UNIVERSITY OF MINNESOTA
Extension
SERVICE

GRAZIER'S ARITHMETIC — Lesson 5

Introduction

Determining the appropriate stocking rate for a particular grazing unit is a key decision affecting the profitability and viability of a grazing operation. Livestock intake and subsequent performance is very dependent upon forage available to the animal on a daily basis. Setting the stocking rate too low results in wasted forage and lost profit potential. Setting the stocking rate too high results in lowered intake and animal output and, very frequently, diminished profits. If a producer has been fairly successful in a traditional grazing system, a fairly good idea of appropriate stocking rate is already available. While in the long term carrying capacity will be increased with improved grazing management, do not expect to increase stocking rate substantially in the first year of a Management Intensive Grazing system.

Seasonal Carrying Capacity

Carrying capacity is the stocking rate that is economically and environmentally sustainable for a particular grazing unit throughout the grazing season. Carrying capacity is largely determined by four factors: 1) annual forage production, 2) seasonal utilization rate, 3) average daily intake, and, 4) length of the grazing season. These terms can be expressed in the mathematical formula below:

Equation 1.

$$\text{Carrying Capacity} = \frac{\text{Annual Forage Production} \times \text{Seasonal Utilization Rate}}{\text{Average Daily Intake} \times \text{Length of Grazing Season}}$$

Annual forage production is the total amount of forage dry matter produced per acre on an annual basis. This would include both hay and pasture harvested from grazed acres. In the formula, this term should be expressed as lbs forage/acre.

Seasonal utilization rate is the percentage of the annual forage production that will actually be harvested by the grazing livestock. This will be very dependent upon rotation frequency and expected level of animal performance. Figure 1 can be used to estimate approximate seasonal utilization rate based on average grazing period length. For example on a 3-day rotation, a reasonable seasonal utilization rate would be 70 percent. Utilization rate is expressed as a unit less decimal fraction in the formula.

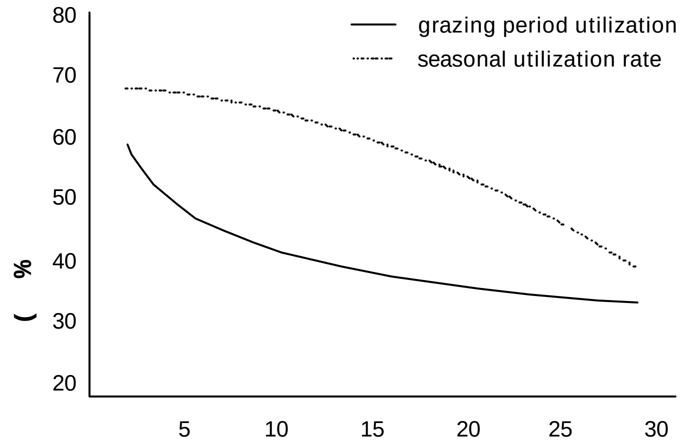

Figure 1. Seasonal and grazing period utilization rates relative to length of grazing period.

Average daily intake should be set at the level that will be required to yield the desired animal performance level. This may well be the most difficult part of the entire process. To accurately determine the appropriate intake value, some estimate of forage digestibility and energy is required. These values cannot be reliably determined without careful forage sampling and laboratory analysis. For this reason we tend to insert arbitrary values in this space and error on the side of overestimating intake. Average forage intake values for high, medium, and low performance of either steers or cow-calf pairs would be 3.5 percent, 3.0 percent, or 2.5 percent as a percentage of the animal's bodyweight.

For example, a 1200 lb. cow of medium milking ability would consume about 36 lbs. of forage dry matter on a daily basis. In the calculation, intake is expressed as lbs. of forage/lb. of liveweight.

Length of the grazing period is a function of how many paddocks are available and the required rest period. Rest period requirements are going to vary for different species and environmental conditions. The choice for length of grazing period must be compatible with the utilization rate used in the calculation as indicated by Figure 1.

When the appropriate values have been entered into the equation and calculations made, the resulting answer is the pounds of animal liveweight that each acre of the grazing unit will support for the indicated grazing season.

As an example, we will assume that an average acre will produce **7600 lbs. of forage annually**. If we plan to use an **average 3 day grazing period**, we find by referring to Figure 1 that the corresponding **seasonal utilization rate is approximately 68 percent**. The livestock will be steers that we hope to have gain 1.5 to 2 lbs./hd/day. This would be a moderate performance level, so **intake** is entered **at 3 percent of bodyweight,** which is **.03 lb. of forage/lb. of liveweight**. It is important to enter intake in this format, not as 3 percent so that units cancel out. We will anticipate grazing the steers from April 20 to October 1 or a total of **164 days**.

