutrient sources are utilized, up to 100 lbs of N may be applied if the application is no more frequent than once every 2 years When applying organic nutrient sources, pasture should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

Native or Unimproved Pastures, Soil Productivity Groups I, II

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	0*	150-200	150-200
M	0*	75-125	75-125
H	0*	0	0
VH	0*	0	0

* If stand contains less than 25% clover, apply 40-60 lbs/ac. of N.

For phosphorus and potassium - apply once every three or four years.
If you are planning to overseed a legume into the stand, omit the N application.

When applying organic nutrient sources, pasture should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

Native or Unimproved Pastures, Soil Productivity Groups III, IV

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	0*	100-120	100-120
M	0*	40-90	40-90
H	0*	0	0
VH	0*	0	0

* If stand contains less than 25% clover, apply 40-60 lbs/ac. N.

When applying organic nutrient sources, pasture should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

For phosphorus and potassium - apply once every three or four years.

Orchardgrass/Fescue (Tall Grass) Hay Production, Soil Productivity Groups I, II

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	80-100*	100-120	200-240
M	80-100*	70-90	160-180
H	80-100*	40-60	40-140
VH	80-100*	0	0

* The N recommendation is for a March application of commercial fertilizer.

If additional hay production is needed, apply 80 lbs/ac N after each cutting during the growing season. Use the number of cuttings to determine total nitrogen rate with a maximum annual rate not to exceed 250 lbs/acre per year.

Organic nutrient sources may be applied in one or more applications, not to exceed 250 lbs/acre plant available nitrogen annually. If applied after 9/1 of any year until 3/1 of the following year, application rates during this period shall not exceed ½ of the total nitrogen rate (125 lbs/acre).

When applying organic nutrient sources, fields should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

Orchardgrass/Fescue (Tall Grass) Hay Production, Soil Productivity Groups III, IV

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	60-80*	70-90	120-150
M	60-80*	40-60	80-110
H	60-80*	40	40-70
VH	60-80*	0	0

* N recommendation is for a March application of commercial fertilizer.

For additional fall hay production apply 60-80 lbs N/acre in late August/early September. Do not apply more than 160 lbs N/acre/year.

Organic nutrient sources may be applied in one or more applications, not to exceed 160 lbs/acre plant available nitrogen annually. If applied after 9/1 of any year until 3/1 of the following year, application rates during this period shall not exceed ½ of the total nitrogen rate (80 lbs/acre).

When applying organic nutrient sources, fields should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

Bermudagrass Establishment

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	70	100-120	100-120
M	70	70-90	70-90
H	70	40-60	40-60
VH	70	0	0

Bermudagrass Pastures - Soil Productivity Groups I, II

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	175-225*	100-120	100-120
M	175-225*	40-90	40-90
H	175-225*	0	0
VH	175-225*	0	0

* The N recommendation represents the total amount of Nitrogen to be applied during the season. Split the N into three applications - April, June and July.

Organic nutrient sources may be applied in one or more applications, not to exceed 225 lbs./ac. plant available nitrogen annually. If applied after 7/1, application rates shall not exceed ½ the total nitrogen rate (112 lbs/ac.) based on above criteria while crop is still actively growing up to 9/15, with the remaining rate not to be applied until after 4/1 of the following year.

When applying organic nutrient sources, pastures should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

Bermudagrass Pastures - Soil Productivity Groups III, IV, V**

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	120-180*	100-120	100-120
M	120-180*	40-90	40-90
H	120-180*	0	0
VH	120-180*	0	0

* The N recommendation represents the total amount of N to be applied during the season. Split the N into three applications - April, June and July.

** Use the lower end of range for Group V soils.

Organic nutrient sources may be applied in one or more applications, not to exceed 180 lbs/ac. plant available nitrogen annually. If applied after 7/1 application rates shall not exceed ½ the total nitrogen rate (90 lbs/ac.) based on above criteria while crop is still actively growing up to 9/15, with the remaining rate not to be applied until after 4/1 of the following year.

When applying organic nutrient sources, pastures should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

Bermudagrass Hay Production, Soil Productivity Groups I, II
(Use Tall Grass Productivity Group)

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	240-300*	100-120	235-275
M	240-300*	70-90	185-225
H	240-300*	40-60	40-165
VH	240-300*	0	0

* Total application of N should be divided equally between an early April application and applications made after the first and second harvests.

