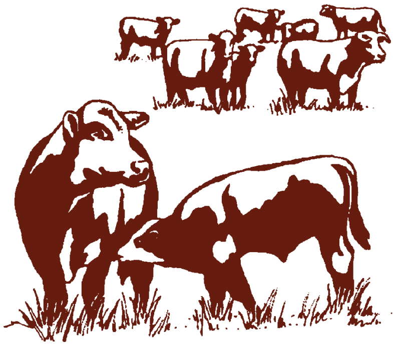

Beef Cattle Handbook

BCH-6100 Product of Extension Beef Cattle Resource Committee

Grazing System Layout And Design

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A smoothly operating grazing system is just like a tool that feels right in your hand. It is a joy to use. Managing a poorly designed system is like using a monkey wrench to drive fence staples, it will work but it sure isn't fun. If a few guidelines are followed, the likelihood of having a smoothly working system is greatly increased. The main considerations for designing a system will be 1) water supply, 2) fence system, 3) paddock size and number, and 4) fitting the system to the landscape.

Water Availability

An adequate supply of good quality water is essential to any livestock operation. Daily water consumption by grazing animals is affected by several factors including ambient temperature and humidity, moisture content of the forage, and production stage of the animal. A beef cow will drink about twice as much water when the air temperature is 90 degrees compared to 60 degrees. Stock grazing succulent pasture can frequently obtain their full water requirement from the forage itself. Young animals will drink a greater volume of water per unit of liveweight than do older animals of the same species. Lactating cows drink 30 - 40 percent more water than their non-lactating counterparts. The water supply system must be designed to handle the high end of the demand spectrum or supplemental water supply must be made available during peak demand periods.

A beef cow on pasture during midsummer will typically travel to water 3 - 5 times daily, depending upon the distance she must travel to water. At each visit to the water tank, she will drink 1 - 4 minutes at a rate of 1 - 2 gallons per minute. By knowing these relationships for cows or other types of livestock, the water demand rate for any herd can be calculated. If 10 cows can get to the tank to drink at one time and each cow drinks two gallons per minute, the tank must either have substantial reservoir capacity, or the control valve must recharge the tank at a rate of 20 gallons per minute. Traditionally the solution to the question has been a large reservoir, based on the typical herd behavior when drinking. By placing water closer to the animals and using a high flow-rate valve, much smaller water reservoirs can be used.

If stock are to be allowed access to water at all times, the maximum distance stock should be forced to travel is one-quarter mile. As stock walk greater distances to water, grazing distribution becomes less uniform, less manure is returned to the paddock, and more and more energy that could be used for gain or milk production is diverted to maintenance. Availability of water in every paddock is the ideal situation and should be the long range objective.

Water Access

In much of the Midwest, stock water is supplied from ponds and lakes. If cattle are allowed direct access to the ponds, water quality is typically lowered, particularly during the summer months when stock are likely to spend time in the water for cooling. Diseases and parasites can be transmitted from one animal to another, if allowed direct access to drinking water sources. Although very little research data is available regarding effect of water quality on performance of grazing livestock, producer experience has often reflected a significant increase in individual performance when access to the water source is restricted.

If a pipeline system cannot be installed, using a fence along the pond bank to limit access to only drinking availability can significantly improve water quality. A single strand electric fence set at the water edge will allow the stock to drink from the pond without allowing wading and prevent fouling of the water. Using large gravel to stabilize the bank and backhoeing a deep drinking area will help maintain the watering area in healthy condition for several years.

In larger scale permanent grazing systems, underground piping will be more appropriate for distributing water to individual paddocks. Size and type of pipe to use will depend upon individual situations and local availability. Pipe size will be dependent upon distance which water is to be transferred, pressure in the watering system, and number and class of livestock to be watered. Larger pipe sizes are required as the distance which water is to be piped increases, due to the frictional loss of pressure as the length of pipe increases. Gravity feed systems will require a larger pipe diameter than pressure systems as they generally operate at substantially lower pressure levels. There is a practical limit to the number of head which can be watered effectively with a low pressure, gravity feed distribution system.

Temporary water systems utilizing plastic pipe laid over the soil surface and movable tanks work well in smaller operations for seasonal use. This type of system allows even more flexibility in keeping stock away from areas used for watering and loafing in preceding grazing periods. These portable water systems are a powerful tool for managing grazing distribution and manure cycling, and should be seriously considered by small to medium size grazing operations.