We make the following calculation:

$$\frac{7600 \text{ lb forage/acre} \times .68}{.03 \text{ lb forage/lb liveweight} \times 164 \text{ days}} = 1050 \text{ lb liveweight/acre}$$

The 1050 lbs. liveweight/acre is an indication of the carrying capacity of this unit. If we purchase 525 lb. steers, can we stock the unit at 2 steers (1050 lb. liveweight/acre ÷ 525 lb./steer) to the acre? Only on the first day of the season! Why? Because the animals are, hopefully, gaining weight every day and quite likely the average forage availability in August is lower than that in May. If expected average daily gain is 1¾ lb./hd/day, the average weight of steers at mid-season will be 668 lb. (525 lb. + (82days X 1¾lb./day)). Initial **stocking rate** could be set at **1.6 steers/acre (1050 lbs. liveweight/acre ÷ 668 lbs. liveweight/steer**). Remember this is a guideline to help make initial stocking decisions, and not a magical recipe for universal financial success.

GRAZING PERIOD STOCK DENSITY

After making basic farm stocking decisions, the time comes for every beginning grazier to make the actual decision of where to place a break fence or how many animals to place in a particular paddock. That decision is based on the same principles used in the carrying capacity equation discussed above but modified to represent single grazing period conditions rather than seasonal values.

The carrying capacity equation becomes the stock density equation with the following modifications:

Equation 2.

$$\text{Stock Density} = \frac{\text{Available Forage} \times \text{Grazing Period Utilization Rate}}{\text{Average Daily Intake} \times \text{Length of Grazing Period}}$$

Available forage is the quantity of forage dry matter that is actually allotted to the animals for a grazing period. Accurately measuring forage availability is time consuming and expensive so we tend to rely on estimations of yield. The simplest method is to look at a pasture and make an educated guess as to what the forage availability is likely to be. With practice, a good grazier can consistently estimate within 20 percent± the actual yield. A second method relates height and condition of the pasture to dry matter yield. Height X dry matter yield relationships for several types of pasture are given in Table 1.

The stand condition is determined based on visual estimate of green plant ground cover after the paddock has been grazed to a 2-4 in. residual. An **excellent** stand has at least **90 percent** of the ground covered by green plant material or less than 10 percent exposed soil. The **good** condition has **75 - 90 percent** ground cover or 10 - 25 percent bare ground. **Fair** condition has **less than 75 percent** ground cover or greater than 25 percent bare ground exposed. In all cases, moderate soil fertility is assumed.

The following example illustrates how to determine where to place a temporary fence to create a paddock to feed a herd of **100 steers** weighing **600 lb./hd** for **3 days** with a rate of gain objective of **2.25 lb./hd/day**. The pasture is **orchardgrass-red clover 8-10 inch tall** and the area where the steers have just finished grazing has about **20 percent bare ground**. The pasture is **40 acres** and is **660 ft wide**. To use the stock density equation we must first determine the appropriate values.

Forage availability can be estimated from Table 1 using the average sward height of 9 inches and the stand condition as good. The corresponding value for an orchardgrass-legume pasture is approximately 250 lbs./acre-inch, so the available forage is **2250 lbs./acre** (9 inches X 250 lbs./acre-inch).

Figure 1 can be used to estimate the appropriate **utilization rate** for a **3 day grazing period**. As an average daily gain of **2.25 lbs./hd/day** is a high performance objective, utilization cannot be excessive or else intake will be limited. To maintain an intake rate of **3.5 percent of bodyweight**, a **50 percent utilization rate** appears to be appropriate to use in the calculation. Assuming the 3 day grazing period, we can make the following calculation:

$$\frac{\text{2250 lbs. forage/acre} \times \text{.5 utilization rate}}{\text{0.035 lbs. forage/lb. liveweight} \times \text{3 days}} = \text{10,714 lbs. liveweight/acre}$$

The steers weigh **600 lb/head** and each acre will support **10,714 lbs. liveweight**, so the pasture can be stocked at the rate of **17 steers/acre/3 day period** (10,714 lbs. liveweight/acre ÷ 600 lb. liveweight/steer). The herd of **100 steers** will require **5.8 acres/paddock (100 steers ÷ 17 steers/acre)**.

