COLORADO STATE UNIVERSITY EXTENSION

Winter 2022

Soil Health Resources

Providing trusted, practical education to help you solve problems, develop skills, and build a better future since 1908.

Who is CSU Extension?

CSU Extension is an extension of Colorado State University, the land-grant university of Colorado. Extension is dedicated to serving the needs of Coloradans by providing educational information and programs that safeguard health, increase livelihood, and enhance well being.

CSU Extension has a presence across the state of Colorado and is apart of a nation wide system of Extension services.
This document will provide you with resources specific to soil health for the Centennial State. In addition to CSU materials, a list of other originations with resources regarding soil health have been included.

If you have any questions about the materials or about other Extension programs, please contact your local Extension office.

CSU Extension Website:
extension.colostate.edu

Small Acreage Management:
sam.extension.colostate.edu

CSU Extension Agriculture Publications:
col.st/o3cqS

Other Resources

- Soil Health Nexus
  - soilhealthnexus.org
  - Resource cooperative from 12 north-central land grant universities.
  - Resources on soil health, soil physical properties, demonstrations, and educational materials.

- NRCS Soil Health
  - nrcs.usda.gov/conservation-basics/natural-resource-concerns/soils/soil-health
  - The NRCS general soil health webpage.

- Soil Health Institute
  - soilhealthinstitute.org
  - Research group around soil health.

- Colorado Conservation Tillage Association
  - highplainsnotill.com
  - CO soil conservation group.
  - Currently conducting soil health demo: Farmers Advancing Regenerative Management Systems

- No-till on the Plains
  - notill.org
  - Large, no-till organisation that focuses on the High Plains

- UNL CropWatch
  - cropwatch.unl.edu
  - University of Nebraska crop updates webpage, use the tag "soil health"
  - Research updates on soil health studies in NE

- North Dakota State University - Soil Health
  - ndsu.edu/soilhealth/
  - Includes general information and research updates.

- CO Dept of Ag Soil Health
  - ag.colorado.gov/soil-health
  - Website home of the STAR program

- CSU Crops Testing
  - csucrops.com
  - CSU Crop Variety Testing program.
  - Includes producer site results and variety trial results.

- Quivira Coalition
  - quiviracoalition.org
  - Non-profit working in different sectors around regenerative agriculture and rangeland.

- Soil for Water
  - soilforwater.org
  - A project of NCAT around soil improvement for water use.

Colorado State University
Department of Soil and Crop Sciences

Soil, Water, and Plant Testing Laboratory
1120 Campus Delivery
Fort Collin, CO 80523
Email: soiltestinglab@mail.colostate.edu

SOIL SAMPLING INSTRUCTIONS

The reliability of the soil test results depends upon the quality of the sample submitted. A sample must reflect the overall or average fertility of an area, field, garden, or flower bed.

Tools

1. A stainless steel soil-sampling probe, an auger, or a shovel/trowel (Figure 1)
2. Clean bucket
3. Plastic bags or water-proof lined paper bags
4. Permanent marker

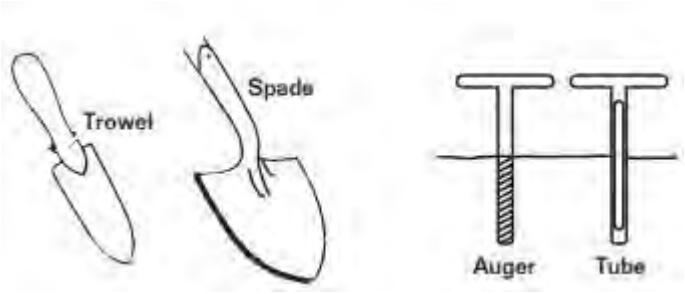


Figure 1. Sampling tools.

Sample Collection

Use a systematic and/or random sampling pattern to collect samples (Figure 2). Take 10 to 15 samples from **the soil surface (0 inches) to a depth of 6 inches or 8 inches** to form a representative composite sample.

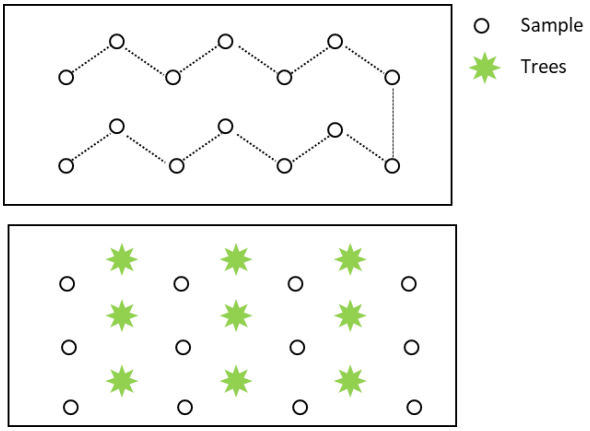


Figure 2. Sampling patten for fields, lawns, gardens, flowers beds, and trees/orchards.

Sampling depth for turf or lawn soils is 2 inches to 3 inches. If you have areas with different crop growth, soil color, or fertilizer/amendment histories, take a sample from each area. Keep the samples separated.

If a tool such as a spade is used, dig a V-shaped hole to sample depth; then cut a thin (approximately **1 inch** thick) slice of soil from one side of the hole. For the sample, save a 1-inch-wide strip of soil from the center of the spade (Figure 3).

When using an auger for sampling, bore a hole to the desired sampling depth and then withdraw it. Replace

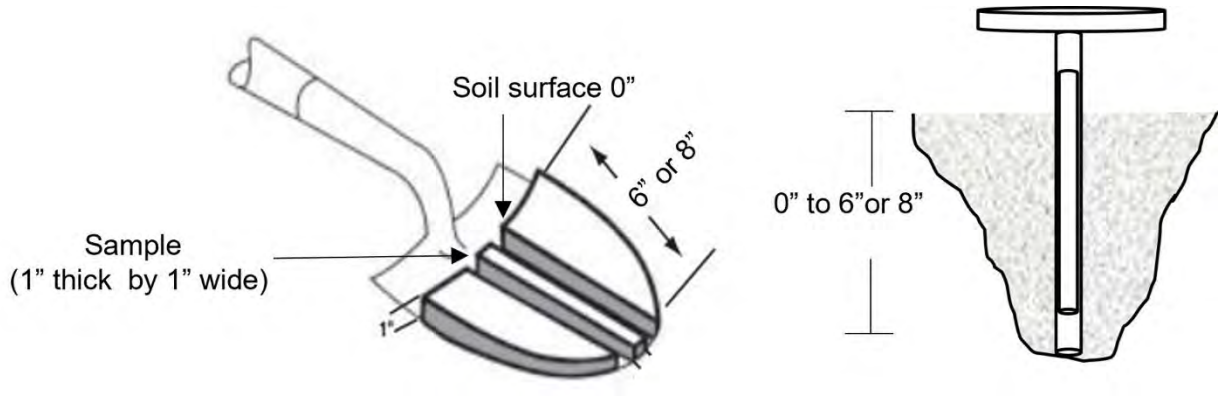


Figure 3. Sample Depth at 6 to 8 inches.

the auger tip with a core sampler, lower it down the borehole in to the soil at the completion depth. Withdraw the tube core sampler and the sample collected.

Deeper subsoil samples (**8 inches to 24 inches**) are needed for nitrate-nitrogen (NO_3-N) and sulfate -S (SO_4-S) analyses if nitrogen (N) and sulfur (S) fertilizer recommendations for crops are of special importance. Keep each depth separated.

Make sure to remove and discard surface litter (crop residue, grass, wood chips, manure, roots, or rocks/ gravel). Place each sample depth in a separated clean bucket, mix thoroughly until you have a homogeneous mixture. This is your representative composite sample.

Take and place **two cups** (approximately one pound) of representative sample into a plastic or water-proof lined paper bag. Using a permanent marker, label the bag with your name, sample depth increment, and some sort of sample identifier such as FIELD1, GARDEN1, LAWN, BACK YARD, etc. Fill out the appropriate submittal form. These forms are available at the CSU County Extension Offices and the CSU Soil, Water and Plant Testing Laboratory webpage. Make sure that the sample ID on your bag matches the ID on the submission form.

Shipping

Place sample(s) and submittal form in a sturdy box or envelope. Seal the box with packing tape and mail to the address in the submittal form. **Do not include payment**. You will receive an invoice and the soil testing results when testing is complete.

Using Web Soil Survey and Ecological Site Descriptions

Web Soil Survey Overview

Use Web Soil Survey to answer questions about your property (or someone else's property if you don't own land yet). You will learn about your soils, plants, and land characteristics.

Instructions:

1. Visit https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm (Use Internet Explorer or Chrome, not Firefox)
   - Read about web soil survey and then click on the green circle "**Start WSS**" to open

2. Find the property using the address, Section Township and Range, or others.
   - Use the AOI tool to outline the property

3. Once the property is delineated, click on the **Soils Map tab**. Note the soil textures and delineations on the property. Click on a map unit name to learn more about the soil characteristics. Note the following information:
   - Name of Soil_____
   - Soil Texture_____
   - Elevation_____
   - Mean annual precipitation_____
   - Frost-free period_____
   - Farmland classification_____
   - Slope_____
   - Drainage class_____
   - Depth to water table_____
   - Ecological site_____
   - Ecological Site Code (example- RO67BY002CO)_____
   - Hydric soil rating_____

4. Click on the **Soil Data Explorer tab**. On the left list, find Vegetative Productivity. Click to open the dropdown list. Here you can look at range, forest, and crop production data. This information may not be available for your site.
   - Click on Range Production (normal year). Then click on View Rating.
   - List pounds per acre per year (if available). This number will vary per soil type.
     _____

5. Now open the **Ecological Site Assessment tab**. On the left, the ecological sites are listed. Click to open one. This data may not be populated for your site.
    - If the data is available, look at the Reference Plant Community and note the native plants which are adapted to your site.

      _____
      _____
      _____

6. Open the **Soil Reports tab**. On the left list, click to open Soil Erosion. Click on Windbreaks and Environmental Plantings and view this report. This data may not be populated for your site.
    - If the data is available, list the trees and shrubs which are adapted to your site. These species are good options for a windbreak.

      _____
      _____
      _____

<u>Ecological Site Description Overview</u>

USDA-NRCS has used soils and vegetation information to divide the US into many ecological sites. By looking at ecological site information for your property, you can learn what native grasses, forbs, shrubs, and trees adapted for your site.

You will need to know the name and code of the ecological sites on your property (found previously on the web soil survey).

Instructions:

1. Visit NRCS Ecological Site Description (ESD) website - https://esis.sc.egov.usda.gov/Welcome/pgReportLocation.aspx?type=ESD
2. Select the state and MLRA that your site is in. Then click submit. (The MLRA is the first few letters and numbers of the ecological site code from the Web Soil Survey).
3. Read through the list of ecological sites. Select your site by clicking on the code listed under the "report link" column.
4. Select ESD Regular Report. Click Continue.

- Explore your report by using the Report Selections options on the left list. Visit each topic and take note of any helpful information.

  _____
  _____
  _____
  _____
  _____

- Under Report Selections, click on **Plant Communities**. Read the information about your site. Note any interesting history or information about the site.

_____
_____
_____

- Note the Reference Plant Community Plant Species

_____
_____
_____
_____
_____

- Select **Site Interpretations** under Report Selections. What wildlife can you expect on the site?

