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ATTRA Grazing Planning Manual and Workbook

By Lee Rinehart
NCAT Program Specialist
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Contents

This manual provides all the resources you need to write your own grazing plan, monitor its efficacy, and adjust your management throughout the grazing season. Periodically reviewing your plan and records will help you assess how well you are working toward your goals, and will suggest ways to improve the next season. The manual starts with a discussion of grazing principles and how to conduct a resource assessment, followed by a step-by-step process for writing a grazing plan. A template and instructions are provided. This manual covers the importance of developing a simple pasture-monitoring system and provides further resources to assist producers with planning, charting, and recording grazing throughout the season. Additional resources help you understand grazing concepts, as well as obtain access to some good, online tools for recordkeeping and monitoring.

Photo: Lee Rinehart, NCAT

Introduction

Planning is the first step in any successful farm enterprise. The benefits that accrue to graziers from having a grazing plan include greater forecasting ability for grazing decision-making, extension of the grazing season, more consistent supply of forage, greater dry-matter intake from pasture, and increased pasture sustainability.

Implementing an effective grazing plan is about applying observation to management, observing some more, adjusting as needed, and recording your plan in a simple, easy-to-access format. There are five steps in developing a grazing plan: (1) set goals; (2) inventory resources; (3) match available forage to animal needs; (4) develop a grazing schedule; and (5) monitor the effectiveness of the grazing plan.

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This manual was developed to be a logical tool to help you write your plan. Each section builds on the previous and is designed to be used with the grazing plan template. Using this manual, you can capture crucial information to help you make adjustments from season to season and year to year.

There are many benefits to having a grazing plan and schedule. They allow a producer to balance forage productivity with animal intake requirements, plan pasture use before the grazing season starts, and obtain accurate information on forage productivity and use. They also provide documentation for programs and certifications, such as NRCS conservation programs and organic certification requirements.

Related ATTRA Publications
www.attra.ncat.org

Managed Grazing Tutorial

Grazing Calculator: Extended Cow Calf Pair

Integrating Livestock and Crops: Improving Soil, Solving Problems, Increasing Income

Irrigated Pastures: Setting Up an Intensive Grazing System That Works

Paddock Design, Fencing, and Water Systems for Controlled Grazing

Pasture, Rangeland, and Grazing Management

Why Intensive Grazing on Irrigated Pastures?

Grazing Basics

Pasture Dynamics

A pasture is a dynamic ecosystem encompassing numerous complex interactions among organisms and elements. Managing livestock grazing involves an understanding of these interactions and relationships. The sun drives the system, providing energy for plants to generate sugars from oxygen, carbon, and hydrogen. These sugars feed the plants and the microorganisms associated with them in the soil profile. Soil microorganisms move nutrients around, feeding themselves and contributing to the plants' nutrient needs through mineralization, while producing glomalin that holds soil particles together in aggregates. These aggregates, or large, porous soil particles, provide habitat for microorganisms, pore space for water and air, and storage for nutrients. Finally, animals, bacteria, and other organisms complete the cycling of nutrients through grazing, feeding, and contributing organic matter back to the soil. A soil that is well aggregated, rich in organic matter and biological life, and grazed appropriately is a resilient ecosystem, and is resistant to drought, erosion, and nutrient leaching. Think of it as one big merry-go-round of cycling nutrients and water.

Perennial pastures, because of permanent cover and the lack of soil disturbance, are higher in carbon and organic matter than tilled crop fields. This provides a stable habitat for microorganisms, and the nutrient cycles can sustain themselves.

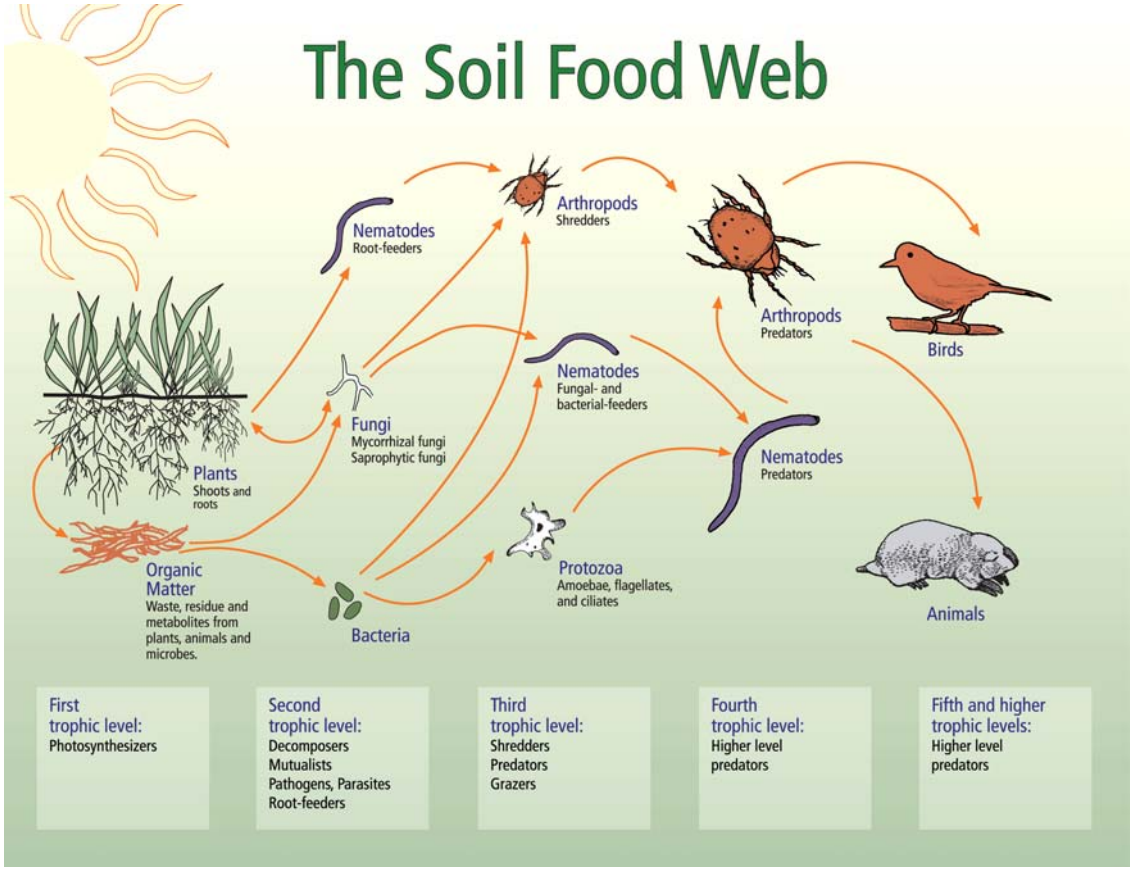


Illustration: USDA Soil Biology Primer

Learn about how you can manage your livestock to improve soil health, pasture condition, and your bottom line with the ATTRA *Managed Grazing Tutorial.* The lessons are taught by National Center for Appropriate Technology specialists who are also livestock producers, and they share years of experience managing their own pastures. Detailed presentations and real-world examples will get you on the road to managed grazing. Check out the free tutorial at www.attra.ncat.org/tutorials/grazing/. For an ATTRA video on a farm's multi-paddock grazing, see ***Intensive Grazing: One Farm's Set Up***, www.youtube.com/playlist?list=PLDu0ElBiEy9w4vhL87vWjzCtyazcvPYGx.

However, adding livestock to the mix has a multiplier effect on soil health, even in systems that are cover-cropped with a cash crop as part of the rotation.

The impact of grazing is known to increase soil carbon and nitrogen stocks. As an animal grazes, it sends a signal to the plant to pump out sugars through its roots and into the surrounding soil, or rhizosphere. These root exudates (sugars developed by the plant through photosynthesis) are food sources for the microorganisms in the soil. The action of grazing jump-starts the soil food web and increases nutrient cycling, making nitrogen, phosphorus, and carbon available to the growing plants.

Soil Fertility

As a grazier, you can take advantage of the benefits of grazing and plant diversity to build healthy soils and provide fertility to the system, while using less fertilizer and pesticide. Diverse perennial pastures and cover crops in annual rotations contribute organic matter to the soil and feed microorganisms that ensure nutrient cycling. Soils that are well aggregated with various-size soil particles, and that have many different plants growing for most of the year, are resilient and restorative.

And when you add a well-managed grazing plan to the system, you get the benefit of animal impact that contributes organic matter and biology to the soil system. Increases in soil aggregation, organic matter, and diversity buffer soil temperatures, preserve water, and minimize soil compaction. In short, the functionality of your soil improves.