Organic nutrient sources may be applied in one or more applications, not to exceed 300 lbs/ac. plant available nitrogen annually. If applied after 7/1, application rates shall not exceed ½ the total nitrogen rate (150 lbs/ac.) based on above criteria while crop is still actively growing up to 9/15, with the remaining rate not to be applied until after 4/1 of the following year.

When applying organic nutrient sources, fields should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

Bermudagrass Hay Production, Soil Productivity Groups III, IV, V**
(Use Tall Grass Productivity Group)

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	210-260*	100-120	235-275
M	210-260*	70-90	185-225
H	210-260*	40-60	40-165
VH	210-260*	0	0

* Total application of N should be divided equally between an early April application and applications made after the first and second harvests.

** Use the lower end of range for Group V soils.

Organic nutrient sources may be applied in one or more applications, not to exceed 260 lbs/ac. plant available nitrogen annually. If applied after 7/1 application rates shall not exceed ½ the total nitrogen rate (130 lbs/ac.) based on above criteria while crop is still actively growing up to 9/15, with the remaining rate not to be applied until after 4/1 of the following year.

When applying organic nutrient sources fields should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

Annual Ryegrass Hay Production, Soil Productivity Groups I and II
(Use Tall Grass Productivity Group)

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	40-50*	100-120	200-240
M	40-50*	70-90	160-180
H	40-50*	40-60	40-140
VH	40-50*	0	0

* The above N rates are recommended at seeding during the Fall. For additional production 30-40 lbs/ac of N should be added after each grazing, not to exceed 160 lbs/ac. annually. For hay production 40-60 lbs/ac N after each cutting, not to exceed 200 lbs/ac. annually.

When applying organic nutrient sources, fields should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

Annual Ryegrass Hay Production, Soil Productivity Groups III and IV (Use Tall Grass Productivity Group)

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	40-50*	70-90	120-150
M	40-50*	40-60	80-110
H	40-50*	40	40-70
VH	40-50*	0	0

* The above N rates are recommended at seeding during the Fall. For additional production 30-40 lbs/ac of N should be added after each grazing, not to exceed 140 lbs/ac annually. For hay production 40-60 lbs/ac N after each cutting, not to exceed 180 lbs/ac annually.

When applying organic nutrient sources, fields should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

Prairie Grass (Matua) Hay Production, Soil Productivity Groups I and II (Use Tall Grass Productivity Group)

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	80-100*	100-120	280-330
M	80-100*	70-90	220-270
H	80-100*	40-60	60-200
VH	80-100*	0	0

* The N recommendation is for a March application. Apply 40-60 lbs/A after hay or silage cutting. Do not exceed 300 lbs/A per year for hay. When pastured after hay harvest, apply 30-40 lbs/ac after each grazing. Do not exceed 200 lbs/A per year for intensive rotational grazing.

When applying organic nutrient sources, fields should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

Prairie Grass (Matua) Hay Production, Soil Productivity Groups III and IV (Use Tall Grass Productivity Group)

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	60-80*	100-120	200-240
M	60-80*	70-90	160-180
H	60-80*	40-60	40-140
VH	60-80*	0	0

* The N recommendation is for a March application. Apply 40-60 lbs/A after hay or silage cutting. Do not exceed 250 lbs/A per year for hay. When pastured after hay harvest, apply 30-40 lbs/ac after each grazing. Do not exceed 180 lbs/ac per year for intensive rotational grazing.

When applying organic nutrient sources, fields should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

Switchgrass - All Soil Productivity Groups

Soil Test Level	Nutrient Needs (lbs/ac)		
	N*	P_2O_5	K_2O
L	40-60	100-120	100-120
M	40-60	40-90	40-90
H	40-60	0	0
VH	40-60	0	0

*If stand contains greater than 25% legumes, no Nitrogen is required.

For establishment no Nitrogen is needed, follow P_2O_5 and K_2O soil test recommendations shown above.

When applying organic nutrient sources, fields should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

Caucasian Bluestem (hay or pasture), All Soil Productivity Groups

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L	60-120*	100-120	100-120
M	60-120*	40-90	40-90
H	60-120*	0	0
VH	60-120*	0	0

*This is an annual nitrogen rate. Annual nitrogen rate should be applied in split applications, such as between grazings or cuttings if used for hay.