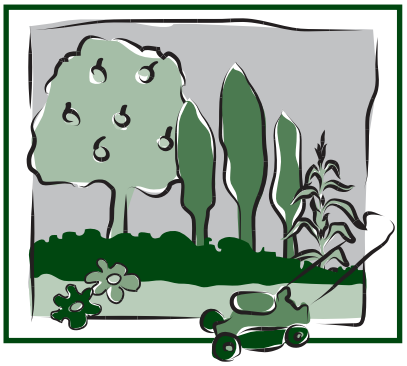
_____
_____
_____

- Which plant community does your site most resemble and why?

_____
_____
_____

COLORADO
Small Acreage Management
COLORADO STATE UNIVERSITY EXTENSION
USDA United States Department of Agriculture
Natural Resources Conservation Service

Colorado State University
Extension



Choosing a Soil Amendment

Fact Sheet No. **7.235** Gardening Series | **Basics**

by J.G. Davis and D. Whiting*

A soil amendment is any material added to a soil to improve its physical properties, such as water retention, permeability, water infiltration, drainage, aeration and structure. The goal is to provide a better environment for roots.

To do its work, an amendment must be thoroughly mixed into the soil. If it is merely buried, its effectiveness is reduced, and it will interfere with water and air movement and root growth.

Amending a soil is not the same thing as mulching, although many mulches also are used as amendments. A mulch is left on the soil surface. Its purpose is to reduce evaporation and runoff, inhibit weed growth, and create an attractive appearance. Mulches also moderate soil temperature. Organic mulches may be incorporated into the soil as amendments after they have decomposed to the point that they no longer serve their purpose.

Organic vs. Inorganic Amendments

There are two broad categories of soil amendments: organic and inorganic. Organic amendments come from something that was alive. Inorganic amendments, on the other hand, are either mined or man-made. Organic amendments include sphagnum peat, wood chips, grass clippings, straw, compost, manure, biosolids, sawdust and wood ash. Inorganic amendments include vermiculite, perlite, tire chunks, pea gravel and sand.

Not all of the above are recommended by Colorado State University. These are merely examples. Wood ash, an organic amendment, is high in both pH and salt. It can magnify common Colorado soil problems and should not be used as a soil amendment. Don't add sand to clay soil — this creates a soil structure similar to concrete.

Organic amendments increase soil organic matter content and offer many benefits. Over time, organic matter improves soil aeration, water infiltration, and both water- and nutrient-holding capacity. Many organic amendments contain plant nutrients and act as organic fertilizers. Organic matter also is an important energy source for bacteria, fungi and earthworms that live in the soil.

Application Rates

Ideally, the landscape and garden soils are improved to 4-5% organic matter. At this level, the *mineralization* (release) of nitrogen from the organic matter will be adequate for most plants without additional fertilizers. Many cities now require that the landscape soils be brought up to this level in new developments as a water conservation technique. With the improved aeration and deeper rooting, plants are more efficient in capturing rain events.

Table 1 gives the routine application rates. Where the soil amendments may be high in salts, the rate is limited due to the salt problem. Salt burn of roots and death of landscape and garden plants is common from over application of salty soil amendments.

Wood Products

Wood products can tie up nitrogen in the soil and cause nitrogen deficiency in plants. Microorganisms in the soil use nitrogen to break down the wood. Over several months to years, as microorganisms complete the rapid decomposition process, the nitrogen is released and again becomes available to plants. This hazard is greatest with sawdust, because it has a greater surface area than wood chips.

Compost wood products, before using them as soil amendments. For these products to decompose rapidly, add a nitrogen

Quick Facts

- On clayey soils, soil amendments improve the soil aggregation, increase porosity and permeability, and improve aeration, drainage, and rooting depth.
- On sandy soils, soil amendments increase the water and nutrient holding capacity.
- A variety of products are available bagged or bulk for soil amendments. However, soil amendments are not regulated. Many are extremely high in salts.
- With Colorado's large livestock industry, manure and manure-based compost are readily available. These are often high in salts, limiting application rates. Use with caution.
- Plant-based composts are low in salt. These may be applied at higher application rates, more effectively improving the soil. Plant-based composts are typically higher in price.

www.ext.colostate.edu

*J.G. Davis, Colorado State University Extension specialist and associate professor, soil and crop sciences; and D. Whiting, Extension specialist. 2/2013

source to the compost pile. This could be plant residues high in nitrogen (such as grass clippings or manure), or a nitrogen fertilizer. Do not use uncomposted wood products or sawdust as a soil amendment. It is slow to break down, ties up nitrogen, interferes with seedbed preparation, and interferes with soil and water movement through the soil profile.

Sphagnum Peat vs. Mountain Peat

Sphagnum peat is an excellent soil amendment, especially for sandy soils, which will retain more water after sphagnum peat application. Sphagnum peat is generally acid (i.e., low pH) and can help gardeners grow plants that require a more acidic soil.

Sphagnum peat is harvested from bogs in Canada and the northern United States. The bogs can be revegetated after harvest in this moist environment. However, the harvest rate greatly exceeds the vegetation rate of the peat bogs, so it is considered a semi-renewal resource.

Colorado mountain peat is not a good soil amendment. It often is too fine in texture and generally has a higher pH.

Mountain peat is mined from high-altitude wetlands that will take hundreds of years to rejuvenate, if ever. This mining is extremely disruptive to hydrologic cycles and mountain ecosystems.

Are Biosolids Safe?

Biosolids are byproducts of sewage treatment. They may be found alone or composted with leaves or other organic materials.

The primary concerns about biosolids are heavy metal content, pathogen levels and salts. Use only Class A biosolids, it has been treated to reduce the bacterial content. Class A biosolids are approved for use in production agriculture. However, it is advisable to avoid application to vegetable gardens due to the potential for heavy metals (such as cadmium and lead).

Some cities sell or give away biosolids or compost made with biosolids. It is often extremely high in salts. Ask about the salt content. Use with caution.

Manure

Fresh manure can harm plants due to elevated ammonia levels. To avoid this problem, use only aged or composted manure.

Table 1: Routine application rate for soil amendments.

Site		Depth of soil amendment prior to incorporation[A] (based on an incorporation depth of 6-8 inches)[B]	
		Plant-based composts and other soil amendments low in salts[C]	Manure, manure-based compost, biosolids, biosolid-based compost and other soil amendments that may be high in salts[D]
One-time application to new landscapes prior to planting trees, shrubs, perennials, and lawns.		2-3 inches	1 inch[E]
Annual application to vegetable garden and annual flowerbeds	First three years	2-3 inches	1 inch[E]
	Fourth year and beyond	1-2 inches	1 inch[E]

[A] Three cubic yards (87 bushel) covers 1,000 square feet approximately 1 inch deep.
[B] Cultivate the soil amendment into the top 6-8 inches of soil. On compacted/clayey soils, anything less may result in a shallow rooting depth predisposing plants to reduced growth, low vigor, and low stress tolerance. Rate should be adjusted if incorporation depth is different.
[C] Plant-based compost are derived solely from plant materials (leaves, grass clippings, wood chips, and other yard wastes). Use this application rate for other soil amendments know to be low in salt.
[D] Use this application rate for any soil amendment with maure or biosolids, unless the salt content is actually known, by soil test, to be low. Excessive salts are common in many commercially available bagged and bulk products. Use with caution.
[E] For soil amendments with high salts, this routine application rate may be too high. Use with caution.

Human pathogens, including *E coli*, are another potential problem with fresh manure, especially on vegetable gardens. For vegetables with direct contact with the soil, fresh manure must be applied at least four months prior to harvest. For other fruits and vegetables, fresh manure must be applied at least three month prior to harvest. In simple words, fresh manure would be only fall applied for the spring garden. For additional information on *E.coli*, refer to fact sheet *9.369 Preventing E. coli from Garden to Plate*.

Aged manure refers to manure that has been piled for at least six months. Excessive ammonia will have escaped. Salt levels may be higher as the salts concentrate in the decomposing material, or may be leach out with high rainfall. Weed seeds will be viable.

Composted manure technically refers to manure that has been through multiple active heating cycles and turned in between. If heated above 145 degrees F, it will kill pathogens and weed seeds. In composted manure, the organic matter is stabilized

Table 2: Permeability and water retention of various soil types.

Soil Texture	Permeability	Water Retention
Sand	high	low
Loam	medium	medium
Silt	low	high
Clay	low	high

Table 3: Permeability and water retention of various soil amendments.

Amendment	Permeability	Water Retention
Fibrous		
Peat	low-medium	very high
Wood chips	high	low-medium
Hardwood bark	high	low-medium
Humus		
Compost	low-medium	medium-high
Aged manure	low-medium	medium
Inorganic		
Vermiculite	high	high
Perlite	high	low

(through the rapid decomposition process) making it an ideal soil amendment. Salt level may be concentrated or may be leach out with high rainfall.

As a point of clarification, composts and manures are not regulated. Many commercially available products are labeled as "composted." However, this does not mean that it has been through the active decomposition process.

Compost

Compost refers to decomposed organic matter. It is not regulated, so there is no standard about the state of decomposition. In commercially available products the term "compost" is often used generically, and does not infer that the product has been through the actively heating, decomposition process.

In Colorado, a wide variety of compost products are available in bagged and bulk products. These may be a combination of plant-based compost, manure-based composts, biosolids, and other agriculture by-products (such as chicken feathers).

With the large livestock industry in Colorado, manure-based composts are most common. These are often high in salts. Use with caution.

Compost made solely from plant-based products (such as wood chips and yard wastes) are low in salts. These are preferred over manure based composts which are often higher in salts. However, they are generally more expensive.

Working with Dr. Jean Reeder, the Colorado Master Gardener Program had soils tests done on samples of locally available, bagged, manures and composts. The majority had high salts. Use with caution!

Factors to Consider When Choosing an Amendment

There are at least four factors to consider in selecting a soil amendment:

- how long the amendment will last in the soil,
- soil texture,
- soil salinity and plant sensitivities to salts, and
- salt content and pH of the amendment.

Laboratory tests can determine the salt content, pH and organic matter of organic amendments. The quality of bulk organic amendments for large-scale landscape uses can then be determined.

Longevity of the Amendment

The amendment you choose depends on your goals.

- Are you trying to improve soil physical properties quickly? Choose an amendment that decomposes rapidly.
- Do you want a long-lasting improvement to your soil? Choose an amendment that decomposes slowly.
- Do you want a quick improvement that lasts a long time? Choose a combination of amendments.

Soil Texture

Soil texture, or the way a soil feels, reflects the size of the soil particles. Sandy soils have large soil particles and feel gritty. Clay soils have small soil particles and feel sticky. Both sandy soils and clay soils are a challenge for gardeners. Loam soils have the mixture of different size soil particles.

When amending sandy soils, the goal is to increase the soil's ability to hold moisture and store nutrients. To achieve this, use organic amendments that are well decomposed, like composts, peat, or aged manures.

With clay soils, the goal is to improve soil aggregation, increase porosity and permeability, and improve aeration and drainage. Fibrous amendments like peat, wood chips, tree bark or straw are most effective in this situation.

Use Tables 2 and 3 for more specific recommendations. Because sandy soils have low water retention, choose an amendment with high water retention, like peat, compost or vermiculite. Clay soils have low permeability, so choose an amendment with high permeability, like composted wood chips, composted hardwood bark or perlite. Vermiculite is not a good choice for clay soils because of its high water retention.

Soil Salinity and Plant Sensitivity to Salts

Many forms of compost made with manure, and biosolids are high in salts. Avoid these amendments in soils that are already high in salts (above 3 mmhos/cm) or when growing plants that are sensitive to salts. Raspberry, strawberry, bean, carrot, onion, Kentucky bluegrass, maple, pine, viburnum and many other landscape plants are salt sensitive. In such cases, choose plant-based composts or sphagnum peat.

