Maryland Nutrient Management

Consultant's Resource Notebook

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EPA REGION III
JUN 23 2011
NPDES ENFORCEMENT BRANCH
(3WP42)

Maryland Department of Agriculture
Nutrient Management Program
50 Harry S. Truman Parkway
Annapolis, Maryland 21401
410-841-5959

Introduction

This notebook contains a variety of resources that you will turn to over and over as you work with agricultural operators.

The design follows the outline of the "Fundamentals" course, allowing you to add notes and handouts. Space has been left intentionally for you to add materials in the future. The MDA Nutrient Management Program will help you keep your "Law, Regulations and Reference Manual" up to date. This notebook however, is yours. Use the internet references and continuing education courses to keep your notes up to date. Add materials that relate to the type of operations you work with.

Materials for "Fundamentals of Nutrient Management Course"

1) Textbook: "Chesapeake Bay Region Nutrient Management Training Manual"

   New version just released digitally:
   http://www.agnr.umd.edu/users/waterqual/themes/nutrient_management/manmh2006.htm

2) Notebook: "Maryland Nutrient Management: Law, Regulations and Manual"

3) Consultant's Resource Notebook

Course Description for "Fundamentals of Nutrient Management"

This two-day course provides instruction in the basic concepts of nutrient management required to pass the Nutrient Management Certification Exam. The exam consists of 100 multiple choice questions from nine knowledge areas. Eight of these knowledge areas are covered by the "Chesapeake Bay Region Nutrient Management Training Manual." Each of the Bay states uses this core question pool for its certification exam. The ninth knowledge area is specific to Maryland.

Knowledge Area	Percentage
1. General Nutrient Management	10
2. Basic Soil Science	12
3. Agricultural & Environmental Management	15
4. Sampling, Testing and Analysis	10
5. Basic Soil Fertility	15
6. Fertilizer Management	10
7. Manure Management	12
8. Biosolids (Sludge) Management	6
9. Technical Recommendations, Regulations & Incentives	10
Total	**100**

Reciprocity Agreements

Maryland, Pennsylvania, Virginia and Delaware have reciprocity agreements on training, exam standards, certification and continuing education credits. Persons seeking certification in Maryland who plan to work in PA, VA or DE need to consult their state nutrient management program for state-specific regulations and requirements.

Questions or comments should be directed to:

Maryland Nutrient Management Program
Maryland Department of Agriculture
50 Harry S. Truman Parkway
Annapolis, MD 21401
Phone: 410-841-5959 Fax: 410-841-5950

Consultant's Resource Notebook
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- Sources for Soil Maps
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Appendix 3: **Telephone Contacts**

- **Soil Sampling Procedures for Nutrient Management**

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UNIVERSITY OF MARYLAND

For the Nutrient Management Advisor

Soil Sampling Procedures for Nutrient Management

1. **Define the management units.** A management area is an area that can and will be managed separately from any other. If different field areas have different soil types, past cropping histories, or different production potentials, these areas should be sampled separately and managed separately (See *Figure 1*). If it is impossible for a farmer to manage different areas separately, they should be treated as one management unit.

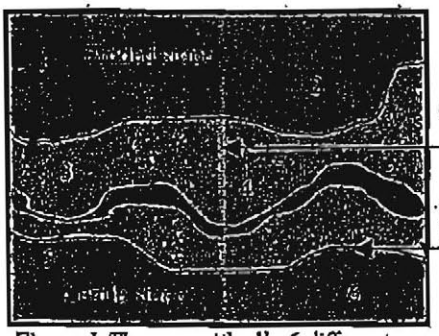

Figure 1: There are ideally 6 different management units in this field because of differences in landscape position and past management.

2. **Sample the management units.** Each unit should be sampled separately. Follow these steps for each management unit.
- Collect 15 to 20 samples in a clean plastic bucket.
- Take samples from throughout the entire area of the unit.
- Follow a sampling pattern similar to that in *Figure 2*.
- Avoid sampling unusual areas such as windbreaks, old fence lines, wet areas or areas near lime rock roads.
- Scrape away any surface residues.
- Sample to the correct depth (See *Figure 3*).
  - 2 inches for monitoring pH on no till cropland and pasture
  - 8 inches for fertility samples on cropland and pasture
  - 12 inches for PSNT

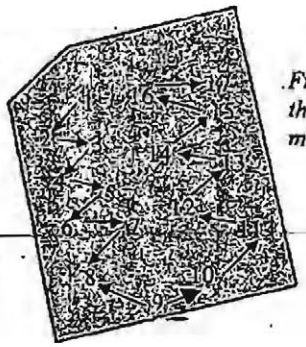

Figure 2: Sample from the entire area of the management unit.

3. **Mix the sample.** Thorough mixing is essential.
- Sieve the samples through the sieve into a receiving box. If the sample is hard or strongly aggregated, use a mallet to help break up soil aggregates.
- Transfer the soil to the ODJOB mixer. Roll the mixer at least 50 revolutions. Spread the sample out.
- Return the soil to the receiving box. Spread the sample out.

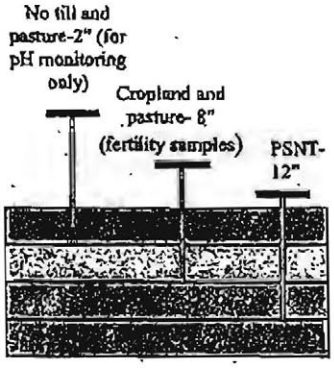

Figure 3: Sample to the correct depth.

Soil Sampling Procedures for Nutrient Management (continued)

- Take 5 scoops of soil from different parts of the sample to provide a total soil volume of approximately 1 pint.
- Place the soil into the sample bag.
- Take the soil back to the office.

4. **Drying the sample.**

- Spread the sample out in a warm place overnight to air dry it.
- DO NOT HEAT the soil.

5. **Label and place the soil into a soil bag.**

6. **Fill out the information sheet** as completely and accurately as possible.

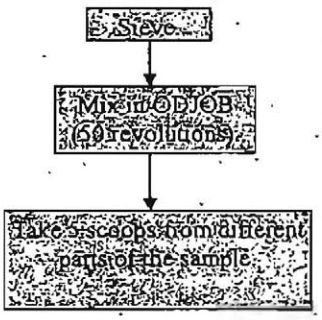

Figure 4: Thorough mixing is essential.

February 2006, Agricultural Nutrient Management Program

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- **Comparison of Soil Test Labs**

Comparison of Soil Test Labs
(Labs Participating in the 2000 Sample Exchange)
(2/28/08 update)

Lab	Cost	Analyses	Comments	Soil Submission Form on Website?	Ordering Supplies
A & L Eastern Agricultural Lab 7621 Whitepine Road Richmond, VA 23237 Ph: 804-743-9401 www.al-labs-eastern.com	**$7.60 (Mehlich-3)** without recs **$8.40 (Bray-Ammonium Acetate)** without recs	**Basic Mehlich Package (S1)** OM, P, K, Ca, Mg, Ca, pH, buffer pH, CEC, percent base saturation of cations **Basic (Bray-Ammonium Acetate) Package (SA1)** OM, P, K, Ca, Mg, Ca, pH, buffer pH, CEC, percent base saturation of cations	Several micronutrient combinations are also available. See Schedule of Fees.	Yes. Go to www.al-labs-eastern.com/agri Choose "Submittal Form" next to Soil Analysis.	Order form is on the website. www.al-labs-eastern.com/agri Choose "Download the Supply Order form."
Agri Analysis, Inc. 280 Newport Road PO Box 483 Leola, PA 17540 Ph: 717-656-9326 www.agrianalysis.com	**$6.50 commercial** **$8.25 private** **$8.75 commercial** **$10.00 private**	**SBA** pH, buffer pH, lime requirement, P_2O_5, K_2O, Ca, Mg, CEC **SBOM** SBA+OM Also have several analyte lists with trace elements (see website).	Lab has pick-up locations in Cecil County, Walkersville, and Keymar. <10 samples - $5.00; 10-20 samples - $0.50 each; >20 samples - $10.00 See website for routes. Reduced shipping rates are also available through DHL.	Yes. Go to www.agrianalysis.com Click on "Resources." Scroll down to the Soil Information heading and click on "Soil Request Form Page 1."	Call 717-656-9326 or send e-mail to info@agrianalysis.com for bags and info sheets.
Brookside Laboratories, Inc. 308 South Main Street New Knoxville, OH 45871 Ph: 419-753-2448 www.blinc.com	**Will be determined by a consultant**	**SOO1** pH, OM, Mehlich-3 P, Mn, Zn, B, Cu, Fe, Al, CEC, percent base saturation of cations, S, Bray II P	Brookside does not provide recs. Consultants develop the recs. Brookside prefers to receive samples from their consultants only.	Yes. www.blinc.com/worksheet_pdf/SoilWorksheet.pdf	Call 419-753-2448 to order soil bags.