A diverse pasture mix of rye, peas, and brassicas builds healthy soil and provides high-quality forage. Photo: Lee Rinehart, NCAT

In order to ensure fertile and productive soils, incorporate the six principles of healthy soil into your management:

1. **Minimize tillage**—this preserves soil structure, encourages aggregation, and keeps soil carbon in the soil profile where it belongs. Tillage brings a flush of oxygen into the soil that spurs microbes into a feeding frenzy on carbon molecules, resulting in CO_2 release. Tillage is reduced through the use of perennial pasture and minimum tillage or no-till for cover crops.
2. **Maintain living roots year-round**—this feeds soil microorganisms all year and maintains healthy microbial populations. The carbon in roots, leaves, and stems provides food for microorganisms, and a fallow period will slow down biological activity.
3. **Protect the soil with residue and living plants**—year-round cover forms an "armor" on the soil to protect it from moisture loss and buffer soil temperature.
4. **Maintain crop/pasture plant-species diversity**—this is achieved with cover crop mixes and the use of diverse perennial pasture mixes. Try to incorporate warm-season and cool-season plants, both grasses and broadleaf plants, in the same fields.
5. **Manage grazing for plant recovery**—plan for an appropriate grazing-recovery period on your paddocks, keeping in mind that plants need various recovery periods depending on the species, the time of year, and the soil moisture content.
6. **Use animal impact to contribute organic matter**—livestock provide nutrient cycling in pastures, contribute to soil organic matter, and graze forage plants to encourage root growth and root exudation of plant sugars that feed soil microorganisms.

For more detailed information on soil fertility, including nutrient cycling, soil management principles, and practices to build healthy soil, see the *Fertility* lesson in the ATTRA *Managed Grazing Tutorial* at www./attra.ncat.org/tutorials/grazing.

Grazing Systems

A grazing system is just an organized, planned way of using the pasture resource to ensure that the animals receive the right amount of high-quality forage while maintaining the productivity and vigor of the pasture and soil. A grazing system should result in the highest forage production and use per acre, have variable stocking rates based on the pasture plants' need for recovery, provide an even distribution of manure, control weeds through grazing or trampling, and provide more grazing options while reducing the need for mechanically harvested forages for most of the year.

The best way to ensure this is to develop a grazing plan and schedule that rotates animals from paddock to paddock and allows adequate time for plant recovery. Consider the following principles in planning a grazing system:

1. Managing recovery and grazing periods
2. Using animal impact to benefit the pasture and soil,
3. Setting up the right size and number of paddocks, and
4. Lengthening the grazing season for more time on pasture

Grazing period is the length of time animals are exposed to a paddock and is important in maintaining post-grazing residual.

Recovery period is all about plant regrowth and is fundamental to developing a grazing schedule. It is important to plan for increasing recovery time when grass growth slows down. Grazing period is the length of time animals are exposed to a paddock and is important in maintaining post-grazing residual. Be sure to allow adequate stubble height and enough leaf area for plant regrowth, or you'll slow the process down. Following are some things you can do to help manage recovery and grazing periods:

- Graze early-spring pasture to remove top growth and allow grasses to tiller and get more dense.
- Machine-harvest excess early-spring growth to capture dry matter and allow grass to regrow for the next grazing cycle.
- Follow high-producing cows with dry cows, but make sure they don't stay in the paddock too long.
- Provide supplemental pastures when pasture growth is slow and decrease grazing period when growth is rapid, leaving some grass behind.
- Reduce stocking rate by selling young stock or culling as needed; do not allow too many animals to degrade forage and soil resources.
- Feed stored forages when necessary to protect resources, such as during drought.
- Quicker paddock moves give animals fresh un-fouled (manured) ground, meaning better intake.

High animal density is a useful management tool that allows plants to be grazed more evenly. It encourages a more even distribution of urine and manure and returns a substantial amount of carbon (trampled organic matter) to the soil to feed soil microorganisms. Livestock that are more concentrated on a paddock tend to consume a more diverse diet, as grazing selectivity for the most palatable plants decreases. In addition, high animal impact forces plants to grow closer together, forming tighter plant communities and decreasing bare spots. High animal density for short periods of time (several hours to a day per grazing period) more efficiently uses grazing resources, but requires more frequent animal moves from paddock to paddock. Animal densities of greater than 100,000 pounds per acre are recommended. There is great potential to increase the numbers of paddocks and the number of animals on a farm through high-density, multi-paddock rotational grazing.

The next principle to consider is *paddock size and number*. How big should they be, and how many should you have to ensure animals get enough dry matter intake and the forage base stays healthy? This is likely the most important, most fundamental question a grazer can ask. Everything else stems from this. As you work through this manual, you'll find that calculating paddock size and number is what will balance the amount of forage you have with the number of animals you are grazing.

Recommended maximum grazing periods: one to two days for dairy and three to four days for all other classes of livestock.

Animals must remain in a paddock long enough for them to get their fill, but not so long that they begin to graze plant regrowth. Plants may have grazable regrowth after two to three days, and the shorter the period in the paddock, the better the plant and animal production per acre. Short grazing durations also foster increased animal intake and provide higher quality forages than if the animals are in the paddock for longer periods of time. In fact, as animals remain in a paddock (for more than a few days) their intake of protein decreases, as does availability of high-quality digestible dry matter (energy). This is one reason dairy producers who graze high-producing cows will move animals to a new paddock daily, or even a few times a day.

Overgrazing

Overgrazing is not merely a function of how many animals are on a paddock, but how long they remain there. Time is an important factor in grazing management. Continuous grazing allows livestock to selectively graze the most palatable plants over and over. Plant roots and leaves do not have the time to regrow before the plant is grazed again, creating a loss of both, resulting in less root exudates and less top growth. New growth is more palatable and digestible than older growth, so animals will graze new growth unless they are moved off the paddock. Paddock grazing periods should be short enough that any particular plant is grazed only once. Frequent movement from paddock to paddock is a way to ensure that all plants have ample time to re-grow after grazing. In addition, a high stock density encourages animals to graze the paddock more uniformly than if it was lightly stocked. In this situation, the "weedy" species are being grazed at the same intensity as the "good" species. Managed grazing decreases overgrazing and builds dense, diverse, and healthy forages.

Paddocks should be sized small enough for uniform grazing of forage while providing enough dry-matter intake for the livestock during the grazing period. This manual will help you determine paddock size as a way of balancing your livestock's feed requirements with the amount of forage growing in the paddocks. In the next section, we will discuss resource assessment, including estimating forage dry-matter availability. With this, and an estimate of your livestock's forage needs, your grazing plan will begin to take shape.

Your grazing plan may need to be adjusted as the season progresses, due to precipitation (either a lack or an excess) and forage growth. This can be done by either speeding up or slowing down the rotation, or adjusting the size of the paddocks. For example, if you have to keep animals on a paddock a long time, it most likely indicates surplus forage (i.e., early season), and you may have to either adjust your paddock sizes, harvest excess forage with other livestock, or take it off as hay. On the other hand, if your livestock are eating faster than pasture can grow, you may need to sell some stock or find another pasture to use.

The *Grazier's Math* worksheet provides details on how to balance forages with animal requirements by determining recovery period, grazing period, paddock size, and number of paddocks. You can record this information on the *Grazing Plan Template*.

The *Grazier's Calculator* is an easy way to match forage production with animal demand. If you choose to use this tool, you will need to enter the following values:

- Grazing dates
- Total acres
- Forage production in dry-matter pounds per acre per day
- Recovery period in days
- Grazing period in days
- Animal feed intake demand in dry-matter pounds per day
- Number of animals
- Grazing utilization (percent of forage that will be consumed by the animals, leaving the rest as a residual for plant regrowth and soil organic matter)

For more on the *Grazier's Calculator*, refer to the *Grazier's Math* worksheet. You can download the calculator at https://attra.ncat.org/attra-pub/summaries/summary.php?pub=575.

Putting time and energy into planning paddock sizes and moves leads to efficiencies of pasture use. Go even further by thinking how you can extend the grazing season and take advantage of reduced feed costs. Lengthening your grazing season can be accomplished by grazing winter crops or stockpile, grazing annual cover crops prior to a cash crop, or seeding annuals in the warm season, when cool-season plants decline. Think of cool-season annual grasses such as ryegrass and

cereal grains, forage brassicas such as kale, rape, and turnips, warm-season annual grasses such as sorghum-sudan hybrids, pearl millet, and corn, or legumes such as Austrian winter pea (cool-season) and forage soybeans (warm-season). In addition, stockpiling pastures such as bermudagrass, tall fescue, and reed canarygrass can add months of grazing when the grasses go dormant. A diversity of crops and pasture species provides forage for grazing livestock for more of the year, and feeds the soil microorganisms that drive nutrient cycling. For more information on grazing for a longer portion of the year, see *Extending Grazing and Reducing Stored Feed Needs*, a Grazing Lands Conservation Initiative publication listed in the Further Resources section.

