Forage Resource Management and Integration

THE SAMUEL ROBERTS NOBLE FOUNDATION

by Chuck R. Coffey / crcoffey@noble.org

The proper management and integration of available forage resources is critical to the sustainability of these resources and the land. As time progresses, it becomes more and more evident that we, as agricultural producers, must become increasingly efficient with each unit of product produced. To better understand forages and their integration, let's take a look at their energy requirements, how they manufacture food, how they might respond to grazing, their management for sustained use and their integration.

Table 1

Essential Plant Nutrients		
Carbon	C	Available from air and water
Hydrogen	H	
Oxygen	O	
Nitrogen	N	Primary nutrients
Phosphorus	P	
Potassium	K	
Calcium	Ca	Secondary nutrients
Magnesium	Mg	
Sulfur	S	
Iron	Fe	Micronutrients
Manganese	Mn	
Boron	B	
Molybdenum	Mo	
Zinc	Zn	
Copper	Cu	
Sodium	Na	
Chlorine	Cl	
Cobolt	Co	
Silicon	Si	
Vanadium	V	

Energy Requirements for Plant Growth

Plants require numerous nutrients and compounds for sustained production. There are 20 elements that are used by plants and are considered to be essential. They are shown in Table 1:

Many of us put forth significant effort to maintain a plant's requirement for nitrogen (N), phosphorus (P) and potassium (K) while taking for granted its need for carbon (C), hydrogen (H) and oxygen (O). Secondary nutrients and micronutrients are needed in such small quantities that we tend to disregard their importance and rightfully so. They may be present in insufficient amounts for a specific crop being grown or a given soil type, but can usually be corrected by adjusting a soil's pH, especially in grazing situations. Henceforth, the focus will be on a plant's need for carbon, hydrogen and oxygen. Let's take a look at the makeup of a typical plant in order to put our thoughts into perspective. Table 2 is a listing of the elemental composition of a typical plant.

Table 2

Composition of a Typical Plant			
Element	Percent of Fresh Weight	Percent of Dry Weight	
O	81.0	45.0	89.5% from atmosphere
C	6.8	44.5	
H	11.5	6.0	6.0% from H_2O
N	0.2	1.5	4.5% from mineral elements
K	0.15	1.0	
Ca	0.05	0.35	
P	0.03	0.20	
Mg	0.03	0.20	
S	0.02	0.15	
Cl	0.015	0.10	
Fe	0.015	0.10	
Mo	0.008	0.05	
Zn	0.003	0.02	
B	0.003	0.02	
Cu	0.001	0.01	
Other	0.175	0.80	
Total	100.00	100.00	

An interesting point to note about the preceding table is that 95.5 percent of a plant's makeup is carbon, hydrogen and oxygen. These elements come from carbon dioxide (CO_2) and water (H_2O). The carbon dioxide, located in the atmosphere, is responsible for contributing the carbon and oxygen found in plants.

It is taken up by plants through small pores located in the leaves. Water, on the other hand, is taken up by the roots of plants and is responsible for contributing only hydrogen to a plant's makeup. However, the hydrogen used to produce water also comes from the atmosphere. Therefore, we can now make the following assumptions: (1) the atmosphere and sun provide 95.5 percent of the necessary ingredients for plant growth; and (2) minerals provide 4.5 percent of the necessary ingredients for plant growth. Diagram 1 is a simplistic picture of how most plants derive nutrients needed for growth.

In short, we need to be managing the above-ground portion of plants (leaves and stems) in order to achieve maximum sustained yield of our forages. This will allow plants to be much more efficient in their uptake of water and nutrients.