NOTES:

- **ASSUME PAYMENT MUST BE INCLUDED WITH SAMPLES.**
- Organic matter (OM) is an important soil property to track but is not offered in some basic packages. Producers are advised to request OM even if they choose a lab that charges an additional fee for the information.
- Soil texture is not offered by most labs and is very expensive by those who do offer it. Obtain information from soil survey after determining the dominant mapping unit of a field.
- Sample depths should be 8 inches.
- There is no need to request recommendations from the soil test labs.
- Web pages are updated frequently and addresses for the soil information sheets may change. If this occurs, go to the lab's home page and follow the links to the soil information sheet.

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(301) 405-1319 • FAX (301) 314-7375

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MARYLAND COOPERATIVE EXTENSION

Comparison of Soil Test Labs
(Labs Participating in the 2000 Sample Exchange)
(2/28/08 update)

Lab	Cost	Analyses	Comments	Soil Submission Form on Website?	Ordering Supplies
Pennsylvania Agricultural Analytical Services Penn State University University Park, PA 16802 Ph: 814-863-0841 www.aasl.psu.edu	$9.00 $5.00	Standard Soil Test pH, Mehlich lime requirement, P, K, Ca, Mg, Zn, Cu, S OM	See website for more analyses.	Yes. Go to www.aasl.psu.edu/Submissionforms_all.html Click on the desired form.	Call 814-863-0841 to purchase kits.
Spectrum Analytic, Inc. PO Box 639 1087 Jamison Road NW Washington Court House, OH 43160 Ph: 800-321-1562 www.spectrumanalytic.com	$7.00 (dealer) $10.00 (grower) $10.00 (dealer) $13.00 (grower)	S1 pH, buffer pH, OM, P, K, Ca, Mg, CEC, percent base saturation of cations S2 Basic package plus any 3 of the following - B, Cu, Fe, Mn, S, Zn	Dealer price is available to MCE or other consultants. Soil info form would have to indicate "MCE" under "company," and the sample must be sent by the MCE office. Report comes back to MCE, not the grower. Checks from individual growers are OK.	Yes. Go to www.spectrumanalytic.com/services/forms/agsoil.pdf	Order form is on the website. www.spectrumanalytic.com/services/supplies
University of Delaware Soil Testing Program 152 Townsend Hall 531 S. College Avenue Newark, DE 19717-1303 Ph: 302-831-1392 http://ag.udel.edu/other_websites/DSTP/	$7.50	M3 Routine Analysis pH, buffer pH, OM, P, K, Ca, Mg, Mn, Zn, Cu, Fe, S, B, Al		Yes. Go to http://ag.udel.edu/other_websites/DSTP/forms/cominfo.pdf	Call 302-831-1392 or e-mail kgartley@Udel.edu Soil bags are purchased for $7.50, which includes the price of analysis.

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Comparison of Soil Test Labs
(Labs Participating in the 2000 Sample Exchange)
(2/28/08 update)

Lab	Cost	Analyses	Comments	Soil Submission Form on Website?	Ordering Supplies
Waters Agricultural Laboratories, Inc. PO Box 382 257 Newton Highway Camilla, GA 31730-0382 Ph: 229-336-7216 www.watersag.com	$6.50 $5.50 $10.00 $0.75 (If requested along with other soil tests.)	**Routine Test 1** pH, buffer pH, P, K, Ca, Mg, CEC, percent base saturation of cations plus any 2 of the following – Zn, Mn, Fe, Cu, B **Basic Test 2** pH, buffer pH, P, K, Ca, Mg, CEC, percent base saturation of cations **Basic Test 3** pH, buffer pH, P, K, Ca, Mg, CEC, percent base saturation of cations, Zn, Mn, Fe, Cu, B Other packages are available. Check web site. **OM**	Waters has UPS ARS labels available and will pay for shipping of cartons, which contain 25 or more samples of any kind – soil, manure, or plant tissue. Waters offers both Melich-1 and Melich-3 extraction methods. All Maryland samples should be analyzed using Melich-1. Confirm the extraction method in the upper left corner of the report. If Melich-3 was used, contact a regional specialist for the appropriate conversion.	Yes. Go to www.watersag.com Click on the "Soil Analysis" link (#1). Scroll down to the SUPPLIES section and click on the "Sample Submission Sheet."	Order form is on the web site. www.watersag.com Click on the "Sampling Supplies" link (#17). (UPS ARS labels can be ordered here.)

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Department of Natural Resource Sciences
and Landscape Architecture

Agricultural Nutrient Management Program

MANAGING OUTPUT FROM VARIOUS SOIL TEST LABORATORIES NOT INCLUDED IN 2000 SAMPLE EXCHANGE (12-05)

A & L (Memphis, Tennessee)

NUTRIENT	EXTRACT USED	EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED	UNITS	ACTION
	Mehlich-3	Mehlich-3	ppm P (default) lbs P/A (if requested)	**If results are expressed in ppm**, choose "Penn State, ppm" in *NuMan Pro* and enter the A&L (Tennessee) soil test values. **If results are expressed in lb/A** elemental P, K, Ca, and Mg, you must first pre-convert to oxide basis. Multiply – P by 2.3 K by 1.2 Ca by 1.4 Mg by 1.7 Choose "Penn State, lb/A" in *NuMan Pro* and enter the converted soil test values. **You must also enter soil texture for fields to generate recommendations.**
K, Ca, Mg	Mehlich-3	Mehlich-3	ppm K, Ca, Mg (default) lbs K, Ca, Mg/A (if requested)	

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AgriEnergy Resources

NUTRIENT	EXTRACT USED	EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED	UNITS	ACTION
P	Bray P1, Bray P2	Bray P1, Bray P2	lbs P/A	For P, use Soluble Tests (Bray 1, P-1) to convert to "A&L, VA, Bray" ppm. (Do **NOT** use Bray 2, P-2, reported as Exchangeable Extracts.) For K, Mg, and Ca, use Exchangeable Extracts (Ca-2, Mg-2, K-2) to convert to "A&L VA, Bray" ppm. (Do **NOT** use Soluble Tests for K, Ca and Mg.) Multiply the AgriEnergy Resources soil test results by 0.5 to convert them to ppm, and then choose "A&L, VA, Bray" in *NuMan Pro*, and enter the converted values. **You must also enter soil texture for fields to generate recommendations.**
K, Ca, Mg	1N NH_4OAC	1N NH_4OAC	lbs K, Ca, Mg/A	

CLC

NUTRIENT	EXTRACT USED	EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED	UNITS	ACTION
P	Bray P1	Bray P1	lbs P/A	Multiply the CLC soil test results by 0.5 to convert them to ppm, and then choose "A&L, VA, Bray" in *NuMan Pro*, and enter the converted values. **You must also enter soil texture for the fields to generate recommendations.**
K, Ca, Mg	1N NH_4OAC	1N NH_4OAC	lbs K, Ca, Mg/A	

Kinsey Ag Services (using Parry Agricultural Laboratory)

NUTRIENT	EXTRACT USED	EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED	UNITS	ACTION
P	Bray P2; Olsen (routine); Bray P1 by request only	Bray P1, Bray P2 or Olsen	lbs P_2O_5/A	**ONLY Bray P1 P results can be used!** Multiply the Kinsey soil test results for P by 0.22 and K, Ca, and Mg by 0.5 to convert them to ppm, and then choose "A&L, VA, Bray" in *NuMan Pro*, and enter the converted values. **You must also enter soil texture for the fields to generate recommendations.**
K, Ca, Mg	1N NH_4OAC	1N NH_4OAC	lbs K, Ca, Mg/A	

Agron Labs, LLC

NUTRIENT	EXTRACT USED	EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED	UNITS	ACTION
P	Mehlich-3	Mehlich-3	lbs P_2O_5/A	Choose "Brookside, lb/A" in *NuMan Pro*. Note: Use easily extractable P values. **You must also enter soil texture for fields to generate recommendations.**
K, Ca, Mg	Mehlich-3	Mehlich-3	lbs K, Ca, Mg/A	

Midwest Laboratories Inc.

NUTRIENT	EXTRACT USED	EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED	UNITS	ACTION
P	Bray P1	Bray P1	ppm P	Choose "A&L, VA, Bray" in *NuMan Pro* and enter the Midwest soil test values. **You must also enter soil texture for fields to generate recommendations.** Note: For P, enter P1 (weak Bray or available P) values into *NuMan Pro*, **NOT** P2 (strong Bray) or Bicarbonate P.
K, Ca, Mg	1N NH_4OAC	1N NH_4OAC	ppm K, Ca, Mg	

Skyview Laboratory Inc. (Samples analyzed after 1/1/03).[3]

NUTRIENT	EXTRACT USED	EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED	UNITS	ACTION
P	Mehlich-3	Mehlich-3	ppm P	Choose "Penn State, ppm" *in NuMan Pro* and enter the Skyview Lab soil test values. **You must also enter soil texture for fields to generate recommendations.**
K, Ca, Mg	Mehlich-3	Mehlich-3	ppm K, Ca, Mg	

[3] Soil test values from all samples received from a Maryland address will be reported in ppm. If you receive a soil test report with other units, contact your regional specialist for information on appropriate conversions.