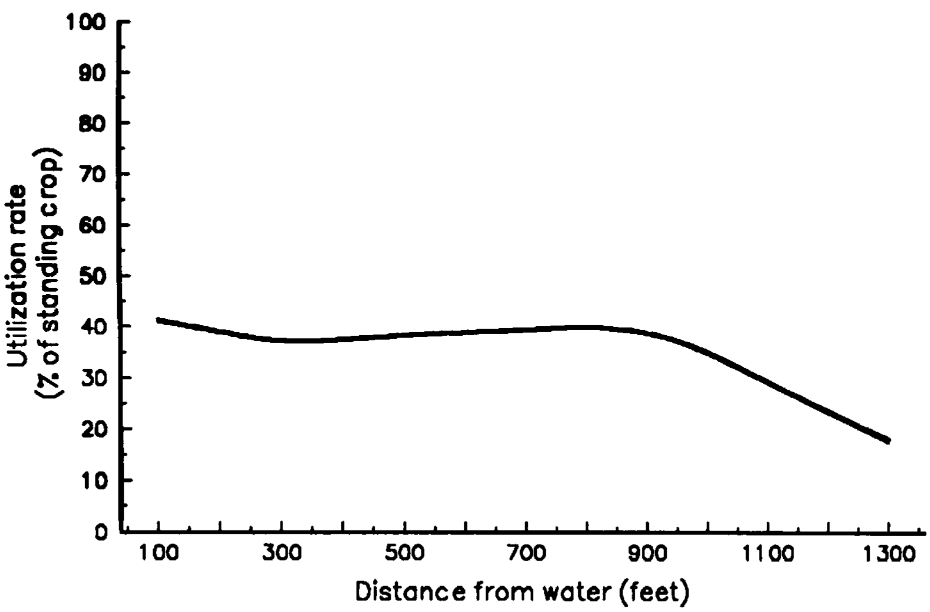

Figure 1. Impact of Distance from Water on Temporal Utilization Rate in Ten Acre Pastures with 4:1 Length to Width Ratio.

If short term capital or labor limitations prevent installation of water in each paddock, it will be necessary to bring stock to the watering site. Access to water is generally either by way of a lane which connects all the paddocks to the water source or the paddocks radiate from a common water source in a “wagonwheel” design. If a lane is used, it should follow a level contour as much as feasible to prevent gully development where animal traffic is concentrated and to reduce animal energy expended by livestock travelling to water. It takes more maintenance energy for livestock to climb hills to reach water compared to walking on a level track. Lanes may be situated on ridgetops, along valley floors, or along any contour line that is convenient. Broadbase terraces on converted crop land make a nice lane.

Width of the lane should not be excessive as this is a sacrifice area that is not going to be very productive. A wide lane encourages loafing in the lane and deposition of manure in that area rather than on the paddock. Research in Missouri found approximately 15 percent of annual manure production was deposited in the lane. If properly placed, 16-24 feet is adequate lane width for animal traffic. If paddocks are expected to be alternatively harvested as hay, it is very practical to have a gate at the back of all paddocks so that machine traffic is not forced to use the livestock lane.

Wagonwheel designs in the higher rainfall areas of the Midwest are limited by the extent to which they can sustain trampling damage during wet weather in the narrow areas near the hub. Most Midwest pastures are simply not large enough to accommodate a true range country wagonwheel. A combination of the two systems can be made to work. If it is not feasible to place water in every paddock, then the use of short lanes coming into a central hub can make the available water facilities go a little further, yet minimize the amount of area sacrificed as lanes.

Gateways into lanes or other central animal traffic points should be placed in the corner of the paddock where livestock ~~would naturally flow to. Setting up pad~~docks and lanes to fit normal animal travel movement will reduce fence maintenance requirements and enhance system performance. Gates should be placed to avoid potential sites for gully development. Gateways from lane into paddocks should be the same width as the lane so that animal traffic in the portion of the lane beyond the current paddock can be blocked.

