Lesson 1: Soil Tests

Grassland soils are important in meeting production goals on any given plot of land. To best manage the area, analyses to evaluate the fertility status of the soil must be performed. A soil test report, which provides information from such tests, is a valuable tool in grassland management.

The procedures used to collect a soil sample may influence the results of the test. A representative sample must be taken from within the grassland; for example, wet spots as well as dry spots should be represented. Ideally, about 15 to 20 subsamples should be taken to a depth of 6 to 7 inches and then combined in a composite sample. Once the sample is taken, it may be analyzed by the University Extension service or private soil testing labs.

Soil Test Information

Soil test reports should include the following information (see Figure 1.1).

Field information (A) – This section contains information provided by the producer to identify the field and summarize previous management. This information includes, for example, the field name or number, field size, and previous crop.

Soil test information (B) – This section provides the results of the soil tests performed on the sample. The regular soil tests include the soil salt pH; available phosphorus, potassium, calcium, and magnesium; organic matter; neutralizable acidity; and cation exchange capacity. Tests for other nutrients can be obtained at additional charge. The basic set of tests provides the necessary data to develop nitrogen, phosphate, potash, and agricultural lime recommendations for the intended cropping plan.

Rating (C) – This section provides a rating for the salt pH and nutrients tested. The rating system helps interpret the soil test information in Section B.

Nutrient requirements (D) – This section contains three parts: cropping options, yield goal, and fertilizer recommendations.

Cropping options (E) – This section lists cropping plans or crops for which fertilizer recommendations were requested. Recommendations can be given for up to four different cropping scenarios. Additional scenarios can be done at the local University Extension center if plans change after the lab report comes back.

Yield goal (F) – The yield goal section shows the level of production selected for the crops listed in Section E, "Cropping Options." The yield goal chosen should be based on soil type, yield history, fertility level, presence of irrigation, and economic considerations.

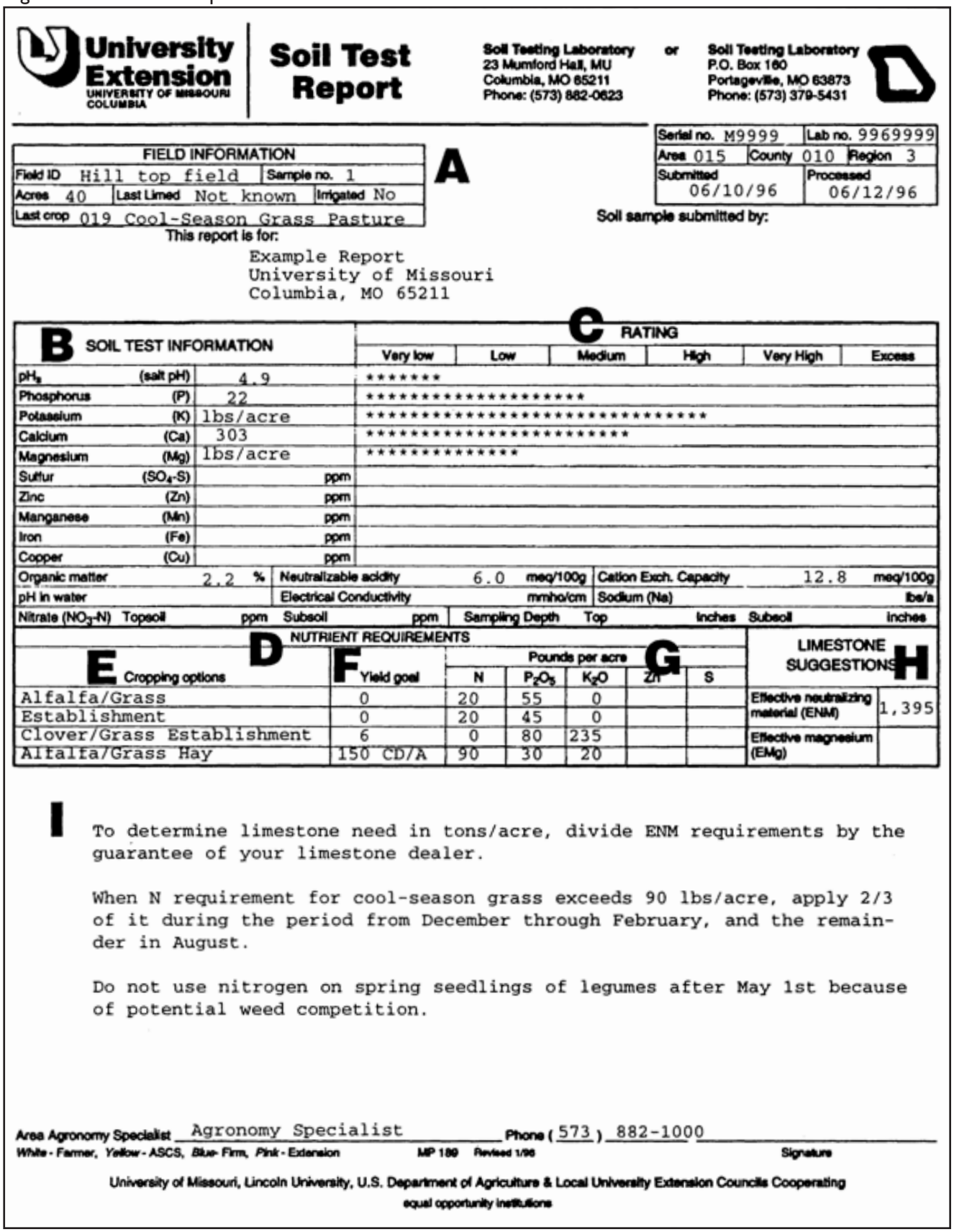
Pounds per acre (G) – This section lists the fertilizer recommendations for the crops and yield goals listed. The recommendations are reported as pounds of N (nitrogen), P_2O_5, (phosphate), and K_2O (potash) per acre. The fertilizer recommendation is designed to provide an agronomic recommendation of the nutrients needed to meet the yield goal in Section F and improve soil fertility over time. Following these soil test recommendations will increase or maintain the levels of phosphorus and potassium needed for the high rating category if the recommended fertilizer rate is applied annually for 8 years Micronutrient recommendations, such as zinc, should be applied once and the soil resampled in 3 to 5 years to determine the need for additional applications.