Diagram 1

How Plants Grow

Diagram 2

$$\text{Photosynthesis} = \underset{\text{carbon dioxide}}{6CO_2} + \underset{\text{water}}{6H_2O} + \text{sunlight} \longrightarrow \underset{\text{carbohydrates}}{C_6H_{12}O_6} + \underset{\text{oxygen}}{6O_2}$$

$$\text{Respiration} = C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$$

How Plants Manufacture Food

The process of photosynthesis is the means by which plants manufacture food. Plants assimilate carbon dioxide from the atmosphere, take up water and nutrients from the ground and, in the presence of sunlight, produce carbohydrates (CHOs) and oxygen, which the plant will then use for respiration, growth, reproduction and storage. A plant will first use the food (CHOs) it produces for respiration, followed by growth, then reproduction and finally storage. Plants are unique organisms because they are self perpetuating as depicted by the formulas in Diagram 2.

As you can see, the products of photosynthesis are the inputs of respiration and vice versa. It is important to remember that plants cannot photosynthesize unless they have green, leafy materials (solar panels) above the ground to absorb the sunlight. This is not to imply, however, that plants should not be grazed if they are to reach their full growth potential. In fact, grazing is beneficial to most grasses if applied properly. Grazing by livestock removes older plant growth and stimulates tillering, allowing for increased new growth, which is more photosynthetically efficient. With proper frequency, intensity and season of grazing, most forages are indefinitely sustainable.

Factors Affecting a Plant's Response to Grazing

Most forages used by livestock have evolved under the influence of grazing. Therefore, proper grazing by livestock can be a useful tool in maintaining productive, healthy plants. Two major factors that will determine a plant's response to grazing are frequency of grazing and intensity of grazing.

Frequency of grazing refers to "how often" a plant is grazed. Livestock are very selective in their grazing habits. These grazing preferences can be seen between plant species as well as within a single plant species. If livestock are allowed to be too selective, many plants will be overgrazed while others will be undergrazed. When grazing frequency is too often, this disproportionate use of plants can cause dramatic shifts in plant species composition. Plants need time to recover after grazing. The proper recovery period will vary greatly depending on the plant species and its stage of growth.

Grazing intensity refers to the amount of plant material removed from a single grazing event. Generally, it is advisable to take half and leave half, especially when grazing native plant communities. Table 3 supports this rule of thumb.

The removal of 50 percent or less of top growth has little or no effect

Table 3

Effects of Grazing Intensity		
Percent Leaf Volume Removed	Percent Root Growth Storage	Days to Root Recovery
10	0	0
20	0	0
30	0	0
40	0	0
50	3	17
60	50	19
70	78	31
80	100	>33
90	100	>33

(Adapted from C rider 1955)

on root growth; however, as we begin to remove more than 50 percent of top growth, root growth stoppage becomes increasingly evident.

Another factor to consider regarding the "take half, leave half" rule is the regrowth potential of the above ground portion of the plant. The most important factor of a plant's regrowth potential is the amount of leaf area remaining after grazing has occurred. If very little above ground forage is present, the plant will draw upon carbohydrates located in the crown. Repeated use of these carbohydrates may ultimately result in a plant's inability to overwinter, reduced vigor or very slow regrowth. It was once believed a plant could mobilize energy from its root system for use in topgrowth. Research, however, indicates that carbohydrates allocated to the root system are not capable of being used for above ground growth (Davidson and Milthorpe 1966). Thus, the most important consideration for a plant's regrowth potential is the rate and amount of photosynthesis from the existing leaf area (Sambo 1983, Zarrough, et al 1984, Volenec and Nelson 1984). Moreover, the term "reserve energy" may well be a misconception of a plant's ability to regrow (Deregibus 1982).

Grazing frequency and intensity must be considered simultaneously in an overall grazing plan to maintain the integrity of forages. Remember to take half and leave half and allow plants time to regrow before removing the next half.

