

# Soil Sampling and Nutrient Management in Small Ruminant Pastures

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Pastures for sheep and goats are fertilized to ensure a reliable supply of energy, protein, and other nutrients for a long season of grazing. Management of plant nutrients maintains a balance of improved grasses and legumes and improves forage species' competitiveness with many pasture weeds.

The most important part of obtaining fertilizer recommendations is collecting a representative soil sample to send to the lab. Soil test results and fertilizer recommendations are based solely on 10 to 20 ounces of soil submitted to the lab for analysis, which are assumed to represent several million pounds of soil in the field. If this sample does not reflect actual soil chemical conditions, the results can be misleading and cause costly over- or under-fertilization.

## Timing

Soil samples can be collected throughout much of the year, although fall (September through December) or spring (February through April) are the best times. With fall sampling, lab results and nutrient recommendations may be returned more quickly because fewer samples are submitted to the lab at this time. Fall sampling will also allow you to apply fertilizer when prices are generally lower and soils are drier, making them less likely to be compacted by traffic. Some Kentucky soils contain clay minerals that cause differences between fall and spring soil test potassium (K) values. With the right seasonal weather, cool season grass pastures may continue to take up soil K well into December. In any case, a field should always be resampled at the same time of the year so you can make historical comparisons.

Fields should be sampled every two years. If you use manure as a fertilizer source, you should sample annually, be-

cause manures can rapidly raise soil phosphorus (P), potassium (K), and zinc (Zn) levels.

## Tools

A soil probe, auger, or spade is the tool needed to take individual cores that make up the composite sample. The spade sample should be trimmed with a knife (Figure 1). You will also need a clean, dry plastic bucket in which to collect and mix the sample cores. Be sure not to use galvanized or rubber buckets; they will contaminate the sample with Zn. Information forms and soil sample boxes/bags for submitting samples are available at all county Extension offices.

## Collecting Field Samples

An individual sample should represent no more than 20 acres unless your soils, past management, and cropping history are uniform. You can obtain the most representative sample from a large field by sampling smaller areas that vary by soil type, cropping history, topography, and/or erosion/past management practices (Figure 2). For example, manure may have been applied recently to one part of a field but not the other. Phosphorus and potassium levels likely will be higher in areas where you have applied manure. If you sample that field as one unit, the soil test will result in the unmanured part of the field being under-fertilized. Separate samples should be taken from areas that differ because their nutrient require-

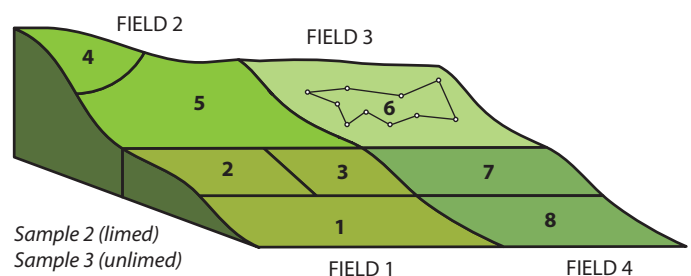


**Figure 1.** A soil probe, auger, or spade should be used in sampling soils. The spade sample (shown in the center of the picture) should be trimmed as shown with a knife.

ments are likely quite different. Grid soil sampling [sampling smaller defined areas (grid cells) within larger fields] and prescription fertilizer applications could result in more accurate recommendations and lead to greater fertilizer efficiency. However, such intensive sampling is costly, and to date Kentucky research has not shown an economic benefit. See University of Kentucky Cooperative Extension publication *Taking Soil Test Samples* (AGR-16), for specific details on recommended grid sampling methods.

You can also use soil sampling to troubleshoot areas of the field that are visually different or are consistently low yielding when compared to the rest of the

**Figure 2.** This figure shows how four fields might require the analysis of one to three composite samples for determining fertility needs. Each composite must contain 10 or more cores, as shown for sample 6 in field 3.



field. Take a sample from both the poor-growth area and adjacent good-growth areas. A handheld GPS unit may be useful in locating sampling sites. Keep good records of where each sample was taken.

Collect at least 10 soil cores for small areas (1-2 acres) and up to 30 cores for larger fields (up to 20 acres). Randomly take the soil cores throughout the sampling area and place them in the bucket.

Do not sample:

- Dung piles.
- Old fencerows or under trees.
- Areas used for manure or hay storage.
- Livestock feeding areas.
- Where lime was previously stockpiled.