Virginia Tech

NUTRIENT	EXTRACT USED	EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED	UNITS	ACTION
P	Mehlich-1	Mehlich-1	lbs P/A	Choose "Waters" in *NuMan Pro* and enter the Virginia Tech soil test values. **You must also enter soil texture for fields to generate recommendations.**
K, Ca, Mg	Mehlich-1	Mehlich-1	lbs K, Ca, Mg/A	

NUTRIENT	EXTRACT USED	EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED	UNITS	ACTION
P	Mehlich-1	Mehlich-1	lbs P/A	Convert from lbs/A of the elemental form to lbs/A of the oxide form as follows: Multiply lbs P/A x 2.3 Multiply lbs K/A x 1.2 Then consult Table 2 in SFM-3 to convert to index.
K, Ca, Mg	Mehlich-1	Mehlich-1	lbs K, Ca, Mg/A	Consult Table 2 in SFM-3 to convert Ca and Mg to index. Choose "U. of Maryland" in *NuMan Pro* and enter these converted values. **You must also enter soil texture for fields to generate recommendations.**

- **Equivalent Phosphorus Index Threshold Levels**

Equivalent Phosphorus Index Threshold Levels

University of Maryland, Mehlich 1, FIV	150
A & L Labs (Richmond)	
Bray P1 (weak Bray), P1 (ppm)	86
Mehlich 3 (ppm)	136
Agri Analysis, Mehlich 3, P_2O_5 (lb/A)	640
Brookside	
Mehlich 3 (easily extractable), P (ppm)	123
Mehlich 3 (easily extractable), P_2O_5 (lb/A)	565
Penn State	
Mehlich 3, P (ppm)	129
Mehlich 3, P_2O_5 (lb/A)	591
Spectrum Analytic	
Mehlich 3 expressed as Bray, P (lb/A)*	187
Mehlich 3, P (ppm)**	134
~~University of Delaware, Mehlich 3, P (index)~~	~~142~~
Waters, Mehlich 1, P (lb/A)	124

* mode of reporting until 7/1/05
** default mode of reporting effective July 1, 2005

(Printed by the Agricultural Nutrient Management Program. Updated 2/27/06; replaces previous versions; consistent with SFM-4 "Converting Among Soil Test Analyses Frequently Used in Maryland", revised May 2001)

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• Making Decisions for Nitrogen Fertilization of Corn Using the Pre-sidedress Soil Nitrate Test (PSNT)

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Information

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Soil Fertility Management

SFM-2
April 1996

MAKING DECISIONS FOR NITROGEN FERTILIZATION OF CORN USING THE PRE-SIDEDRESS SOIL NITRATE TEST (PSNT)

The pre-sidedress soil nitrate test (PSNT) has become a valuable and widely-used tool for optimizing the N fertilizer use efficiency for corn production in Maryland. The rationale for use of the PSNT has been presented in Maryland Cooperative Extension Service Fact Sheet 559, "Nitrogen Recommendations for Corn Using the Pre-sidedress Nitrate-Nitrogen Soil Test." The PSNT is based on a timely measurement of the recently mineralized soil nitrate in the top foot of soil just prior to the corn crop's period of rapid N uptake. The PSNT is most useful for soils with high N mineralization capacities.

As our understanding of soil nitrogen dynamics has advanced, and as we use the PSNT under many different field conditions, we are able to refine and update the use of this nutrient management tool. The data set used to develop these PSNT recommendations was derived from 58 site-years of field research conducted in 15 Maryland counties (7 Eastern Shore, 5, Central & Western Maryland, 3 Southern Maryland). The purpose of this publication is to revise the existing decision-making process when using the PSNT to determine optimum sidedress N application rate for corn.

What is the PSNT and when should I use it?

The PSNT should be used as a tool that is both complementary to and an integral part of a comprehensive nutrient management plan for N fertilization of corn. The flowchart on the following page outlines the logical decision making process for appropriate use of both the PSNT and the information generated from using this tool.

The PSNT is highly recommended on fields that have received manure, sewage sludge, or other organic residual products or have grown a forage legume (alfalfa or clover) or a legume cover crop. Use of the PSNT is appropriate if the manure or sludge was applied recently (this year) or if it has been several years since application. The PSNT is not recommended on fields where commercial fertilizer N is, and historically has been, the only source of N for corn production.

In order for the PSNT to be a reliable tool for determining corn sidedress N rate, the total fertilizer N application prior to sidedress must not be greater than 50 lb N/acre. This total maximum of 50 lb N/acre includes preplant broadcast and starter band applied N.

How do I take a PSNT sample?

The PSNT should be conducted when the corn measures 6 - 12 inches tall from the soil surface to the top of the leaf canopy. The PSNT soil sample should be collected from 0 - 12 inches and represent areas of the field that have similar soil properties and past managment histories. One composite PSNT sample should contain 30 to 40 soil cores. Soil nitrate nitrogen (NO_3-N) should be determined in strict accordance with the instructions provided with the particular test kit being used.

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How do I interpret the PSNT?

A critical level of soil NO_3-N measured by the PSNT has been established above which corn yield response to sidedress fertilizer N is not expected. If PSNT NO_3-N concentrations are greater than or equal to 21 parts per million (ppm or mg N/kg soil) do not apply sidedress N fertilizer. The PSNT critical level of 21 ppm NO_3-N is a revised value that is lower than the critical level previously used for the PSNT (which was 25 ppm). This revision is the result of continuing research and PSNT calibration in commercial corn fields. Future revisions will be made as dictated by new research results.

What if the PSNT is below 21 ppm?

If the PSNT NO_3-N concentrations are less than 21 ppm, refer to the existing nutrient management plan. If the measured PSNT NO_3-N concentrations are less than 21 ppm and the nutrient management plan recommends sidedress N fertilization, then apply the sidedress N rate recommended in the nutrient management plan.

What if the PSNT is below 21 ppm and the nutrient management plan does not recommend any sidedress N application?

First, review the nutrient management plan and determine if the data used, field history, available N supply and crop N requirement calculations are accurate and reliable. If the site specific data and field history information used for the original calculation of the nutrient management plan N recommendations are inaccurate, questionable, rough approximations, or guesses, recalculate the N fertilization recommendation using the most accurate available data, including conservative estimates for crop available N from organic sources. If the new, recalculated nutrient management plan recommends sidedress N application, apply the sidedress N rate recommended by the revised nutrient management plan.

What if the PSNT is below 21 ppm and I am confident that the nutrient management plan is reliable, but the plan still does not recommend any sidedress N application?

If PSNT NO_3-N concentrations are less than 21 ppm and, after critical review, the nutrient management plan is deemed accurate and reliable, and the nutrient management plan still does not recommend any sidedress N application, then the sidedress N fertilizer rate should be determined as follows:

1) If the nutrient management plan does not forecast a need for sidedress N fertilization, and PSNT NO_3-N concentrations are 15 - 21 ppm, apply 0 - 40 lb N/acre sidedress (Fig. 1).

2) If the nutrient management plan does not forecast a need for sidedress N fertilizer and PSNT NO_3-N concentrations are less than 15 ppm, there are two different sidedress N recommendations depending on whether or not an alfalfa crop preceeded the corn:

a) If the nutrient management plan does not predict a need for sidedress N fertilization, and PSNT NO_3-N concentrations are less than 15 ppm and alfalfa was growing on this soil within 6 months of the PSNT sample collection, then apply 0 - 40 lb N/acre sidedress (Fig. 1).

b) If the nutrient management plan does not predict a need for sidedress N fertilization, and PSNT NO_3-N concentrations are less than 15 ppm and alfalfa was not growing on this soil within 6 months of the PSNT sample collection, then apply 40 - 80 lb N/acre sidedress (Fig. 1).

How should I interpret the ranges in N recommendations given in Figure 1?

All sidedress N recommendations are given as ranges of application rates (e.g. 40 - 80 lb N/acre). Selection of a sidedress N rate in the lower or higher portion of the recommended range should be based on specific site characteristics. Site specific factors that would favor choosing a lower or higher sidedress N rate within a recommended range appear in Table 1, on the following page. These factors include soil physical characteristics, recent weather conditions, manure analysis and application practices, and farm management practices.

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Figure 1. Nitrogen fertilization of corn using the pre-sidedress soil nitrate test (PSNT).