Management for Sustainability

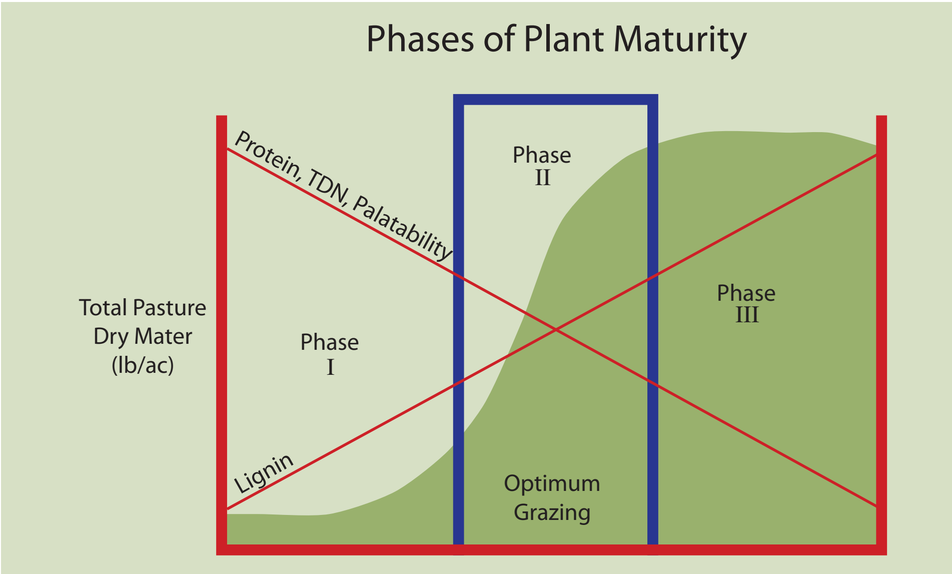
In theory, the idea of "taking half and leaving half" is one of the most important principles of range management; however, in practice, it is one of the most difficult to accomplish. Because cattle are very selective in their diets, they tend to graze the most desirable plants or areas first. They are also more likely to graze new, tender regrowth from a previously bitten plant than they are more mature plants. You may be "taking half and leaving half" by grazing all of some plants and none of others or grazing out one area (spot grazing) while another isn't even used. The term used for this is vertical grazing. The result is overgrazing and undergrazing occurring in the same pasture. Weeds tend to become more prevalent in the overgrazed areas while brush becomes more prevalent in the undergrazed areas. This is often the case in pastures that are continuously grazed. At this point, many producers respond with chemical control of weeds and brush. This may provide temporary relief, but it does nothing to fix the problem of inefficient grazing management practices.

The principle of "taking half and leaving half" only applies to horizontal grazing which means taking half of "each plant" and leaving half of "each plant." The most efficient way I know to do this, using livestock, is through rotational grazing. To stop overgrazing, I think it is necessary to have a minimum of eight paddocks per herd. This will allow plants sufficient time to recover between grazing intervals so long as the forage is properly stocked. As you increase beyond eight paddocks, thus increasing stock density, uniformity of utilization will increase through even better harvest efficiency of forages.

Diagram 3 represents different phases of plant maturity and outlines proper grazing management practices:

As a plant matures throughout the growing season, lignin content increases, palatability decreases, protein decreases and total digestible nutrients decrease. In relation to plant maturity throughout the growing season, Phase I growth represents minimal forage quantity but excellent forage quality while plant growth is slow. Phase II growth represents sufficient forage quantity and quality with rapid plant growth. Phase III growth represents maximum forage quantity, but poor forage quality, while plant growth is again slow. To optimize the quantity and quality of harvestable nutrients, forages should be used and maintained in Phase II growth.

Diagram 3



In relation to a plant's ability to regrow after grazing, a pasture should not be grazed too short, leaving so little leaf that growth must return to Phase I. If a plant does return to Phase I, it must develop a completely new "factory" to begin photosynthesis. Likewise, a pasture should not be left to grow so long that it reaches Phase III. If a plant reaches Plant III, shading and old growth begin to reduce photosynthesis. We should attempt to maintain a pasture in Phase II so plants will have the ability to regrow more rapidly. To do this, the periods between grazing must vary according to the rate of plant growth. When growth is fast, the rest periods should be shorter. When growth is slow, the rest periods should be longer.