Finally, a grazing plan will result in a *grazing schedule*. A schedule allows you to chart the grazing events visually for each management unit throughout the season and over the years and, when used with a monitoring plan, can assist in refining and adapting the grazing system over time. A grazing schedule can serve as a summary of all management activities and monitoring conducted on each pasture.

A grazing schedule can serve as a summary of all management activities and monitoring conducted on each pasture.

Some of the items you might incorporate in a schedule include the following:

- Forage production values for each unit
- Forage use in each unit for the class of livestock grazing
- Forage balance, or the prospective surplus or deficit of forage after the grazing event
- General observations, such as how long animals should graze a particular pasture, rainfall, calving dates, etc.

Developing a grazing schedule will be discussed in the *writing the grazing plan* section on page 7. But first, as with any good plan, you should take stock of your assets. This will be discussed below in the *resource assessment* section.

Goals and Resource Assessment

You'll need to have an idea of your goals and farm assets to write and implement an accurate grazing plan. Assessment should be an ongoing endeavor, beginning with an initial inventory and then adjusting periodically through monitoring to fine-tune your plan. This will help you become more accurate at managing grazing.

Start with your farm goals. What are your overarching purposes? What do you want to get out of your whole-farm plan? Perhaps you are interested in conserving sensitive areas, or renovating poor-performing soils. Write these down and mark them on a farm map. Maybe you would like to increase the diversity of pasture-plant species composition, or maximize animal production. And don't forget marketing. How will you sell your animals or products? What is the yearly schedule for this and how does it affect the seasonal flow of tasks and management events such as calving, lambing, or weaning? What effect do these events have on your pasture needs? Think about your financial goals. What in your grazing plan costs money, and what will make you money? How can you become a more efficient grazier so you can minimize costs while maintaining an adequate cash flow? And finally, what about estate planning and succession? Do you have a plan for transferring the farm to a family member or selling to another farmer when you have finished your farming career? How will you involve them in your plan so they understand the natural-resource carrying capacity, the soil types, the grazing system, and the markets?

Next is a resource inventory. Here you will list the numbers of various classes of livestock currently on the farm. Include potential numbers for the future in order to achieve farm/ranch goals. Animal numbers should include brood cows, bulls, calves, yearlings, replacement heifers, ewes, lambs, horses, etc., and must also include the weights of the animals in order to match forage resources to animal demand.

Use the *Grazier's Math* worksheet or the *Grazier's Calculator,* which have some simple methods for estimating forage yield, and record the forage yield on your grazing plan (see the *Grazing Plan Template*).

- Record pasture and paddock acreage, number of pastures or paddocks, and dry-matter forage production estimates for each unit.
- Record animal types and classes (cows, ewes, calves, lambs, dry animals, etc.) with their average weights, and dry-matter forage demand in dry-matter pounds per day for each type and class.
- List fencing (perimeter, pasture and paddock divisions, corrals, working facilities, etc.), stock water (sources, equipment, flow rates, water tests), and shelter.

You'll also want to provide details on the forage resources of each paddock or pasture on the farm. List your total acreage, annual precipitation, precipitation in a drought year, irrigation if any, a basic description of your soils and any soil problems, and your average annual forage productivity. Consider documenting any weed problems, critical areas, and general observations that you have on your pastures. This will help you as you review your grazing plan each year to assess its efficacy.

Once you have your resource inventory, you're ready to write your grazing plan.

Writing the Grazing Plan

There are several tools in the workbook that will help you write your grazing plan. Here you'll find the following instructional worksheets:

- A grazing plan checklist
- A grazier's math instructional worksheet to match forage to animal demand
- A clip-and-weigh forage measurement instructional worksheet, for optional objective measurement of forage yield
- A grazing plan template, to record inventory and forage/animal balance
- A monitoring checklist

Your grazing plan will detail, in one place, the elements of your farm that make up your grazing system. The *Grazing Plan Template* was developed to assist you in doing this. You can use it to record your farm description, your goals, your resource inventory (landscape, livestock, and infrastructure), and your grazing calculations to balance forage with animal demand. Other elements can be included, such as your weed plan and how you will manage drought and periods of low forage productivity.

Elements of the Grazing Plan Template

Farm description: Record basic farm information that matters to your grazing enterprise. This is a go-to source for planning your grazing season year by year, and includes space to document your farm name and location, climate (mean annual precipitation and air temperature and rain and dry season, first frost, last frost, frost-free days), grazing-season length, soil types, and predominant pasture species.

Goals description: Record the goals for your operation, including leadership structure, conservation goals, pasture goals, animal goals, financial performance goals, and marketing goals.

Use the grazing plan to help you think through short- and long-term planning. Ask yourself the following questions and document them on your plan.

- What are your goals for the operation?
- What are your resources for forage, infrastructure, and livestock?
- What are your soil types and fertility needs?
- How and what will you monitor?
- How will you handle drought, weeds, or excess forage?

Resource inventory: Document your inventory for land, livestock, and infrastructure. Important items are a record of forage demand of livestock in pounds of dry matter per head per day, and an estimate of the amount of forage available.

Forage/animal balance: Document how you will allot your forage resources to animal needs. This is accomplished by simple grazing calculations to match forage resources to animal demand. Forage productivity in each pasture is averaged and

Sample forage inventory

Grazing season	Date range	Acres	Forage production in pounds per acre per day	Recovery period in days	Forage production in pounds per acre at turn in *Forage production in pounds per acre per day X recovery period*
Example	*May 1 to June 5*	*80*	*107.14*	*35*	*3,750*
1					
2					
3					
4					
5					
6					
7					

matched with animal demand to determine the amount of use of the grazing resource and to plan for sustainable grazing in the future. The length of your rest period and paddock grazing periods will determine the number of paddocks in your pasture.

The recovery period and paddock grazing period determine the number of paddocks in a pasture according to the formula (Rest Period/ Grazing Period) +1. The forage production and animal demand then determine the stocking rate with any paddock size, which determines the stocking density. Use the *Grazing Plan Template* and/or the *Grazier's Calculator* to balance available forage with livestock demand.

The Grazing Schedule

There are many tools available to help you plan and monitor your grazing system. What is most important, though, is that the tool be simple and accessible, so that it is easy to use. And if all of your information is available in one place, so much the better.

One method that meets these criteria is a grazing chart. One of the most notable is the grazing chart developed by Troy Bishopp, a New York grazing specialist and contract grazier, which offers graziers the ability to track grazing each day. There is plenty of room on the chart to record production information, weather and precipitation, recovery periods, or anything else that you think important to track.