## Depth

To obtain accurate results that are consistent from year to year, pasture samples should be taken to a depth of 4 inches, and no deeper. Previously applied broadcast fertilizer and surface decomposition of plant residue cause most plant nutrients to accumulate at the soil surface, so soil test values will usually decrease as the sample depth increases. Sampling depths greater than 4 inches can result in over-application of fertilizers and lime.

## Sample Preparation

After all cores for an individual sample are collected and placed in the bucket, crush the soil and mix the sample thoroughly (Figure 3). Allow wet samples to air-dry until merely moist in an open space free from contamination. Do not dry the sample in an oven or at an abnormally high temperature. When the sample is dry, follow directions when putting soil in the sample container.

Sampling and preparing the soil for submission is only half of the process. The other equally important part is filling out a sample information sheet so that the soil test lab can consider desired crop, tillage, and other information when making the fertilizer recommendation (Figure 4). The form contains all the additional information needed to provide accurate lime and fertilizer recommendations after the lab test results are known. Sample information sheets for the University of Kentucky soil testing laboratories can be found on the web at [www.rs.uky.edu](http://www.rs.uky.edu). Use the agricultural form when submitting samples from your pastures or hay fields.



**Figure 3.** Break up clods while the sample is moist, and spread the sample out to air-dry in a clean area.

When complete, take the form and the sample to your county extension office. Staff at your local county extension office can help you complete the form and will send it with the sample to the UK soil testing laboratory. Results and recommendations will be e-mailed to the county office, usually within one to two weeks, and returned to you.

## Nutrient and Fertilizer Management

Lime and fertilize pastures with P and K according to soil test recommendations so desired forages will grow vigorously and compete against undesirable weeds (Table 1). Maintain soil pH in pastures between 6.0 and 6.5 by applying agricultural limestone every four to five years according to test recommendations—typically 2 to 3 tons per acre every four to five years. Soil pH in this range ensures an optimum chemical environment for plant nutrient availability and pasture growth. Different P and K fertilizer materials vary little in solubility and plant nutrient release; choose the one with the least cost per unit nutrient (N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O) weight.

Remember that pasture fertilization cannot always alleviate small ruminant macronutrient and micronutrient deficiencies. These problems may be better addressed by feeding appropriate mineral supplements.



**Figure 4.** Complete a sample information sheet so the soil analyst can consider desired crop, tillage, and other information when making the fertilizer recommendation. The form contains all the information needed to provide accurate lime and fertilizer recommendations.

## Broadcasting Nitrogen on Cool-Season Grass Pastures

The need to topdress nitrogen (N) on pastures for small ruminants in Kentucky will depend on the percent clover in the stand and the stocking rate of the pasture. For grass-clover pastures, N fertilizer is not recommended if the sward contains more than 25% clover in the stand by weight. For best pasture yields the legume needs to be a high yielding type like ladino or red clover. Legumes do not supply N directly to companion grasses, but indirectly through the breakdown of manure and urine. Tables 2 and 3 give N fertilization guidelines for a cool-season grass pasture, based on small ruminant stocking rates.

Cool-season grasses, such as Kentucky bluegrass, orchardgrass, timothy, and tall fescue, grow most vigorously from early spring into early summer and then again in the fall into early winter. When soil moisture, pH (greater than 6.0), and soil test levels of P and K are adequate (P more than 30 lb/acre, K more than 200 lb/acre), fertilizer N will stimulate cool-season grass growth during these peak production periods. The use of N should depend on what is expected from the pasture. Nitrogen fertilization can help increase total production and protein content, extend spring grass growth into the early summer, and extend fall pasture production into early winter. However,



unless the increased pasture yield is used, the added N expense yields no return.

Nitrogen fertilization of small ruminant pastures may have disadvantages. Stimulating grass growth in the spring can be helpful in maintaining a high stocking rate, but frequent clipping will be required to maintain pasture quality in a lightly stocked pasture. Late spring N application may have the unintended result of promoting the growth of summer weeds, such as crabgrass, yellow foxtail, nimblewill, and common ragweed. In addition, you'll need to be aware that adding spring N to tall fescue has been known to increase levels of ergot alkaloids, leading to an increased likelihood of symptoms of fescue toxicity (heat stress and lower animal gains). Maintaining good clover stands, keeping pastures leafy, avoiding tall fescue during mid-summer and fescue replacement are all viable options for dealing with fields with large areas of tall fescue containing the toxic endophyte.