Limestone suggestions (H) – This section gives the suggested amount of limestone to raise soil salt pH to an optimal level for the cropping options listed. Desired soil salt pH ranges for Missouri crops are given in Figure 1.2.

The limestone recommendation is given for the cropping option requiring the highest salt pH range. For example, if a cool-season grass and alfalfa were both listed in Section E, the limestone recommendation would be for alfalfa since it requires a higher soil salt pH level. The recommendation is reported as pounds of effective neutralizing material (ENM) per acre.

Special Notes (I) – Many times notes appear at the bottom of the soil test report to help the producer interpret and use the results and recommendations.

Figure 1.1 – Soil Test Report



University Extension
UNIVERSITY OF MISSOURI COLUMBIA

Soil Test Report

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Columbia, MO 65211
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or

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Phone: (573) 379-5431

Serial no. M9999		Lab no. 9969999
Area 015	County 010	Region 3
Submitted 06/10/96		Processed 06/12/96

A

FIELD INFORMATION		
Field ID Hill top field	Sample no. 1	
Acres 40	Last Limed Not known	Irrigated No
Last crop 019 Cool-Season Grass Pasture		

Soil sample submitted by:

This report is for:
Example Report
University of Missouri
Columbia, MO 65211

B SOIL TEST INFORMATION — **C** RATING

			Very low	Low	Medium	High	Very High	Excess
pH$_s$	(salt pH)	4.9	*******					
Phosphorus	(P)	22			**********			
Potassium	(K)	lbs/acre				**********		
Calcium	(Ca)	303				**********		
Magnesium	(Mg)	lbs/acre			**********			
Sulfur	(SO_4-S)	ppm						
Zinc	(Zn)	ppm						
Manganese	(Mn)	ppm						
Iron	(Fe)	ppm						
Copper	(Cu)	ppm						

Organic matter	2.2 %	Neutralizable acidity	6.0 meq/100g	Cation Exch. Capacity	12.8 meq/100g
pH in water		Electrical Conductivity	mmho/cm	Sodium (Na)	lbs/a
Nitrate (NO_3-N) Topsoil	ppm	Subsoil ppm	Sampling Depth Top	inches Subsoil	inches

D NUTRIENT REQUIREMENTS

E Cropping options	**F** Yield goal	Pounds per acre **G** N	P_2O_5	K_2O	Zn	S
Alfalfa/Grass Establishment	0	20	55	0		
Clover/Grass Establishment	0	20	45	0		
Alfalfa/Grass Hay	6	0	80	235		
	150 CD/A	90	30	20		

H LIMESTONE SUGGESTIONS

Effective neutralizing material (ENM)	1,395
Effective magnesium (EMg)	

I

To determine limestone need in tons/acre, divide ENM requirements by the guarantee of your limestone dealer.

