Stepping Up Your Grazing Management

Profitable livestock production with:

Soil health
Air and water quality
Resilience to extreme weather

Photo by Jake Kristophel, Fallen Aspen Farm

Chesapeake Bay Stewardship Fund

Cover photo by Kelly O'Neill, Chesapeake Bay Foundation

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Why focus on grazing?


Photo by Amanda Grev, University of Maryland Extension

Regenerative grazing, sometimes called “rotational grazing” or “improved grazing management,” involves a range of management techniques with skillful stewardship of livestock and pastures, and time for forages to rest and regenerate between uses. It is both an art and science, with constant adaptations for weather, forage growth, soil conditions, livestock needs, and many other factors. It requires managing the intensity, frequency, duration, timing, and animal numbers on pasture according to the rate of plant growth, vegetation density, plant types, and livestock nutritional needs, to ensure that animals get highly digestible and nutritious forage every day while protecting the environment.

Regenerative grazing has helped many farmers to balance expenses and income, while improving the quality of farm life by reducing labor and costs. In a regenerative grazing system, livestock move frequently through a series of paddocks, allowing the forage plants to recover while the animals are grazing other paddocks. Many farms can raise more livestock on the same acreage and/or reduce feed purchases.

Grazing operations generally have lower start-up and maintenance costs than confinement operations. Livestock do most of their own harvesting and manure spreading, reducing labor, fuel, and equipment expenses. Many livestock producers shifting from confinement operations to grazing can spend more time managing pastures and monitoring herd performance, and less on a tractor.

Although production may decrease on a diet with mostly or solely forages, production costs and risks may also decrease. Pastures with deep-rooted forages will often be more resilient to extreme weather, such as prolonged droughts or torrential rains. Veterinary expenses and cull rates also often drop due to fewer foot ailments, mastitis, and other herd health problems, since the livestock are more active and outside with less exposure to pathogens.

There is steady, demand-driven growth in the market for locally produced, pasture-raised meats, eggs, and dairy products. Many consumers are willing to pay a higher price for products from grass-fed livestock that they perceive will help improve their families’ health. Some retailers pay premiums for products from grass-fed livestock. Direct marketing provides opportunities to educate consumers on the health and flavor benefits of your products, and set your price.


Photo by Michael Kovach, Walnut Hill Farm

Soil Health to Improve Productivity

Crumbly soil, dark with abundant organic matter on left. Pale, lifeless, densely compacted soil on right.
Photo by Lance Cheung, USDA Natural Resources Conservation Service

Healthy soil functions as a living ecosystem, teeming with bacteria, fungi, and other microbes in a symbiotic relationship with plants and animals. Critical components of healthy soils include cover and living roots throughout the year, plant diversity, and minimal soil disturbance. When animals graze only a portion of the forages and then allow them to rest, plants will regenerate vegetative cover as well as maintain active root growth. Grazing animals strengthen soil health by promoting nutrient cycling and maintaining forages in an actively growing, vegetative state.

Pastures with living vegetative cover throughout the year will provide many benefits over the long-term, especially to soil health. This cover regulates soil temperature, suppresses weed growth, and slows the impact from rainfall to increase water infiltration and reduce the potential for runoff. With greater water infiltration, pastures are less prone to erosion, flooding, and extreme droughts, that are becoming more problematic with less frequent but more intense rains.

A cover of living plants with deep roots also feeds and protects soil organisms, such as bacteria, fungi, and earthworms. This “soil livestock” works for you by breaking down dead vegetative material, promoting nutrient cycling, building good soil structure, and creating fertile channels. These allow water, air, and nutrients to be transported throughout the soil and stored for use when needed. The soil structure of these pastures can support the weight of grazing animals without compaction and erosion. Pastures with healthy soil may start growth earlier in the spring and continue growing further into the hot summer and cool autumn. Soil health increases forage quality, yields, and resistance to pests and diseases.

Grazing paddocks for short durations with high animal density results in more uniform grazing, weed trampling, and manure distribution. Overgrazing is a result of livestock spending too much time in an area, rather than the number of animals. A dense stand of plants captures more sunlight to produce more forage. Under prolonged overgrazing, the most palatable and nutritious plants are eaten again and again, leaving the least desirable plants to thrive. This reduces the longevity and quality of the forage stand.

A shorter grazing period provides plants with longer recovery times, increases rooting depth, and boosts overall forage quality. Adequate forage rest after grazing allows the leaves to regrow and produce energy through photosynthesis, replenishing plant energy reserves. In contrast, grazing too short depletes stored energy reserves and hinders future plant growth. Recovery rates will vary based on temperature, moisture, species of plants and livestock, so you’ll need to carefully monitor pastures and adapt to conditions.

Photo by Lisa Blazure

Regenerative grazing provides many environmental benefits: less soil erosion, reduced manure runoff into local water, and better integration of organic carbon into the soil, rather than carbon atmospheric emissions.

Livestock Nutritional Needs

All livestock need protein, energy, fiber, minerals, vitamins, and water, in the correct balance. Their nutrient needs will vary according to their size, genetics, stage of growth, lactation or pregnancy, production, weather, and other factors. To further challenge producers, the palatability, nutrient levels, and digestibility of forages will vary based on weather, species mix, growth stage, soils, and weed pressures. A mixture of various grasses, forbs, and legumes will usually provide most of the essential nutrients, and also reduce risk by providing some resiliency against various growing conditions.

High quality forages will typically have soft, fine stems with many leaves, and high levels of protein. As the plants age, they yield a larger quantity, but with less leafy and more fibrous stems, and lower levels of digestibility and protein. Use high quality pastures for animals with the greatest nutritional needs, like during calving/lambing/kidding, peak lactation, the third trimester of pregnancy, or for young growing animals. For young stock, you may allow them to graze ahead of adults, so they can access the plants with the most energy for growth.

Lush, spring pastures will be very high in protein and low in fiber, which may cause diarrhea and require livestock to spend energy to excrete the excess nutrients, rather than using this energy for milk production or growth. This fresh forage can be balanced with mature forage or hay.