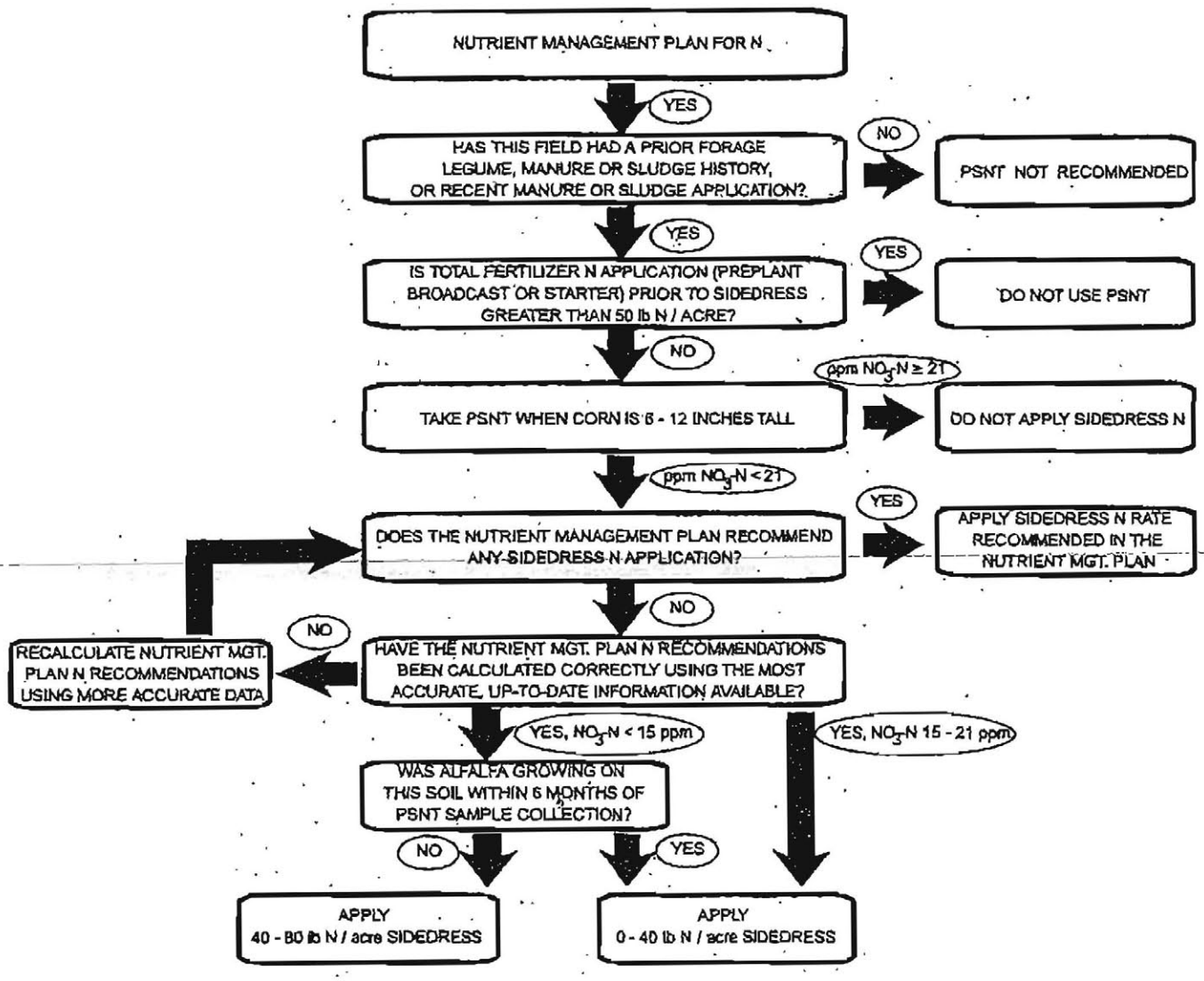
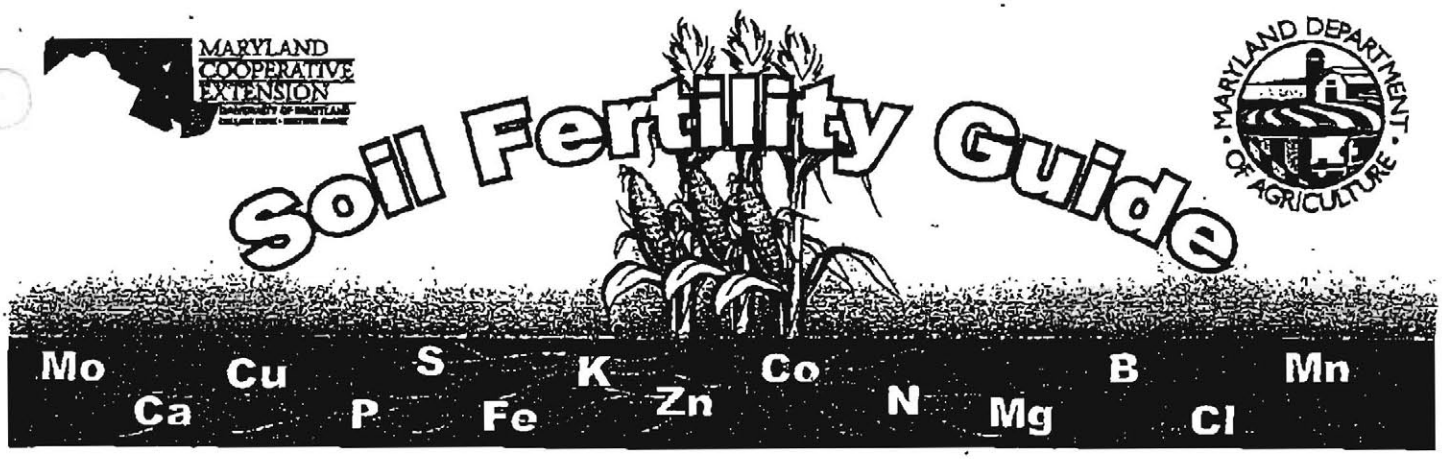


Table 1. Site specific factors that would favor choosing a higher or lower sidedress N rate within the recommended ranges based on the pre-sidedress soil nitrate test (PSNT).

Factors that would favor choosing a lower sidedress N rate within the recommended range	Factors that would favor choosing a higher sidedress N rate within the recommended range
Well drained soils	Poorly drained & excessively well drained soils
Silt loam & loam soils	Loamy sands, sands, & sandy loam soils
Manure applied 0 - 3 months before PSNT	Most recent manure application was more than 3 months before PSNT
Reliable, recent manure sampling & analysis	Uncertain, old (several years), questionable manure sampling & analysis
Manure spreader calibrated, uniform application	Manure spreader not calibrated, uneven application
Less than 4" of rain within the last 30 days	More than 4" of rain within the last 30 days
Alfalfa was the prior crop	The prior crop was not alfalfa
Legume winter cover crop was grown	Rye, small grain winter cover crop
Ammonium was not credited when calculating the manure application rate	Ammonium was credited when calculating manure application rate, but may have volatilized
The measured ppm NO_3-N was near the high cutoff value in one of the above ranges (i.e almost 15 ppm or almost 21 ppm)	The measured ppm NO_3-N was greater than, but near the lower cutoff value of 15 ppm
Soils with relatively low yield potentials	Soils with a relatively high yield potential

Plant Tissue Analysis



PLANT TISSUE ANALYSIS

Introduction

Plant tissue analysis is a laboratory determination of the total elemental content of plants or of certain plant parts. It is used for a variety of purposes including monitoring the nutrient status of crops and troubleshooting problem areas. It also serves as the basis for nutrient recommendations for perennial fruit crops.

Plant tissue analysis should not be confused with tissue testing. Tissue testing typically refers to a field test that involves taking sap samples from fresh plant tissue and analyzing the samples on site. Plant tissue analysis is performed on dried plant tissue that has been processed in a laboratory.

Interpreting Plant Tissue Analysis Information

When using plant tissue analysis information from a laboratory, you need to use interpretive guidance in order to determine the nutrient status categories. Plant and soil scientists have spent years performing experiments in order to develop this interpretive guidance for plant tissue analysis.

Figure 1 on page 2 is a graphical depiction of interpretive guidance for a generic crop. The nutrient concentration ranges (% or ppm) for each nutrient status category and the shape of the growth curve will change for each crop.

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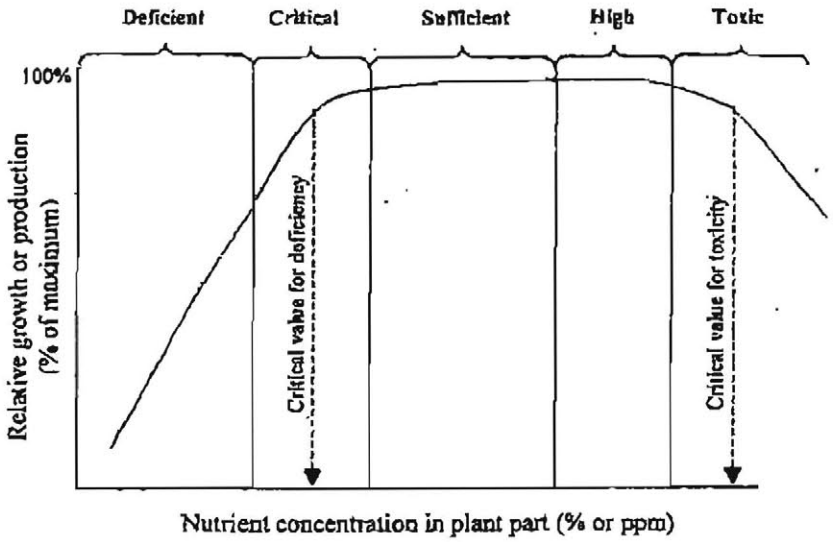

Figure 1. An illustration of the meaning of plant tissue analysis interpretive terminology (© Australasian Soil and Plant Analysis Council Inc. 1997; Modified from p. 78 in *Plant Analysis: An Interpretation Manual* (DJ Reuter et al.), with permission from CSIRO PUBLISHING, Melbourne Australia – http://www.publish.csiro.au/pid/437.htm)

Table 1 on page 3 gives a more detailed explanation of the nutrient status categories encountered when interpreting plant tissue nutrient concentration data for manganese (Mn) in corn. For corn, a plant tissue analysis showing a value of 16 for Mn would indicate that the nutrient status category is the critical range. Nutrients may need to be added to bring plant tissue levels into the sufficient range and improve crop yield. If nutrient applications to the current crop are not feasible they can be made before planting future crops.