Salt Content and pH of the Amendment

Always beware of salts in soil amendments. High salt content and high pH are common problems in Colorado soils. Therefore, avoid amendments that are high in salts or that have a high pH. Amendments frequently high in salts and/or pH include wood ash, Colorado mountain peat and manures, and manure-based compost, biosolids, and biosolid-based compost.

An amendment with up to 10 mmhos/cm total salts is acceptable if mixed well into low-salt soils (less than 1 mmhos/cm). Amendments with a salt content greater than 10 mmhos/ cm are questionable. Choose a low-salt amendment for soils testing high in salts.

Sphagnum peat and compost made from purely plant sources are low in salts and are good choices for amending Colorado soils.

Ask for an analysis of the organic amendments that you are considering, and choose your amendments wisely. If no analysis is available, test a small amount of the amendment before purchasing a large quantity.

Use caution as the salt content in compost may vary from batch to batch.

COLORADO STATE UNIVERSITY
EXTENSION

Management-intensive Grazing (MiG) on Irrigated Pasture

Fact Sheet 1.635 Livestock Series | Management

By Casey Shawver, Joe Brummer, Jim Ippolito, Jason Ahola, and Ryan Rhoades (9/20)*

What is MiG?

Management-intensive Grazing (MiG), a concept credited to grazing specialist Jim Gerrish, is often defined as "a flexible approach to rotational grazing management whereby animal nutrient demand through the grazing season is balanced with forage supply and available forage is allocated based on animal requirements" (4, 7). This type of system requires manipulating the length of time animals graze and space allotted based on available forage resources to achieve desired objectives. It also requires an understanding of how plant, animal, soil, and environmental components work together to make management decisions (4). MiG is often characterized by relatively frequent movements of animals, typically every 1-4 days (Figs. 1, 2). This method ranks MiG as more "management-intensive" than planned rotational grazing (3-10 day moves), but less so than mob grazing (2-10 moves daily).

Figure 1: Daily cattle move in the irrigated MiG system at Colorado State University's research facility (Photo by Casey Shawver).

More intensive, irrigated systems are being considered as an option by many ranchers due to pressure to reduce grazing on public lands and the declining land available for pasture (2). Within intensive, irrigated pasture systems, MiG can result in more homogenous utilization of available forage, increased forage yield and quality, less severe soil compaction, improved soil health, and more evenly distributed manure and urine over an area leading to reduced production costs by providing increased animal output and greater land use efficiency (6, 8, 9, 10). At Colorado State University (CSU), an irrigated, full-scale MiG project was established in 2016. Experiences and lessons learned from this project are included within this document to provide further insight. Although some of the principles discussed in this document apply to management of native rangeland, keep in mind that there are also many differences, especially with respect to the potential for forage regrowth to occur under irrigated conditions compared to dry, native rangeland in the western US.

MiG Principles

Core components of MiG can be summarized by the FIO principle: minimizing frequency of plant defoliation (F), controlling intensity of plant defoliation (I), and allowing

Quick Facts

- MiG emphasizes "intensive management" and not "intensive pasture use" by controlling grazing time and space to balance available forage with animal demand.
- Balancing grazing frequency and intensity with the opportunity for forage regrowth are core MiG principles.
- Determining pasture size incorporates estimates of forage supply and animal demand.
- Short- and long-term monitoring is integral for making management decisions to achieve goals and objectives more effectively.

**Casey Shawver, Former Graduate Student, Joe Brummer, Associate Professor-Forage Extension Specialist, and Jim Ippolito, Associate Professor-Soil Fertility and Environmental Soil Quality, Department of Soil and Crop Sciences; Jason Ahola, Professor-Beef Production Systems, and Ryan Rhoades, Associate Professor-Beef Extension Specialist, Department of Animal Sciences. 9/20.*

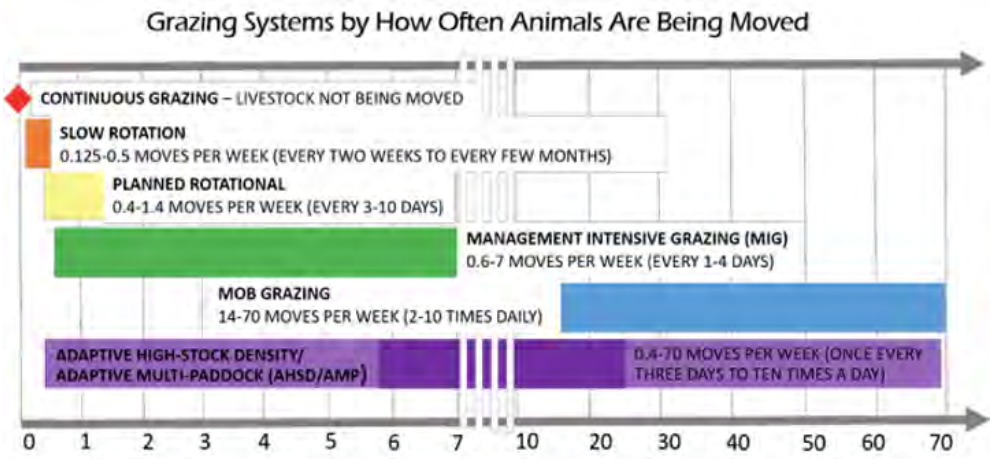


Figure 2: Diagram illustrating frequency of animal movements based on grazing strategy (Figure by the Pasture Project).

opportunity for plant growth/regrowth (O). These factors are all focused on maximizing productivity and utilization while protecting plant health to ensure long-term pasture productivity.

Frequency

MiG involves frequent movements that result in infrequent defoliation of individual plants. In contrast, allowing animals to spend time in an area for an extended period can lead to multiple defoliations of individual plants during a grazing event. Multiple defoliations of individual plants impact the energy balance between roots and shoots. This leads to weakening of plants, which ultimately results in reduced productivity and eventual thinning of the stand. Bare soil in a pasture is an open invitation for invasion by unwanted weeds.

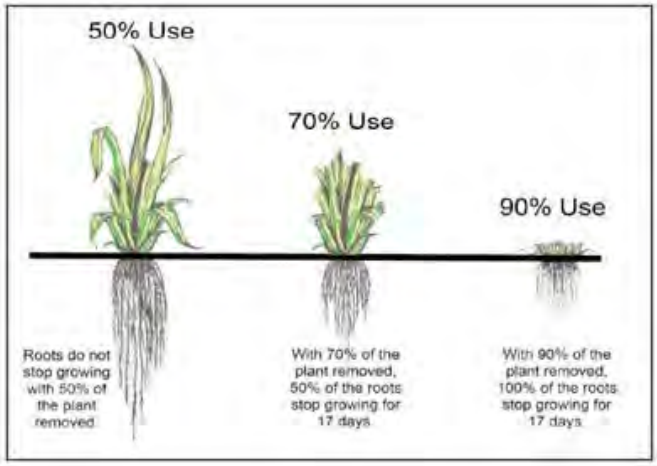


Figure 3. Illustration of forage utilization and its impact on root growth (Interpretation of research by Crider, 1955, Figure by Kathy Voth, Great "Grass Farmers" Grow Roots).

Intensity

Intensity of defoliation has direct impacts on rate of forage regrowth as well as overall root growth. When forage utilization exceeds 50%, regrowth and productivity slow due to reduced leaf area, which limits photosynthesis (3). In addition, root growth slows and will eventually cease at utilization levels greater than 50% (Fig. 3). Continued utilization above 50% will weaken plants, eventually leading to plant death and invasion by weeds. In addition, it is important to note that sufficient leaf area needs to be maintained to enable initiation of plant regrowth. The residual height at which sufficient leaf area is maintained varies depending on the grass species, however, most cool-season irrigated pasture grasses should not be grazed below 4 inches. Grazers often refer to these 4 inches as "belonging to the plant" to ensure energy is maintained for quick regrowth and overall plant health. As a general guideline, a minimum of 8 inches of forage should be available before grazing to assist in maintaining both the 4-inch residue height and 50% utilization objectives that will ultimately ensure adequate plant recovery.

Although 50% use is generally the desired target, there are circumstances in which lower or higher levels of utilization are warranted. Examples of when you might want to graze more intensively (>50% utilization) would be to remove more of the grass canopy to allow light to penetrate and stimulate growth of legumes like white clover or increase establishment success of interseeded forages. An example of when you might want to graze less intensively (<50% utilization) would be during spring growth when cool-season species grow rapidly and forage can begin to mature faster than it can be grazed. On the CSU grazing project, we found

that it was important to move animals quickly through the first rotation early in the season, generally only utilizing 20-30% of available forage in an effort to remove growing points from some of the grass and keep it from jointing and becoming over-mature. In other words, since forage was growing rapidly in the spring, we moved livestock more quickly between units in response to conditions, whereas livestock spent longer time periods in each unit later in the year. This example illustrates the adaptive nature of MiG where we were monitoring plant growth rates and utilization levels in order to make decisions on when to move our livestock. The emphasis of MiG is on "intensive management" and not "intensive pasture use" which is why fixed grazing periods do not work well to maintain plant health and vigor.

Opportunity for Regrowth

The period of rest following a grazing event is vital for regrowth. In general, over-utilization results in decreased animal performance and the need for longer rest periods. Shorter grazing periods and proper utilization, as discussed above, can help mitigate the need for prolonged rest periods. In a cool-season, irrigated pasture system, the optimum rest period is not only dependent on grazing management practices, but also temperature, which is related to the point in time during the growing season. Cool-season grasses experience a period of slower growth during the hottest period of the growing season, also known as "summer slump." During this period, length of the rest period should be longer to compensate for slowed growth (Fig. 4).

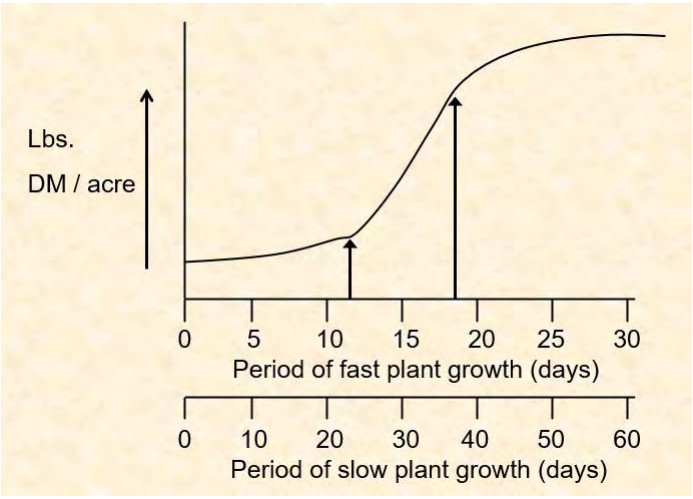


Figure 4. Optimum rest period (plus/minus a few days either side of vertical line on the right) for fast and slow plant growth periods to maintain plants in the most rapid growth stage (Craig Saxe, Univ. Wisconsin).

In the spring, cool-season species grow rapidly, requiring cattle to be moved quickly to keep up with growth as well as remove growing points before grass begins heading. The ultimate goal of determining a rest period is to maintain plants in their most rapid rate of growth (i.e. steepest part of growth curve in Fig. 4). This gives enough time for plants to recover and produce adequate forage before another grazing event, but not so long that plants become mature and quality and rate of growth begins to decline. The recommendations in Figure 4 are approximate and actual values are site dependent and can change based on environmental factors, primarily temperature and moisture.