As vegetation density increases, livestock gain more nutrition with each bite they take. Animals will be better able to meet their nutritional needs if they graze only the upper portions of the plants, where there is the most energy and protein. The lower sections of the plants have less nutrition and may also harbor more parasitic larvae. Therefore, your animals will be healthier if you move them before they have grazed too low.

Animals will test new plants, and if they are nutritious and have no negative effects, will return to eat them. Young stock learn from their mothers, and exposing them to feed and forage with adult animals improves overall intake.

It is essential to walk pastures often to monitor forage growth, species composition, soil compaction, and stand density, to assess whether management changes are needed. Be flexible in rotating animals without a rigid timeline or sequence; instead, rotate according to forage growth and availability. If forage is growing quickly, consider portable cross fencing to split pastures and increase stock density. Additional forage can be harvested and stored as hay or haylage to keep it from maturing and losing quality before being grazed.

Photo by Kelly O'Neill, Chesapeake Bay Foundation

Common Forage Species

Plant diversity improves resilience to extreme weather and decreases the risks of crop failure, as different plants thrive in different seasons and weather conditions. Including a diverse mix of forages in pastures will also provide a wider variety of nutrients to livestock

Legumes

Clovers, alfalfa, and other legumes have nitrogen fixing nodules on their roots that can convert atmospheric nitrogen to plant-available forms, so they require little or no nitrogen fertilizer. Over-seeding cool season forages with clover will reduce the need for additional nitrogen for those forages, especially if the seed is coated or applied with an inoculant containing the nitrogen-fixing bacteria. Most legumes have high protein levels, which can be beneficial for livestock nutrition but could cause problems with bloat if they exceed 30 to 40 percent of the total forage biomass.

Red clover is a short-lived perennial legume that is well-adapted to cool summers with adequate moisture. It tolerates shade, but has low winter hardiness and drought tolerance. It is best used in mixtures with cool season grasses, and is highly nutritious and palatable to livestock. High levels of red clover are undesirable for fields where hay is harvested because it dries much more slowly than grasses or other legumes.


Red and White Clover
Photo by Kelly O'Neill, Chesapeake Bay Foundation

White clover grows best in cool, moist conditions and is winter hardy, but will not survive drought or extreme heat due to its shallow root system. It is tolerant of heavy grazing and has the ability to spread via stolons that grow across the soil surface; these characteristics allow it to dominate in overgrazed pastures.

Birdsfoot trefoil produces a high-quality forage rich in protein, has a long stand life, and thrives in acidic soils with poor drainage and fertility, where alfalfa doesn't grow. Trefoil holds its leaves at maturity, allowing it to maintain forage quality for a longer period to hay or graze. Unlike other legumes, it does not cause bloat, and may help control internal parasites because its tannins act as a natural dewormer in sheep, goats, llamas, and alpacas. The hard seed coat needs to be scarified prior to planting.


Alfalfa
Photo by USDA Agricultural Research Service

Alfalfa is a deep-rooted legume that grows best in moderate to well-drained soils. It can be harvested as hay or silage, or grazed in a stand as long as there are other forages to decrease the risk of bloat. Also, as plants mature and the fiber content increases, the risk of bloat greatly decreases. Frequent cutting produces high-quality forage while less frequent cutting generally results in increased stand longevity. High energy reserves in the taproots and crowns of the plants are important for fast regrowth, which results in higher yields.

Common Forage Species

Cool season grasses

Cool-season grasses are the foundation of most hay and pasture systems in the northern United States. They produce high quality forage in the spring and fall, but have a summer dormancy period typically referred to as the summer slump.

Kentucky bluegrass forms a dense sod in fertile, well-drained soils. It has excellent forage quality, tolerates overgrazing and trampling, is winter hardy, and spreads to fill bare spots and reduce weed establishment. Because it is a low-growing, low-yielding grass, it is best used to vegetate overgrazed, compacted areas, or as part of a pasture mix, rather than as a primary forage. Kentucky bluegrass can tolerate much closer grazing than other cool season perennial grass species, so its prevalence in a pasture may be a sign of overgrazing.


Orchardgrass

Orchardgrass starts growing early in the spring, develops rapidly, and tolerates shade, drought, and heat. Repeated, close grazing reduces regrowth and winter hardiness because its energy reserves are located in the stem base, above the soil surface. The early spring maturity of orchardgrass requires an early harvest as it rapidly goes to seed and loses its quality. A dense stand of this productive high-quality grass can compete with legumes.

Tall fescue is a coarse-bladed grass that tolerates many soil conditions, heat, poor fertility, heavy traffic, and frequent grazing. It provides summer growth when other cool season grasses go dormant, and can aggressively compete with legumes and other forages. Tall fescue holds its quality well for winter grazing if "stockpiled" in late summer and fall. Older forage varieties like K31 contain toxins that reduce weight gain and cause reproductive and other problems. When planting, select newer varieties that are described as "soft leaf" or "novel-endophyte," as these varieties are not toxic to livestock. If fescue with the toxic endophyte is already in your pastures, minimize toxicity concerns by incorporating other grasses and legumes into the stand, mowing seedheads (where toxins are concentrated), and avoiding overgrazing.


Tall Fescue

Perennial ryegrass grows best in cool, fertile, well-drained soils. It has quick germination, rapid establishment and a long growing season. Perennial ryegrass is highly palatable and digestible for all livestock species. It is also adapted to withstand frequent grazing and tolerate wet soil, but has poor winter hardiness, and drought and heat tolerance.


Perennial Ryegrass

Timothy is a shallow-rooted species, adapted to cool, moist environments. It does best alone in a stand of hay due to its later maturity but sometimes is included in grazing mixes, particularly those designed for horses. Timothy can tolerate moderate continuous grazing, but frequent grazing will deplete the stand.


Smooth Bromegrass

Smooth bromegrass is a hardy species that can survive long periods of drought and temperature extremes. It matures and maintains forage quality later in the spring than orchardgrass, helping to extend the hay making window. It has high stand persistence, but slow recovery after harvest or grazing. It is slow to establish, with full yields typically reached in the second or third year of production.