Table 1. Nutrient status category terminology using corn as an example

Nutrient Status Category	Definition	Manganese (Mn) in corn# (ppm*)
deficient	• concentration of a nutrient associated with visible deficiency symptoms • deficiencies severely reduce growth and production	less than 15
critical value or range (marginal)	• concentration of a nutrient below which production is adversely affected • producers should strive to keep all nutrient levels above their critical value or critical range	16 – 19
sufficient range (adequate/normal/ optimal)	• concentration of a nutrient that is optimal for plant growth and production • if all nutrient concentrations for a crop are within each nutrient's sufficiency range, nutrient status should not be considered a limiting factor for crop production	20 – 150
high	• concentration of a nutrient that is greater than needed for optimal growth • in some crops, this level of nutrients may be associated with undesirable quality or vigor	151 – 200
toxic (excessive)	• concentration of a nutrient, greater than optimal, that is associated with reduced growth and production • this is usually observed only for minor nutrients	greater than 200

An example taken from *Plant Analysis: An Interpretation Manual*
* ppm = parts per million

Important Basics of Plant Tissue Analysis

RULE 1: The amount of a specific nutrient that is sufficient or adequate for plant growth varies from crop to crop.

Table 2 shows the sufficiency ranges in percentages (%) of dry weight for N, P, and K for five different crops.

Table 2. Sufficiency ranges of N, P, and K for five selected crops

Crop	N (%)*	P (%)*	K (%)*
corn	2.70 – 4.00	0.25 – 0.50	1.70 – 3.00
wheat	1.75 – 3.00	0.21 – 0.50	1.50 – 3.00
soybeans	4.00 – 5.50	0.26 – 0.50	1.70 – 2.50
cucumbers	4.50 – 6.00	0.34 – 0.75	3.90 – 5.00
tomatoes	4.50 – 6.00	0.25 – 0.75	2.90 – 5.00

* Information obtained from *Plant Nutrition Manual*

Caveat – If a producer is using plant tissue analysis as a monitoring tool, access to interpretive information for the specific crops being monitored (like those shown in Table 2) is essential.

RULE 2: The amount of a specific nutrient for a particular crop that is adequate for growth varies across the season. The concentration of many nutrients decreases as the crop matures.

As shown in Figure 2, the optimal concentration of nitrate in potato petioles decreases as the season progresses.

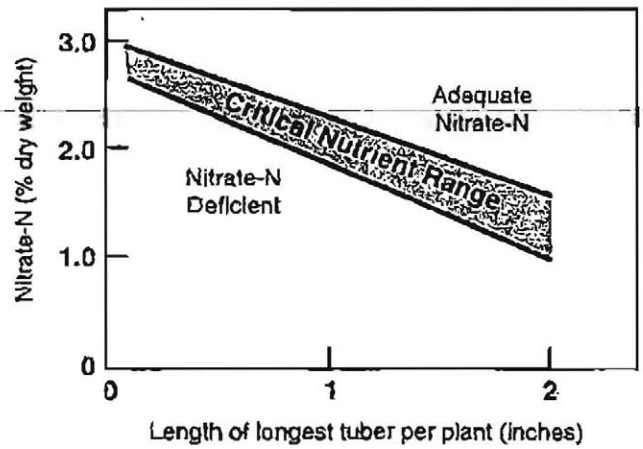

Figure 2. Nutrient status categories for nitrate-N in potato petioles over time (© 1990 From Journal of Plant Nutrition by Williams & Maier. Modified and used with permission by Taylor & Francis Group, LLC, http://www.taylorandfrancis.com)

Caveat – Collect plant tissue samples at the same growth stage that was used in the development of the interpretive guidance.

RULE 3: The amount of a specific nutrient that is adequate for plant growth may vary from one plant part to another plant part.

Table 3 shows five crops and the appropriate sampling time as well as the appropriate plant part to sample.

Table 3. Sampling time and plant part for five crops

Crop	Sampling Time	Plant Part
corn	initial silk	ear leaf
wheat	just prior to heading	top two leaves
soybeans	prior to pod set	most recent leaf
cucumbers	flower to small fruit set	fifth leaf from growing tip
tomatoes	mid-bloom	leaf adjacent to top flower cluster

Caveat – Collect plant tissue samples from the same plant part used in the development of the interpretive guidance.

Collecting Plant Tissue Samples

Just like in soil sampling, it is important to collect a representative plant tissue sample. This involves taking samples from many plants (25 – 50, depending upon size of plant part) throughout the entire area of interest. Two sampling patterns are shown in Figure 3.

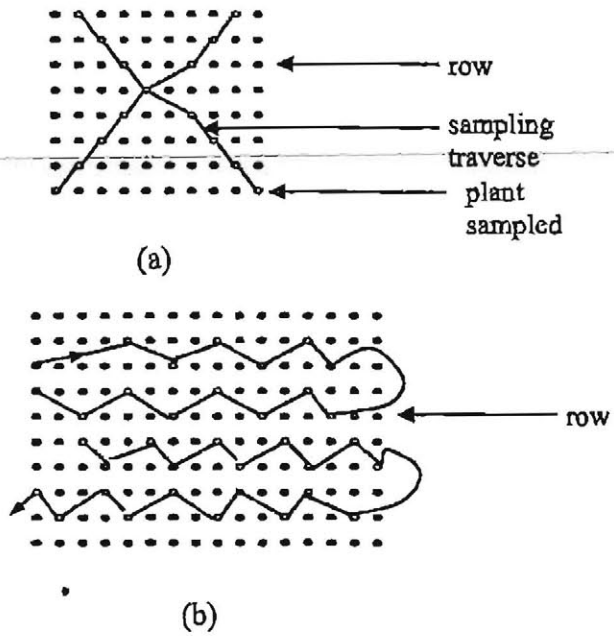

Figure 3. Sampling patterns for collecting representative samples
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Do not include diseased leaves in the sample unless your intent is to determine the nutrient status of the diseased tissue.

Many agricultural testing laboratories provide nutrient status information along with plant tissue nutrient analysis. If that is the case, contact your laboratory for any guidance they can provide on sampling time, plant part, and number of plants to sample.

Analyzing Plant Tissue for Nutrient Content

Plant tissue analysis is a laboratory procedure that involves certain steps (see Table 4).

Table 4. Laboratory procedures for analyzing plant tissue samples

Step	Action
1	Preliminary preparation • drying, grinding, and mixing plant tissue
2	Destruction of organic matrix • strong acids or very high temperatures are used during this step
3	Analysis of mineral residue for nutrient content • many different techniques can be used for this step

Plant tissue analysis is a more time-consuming process than soil testing, therefore leading to longer turn-around times for agricultural analytical laboratories. Plant tissue analysis is also more expensive than soil testing.

Using Plant Tissue Analysis in a Monitoring Program

For some producers, especially producers of high-value vegetable crops, plant tissue analysis is used as part of a monitoring program that also includes soil testing.

Plant tissue analysis can confirm the adequacy of all nutrients or identify an inadequacy of one or more nutrients.

Plant tissue samples should be collected from the correct plant part at the appropriate stage of development.

Using Plant Tissue Analysis as a Trouble-shooting Tool

Producers often face situations where the crop in one part of a field is doing poorly even though it has been managed the same way as the part of the field where the crop is growing well.

The first step in information gathering should be to collect soil samples from both areas (the healthy area and the problem area).

If the soil tests reveal a difference, address the fertility issues. If soil tests indicate similar results, analysis of plant tissue samples from both the healthy area and the problem area should be taken. They may indicate the nature of the problem, assuming the problem is nutritional.

Plant Tissue Analysis as a Basis of Nutrient Recommendations

Although soil tests are most commonly used as a basis of generating nutrient recommendations for row crops and hay and pasture, soil testing alone has not proven useful for perennial crops like tree fruits and small fruits. Perennial fruit crops have deep root systems, take up nutrients for a larger portion of the growing season, and have efficient mechanisms for recycling nutrients from season to season.

Fruit scientists have found that nutrient concentrations in plant tissue do a better job of indicating the nutrient status than soil tests alone. For these reasons, nutrient recommendations for mature (bearing) perennial fruit crops are based primarily on plant tissue nutrient concentrations and only secondarily rely on soil tests.