Sample forage/animal balance

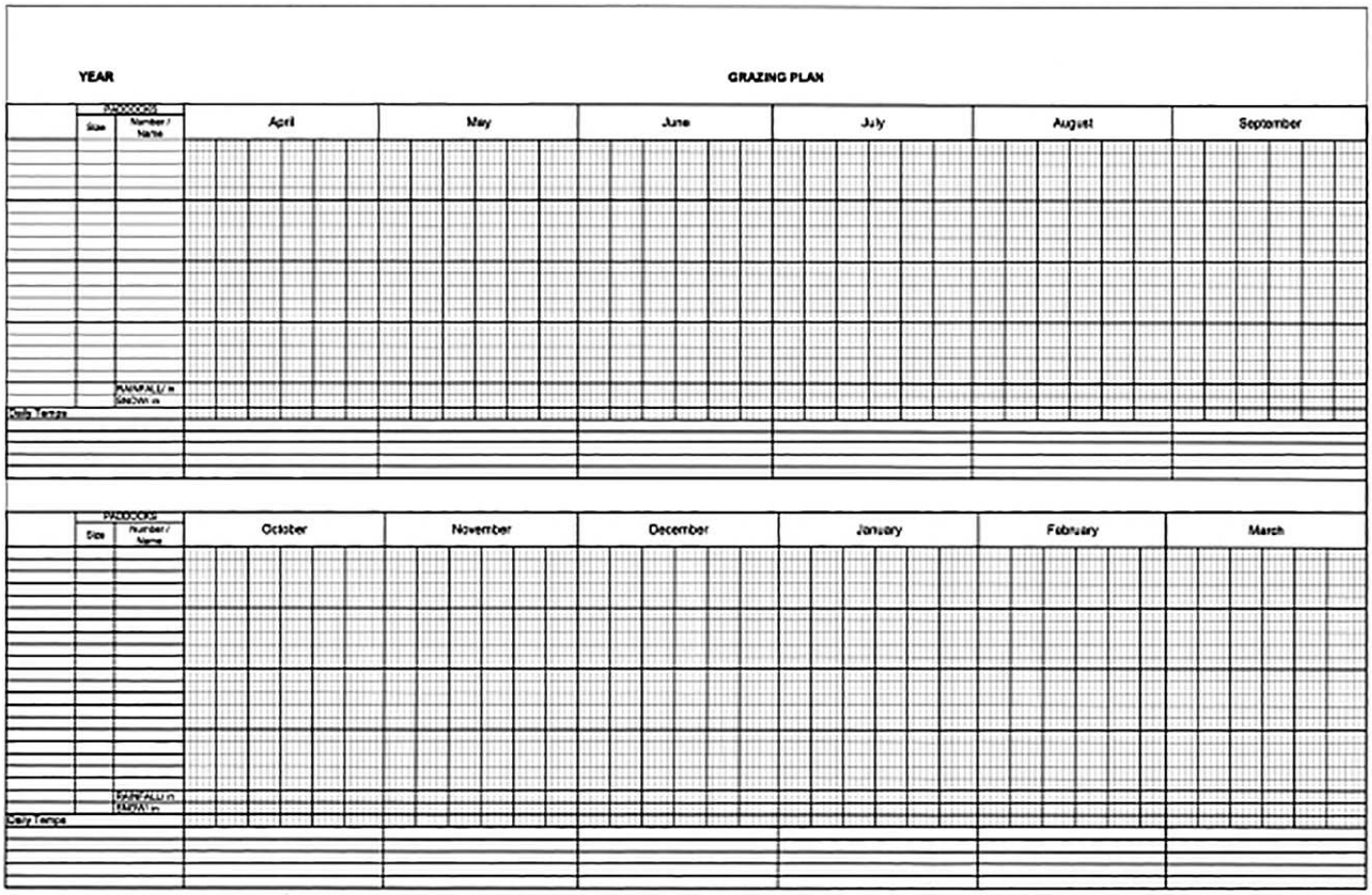
Grazing Season	Acres	Number of Paddocks *	Average Paddock Size *	Forage Production Per Paddock*	Grazing Utilization*	Paddock Residual lbs. *	Paddock Residual LBS. per Acre	Forage Available per Paddock	Grazing Unit Demand *	Forage Inventory Vs. Grazing Demand: Adequate or Deficient
1	80	36	2.2	9333	0.5	4667	2100	4667	3900	767
2	80	41	2.0	9366	0.5	4683	2400	4683	3900	783
3	80	41	2.0	10927	0.5	5463	2800	5463	3900	1563
4	80	24	3.4	6128	0.8	1532	450	4596	3200	1396

The *forage/animal balance* is based on the interaction of the length of your recovery period, your grazing period, and forage growth.

The more paddocks you have, the better, and they should be small enough for uniform grazing of forage and flexible enough to allow for adjustment as the grazing season progresses. Your *grazing efficiency*, or overall forage growth and harvest per acre, increases as the number of paddocks in your pasture increases. This is because any given place in your pasture has more total days of recovery as paddock size decreases (or number of paddocks increases).

Troy Bishopp's grazing charts can be downloaded from his website, http://thegrasswhisperer.com/grazing-assistance/. Detailed information on using the grazing chart is available at Troy Bishopps's website. *On Pasture* also has an article on how to use the charts at http://onpasture.com/2017/01/02/the-new-grazing-charts-are-here-the-new-grazing-charts-are-here.

Sample grazing chart. Courtesy of Troy Bishopp



The grazing chart is a tool that can be customized based on your own goals, constraints, and needs for documentation and recordkeeping. You can choose the events, indicators, and management tasks that are most important to you, such as animal weights, breeding, calving or lambing, grazing days, paddock recovery period, rainfall or snowfall, temperature, forage yield, forage residual after grazing, and monitoring data, just to name a few. Pasture monitoring is particularly important because the information obtained will inform grazing planning for subsequent grazing seasons, thus giving you a feedback loop to validate and update your grazing calculations.

PastureMap is a ranch-size-scalable app for drawing and subdividing pastures, recording acreage, infrastructure, and grazing moves, and managing herds by logging daily gain and forage intake. Access the app at http://pasturemap.com/.

Grazing System Operation

By this time you've got a sense of the concept of planned grazing. You've conducted a resource assessment and have gotten an idea of how much forage you have and how many animals it will support. You've also developed a schedule for grazing to allow for pasture recovery and have a plan for how you will rotate livestock through your grazing system. Now, it's time to look at the mechanics of grazing and how to get set up.

Setting up the Paddocks

Pastures should be divided into paddocks that will serve as grazing units, where livestock will graze a specific amount of forage (based on their demand) for a specific time period. The actual number of paddocks and their associated grazing times will be determined by the paddock recovery period. The shapes of the paddocks will depend on many factors. Topography, water sources, roads, grazing access lanes, and existing fencing are potential

obstacles to overcome. You'll need to get a map of your farm to best plan out your paddock sizes and shapes.

Maps can be obtained from your local NRCS conservation planner, or you can search for your farm on a mapping program such as Google Maps. Print the map and walk your fields, taking note of obstacles, fencing, and ease of access. Make sure the animals have access to working facilities, the milking parlor, water sources, and shade. If shade is a limiting factor, portable shade units can be employed. Keep in mind, however, that this will influence manure and urine distribution; hence pasture fertility. For more on this, refer to the Fertility lesson in the ATTRA *Managed Grazing* tutorial.

Square paddocks work well for encouraging uniform grazing. Long, narrow paddocks may not work very well because livestock tend to graze one end of the paddock more intensely, but with high stock density (100,000 pounds or more of live-animal weight per acre), livestock will usually graze an odd-shaped paddock from one end to the other with no problems. In general, maintaining high animal density encourages more uniform grazing. In addition to efficient forage utilization, high stock density also allows for uniform urine and manure distribution, enhancing soil fertility.

Dividing paddocks will necessitate some kind of fencing. You likely have existing perimeter fencing and maybe even a few divided pastures you can start with. Ensure your perimeter fencing is more than adequate to keep livestock out of roadways, streams, and the neighbors' fields. High tensile fencing or even 12.5-gauge, two-point barbed wire work well for cattle, and woven wire for sheep. The internal fencing that will divide your paddocks is much simpler and less costly.

Poly tape, poly wire, poly nets, and cable are the typical choices of graziers for subdividing pastures. Missouri NRCS has an excellent publication, listed in the Further Resources section, that describes each type and provides guidelines for installation and maintenance. For information on grazing system design, paddocks, and fencing, see the ATTRA publication *Paddock Design, Fencing, and Water Systems for Controlled Grazing,* available at https://attra.ncat.org/attra-pub/summaries/summary.php?pub=249.

Electric Fencing for Serious Graziers, a publication from Missouri NRCS, provides detailed information on energizers, grounding, selecting wire, installation, tools, floodplain fences, and troubleshooting. Access the free publication at https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_010636.pdf

Water is the most important nutrient for grazing animals. Without access to clean water, protein, carbohydrates, and minerals will not be metabolized by the animal. Within a planned, rotational grazing system, water access is a serious logistical consideration.

The considerations for water delivery are placement, distribution, quantity, and materials. Watering points should be easily accessible and easy to maintain. Ponds and stream access points are the simplest sources of water and, if protected with livestock access controls, can be a good source of water. But ponds and streams are often not accessible from all the paddocks when the pasture is divided into multiple paddocks. Some way of delivering water to each paddock is necessary.

Some graziers will provide one or more water-access points for an entire subdivided pasture. A laneway is constructed with fencing from the watering point, usually a central area, to the paddocks. In this arrangement, livestock will travel from the paddock to the watering point several times a day. If this arrangement is chosen, you'll need to make sure the water trough is large enough to accommodate all the animals at once. Because of herd instinct, animals will usually travel in groups to water if it is not located within about 300 feet of the farthest point of the paddock.

If you can place water in each paddock, so much the better. This will reduce the herd-instinct behavior of traveling to water as a group, as water is much closer to the animals. Livestock will travel to water individually as needed, and this not only reduces competition at the watering point but allows you to use a much smaller tank.

An example of a simple watering system, from ATTRA specialist and sheep rancher Dave Scott, is to use 1¼- to 2-inch black poly piping, laid out along the fence lines. Quick disconnects can be placed at any time at strategic points for a water tank or trough with a float valve. With this system, a 150- to 200-gallon tank will provide 35 to 50 cows with adequate water. Each paddock can have a tank, or tanks can be moved across the fence line each time the animals are moved to the next paddock.

Seasonal Adjustments

So, how do you get started? Really, managed grazing is mostly execution, observation, and adjustment. This is why monitoring and recording grazing data are so important. They give you the ability to capture information and adjust based on what's happening in the paddocks. Make good use of a grazing chart or notebook to record your observations and your monitoring. We'll discuss more about monitoring later, but for now we will begin at the beginning—in the spring when the grass starts to grow.