All photos on this page by Dave Hartman, Pennsylvania Grazing Lands Coalition

Common Forage Species

Under certain circumstances, annuals can be a valuable addition to a grazing system. They can be established in a field designated for annual forage rotation (such as a winter annual followed by summer annual), or they can be used as cover crops following row crops grown for grain. However, annuals usually do not perform well when planted into perennial pasture.

Cool season annuals

Triticale, wheat, cereal rye, annual ryegrass, oats, radishes, and turnips may be used as cover crops to improve soil health in row crop fields, and can provide high-quality forages in the fall and/or spring. Cover crops to be used for forage should be planted earlier and at a higher seeding rate than if they are planted for grain. Some species will overwinter and provide dual-season use, while others, like radishes, turnips, and oats, will not survive the winter.

Cattle grazing cereal rye

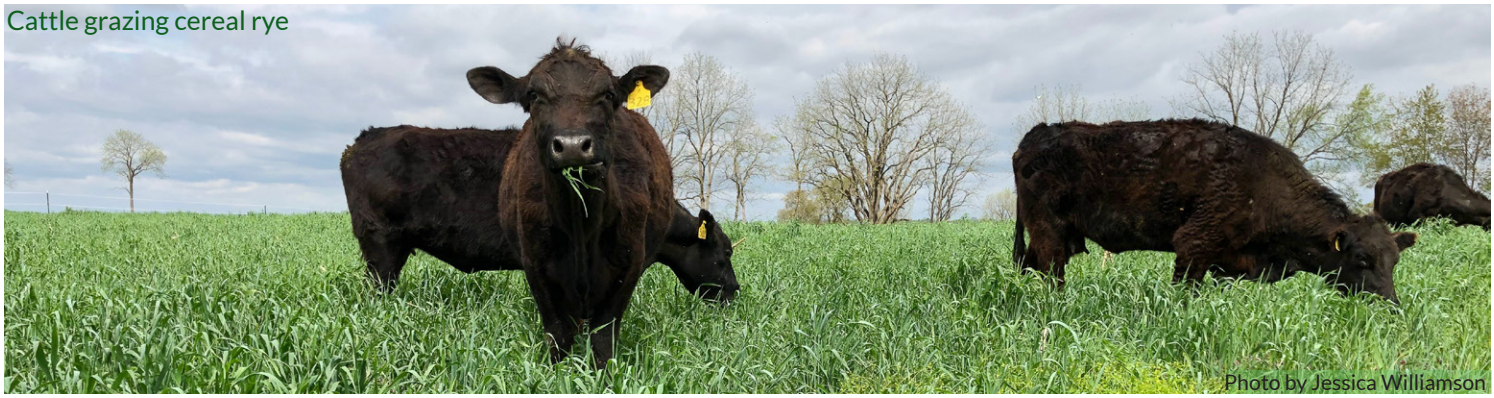


Photo by Jessica Williamson

Brassicas, such as radish and turnips, are considered "miner plants," because their long roots can grow deeply into the soil, helping to alleviate some compaction and bring nutrients to the surface. When planted in late summer, they can provide a high-quality source of forage for the fall. However, they may not provide adequate fiber for grazing livestock, so they should be included as a small component of the livestock diet. They may be a good fit in a field where planting is needed, because the soil will be bare after grazing.

Radish

Photo by Kelly O'Neill, Chesapeake Bay Foundation

Cattle grazing warm season annuals

Photo by Kelly O'Neill, Chesapeake Bay Foundation

Warm season annuals

Unlike their cool-season counterparts, warm-season annuals like sorghum, sorghum-sudangrass, and millet thrive in hot weather and are more tolerant of heat and drought. As a result, they can be used to extend the grazing season and provide forage in the summer when cool season perennial pastures are less productive and can be grazed or harvested as hay or silage. This strategy increases summer forage productivity and allows other pastures time to rest and regenerate during the summer slump to provide forage later in the fall.

Native warm season grasses and hardwood silvopasture

Photo by Brian Campbell, USDA Natural Resources Conservation Service

Native warm season grasses

Grasses such as big bluestem, indiangrass, eastern gamagrass, and switchgrass are deep-rooted and may extend the grazing season with high forage yields in the summer when cool season pastures are less productive. Similar to warm-season annuals, they can provide forage during the summer months and give other pastures time to recover and provide forage later in the fall. Warm-season grasses are heat and drought tolerant, and may require less inputs because they are adapted to lower fertility soils.

However, native warm-season grasses establish very slowly and require careful establishment and weed control while they are establishing. They also attract pollinators, songbirds, and barn swallows to help manage fly populations.

Silvopasture

A silvopasture system integrates forages, trees, and livestock together, and has potential to provide income from both livestock and forest products. Planting trees into pastures provides shade for livestock during the summer and windbreaks in the winter to improve livestock weight gain, milk production, and conception rates. Silvopasture systems can also produce timber and food products such as maple syrup, paw paws, apples, black walnuts, or hazelnuts. The prunings of some trees, such as poplar, may provide nutritious fodder.

Trees take time to establish, and young trees will need protection from livestock and wildlife. Cattle habitually lounge under trees, even when shade is unnecessary, causing potential for soil degradation and an excess concentration of manure nutrients there. Sheep and goats may chew on the bark, and cattle may rub on younger trees. Careful management, including livestock exclusion at certain times, is needed to maintain the ideal combination of woody and forage plant species, and to prevent soil compaction, poor regeneration, and damage to young saplings.

Sheep grazing among trees of various ages

Photo by Kelly O'Neill, Chesapeake Bay Foundation

Forage Growth and Management

Rotate animals to new paddocks often to maintain ground cover and increase plant recovery. Maintaining adequate plant material following grazing will conserve leaf area and allow plants to continue to harness more energy from the sun, rather than depleting precious energy reserves. Adequate time for rest, recovery, and regrowth allows the plants to produce higher amounts of forage.

Rotations should be based on forage growth and the height of the available forage: moving livestock into a paddock at the recommended "start" height will provide an optimal balance of forage quality and quantity; moving livestock out at the "stop" height will allow forages to maintain enough leaf area to harness the sun's energy to recover quickly from the grazing. These start and stop grazing heights are the basis for the general "take half/leave half" rule of thumb.

Recommended forage heights to start and stop grazing to optimize forage availability, quality, and recovery.

