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Soil Compaction and Pasture Performance

By Adam Speir
Madison County CEC

A healthy soil is the basis for any agricultural production. Without a healthy and productive soil, our efforts at management will prove inefficient at best and ineffective at worst. Soil compaction is one issue that can be common to forage producers. What are the “root” causes of soil compaction, and how do we effectively manage this issue so that our forage systems are sustainably productive?

Compaction is the result of repeated movement and traffic on soils, either by equipment or animals. Typically, soil compaction becomes an issue on saturated or wet soils, but compaction can also affect dry soils. In pastures and hayfields specifically, compaction most often affects the top 3-4 inches of soil which directly impacts root movement and development of our forages. But compaction can also occur and greater depths in the soil. Often known as a tillage pan, or “hard pan”, this is the result of frequent passes with tillage implements (in the past or present) in attempts to relieve surface soil compaction. This hard pan will only allow root and water movement in areas above the hard pan, usually in the top 6-8 inches. There are also sub-surface hardpans, which are the result of downward movement of clay particles and minerals in the soil until they accumulate into a dense layer.

Compaction results in a multitude of problems that impact forage producers. Compaction affects the physical properties of soils, which reduces the pore spaces that allow for air, water, nutrient, and root movement. When these pore spaces are eliminated, it reduces water infiltration which not only reduces soil water storage capacity and resistance to drought, but also leads to increased water ponding or surface erosion in rainfall events. With reduced porosity, plant root systems are stunted, which also reduces drought resistance, and results in poor stands and poor competitiveness against weed pressure and other stresses.

Compaction also affects the biological properties of soil. Healthy soils are a thriving ecosystem, with bacteria, earthworms, fungi, and other organisms that help break down organic materials and recycle nutrients. These organisms exist in the pore spaces within healthy soils, so soil compaction directly impacts their ability to function. With compacted soils, organic matter is reduced, as well as overall soil health.

Preventing compaction and promoting organic matter is important for many reasons. Organic matter serves as a storage system for nutrients and water. This organic material, which is a combination of decomposed roots, fungi, manure, microbes, complex organic molecules, and many other components, is high in surface area, which provides sites for nutrients to be held in place rather than leaching through the soil profile. Having material so high in surface area also allows it to act like a sponge, holding moisture and reducing drought stresses.



Soil Compaction (cont.)

Determining if your soils are compacted may be as easy as making visual observations of fields or noticing plant rooting depths. If plant roots are concentrated in the top few inches, then compaction may be an issue. You can also use tools such as penetrometer, which is a metal rod with a pressure sensor that measures the amount of force required to drive through the soil. Soils that are compacted will have a higher pressure reading and will be harder to push into the ground. It should be noted that dry soils will naturally be harder, but this doesn't necessarily mean they are compacted. Wait until soils are wet or saturated before attempting to gauge soil compaction with a penetrometer.

If your soils are compacted, aeration is often seen as the solution. However, in forage and hayfield applications, research has shown that aeration is, at best, a temporary solution. Studies comparing fields with aerated vs. non-aerated areas tend to only show a difference in performance for 1-2 years. Short-term benefits or improvements are usually more a result in tillage or disturbance that releases nutrients from organic matter. Results from studies in the past have shown that aeration and deep tillage could alleviate compaction in severe cases, but studies have also shown that these methods do not help, or can even make things worse. With this variability in benefits, the costs of aeration are unlikely to be a worthy investment.

The best way to deal with compaction is to implement practices that prevent it from ever becoming a serious issue. These management techniques will not only help prevent compaction, but will also provide other production benefits. The keys to preventing compaction are to maintain a healthy and vigorous plant root system and prevent constant or consistent livestock/equipment traffic.

Maintaining a healthy and vigorous root system is directly related to the amount of time between grazing or cutting of grasses. Whenever grass is cut or grazed, the plants take energy out of the root system to regrow the foliage above-ground. If pastures are continuously grazed, or hayfields are cut too short or too often, grasses will be over-stressed and have very short root systems that cannot work down into the soil profile to add organic matter and contribute to healthy soil structure. Livestock producers should seriously consider grazing management that allows pastures to rest after grazing that allows root systems to maintain their condition and allows soils to add organic matter. When it comes to maintaining a healthy root system, soil fertility is also important. Soil sampling and fertility testing will help you determine if forages are receiving what they need to be productive.