Excessive N applications may merely result in wasted forage. At low stocking rates (less than 500 lb of liveweight per acre) on soils with good productivity, N should be broadcast only in the fall (Table 2). Fall applications stimulate tillering of individual grass plants and produce a denser grass stand, which can suppress weed growth. Fall applications also lengthen the period of active photosynthesis, which promotes root growth and winter survival. If the primary goal is a denser grass stand, one late fall application, between late October and early November, is sufficient. If fall pasture growth is important, also apply N between mid-August and mid-September.

At higher stocking rates (more than 500 pounds of liveweight per acre) on soils with good productivity, fertilizer N may be broadcast on cool-season grasses throughout much of the growing season (Table 3). A late winter application will stimulate a growth flush in early spring. An N application in May will help extend the pasture into the early summer, and an application in August will stimulate cool-season pasture grass production in the fall and early winter. The major limitation to summer N fertilization is its stimulation of summer weed growth.

The stocking rates in Tables 2 and 3 are estimates for Kentucky soils of average productivity. Soils of highest productivity

**Table 1.** Phosphate and potash recommendations (lb/A) for cool-season grass small ruminant pastures when applying annual fertilizer applications.

Category	Test Result: P	P <sub>2</sub> O <sub>5</sub> Needed	Test Result: K	K <sub>2</sub> O Needed
Very high			>420	0
High	>60	0	321 - 420	0
			301 - 320	0
Medium	46 - 60	30	267 - 300	30
	41 - 45	40	240 - 266	30
	37 - 40	50	213 - 239	30
	33 - 36	60	187 - 212	40
	28 - 32	70		
Low	23 - 27	80	159 - 186	50
	19 - 22	90	132 - 158	60
	14 - 18	100	104 - 131	70
	9 - 13	110		
Very low	<9	120	<104	80

**Table 2.** Topdressing nitrogen (lb/A) on cool-season small ruminant pastures when maintained at low stocking rates (less than 3 or 4 mature does or ewes or 500 pounds of small ruminants grazing per acre).

Date	N per Application <sup>1</sup>
Aug. 15 – Sept. 15	30 - 40
Oct. 15 – Nov. 15	30 - 60

<sup>1</sup> Total amount of N to topdress depends on desired result. No N is recommended if clover makes up more than 25% of the pasture. If primary goal is increased tillering for a denser grass stand in winter, then one late fall application is sufficient. If fall pasture growth is important then also apply N in late August-early September. Suggested dates and rates for topdressing with N are shown above.

will support three or four 150 pound does or ewes on an acre or less, while those with the lowest productivity (often with significant slopes) will only support one or two per acre. It is important to determine the recommended stocking rate for your soil type. See your county extension agent for the average stocking rates for the soil types found in your area. Or consult University of Kentucky publication AGR-222: *Estimating Carrying Capacity of Cool-Season Pastures in Kentucky using Web*

**Table 3.** Topdressing nitrogen (lb/A) on cool-season small ruminant pastures when maintained at high stocking rates (more than 3 or 4 mature does or ewes or 500 pounds of small ruminants grazing per acre).

Date	N per Application <sup>1</sup>
Feb. 15 – Mar. 15	up to 40 - 80
May 1-15	up to 30 - 40
Aug. 15-30	up to 40 - 80

<sup>1</sup> Total amount of N to topdress should depend on how much additional production is needed. Late spring N applications may have the unintended effect of stimulating unwanted summer weeds. Little or no N is recommended if clover makes up more than 25% of the pasture. Suggested dates and rates for topdressing with N are shown above.

*Soil Survey* (<http://www2.ca.uky.edu/agcomm/pubs/AGR/AGR222/AGR222.pdf>), which will provide step-by-step instructions for calculating stocking rates for your farms based on soil types. You can access the USDA's Web Soil Survey at <http://websoilsurvey.nrcs.usda.gov>.