Forage	Height (inches) to start grazing	Height (inches) to stop grazing
Kentucky bluegrass	6	3
Alfalfa, birdsfoot trefoil, fescue, orchardgrass, clover, ryegrass, small grains, smooth bromegrass, timothy	10	4
Indiangrass, big bluestem, eastern gamagrass, switchgrass	16	8
Brassicas	12	3
Sudangrass, sorghum, millet, other warm season annuals	24	8
Crop residues	Immediately after harvest	n/a

Any trampled forage that your animals leave behind is not wasted. Plant matter not consumed by livestock will feed the soil life (your "underground herd of fungi and microbes"). This releases nutrients and builds organic matter, improving the soil's ability to access essential nutrients and hold moisture. The remaining leaves will also act as "solar panels" to allow for faster regrowth. The trampled vegetation will also help retain moisture and insulate the soil from extreme temperatures.

Goat eating pigweed

Photo by Brian Campbell, USDA Natural Resources Conservation Service

Weed Management

The best weed management tool is a healthy stand of forages to reduce germination of weed seeds and shade and out-compete weed seedlings. Weed management strategies will depend largely on the weed species and life cycle. Perennials like horse nettle and hemp dogbane may be difficult to manage since they can produce seeds and reproduce from underground rhizomes. Mowing after grazing may help reduce weed pressure, particularly for annual weeds that rely on seed production to reproduce. If there are tall weeds shading more desirable forages, a high stocking density of animals with lower nutritional needs can control them, with a combination of grazing, foot pressure, and trampling.

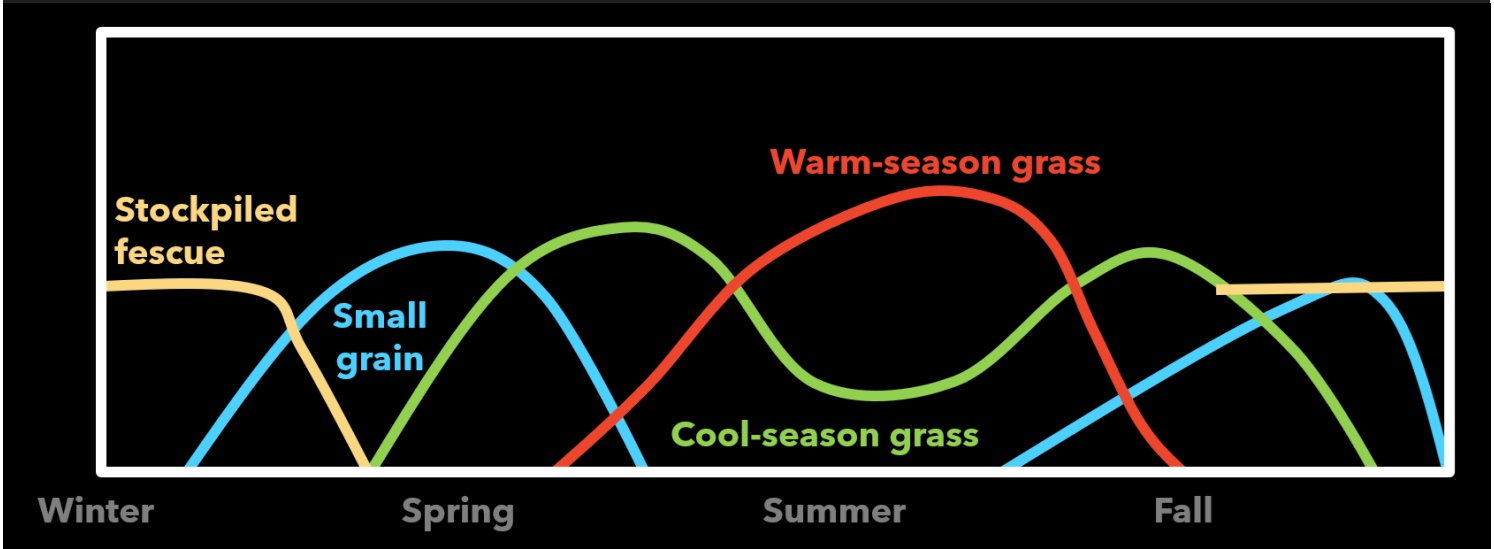
However, weeds are not necessarily your enemy. Many plants not typically considered forage, like lambsquarters or ragweed, can offer good nutrition. Multi-species herds and/or higher density grazing will encourage consumption of a variety of plants and trampling of unconsumed plants.

Forage Availability

One of the biggest challenges with grazing systems is ensuring adequate forage quantity and quality throughout the year. Grazing year-round, or almost year-round, can be feasible with good management and planning. Strategies to help maximize year-round forage availability include:

- A diverse forage stand, with forages that will perform well under different weather conditions and at different times of the year.
- Careful management to maximize forage recovery following grazing by maintaining plant energy reserves and preserving leaf material for photosynthesis.
- Feeding hay, haylage or other stored feeds when grazing would hinder future growth, such as during very dry or wet conditions.
- Mobile water units, buried water lines, and other strategies to provide water throughout the year.
- An appropriate stocking rate, calculated based on times of limited forage growth and greatest livestock nutritional needs, to prevent over-grazing.

Approximate growth curves of various forages throughout the year, although there will be variations due to weather and other factors.



Graph by Brian Campbell, USDA Natural Resources Conservation Service

Photo by Susan Schoenian, The Baalands Farm

Grazing Math

The Questions

To develop a grazing system to use forages efficiently and avoid damaging existing pastures through overstocking, overgrazing, or undersizing them, it's useful to calculate:

- How many animals can this pasture/paddock feed?
- How many days can I graze this pasture/paddock?
- How many acres should this paddock/pasture be?

The Assumptions

Your calculations will rely on estimates that may be obtained from these tables for:

- Daily dry-matter intake needed (based on the class of livestock and their liveweight).
- Efficiency of using pasture forages (based on how intensively livestock are rotated through pastures or paddocks).
- How much forage the pasture has available (based on vegetation height and density).