Integrating Forage Resources

Integrating forage resources means using a combination of different forage types to maximize the efficiency of forage use by livestock. Matching an animal's nutrient requirement to the quantity and quality of forage available can be one of the most efficient ways to maximize animal performance, thereby reducing the cost of livestock produced per acre. Using a combination of different forage types may allow producers to:

- Extend the grazing season, thus reducing the need for supplemental feed,
- Increase production per unit of land,
- Improve forage quality for better animal performance,
- Reduce overall production costs thereby increasing profitability.

A nativegrass pasture in good condition is an integrated forage resource within itself. It will contain a diversity of mostly warm-season grasses with a few cool-season species in more shaded areas or riparian zones. Plains bluestem, Caucasian bluestem, bermudagrass and Weeping lovegrass are all excellent perennial forage producers in the southern Oklahoma and North Texas area. If you are considering the establishment of one of these, be sure and evaluate soil texture, slope and drainage before making your selection. Crabgrass is an excellent annual forage producer. It is often used as a double crop with many of our annual cool-season forages.

Fescue is probably the most dependable cool-season perennial forage adapted to our area, but it has some manageable problems. The threat of toxicity and reduced animal performance can be minimized by diluting pure stands with clover, ryegrass or other compatible species. Planting endophyte-free varieties will also reducetoxicity and increase palatability, but these varieties are less drought-tolerant, thus more difficult to sustain than the endophyte-infected varieties. If you consider establishing fescue (and probably should if you have proper sites), be aware of its potential toxicity and reduced palatability and have a plan to overcome these problems. Other cool season perennial forages such as Matua rescuegrass, Orchardgrass and Jose tall wheatgrass may be useful but, like Fescue, are often site-specific and difficult to maintain.

Annual ryegrass is an excellent forage producer for winter pasture production and can also be overseeded on permanent pasture such as Bermudagrass. It is an excellent reseeder, which means it isn't necessary to plant every year if managed for seedset and sustained production. Rye, wheat, oats and barley are all cereal grains and can be used for grain, forage or both. Oats and barley are not as cold tolerant and are susceptible to winter kill, so be aware of this potential hazard. Barley is probably the best choice for reclaiming saline soils. Rye and wheat are currently the best choices for clean-till winter pasture production in our area. Let production, site selection and seed availability dictate your choice of variety selections of rye and wheat.

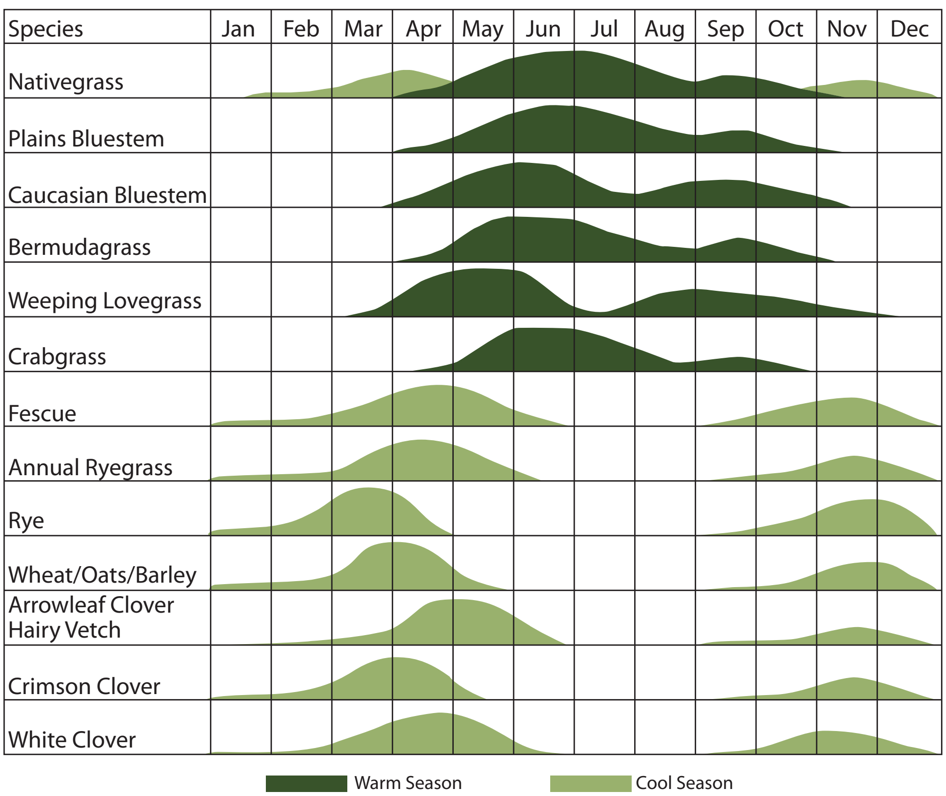
Legumes are often an important component in many pastures. Their potential inputs of nitrogen and grazing value should not be overlooked. Of the annual legumes, Arrowleaf clover is the most widely adapted in our area. Its reseeding success from year to year is one of its primary advantages. Crimson clover offers the greatest probability for early production, but is a poor reseeder. Hairy vetch is also an excellent forage choice, but it too has problems with perpetuating itself. White clovers are mostly perennial, meaning they don't depend on seed production from season to season to survive; however, site selection and management are two very critical factors to consider.