Often, stocking rate information in soil surveys is given in animal unit months (AUM). To convert animal unit months to recommended acres per sheep or goat, use the following formula:

$$(12 \div \text{AUM}) \times (\text{weight of individual sheep or goat} \div 1000) = \text{acres required per animal}$$

For example, if the productivity of a given pasture is 9 AUM, and you are grazing 100 pound does or ewes, the calculated acres required per animal would be:  $(12/9) \times (100/1000)$  or 0.13 acres per animal. This calculation also works if you want to calculate the carrying capacity of cool-season pastureland for a group of animals. Simply use the total weight of the grazing group instead of the individual weight. For example, if we want to repeat the same calculation using a total grazing weight (sum of the weight of all animals in a grazing group), substitute the total weight for that of the individual. If we have a total grazing weight of 1000 pounds, then the calculation would be  $(12/9) \times (1000/1000)$  or 1.3 acres.



**Figure 5.** Excessive phosphorus in surface water bodies (ponds and streams) can cause eutrophication (algae-like blooms that may cause fish kills).

## Nitrogen Sources

Kentucky research has shown that in late fall, late winter, and early spring, little difference exists among the N sources commonly used for topdressing cool-season grasses. After May 1, risk increases that broadcast urea will not be as effective as other N sources. Average efficiency values for urea N applied after early May ranged from 51% to 78% of that observed for ammonium nitrate, depending largely on the length of time between urea application and the next rainfall. When a urease inhibitor is used along with urea, urea efficiency is comparable to that of ammonium nitrate. For urea without an inhibitor applied after early May to be an economical substitute for ammonium nitrate, the cost per pound of nitrogen would probably need to be 15% to 20% less than that of ammonium nitrate.

Research indicates that the efficiency of urea-ammonium nitrate (UAN) solution applied after early May is greater than

urea but less than ammonium nitrate. A urease inhibitor can also be used along with UAN. See University of Kentucky Cooperative Extension publication *Nitrogen Transformation Inhibitors and Controlled Release Urea* (AGR-185) for specific information on products designed to reduce N loss.

To avoid burning symptoms on forage leaves, apply any granular N source when the leaf surface is dry. Also, avoid leaving piles of granular N in the field, either from misapplication or improper equipment operation.

## Phosphorus Fertilization in Central Kentucky

Most soil in the Inner and Outer Bluegrass Region of Kentucky has been formed from limestone that is naturally high in P. Plant available P is high in these fields (soil test P often exceeds 200 lb/acre), and they may never have a need for P fertilization. Adding fertilizer P to these

high-P soils simply increases the chances for eutrophication—algae-like blooms that may cause fish kills (Figure 5) and can diminish the uptake of other essential plant nutrients like Zn. Since fertilizer analysis is given in N%-P<sub>2</sub>O<sub>5</sub>%-K<sub>2</sub>O%, make certain that the center number in a fertilizer product is 0 (e.g. 23-0-30) when soils are already high in P.

## Conclusion

Conducting routine soil sampling and applying appropriate rates of fertilizer are the best steps in achieving your long-term goals for productivity in your small ruminant pasture. Applying excessive rates of fertilizers is expensive and can cause undesirable weed growth and micronutrient deficiencies and could negatively impact the environment. Further advice on fertilizing your small ruminant pastures is available from your county cooperative extension agent. To locate your extension office, go to [www.ca.uky.edu/county](http://www.ca.uky.edu/county).

## Note to Small Ruminant Owners

In 1994, the Kentucky General Assembly passed The Kentucky Agriculture Water Quality Act (AWQA). The AWQA (KRS 224.71-100 through 224.71-140) states that landowners of 10 acres or more who conduct or allow agriculture or silviculture (forestry) production on their land were to be required to develop and implement a water quality plan as of October 23, 2001.

These individual water quality plans should be based upon guidance found in the Kentucky Agriculture Water Quality Plan. One of the six sections that make up the Kentucky Agriculture Water Quality Plan is Pesticides and Fertilizers (Section 2). This section requires routine soil sampling and appropriate fertilizer/manure applications. A website designed to help

landowners write water quality plans can be found at [www.ca.uky.edu/awqa](http://www.ca.uky.edu/awqa).

The following agencies can provide more information about the Kentucky Agriculture Water Quality Act:

- Your county office of the Kentucky Cooperative Extension Service (which can also provide information about Ky-A-Syst publications that apply to your land)
- Kentucky Division of Conservation
- Kentucky Division of Water, regional office
- USDA Natural Resources Conservation Service
- USDA Farm Service Agency
- Kentucky Division of Forestry, district office
- Your local soil and water conservation district office
- Your county health department
- Kentucky Farm Bureau Federation

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