University of Minnesota
EXTENSION

Managing Soils for Greater Grazing Productivity

PATTERSON CREEK PHOTOS

Minnesota Department of
AGRICULTURE
From the Farm to Your Family

Funding Information

Funding for this publication is through the Minnesota Department of Agriculture, under Section 319, "Non-Point Source Management", of the federal Clean Water Act.

About the Author

Brad Carlson is an Extension Educator, Agricultural Production Systems, with the University of Minnesota Extension. He specializes in soil management and tillage, and is located in Rice and Steele Counties.

On the cover – Considered taboo for many years, grazing has been recognized as a valuable part of the management of healthy riparian areas. Note that the grass is not overgrazed and the stream banks are vegetated and stable.

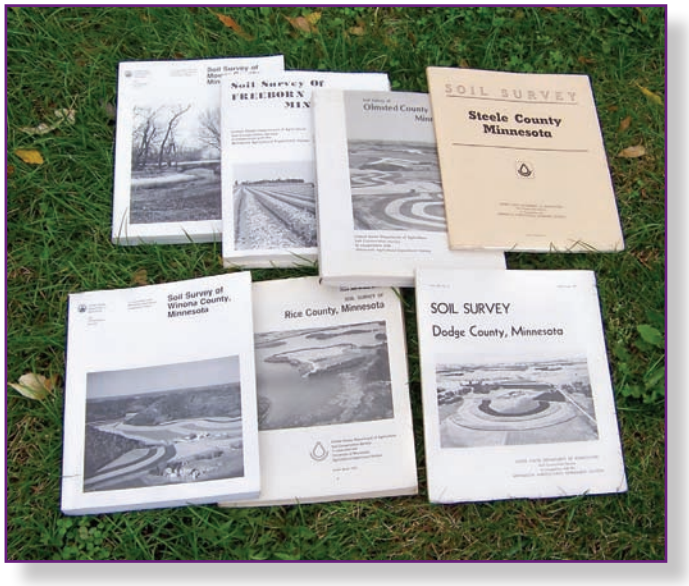
Managing Soils for Greater Grazing Productivity

Grazing has been lauded for many years for the environmental benefits that pastures provide on the landscape. The success of a grazing system is tied directly to the productivity of the pasture. That productivity is determined first and foremost by the soils.

This publication will discuss soil management for optimizing productivity from existing pastures, and will be of some use when establishing pastures. Nevertheless, if you are starting a new pasture you should consult other sources for a more thorough discussion on this subject.

Know What You Have

The first step in the management of soils for pastures is to use the soil survey to identify what you have. Many farmers know the soil types present on their farms, yet never take the time to fully understand the characteristics of each soil. The introductory portion of the soil survey contains valuable information for every soil found in your county. This includes: texture, depth of topsoil, drainage, slope, past erosion problems, and suitability for various uses (including pasture land). Recently, much of this information is available from the USDA Natural Resources Conservation Service (NRCS) over the internet at: http://websoilsurvey.nrcs.usda.gov. The bottom line is that you can not change the inherent properties of your soils, but by understanding them you can manage them to maximize their productivity.



Printed copies of the soil survey for your county might be available from your county NRCS or Extension office. If not, much of this information is now available online.

It is important to identify steep slopes where your management options may be limited. Look for soils with a history of erosion or severe erosion and realize that topsoil is lacking and that productivity will be limited. Areas with alluvial soils (those deposited via erosion from somewhere else) will have your highest inherent fertility, but are likely to be along riparian areas which may be more sensitive to flooding or damage from grazing. Shallow soils caused by a high water table or shallow depth to bedrock are not as likely to be as productive as ones that allow plants to root deeper. With some research, you can find out which pasture plants will be most productive for various soil types.

It is also important to realize that the past farming history of the land may make it differ some from the "textbook" descriptions that you find for soil types. For this reason, it is advisable that you walk your pastures and look for the things that you found in the soil survey. You should be able to easily determine slope boundaries by sight (with the help of the soils map). In addition, you should take a soil probe or shovel and check the depth

of topsoil and texture to see if you agree with what is printed. If there are adjacent unfarmed lands (such as woods or fence lines) you may find it interesting to compare same soil types for some of these properties. The soil characteristics of these "virgin" areas are more or less unattainable under most agricultural scenarios, but they do provide interesting context to how farming has changed the land.

Soil Sampling is an Important Step

Obtaining soil nutrient information is the next step in understanding the soil in your pastures. Under most circumstances, testing by soil type is advisable for grazing situations. There should be no problems putting the same soil type from non-adjacent areas together for the purposes of testing unless there has been a significant difference in the way that the land has been managed. You may combine similar soil types or similar slopes if necessary to keep the number of samples down.

Soil test results are most useable when sampling corresponds to management zones. Management zones can be determined based on soil type, landscape position, paddock locations and other relevant factors.