How to Determine When Plants are Fully Recovered

Use the basal leaf method: For cool-season grasses, full recovery occurs when three to five new leaves have grown and the bottom leaf is brown at least one inch from the tip. At this point, nutrients from the basal part of the plant have filled the top-most leaves. Stem elongation may occur, and some seed heads may be present at this time, depending on the season. See Chapter 2 of the ATTRA video, *Intensive Grazing: One Farm's Set Up,* www.youtube.com/playlist?list=PLDu0ElBiEy9w4vhL87vWjzCtyazcvPYGx .

Now that your pastures are divided into paddocks based on recovery period and number of animals, we can begin when the grass is established and at the three- to five-leaf stage. For cool-season grasses like orchardgrass and fescue, graze quickly through the rotation at first, with a recovery period of around 20 days. This will allow you to keep up with grass growth and ensure that the grasses recover and tiller, making them more productive and getting them firmly established for later in the season when it gets warmer and dryer. Then, as the summer sets in and the temperatures increase, lengthen the recovery period to 30 days or more, depending on your regrowth potential. Make sure your grazing period is short enough to leave a residual of 50% of what you start with. A good guideline is 3- to 4-inch residual for perennial ryegrass and about six inches or more for other cool-season grasses. We all tend to graze too short. Grazing too short markedly reduces leaves and roots, reducing the ability of the pasture to grow back fast and provide carbon nutrients to soil microbes.

For warm-season grasses like bermudagrass and bahaigrass, start when the grass has greened up and make your recovery period between 25 and 30 days. These grasses can take more defoliation, but be sure to leave a residual of at least two to three inches so the plant can capture sunlight and adequately regrow. If you're grazing native warm-season grasses like Indiangrass, bluestem, or switchgrass, make your recovery period about 40 days and make sure you graze them no shorter than about six inches.

For annual grasses like oats, ryegrass, and wheat, graze heavily in the spring to keep them vegetative as long as possible and provide enough defoliation to remove all the biomass, especially if the annual grass was overseeded on a warm-season perennial pasture. This will allow the warm-season grasses to get off to a good start when the annual grasses are done. Warm-season annuals like sorghum-sudan should be grazed when they are about 18 to 24 inches tall, and the animals moved off when these grasses are about five to six inches tall. Many graziers get several successive grazing events with sorghum-sudan, using a rotational or strip-graze system. Sorghum-sudan, a warm-season annual grass, makes a great, high-quality forage, especially when cool-season pastures slow down in the summer.

Warm-Season Annual Grasses and Prussic Acid

Prussic acid poisoning is normally associated with stress in some annual grasses. Dangerous times are immediately after a killing frost or in young regrowth after a drought. Prussic-acid levels in the plant will decrease with time, unlike nitrates, which persist even in hay. Generally, one week is needed on standing plants, and about three weeks on silage, to reduce prussic acid levels.

Other options for grazing include forage brassicas such as kale, rape, and turnips; legumes such as Austrian winter pea (cool-season) and forage soybeans (warm-season); and stockpiled bermudagrass, tall fescue, and reed canarygrass for grazing well into December and January. Be mindful that brassicas are not recommended to be grazed without complementary forages such as oats, barley, cereal rye, vetch, or some combination of other species. Brassicas can cause nitrate poisoning when grazed as a monoculture. They are also non-mycorrhizal, so you are doing your microbes no favors by planting them alone. Extending the grazing season with these options will reduce your feed bill and can fit nicely into your grazing rotation.

When you make your paddock moves, remember that your grazing period—the amount of time the livestock spend on a paddock— should be timed such that it prevents grazing of forage regrowth. Since plants may have enough grazable regrowth two to three days after defoliation, most intensive graziers use this as a rule of thumb for grazing period. Short grazing periods also ensure intake of higher-quality forages, which is why dairy graziers often have grazing periods of a day or less.

Finally, there are some rules of thumb for adapting as the season progresses. You can be sure you'll have periods of low precipitation, high temperature, or extreme weather. So, for periods of low forage growth, you should slow down the rotation. This will give you a longer recovery period. This requires planned supplemental pastures or stored-forage feeding. For periods of rapid forage growth, you can speed up the rotation in order to keep up with productivity and not let the forage get too mature and indigestible. Another option for rapid-growth periods is to make hay. However, remember that making hay removes nutrients so that they do not get cycled back into the system. Fields that are hayed year after year will decline in productivity.

The Grazing Plan Template and the *Grazier's Calculator* will help you determine how to adjust recovery period, paddock size, grazing period, or paddock numbers as the season progresses. To get a good sense of how you should adjust, know the average forage productivity of your paddocks in pounds per acre per day. Knowing how much forage your paddocks produce each day for each season of use is fundamental to adjusting stock numbers to forage available throughout the year. For more information on forage yield and forage productivity in pounds per acre per day, consult the *Grazier's Math* worksheet.

Monitoring

Monitoring is often the most neglected part of pasture management. However, it's crucial to maintaining a well-functioning grazing plan. A good monitoring system will allow you to check how your management decisions are working on the ground and will allow you to determine if a particular grazing plan is having the desired effect over time. Monitoring helps you update your grazing calculations on a seasonal and yearly basis.

Research has shown that monitoring pasture gives farmers a planning orientation, sets a baseline of data from which to make planning decisions, and tracks ecological changes due to management and weather events (Sanderson et al., 2009). Farmers who maintain a simple pasture-monitoring program will see benefits, especially in identifying areas that need improvement, selecting land-improvement practices, and obtaining information on yields and productivity to inform future grazing planning.

Monitoring provides information to make course corrections in grazing planning and allows for positive changes in several indicators:

- Soil health
- Plant and animal performance
- Profitability
- Quality of life

A monitoring plan will often involve a few important evaluation criteria, such as plant species composition and percent cover. By comparing measurements and key indicators over time, you can start to see trends. And by comparing them to your grazing system, you can alter and adjust as needed in order to arrive at your goals.

Monitoring pastures— in addition to animal productivity and health— gives you a more holistic picture of what's going on in a grazing system. Animal performance will decline after forage resources have been degraded, and pasture and soil health are not always evident if livestock productivity is the only indicator monitored. By monitoring pasture health, you can identify and correct problems before they get too bad and negatively affect animal performance and pasture ecology. A basic pasture-monitoring program will look closely at forage use, pasture and/or paddock use, problem and critical (ecologically sensitive) areas, and changes in management. The three areas of monitoring include observing, collecting data, and keeping records.

Ideas for Simple, Consistent Monitoring Systems

There are three areas where monitoring will be crucial for planning and adapting your grazing system seasonally and annually. Here we will cover simple monitoring ideas for these three areas:

- Soil health
- Forage productivity and resiliency
- Animal behavior

Soil is the basis for maintaining sustainable production over the long term. The microorganisms in the soil provide hospitable habitat for a diverse array of soil organisms and make nutrients available for plants and animals. Monitoring soil health is an important way to discover how your grazing system is affecting—positively or negatively—the soil habitat and the biology it supports.

> For a descriptive and comprehensive discussion of soil health in pastures, take a look at the ATTRA *Managed Grazing Tutorial*. This tutorial provides soil health principles, practices, resources, and examples that will help you manage pastures for sustainable, regenerative production. Pay particular attention to Lesson 6: Fertility: Building Healthy Pasture Soils, and Lesson 7: Monitoring. Access the Managed Grazing tutorial at https://attra.ncat.org/tutorials/grazing.

You can easily monitor your soil health periodically. Two instant, revealing tests you can do in the field are a shovel test and a filtration/slake test. *The Monitoring Checklist, Appendix E*, has detailed instructions on these simple tests. Also, consider sending soil samples to a biological lab that assesses the microbiological activity in the soil. The *Monitoring Checklist* includes some labs and tests that will help you assess the biological health of your soils.

Monitoring forage production is simple and yields some good information to help you: (1) assess the productivity of your forages to help match them to animal needs; and (2) obtain feedback on how well your estimates of forage productivity and quality matched the animal demand for the grazing season. This allows you to adjust and refine your grazing calculations to better reflect the actual amount of forages you have. Some simple techniques for forage monitoring are covered in the *Monitoring Checklist* and in the Further Resources section of this manual.

One of the best ways to monitor forage productivity is to clip and weigh forage from your paddocks periodically. You can do this yearly on a few paddocks just to get a baseline and assess changes over time. You can also use a ruler or grazing stick to measure forage height and estimate yield accordingly. For more on forage assessment, see the *Grazier's Math* and the *Clip and Weigh Forage Measurement* worksheets.

Next Steps

This manual has provided you with the basics of how to write your own grazing plan, from the principles of grazing management to resource assessment and to matching animal demand with available forage. Resource assessment and monitoring are of utmost importance, and we've discussed some methods and resources to help you get started.