Reducing livestock traffic and equipment movement will help prevent compaction issues. Livestock can exert as much force on soils over time as heavy equipment. Reducing foot traffic goes back to grazing management. When cows are pulled off and moved to another paddock rather than continuously on one pasture, soils are allowed time to preserve some of their structure and maintain pore space. Producers also have to consider soil conditions related to weather. Soils are more easily compacted in wet conditions, so keeping cows or equipment off of bottomlands or areas that would be wet will help mitigate damage.

Compaction is a real and serious concern for forage and livestock producers. Soil types can play some part in this, with heavier, clay soils more likely to suffer from compaction than sandier soils. But management plays a large role in preventing compaction from becoming a serious concern. Promoting practices that increase soil health and soil organic matter will be the best way to prevent compaction from reducing your farm's performance.

Upcoming Events

American Forage and Grassland Council's Annual Meeting

Jan. 10-12, 2016 Baton Rouge, LA

SE Hay Convention

March 8-9, 2016 Moultrie, GA

Georgia Forages Conference

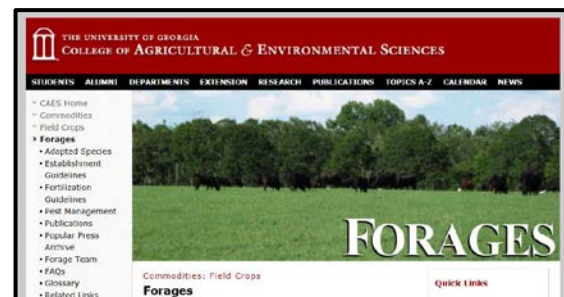
March 30, 2016 Perry, GA

Georgia Grazing School - 2016

Sept. 20-21, 2016 Location TBD

Looking for more forage information?

Be sure to visit
GeorgiaForages.com!



Time to Lime

By **Sam Ingram**

Effingham County CEA

Liming a pasture or hayfield is usually the most economical application one can make. This is really nice for a producer because it is the most important application, too!

Why?

Most Georgia soils are acidic or will naturally become more acidic over time. The addition of ammoniacal forms of nitrogen fertilizer (e.g., ammonium sulfate, urea, UAN solutions, ammonium nitrate, etc.) accelerate soil acidification. To correct low soil pH, the soil acidity must be neutralized. Lime supplies carbonate ions that neutralize soil acidity (increase soil pH).

When soil pH is kept at the level appropriate for the forage crop(s) being grown, the nutrients stored in the soil will be most freely available to the plant (Figure 1). Most forage crops grow best when the soil pH is 6.0-6.5. This increases the plant's ability to efficiently use fertilizer and nutrients already in the soil. Proper soil pH also prevents high concentrations of toxic elements (e.g., aluminum) that can injure root tips and prevent proper rooting. If our soil pH is below the preferred level for that forage crop, a producer could be wasting an expensive application of fertilizer.

When?

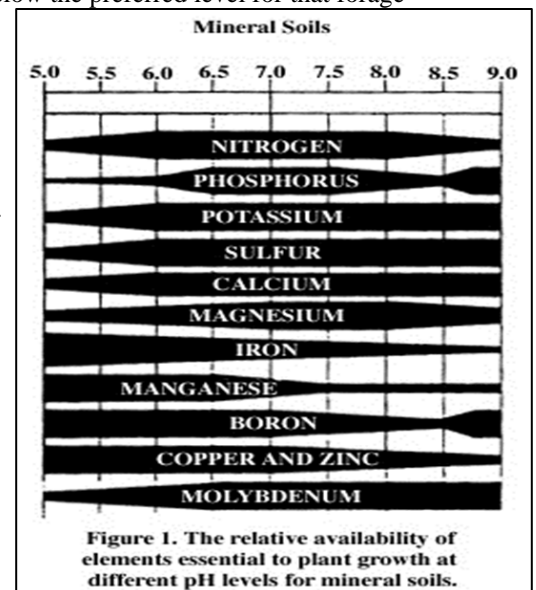
Lime applications can be made anytime during the year. However, consideration must be given to the fact that lime may take several months (sometimes a whole year) to be fully effective. The amount of time for lime effectiveness depends upon the soil type and the quality of the material, particle size, and application method of the lime product. More on this below. Many producers apply lime in the fall. This gives the lime some time to raise the soil pH before the next growing season.