As with any crop, sampling the appropriate plant part at the appropriate time is critical for reliable, valid plant tissue analyses of perennial fruit tissue. Consult Table 5 on page 8 to determine the appropriate time to sample, number of samples, plant part to sample, and the sampling location on the plant for each fruit crop. Figure 4, also on page 8, has additional information on the proper sampling location for fruit trees. On fruit trees, the current year's growth extends from the last set of bud scale scars to the bud.

Table 5. Plant tissue sampling information for perennial fruit crops

Crop	Time to Sample	Number of Samples/Plant Part to Sample	Sampling Location on Plant
blueberries	1st week of harvest	40 leaves (detach petioles)	Current year's growth.
brambles	Aug 1st – Aug 20th	60 leaves (detach petioles)	Select the most recent fully expanded leaf blade of each primocane.
fruit trees	Jul 15th – Sept 1st	50 leaves and petioles	Select shoots at eye level from around the outside of the tree that make a vertical angle of 45-60 degrees to the ground. Remove 1 or 2 leaves from the mid-portion of the current year's growth. (See Figure 4.)
grapes	at full bloom	75 petioles	Remove the petiole across from the first blossom cluster, closest to the cordon or permanent cane.

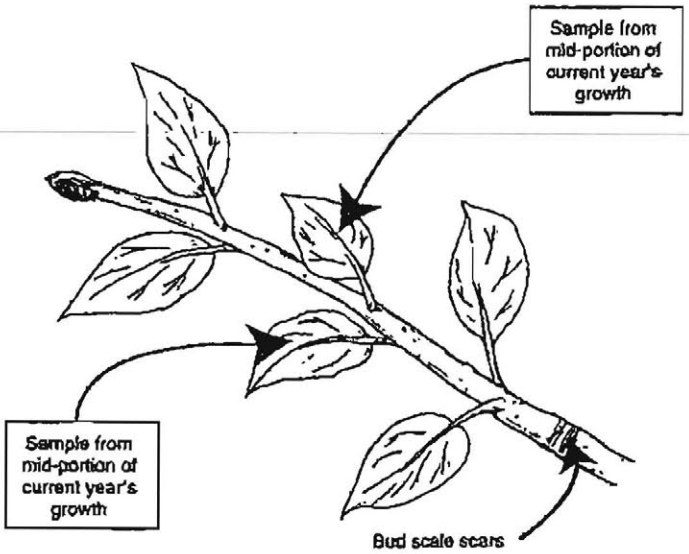

Figure 4. Proper sampling locations for fruit trees (Drawn by Pete Mazzocchi, Senior Graphic Designer, UMCP, College of AGNR)

In Maryland, there are four nutrient status categories for tree fruits and small fruits: deficient, low, normal, and high. Nutrient concentrations associated with each category vary from species to species. Furthermore, nutrient concentrations for nitrogen in apples actually vary among cultivars. (Apples are the only tree fruit crop in Maryland where nitrogen recommendations vary across cultivars.) Table 6 shows the variation for two groups of apples and three other fruit crops.

Table 6. Normal or adequate N, P, and K concentrations in plant tissue of four perennial fruit crops

Fruit Crop	N (%)*	P (%)*	K (%)*
apples			
soft	1.80 – 2.10	0.15 – 0.31	1.20 – 2.01
fresh market	2.20 – 2.25	0.15 – 0.31	1.20 – 2.01
peaches	2.50 – 3.41	0.15 – 0.31	2.10 – 3.01
brambles	2.00 – 3.00	0.25 – 0.40	1.50 – 2.50
blueberries	1.70 – 2.10	0.07 – 0.18	0.40 – 0.65

* Information obtained from *NM-5, Nutrient Management for Tree Fruits and Small Fruits*

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- **Comparison of Some Labs Testing Plant Tissue**

Comparison of Some Labs Testing Plant Tissue
(8-15-06 update)

Lab	Cost	Analyses	Comments	Sample Preparation	Tissue Submission Form on Website?
A & L Eastern Agricultural Lab 7621 Whitepine Road Richmond, VA 23237 Ph: 804-743-9401 www.al-labs-eastern.com	$22.20 w/o recommendations	PT2 N, P, K, Mg, Ca, Na, Fe, Al, Mg, B, Cu, Zn		Air dry if very wet and place in paper bag – no plastic.	Yes. Go to www.al-labs-eastern.com/agri Choose "Submittal Form" next to Plant Analysis.
Agri Analysis, Inc. 280 Newport Road PO Box 483 Leola, PA 17540 Ph: 717-656-9326 www.agrianalysis.com	$24.00 $28.00	PLT N, P, K, Ca, Mg, Cu, Fe, Mn, Zn, B, Al, Na, S PMO PLT plus Molybdenum		Do not dry samples. Place in paper bag.	Yes. Go to www.agrianalysis.com Click on "Resources." Scroll down to the Plant Tissue heading and click on "Plant Tissue Request Form 1."
Brookside Laboratories, Inc. 308 South Main Street New Knoxville, OH 45871 Ph: 419-753-2448 www.blinc.com	N/A	N/A	Brookside prefers to receive samples from their consultants only.	Samples should be taken by a Brookside consultant.	N/A
Pennsylvania Agricultural Analytical Services Penn State University University Park, PA 16802 Ph: 814-863-0841 www.aasl.psu.edu	$24.00	Standard N, P, K, Ca, Mg, Mn, Fe, Cu, B, Zn	Sulfur is not included as part of the standard analysis. $15.00 – sulfur testing	Air dry samples and place in paper bag – no plastic.	Yes. Go to www.aasl.psu.edu/Submissionforms_all.html Click on the desired form.

NOTES:

- ASSUME PAYMENT MUST BE INCLUDED WITH SAMPLES.
- Follow University of Maryland recommendations for sampling protocol. See NM-5 "Nutrient Management for Tree Fruits and Small Fruits" at www.agnr.umd.edu/users/agron/nutrient.
- Web pages are updated frequently and addresses for the plant tissue information sheets may change. If this occurs, go to the lab's home page and follow the links to the plant tissue information sheet.

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Comparison of Some Labs Testing Plant Tissue
(8-15-06 update)

Lab	Cost	Analyses	Comments	Sample Preparation	Tissue Submission Form on Website?
Spectrum Analytic, Inc. PO Box 639 1087 Jamison Road NW Washington Court House, OH 43160 Ph: 800-321-1562 www.spectrumanalytic.com	$20.00 w/o recommendations	P2 N, P, K, Ca, Mg, S, B, Cu, Fe, Mn, Na, Zn		Air dry samples and place in a paper bag – no plastic.	Yes. Go to www.spectrumanalytic.com/services/forms/plant.pdf
University of Delaware Soil Testing Program 152 Townsend Hall 531 S. College Avenue Newark, DE 19717-1303 Ph: 302-831-1392 http://ag.udel.edu/other_websites/DSTP/	N/A	N/A		N/A	N/A
Waters Agricultural Laboratories, Inc. PO Box 382 257 Newton Highway Camilla, GA 31730-0382 Ph: 229-336-7216 www.watersag.com	$14.00	Basic Test N, P, K, Mg, Ca, S, B, Zn, Mn, Fe, Cu Individual analysis available. See price list.		Air dry and place in a paper bag.	Yes. Go to www.watersag.com Click on the "Plant Analysis" link (#2). Scroll down to "How to Take a Plant Sample" and choose the "Information Sheet" link.

NOTES:

- ASSUME PAYMENT MUST BE INCLUDED WITH SAMPLES.
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- **Sampling Manure for Nutrient Content**

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Nutrient Management

NM-6
Revised February 2006

SAMPLING MANURE FOR NUTRIENT CONTENT

Introduction

For manure to be utilized in an economically and environmentally sound manner in crop production, its nutrient content must be known. Collecting a valid, representative sample of the manure is the key to having a meaningful nutrient analysis.

Information on the average nutrient content of manures is available from many sources. However, manures vary in nutrient content from farm to farm depending upon time of year, storage, type and age of livestock, feed management, amount and type of bedding, and manure management practices. Considerable variability can be encountered within a manure pile or liquid storage system. Some liquid storage systems have agitation capability and can be mixed before sampling thus aiding in the collection of a representative sample. Others have no agitation capability. Liquid manure in a non-agitated liquid storage system will be stratified with a watery, low-nutrient material on top, a material of intermediate solids and nutrient content in the middle, and a nutrient-rich sludge material on the bottom.

The current policy of the Maryland Department of Agriculture's Nutrient Management Program allows the use of a published "typical" manure analysis ("book value") for the development of a producer's first nutrient management plan and requires actual manure analysis for updated plans.

Because the nutrient composition of manure varies from operation to operation, the use of book values is not a recommended practice.