The Appendices to this manual are useful checklists and guides. Managed grazing can seem daunting, but it can be tackled easily, one step at a time. Use the *Grazing Plan Checklist* and study the helpful guides attached as appendices. Then do a thorough farm-resource assessment. This will give you the data to work through the calculations (see the *Grazier's Math: Matching forage to animal demand* worksheet or the *Grazier's Calculator*). Then you can develop your grazing schedule and a simple monitoring plan. Expect to make some mistakes: all graziers have and do. Monitor to find the root of the problem and then modify your grazing to correct it. Grazing is a very dynamic business—constantly adapt to what you observe and you will be successful!

Monitoring soil health is an important way to discover how your grazing system is affecting—positively or negatively—the soil habitat and the biology it supports.

References

Sanderson, M.A., S.C. Goslee, J. Gonet, and R. Stout. 2009. Pasture monitoring at a farm scale with the USDA NRCS pasture condition score system. Journal of Soil and Water Conservation. November/December.

Further Resources

ATTRA Resources

Grazing Calculator: Extended Cow Calf Pair. ATTRA spreadsheet. 2013. By Dave Scott. National Center for Appropriate Technology, Butte, MT. https://attra.ncat.org/attra-pub/summaries/summary.php?pub=451

Download this Excel spreadsheet from the ATTRA website

Grazier's Calculator. ATTRA spreadsheet. 2017. By Dave Scott. National Center for Appropriate Technology, Butte, MT. https://attra.ncat.org/attra-pub/summaries/summary.php?pub=575

Spreadsheet for matching forage inventory with grazing demand for each grazing period throughout the grazing season.

Intensive Grazing: One Farm's Setup. ATTRA video. 2014. By Dave Scott. www.youtube.com/playlist?list=PLDu0ElBiEy9w4vhL87vWjzCtyazcvPYGx

Detailed how-to video that describes and shows how to divide paddocks, set up fencing and water, monitor and assess livestock and forage, and use grazing to build soil health.

Irrigated Pastures: Setting up an Intensive Grazing System That Works. ATTRA publication. 2013. By Dave Scott. National Center for Appropriate Technology, Butte, MT. https://attra.ncat.org/attra-pub/summaries/summary.php?pub=449

Get a printed copy by calling 800-346-9140 or download it free from the ATTRA website

Managed Grazing Tutorial. ATTRA tutorial. By ATTRA Agriculture Specialists. National Center for Appropriate Technology, Butte, MT. https://attra.ncat.org/tutorials/grazing

Access the tutorial from the ATTRA website.

Basic Grazing Skills and Tools

Electric Fencing for Serious Graziers. 2005. USDA Natural Resources Conservation Service, Missouri. www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_010636.pdf
Download in PDF or order from:
USDA NRCS
601 Business Loop 70 West, Suite 250
Columbia, MO 65203

Topics include selecting an energizer, grounding, selecting wire, temporary fencing, gates and braces, tools, safety, and troubleshooting.

Extending Grazing and Reducing Stored Feed Needs. 2008. By Don Ball, Ed Ballard, Mark Kennedy, Garry Lacefield, and Dan Undersander. Grazing Lands Conservation Initiative. www.agry.purdue.edu/Ext/forages/pdf/ExtendingGrazing-Auburn.pdf

Extending the grazing season and reducing the need for stored feed is highly desirable. Though the best techniques to accomplish this vary with geographic region, type of farming operation, and other factors, this publication outlines strategies that can be used in some or many areas to extend grazing and reduce stored-feed needs, thus increasing profit.

Fence Systems for Grazing Management 1: Electric Fence Energizers. No date. By James R. Gerrish. In: Beef Cattle Handbook. Extension Beef Cattle Resource Committee. University of Wisconsin-Extension, Cooperative Extension. www.iowabeefcenter.org/bch/ElectricFenceEnergizers.pdf

This chapter deals with fence energizer selection and proper installation. Fencing materials and construction are covered in individual sections in this manual.

Grazing Systems Planning Guide. 2000. By Kevin Blanchet, Howard Moechnig, and Jodi Dejong-Hughes. University of Minnesota Extension Service. Publication No. BU-07606. www.extension.umn.edu/agriculture/dairy/grazing-systems/grazing-systems-handbook.pdf

This guide discusses the components of a grazing system by taking you through the grazing-management planning process. Information on grazing resource inventory, plan development, pasture management, and system monitoring is provided.

Pastures for Profit: A Guide to Rotational Grazing. 2002. By Dan Undersander, Beth Albert, Dennis Cosgrove, Dennis Johnson, and Paul Peterson. Cooperative Extension Publishing, University of Wisconsin-Extension. www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1097378.pdf

To produce good livestock feed from pasture, we must manage our pastures differently. This bulletin outlines an alternative: rotational grazing. By using rotational grazing, you can make a profit from pastures. This bulletin covers the basics of setting up a rotational grazing system on your farm.

Understanding Forage Quality. 2001. By Dr. Don Ball, Dr. Mike Collins, Dr. Garry Lacefield, Dr. Neal Martin, Dr. David Mertens, Dr. Ken Olson, Dr. Dan Putnam, Dr. Dan Undersander, and Mr. Mike Wolf. American Farm Bureau Federation, Park Ridge, IL. www.uky.edu/Ag/Forage/ForageQuality.pdf

Information about forage quality and forage testing that can be used to increase animal performance and producer profits.

Watering Systems for Serious Graziers. 2006. USDA Natural Resources Conservation Service, Missouri. https://prod.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1144213.pdf Download in PDF or order from:

USDA NRCS
601 Business Loop 70 West, Suite 250
Columbia, MO 65203

Topics include livestock water needs, water sources, delivery systems, tanks, protecting watering areas, tank location, installing pipes, and spring water development.

Recordkeeping

Grazing Charts by Troy Bishopp. The Grass Whisperer Blog. http://thegrasswhisperer.com/grazing-assistance

Developed by a project funded by Northeast SARE, Troy's grazing charts will help you tailor planning and recordkeeping to your own operation. There are several versions available based on your needs. Download, print, and take it to your local copy shop to have it enlarged to hang on your wall.

The New Grazing Charts Are Here by Kathy Voth. On Pasture. http://onpasture.com/2017/01/02/the-new-grazing-charts-are-here-the-new-grazing-charts-are-here

Excellent instructions for downloading and using Troy Bishopp's grazing charts, including examples and links to articles by Troy Bishopp.

Pasture Map. An online livestock and forage inventory and tracking tool. http://pasturemap.com

Ranch-management software app that allows you to plan pastures and subdivisions, water-tank placement, gates, and monitoring points; record herd data; plan your paddock moves; track forage utilization; and upload photos for forage inventory.

Monitoring Systems

Bullseye! Targeting Your Rangeland Health Objectives. 2013. By Kirk Gadzia and Todd Graham. Quivira Coalition, Santa Fe, NM. www.ncat.org/wp-content/uploads/2015/08/Bulleseye-Manual.pdf

A simple, non-technical manual to help ranchers establish their own monitoring program in grasslands, shrublands, and grass/shrub mixes.

Pasture Condition Score Sheet. 2001. By Dennis Cosgrove, Dan Undersander, and James Cropper. USDA NRCS – GLCI. www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044243.pdf

Scoresheet and instructions for use with the Guide to Pasture Condition Scoring.

Soil Quality Test Kit. USDA Natural Resources Conservation Service. www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/health/assessment/?cid=nrcs142p2_053873

An expanded list of soil health tests and procedures you can perform on the farm, including measuring soil quality, infiltration test, bulk density test, aggregate stability test, slake test, water quality tests, and more.