Diagram 4 is a listing of the major forages grown in our area and their seasonal forage production potential.

By having a combination of different forage types, the potential for flexibility is greatly increased. The key is to supply enough forage (quantity and quality) to meet the demand by livestock or to supply enough livestock (proper kind and class) to match the forage produced.

Diagram 4

Seasonal Growth Curves of Selected Forages in South Central Oklahoma



Literature Cited

Barden, J.A., R.G. Halfacre, and D.J. Parrish. 1987. Plant Science. McGraw-Hill Book Company, New York, New York.

Crider, F.J. 1955. Root-growth stoppage resulting from defoliation of grass. USDA Tech. Bull. 1102.

Davidson, J.L., and F.L. Milthorpe. 1966. Leaf growth in Dactylis glomerata following defoliation. Ann. Bot. 30:173-184.

Deregibus, V.A., M.J. Trlica, and D.A. Jameson. 1982. Organic reserves in herbage plants: Their relationship to grassland management, p. 315-344. In M.J. Recheigl (ed.), Handbook of agricultural productivity. Vol. I. Plant productivity. CRC Press, Bocona, FL. USA.

Sambo, E.Y. 1983. Leaf extension rate in temperate pasture grasses in relation to assimilate pool in the extension zone. J. Exp. Bot. 34:1281-1290.

Volenec, J.J., and C.J. Nelson. 1984. Carbohydrate metabolism in leaf meristem of tall fescue. I. Relationship to genetically altered leaf elongation rates. Plant Physiol. 74:590-594.

Zarrough, K.M., C.J. Nelson, and D.A. Sleper. 1984. Interrelationships between rates of leaf appearance and tillering in selected tall fescue populations. Crop Sci. 24:565-569.

THE SAMUEL ROBERTS
NOBLE
FOUNDATION

The Samuel Roberts Noble Foundation
2510 Sam Noble Parkway
Ardmore, Oklahoma 73401
Phone: (580) 223-5810
www.noble.org

THE SAMUEL ROBERTS
NOBLE
FOUNDATION

AG News and Views

Originally published August 2003

FORAGE

Management Guidelines Can Help Improve Pasture Condition, Optimize Forage Utilization

by Chuck Coffey / crcoffey@noble.org

Here are some general management strategies for maintaining or improving the condition of your pastures while optimizing forage utilization by livestock. Those of you who have both introduced pastures (such as bermudagrass or plains bluestem) and native grass pastures have the luxury of lengthened rest periods on your native grass pastures.