If organic nutrient sources are utilized, up to 120 lbs of N may be applied if the application is no more frequent than once every 2 years.

When applying organic nutrient sources, fields should be maintained at no less than three inches in height in order to reduce runoff and assure adequate regrowth of crop.

Tobacco Recommendations:

Flue-Cured

Soil Test Level	Nutrient Needs (lbs/ac)		
	N	P_2O_5	K_2O
L		290-330	150-175
M	60-70	60-100	100-150
H		40	100
VH		40*	100

* For phosphorus soil test levels exceeding 65% saturation as shown in Table 4-1,Section IV, or if the Phosphorus Index is greater than 100, no phosphorus application shall be made to the field, including starter.

- 50% of the total nitrogen need should be in the nitrate nitrogen form.
- Pre-plant broadcast fertilizer should not exceed 40 lbs/ac of nitrogen and 120 lbs/ac. of potash. Balance of nutrient recommendation can be applied as a sidedress application.
- Use of soluble fertilizer in transplant water is discouraged where soil test levels are M+ and higher. For phosphorus soil test levels Medium or below, soluble fertilizer may be used. Select a product approved for direct application in the row with the plant. Total phosphorus applied can not exceed phosphorus nutrient need.
- Potassium source should not contain any chloride compounds.

Appendix 8

Table 1-1, Agronomic and Environmental Management of soils and Other Site Features, and **Table 1-2,** Estimated Yields in Bushels (Bu) or Tons (T) per Acre (A) of Various Non-Irrigated Crops for Identified Soil Productivity Group.

Prepared by James Thompson associate professor pedology and land use at West Virginia University

*Note: Tile drained soils to be added upon completion.

I. Agronomic and Environmental Management of Soils and Other Site Features

Table 1-1
WV Soil Productivity Groupings for Various Cropping Categories

Soil Series	Soil Mgt Group	Corn	Grain Sorghum	Small Grain	Soybeans	Alfalfa	Tall Grass, Clover, Hay, Pasture
Airmont	BB	IVb	IVb	III	IV	NS*	III
Albrights	BB	IVb	IVb	III	IV	NS*	III
Albrights (drained)	W	IVa	IVa	IV	III	NS*	IV
Allegheny	L	IIb	IIb	I	II	III	II
Alluvial Land, wet	MM	V	V	V	V	NS*	IV
Andover	BB	IVb	IVb	III	IV	NS*	III
Andover (drained)	W	IVa	IVa	IV	III	NS*	IV
Ashton	L	IIb	IIb	I	II	I	II
Atkins	NN	V	V	V	V	NS*	NS*
Atkins (drained)	H	IIa	IIa	III	II	NS*	IV
Bagtown	CC	IVb	IVb	II	IV	NS*	III
Barbour	CC	IVb	IVb	II	IV	NS*	III
Basher	HH	IVb	IVb	III	IV	NS*	IV
Basher (drained)	H	IIa	IIa	III	II	NS*	IV
Beech	HH	IIb	IIb	I	II	I	II
Beech (drained)	L	IIb	IIb	I	II	III	II
Belmont	M	IIb	IIb	I	II	I	II
Benevola	M	IIb	IIb	I	II	I	II
Berks	FF	IVb	IVb	III	IV	NS*	III
Berks/Weikert	JJ	V	V	IV	V	NS*	IV
Bethesda	JJ	V	V	IV	V	NS*	IV
Bigpool	L	IIb	IIb	I	II	III	II
Blackthorn	G						
Blago	Z	IVb	IVb	III	IV	NS*	IV
Blago (drained)	P	IIb	IIb	II	II	NS*	III
Blairton	AA	IVa	IVa	II	III	NS*	IV
Blairton (drained)	U	IIIb	IIIb	II	II	III	II
Braddock	O	IIb	IIb	I	II	II	II
Briery	FF	IVb	IVb	III	IV	NS*	III
Brevard	B	Ia	Ia	I	Ia	II	I
Brickhaven	Y	IVa	IVa	III	III	NS*	III
Brinkerton	BB	IVb	IVb	III	IV	NS*	III
Brinkerton (drained)	W	IVa	IVa	IV	III	NS*	IV
Brooke	Y	IVa	IVa	III	III	NS*	III
Brooke (drained)	Y	IVa	IVa	III	III	NS*	III
Brookside	HH	IVb	IVb	III	IV	NS*	IV
Brookside (drained)	L	IIb	IIb	I	II	III	II
Buchanan	BB	IVb	IVb	III	IV	NS*	III
Buchanan (drained)	W	IVa	IVa	IV	III	NS*	IV