Appendices: Grazing Planning Workbook

Grazing Plan Checklist

Grazier's Math: Matching forage to animal demand

Clip-and-Weigh Forage Measurement

Grazing Plan Template

Monitoring Checklist

Appendix A: Grazing Plan Checklist

1. **Farm description:** A description of the farm in terms of things like history of land use, location, mean annual precipitation and distribution, air temperature mean and range, first and last frost, frost-free period, grazing season length, total acreage, soil types, crops and livestock, predominant pasture species, areas of ecological concern, conservation projects, and condition and inventory of infrastructure including buildings, fences, corrals, and watering systems.
2. **Farm goals:** This is a description of your farm leadership structure, your landowner goals (e.g., conservation, pasture species composition and productivity, animal production, and ecological renovation), enterprises, financial performance, and marketing goals.
3. **Resource inventory:** This gives you a starting point in assessing what you'll need to implement your grazing plan.
    a. Landscape: Your total acreage, current number of paddocks or pastures, paddock acreage, estimated dry matter forage productivity, forage species present, weed problems, and percent legumes in pastures.
    b. *Livestock:* Your total number of animals, animal types, average weight of animals per animal type, and average dry matter forage demand per animal type.
    c. *Infrastructure:* An assessment of infrastructure will provide you with information to evaluate its use, effectiveness, efficiency, and whether you need to upgrade. Consider:
        i. Water: source, water tests, pipelines and standpipes, watering points, capacity, water demand
        ii. Corrals: locations, type, capacity, working condition, chutes, and restraints
        iii. Fencing: type, construction, age, working condition, appropriateness for livestock species
        iv. Barns: purpose, condition, use
        v. Lanes and roads: construction, conditions, layout, efficiency
4. **Grazing calculations**: Refer to the *Grazier's Math* document and/or the *Grazier's Calculator*. Here you'll find easy calculations to match animal demand to forage productivity, based on your assessment of animal needs and forage yield. This is the first step in determining your grazing schedule. Start by determining your paddock recovery periods for each period of the grazing season (spring, summer, fall, winter, etc.). This is the most important step and will determine everything else for the rest of the season.
5. **Grazing schedule**: This allows you to chart what happens in each paddock and, combined with monitoring feedback, will help you adapt your grazing throughout the season. If visually represented on a chart, it can help you plan the year's grazing. Some of the items you might include are:
    a. Forage yield for each paddock
    b. Forage height at beginning and end of grazing period for each paddock
    c. Estimated forage balance after each grazing period
    d. Grazing period length
    e. Rainfall amounts
    f. Calving, lambing, breeding, and weaning dates
    g. Estimated periods of low forage productivity, with contingency plans
6. **Monitoring plan:** Monitoring is often the most neglected part of pasture management, and one of the most important. A good monitoring system will allow you to check how your management decisions are working on the ground. It will allow you to determine, for instance, if a particular grazing plan is having the desired effect over time. A monitoring plan will often involve a few important evaluation criteria, such as plant species composition, percent cover, percent bare ground, and frequency of species. Also important are biological tests to collect data on soil health. By comparing these measurements over time, you can start to see trends, and by comparing them to your grazing system, you can alter and adjust where you need to in order to arrive at your goals. Monitoring provides the feedback mechanism to make your grazing schedule work.
7. **Weed control:** Plan for control of invasive species or other problem weeds. Keep in mind that in a highly complex, biologically diverse pasture, many plants that are considered weeds are highly palatable and nutritious during the vegetative stage. They are valuable plants that occupy different root zones and deliver nutrients from various soil depths.
8. **Drought plan:** Consider these options when forage productivity declines:
    a. Rotate the livestock through the grazing system at a "slower" than normal pace. This allows for a longer recovery period.
    b. Plant a small grain in the spring for late spring and early summer grazing.
    c. Plant summer annuals in one of your paddocks, such as sorghum-sudan or millet for late summer grazing. Have forages tested for nitrates if it's droughty. If nitrates are high, graze later in the day to allow nitrates to metabolize in the plants before grazing, and give access to quality hay.
    d. If pastures are not growing back and grass is scarce, supplement with quality hay, as this will provide rumen fill and reduce dry matter intake from pasture. Do not supplement with grain, as this will usually increase dry matter intake of pasture.
    e. If drought runs for too long, consider grazing hayfields or de-stocking.

Appendix B: Grazier's Math: Matching forage to animal demand

Estimate animal forage demand: Species dry matter intake per day (as a percent of body weight):

- Beef Cattle: 2.5 to 3.0% (0.025 to 0.03)
- Dairy Cattle: 2.5 to 3.5% (0.025 to 0.035), depending on lactation
- Growing Cattle: 3% (0.03)
- Lactating ewes: 4.5% (.045)
- Dry ewes: 2.5% (.025)
- Goats: 4 to 5% (0.04 to 0.05)

Example, a 1,050-pound beef cow has a DMI of: (1050 × 0.03) = 31.5 pounds per day

Estimating forage productivity: estimating forage production in pounds per acre per day

You can estimate forage production with the clip-and-weigh method (see ***Clip-and-Weigh Forage Measurement*** worksheet), or you can estimate forage available by *hay yield* on a pounds-per-acre basis. If your spring hay harvest is 1.8 tons per acre, multiply 1.8 by 2,000 and divide by the number of days between hay cuttings.

Example: 1.8 × 2,000 = 3,600 ÷ 35 days = 103 pounds per acre per day

Knowing the amount of forage your paddocks produce in pounds per acre per day during each season of the year (for example, May to June, June to August, etc.) will help you adjust recovery days, grazing days, and paddock number or size throughout the grazing season.

Matching Forage Productivity with Demand

Estimating number of paddocks:

First, decide on a recovery (rest) period. This is usually lower in the spring, increases as the summer progresses, and may increase again in the fall for cool-season grasses.

Second, decide on a grazing period, or how long the animals will remain in a paddock before they are moved. Keep in mind, plants begin to regrow after about three days, and this should be the beginning of the recovery period. Use the formula below to determine number of paddocks:

Recovery Period ÷ Paddock Grazing Period +1 paddock

Example: 35 days recovery ÷ 1 day grazing period + 1 = 36 paddocks

Estimating paddock size:

Determine paddock size: This is a function of herd dry matter intake of forages (grazing unit demand) relative to forage production. To calculate, multiply the herd intake by days grazed and divide this by forage availability and a utilization rate. Forage utilization is the estimated percentage of the forage sward that will actually be consumed by livestock. A good rule of thumb is 50% (or 0.5), but because intense rotational systems are more efficient, we can increase the utilization to no more than 70% (.07). When using 70 % utilization, it is essential to fully recover grasses before re-grazing. For a way to determine this, see Chapter 2 in the ATTRA video *Intensive Grazing: One Farm's Set-Up,* at 3:40 minutes https://www.youtube.com/playlist?list=PLDu0ElBiEy9w4vhL87vWjzCtyazcvPYGx.

Example: Assume dry matter demand of forage for 100 cows is 39 pounds per head per day, and forage productivity is 3,600 pounds per acre per rotation.

$$\frac{\text{3,900 pounds herd intake} \times \text{1 day grazing period}}{\text{3,600 pounds dry matter forage} \times \text{0.5 utilization rate}} = \text{2.2 acres paddock size}$$

So, in this scenario, 36 paddocks of 2.2 acres average will support 100 cows with a move every day, giving us a 35-day recovery period. The total acreage needed for this system is 79.2 acres.

Using the *Grazier's Calculator*

The *Grazier's Calculator* is an easy way to match forage production with animal demand. This spreadsheet will calculate, seasonally, the number of paddocks and average paddock size, total forage production, paddock residual, forage available for grazing per paddock, and forage inventory vs. grazing demand, to tell you if your balance is adequate or deficient. If you choose to use this tool, the values you will need to enter are as follows:

- Grazing dates for each grazing season of the year (i.e., spring, summer, fall, winter)
- Total acres
- Forage production estimate in dry matter pounds per acre per day
- Recovery period in days
- Grazing period in days
- Animal demand in dry matter pounds per day
- Number of animals
- Grazing utilization (percent of forage that will be consumed by the animals, leaving the rest as a residual for plant regrowth and soil organic matter)

Download the Excel spreadsheet Grazier's Calculator at https://attra.ncat.org/attra-pub/summaries/summary.php?pub=575

How to use the calculator:

1. Enter your values in the gray cells. The spreadsheet will calculate all other values.
2. Use the forage-production and grazing-unit-demand calculators in Worksheet 1 to determine projected forage inventory and grazing-unit intake demand.
3. Use Worksheet 2 to determine the projected stocking rate for each grazing period. Note that the calculator will calculate the pounds of paddock residual. This is as important as the livestock you are feeding. Residual that is cycled through the rhizosphere provides carbon and other nutrients for the soil microbes and ends up as plant-available nutrients. Microbes are essential to maintaining soil health, a functioning soil, and less input, such as fertilizer and pesticides.
4. The calculator on Worksheet 2 will determine if the forage production or inventory is adequate to feed your livestock while maintaining a residual base to feed soil microbes.

Appendix C: Clip-and-Weigh Forage Measurement

The *clip-and-weigh method* will allow you to calibrate a pasture ruler or pasture stick. To accomplish this, construct a 2-square-foot quadrant frame from PVC or copper pipe. Each straight edge should measure 17 inches. Randomly throw the frame on the ground and clip all the plants inside the hoop at ground level. Place the clipped forage into a paper sack and repeat the procedure at least nine more times, placing samples in separate paper bags.

1. To determine percent dry matter, weigh one sample in grams, and place in a microwave for two minutes on a high setting. Weigh the sample in grams and repeat until no change in weight occurs. Place a small dish of water in the microwave to prevent damage to the microwave oven.
2. Calculate the dry matter percentage of the sample by dividing the dry weight by the fresh weight.
3. Multiply the percent dry matter by the fresh weights of the remaining samples.
4. Average the dry matter weights of all samples and multiply the average dry matter weight in grams by 50 to get pounds per acre.