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General Principles of Sampling

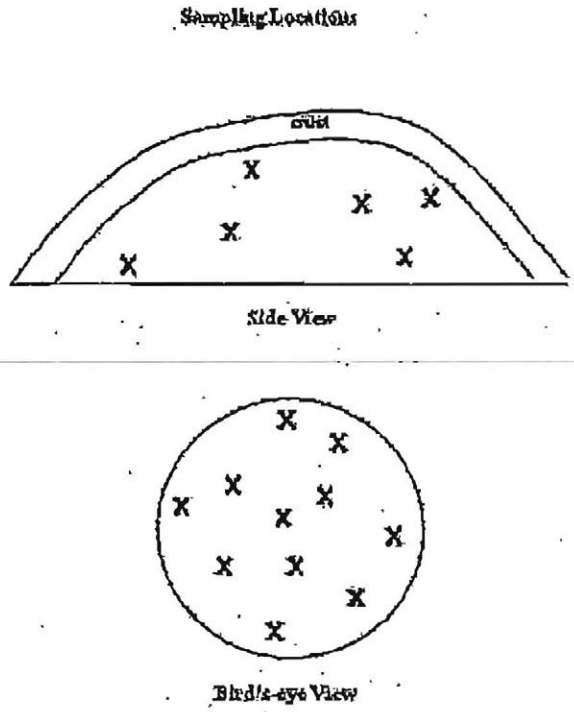
Goal

- COLLECT A REPRESENTATIVE SAMPLE, i.e., a sample whose nutrient analysis represents the nutrient content of the manure being utilized.

Accomplishing the Goal

1. Many individual samples (10 – 15) must be collected to form a composite sample. See Figure 1.
2. Be sure to include any bedding in the sample to the same extent that it exists in the animal waste material being characterized.
3. Mix the composite sample thoroughly in a plastic container. **The composite sample must be mixed well.**
4. Take a small sample (laboratory sample) from the well-mixed composite sample and prepare the laboratory sample for shipment to the lab.

Figure 1. How to collect a sample of solid manure



Avoid the outer crust. Using a long, narrow shovel, collect 10 – 15 samples from various locations and depths around the pile and place the composite sample in a clean, plastic container.

Sampling Options

SAMPLING BEFORE APPLICATION

- For those situations where a representative sample of manure can be collected, sampling before application allows the manure analysis to be used for the calculation of the appropriate rate of manure application.
- Sampling before application is practical for many solid manures.
- The nutrient content of manure can change during storage. Sample as close to application time as is practical, allowing time for both analysis and plan development. Four (4) to 6 weeks is advisable.

SAMPLING DURING LOADING

Sampling during loading is a quick and easy way to collect a representative sample.

Solid or Semi-solid

- Sampling solid and semi-solid manure during loading of the manure spreader is advantageous because the manure has already undergone some mixing.
- It is the most practical time to collect a representative sample in a daily haul operation.
- Collect one or more grab samples from 10 – 15 loads to make the composite sample.
- For daily haul operations, collect a total of 10 – 15 samples, collecting some samples from each load if more than one load is being applied.

Liquid

A good time to collect a liquid sample from an agitated pit is immediately after filling the spreader tank. One or more samples can be collected from each load (tank) at the unloading or outlet port.

SAMPLING DURING SPREADING

Sampling during spreading is a good option for many situations.

Solid or Semi-solid

- For solid manures with lots of bedding, sampling during spreading may be the best method of collecting a representative sample.
- Spread a total of 10 – 15 plastic sheets (3' x 3', for example) in the path of the manure spreader, collecting some samples from each load.
- Combine all samples to make a composite sample.

Liquid

- For non-agitated pits, sample collection during spreading is the only practical time to collect samples that represent the different layers of the pit. Separate samples should be collected from the upper, middle, and lower layers of the pit.
- Place collection containers (for example, aluminum baking pans) near the path of the manure spreader. Collect separate samples at the beginning, middle, and end of the pit emptying process so that samples represent the top, middle, and lower layers of the pit. Make a separate composite sample for each layer in the pit.

Mixing Composite Samples

The composite manure sample must be very well mixed before shipment to the laboratory for analysis.

- For easily mixed materials like poultry litter, mix well using a baffled tumbler or the sheet method (see page 5).
- Moist manures can be mixed using the sheet method (see page 5).
- Liquid samples should be swirled or mixed thoroughly.

How to Mix a Sample of Manure Using the Sheet Method

1. Pour composite sample onto a plastic sheet (6' x 6').
2. Break up any clumps of manure with a shovel or fork.
3. To obtain a good mix, gradually lift one corner of the plastic sheet, rolling the litter over itself towards the middle of the sheet. Do the same from the diagonally opposite corner. See Figure 2.
4. Roll the manure into a pile using the other two corners. See Figure 3.
5. Once the manure is piled in the center of the sheet, spread it out again and repeat steps 3 and 4 at least 10 more times.

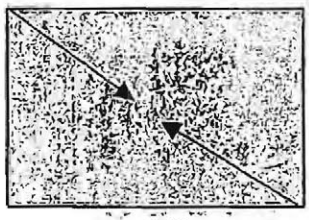


Figure 2

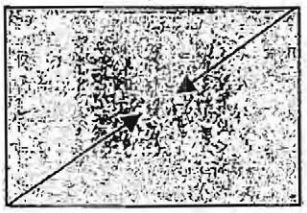


Figure 3

Selecting a Laboratory Sample for Shipment

The composite sample is too large to send to the laboratory for analysis. Consult Table 1 on page 6 to determine the sample size required by the analytical lab you choose. Additional information is available at the University of Maryland Agricultural Nutrient Management Program's website (www.agnr.umd.edu/users/agron/nutrient).

Solid and Semi-solid Manures

1. Take several grab samples from the well-mixed composite manure sample and place in a resealable plastic bag, filling the bag about half full.
2. Squeeze out excess air before sealing.
3. Double bagging is preferable both for containing the sample and for odor control during shipment.

Liquid Manures

1. While swirling the composite sample, pour the laboratory sample into a clean, plastic bottle. **Never use a glass jar!**
2. Rinse outside of the bottle with clean water before packing.

Table 1. Comparison of some labs testing manure

Lab Information	Minimum Package to Request	Sample Size Solid/Liquid
A & L Eastern Agricultural Laboratories, Inc. 7621 Whitepine Road Richmond, VA 23237 Ph: 804-743-9401 www.al-labs-eastern.com	M1 package N (total), NH_4-N, P_2O_5, K_2O, % moisture, and density (lbs/100 gallons)	2 cups/2 cups
Agri Analysis, Inc. 280 Newport Road P.O. Box 483 Leola, PA 17540 Ph: 717-656-9326 www.agrianalysis.com	MDMP4 package N (total), NH_4-N, P_2O_5, K_2O, % moisture, density (lbs/100 gallons), and % dry matter	4 cups/2 cups
Agricultural Analytical Services Laboratory Penn State University University Park, PA 16802 Ph: 814-863-0841 www.aasl.psu.edu	Standard Manure Test 1 N (total), NH_4-N, P_2O_5, K_2O, and % solids	2 cups/2 cups
Spectrum Analytic, Inc. P.O. Box 639 1087 Jamison Road NW Washington Court House, OH 43160 Ph: 800-321-1562 www.spectrumanalytic.com	M3 package N (total), NH_4-N, P_2O_5, K_2O, % moisture, and % solids	1 cup/2 cups
Waters Agricultural Laboratories, Inc. P.O. Box 382 257 Newton Highway Camilla, GA 31730-0382 Ph: 229-336-7216 www.watersag.com	#1 Maryland package N (total), NH_4-N, P_2O_5, K_2O, and % moisture	4 cups/2 cups

General Principles of Packaging and Shipping

- Label bag or bottle with your name, address, and a manure identification.
- Keep sample cool (preferably refrigerated) until shipment.
- Ship early in the week so the sample does not sit in a mail handling facility over the weekend.
- Ship as soon as possible to minimize sample degradation.

Nutrient Analysis

Minimum analyses required

Be sure the laboratory you choose tests for the following:

- total nitrogen
- ammonium nitrogen
- total phosphorus
- total potassium
- moisture (or dry matter)

Optional analyses

Most laboratories offer a selection of secondary and micronutrient analyses for an additional charge.

Prepared By

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Agricultural Nutrient Management Program Coordinator

Jennifer Salak
Agricultural Nutrient Management Program Communications Coordinator

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1st printing: March 2005

- **Comparison of Some Labs Testing Manure**

Comparison of S[illegible] Labs Testing Manure
(2/28/08 update)

Lab	Cost[1]	Analyses	C Reporting Available?	Comments	Manure Submission Form on Website?[2]	Ordering Supplies
Pennsylvania Agricultural Analytical Services Penn State University University Park, PA 16802 Ph: 814-863-0841 www.aasl.psu.edu	$32.00	**Standard Manure Test 1** N (total), ammonium N, P_2O_5, K_2O, % solids A more extensive analyte list is available for an additional charge.	Order C:N ratio - $15.00	% moisture = 100 - % solids If using manure information form from the website, Maryland clients fill out Page 1 only.	Yes. Go to www.aasl.psu.edu/Submissionforms_all.html Click on the desired form.	
Spectrum Analytic Inc. PO Box 639 1087 Jamison Road NW Washington Court House, OH 43160 Ph: 800-321-1562 www.spectrumanalytic.com	$37.00	**M3 Package** N (total), ammonium N, P_2O_5, K_2O, % moisture, % solids A more extensive analyte list is also available for an additional charge.	C:N ratio - $8.00 when ordered with the basic test.	Does not provide density (lbs/100 gallons); planner must use average value for liquids.	Yes. Go to www.spectrumanalytic.com/services/forms/manure.pdf	Order form is on the web site. www.spectrumanalytic.com/services/supplies
University of Delaware Soil Testing Program 152 Townsend Hall 531 S. College Avenue Newark, DE 19717-1303 Ph: 302-831-1392 http://ag.udel.edu/other_websites/DSTP/	N/A	University of Delaware Soils Lab does not do manure analyses. Delaware Department of Agriculture has a manure test lab, but they will only accept Delaware samples.	N/A		N/A	N/A
Waters Agricultural Laboratories, Inc. PO Box 382 257 Newton Highway Camilla, GA 31730-0382 Ph: 229-336-7216 www.watersag.com	$25.00	**#1 Maryland package** N (total), ammonium N, P_2O_5, K_2O, % moisture A more extensive analyte list is also available for an additional charge.	No	Does not provide density (lbs/100 gallons); planner must use average value for liquids. Manure is reported as ppm. ppm x .0001 = %	Yes. Go to www.watersag.com Click on the "Manure/Sludge Analysis" link (#10). Download "Sample Information Sheet."	Order form is on the web site. www.watersag.com Click on the "Sampling Supplies" link (#17). (UPS ARS labels can be ordered here.)