The rest period on the CSU grazing project was not fixed and averaged around 30 days over the 6-month grazing season. The amount of regrowth is what we keyed on to determine if a paddock was ready to be grazed again. As mentioned above, a minimum of 8 inches of regrowth and a full (closed) canopy is what was targeted. Rest periods ranged from 18 to 24 days early in the season during rapid growth, to 35 to 40 days during the summer slow growth period, to 28 to 32 days later in the season when temperatures cooled and the rate of regrowth increased again.

Selecting Forage Species

There are many cool-season species that perform well under irrigated MiG. However, based on experiences from the grazing project at CSU, there are pros and cons associated with some of these species that need to be considered when choosing what species to include in a mixture and if altered management strategies are required for establishment and grazing.

Orchardgrass

Orchardgrass is commonly included in irrigated pasture mixes. It is a very palatable species that is high in quality and productive in an irrigated pasture setting. If including orchardgrass in a mixture with grasses such as meadow brome that have increased seedling vigor, include a higher percentage of orchardgrass seed in the mix. This will help mitigate competition between orchardgrass seedlings and more vigorous species such as meadow brome.

Meadow Brome

Meadow brome is also included in many irrigated pasture mixes and is very productive, nearly to a fault during early season growth. During early growth, meadow brome tends to joint (i.e. elongate stems) before most other cool-season grasses. If the growing points are not removed early with grazing, then meadow brome plants will set seed, which reduces palatability and utilization. Rapid rotation in con-junction with a high stock density (number of animals per unit area) is critical during the first 4 to 6 weeks of the growing season if meadow brome is included in the grass mixture. This is not as much of an issue with most other cool-season grasses.

Another issue with meadow brome is related to the morphology of its leaves which are soft and lax (i.e., not rigid, upright). During rapid spring growth, leaves become long (>20 inches) and tend to lodge or lay on the ground. When cattle enter a paddock to graze, the leaves are easily trampled. This was observed on the grazing project at CSU which resulted in the accumulation of dense layers of litter on the soil surface that slowed regrowth. Slowed regrowth can be a disadvantage in a MiG system resulting in paddocks where grazing needs to be delayed or skipped on the following rotation.

Tall Fescue

Although a common, productive irrigated pasture species, tall fescue is not very palatable to cattle if they have a choice within a pasture mix, especially when using the older, tough-leafed cultivars. This was observed clearly within our paddocks at CSU when cattle overgrazed other species and mostly avoided tall fescue in the mixture that contained one of the older cultivars. However, another species mixture on the project had a newer, soft-leafed cultivar of tall fescue that was not avoided by cattle. It was evident that the tough-leafed tall fescue deterred cattle and utilizing a soft-leaved cultivar can alleviate this issue. Older varieties of tall fescue are better utilized in monocultures or as stockpiled forage for fall/winter grazing to reduce selectivity.

Creeping Meadow Foxtail

Creeping meadow foxtail is a complementary addition to a cool-season pasture mix due to its rhizomatous growth habit. Many of the cool-season species used in irrigated pastures are bunchgrass types, which have generally less resilience to grazing. Grasses such as creeping meadow foxtail will fill in gaps between bunchgrasses over time to create thicker ground cover. Ground cover in a pasture is vital to maximizing productivity because bare ground is a missed opportunity for photo-synthesis and plant growth. Another quality that this species has is that it thrives in wet environments where other species cannot. If there are wet, low lying areas in your pasture, this species should be con-sidered for inclusion in the mix. One caveat is that creeping meadow foxtail can become dominant in areas such as high mountain meadows due to the wild flood irrigation method which creates saturated soil conditions conducive to growth of this species.

Smooth Brome

Smooth brome is rhizomatous and is often included in irrigated pasture mixes to help fill in bare areas between bunchgrasses to maintain thick stands. Smooth brome is very palatable and produces an abundance of forage during initial spring growth. However, it regrows slowly during the hot part of the summer which can limit forage availability, leading to the need to reduce stocking rates during that time. It can also lead to sod-bound conditions if it makes up too much of the stand, which results in reduced productivity. The key to including smooth brome in mixtures is to keep the percentage low, no more than 5 to 10% of the total mix (i.e., 1 to 2 lbs/acre). Even when seeded at low rates, smooth brome will often come to dominate a stand over time due to its aggressive spread through rhizomes. However, this can be minimized with proper grazing management that maintains the health and vigor of the bunchgrasses in the mix.

Perennial Ryegrass

Worldwide, perennial ryegrass is one of the most common grasses planted for improved pasture. However, most varieties do not persist well under Colorado's fluctuating environmental conditions and will often winterkill. Because it establishes quickly and

easily, it is often included in irrigated pasture mixes but stands will tend to thin within 1 to 3 years. If you look at the tag on a typical seed mixture, perennial ryegrass will often make up 25% or more of the mix, which can result in significant declines in productivity as it disappears from the stand. Several seed companies are working on cultivars adapted to Colorado's continental climate, so be sure to ask where the cultivar in the mix was developed. Otherwise, be wary and keep the percentage in the mix to a minimum.

Assessing Forage Availability

Estimating how much forage is available is an integral step prior to determining paddock size. One of the simplest, most affordable, and quickest methods is measuring average sward height with a pasture/grazing or yard stick (Fig. 5). To utilize this method, choose a pattern that you will take measurements along (e.g. walk the pasture in an "M", "S", or "Z" pattern) to eliminate bias of certain areas of the pasture. When taking your first measure-ment, place the measuring stick into the grass and record the height below which 90% of forage mass is found. You do not want to measure the tall, wispy leaves or pull the grass leaves up to the stick. If this method is practiced enough, you can calibrate yourself to visually estimate available forage in our pastures. While walking, take measure-ments at regular intervals so that you collect 20-30 values. Take an average of the measurements to determine sward height. Generally, in a cool-season irrigated pasture with 75-90% ground cover, 250-350 pounds of forage dry matter (DM) per acre are available per inch of sward height. Multiply the average sward height by the pounds of DM per acre inch to estimate yield in pounds per acre. It is a judgement call as to what yield per inch of height to use. If the ground cover is a little sparse (~75%), then use 250 lbs/acre/inch but if it is a nice dense stand (~90% ground cover), then use 350 lbs/acre/inch. Remem-ber that this is just a ballpark estimate, so using the midpoint of 300 lbs/acre/inch will provide an acceptable estimate in most situations. Other methods such as the rising and falling plate meters are also reliable options for estimating forage yield. More information on these methods can be found in Pasture and Grazing Management in the Northwest by Shewmaker and Bohle (10). Note that these methods work best in areas of relatively uniform vegetation, like irrigated pasture, but do not translate well to estimating available forage on dryland pastures or rangelands with sparse plant cover (<60%).

Figure 5. Demonstrating sward height measurement with a pasture/grazing stick (Photo by Ariel Bobbett).

Infrastructure

Common pasture infrastructure in an irrigated, MiG system includes barbed wire or high-tensile electrified perimeter fence, electrified polywire and step-in posts used to establish cross fences, waterers, and gates. Infrastructure design and day-to-day setup varies by ranch; however, the common concept is utilizing moveable fence and posts to create paddocks based on forage availability and animal demand. Moveable, temporary fence makes this system extremely flexible depending on how quickly forage is growing or how many animals are being grazed at a point in time. Animal demand and forage supply are in a constant state of flux and it is important that the infrastructure can adapt to account for that variability. In the system installed at CSU, three concentric, permanent, electrified high-tensile fences create the foundation within a 200-acre pivot, while electric polywire is connected from outer to inner circles to create temp-orary paddocks of varying sizes based on number of animals being grazed and current forage supply (Fig. 6). This is an effective fence design for a pivot system of this size, particularly when managing multiple herds. The three-ring fence design allows flexibility to graze up to 3 herds simultaneously within a given quarter of the pivot while having access to separate watering points and allowing for irrigation on the other 3 quarters (Fig. 6).

Figure 6. MiG system design on a 200-acre pivot including high-tensile concentric fences (green), moveable polywire paddock fencing (white), and watering locations at Colorado State University. Polywire locations represent areas associated with given water points and are often further subdivided into 2 or 3 smaller paddocks depending on animal numbers and current forage supply (Figure by Casey Shawver, retrieved from PastureMap mobile application).

Determining Paddock Size and Stocking Rate

The paddock size needed to balance forage supply with animal demand can be determined through two simple equations (Fig. 7). For the first equation, forage supply is determined by multiplying estimated available forage (using the pasture stick, etc.) by the utilization goal (generally 50%). Animal demand is then determined by multiplying estimated daily intake as a percent of body weight (be sure to use the decimal fraction) by the number of days planned to graze. The percent of body weight value changes based on cattle characteristics (e.g. sex, reproductive state, and age) (Table 1). Steers and heifers will generally consume between 3 and 3.5% of bodyweight. Then, forage supply is divided by animal demand to get pounds of liveweight per acre. In the second equation, total pounds of liveweight (average animal weight x number of animals) is divided by the pounds of live-weight per acre (answer from the first equation) to get the size of paddock in acres. Once the area is determined, the paddock can be constructed using poly-wire and step-in posts. However, knowing where to set the fence(s) to achieve the desired area can be difficult. There are numerous free phone apps that use GPS and can measure land area while in the field (e.g. Geo Measure, GPS Fields Area Measure, etc.). Paid apps, such as PastureMap, are designed specifically for grazing systems and offer the paddock building tool as well as recordkeeping, grazing reports, and many other options. This is the tool we used and found it very useful. An example of the map you can create of your pasture layout can be found in Figure 6.

If you are not into technology, you can always just pace off, count fence posts, etc. to estimate the area to fence off for a paddock and then evaluate your level of use the next time you go out and adjust the size of the next paddock accordingly (i.e., larger, about the same, or smaller). Regardless if you do or do not use technology, visual estimation of utilization should be part of your daily monitoring followed by subsequent adjustment of paddock size or time in a paddock.

Although it is important to accurately estimate paddock size, please keep in mind that you also need to estimate and set a realistic stocking rate based on what the pasture will produce over the growing season. Changing paddock size and speed of the rotation will not make up for a deficit in forage production if you have too many animals. The first equation in Figure 7 can be used to estimate stocking rate for your pasture in lbs of

Calculating paddock size:

$$\frac{\text{Available forage estimation (lbs DM acre) x .50 (utilization goal)}}{\text{Estimated daily intake (\% bodyweight) x Duration of grazing (days)}} = \text{lbs of liveweight acre}$$

$$\frac{\text{Total lbs of liveweight for entire herd}}{\text{lbs of liveweight acre}} = \text{Size of paddock in acres}$$

Figure 7. Equations to calculate paddock size based on animal and forage information.

liveweight per acre. Instead of the amount of forage available at a point in time when determining paddock size, you need to use what you think the pasture will produce over the growing season. At lower elevations (below 6,000 ft), it is generally safe to assume that most well managed irrigated pastures in Colorado will produce at least 4 tons or 8,000 lbs per acre. As you move up in elevation, production will decline due to the shorter growing season down to 1.5 to 2 tons per acre at around 8,000 ft. For utilization, you can conservatively assume about 70% of what is produced over the growing season will be utilized by the livestock. At any point in time, you do not want to use more than about 50%, but when you add up utilization from all grazing periods over the season, it will generally total 70% or more of what was produced. Use the average intake over the season for the type of animals you will be grazing and how many days they will graze (e.g., 6 months or 180 days). In our system at CSU, the approximate stocking rate was 1,000 lbs of liveweight per acre (i.e., 1 animal unit per acre). To arrive at this value, we assumed 8,000 lbs/ac, 70% utilization, 3% bodyweight intake (be sure to use the decimal fraction, 0.03), and 180 days of grazing which equates to 1,037 lbs of liveweight per acre. This estimate proved to be very close for our situation.