For conversion, there are 453.6 grams per pound, 16 ounces per pound, and 28.47 grams per ounce.

Fresh Weight	Dry Weight	Percent DM	lbs./ac
Example: 10 ounces (285 grams)	*1.5 ounces (43 grams)*	*15%*	*2,150*

Appendix D: Grazing Plan Template

Year_____

1. Farm Description

Name _____

Location_____

Mean annual precipitation_____ Mean avg air temp and range_____

Rainy season_____ Dry season_____

First frost_____ Last frost_____ Frost-free days_____

Start of grazing (date) _____ End of grazing _____ Grazing-season length_____

Soil types_____

Soil infiltration rates (see Monitoring Checklist)_____

Predominant pasture species_____

_____

Notes _____

_____

2. Farm Goals

Leadership structure_____

Conservation goals_____

_____

Pasture goals_____

_____

Animal goals (per acre and per animal) _____

_____

Financial performance goals _____

_____

Marketing goals_____

_____

Notes_____

_____

_____

_____

_____

3. Resource Inventory

Water			
Source	**Water test results**	**Capacity (gpm)**	**Description (source, piping size, distance, locations, etc.)**

Fencing				
Type	**Construction**	**Charger type and joule rating**	**Source of equipment**	**Condition of fencing**
Perimeter				
Perimeter				
Paddocks				
Paddocks				
Paddocks				

Livestock			
Animal type i.e., lactating dairy, dairy replacement, cow- calf, feeder beef, finishing beef, ewe- lamb, lambs, etc.	**Number of animals**	**Average weight**	**Average dry matter demand (lbs/day) ***

***Dry Matter Demand for various species as a percent of body weight**

- Beef cattle: 2.5 to 3.0% (0.025 to 0.03)
- Lactating dairy cattle: 3.5 to 4% (0.035 to 0.04)
- Dry dairy cattle: 2.5 to 3% (0.025 to 0.03)
- Growing cattle: 3% (0.03)
- Lactating ewes: 4.5% (.045)
- Dry ewes: 2.5% (.025)
- Goats: 4 to 5% (0.04 to 0.05)

4. Grazing calculations: matching forage production to animal demand

Forage Production					
Grazing season	**Date range**	**Acres**	**Forage production in pounds per acre per day**	**Recovery period in days**	**Forage production in pounds per acre at turn in *Forage production in pounds per acre per day X recovery period***
Example	*May 1 to June 5*	*80*	*107.14*	*35*	*3,750*
1					
2					
3					
4					
5					
6					
7					

Note: If you are unsure of how many pounds of forage your fields produce per day, you can estimate it by dividing dry matter hay yield in pounds by the number of days between cuttings. See the Grazier's Math *worksheet for more information.*

Grazing Unit Demand				
Grazing season	Grazing unit type (Cow-calf, ewes, stockers, etc.)	Dry matter demand per head in pounds	Number of animals per grazing unit	Dry matter demand per grazing unit (dry matter pounds per day) Pounds dry matter × number of animals
Example	*Cow-calf*	*39*	*100*	*3,900*
1				
2				
3				
4				
5				
6				
7				

5. Matching Forage Inventory with Grazing Demand for Each Grazing Period

See the Grazier's Math *worksheet for instructions or use the Grazier's Calculator. Download the calculator at https://attra.ncat.org/attra-pub/summaries/summary.php?pub=575*

Grazing season	Acres	Number of paddocks *Recovery (Rest) Period ÷ Paddock Grazing Period + 1 paddock*	Average paddock size *Acres ÷ number of paddocks*	Dry matter forage production in pounds per acre	Forage production per paddock *Forage production per acre × paddock size*	Grazing utilization *35% to 75% depending on residual goals*	Paddock residual pounds *Forage production per paddock — utilization*	Paddock residual pounds per acre *Residual per paddock ÷ paddock size*	Forage available for grazing per paddock in pounds *Forage production per paddock × utilization*	Grazing unit demand	Forage Inventory Vs. Grazing Demand: Adequate or Deficient *Forage available for grazing per paddock — grazing unit demand*
Example	*80*	*36*	*2.2*	*3,750*	*8,250*	*0.5*	*4,125*	*1,875*	*4,125*	*3,900*	*225*
1											
2											
3											
4											
5											
6											
7											

Appendix E: Monitoring Checklist

Adapted from the Monitoring lesson by Dave Scott, in ATTRA's Managed Grazing Tutorial. *For a full monitoring discussion, see the tutorial at www.attra.ncat.org/tutorials/grazing.*

A monitoring plan is an essential part of a grazing plan, and is a feedback mechanism that will provide you with information on what's going on in your pastures, both from climate and ecological factors as well as management decisions. A good monitoring system will alert you to failure before it is too late and will record successful grazing strategies.

Monitoring must be consistent, practical, and simple.

Assessing Soil Function

1. The Shovel Test. Look for:
   - Aggregation
   - Color
   - Smell
   - Root mass
   - Take photos and compare over time

Figure 1. Excellent aggregation. Photo: Dave Scott, NCAT

Figure 2. Aggregation, root mass needing improvement. Photo: Dave Scott, NCAT

2. Water Infiltration Test
   - Insert a ring formed from a 6-inch can with the top and bottom cut out into the soil to a 3-inch depth.
   - Gently pour in water to a line on the can one inch above the sil.
   - Time how long it takes for the water to infiltrate. Do it again and record the time.
   - We want rapid infiltration. Some of the best soils will infiltrate several inches of water in one hour; poorly functioning soils may take 30 minutes to absorb one inch.
   - Write down how well your soil does. Trampling grass into the soil with livestock and adding compost to encourage microbial populations will improve water cycling.

Excellent	Several inches per hour
Good	Three to four inches per hour
Lacking	Less than one inch per hour
Write the results down in a notebook or spreadsheet and compare over time.	

3. Slake Test
   - Archuleta Slake Test http://soilquality.org/indicators/slaking.html
   - Gently suspend an air-dried, ping pong ball-sized clump of your soil into a clear one gallon jar, filled with water.
   - The water will rush into the pores of the soil. If the soil does not have enough strength in its structure, the soil will "slake" or disintegrate as the water applies internal pressure.
   - The longer the soil remains intact, the more aggregated it is, and the better structure it has.
   - Record, compare over time.

4. Biological Lab Testing
   - Determine the biological activity and diversity in your soil
     - — Haney test
       1. Ward Labs, www.wardlab.com/haney/haney_info.aspx
       2. Midwest Labs, www.midwestlabs.com/soil-testing-packages
     - — Cornell, https://soilhealth.cals.cornell.edu/testing-services
     - — Earthfort, www.earthfort.com/lab-services

Assessing the Forage Base

1. Desire increased:
   - Carrying capacity
   - Nutrient density: high digestible NDF (testing lab) and Brix readings
   - Species diversity
   - Longevity

2. Desire less:
   - Weeds
   - Bare soil

3. Monitor: Record in notebook or spreadsheet- compare over time:
   - Simple Forage Photo Transect
     - 100-foot intervals across paddock
     - Take photo of 2-foot by 2-foot plot
     - Note % grasses, legumes, weeds, bare soil, litter, erosion in each plot
   - Monitoring methodologies
     - For rangeland:
       1. Bullseye! Targeting your Rangeland Health Objectives https://www.ncat.org/wp-content/uploads/2015/08/Bulleseye-Manual.pdf
       2. Calculating Available Forage www.wyoextension.org/werawater/region8/PDFs/range3.pdf
     - For temperate pasture:
       1. Pasture Condition Score Sheet www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/pasture/?cid=STELPRDB1045215
       2. Estimating Amount of Forage in Hay Fields and Pastures http://edis.ifas.ufl.edu/ag369
   - Forage nutrient analysis: www.foragetesting.org files/2015_Certified_Labs.pdf, Brix test
   - Grazing stocking rates, paddock moves, etc.
     - Use red book, spreadsheet, grazing chart, or calculator

Assessing Livestock

1. Appearance and Behavior
   - Rumen fill
   - Thriftiness
   - Cud chewing
   - Gate watching
   - Playfulness and contentment

2. Production
   - ADG per acre
   - Diseases - pneumonia, mastitis, foot rot, and parasites
   - Record and compare over time

Financial Assessment

1. Identify the biggest drains on your income and make reducing them your goal
   a. Fertilizer
   b. Supplemental feed—winter and summer
   c. Irrigation power
   d. Pesticides
   e. Vet bills
   f. Seed

2. Monitor Progress with Adequate Accounting – compare over time
   a. Gross/Acre
   b. Expenses/Acre
   c. Net margin/Acre

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