Dry Matter Intake Needed	
Livestock Class	% of Liveweight
Ruminants – Mature	2%
Ruminants – Growing	3%
Ruminants - Lactating	4%
Horses / Alpacas / Llamas	2%
Donkeys	1.5%

Utilization Efficiency (based on time in paddock)	
Continuous grazing	35%
15-21 days	45%
11-14 days	50%
5-10 days	55%
2-4 days	65%
≤1 day	75%

Pounds of Forage Dry Matter per Acre (based on a perennial stand)			
Average canopy height (inches)	Thin Density	Medium Density	Thick Density
2	270	720	1,220
3	490	1,060	1,720
4	720	1,380	2,130
5	960	1,680	2,490
6	1,210	1.960	2,810
7	1,470	2,230	3,080
8	1,730	2,480	3,330
9	2,000	2,720	3,550
10	2,270	2,960	3,740
11	2,550	3,190	3,910
12	2.820	3,410	4,070
13	3,110	3,620	4,200
14	3,390	3,830	4,320

Thin density pastures include harvested hayfields that will now be grazed, pastures that were planted within the past two years, and pastures that lack an understory of sod-forming grasses or clover.

Medium density pastures include mixed-species stands of perennial cool season grasses and clovers.

Thick density pastures are primarily well-managed mixed stands on fertile soil.

"Pounds of Forage Dry Matter per Acre" table adapted from: Rayburn, E. (2019). Accurately Measuring Available Forage Mass Using Ruler or Plate Meter Pasture Height. Poster presented at the annual conference of the Northeast Pasture Consortium, Grantville, PA.

Brian Campbell, USDA Natural Resources Conservation Service, developed "Grazing Math."

Grazing Math

Instructions

Remember that these calculations will only provide a rough guideline. You'll also need to monitor forage growth and use, livestock performance, and make adjustments as needed.

Once you find the appropriate numbers for your situation from the tables at the left, enter them into the equations below. Remember to convert percentages into decimals, for example, 3% as 0.03. You will probably only use one of the equations at a time because you will usually only be changing a single variable: the number of animals on a pasture/paddock, the number of days your animals remain there, or the size of a pasture/paddock.

The examples shown here assume the following scenario: Five retired horses averaging 1,100 pounds each graze a 1.7 acre pasture of mixed perennial cool season forages with a height of 5 inches; these horses are expected to meet their dry-matter needs on pasture alone (without supplemental feed) and are moved to a new paddock once a week.

How many animals can this pasture/paddock feed?

$$\frac{\text{(Pounds of forage dry-matter per acre) x (Size in acres) x (Utilization \%)}}{\text{(Average animal weight) x (Daily intake \%) x (Days of grazing)}}$$

How many animals? Example.

$$\frac{\text{(1,680 pounds forage per acre) x (1.7 acres) x (55\% utilization)}}{\text{(1,100 pounds) x (2\% intake) x (7 days on that paddock)}}$$

= This paddock can support 10 horses during a 7-day grazing period.

How many days can this pasture/paddock be grazed?

$$\frac{\text{(Pounds of forage dry-matter per acre) x (Size in acres) x (Utilization \%)}}{\text{(Average animal weight) x (Daily intake \%) x (Number of animals)}}$$

How many days? Example.

$$\frac{\text{(1,680 pounds forage per acre) x (1.7 acres) x (55\% utilization)}}{\text{(1,100 pounds) x (2\% intake) x (5 horses)}}$$

= This paddock can support 5 horses for 14 days.

How many acres should I make this pasture/paddock?

$$\frac{\text{(Average animal weight) x (Daily intake \%) x (Number of animals) x (Days of grazing)}}{\text{(Pounds of forage dry-matter per acre) x (Utilization \%)}}$$

How many acres? Example.

$$\frac{\text{(1,100 pounds) x (2\% intake) x (5 horses) x (7 days on that paddock)}}{\text{(1,680 pounds per acre) x (55\% utilization)}}$$

= This paddock should be 0.8 acres to support these horses for 7 days.

Winter Advice (December - February)

Livestock that are acclimated and in good body condition can usually tolerate cold weather fairly well. Wet or thin animals, or animals that were recently moved from warmer regions, are most vulnerable to wind and cold. Cattle can graze stockpiled forages through snow cover, but not ice crusts or very deep snow. However, they should not graze on wet soils, as this can cause pugging and compaction, damaging root systems and diminishing future pasture productivity.

Some recommendations to keep livestock healthy and maintain production during the winter months include:

- Provide windbreaks or shelters in very cold weather.
- Have a plan (and a backup) for keeping water supplies from freezing.
- Unroll large bales and change locations to improve manure distribution and reduce soil compaction. This allows more animals to feed at one time, with dominant animals less likely to intimidate others.
- Stay aware of changing nutritional requirements for pregnant animals, especially because forage quality in pastures tends to decrease as the winter progresses. Supplement or provide higher-quality forage as needed.
- Frost seed pastures that need additional vegetation, on warm days with freezing nights in late winter.

Photo by Jared Planz, Chesapeake Bay Foundation

Animal Concentration Area

Grazing plants too close to the ground that are dormant throughout the winter or hot summer damages their root systems and leads to soil compaction under wet conditions. Forage growth during the following year will suffer.

You may limit this problem by concentrating your feeding to a relatively small, dry area that is easily accessible for feeding, but at least 100 feet from any streams, wells, swales, sinkholes, drainage ways, or environmentally sensitive areas. You might also choose an area where the soil is low in nutrients, because it will receive a large amount of manure and forage residue. Clean water from upslope fields, driveways, and barn roofs should be diverted away from and around this area.

Photo by Russ Wilson, Wilson Land & Cattle Company

Stockpiled Grazing

Tall fescue, orchardgrass, perennial ryegrass, annual rye, white clover, and other forages can be stockpiled to extend grazing beyond the vegetative growing season. Of these species, tall fescue works best for stockpiling as it maintains its quality better over the winter.

To stockpile forages, mow or graze the paddocks, starting mid-July through mid-August, down to about 4 inches, and then exclude the livestock. Avoid grazing stockpiled forages, allowing biomass to accumulate, until the late fall or winter. For maximum utilization, strip graze the stockpile, giving animals access to no more than three days of forage at a time.