Table 1. Pounds of dry matter intake (DMI) by a mature cow at varying weights and reproductive stages (5).

Body Weight (lbs)	Post- Partum	Lactating & Pregnant	Gestating	Pre-Calving
	---------- DMI (% of Bodyweight) ----------			
1100	2.62	2.51	2.13	2.27
1200	2.76	2.65	2.28	2.44
1300	2.91	2.80	2.43	2.58
1400	3.04	2.94	2.56	2.73

Pasture Monitoring

Pasture assessment over the short- and long-term is important for making management decisions to achieve goals. Examples of goals that we had for the CSU grazing project included:

- maintaining an average residue height of 4 inches following grazing to ensure adequate leaf area for photosynthesis and rapid regrowth
- utilization of 50% or less of the vegetation in a paddock during a grazing period
- rest periods no shorter than 18 days (preferably 21 days) with an average over the grazing season of about 30 days
- cows that maintained or increased in body condition over the grazing season
- calves that weaned as heavy or heavier than average
- minimal animal health issues

Table 2 outlines some of the factors to consider monitoring, what those factors tell you, how often to monitor, and monitoring methods.

Short-term assessments can be done visually when animals leave a pasture to determine if residue height/utilization goals are being met and assess livestock health. Moving animals more often allows managers to have a more intimate knowledge of weight gain/body condition status or illness within the herd. This information can be used to make more responsive improvements to the system. Pasture productivity can be assessed less frequently, approximately twice per month. This monitoring provides an idea of what forage production looks like moving forward in the grazing rotation and how forage is regrowing from previous grazing events. Longer term monitoring, which can be done once to a few times a season, focuses more broadly on overall pasture health. Observations in this type of monitoring could include plant diversity, basal cover, residue, fertility, soil characteristics, and others. There are several score sheets that can be used to record pasture observations and aid in determining overall pasture health. The Pasture Condition Scoresheet published by the NRCS is one good example to check out (1).

Challenges

When grazing cool-season irrigated pastures, one of the biggest challenges is balancing livestock forage demand with available forage throughout the season as both are always changing. As hard as one might try, it is difficult to rotate fast enough in the spring to keep up with rapid forage growth. Grass in some paddocks will end up transitioning to the reproductive phase and palatability and forage quality will decline. There are several options to address this issue. One is to have a flexible herd size with more animals available for grazing in the spring. If you are primarily grazing cow/calf pairs, you could also run some additional stocker steers for a couple of months. If you are running stocker steers, you could have a larger number in the

Table 2. List of monitoring indicators, what they tell you, suggested frequency of effort, and method to accomplish.

Monitoring Indicator	What It Tells You	Frequency of Effort	Method
Dry Matter Yield	Amount of forage present to inform paddock size	2x per month	See above – Assessing Forage Availability
Residue Height	Intensity of utilization - does enough leaf area remain for photosynthesis and rapid regrowth, does paddock size need to be adjusted	At every move	Pasture/grazing stick measurement combined with visual assessment to determine if the minimum 4-inch residue height was achieved
Body Condition	Weight gain/loss	Beginning and end of grazing season	Body condition score or actual weight
Animal Health	Need to treat an animal or remove it from the herd	At every move	Visual assessment of such things as droopy head/ears, lameness, slow to move to new paddock, etc.
Trend Monitoring	General ecological trend to determine if changes in management are required to maintain pasture productivity and stability of the plant community, soil, and water resources	Once per season at about the same time every year	See Pasture Condition Scoresheet by NRCS

spring and either sell the larger ones after a couple of months or move part of the herd to other forage re-sources such as native rangeland. A second option is to stock the pasture for when forage supply will be at its lowest point, which will be during the summer slump in July and August, and plan on haying some of the paddocks. The third option is to allow the forage in some paddocks to stockpile during June which will provide a reserve to help make it through the summer slump in July and August. We found that although palatability of standing, stockpiled forage declines significantly, if you mow the stand just prior to turning cattle into a stockpiled paddock that animals will do a good job of cleaning up the mowed forage. It has that nice smell of freshly cut, curing hay which draws animals to it. They will eat much of the cut forage along with grazing some of the leaves down in the canopy. We found that mowing between 6 and 10 inches (i.e. stubble height) with a rotary mower was ideal and led to quick regrowth of the forage which was nice and leafy by the next rotation through the mowed paddock.

A final consideration to keep in mind is that, although cool-season forages will regrow in the late summer/early fall, the amount and rate of regrowth will drop off quickly in late September into early October in Colorado. This means that the grazing season will generally be over by the end of October unless you have set aside paddocks earlier in the season (i.e. August) for stockpiling of forage. If grazing later into the fall is an objective, then having about a quarter of the area in monoculture tall fescue is a good option since it grows later into the fall, stands up well under a snow load, and stockpiles well (i.e., maintains forage quality). When grazing late in the growing season, you want to leave at least 4 inches of stubble for the plants to have enough stored carbohydrates to ensure survival and vigorous spring growth. Grazing too close (i.e., less than 4 inches) in the fall will lead to weakened stands the following year that green up later in the spring and are not as productive. Just like earlier in the growing season, you must “leave some grass in the fall to grow some grass the next spring”.

More information on MiG can be found at:

1. Management-intensive Grazing: The Grassroots of Grass Farming by Jim Gerrish
2. Pasture and Grazing Management in the Northwest by Shewmaker and Bohle: https://www.extension.uidaho.edu/publishing/pdf/pnw/pnw0614.pdf
3. Management-intensive Grazing in Indiana, a Purdue/NRCS publication: https://www.extension.purdue.edu/extmedia/AY/AY-328.pdf

References:

1. Cosgrove, D., Undersander, D., Cropper, J., 2001. Pasture Condition Score Sheet. USDA-NRCS Grazing Lands Technology Institute.
2. Cox, S., Peel, M.D., Creech, J.E., Waldron, B.L., Eun, J.S., Zobell, D.R., Miller, R.L., Snyder, D.L., 2017. Forage production of grass–legume binary mixtures on intermountain western USA irrigated pastures. Crop Sci. 57, 1742–1753.3.
3. Crider, F.J., 1955. Root growth stoppage resulting from defoliation of grass. U.S. Department of Agriculture Technical Bulletin 1102, 23.
4. Gerrish, J., Ohlenbusch, P.D., 1998. Using terms: Management-intensive Grazing or Management Intensive Grazing. Rangelands 20, 13-14.
5. Hall, J., Seay, W., Baker, S., 2009. Nutrition and feeding of the cow-calf herd: Production cycle nutrition and nutrient requirements of cows, pregnant heifers and bulls. Virginia Cooperative Extension. 300, 1-2.
6. Hanson, G., 1995. Adoption of intensive grazing systems. J. Ext. 33 https://www.joe.org/joe/1995august/rb3.php (accessed 2 October 2019).
7. Martz, F.A., Gerrish, J., Belyea, R., Tate, V., 1999. Nutrient content, dry matter yield, and species composition of cool-season pasture with management-intensive grazing. J. Dairy Sci. 82, 1538–44.8.
8. Morrison, J., Barnhart, S., Johnson, K., 2009. Hay and Pasture. Illinois Agron. Handb. 65–81.
9. Oates, L.G., Undersander, D.J., Gratton, C., Bell, M.M., Jackson, R.D., 2011. Management-intensive rotational grazing enhances forage production and quality of subhumid cool-season pastures. Crop Sci. 51, 892–901.
10. Shewmaker, G.E., Bohle, M.G., 2010. Pasture and Grazing Management in the Northwest. Pacific Northwest Ext. Pub. PNW 214. Univ Idaho Ext, Moscow, ID. 208 pp.

USDA United States Department of Agriculture

NRCS Cover Crop Termination Guidelines Version 4: June 2019

Cover Crops and Crop Insurance Overview – What you need to know as a producer:

Prior to the passage of the 2018 Farm Bill, the NRCS Cover Crop Termination Guidelines (Guidelines) had to be followed, or a deviation had to be approved in advance, for insurance to attach to a crop planted in a management system that included cover crops. However, cover crop adoption and regional availability of data on successful cover crop management have expanded significantly since the last Guidelines revision in 2014. For crops planted in the 2020 crop year and later, insurance will now attach at time of planting the insured crop and cover crop management practices will be reviewed under Risk Management Agency (RMA) rules for Good Farming Practice (GFP) determinations similar to other management decisions (e.g. fertilizer application, seeding rates, etc.)

Insurance attaches at planting as per the changes in the 2018 Farm Bill. In the event of a claim that is questioned by an Approved Insurance Provider (AIP) on the grounds of cover crop management, the AIP will complete research to adhere to procedure in order to make an initial GFP decision. For additional details regarding good farming practice determinations please see the RMA Good Farming Practice Handbook.

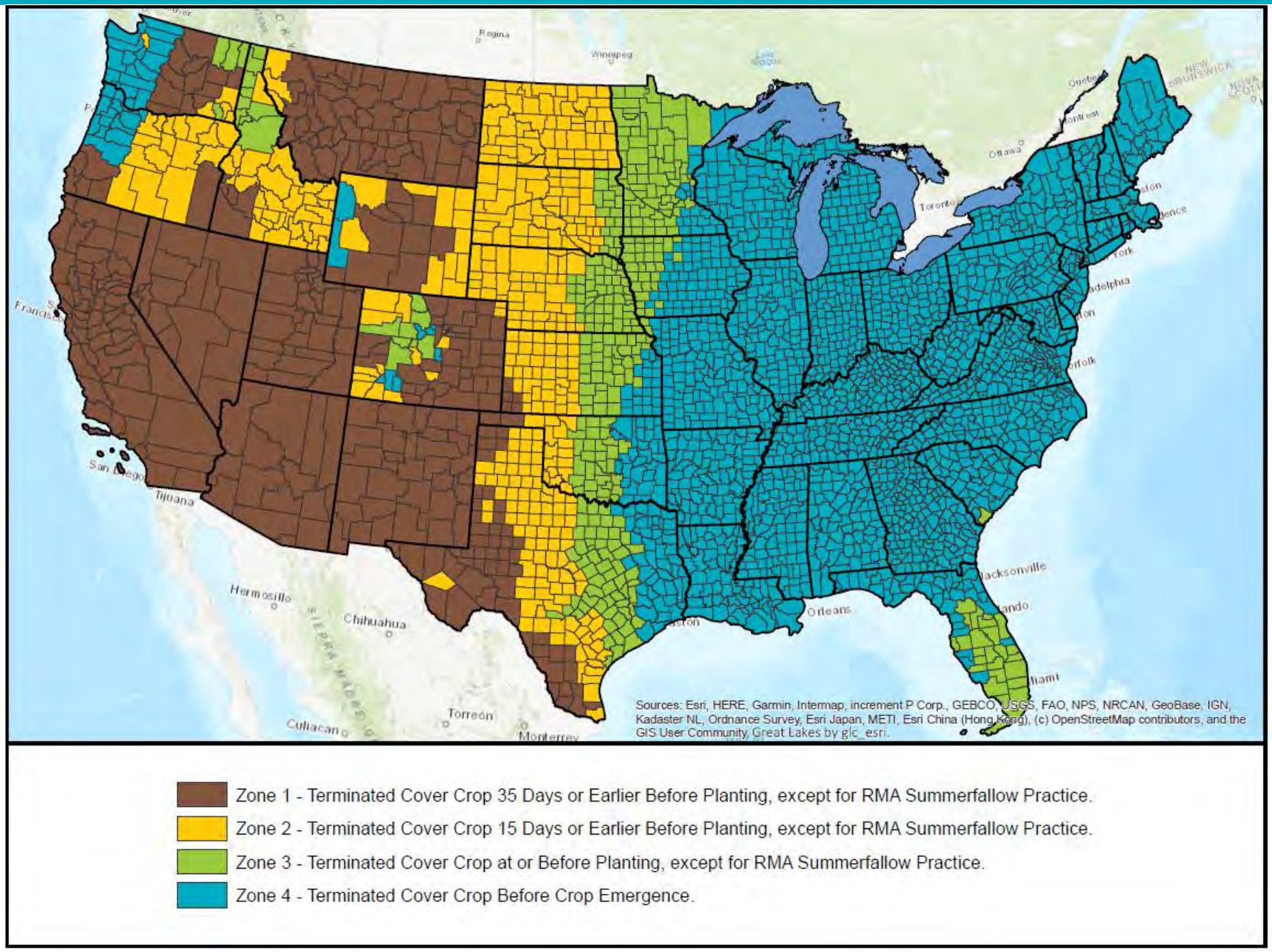
These Guidelines[1] are not intended as a substitute for best locally adaptive management for cover crop termination timing that optimizes water use efficiency, erosion control, soil health improvement, weed and pest control, allelopathy, habitat for beneficial organisms, nutrient cycling, and water quality improvement. The Guidelines provide a pre-approved latest end date for termination from a water availability standpoint for USDA programs. The Guidelines only apply to non-irrigated cropland, including systems that contain a fallow period. Cover crops in an irrigated cropping system should be terminated based on the crop system, water availability, and the conservation purpose, but before the planted crop emerges.