ASSUME PAYMENT MUST BE INCLUDED WITH SAMPLES. Prices may change without notice. Check with lab for current price.
Web pages are updated frequently and addresses for the manure information sheets may change. If this occurs, go to the lab's home page and follow the links to the manure information sheet.

AGRICULTURAL NUTRIENT MANAGEMENT PROGRAM
(301) 405-1319 ▪ FAX (301) 314-7375
1145 COLE STUDENT ACTIVITIES BUILDING ▪ ENVIRONMENTAL SCIENCE AND TECHNOLOGY ▪ COLLEGE PARK, MARYLAND 20742-1038
LOCAL GOVERNMENTS ▪ U.S. DEPARTMENT OF AGRICULTURE COOPERATING EQUAL OPPORTUNITY PROGRAMS
WWW.ANMP.UMD.EDU

Comparison of Some Labs Testing Manure
(2/28/08 update)

Lab	Cost[1]	Analyses	C Reporting Available?	Comments	Manure Submission Form on Website?[2]	Ordering Supplies
A & L Eastern Agricultural Lab 7621 Whitepine Road Richmond, VA 23237 Ph: 804-743-9401 www.al-labs-eastern.com	$40.00	**M1 package** N (total), ammonium N, P_2O_5, K_2O, % moisture, density (lbs/100 gallons) A more extensive analyte list is also available for an additional charge.	No		Yes. Go to www.al-labs-eastern.com/agri Choose "Submittal Form" next to Manure Analysis.	Order form is on the web site. www.al-labs-eastern.com/agri Choose "Download the Supply Order form."
Agri Analysis, Inc. 280 Newport Road PO Box 483 Leola, PA 17540 Ph: 717-656-9326 www.agrianalysis.com	$47.00	**MDMP4 package** N (total), ammonium N, P_2O_5, K_2O, % moisture, density (lbs/100 gallons), % dry matter A more extensive analyte list is also available for an additional charge.	Order the Ash test and write on the request form "Include C:N ratio." Ash test - $10.00		Yes. Go to www.agrianalysis.com Click on "Resources." Scroll down to the Manure & Compost Information heading and click on "Manure Request Form."	Call 717-656-9326 or send an e-mail to info@agrianalysis.com for bags and info sheets.
Brookside Laboratories, Inc. 308 South Main Street New Knoxville, OH 45871 Ph: 419-753-2448 www.blinc.com	Will be determined by a consultant	**Standard Manure Analysis** N (total), ammonium N, nitrate N, P_2O_5, K_2O, % moisture, organic matter A more extensive analyte list is also available for an additional charge.	$6.90	Expresses results for P and K on both oxide and elemental basis. Be sure to use oxide data in *NuMan Pro*.	No. Brookside prefers to receive samples from their consultants only.	

ASSUME PAYMENT MUST BE INCLUDED WITH SAMPLES. Prices may change without notice. Check with lab for current price.
Web pages are updated frequently and addresses for the manure information sheets may change. If this occurs, go to the lab's home page and follow the links to the manure information sheet.

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- **Sampling Litter for Nutrient Content in Poultry Houses**

SAMPLING LITTER FOR NUTRIENT CONTENT IN POULTRY HOUSES

1. MATERIALS

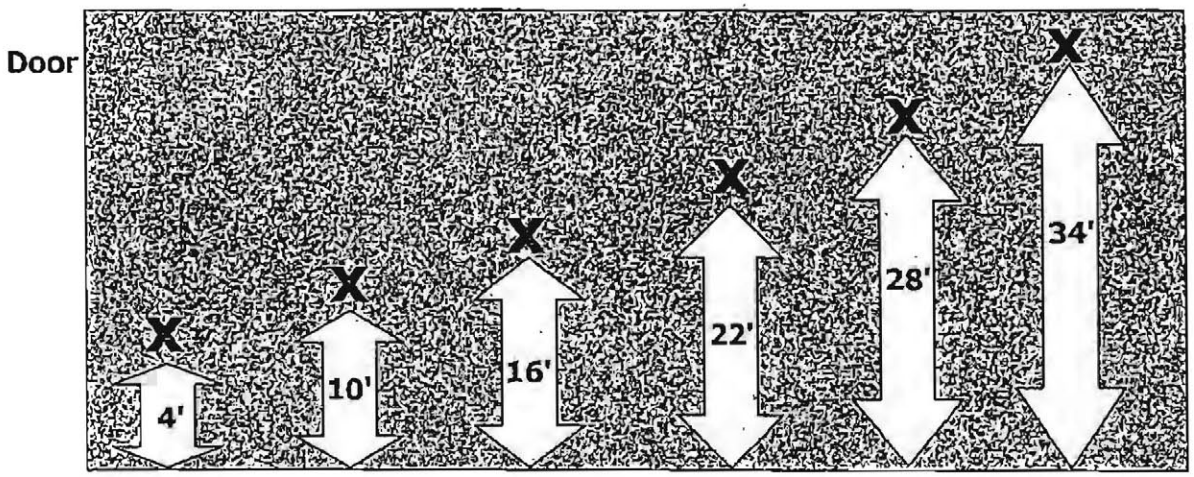
- A trowel or narrow-bladed tool such as a tiling spade or small post hole digger for sampling
- One or two clean plastic buckets for collecting samples
- A plastic sheet about 6′ X 6′ for mixing
- A plastic zip-lock bag about 8″ X 10″ for shipping the litter sample to the lab (bags of 4 mi thickness are preferred)

2. SAMPLING

SAMPLING PATTERN

1. Mentally divide the poultry house into 3 chambers of equal size. Within *each chamber* take 6 cores (see Figure 1). Take one core from within 1 foot of the feed line and one core from within 1 foot of the water line.
2. Repeat the sampling procedure in the remaining 2 chambers. Take a total of 18 cores for all 3 chambers.

Figure 1. An example of a poultry house. Each **X** represents the area to be sampled,



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SAMPLING PROCEDURE

1. Using the sampling tool, take a representative cross section of litter from the litter surface down to where it contacts the soil.
2. Empty the sample into the bucket. If the bucket(s) becomes full before all 18 samples are taken, pour the contents onto the plastic sheet and continue sampling.

MIXING THE SAMPLE

1. After you take 18 samples, 6 from each chamber, pour the litter from all 3 chambers onto the plastic sheet.
2. Thorough mixing is critical to ensure that the sample you send for analysis is representative of the entire house. Break up any clumps of litter. If clumps are sticky, you may need to break them up by grating them against a coarse screen.
3. To obtain a good mix, gradually lift one corner of the plastic sheet, rolling the litter over itself toward the middle of the sheet. Do the same from the diagonally opposite corner. See Figure 2.
4. Once the litter is piled in the center of the sheet, spread it out again and roll it into a pile using the other 2 corners. See Figure 3.
5. Repeat steps 3 and 4 at least 5 more times.
6. After the litter is well mixed, spread the litter over the entire sheet again and take at least 9 small sub-samples (about 1 quart total for all 9 sub-samples in a grid pattern). Sample all the way to the plastic in case finer material has settled out during mixing. See Figure 4.

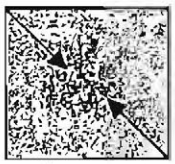

Figure 2

Figure 3

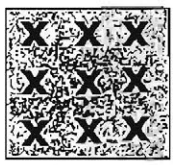

Figure 4

3. PACKAGING THE SAMPLE FOR SHIPMENT

1. Fill the plastic bag about 2/3 full with the sample and squeeze the air out before sealing.
2. Keep the sample cool until it is shipped to an analytical laboratory for analysis.

February 2006, Agricultural Nutrient Management Program
University of Maryland Cooperative Extension would like to acknowledge Bud Malone, Extension Poultry Specialist, University of Delaware, Georgetown, DE, for his assistance in developing this procedure.