Taking Stock

Winter is a good time to look back at the past year and contemplate goals for the coming year. Consider:

- Were there times of the year with inadequate forage, or others with a surplus?
- Could your paddocks be divided more efficiently?
- Do your Nutrient/Manure Management Plan and/or Conservation Plan need updates, with any changes to animal numbers, acreage or management? Contact your local Conservation District or USDA Natural Resources Conservation Service office to request financial, technical or planning assistance.
- Are there bare spots in your pastures that need seed?
- Do you need to make changes to your mix of legumes and warm and cool season grasses?
- Did you have a good balance of livestock numbers and forage availability throughout the year, especially at calving or lambing, and other times of high demand?
- How was forage quality, and did it fluctuate through the year?
- Do you have adequate high-quality water available in all paddocks?
- Did livestock maintain health and body condition throughout the year?
- Do you need additional temporary or permanent watering locations?
- Would adding other livestock species complement the operation?
- Are there opportunities for new markets for pasture-raised eggs, milk, and livestock?

Check schedules for winter meetings to network with other graziers and learn new strategies. See Pasa Sustainable Agriculture (pasafarming.org), Mountains-to-Bay Grazing Alliance (m2balliance.org), Pennsylvania Grazing Lands Coalition (paglc.org), Virginia Forage and Grassland Council (vaforages.org), Maryland-Delaware Forage Council (foragecouncil.com), and Future Harvest (futureharvest.org).

Photo by Russ Wilson, Wilson Land & Cattle Company

Spring Advice (March - May)

As your pastures come out of dormancy and start to "green up," take a walk to assess conditions. Look for germination from frost seeding, bare spots or weedy areas, and the balance of grass and legume species to determine if additional seeding is needed.

Although it may be a challenge, resist the temptation to let animals out too early. Wait until pastures reach at least six to eight inches in height and the vegetation has roots strong enough to withstand grazing before starting spring grazing. Continue feeding hay or other feeds in the meantime.

Spring recommendations include:

- Continue frost-seeding in early spring (depending on your location).
- Graze cover crops or winter annuals, such as cereal rye, triticale, and ryegrass.
- Seed any bare areas, such as winter feeding areas or thin stands. Cool season forages should be planted first, and warm season grasses later. However, there will be greater weed competition and risk of compaction with equipment on wet soils in spring than in the fall.
- Make sure plants are established well enough to withstand grazing before putting animals in a newly seeded paddock. Grab a handful of forage and pull quickly (like a cow would with her tongue). If the forage comes out by the roots, grazing would cause severe damage, so wait until pasture is more mature. You could also take a first cutting of hay or haylage instead of grazing.
- Transition gradually from stored feeds to fresh pasture, to allow rumen microbes to adjust.
- Don't turn hungry livestock on to fresh pastures, or they may eat too much and bloat.
- Rotate animals to new paddocks quickly to maintain residual cover and increase plant recovery.

Photo by Michael Kovach, Walnut Hill Farm

- Consider portable cross fencing to split pastures and increase stock density to promote more even grazing, especially when forage is growing quickly.
- Set aside pastures with excess spring growth for hay or silage. Cut hay on cool season grass fields in boot stage and legume fields in half bloom.
- Offer minerals to livestock, especially magnesium to cattle, to avoid grass tetany.
- Consider planting trees to provide shade for livestock.
- Control weeds before they become a serious problem.

Summer Advice (June - August)

Forage quality and availability, for summer and also the following seasons, requires careful management.

- Consider planting warm season annuals, such as sorghum or sorghum-sudangrass, in June for late summer grazing. These crops may provide additional forage for summer grazing while allowing cool-season pastures to rest and accumulate growth for fall grazing.
- Consider planting winter annuals such as wheat, rye, ryegrass, oats, radishes, and turnips in late summer to provide fall forage to extend the grazing season.
- Clip mature but undergrazed forage to encourage new growth, increase forage quality, and reduce animals' eye irritation. Mowing won't interfere with the forages' recovery when done immediately after animals graze, but don't mow too short as energy reserves are stored in the lower part of the plant.
- Make sure animals have access to water, shade, and minerals.
- Consider setting aside a few paddocks to stockpile for fall or winter grazing. Begin stockpiling forages in late summer following a grazing or mowing; growth accumulated in late summer and fall will be higher quality, mostly vegetative growth.
- Cut warm-season grass hay in boot stage, before seedhead emergence, for highest quality, if needed.
- Ensure that cool season grasses have an adequate rest period as their growth slows.
- Avoid grazing too low, because that will eliminate the canopy's shade and expose crowns and tillers to damaging heat. Maintaining an appropriate forage residual will also shade the soil, helping to moderate soil temperatures and maintain soil moisture.
- If forage regrowth is limited by dry weather, feed hay or other stored forages in an animal concentration area to avoid overgrazing and damaging plants.
- Observe how grazing behavior distributes manure (such as in concentrated areas around shade, water, minerals, or fencelines), and determine if changes are needed.

Cattle grazing summer annuals

Photo by Kelly O'Neill, Chesapeake Bay Foundation

Fall Advice (September - November)

Grasses will need time to replenish and store carbohydrate root reserves during the fall, to strengthen root systems to provide high-quality forages and reduce the need for hay or purchased feed in the future.

- Graze hard on areas that need to be reseeded in the fall or that will be frost-seeded in late winter or early spring.
- Seed any bare areas or overseed as needed, at least six weeks prior to a killing frost. Fall is usually the preferred time to establish cool-season forage stands.
- Exclude livestock from paddocks where you have forages stockpiled for winter.
- Leave four to five inches of residual vegetation on remaining pastures so they have sufficient energy reserves and healthy roots to start growth in spring.
- Test soils and apply lime or other nutrients based on soil test recommendations. Providing good soil fertility and maintaining soil pH will set forages up for success for overwintering and regrowth the following spring.
- Identify areas for winter feeding of hay or silage. Areas that are well-drained, easily accessible, and in need of some additional fertility are preferred.
- Plant cover crops, especially multi-species mixes, into row crop fields to improve soil health and provide early spring forages.
- Inventory winter feed supplies, and purchase additional hay if needed. Measure standing biomass on stockpiled pasture to estimate forage available for winter grazing (see Pounds of Forage Dry Matter per Acre Table on page 10).
- Test hay and other feeds to determine nutrient levels and whether supplements are needed.
- Avoid grazing sorghum or sorghum sudangrass that may have been frosted to mitigate potential for prussic acid toxicity.
- Plan for manure storage over winter.