Soil samples should be to a depth of six inches. You should avoid adding significant amounts of live plant and root tissue from the pasture sod. At least twenty soil cores taken randomly in the area that you are testing are necessary to get a reliable sample. Sampled soil should be combined together, mixed, and air-dried. Brown paper "lunch" bags work well, as they are inexpensive and dry easily. Make sure to mark your sample bags clearly.

Samples should be submitted to a testing laboratory approved by the state of Minnesota. Minimum analysis should include: texture, % organic matter, pH, phosphorus, and potassium. You might want to test for zinc if your soil has a high pH (greater than 7.3) and for boron in lower organic matter and sandy situations. Sulfur may improve plant growth, but unfortunately, the soil test for sulfur is not accurate in medium to heavy textured soils. There are many other chemical characteristics that you can analyze for, but these rarely, if ever, have management implications in Minnesota.

Soil Physical Characteristics Often Overlooked

Soil with good "tilth" is highly productive. Tilth is a word that is difficult to define, but mostly reflects physical characteristics of the soil. Soils with good tilth have faster water infiltration, greater root density and depth, and a higher water holding capacity.

Compaction is a serious impediment to productivity. Measurement of compaction is rarely conducted because it is difficult to accomplish, and interpret the results. Many farmers have used a penetrometer which measures resistance in pounds per square inch for a rod to penetrate the soil. It needs to be understood, though, that the readings from this instrument change based on soil texture and moisture. This means that you can not simply look at a

table to determine whether a number is good or bad. It also means that you can not easily measure any changes over time, as the percent of soil moisture is surely to be different every time you take a measurement. Ultimately, this tool can be of some use in finding compacted zones at a specific location, or comparing one area to another on the same day.

A much more accurate, and more difficult, way to identify compaction is to determine the soil bulk density. Bulk density is measured in grams per cubic centimeter (g/cc). There are not very many bulk density coring tools around to take precise measurements, but you can take rough measurements with something as simple as a can or piece of pipe. Simply drive it into the ground, extract it, cut the ends smooth, and push the soil out into a can, bowl or other container to be oven dried. By weighing the dry soil and measuring the volume of your coring tool you can determine your bulk density.

You probably will not have access to a soil bulk density probe, but you can still measure it with any cylinder of known volume.

A concept closely related to bulk density is that of soil structure. Soil with good structure resists compaction, allows for faster and more thorough water infiltration, and provides a good environment for root growth (ultimately leading to healthier, more productive plants). Water infiltration can be measured with some effort, but the data is not usually considered useful for agricultural situations. Another measurement that can be made is that of aggregate stability, or simply put, how well a soil holds its shape when wet. This measurement characterization is not typically conducted outside of the purposes of research, but testing can be arranged, if you think that it would be of value, by contacting your county Extension office. Ultimately, soil structure is classified subjectively based on experience. For practical purposes, farmers need to be aware of the consequences of poor water infiltration or poor root growth and watch for them.

Manage According to the Information You Have

Once you have a good handle on the properties of your soil, it is time to plan for management changes. The first step in this process is to evaluate the plant species composition of the pasture and estimate the productivity. It is not within the scope of this publication to go through all of the species commonly used and their preferred sites and growth characteristics, as this will vary widely from one site to another. You can obtain this information from a NRCS grazing specialist via your county NRCS office. In general, there are many species that are highly productive under high fertility situations, and only a small number that perform adequately under adverse conditions.

Many grazers prefer to have legumes in their pastures. Keep in mind that most grass species will out-perform legumes and crowd them out if high enough fertility levels are maintained. You should consider whether your management practices lead to a sustainable situation, or whether they alter the pasture in ways that require continual attention. Pastures that receive little or no management are usually under-performing, and those that require

too much attention can quickly cross the line to be too expensive or take too much time to care for. You need to decide what is right for you and make a plan that corresponds.

When considering fertilizing your pasture, you should use the University of Minnesota recommendations that are supplied with your soil test report. Soils located in Western Minnesota are most frequently going to require phosphorus, and those in Southeastern Minnesota are likely to need potassium. University of Minnesota recommendations are for 60 to 150 lb./A of nitrogen to be applied depending on the projected productivity of the pasture. Despite this, most farmers do not add nitrogen fertilizer to their pastures, and recent U of M research has shown mixed results. Most grass will benefit from the addition of nitrogen, but as mentioned earlier, this may lead to the smothering out of legumes. It is probable that soils with poor organic matter or shallow topsoil would benefit greatly from the addition of some nitrogen. If you choose, you can try some low rates on your site and see how it responds. It is likely that higher rates will need to be applied as split applications. Ultimately you will need to weigh the benefits of nitrogen fertilizer on your pastures versus the time and expense necessary to accomplish them. Increasing the productivity on a poor soil can help build it by adding soil organic matter and improving soil structure.