BACKGROUND

To ensure that USDA policies are coordinated and up to date with evolving cover crop practices, the Chief of the Natural Resources Conservation Service (NRCS), and the administrators of RMA and Farm Service Agency (FSA) organized an interagency workgroup to develop consistent, simple and flexible policy across the three agencies. National and local experts, along with multiple stakeholders, were involved in the process. Research literature, plant growth, soil hydrology models, and input from national/local experts in cover crop management provided the basis for the Guidelines to achieve their conservation benefits while minimizing risk of reducing yield to the following crop due to soil water use. These Guidelines are applicable to all USDA programs. The agencies welcome stakeholders to provide literature and data for use in improving these Guidelines over time. To share literature and data, stakeholders may contact their local NRCS office.

1 The purpose of these Guidelines is to provide an additional level of comfort for producers that may be unfamiliar with cover crops and want up front assurance that their crop is insured and their cover cropping management decisions will be considered a GFP. These Guidelines serve as a recognized nationally applicable agricultural expert resource for cover crop termination in cover cropping management systems. However, producers may also be implementing innovative cover cropping systems that fall outside these Guidelines. To help maximize additional flexibility and up - front assurance, producers can choose to pursue any one of the following options to assure that their cover cropping management system is a GFP.

1. A producer can follow the generalized zonal guidance provided in these Guidelines,
2. A producer can utilize already available published materials from agricultural experts (e.g., from a university) that are applicable for the crop and the area that support the cover crop management practice as a GFP determination (per the GFP Handbook
3. In rare instance where 1 and 2 do not cover a specific cover cropping management system, request an exception to these Guidelines by receiving agricultural expert support in writing in accordance with the GFP Handbook.


Regina
Winnipeg
Ottawa
Toronto
Montreal
Quebec
Tijuana
Hermosillo
Chihuahua
Culiacan
Torreon
Monterrey
Jacksonville
Orleans
Miami
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community, Great Lakes by glc_esri.
Zone 1 - Terminated Cover Crop 35 Days or Earlier Before Planting, except for RMA Summerfallow Practice.
Zone 2 - Terminated Cover Crop 15 Days or Earlier Before Planting, except for RMA Summerfallow Practice.
Zone 3 - Terminated Cover Crop at or Before Planting, except for RMA Summerfallow Practice.
Zone 4 - Terminated Cover Crop Before Crop Emergence.

Map Legend

Zone 1 – See Map	Zone 2 – See Map	Zone 3 – See Map	Zone 4 – See Map
For Late Spring to Fall Seeded Crops – Terminate cover crops 35 days or earlier prior to planting the crop. Early Spring Seeded Crops – Terminate cover crops as soon as practical prior to planting the crop. (Additional Zone Guidance #2 and Definition #12.)	For Late Spring to Fall Seeded Crops – Terminate cover crops 15 days or earlier prior to planting the crop. Early Spring Seeded Crops – Terminate cover crops as soon as practical prior to planting the crop. (Additional Zone Guidance #2 and Definition #12.)	Terminate cover crop at or before planting the crop	Terminate cover crop before crop emergence.
RMA Designated Summerfallow Practice (See Definition #13 for additional guidance)	RMA Designated Summerfallow Practice See Definition #13 for additional guidance)	RMA Designated Summerfallow Practice See Definition #13 for additional guidance)	

Additional Zone Guidance

1. If the cover crop is part of a no-till system, termination may be delayed up to 7 days from the zone-based termination deadline.
2. Fall seeded cover crops will have limited growth in the spring prior to "early" spring seeded crops, seeded prior to March 20, (e.g., spring wheat, sugar beets, corn), and therefore the cover crop may be terminated as late as at crop planting.
3. When earlier than normal planting occurs due to favorable weather or soil conditions, cover crop termination will naturally occur closer to planting. For example, if planting occurs 15 days earlier than normal, the cover crop termination period may be 15 days closer to planting (or at planting in zone 2).
4. If the season is drier than normal nearing cover crop termination time, consider an earlier termination to conserve soil moisture.
5. If the spring season is wetter than normal at cover crop termination time, consider a later termination to use excess soil moisture, increase infiltration of additional rain, and improve soil health and seedbed condition. For example, in zone 2, if the field is too wet to terminate a cover crop 15 days before planting, the cover crop may be terminated closer to planting.
6. Seasonal cover species used as herbaceous wind barriers or nurse crops (short season cover crops) that protect the insured crop as it establishes (see definitions) are not considered cover crops and do not impede insurability. The seasonal covers used for the purpose of early crop establishment must be appropriate species for the area and the planned purpose.

Definitions

1. **Cover Crop** – Crops including grasses, legumes and forbs for seasonal cover and other conservation purposes. Cover crops are primarily used for erosion control, soil health improvement, weed and other pest control, habitat for beneficial organisms, improved water efficiency, nutrient cycling, and water quality improvement. A cover crop managed and terminated according to these Guidelines is not considered a "crop" for crop insurance purposes. The cover crop may be terminated by natural causes such as frost, or intentionally terminated through management such as chemical application, crimping, rolling, tillage, grazing, or cutting.
2. **Cover Crop Termination** – Means a practice that historically and under reasonable circumstances results in the termination of the growth of a cover crop.
3. **Good Farming Practice** – RMAterm - The production methods utilized to produce the insured crop and allow it to make normal progress toward maturity and produce at least the yield used to determine the production guarantee or amount of insurance, including any adjustments for late planted acreage, which are those generally recognized by agricultural experts or organic agricultural experts, depending on the practice, for the area.
4. **Continuous Cropping** – RMA Term – Any non-irrigated production practice that does not qualify as a summerfallow practice.
5. **Over-Seeding/Interseeding** – Both terms can be defined as planting one or more cover crop species into an existing or established crop. Common uses that involve over-seeding or interseeding include: (1) over-seeding a grass and/or legume cover crop into an existing stand of small grain at an appropriate time for the cover and germination, or (2) seeding a cover crop into an existing crop (e.g., corn or soybeans) and in a way where cover crop and main crop planting permits separate agronomic maintenance or management at a time that will not impact the yield or harvest of the insured crop. This seeding method does not affect the insurability of the main crop. Insurance attaches at the time of planting the insured crop and overseeding/interseeding occurs after the insured crop is planted, so the crop is insurable. Overseeding/interseeding is a separate planting method from interplanting.
6. **Interplanting** – This involves multiple crop species grown together, with no distinct row pattern and does not permit separate agronomic maintenance or management. For RMA purposes, this means if a cover crop and insured crop are planted in a way that does not permit separate agronomic maintenance or management, then that crop is not insurable. This would also apply to cover crops if interplanted into the insured crop and the cover crop interfered with the agronomic management and harvest of the main crop.
7. **Relay Cropping** – The practice of interseeding a second crop into the first crop well before the first crop is harvested. The relay cropping strategy is used to enable production of a second crop in areas where time for seeding the second crop following harvest of the first is considered inadequate for double cropping. This is not considered a cover cropping practice, but a method of double cropping and may fall under the RMA 1st / 2nd crop rules.
8. **Double-Cropping** – RMA and NRCS term - Producing at least 2 crops for harvest from the same acreage in the same crop year. This does not include cover crops that have been managed and terminated according to these Guidelines.
9. **Early Spring-Seeded Crops** – Crops planted as early as possible after the spring thaw are considered early spring crops (e.g., spring wheat, spring barley, sugar beets, corn).
10. **Herbaceous Wind Barriers** – There are specific cropping situations when seasonal cover is needed to protect young seedlings from wind erosion abrasion. The typical seasonal covers may include such crops as wheat, rye, or oats that are planted in rows (e.g., 20 feet apart, single or double row of small grain). These seasonal covers fall under the NRCS CPS Herbaceous Wind Barriers (Code 603). These barriers are not considered cover crops.

Definitions

11. **Nurse crop (companion crop)** – A crop planted into the same acreage as another crop, that is intended to be harvested or terminated separately, and which is planted to improve growing conditions for the crop with which it is grown. Short season cover crops are nurse crops in specific cropping situations, where the producer will plant the intended crop, plus a short-term seasonal cover crop (NRCS CPS Cover Crop, (Code 340)) prior to or at the same time as planting the main or insured crop. In this case the seasonal cover emerges first and provides short term wind erosion protection until the main crop becomes established and provides its own protection from wind erosion. These seasonal cover crops are terminated by cultivation, frost /winterkill, or herbicides once the main crop is established. The seasonal covers used for the purpose of early crop establishment must be appropriate species for the area and the planned purpose and permit separate agronomic maintenance or management that will not impact the yield or harvest of the insured crop and in accordance with applicable crop provisions.

12. **Cover Crop Haying, Grazing, or Forage Harvest** – Cover crops may be hayed, grazed, or harvested as silage, unless prohibited by RMA crop insurance policy provisions. Cover crops cannot be harvested for grain or seed.

13. **RMA Summerfallow Practice** – If a cover crop is planted during the fallow year, the acreage may be insured under the summerfallow practice for the current crop year provided the cover crop was not hayed, grazed, or otherwise harvested, and terminated in accordance with the Guidelines but no later than June 1 preceding the insured crop. RMA summerfallow practice is an insurability requirement and cover crops planted on summerfallow acreage must be terminated in accordance with this definition. Producers should contact their local NRCS office for appropriate cover crops that can be grown in summerfallow regions. Examples of high water use cover crops are alfalfa, sugar beets, cereal rye, corn, mustard, radishes, and turnips.