What?

The effectiveness of a lime product depends on the material, the particle size, and the application method of the lime product to the forage crop. There are several materials used to raise soil pH in Georgia, some of the major materials are listed below. The only product mentioned below with minimum standard of magnesium is dolomitic limestone and should be used (if possible) to maintain sufficient soil magnesium levels. If magnesium is present in adequate levels, then calcitic limestone can be used.

- Dolomitic limestone- material consisting of calcium carbonate and magnesium carbonate (110-118%)
- Calcitic (or "High-Cal") limestone- material composed wholly or primarily of calcium carbonate (100%)
- Hydrated lime-material composed of calcium hydroxide or a combination of calcium hydroxide and magnesium hydroxide (135%)
- Papermill lime sludge- material composed primarily of calcium carbonate which is produced as part of the process that turns wood chips into pulp for paper (variable)
- Industrial by-products- any industrial material or by-product containing calcium or calcium and magnesium compounds (variable)

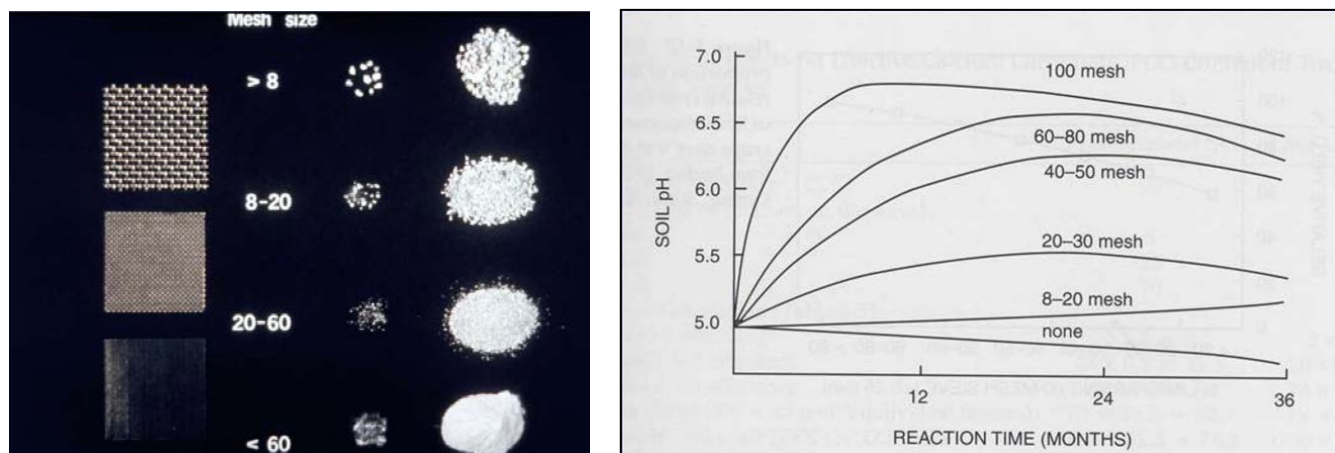
To judge the effectiveness of a lime product a producer needs to look at the calcium carbonate equivalent (CCE) of the product. This value is expressed as a percentage and defines the acid neutralizing capacity of a liming product. Dolomitic limestone should be used as a basis for evaluation; the CCE is 110-118%. (Note: It should be pointed out that the CCE values expressed here are from chemical grade versions of dolomitic limestone, hi-cal lime, etc. This is never the case in reality. Most of our aglime has impurities in it and it is rarely better than 90-95% CCE.) The CCE for each major lime product is listed above in parenthesis. Note the sludge and by-product are highly variable and dependent on source.



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Time to Lime (cont.)