Calvin	FF						
Calvin cobbly	JJ	V	V	IV	V	NS*	IV
Caneyville	Y	IVa	IVa	III	III	NS*	III
Captina	W	IVa	IVa	IV	III	NS*	IV
Captina (drained)	W	IVa	IVa	IV	III	NS*	IV
Carbo	Y	IVa	IVa	III	III	NS*	III
Cardova	U	IIIb	IIIb	II	II	III	II
Cateache	U	IIIb	IIIb	II	II	III	II
Catoctin	FF	V	V	IV	V	NS*	IV
Cavode	AA	IVa	IVa	II	III	NS*	IV
Cavode (drained)							
Cedarcreek	FF	V	V	IV	V	NS*	IV
Chagrin	A	Ia	Ia	I	Ia	I	I
Chavies	L	IIb	IIb	I	II	III	II
Chilhowie	Y	IVa	IVa	III	III	NS*	III
Clarksburg	W	IVa	IVa	IV	III	NS*	IV
Clarksburg (drained)	W	IVa	IVa	IV	III	NS*	IV
Clearbrook	AA	V	V	IV	V	NS*	IV
Clearbrook (drained)	U	IIIb	IIIb	II	II	III	II
Clifton	L	IIb	IIb	I	II	III	II
Cloverlick	FF	V	V	IV	V	NS*	IV
Clymer	U	IIIb	IIIb	II	II	III	II
Combs	A	Ia	Ia	I	Ia	I	I
Conotton	LL	V	V	V	V	NS*	IV
Cookport	W	V	V	IV	V	NS*	IV
Cookport (drained)	W	V	V	IV	V	NS*	IV
Coolville	G	IIa	IIa	I	II	II	I
Coolville (drained)	G						
Cotaco	HH	IVb	IVb	III	IV	NS*	IV
Cotaco (drained)	L	IIb	IIb	I	II	III	II
Craigsville	CC	IVb	IVb	II	IV	NS*	III
Culleoka	U	IIIb	IIIb	II	II	III	II
Dekalb	FF	IVb	IVb	III	IV	NS*	III
Dormont	HH	IIa	IIa	I	II	II	I
Dormont (drained)	L	IIb	IIb	I	II	III	II
Downsville	CC	IVb	IVb	II	IV	NS*	III
Duffield	M	IIa	IIa	I	II	II	I
Duncannon	L	IIb	IIb	I	II	III	II
Dunmore	M	IIb	IIb	I	II	I	II
Dunning (drained)	H	IIa	IIa	III	II	NS*	IV
Dunning	NN	V	V	V	V	NS*	NS*
Edgemont	U	IIIb	IIIb	II	II	III	II
Edom	M	IIb	IIb	I	II	I	II
Elk	A	Ia	Ia	I	Ia	I	I
Elkins (drained)	H	IIa	IIa	III	II	NS*	IV
Elkins	NN	V	V	V	V	NS*	NS*