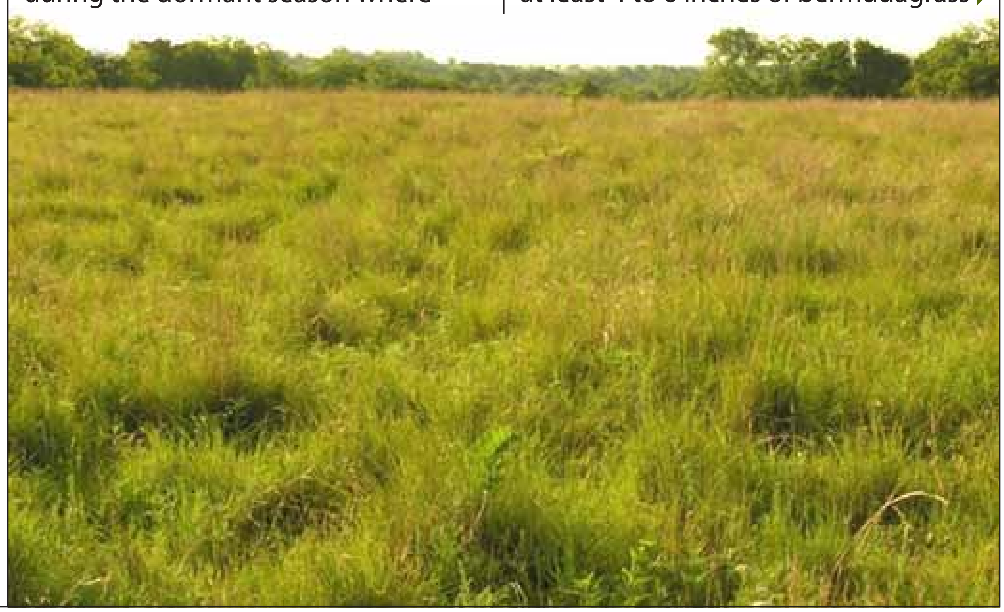
Management of Nativegrass Pastures

Full-season rest (May 1 through November 15) should be applied to pastures in poor to fair condition where maximum recovery is desired. These pastures should be rested from May 1 to November 15 and used as a standing hay crop with protein supplement from November 15 to May 1. It is still important to maintain a minimum residual height of 6 inches. If brush encroachment is a problem, consider prescribed burning during the dormant season to control woody plants. Be prepared to reduce your stocking rate to accommodate the reduction of available forage if you burn.

Half-season rest (May 1 through July 15 or July 15 through November 15) should be applied to pastures in good condition but where an improvement in condition is still desired. This does not mean you will be continuously grazing these sites the full length of the allowable grazing period — rather, you will most likely utilize the forage in one to two grazing events allowing 30 to 90 days rest between grazing events. Do not graze below a 6- to 8-inch minimum height at any time during the growing season, and do not graze below 10 to 12 inches during the dormant season where optimum wildlife habitat is desired. Half-season rest may also be applied to pastures in good condition but where periodic burning is necessary to suppress woody plants or alter species composition for wildlife habitat manipulation.

Management of Bermudagrass Pastures

Bermudagrass pastures should be fertilized in the spring and can be grazed any time during the growing season. However, for optimum plant growth and recovery, it is important to leave at least 4 to 6 inches of bermudagrass



in the pasture after each grazing event throughout the growing season. This can best be accomplished by rotating your livestock from pasture to pasture. The recovery period after each grazing event may range from 30 to 60 days depending on the time of year and how fast the grass is growing.

Also, we encourage you to promote ryegrass production on some of your bermudagrass pastures to extend the season and quality of grazing, especially if you are calving in February, March and April. A good rule of thumb is to produce one acre of ryegrass per cow unit. Simply broadcast 15 to 20 pounds of ryegrass/acre with starter fertilizer (18-46-0) in October and topdress in February (50-0-0). Seed ryegrass every third year if needed and rely on volunteer growth the other two. This program may not be necessary if you have substantial acres of farmed winter pasture.

Overall Management

The table below illustrates the typical grazing cycles for the above mentioned forage types relative to the general growing conditions:

Forage Type	Grazing Cycle		
	Rapid Growth	Moderate Growth	Slow Growth
Bermudagrass	20-30 days	30-45 days	45-60 days
Nativegrass	30-45 days	45-60 days	60-90 days