    For the 2020 and succeeding crop years, if a cover crop was planted during the fallow year was hayed, grazed, or otherwise harvested, or not terminated by June 1, the acreage may be insured under the “continuous cropping practice” (if available in your county), or by written agreement (if continuous cropping is not available in your county).

References

NRCS Conservation Practice Standard (Code 603) – Herbaceous Wind Barriers -
https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=nrcseprd340685&ext=pdf
NRCS Conservation Practice Standard Cover Crop (Code 340) – Cover Crop -
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1263176.pdf
RMA Good Farming Practice Handbook -
https://www.rma.usda.gov/en/Policy-and-Procedure/Program-Administration---14000
NRCS State FOTG for list of approved cover crop species -
https://efotg.sc.egov.usda.gov/#/details

COLORADO STATE UNIVERSITY
EXTENSION

Managing Spring Planted Cover Crops for Livestock Grazing under Dryland Conditions in the High Plains Region

Fact Sheet No. 0.309 Crop Series | Production

by Joe Brummer[1], Sandy Johnson[2], Augustine Obour[3], Kat Caswell[4], Angie Moore[5], John Holman[6], Meagan Schipanski[7], and Keith Harmoney[8]

Selection of Species

Determining what to plant can be a daunting task with all of the varied species available for use as cover crops. For Kansas and Nebraska producers, local Land Grant Universities and the Midwest Cover Crops Council have developed a **decision tool** to help select species based on specified goals. When cover crops are grazed, one needs to choose species that will not only benefit soil health but will also be palatable and safe as forage for livestock. Fortunately, many of the species currently recommended for use as cover crops are also good for forage production. Factors such as nutritive content and potential toxicities must be considered.

While a number of potential problems can occur with various forages, most can be managed. The most frequent problem is the accumulation of nitrates that is common with oats and brassicas but can occur in a variety of species under certain growing and management conditions. Most recommendations for feeding nitrate containing feeds come from dry forages. Anecdotal evidence would support the idea that the tolerance level may be different in green growing forages than in dried and baled hay. Rate of intake is less in green forage than baled feed, and selectively grazing leaves prior to stalks, which are lower in nitrates, helps reduce the potential toxicity issues associated with high nitrates. However, caution is still required when grazing high nitrate forages and testing before grazing is recommended. Prussic acid is another toxicity to beware of when grazing, particularly with sorghums, but these species are less common in spring planted mixtures. Refer to publications on nitrate (**CSU** or **KSU** fact sheets) and prussic acid (**CSU** or **KSU** fact sheets) toxicities for more information. For a more complete overview of forage crops with potential toxicities, please see the publication **Grazing Management: Toxic Plants**.

For spring planted cover crops, most, if not all, of the species planted should be classified as cool-season in order to be able to plant early and take advantage of winter and early spring moisture. Species that fall into this category include the small grains (e.g. wheat, barley, oats, triticale, and cereal rye), brassicas (e.g. turnip, rapeseed/canola, and radish), and legumes (e.g. field/winter peas, winter lentils, vetch, and sweetclover). In our experience, including warm-season species like millet, sorghum-sudangrass, and sunflower in spring planted mixes results in only minimal establishment and contribution of these species to yield and forage quality. By the time warm-season species germinate, the cool-season species have already established and have a competitive advantage. Therefore, instead of investing in complex mixes that include both cool- and warm-season species, your options are to cut back on the total seeding rate by eliminating warm-season species from the mix, increase the seeding rate of cool-season species in the mix, or add other cool-seasons to the mix. Depending on your crop rotation, a targeted planting of warm-season cover crops for summer forage grazing can be a good option.

Complex mixtures of 6 or more species, often referred to as "cocktails," are commonly recommended. The benefits of cocktails relative to single species or simple mixtures of 2 to 4 species depend on your specific management goals. Competitive cool-season grass species tend to be the highest biomass producers, which can optimize weed control

[1]Joe Brummer, Associate Professor/Extension Forage Specialist, [5]Angie Moore, Research Associate, and [7]Meagan Schipanski, Assistant Professor, Colorado State University, Soil and Crop Sciences; [2]Sandy Johnson, Professor/Extension Beef Specialist (Colby), [3]Augustine Obour, Associate Professor (Hays), [6]John Holman, Professor (Garden City), and [8]Keith Harmoney, Range Scientist (Hays), Kansas State University; and [4]Kat Caswell, Extension Educator (McCook), University of Nebraska. (12/18)

Quick Facts

- Cool-season species should be chosen for spring planted cover crops to optimize growth and take advantage of winter and early spring moisture.
- Cool-season grasses tend to dominate, often to the detriment of other species, when planting cover crop mixtures in the spring.
- Yield variability is high when growing cover crops under dryland conditions in the High Plains Region ranging from under 1,000 lbs/ac in dry years to almost 5,000 lb/ac in wet years.
- Stocking rates must be flexible because of the large year-to-year variability in cover crop productivity.
- Spring planted cover crops can provide an average of 30 to 45 days of grazing.
- Start grazing spring planted cover crops when they reach 6 to 8 inches of growth to take advantage of their high nutrient content and palatability.

extension.colostate.edu

and forage production. Mixtures that contain these competitive species along with legumes and/or brassicas can provide similar or, in some cases, less biomass than single species (Table 1). Mixtures are often used for benefits other than biomass production, such as providing nitrogen fixation by including legumes or soil pest suppression by including brassicas. From a grazing perspective, mixtures can produce forage with a range of palatability that can provide benefits and limitations. For example, when a legume is in the mixture, protein can be increased, though protein already tends to be high in cool-season mixtures (Table 1). In addition, species in mixtures are often grazed selectively, which can result in lower utilization of some species although this may ultimately help achieve your residue goals.

Based on a study conducted in western Kansas, the 6-way cocktail mix had higher CP, lower total fiber as measured by NDF, and higher digestibility (Table 1) primarily due to forage peas. However, the drawback to the more complex mixture was that yield tended to be lower and chemical weed control options were limited or not available. Similarly, in a 2-year on-farm study, complex mixtures with 8-9 species were dominated by 2-3 cool season grasses (oats, barley, and triticale) that contributed an average of 66-87% to total forage yield depending on the year. In reality, if your main goal is to produce forage for livestock, then monocultures or simple mixtures of cereal grains may produce more biomass and be more cost effective compared to more complex mixtures while still meeting or exceeding the nutrient requirements of most classes of livestock (Table 1). Grazing management in regard to the maturity of forage consumed will have a large impact on animal performance. Based on our experience from additional studies in eastern Colorado and western Kansas, cereal grains are most competitive and tended to dominate mixtures, even when other cool-season species were included in the mixture, such as rapeseed and forage peas. Once an area has been grazed and competition from the cereal grains reduced, then species like rapeseed and forage peas will grow and/or regrow if soil moisture is available.

Table 1. Forage yield and nutritive content [crude protein (CP), acid detergent fiber (ADF; higher values reflect lower digestibility), neutral detergent fiber (NDF; higher values reflect lower animal intake), and in vitro dry matter digestibility (IVDMD; reflects relative energy differences)] at heading, before grain fill of various cover crops and mixtures averaged over 2 years at the Kansas State University HB Ranch north of Brownell, KS and 4 years at the Kansas State University Southwest Research-Extension Center near Garden City, KS.

	Yield, Brownell (2015-2016)			Yield, Garden City (2015-2018)			Forage Quality, Brownell			
Treatment	Low	Avg	High	Low	Avg	High	CP	ADF	NDF	IVDMD
	----------lbs/acre----------						----------%----------			
Oat	1885	2313 b[3]	2741	145	633 d	1318	12.1 b	37.4 ab	60.3 bcd	76.0 ab
Triticale	3052	3192 a	3331	319	1427 b	1911	13.0 b	38.6 a	63.0 a	71.9 d
Oat/triticale	2836	3126 a	3416	222	1130 bc	1811	12.1 b	38.5 a	62.4 ab	72.9 cd
Oat/triticale (flex)[1]	2575	3066 a	3557	-	1887 a[4]	-	12.4 b	37.8 ab	61.0 abc	74.4 bc
Oat/triticale/pea	2043	2282 b	2521	110	896 cd	1586	15.0 a	36.8 b	58.2 d	76.8 a
Cocktail[2]	2241	2303 b	2364	40	693 d	1359	14.4 a	37.3 ab	59.7 cd	76.1 ab
Cocktail (flex)[1]	-	-	-	-	800 d[4]	-				

[1]Only planted when there was adequate moisture.

[2]Species were spring oat, triticale, forage pea, buckwheat, turnip, and radish.

[3]Values within a column followed by the same letter are not significantly different at the p>0.05 level.

[4]Planted in 2016 only.

Variability in Forage Production

Forage productivity will vary from year-to-year under dryland conditions, which makes this one of the biggest challenges facing producers that graze cover crops in the High Plains Region because stocking rates will need to be adjusted annually. As an example of yield variability across years and among cover crops, Table 1 lists the low, average, and high forage yields for 2 sites in western Kansas. Based on a 2-year on-farm study conducted in western Kansas, southwestern Nebraska, and eastern Colorado, forage yields ranged from just under a 1,000 lbs/ac up to almost 5,000 lbs/ac (Table 2). Spring precipitation was higher in 2016 at all farms, which resulted in an average forage yield of just under 4,000 lbs/ac. Due to the dry spring conditions in 2017, forage yields averaged about 50% less across farms at just over 2,000 lbs/ac. The effect of the east-west precipitation gradient within the region was also evident as the 2 farms that were in the drier part of the region (i.e. eastern Colorado) produced less in 2017 than the farms farther to the east.

Producers have several options to manage this variability in forage production. A flexible herd size where animals can be added or subtracted based on a given years productivity is the ideal situation. Grazing a stocker only herd or the inclusion of stockers with cows and calves makes it relatively easy to add or subtract animals based on differences in carrying capacity among years. If it is difficult to adjust herd size, then the number of days a field can be grazed will have to be shortened or lengthened to achieve residue goals. See the section on "Determining Stocking Rates" for how to calculate the potential number of animals or number of days a field can be grazed based on estimated forage productivity.

In reality, expect to graze spring planted cover crops for about 30 days in most years. This resource should be viewed as supplemental forage during the late spring and early summer to help

Table 2. Examples of dryland cover crop planting dates, growing days, grazing start and end dates, grazing days, and forage production in 2016 and 2017 for various farm fields located in western Kansas, southwestern Nebraska, and eastern Colorado.

Location	Planting Date	Growing Days	Start Graze	End Graze	Days Grazing	DM Yield (lbs/ac)
2016						
NW of Bucklin, KS	3/1	85	5/25	6/30	36	4040
NW of Grainfield, KS	3/17	62	5/18	6/16	29	4460
N of Almena, KS	4/11	86	7/6	8/2	28	3930
S of Oberlin, KS	3/21	65	5/25	6/22	29	4920
NE of Venango, NE	5/15	53	7/7	8/5	28	2610
2017						
NW of Bucklin, KS	3/20	85	6/13	7/13	31	2040
NW of Grainfield, KS	3/16	75	5/30	6/28	28	2400
N of Almena, KS	3/27	71	6/6	6/27	27	2850
S of Seibert, CO	3/14	93	6/15	7/7	22	1880
NE of Brush, CO	3/23	91	6/22	7/17	25	990
Average					**28**	**3012**

relieve dependence on other forage resources such as native rangeland and baled hay. The short spring grazing window is due to the quick growth of cool-season forages which go from 6 to 8 inches of vegetative growth to full seed production in about 30 to 45 days. Producers in our on-farm trial noted that palatability and intake decreased significantly when seedheads emerged, and livestock were standing at the fence looking for something else to eat. In most years, native pasture growth is sufficient for turn-out when cool-season cover crops near maturity. One producer did allow the cover crop forage to stockpile into July before he grazed it, but animal performance was low because of the low nutrient content of the mature forage. High stocking rates can help suppress stem elongation and heading, but producers need to be careful to not overgraze and leave sufficient residue for soil health benefits.