Paddock Size:

The size of paddock needed for a particular herd is obviously dependent upon forage availability per acre. A more productive crop will support a higher stock density than will a less productive crop. Appropriate stock density is calculated by the following equation:

$$\text{Stock density} = \frac{\text{Available forage X Utilization rate}}{\text{Intake X Length of grazing period}}$$

The amount of forage standing in the pasture can be measured by cutting and weighing or other complex methods but out on the farm this part of the operation becomes largely an visual art. With a little experience it is not too difficult to judge the amount of forage present. Most good stockmen can look at a pasture and say, "That will feed 50 cows for three days." Judging approximate forage availability on a per acre basis can be learned with a little practice. In the equation, availability should be expressed as pounds of forage per acre.

Utilization is largely controlled by the length of the grazing period (Figure 2) but must also be adjusted to reflect the desired performance goal for the livestock involved. Forcing the animals to over utilize the pasture is the quickest path to having a performance wreck. Utilization is expressed as the percentage of the original available forage that the livestock will actually consume.

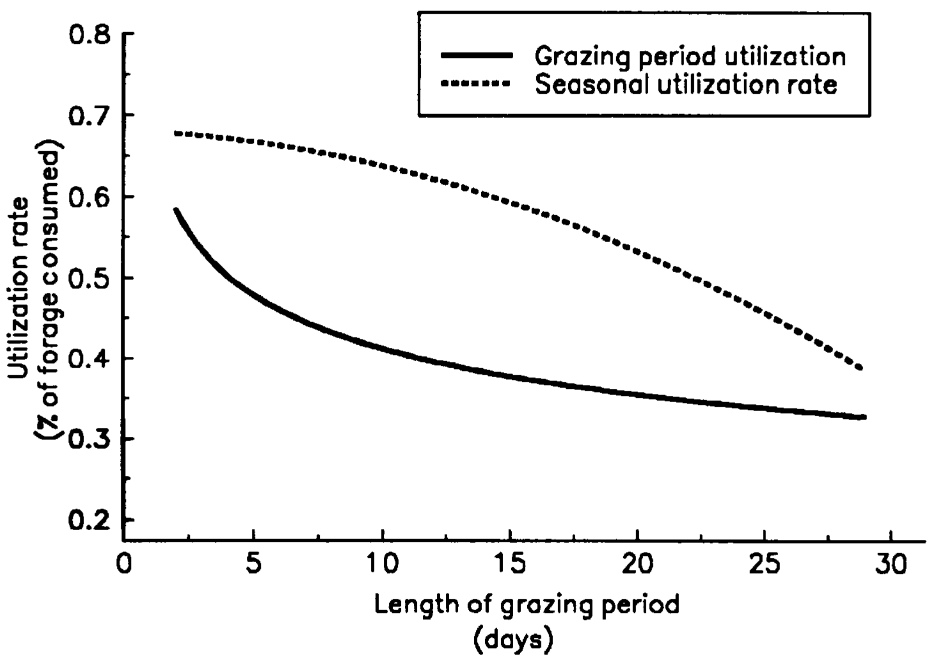

Figure 2. Impact of Length of Grazing Period on Both Seasonal and Temporal Utilization Rates.

Daily intake requirements can be determined approximately from NRC tables. These tables are available from your local extension office and give the daily feed requirements for most classes of livestock. These are average figures calculated under controlled conditions, so always err on the side of being conservative. If the table says an 1100 pound lactating cow will eat 21.6 pounds of dry matter a day, figure that she will eat 27 pounds. To use the equation, the intake must be expressed as pounds of forage per pound of animal liveweight. As a rule of thumb, figure 2.5 - 3% of bodyweight for breeding animals and 3 - 3.5% for growing stock. You might find you're wasting some feed, but that beats running out!

To decide what size paddocks should be, add up the total liveweight of your herd that will run as a single grazing unit, divide that total weight by the desired stock density calculated with the equation above and the answer will be the approximate number of acres that each paddock should be for a single grazing day. If you want a three day grazing period in each paddock, then multiply your answer by three.

Number Of Paddocks:

The optimum number of paddocks will vary with both pasture species and animal type due to desired utilization and performance goals, resistance to grazing, regrowth habit, and economic potential. The ideal system is to have grazing animals move daily to a fresh paddock. The advantages of such a system include minimal feed wastage, consistent forage quality each day, rapid uniform grazing, and more uniform manure distribution. To begin to realize these advantages, grazing periods should be less than four days. To achieve a four-day grazing period, a system should have a minimum of 10 - 15 pastures to allow the appropriate rest period. Most producers quickly see the advantage of more paddocks and move in that direction.