Small spin spreaders work well for the broadcast application of fertilizer and lime in pastures. Incorporation of fertilizer is advisable for most agricultural situations, but not possible on established pasture. Surface application of fertilizer and lime is acceptable for perennial covers, and does produce good results provided that steps are taken to prevent loss.

Areas with the highest levels of organic matter and the deepest topsoil (usually riparian or alluvial soils) will likely have high enough fertility levels that you should focus on grass production. If these areas are prone to spring flooding you might want to consider using a warm season grass that will be productive later in the growing season when the likelihood of flooding is reduced.

In some cases you may benefit from raising the soil pH by applying lime. A pH of 6.5 – 7.0 is usually considered ideal. There are grass and legume species that will tolerate lower soil pH, but these are usually less productive. Increasing the soil pH will allow you to grow more productive species, but you will need to weigh the benefits of this increased productivity versus the cost of liming.

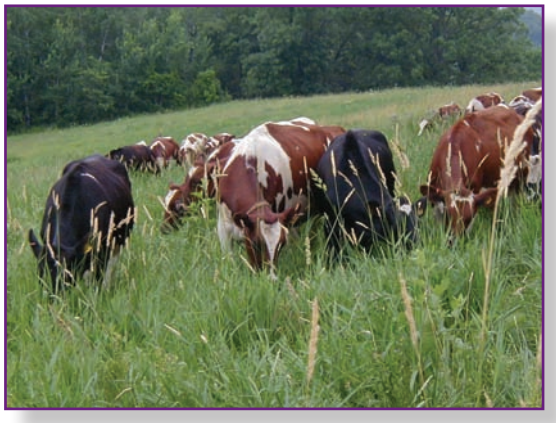
In nearly all cases any fertilizing you do (this includes manure and lime) will be broadcast on the soil surface with virtually no incorporation. While this does not provide the most immediate and complete results, it does work, provided the fertilizer does not move off the site.

Alterations in soil physical properties are not as easily accomplished as those of soil fertility. Under most circumstances pasture plants will perform adequately with any bulk densities under 1.5 g/cc (Brady and Weil). Perennial plants, by their nature, will induce a decrease in bulk density leading to greater water holding capacity, more root growth, and therefore greater forage production (Brady and Weil). The exception to this are highly trafficked

areas, or places where previous uses have led to compaction problems. In some cases tillage is necessary to alleviate these problems, but usually exclusion of animals, plant growth and time will bring soil bulk densities down to the point of good productivity.

Farming is as Much Art as it is Science

When dealing with soils it is easy to get wrapped up in numbers, management practices, and potential increases in productivity. Ultimately, it is imperative that one keeps an eye on the big picture and makes sure to plan adequately and thoroughly. Ensure that what you do maintains or improves profitability, and that you have the time and means to accomplish your objectives. Farming is an art just as much as it is a science, and it requires constant evaluation, and demands that you continually adjust your management and expectations based on what is happening. Your soil is the foundation of your grazing system, it is important to understand it and take care of it. If you would like more information you can contact your county Extension office or NRCS office.



Forage species composition of the pasture is important, but management is just as, or more important to provide the maximum productivity of your pasture resource.

Reference

Elements of the Nature and Properties of Soils, Second Edition. Nyle C. Brady & Ray R. Weil. 2004. Pearson / Prentice Hall, Upper Saddle River, NJ.

More Information

Blanchet, K.; Moechnig, H.; and DeJong-Hughes, J. 2003. *Grazing System Planning Guide*. BU-07606. University of Minnesota. Online at http://www.extension.umn.edu/distribution/livestocksystems/components/DI7601.pdf

Undersander & Pilsbury. *Grazing Streamside Pastures*. A3699. University of Wisconsin.

Undersander, D.; Albert, B; Porter, P; Crossley, A.; and Martin, N. *Pastures for Profit: A Guide to Rotational Grazing.* A3529. University of Wisconsin.

Loeffler, B.; Murray, H.; Johnson, D; and Fuller, E. 1996. *Knee Deep in Grass, A survey of twenty-nine grazing operations in Minnesota.* FO-06693. University of Minnesota Extension.

Lewandowski, A. 2002. *Soil Management Series.* PC-07398. Minnesota Institute for Sustainable Agriculture; University of Minnesota Extension Service; and Soil Quality Institute, USDA Natural Resources Conservation Service. St. Paul MN. Online at http://www.extension.umn.edu/distribution/cropsystems/DC7398.html

Moechnig, H. 2007. *Managing Grazing in Stream Corridors*. Minnesota Department of Agriculture. Online at http://www.mda.state.mn.us

Rehm G.; Schmitt, M.; Lamb, J.; and Eliason, R. 2004. *Fertilizer Recommendations for Agronomic Crops in Minnesota.* BU-06240. University of Minnesota.

UNIVERSITY OF MINNESOTA
EXTENSION

Managing Soils for Greater Grazing Productivity

Publciation Set #08569