Elliber	M VA or GG WV	IIb	IIb	I	II	I	II
Endcav	~~Y VA~~ M WV	IVa	IVa	III	III	NS*	III
Ernest	W	IVa	IVa	IV	III	NS*	IV
Ernest (drained)	W	IVa	IVa	IV	III	NS*	IV
Fairplay	NN	V	V	V	V	NS*	NS*
Fairplay (drained)							
Fairpoint	D-VA FF-WV	Ib	Ib	I	Ib	I	I
Faywood	N-VA Y-WV	IIb	IIb	I	II	II	II
Fedscreek	PP-Va CC-WV	V	V	V	V	NS*	NS*
Fenwick	AA	IVa	IVa	II	III	NS*	IV
Fiveblock	QQ-VA FF-WV	V	V	V	V	NS*	NS*
Frankstown	Z-VA M-WV	IVa	IVa	IV	III	NS*	NS*
Frederick	U	IIIb	IIIb	II	II	III	II
Frederick/Lodi	M	IIb	IIb	I	II	I	II
Funkstown	QQ-VA HH-WV	V	V	V	V	NS*	NS*
Gaila	A-VA L-WV	Ia	Ia	I	Ia	I	I
Gallipolis	L	IIb	IIb	I	II	III	II
Gallipolis (drained)	L						
Gilpin	U	IIIb	IIIb	II	II	III	II
Ginat	NN	V	V	V	V	NS*	NS*
Ginat (drained)							
Glenford	L	IIb	IIb	I	II	III	II
Glenford (drained)							
Grigsby	CC-VA A-WV	IVb	IVb	II	IV	NS*	III
Guernsey	X-VA AA-WV	IVa	IVa	II	III	III	II
Gurensey (drained)							
Guyan	NN	V	V	V	V	NS*	NS*
Guyan (drained)							
Guyandotte	CC	IVb	IVb	II	IV	NS*	III
Hackers	L	IIb	IIb	I	II	III	II
Hagerstown	M	IIb	IIb	I	II	I	II
Hazleton	U-VA FF-WV	IIIb	IIIb	II	II	III	II
Highsplint	CC	IIb	IIb	I	II	II	II
Holly	NN	V	V	V	V	NS*	NS*
Holly (drained)							
Huntington	A	IIb	IIb	I	II	I	II

Hutstontown	W	IVa	IVa	IV	III	NS*	IV
Itman	JJ-VA FF-WV	IVb	IVb	II	IV	NS*	III
Janelew	FF						
Jefferson	U-VA L-WV	IVa	IVa	IV	III	NS*	NS*
Jefferson variant	U	IIIb	IIIb	II	II	III	II
Kanawha	L	IIb	IIb	I	II	III	II
Laidig	W	IVa	IVa	IV	III	NS*	IV
Lakin	II	IVb	IVb	III	IV	NS*	III
Landes	A	IIb	IIb	I	II	I	II
Lappans	A	IIb	IIb	I	II	I	II
Latham	AA	IVa	IVa	II	III	NS*	IV
Latham (drained)							
Lawrence	BB	IVb	IVb	III	IV	NS*	III
Leatherbank	AA	IVa	IVa	II	III	NS*	IV
Leatherbank (drained)							
Leetonia	II	IVb	IVb	III	IV	NS*	III
Lehew	JJ-VA FF-WV	IVa	IVa	II	III	III	III
Lickdale	NN	IIa	IIa	III	II	NS*	IV
Lickdale (drained)							
Licking	L	IIb	IIb	I	II	III	II
Licking (drained)							
Lily	FF-VA U-WV	V	V	V	V	NS*	IV
Linden	F-VA A-WV	IVb	IVb	III	IV	NS*	III
Lindside	A	IIa	IIa	I	II	III	II
Lindside (drained)							
Litz	JJ-VA GG-WV	IVa	IVa	II	III	III	III
Lobdell	A	IIb	IIb	I	II	II	II
Lobdell (drained)							
Lodi	M	IIb	IIb	I	II	I	II
Lowell	M	IIb	IIb	I	II	I	II
Macove	CC	IIa	IIa	I	II	NS*	II
Mandy	JJ-VA FF-WV	Ib	Ib	I	Ib	I	I
Markland	O	IIb	IIb	I	II	II	II
Markland (drained)							
Marrowbone	JJ-VA CC-WV	IIIb	IIIb	II	II	NS*	III
Matewan	FF	IIIa	IIIa	II	II	III	II
Matewan	FF	IVb	IVb	III	IV	NS*	III
McGary	Z	IIb	IIb	II	II	NS*	III
McGary							