Cattle grazing cover crops and corn residue

Photo by Kelly O'Neill, Chesapeake Bay Foundation

Poultry and cattle
Photo by Michael Kovach, Walnut Hill Farm

Livestock Diversity

Diversifying your livestock species may not only provide new products to sell, but also additional tools to manage the landscape. Incorporating a variety of livestock species can help the farm to mimic natural ecosytems. Different species tend to prefer and consume different types of plants, which can help you increase your overall forage utilization. Some internal parasites only affect certain livestock species, so different animals moving through pastures can disrupt the life cycle of the parasites and reduce livestock exposure.

Water

Water is the most important nutrient: an animal's weight is 70-80 percent water; milk is approximately 90 percent water. Water intake varies with the animal's weight, reproductive status, age, diet, and weather conditions. As a general rule of thumb, livestock consume about one to two gallons of water per 100 pounds of body weight per day, equating to about eight to 20 gallons for cattle or two to three gallons for sheep daily.

Livestock will consume less water if it contains high levels of sediment, algae, minerals, or other pollutants. Forage intake declines when water consumption drops. Water quality affects growth, lactation, reproduction, and the immune system's resistance to infection. Polluted water can harbor Cryptosporidium, Salmonella, E. Coli, and other pathogens to cause livestock illness. If animals have a rough hair coat, unexplained illness, breeding problems, or poor body condition, testing your water is recommended.

Solar-powered watering system

Photo by Kenny Fletcher, Chesapeake Bay Foundation

Toxic Plants

When offered diverse choices, livestock will consume a variety of forage and weed species. This allows them to better meet nutrient needs and reduce potential negative effects of plants with higher levels of toxins due to dilution with other forage species. Serious toxicity problems are more likely when animals are confined with no other choice but toxic weeds to eat. Non-ruminant animals, such as horses, are especially at risk. Some potential toxic plants include red maple, box elder, horse nettle, milkweed, nightshade, water hemlock, and wilted cherry leaves. Risks may be reduced by removing the toxic weeds or by providing livestock with an alternative forage before allowing them to graze a paddock with a toxic weed population, and then removing them after the desired forages have been consumed to the proper height. Keeping track of weeds and toxic plants in pastures and being aware of the effects they may have is important.

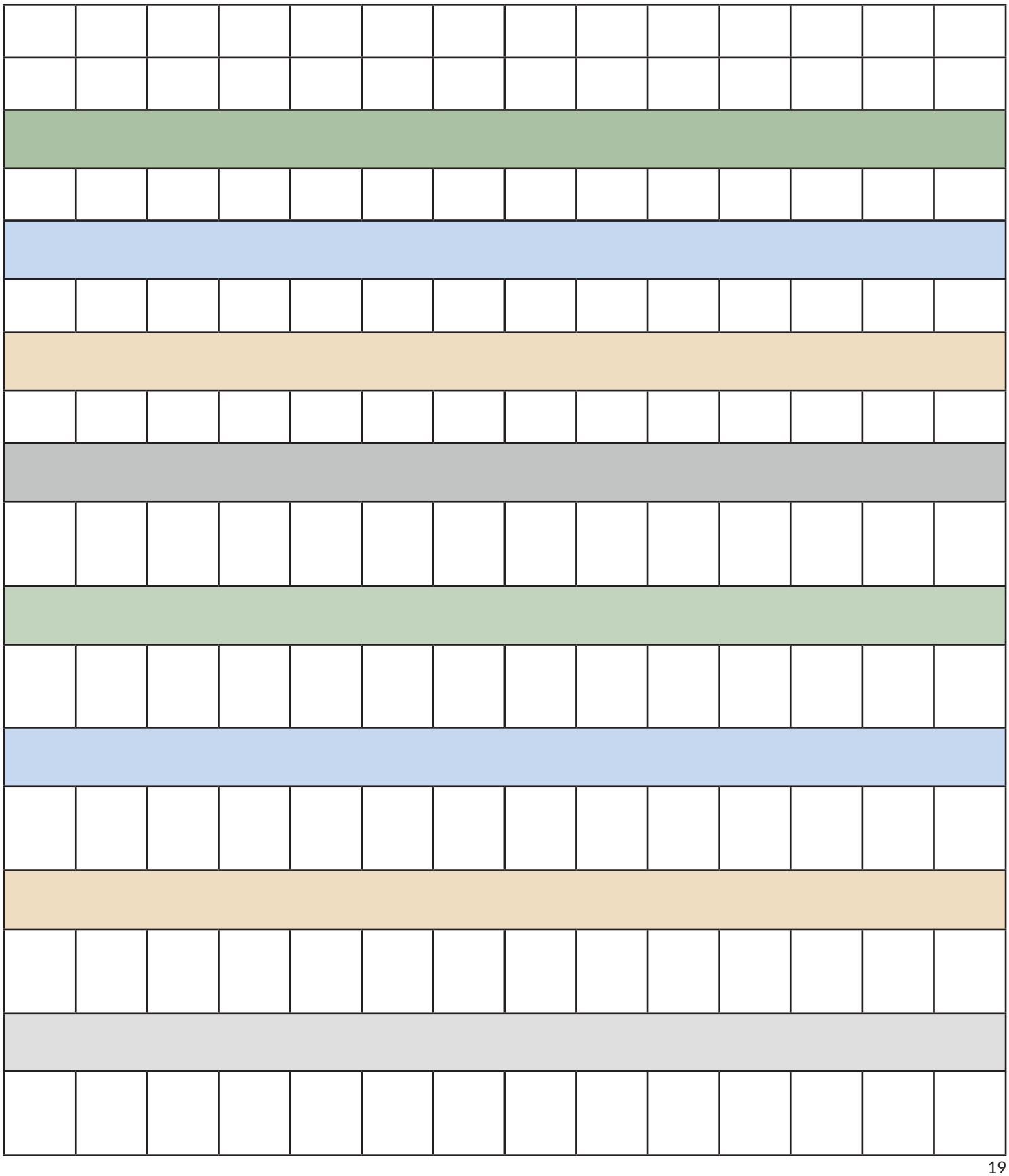
Pasture Evaluation

It is recommended to evaluate pastures seasonally based on each of the conditions below, to assess pasture health and identify areas needing improvement.