When N requirement for cool-season grass exceeds 90 lbs/acre, apply 2/3 of it during the period from December through February, and the remainder in August.

Do not use nitrogen on spring seedlings of legumes after May 1st because of potential weed competition.

Area Agronomy Specialist Agronomy Specialist Phone (573) 882-1000

White - Farmer, Yellow - ASCS, Blue- Firm, Pink - Extension MP 189 Revised 1/96 Signature

University of Missouri, Lincoln University, U.S. Department of Agriculture & Local University Extension Councils Cooperating
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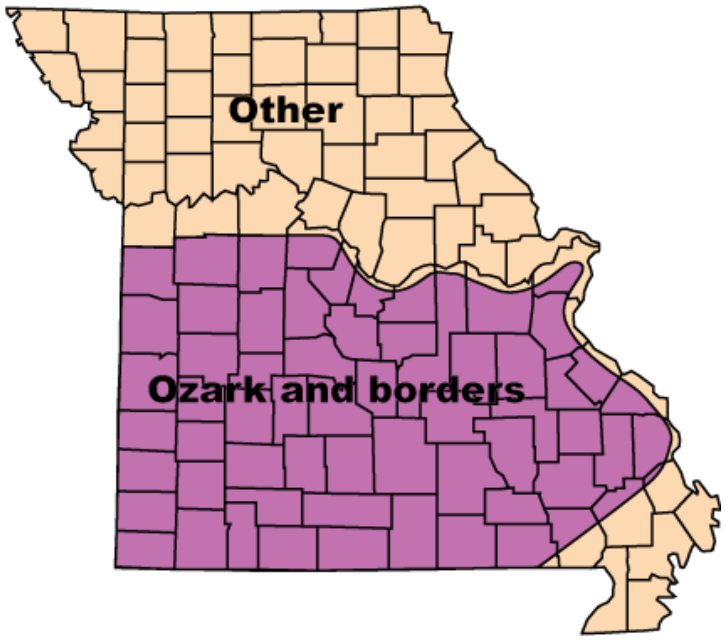
Figure 1.2 – Desired Soil Salt pH Ranges for Missouri Crops

Crop	Soil region: Ozark and border	Soil region: Other
Alfalfa and alfalfa-grass establishment	6.6-7.0	6.1-6.5
Birdsfoot trefoil and birdsfoot trefoil-grass establishment	6.1-6.5	5.6-6.0
Clover and clover-grass establishment	6.1-6.5	5.6-6.0
Cool-season grass establishment and production	5.6-6.0	5.6-6.0
Lespedeza and lesbedeza-grass establishment	6.1-6.5	5.6-6.0
Overseeding legumes	6.1-6.5	5.6-6.0
Warm-season grass establishment and production	5.6-6.0	5.6-6.0
Sudan grass and sudan/sorghum crosses	5.6-6.0	5.6-6.0
All row crops	6.1-6.5	6.1-6.5



Interpreting the Soil Analysis

The basic soil test in Missouri provides results for the salt pH, phosphorus, potassium, calcium, magnesium, organic matter, neutralizable acidity, and cation exchange capacity of the soil sample.

Salt pH (pHs) is a numerical measure of the relative level of soil acidity. Salt pH refers to the salt solution used in the laboratory to measure the pH of the soil sample. Some laboratories used water instead of a salt solution for pH measurements and these results are simply reported as pH. Crops require different pH levels for optimum growth and yield. Proper pH levels help to improve root development and provide a good environment for soil microorganisms. Soil pHs for some crops differs among regions of the state.

Phosphorus (P) is the second line of the table. The test for phosphorus measures the relative availability of phosphorus to the plant for growth, not the total amount in the soil. The ratings range from very low to very high.

Potassium (K) is measured by the amount available for plant growth (also referred to as exchangeable potassium) and not by total potassium in the soil. The cation exchange capacity (CEC) of the soil and the current level of exchangeable potassium are used to determine the need for additional potassium. Generally, as the CEC increases, so does the desired level of exchangeable potassium.