(drained)							
Meckesville	W	IVa	IVa	IV	III	NS*	IV
Melvin	NN	V	V	V	V	NS*	NS*
Melvin (drained)							
Mertz	GG						
Middlebury	G-VA A-WV	V	V	V	V	NS*	NS*
Middlebury (drained)							
Monongahela	W	IVa	IVa	IV	III	NS*	IV
Monogahela (drained)							
Moshannon	A						
Murrill	L-VA G-WV	IIa	IIa	I	II	III	II
Muskingum	JJ-VA U-WV	IIb	IIb	I	II	III	II
Myersville	D-Va U-WV	V	V	V	V	NS*	NS*
Myra	FF	IVb	IVb	III	IV	NS*	III
Nelse	A	Ia	Ia	I	Ia	II	I
Nolin	A	IIb	IIb	I	II	II	II
Nollville	G-VA M-WV	Ia	Ia	I	Ia	I	I
Nolo	BB						
Nolo (drained)							
Oaklet	Y-VA KK-WV	IVb	IVb	III	IV	NS*	III
Omulga	W						
Omulga							
Opequon	JJ-VA Y-WV	V	V	V	V	NS*	IV
Orrville (drained)	C-VA NN-WV	IVb	IVb	II	IV	NS*	III
Orrville (undrained)	OO	Ib	Ib	II	Ib	NS*	I
Orriville (drained)							
Otwell	JJ-VA W-WV	V	V	V	V	NS*	NS*
Otwell (drained)							
Peabody	HH-VA U-WV						
Pecktonville	M	IVb	IVb	III	IV	NS*	IV
Philo (drained)	H-VA A-WV	IVb	IVb	III	IV	NS*	III
Philo (undrained)	NN	V	V	V	V	NS*	NS*
Philo (drained)							
Pineville	U-VA L-WV	IIb	IIb	I	II	III	II
Poorhouse	AA	IVa	IVa	II	III	NS*	IV
Poorhouse (drained)							

Pope	A	IIb	IIb	I	II	III	II
Poplimento	M-VA U-WV	Ia	Ia	I	Ia	I	I
Potomac	II	IVb	IVb	III	IV	NS*	III
Purdy (drained)	H-VA Z-WV	Ib	Ib	I	Ib	I	I
Purdy (undrained)	NN	V	V	V	V	NS*	NS*
Purdy (drained)							
Ramsey	JJ-VA II-WV	V	V	V	V	NS*	NS*
Rayne	U	IVa	IVa	III	III	NS*	III
Robertsville	LL-VA BB-WV	V	V	V	V	NS*	NS*
Robertsville (drained)							
Rough	JJ	Ia	Ia	I	Ia	I	I
Rushtown	FF	IVb	IVb	II	IV	NS*	III
Ryder	Y						
Schaffenaker	II	IVb	IVb	III	IV	NS*	III
Sciotoville	W	IVa	IVa	IV	III	NS*	IV
Sciotoville (drained)							
Sees	L	V	V	IV	V	NS*	IV
Senecaville	A	IIb	IIb	I	II	III	II
Secnecaville (drained)							
Sensabaugh	A	IIb	IIb	I	II	III	II
Sensabaugh (drained)							
Sewell	JJ-VA FF-WV	IIIb	IIIb	II	II	III	II
Sharpcrest	U	IIIb	IIIb	II	II	III	II
Shelocta	L	V	V	IV	V	NS*	IV
Shelocta (drained)							
Shircliff	HH	IVb	IVb	III	IV	NS*	IV
Shircliff (Drained))							
Shouns	G	IIb	IIb	I	II	II	II
Sideling	G	IIb	IIb	I	II	II	II
Simoda	W	IVa	IVa	IV	III	NS*	IV
Skidmore	CC	Ia	Ia	I	Ia	I	I
Snowdog	BB-VA W-WV	IVb	IVb	III	IV	NS*	III
Speedwell	A	IVa	IVa	II	III	III	III
Stumptown	FF	IVa	IVa	II	III	III	II
Summers	GG-VA FF-WV	V	V	V	V	NS*	NS*
Swampond	KK	IIb	IIb	I	II	I	II
Swampond (drained)							
Sylvatus	JJ	V	V	IV	V	NS*	IV
Taggart	HH	IVb	IVb	III	IV	NS*	IV