The actual number of paddocks required for a particular grazing cycle is determined by the necessary rest interval required for that particular pasture mix under the current environmental conditions and by the maximum number of days that animals should be left on a paddock. Typically the carbohydrate replenishment cycle in forage plants takes 20 - 40 days, therefore, this is the range in rest interval we should be generally considering. Under good growing conditions, a 20 day rest may be plenty whereas in midsummer, a cool season forage may require 40+ days to reach a state of positive CHO balance due to high respiration rates. Flexibility in management is required to maintain the desirable level of forage availability and quality for the herd grazing a particular set of paddocks. Changing relative length of grazing period and rest period, degree of utilization and residual height, and using mechanical harvesting are all tools used to maintain desired pasture conditions without changing stocking rate.

Resistance to grazing damage can also affect the necessary number of paddocks. For species which elevate their growing point quickly, a short grazing period is critical to prevent damage to regrowth potential. The grazing duration should be long enough and the stock density adjusted such that a flush of growth will be grazed off before new shoots or leaves elevate to grazing height, usually a maximum of three to seven days depending upon species and weather. Another point to remember is that with a shorter grazing period, the fluctuation in forage quality from the first grazing day to the last grazing day in each paddock is minimized.

As a general rule, paddocks should be sized to provide similar numbers of grazing days, not be the same physical size. A more productive paddock may be five acres while an adjacent paddock on a poorer soil site may need to be eight acres to provide the herd with three grazing days from each paddock. It is much more important to keep the livestock on a fairly consistent rotation frequency than to have all the paddocks on the farm be the same size.

Paddock Shape:

Paddock boundaries which follow approximate contours and changes in soil type allow the producer to better select forage species adapted to a specific site. For example, orchardgrass-alfalfa might be sown on good upland soils, fescue-trefoil on eroded slopes, and canarygrass in a bottom, and each area fenced as separate pastures or sets of multiple paddocks. On more gently rolling land it may be desirable to harvest hay or silage or even crop some paddocks from time to time. In this case, sharply angled fences and tight corners are undesirable.

Where land allows, uniform sized paddocks with parallel sides are most desirable. Paddocks with low length to width ratios tend to be grazed more uniformly than long, narrow paddocks. Long narrow paddocks are frequently grazed much more heavily in the front portion of the paddock compared to the back part of the paddock. As distance from water increases, this becomes a more and more significant factor. On small grazing units where livestock are never more than several hundred feet from the water source, shape is less critical. The shorter the grazing period, the less critical shape becomes. Cattle take about three days to establish a strong grazing pattern within an individual paddock. As cattle are allowed to remain on a paddock beyond three days, spot grazing and pronounced cattle trails will begin to develop. When the cattle return to this paddock in future grazing cycles, the pattern is already established and they will begin to follow those patterns on the first and second day of grazing.

The amount of fencing required to subdivide a large tract into paddocks can vary greatly depending upon the shape and layout of paddocks. Frequently, fencing needs can be cut 10-30 percent by considering different layout options. In most situations we find that a subdivision based on uniform paddocks of low length to width ratio with water in every paddock or a central alleyway to water to be the most efficient fencing layout. On many farms with rough terrain and broken up by timber and creeks, the ideal will be impossible, and numerous trial and error measurements are the only way to find the best design. Working with detailed aerial photos and soil maps will allow the producer to overlay many system designs on the landscape before the first fence is ever built.

Summary

Developing a practical water distribution system is the first step in designing an efficient grazing system. Sizing paddocks to the projected herd size based on forage production potential will keep the frequency of cattle shifts fairly consistent. Designing paddocks to fit the landscape will reduce problems with uneven grazing distribution and wide variance in rotation frequencies.

Table 1. Effect of Pipe Size and Pressure Head on Water Flow Rate in a Gravity Flow Situation.

Pressure Head	Pipe Diameter 1”	1.5”	2”
	(gallon/hour)		
6 foot	285	840	1790
12 foot	405	1185	2535

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This publication was prepared in cooperation with the Extension Beef Cattle Resource Committee and its member states and produced in an electronic format by the University of Wisconsin-Extension, Cooperative Extension. Issued in furtherance of Cooperative Extension work, ACTS of May 8 and June 30, 1914.

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