Calcium (Ca) is measured to help calculate the CEC of the soil. The rating for calcium levels is based on the soil pH. Soils with very low to low soil pH will rate medium for calcium, and soils with pH of medium to high will rank high for calcium. Missouri soils are rarely in need of calcium.

Magnesium (Mg) is only added when levels are very low to medium. For soils that are rated very low to low, crop yields will be improved with applications of magnesium. When lime and magnesium are both needed, dolomitic limestone may be applied because it contains calcium and magnesium.

Organic Matter (O.M.) is the decayed plant material, or humus, in the soil. The level of organic matter is used to determine the potential nitrogen available to a crop during the growing season.

Neutralizable acidity (N.A.) measures the exchangeable hydrogen. It is a measure of the reserve acidity in soil, or its ability to remain acid. Higher N.A. indicates more reserve acidity. This figure aids in the calculation of liming requirements for the soil.

Cation exchange capacity (CEC) measures the soil's ability to hold positively charged nutrients called cations—calcium, magnesium, potassium, and hydrogen.

Routine fertilizer recommendations are made for the major nutrients used by plants. Nitrogen, phosphorus, and potassium are the major nutrients applied in fertilizer for forage production. In some cases, sulfur or micronutrients like zinc (Zn), manganese (Mn), iron (Fe), and copper (Cu) may be added when they become deficient in the soil.

The amount of nitrogen (N) that needs to be added to the soil is determined by the cropping option, soil texture, and organic matter. The figure is expressed in pounds of nitrogen needed per acre.

Phosphorus and potassium are added in the fertilizer mix based upon the soil test and the desired yield of a particular crop. Phosphorus is added in fertilizer to build up or maintain the current level of phosphorus in the soil. Potassium levels needed for alfalfa hay, row crops, and small grains are calculated by the following formula:
220 + 5(CEC) = lbs. K/acre.

Fertilizer Application and Yield Response

The soil test rating in Section C indicates the relative level of each nutrient tested and provides information on the probability that the application of a particular fertilizer will increase crop yield. Table 1.1. can be used to determine the probability of a yield increase from fertilizer applications for each soil test rating. The probability of an increase in yields from fertilizer drops as the soil test rating rises. For example, soil with a rating of very low for a particular nutrient is much more likely to respond to fertilizer than soil with a rating of medium for that nutrient.

Liming to Increase pH

Agricultural limestone is tested based on purity and fineness of grind. These results determine the limestone's effective neutralizing material, or ability to reduce soil acidity. A producer can call an agricultural lime dealer at a quarry to find out the local ENM. This figure and the ENM required by the soil (provided on the soil test report) are all that is necessary to calculate the tons of limestone needed per acre, as shown in the formula below.

$$\frac{\text{ENM required by the soil test}}{\text{ENM of agricultural limestone}} = \text{tons of limestone/acre}$$

To determine the amount of lime needed in tons per acre, divide the ENM value from the soil test by the ENM of the limestone. For example, if the soil test ENM requirement is 1,395 pounds per acre and the quarry guarantees 400 pounds of ENM per ton of limestone, then 3.48 tons of limestone per acre (1,395 ÷ 400 = 3.48) are needed.

Limestone is applied to neutralize soil acidity and increase salt pH. It does contain calcium, but its main use is to neutralize acidity. Dolomitic limestone contains appreciable amounts of magnesium and is often used on magnesium-deficient soils. Some liming materials have a higher ENM rating than calcitric limestone.

Table 1.1 – Probability of Yield Increase from Fertilizer Application

RATING						Probability of response to fertilizer
Very low	**Low**	**Medium**	**High**	**Very High**	**Excess**	
* * * *						very high
* * * * * * * * * *						high
* * * * * * * * * * * * * * * *						medium
* *						low
* *						none

Summary

Soil tests provide important information that can affect a grassland's production. To use the data correctly, an understanding of the soil test results and the suggested treatments is required.

Credits

Dent, David, and Anthony Young. *Soil Survey and Land Evaluation.* London: Allen & Unwin, 1981.

Donahue, Roy L., Raymond W. Miller, and John C. Shickluna. *Soils: An introduction to Soils and Plant Growth.* 5th ed. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1983.

University Extension agricultural publications, University of Missouri-Columbia.

G9102: *Liming Missouri Soils*
G9111: *Using Your Soil Test Results*
G9112: *Interpreting Missouri Soil Test Reports*