As a final note, in years with minimal precipitation and forage productivity (i.e. ~1,000 lbs/ac or less), the best choice might be to not graze at all if your primary goal is soil protection. Ideally, you want to maintain a minimum of 30% ground cover, and approximately 1,000 lbs/ac is needed to achieve that goal.

Grazing Management

When it comes to managing grazing of cover crops, numerous options can be considered. The ultimate strategy that is chosen will be influenced by your overarching goal(s) for the cover crop. Cover crops are generally grown for more reasons than just achieving high levels of harvest efficiency (i.e. percent utilization of available forage) as you would if this were a dedicated forage crop. You want to leave enough residue behind to maintain most of the benefits associated with planting cover crops (Figure 1). With that in mind, the use of continuous grazing is not a bad option. Basically, you would calculate a stocking rate based on the estimated yield and put the whole herd in one large field to graze. Advantages associated with this system of grazing are that no fences are moved and only one water source is needed (i.e. labor and inputs are minimal). However, if the field is large, livestock will tend to overgraze the forage closest to the water source while underutilizing the forage farthest from the water, unless you are able to move the watering location. Livestock are also free to choose any plant or plant part, so their diet quality and performance will be high, especially at first, but will decline over time as they are left with the less palatable and nutritious plants to choose from. Harvest efficiency will generally be around 30% with continuous grazing.

Some form of rotational grazing where a large field is divided into two or more smaller units, or paddocks, and the animals rotated from one paddock to the next is also a good option that has some advantages and disadvantages. The more paddocks that the field is divided into, the higher the stocking density (i.e. number of animals per acre). As stocking density increases, harvest efficiency may increase to the point where 50% or more of the available forage can be utilized by the livestock. This increase in harvest efficiency means that you can graze longer or with more animals, but this benefit may or may not fit with your goal of leaving a given amount of residue in the field. In our experience working with producers that rotated through only 4 paddocks, residue remaining at the end of grazing averaged 75 to 80% of the biomass from ungrazed exclosures even though utilization was greater than 50% in the early grazed paddocks. This simple rotation allowed regrowth to occur in the early grazed paddocks and maintained the level of residue desired. Higher stocking densities will also result in plant material being trampled onto the soil surface, which will result in faster decomposition and nutrient cycling. Manure and urine also tends to be more uniformly distributed across the field as stocking density increases, which reduces the buildup of nutrients near water, shade, and other loafing areas. One of the big drawbacks to concentrating animals into small paddocks is that the effects of soil compaction can be compounded, especially when grazing on heavier clay soils following a significant precipitation event. Alleviating soil compaction is not easy, especially for no-till producers. Expect traffic lanes to and from, and around the watering location to have the most soil compaction. These isolated areas will require either tillage or manure spreading to correct the problem but are generally a small fraction of the entire field.

The need to move fences every day or every few days and how to handle watering the animals are two of the biggest

hurdles to overcome that keep many producers from practicing rotational grazing. However, with the use of temporary electric fencing, it is relatively easy to move fences in minimal time. Water can be more problematic, but with small, moveable tanks and a moveable supply tank on a truck or trailer, water can be moved right along with the animals. Alleys can also be constructed using temporary fencing so that animals can access permanent watering points.

One common method used when grazing annual cover crops is referred to as strip grazing. It is similar to rotational grazing where a temporary fence is set up to allow animals access to one to a few days' worth of feed but differs in that there is no back fence and animals can graze both fresh, residual, and regrowth forage. This method is convenient for watering animals as the fence can be set up so they have continuous access to a single water point. One drawback to this method is that animals are continually crossing back and forth across the same ground as they come and go from water, which can increase the chances of soil compaction, especially near the water source. In addition, the area closest to the water will be grazed more heavily. Manure and urine also tend to concentrate near the water source. Unlike rotational grazing, little regrowth accumulates when strip grazing because animals will continually search out and graze any new growth in the previously grazed strips. Because of this, you may not be able to meet your residue goals. Utilization levels will also be high in the strip grazed first and gradually decrease as you move across the field to the last strip grazed, resulting in uneven distribution of residue, which also may not be ideal for meeting your goals.

Once you have settled on a method of grazing, the next decision you need to make is when to start grazing your cover crop. If you are grazing steers and heifers and your goal is to achieve a given level of weight gain, then you need to start early to take advantage of high forage quality. The mixes we have been using for spring planted cover crops tend to be dominated by cool-season cereal grains like oats and barley. Once these species achieve 6 to 8 inches of growth, you should think seriously about starting to graze (Figure 2). It often looks like not much growth is available and you need to give animals plenty of area at this time or move them often if rotationally grazing, but these forage species will soon enter the rapid growth phase and animals may not be able to graze enough forage to keep up with new growth. Once these cereal grains start to joint, forage quality rapidly declines along with palatability. In as little as 4 to 5 weeks, plants will begin to head and start to dry down and utilization will drop off significantly (Figure 2). At this point, you should think about moving animals to other forage sources if you want to maintain individual gains. If using rotational grazing, you can generally expect to see significant regrowth in the early grazed paddocks, sometimes to the point you can hardly tell paddocks were grazed. You could decide to utilize this regrowth, which will be of higher quality, by rotating animals back through those paddocks, or just leave it as standing biomass to meet soil health goals.

Alternatively, some producers are more concerned about meeting their biomass goals for soil health and delay the start of grazing until plants are fairly mature. In these situations, animals will be very selective and utilization levels will be low. Forage quality will also be lower, so this approach is better suited for grazing cows that have lower nutrient requirements compared to steers and heifers. You will get some forage benefit by doing this, but the main benefit will be trampling of the forage, which will provide ground cover and speed decomposition.

Figure 1. Example of grazing and trampling impacts when predominately cool-season cereal grain cover crops are grazed during the heading stage. Regrowth is minimal and utilization is light (<30%) at this point, but trampling is heavy with greater than the target minimum of 30% ground cover.

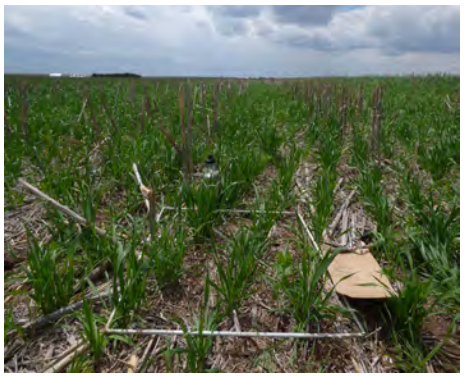


Figure 2. The above photo illustrates the proper time to start grazing (6 to 8 inches) while the photos to the right show the same field heading 30 days later on June 16 when nutrient content and palatability of the forage had dropped significantly.

Table 3. Example calculations to estimate length of grazing for a set number of animals or number of animals for a set grazing period.	
Variables	**Inputs**
Acres	160
Total yield (lbs/ac dry basis)	3000
Utilization (%)	30
Animal wt (lbs, average for period)	800
Dry matter intake (% of body wt)	2.5
Example 1 – estimate number of animals for given grazing period	
Length of grazing (days)	45
Stocking rate (hd) =	$\frac{\text{acres x yield/acre x utilization}}{\text{animal wt x dry matter intake x length of grazing}}$
Stocking rate (hd) =	$\frac{160 \times 3000 \times 0.30}{800 \times 0.025 \times 45} =$ **160 head**
Example 2 – estimate number days a given number of animals can graze	
Number of animals	150
Length of grazing (days) =	$\frac{\text{acres x yield/acre x utilization}}{\text{animal wt x dry matter intake x number of animals}}$
Length of grazing (days) =	$\frac{160 \times 3000 \times 0.30}{800 \times 0.025 \times 45} =$ **48 days**

Determining Stocking Rates

Several key pieces of information are needed to estimate a stocking rate. The first is an estimate of the forage yield your field will produce during the period it will be grazed on a dry matter basis (see the section on variability and Table 1). How much forage will be consumed each day will depend on animal body weight and forage quality. For green and growing forages, intake will run from 2.5 to 3% of body weight on a dry matter basis. Another key input is the percent utilization desired. In dryland systems, 30% is a conservative starting point unless it appears to be an excellent moisture year with above average yields. Calculations can be made to estimate days of grazing for a given number of animals (example 1 in Table 3) or the number of animals for a set grazing period (example 2 in Table 3). A **Carrying Capacity Calculator** is also available to help with these calculations.

Other Considerations

Keep in mind for spring planted cover crops dominated by cereal grains, palatability will decline as plants mature. How quickly the crop matures may determine how long a field can be grazed. Producers that can add or subtract cattle as needed in relationship to fluctuating forage availability, or that remove cattle during wet conditions to an adjacent native pasture or drylot will have an advantage in using these forages. The historical variation in spring growing conditions on dryland acres strongly suggests that backup plans are made at the same time as plans to graze cover crops. In years with excess moisture and high forage production, one should consider putting part of the crop up as silage or hay for drought years.

If grazing starts in a predominately cereal grain cover crop at 6 to 8 inches in height, forage quality will be very high and will work well for growing cattle. Young, old, or thin lactating cows that need to regain condition post calving would also benefit from this high-quality forage. If more grazing pressure is needed than planned, allowing young, growing cattle to graze ahead of mature cows would be a good approach. Moving pairs with young calves when grazing cover crops can be a challenge, thus planning ahead can help when it comes time to implement grazing.

Example Timeline

Following is an example timeline with suggested planting, start grazing, and end grazing dates for spring planted cover crops. This timeline will allow cover crops to effectively utilize winter and spring moisture to produce the highest yields possible under dryland growing conditions while providing livestock with high quality forage.

Published in collaboration with research scientists and extension specialists at Colorado State University, Kansas State University and University of Nebraska.
K-State Research and Extension publication, MF3443.

COLORADO STATE UNIVERSITY
EXTENSION

I have a question about my farm or property. Who should I call?

- What kind of question do you have?
  a. I'm looking for technical assistance in implementing conservation practices
     i. NRCS or Conservation District
  b. I need a weed identified.
     i. Extension (Agents or Master Gardeners)
  c. I just bought a new small acreage property, can someone help me?!
     i. Small Acreage Management program, Extension
  d. I'm a producer and I think I qualify for USDA programs.
     i. NRCS
  e. I am interested in the STAR program
     i. Conservation District

- Where you do you live? Extension, Conservation Districts, and NRCS have local offices that serve individual counties or areas.
  a. County Extension Offices - colorado.extension.edu/field-offices/
  b. Colorado NRCS Offices - col.st/vTvAN
  c. Colorado Conservation Districts - coloradoacd.org

Longmont and Boulder Valley Conservation District
Website: longmonthcd.org
Phone: (720) 378-5521
9595 Nelson Road, Box D
Longmont, CO 80501

NRCS - Longmont Field Office
Phone: (720) 378-5533
9595 Nelson Road, Box D
Longmont, CO 80501

CSU Extension - Boulder County
Website: boulder.extension.colostate.edu
Phone: (970) 491-6281
9595 Nelson Road, Box B
Longmont, CO 80501

CSU Extension - Weld County
Phone: (970) 400-2066
525 N 15th Street
Greeley, CO 80631