Taggart (drained)							
Tarhollow	U	IIIb	IIIb	II	II	III	II
Thurmont	L	IVb	IVb	IV	IV	NS*	III
Tilsit	W	IVa	IVa	IV	III	NS*	IV
Tioga	A	IIa	IIa	I	II	II	I
Toms	C-VA Z-WV	V	V	V	V	NS*	NS*
Toms (drained)							
Trego	W	IVa	IVa	IV	III	NS*	IV
Trussell	BB	IVb	IVb	III	IV	NS*	III
Trussell (drained)							
Tygart	Z	IIb	IIb	II	II	NS*	III
Tygart (drained)							
Tyler	BB	IVb	IVb	III	IV	NS*	III
Tyler (drained)							
Upshur	U	IIIb	IIIb	II	II	III	II
Vandalia	L-VA O-WV	IVa	IVa	III	III	NS*	III
Vanderlip	II	IVb	IVb	III	IV	NS*	III
Vertrees	M	IIIa	IIIa	II	II	NS*	III
Vincent	L	V	V	V	V	NS*	IV
Vincent (drained)							
Weikert	JJ	V	V	V	V	NS*	IV
Wellston	U	IVa	IVa	II	IV	III	III
Westmoreland	U	IVa	IVa	II	IV	III	III
Weverton	GG-VA FF-WV	V	V	III	V	NS*	NS*
Wharton	M-VA U-WV	IVb	IVb	IV	IV	NS*	III
Wharton (drained)							
Wheeling	A-VA L-WV	IIb	IIb	I	II	I	II
Whiteford	U	V	V	V	V	NS*	IV
Woodsfield	U	V	V	V	V	NS*	IV
Yeager	II	IVb	IVb	III	IV	NS*	III
Zoar	K	IVa	IVa	III	III	NS*	III
Zoar (drained)							

Table 1-2
Estimated Yields in Bushels (Bu) or Tons (T) per Acre (A) of Various Non-Irrigated Crops for Identified Soil Productivity Groups

Crop	I		II		III		IV		V
	A	B	A	B	A	B	A	B	
Corn									
Grain (Bu/A)	180	170	160	150	140	130	120	100	80
Silage (T/A)	25	24	23	22	21	20	19	18	16
Grain Sorghum (bu/A)	140	130	120	110	100	90	90		80
Soybeans (Bu/A)									
Early season	50	45	40		35		25		20
Late season (1)	40	34	34	30	25		18		15
Wheat (Bu/A)									
Standard	64		56		48		40		24
Intensive	80		70		60		50		30
Barley (Bu/A)									
Standard	100		70		60		50		30
Intensive	115		88		75		63		38
Oats	80		80				60		60
Cereal Silage (T/A)									
Barley/Oats/Rye	>10		8-10		6-8		3-6		<3
Wheat/Triticale	>12		10-12		8-10		4-8		<4
Tallgrass Hay (T/A)	>4.0		3.5-4.0		3.0-3.5		<3.0		<3.0
Bermudagrass Hay (T/A)	>6.0		5.0-6.0		4.0-5.0		3.0-4.0		<3
Prairie Grass Hay (T/A)	>5		4.25-5		3.5-4.25		3-3.5		<3
Alfalfa (T/A)	>6.0		4.0-6.0		<4.0		<4		<4
Pasture (Ac/AU)	1.0		1.1-1.5		1.6-3.0		3.1-6.5		

(1) Late season beans would be planted on or after 6/21 of that year.

Corn silage yield may be calculated using the following formula:
Grain Yield(bu/ac) X 0.0985 + 7.6964 = Silage Yield Tons/ac.

Appendix 9

2005 Virginia Nutrient Management Standards and Criteria; **Tables 7-1,** Estimated Nitrogen Availability to Succeeding Crops from Legumes and **Table 8-3**, Manure Residual Factors for Previous Applications

Table 7-1

Estimated Nitrogen Availability to Succeeding Crops From Legumes

Crop	% Stand	Description	Residual N (Lbs/ac)
Alfalfa	50-75	Good (>4 T/A)	90
	25-49	Fair (3-4 T/A)	70
	<25	Poor (<3 T/A)	50
Red Clover or Crimson Clover	>50	Good (>3 T/A)	80
	25-49	Fair (2-3 T/A)	60
	<25	Poor (<2 T/A)	40
Hairy Vetch (cover crop)	80-100	Good	100
	50-79	Fair	75
	<50	Poor	50
Peanuts	-	-	45
Soybeans	1/2 lb. N per bushel of yield, if previous yield unknown, 20 lbs.		

Table 8-3
Manure Residual Factors for Previous Applications*

Historical Frequency of Manure Application on the Field	Residual Factor
Rarely Received Manure in Past (0-1 years in last 5)	0
Frequent Past Applications (2-3 out of 5 years)	0.10
Continuously Received Manure (4-5 out of 5 years)	0.20

* The appropriate rate of manure to use in residual calculations is generally the average rate applied for years in which manure was land applied to the field.
* Multiply the initial organic N content by the appropriate manure residual factor to obtain an estimate of residual nitrogen from past manure applications.
* If more detailed manure history information is available, a residual availability of the initial organic nitrogen content of .12, .05, .02 may be used for one, two, and three years respectively following application.