Exceptional	Advanced	Improving	Poor	Date	
3 points	2 points	1 point	0 points	Field	
What percentage of the vegetation is weeds or undesirable species?					
Less than 10%	10-25%	25-40%	More than 40%		
What percent of the soil is covered with live (including dormant) plants?					
More than 90%	75% - 90%	60% - 75%	Less than 60%		
How many forage species make-up at least 20% of your vegetation?					
4 or more	3	2	1		
How does the field look after it is grazed?					
Evenly grazed with no overgrazing	Evenly grazed with small overgrazed areas	Uneven grazing	Mostly overgrazed or refused		
How compacted is a slice of soil? Are there dense, compacted layers like a stack of plates?					
Crumbly soil & abundant deep roots	Minor dense, platy layer & a few horizontal roots	Thin dense, platy layer & many horizontal roots	Thick dense, platy layer & shallow roots		
Are there signs of soil life (tunnels, worms & castings, larvae, ants, and organic matter)?					
Numerous signs, topsoil much darker than sub-soil	Signs scattered, topsoil somewhat darker than sub-soil	Signs scattered only on the soil surface	Few or no signs, topsoil same color as sub-soil		
What signs of soil erosion are seen?					
No evidence of erosion or runoff, high plant density	Erosion on heavily used areas, some runoff	Erosion on slopes, most rainfall runs off field	Erosion throughout, poor plant density		
How vigorous do forages appear?					
Healthy, dark green, quick recovery after grazing	Minor stress, recover well after grazing	Stressed, clear color contrast against urine / dung spots	Stunted growth, not recovering well after grazing		

Pasture Evaluation Records

Record the average point score from several places in each pasture from each of the conditions at left to see changes over time.



Grazing Records

Detailed records are essential to track stocking rates and timing of grazing, identify what works well, troubleshoot where improvements are needed, and plan for future years' grazing needs. Track dates and forage heights when livestock enter and leave each pasture, and other information that will be useful.

Field/ Paddock	Acres	Animal Type and Number	Forage Species	Date		Forage Height		Notes (other feed provided, management, dry matter, production, weather, etc.)
				In	Out	In	Out	

Additional Information

Informational Resources

Northeast Pasture Consortium. *Grazing Guide*. grazingguide.net

Penn State Extension Forages information: extension.psu.edu/forage-and-food-crops/forages

University of Vermont Extension. 2023. *A Farmer's Guide to Grass-fed Dairy Production*. uvm.edu/extension/nwcrops/grass-fed-dairy

University of Maryland Extension Forage Program. go.umd.edu/forage

University of Tennessee Center for Native Grasslands Management. nativegrasses.tennessee.edu

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Sarah Flack. 2016. *The Art and Science of Grazing : How Grass Farmers Can Create Sustainable Systems for Healthy Animals and Farm Ecosystems*. Chelsea Green Publishing.

Austin Unruh. 2022. *The Grazier's Guide to Trees*. treesforgraziers.com

Steve Gabriel. 2018. *Silvopasture: A Guide to Managing Grazing Animals, Forage Crops, and Trees in a Temperate Farm Ecosystem*. Chelsea Green Publishing.

Penn State Extension,*The Penn State Agronomy Guide*. extension.psu.edu/the-penn-state-agronomy-guide

Joseph C. Neal, Richard H. Uva, Joseph M. DiTomaso and Antonio DiTommaso. *Weeds of the Northeast*. 2023. Cornell University Press.

USDA Natural Resources Conservation Service. 2021. Selection and Use of Native Warm-Season Grass Varieties for the Mid-Atlantic Region. Plant Materials Technical Note No. 5. nrcs.usda.gov/plantmaterials/mdpmctn13957.pdf

Sharing silvopasture experiences
Photo by Kelly O'Neill, Chesapeake Bay Foundation

Help is available!

More funds and technical assistance are available now than ever before to help you adopt practices that are part of a regenerative system.

CHESAPEAKE BAY FOUNDATION
Saving a National Treasure

The Chesapeake Bay Foundation (cbf.org/regenag) is dedicated to restoring Pennsylvania waterways and the Chesapeake Bay, by working with agricultural producers to improve profitability and water quality. CBF compiled information about available assistance to help farmers in Pennsylvania (cbf.org/pafarmresource) and Maryland (cbf.org/mdfarmresource).

MOUNTAINS-TO-BAY
GRAZING ALLIANCE

The Mountains-to-Bay Grazing Alliance (m2balliance.org) connects organizations and farmers to support adoption of regenerative grazing and other conservation practices that benefit water quality, improve soil health, and boost farm economies. Across Pennsylvania, Maryland, Virginia, and West Virginia, it provides:

- Financial and technical assistance for landowners
- Website clearinghouse with in-depth information
- Annual grazing conference featuring world-renowned experts
- Quarterly newsletters
- Grazing mentorships
- Field days and grazing schools
- Facilitation of one-on-one farmer discussions.

PAGLC

The Pennsylvania Grazing Lands Coalition (paglc.org) works to maintain and improve the management, productivity, and health of Pennsylvania's grazing land through education, mentorship, and research. PAGLC is a producer-led association that aids farmers and community members in keeping grazing lands productive and in the forefront of agriculture in Pennsylvania.

Seeing other grazing operations is a great way to learn to start or improve your operation. You'll see their forage species, height when animals start and leave a pasture, stocking rate, livestock breeds, paddock layout, walkways, fencing, and watering systems. It's always useful to learn about successes and failures from your fellow graziers, so please reach out to the above organizations to connect with others in your local area.

Free technical assistance is available through USDA Natural Resources Conservation Service (nrcs.usda.gov) and your local conservation district (pacd.org).

Photo by Kelly O'Neill, Chesapeake Bay Foundation