For ease of figuring, assume 6 acres per feed strip. It is better to give a little more and waste a little feed than to allow too little and limit intake. To determine where to place the fence, calculate the total square footage in the 6 acres **(6 acres X 43,560 ft^2 /acre = 261,360 ft^2**) and divide by the known width **(261,360 ft^2 ÷ 660 ft = 396 ft)**. Placing the temporary fence at approximately 400 ft will give adequate forage for the 100 steers for the 3 day grazing period.

It is very important that values used for the parameters in the equation are realistic in how they relate to one another. All of the parameters are interrelated and inserting an inappropriate value for any one parameter will result in erroneous conclusions. For example, if available forage is below 1500 lbs./acre, an intake of 3.5 percent would be impossible to achieve. For this reason, the equation cannot be used as most mathematical formulas where if all but one value is known the remaining value can be calculated. A calculation can be made, but the result may be biologically meaningless.

Table 1. Estimated dry matter yield in pounds per acre-inch for several pasture types and stand conditions.

Pasture Species	Stand Condition (lb/acre-inch)		
	Fair	**Good**	**Excellent**
Tall Fescue + N	250-350	350-450	450-550
Tall Fescue + Legumes	200-300	300-400	400-500
Smooth Bromegrass + Legumes	150-250	250-350	350-450
Orchardgrass + Legumes	100-200	200-300	300-400
Bluegrass + White Clover	150-250	300-400	450-550
Mixed Pasture	150-250	250-350	350-450

AN EVEN SIMPLER APPROACH

For those who find equations like those above a bit intimidating or take a very simple approach to life, forage allocation can be made even simpler. If we compute the average for each stand density, we come up with 216, 325, and 433 lbs./acre-inch for **fair**, **good**, and **excellent** pasture, respectively. If we assume that a **1000 lb. lactating cow will consume around 3%** of her bodyweight, we can figure a **"cow-day" to be equal to 30 lbs. of forage consumed**. If we divide 30 lbs. of forage/cow-day into the lbs. of forage /acre-inch, we find that the **"cow-day" yield of fair**, **good**, and **excellent** pasture to be about **7, 10, and 14 cow-days/inch of pasture consumed.**

This becomes a simple method of allocating pasture: 1) Look at the pasture and determine it to be fair, good, or excellent; 2) measure or estimate the height of the pasture to be allocated, 3) subtract from the total height the height of stubble you want the animals to leave, 4) multiply the difference between starting height and ending height by the cow-days/inch to figure available cow-days/acre, and 5) divide the number of cows in the herd by cow-days/acre to figure how much area should be allocated.

EXAMPLE:

Step 1. We look at the grass and say, "This is average grass" which gives us a cow-day/inch factor of 10.

Step 2. We measure the height to be 8".

Step 3. We would like to leave a 3" residual, so 8" - 3" = 5" to be grazed.

Step 4. 5 inch grazed X 10 cow-days/acre-inch = 50 cow-days/acre.

Step 5. If we have 100 cows, we should allocate 2 acres/day.

If you are going to use a flexible paddock system where temporary fences are strung between two permanent subdivision fences, it is very desirable to set the main fences at a spacing that allows for simple calculation of acre increments. It is very handy to have the line posts in the permanent fences set at known intervals that mark fractional acre increments. For example, if the permanent strips are 300 ft. wide, then line posts at 50 ft. intervals mark about 1/3 acre strips. Forward planning at fence building time can make future operation of the system much simpler.

This example works fine for 1000 lb. cows, but what about other classes of livestock. As grazing management is an imprecise science due to ever changing conditions, we are only looking for an approximation, not perfection. If cows are anywhere in the 900 to 1200 lb range, the simple approach used above will probably be adequate. If you have livestock of different weights, you can add up the total estimated weight of all the livestock in the herd, divide by 1000 and be fairly close to "cow-day" equivalents.

SUMMARY

Initial stocking rate of a grazing unit can best be determined by having an estimate of total forage production from the unit and a target for livestock performance. Do not expect to immediately increase the stocking rate of a particular unit above its current use level without making other improvements in the pasture condition. Daily allocation of forage to livestock can be challenging initially. The examples shown in this lesson offer processes for making educated guesses as to daily stocking decisions, but experience is still the best guide to learning grazing management. No amount of studying and calculating replaces daily experience with a particular group of animals on a particular pasture.

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