Primary Nutrient Availability for Manures

Manure Phosphorus

Available P_2O_5 = Manure Analysis P_2O_5

If soils are testing M+ or above in phosphorus and the manure will supply enough phosphorus for the crop according to the formula Available P_2O_5 = Total P_2O_5, no fertilizer phosphorus should be used due to unlikely crop response and water quality concerns.

For soils testing Medium or below, starter applications of fertilizer phosphorus should be made even if the manure contains sufficient phosphorus since it is contained in slow release organic forms. For soils testing low, higher levels of phosphorus starter fertilizer are recommended.

Manure Potassium

Available K_2O = Manure Analysis K_2O

Appendix 10

2005 *Virginia Nutrient Management Standards and Criteria;* **Table 8-1**, Manure Ammonium Nitrogen Availability Coefficients, **Table 8-2**, Coefficients for Organic N Availability in Manures and **Table 8-3,** Manure Residual Factors for Previous Applications

Table 8-1
Manure Ammonium Nitrogen Availability Coefficients

Method of Application	Semi-Solid Manure	Liquid Manure Slurry	Lagoon Liquid	Dry Litter
Injection	-	0.95	0.95	-
Broadcast with incorporation immediate	0.75	0.75	0.90	0.90
Incorporated after 2 days	0.65	0.65	0.80	0.80
Incorporated after 4 days	0.40	0.40	0.60	0.65
Incorporated after 7 days or no incorporation	0.25	0.25	0.45	0.50
Irrigation without incorporation	-	0.20	0.50	-

To utilize the table, the pounds of NH_4-N per ton or 1000 gallons of manure is determined from a manure test. Multiply the NH_4-N content of the manure by the availability coefficient in the table to obtain plant available nitrogen from the manure ammonium content.

Table 8-2
Coefficients for Organic N Availability in Manures[1]

	Spring or Early[2] Fall Applied	Winter Topdress/ Spring Residual[3]	Perennial Grass
Dairy Manure	.35	.20/.15	.35
Poultry Manure	.60	.30/.30	.60
Swine Manure	.50	.25/.25	.50

1. Multiply the organic nitrogen content by the coefficient in the table to obtain expected available nitrogen.

2. Manure applied in spring for summer annuals such as corn, or early fall (prior to December 1) for small grains. This coefficient shall also be used to calculate Orgainc N availability when the nitrogen need of the next spring crop is being used to determine a nitrogen application rate for fall or winter applications to a trap crop.

3. Use the first coefficient to calculate Organic N released from manure applied in early winter on winter annuals such as rye, wheat, or barley as a topdressing. Use the second coefficient to calculate Organic N released the following Spring.

Table 8-3
Manure Residual Factors for Previous Applications*

Historical Frequency of Manure Application on the Field	Residual Factor
Rarely Received Manure in Past (0-1 years in last 5)	0
Frequent Past Applications (2-3 out of 5 years)	0.10
Continuously Received Manure (4-5 out of 5 years)	0.20

* The appropriate rate of manure to use in residual calculations is generally the average rate applied for years in which manure was land applied to the field.
* Multiply the initial organic N content by the appropriate manure residual factor to obtain an estimate of residual nitrogen from past manure applications.
* If more detailed manure history information is available, a residual availability of the initial organic nitrogen content of .12, .05, .02 may be used for one, two, and three years respectively following application.

Primary Nutrient Availability for Manures

Manure Phosphorus

Available P_2O_5 = Manure Analysis P_2O_5

If soils are testing M+ or above in phosphorus and the manure will supply enough phosphorus for the crop according to the formula Available P_2O_5 = Total P_2O_5, no fertilizer phosphorus should be used due to unlikely crop response and water quality concerns.

For soils testing Medium or below, starter applications of fertilizer phosphorus should be made even if the manure contains sufficient phosphorus since it is contained in slow release organic forms. For soils testing low, higher levels of phosphorus starter fertilizer are recommended.

Manure Potassium

Available K_2O = Manure Analysis K_2O