The particle size of the lime product also affects the effectiveness of a lime product. The smaller the particle, the quicker the product neutralizes the soil in the area where the root zone of the forage crop is pulling nutrients. The picture below gives an illustration of different mesh sizes relative to the products that pass through that mesh size. The graph shows the effect of particle size on soil pH neutralization.



The application method for a lime product can also affect the amount of time it takes to raise the soil pH. The majority of producers will surface-apply lime products to pastures and hayfields. A surface application works well if a producer allows enough time for the product to get to the area where the root zone of the forage crop is pulling nutrients.

So, how does a producer determine the particle size and CCE of a product? Just ask the dealer or sales representative of the product. All liming materials sold in the state of Georgia must be licensed through the Georgia Department of Agriculture. Requirements for CCE and particle size are set for each product and can be found at <http://agr.georgia.gov/liming-materials.aspx>.

The next question should be how much lime product to apply? A simple and cheap test through UGA Extension can determine the soil pH, calcium, magnesium and other nutrient levels in the soil. The results are listed in an easy to read form and also give recommendations for lime. This simple test can save a producer time and money. All soil samples can be submitted through the local county extension office.

Multi-Species Grazing – Is it for my farm?

By Will Lovett
 Bacon County CEA

Multi-species grazing is the oldest form of plant management and is nature's way of managing the environment. The USDA-ARS team defines multi-species grazing as "the use of more than one type of herbivore to graze a common resource". Multi-species grazing may include a combination of cows, sheep, goats, horses, pigs or fowl. We will spend the next several paragraphs discussing basic infrastructure needs, benefits, and limitations that should be taken in to consideration when deciding if multi-species grazing is right for you.

Your infrastructure needs will depend upon what animals you plan to graze. Infrastructure needs for sheep and goats can be significantly different from those needed for cattle or horses. I once heard the statement "if you can pour water through a fence, a goat can escape through it". In fairness, sheep can be just as difficult to contain as goats. Woven wire fencing, electric fencing with 6 inch to 8 inch spacing or "sheep" netting or a combination of these will be needed to contain small ruminants effectively. In addition to fencing, consideration must be taken for water troughs, feed troughs and working facilities which may need to be added and/or modified depending upon the size difference or method of handling for your multi-species group.

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Multi-Species Grazing(cont.)

When considering multi-species grazing you will need to determine if you have available plant material that is not being consumed during the grazing season by your current livestock. This could include brush, grass, briars or weeds. If you have available plant material then this type of grazing may be a good choice.

Your available plant material can help to determine what species would be best suited to add on your farm. Cattle, horses, sheep and goats each have preferences on the mix of grass, forbs and shrubs they consume (see table below). They also have different preferences on grazing heights. The distinct preference by each species improves per acre output. If pastures have weeds or shrubs present, goats or sheep can be added to your grazing system without reducing the stocking rate of horses or cattle. Horses and cattle can be grazed alongside small ruminants or in a leader follower system. Overall the addition of other species allows for better utilization of plant material, specifically broadleaf weeds and browse.



Table 1. Dietary preferences for different livestock species (From “Nutrient management in mixed specie pastures for goats”, An Peischel, 2005 Nutrition Conference, University of Tennessee, Knoxville).

Species	Grass (%)	Weeds (%)	Browse (%)
Horse	90	4	6
Cattle	70	20	10
Sheep	60	30	10
Goats	20	20	60

Adding another livestock species will increase management responsibilities. You will need to spend additional time caring for and marketing the new additions to your farm. Each species has its own requirements for nutrition, vaccination, deworming, and handling methods. Depending on your experience as a stockman and the time you have to devote to another enterprise, this can be a fairly steep learning curve. Be sure to purchase your foundation stock from a reputable farm that manages the animals in a manner similar to what you plan on your farm. For instance, if you plan to extensively graze the animals on your farm, don't buy animals that are primarily fed stored feeds. These animals may not adapt well to a new management style. These animals may cost a bit more than what can be purchased through auctions, but you minimize disease risk, and potentially gain a mentor to assist you with learning to care for your new animals.

Multi-species grazing can offer a way to increase farm output and pasture use efficiency. It will take a bit more management time, especially in the beginning. Talk to your local extension agent if you would like additional information on multi-species grazing.