

Colorado Forage Guide



**COLORADO STATE UNIVERSITY
EXTENSION**

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Jennifer L. Cook
Joe E. Brummer
Paul J. Meiman
Thaddeus Gourd

Adapted from the *Forage Guide for the Northern Colorado Front Range*, by Ron Jepson, Colorado State University Cooperative Extension, 1997



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United States Department of Agriculture

Natural Resources Conservation Service

Book design and layout by Chris Uhing
Special thanks to Sharon Bokan, Ginny Price, and Ron Jepson for their review of this document.

Photo and illustration credits:

Jennifer Cook, front cover photo of slender wheatgrass, figures 6, 8, 25

Ellen Nelson, figure 7

Living on the Land curriculum, figure 9

Pasture and Range Plants, Phillips Petroleum Company, 1963, figures 2, 10–13, 15–19, 21, 23, 24, 28, 29, 31–35

Guide to Grasses, Pawnee Buttes Seed, Inc., figures 14, 20, 22, 26, 27, 30

Contributing authors and editors:

Jennifer L. Cook, Small Acreage Management Coordinator, CSU Extension/NRCS

Joe E. Brummer, CSU Associate Professor/CSU Extension Forage Specialist

Paul J. Meiman, CSU Assistant Professor

Thaddeus Gourd, Adams County Extension Director

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with USDA-Natural Resources Conservation Service, Colorado State University Extension, and Grazing Lands Conservation Initiative. All Extension programs are available without discrimination. No endorsement of products mentioned is intended nor is criticism implied of products not mentioned.

Updated June 2018

CONTENTS

Introduction	1	Wheatgrass, Western	26
		Wildrye, Russian	26
Pasture Renovation	1		
Site Considerations	1	Legume Species and Varieties	27
Bunch and Sod-Forming Grasses	2	Alfalfa	27
Warm- and Cool-Season Grasses	3	Clover, Red	28
Native and Introduced Grasses	3	Clover, White	29
Legumes	3	Milkvetch, Cicer	29
Solo and Mixed Seedings	4	Sainfoin	30
Plant Varieties	5	Trefoil, Birdsfoot	31
Buying Seed	5		
Species Suggestions	5		
Pure Live and Bulk Seed	6		
Designing a Seed Mixture	6		
Plant Establishment	7	Appendices	
Soil Testing	7	Appendix A: Species Suggestions for Various Sites	32
Seedbed Preparation	8	Appendix B: Characteristics of Grasses	34
Seeding Methods	8	Appendix C: Characteristics of Legumes	35
Time of Seeding	9	Appendix D: Seeding Rates for Selected Pasture Plants	36
Early Stand Management	9		
Grazing Management	9		
Overgrazing	10		
Grazing Management Guidelines	11		
General Pasture Management Guidelines	13		
Ungrazed Pastures	14		
Sources of Additional Help	14		
Grass Species and Varieties	14		
Bluegrass, Kentucky	14		
Bluestem, Big	15		
Bluestem, Little	15		
Bluestem, Sand	16		
Brome, Meadow	16		
Brome, Smooth	17		
Fescue, Tall	18		
Gram, Blue	19		
Gram, Sideoats	19		
Indiangrass, Yellow	20		
Needlegrass, Green	20		
Orchardgrass	21		
Sacaton, Alkali	22		
Sandreed, Prairie	22		
Switchgrass	22		
Wheatgrass, Crested	23		
Wheatgrasses, Intermediate and Pubescent	24		
Wheatgrass, Newhy	25		
Wheatgrass, Tall	25		
Wheatgrass, Thickspike	25		

INTRODUCTION

The number of small acreage tracts continues to increase throughout Colorado. Owners of these tracts have a variety of goals for use of their land, including: wildlife habitat, enjoyment of open space, farming enterprises, livestock grazing, greenhouse crop production, forestry, and horticultural activities. Tract owners vary in their levels of expertise in understanding the land and how to manage its resources.

This publication was produced to help small acreage landowners become familiar with livestock forage and grazing management. Information is provided on how grasses differ, what legumes are and how they can fit into pastures, and what to consider if you need to revegetate your pasture, including how to design your own seed mix. The section on grazing management will help you know what to look for and expect before, during, and after your pastures are grazed. Because grazing is an ongoing learning process, this information will complement your own experiences and the advice of others, such as Colorado State University Extension (CSU Extension), the Natural Resources Conservation Service (NRCS), and neighbors.

In the “Grass and Legume Species and Varieties” sections of this publication, plants that can be used for forage in the various regions of Colorado are listed in alphabetical order. Each plant is described briefly, including its site adaptations, advantages and disadvantages, and its potential for use as hay or pasture. On most small acreages, buying hay is more economical than on-farm production.

PASTURE REVEGETATION

Revegetating pastures can cost over \$100 per acre, so it is something you do not want to do over and over again. First, evaluate whether the pasture really needs to be revegetated. On many small acreages, overgrazing has caused deterioration of rangeland or pasture condition. However, if there is enough desirable vegetation remaining in the pasture, then perhaps the pasture can be restored without reseeding. Restoring your pasture may be as simple as deferring grazing for a year or two to allow grass recovery time, controlling undesirable vegetation, and then implementing a rotation grazing system with proper carrying capacity. These grazing management practices are discussed in the Grazing Management chapter.

Revegetation is expensive, requires a number of years to become fully established, may increase erosion and weed problems, and there is no guarantee the conditions will favor establishment. Established pastures will last a lifetime if properly managed. Proper management includes selecting the right forage species for your site and intended land use, purchasing quality seed, preparing a good seedbed, using appropriate seeding methods, and following proper pasture maintenance techniques. It also includes proper water management on irrigated pastures and attention to weed control, especially of noxious weeds like Canada thistle. On dryland pastures, timely precipitation is needed to establish new seedings. Unfortunately, pasture managers have no control over the weather. As a result, some dryland reseedings will fail due to dry winters and springs, and another revegetation attempt will be required.

Site Considerations

The process of revegetating a pasture starts by analyzing the site environment, such as its topography, soils, and amount of water it receives. Soils are the foundation and nutrient source for plants. Soil texture is a measure of the proportion of sand, silt, and clay in the soil. Plant species grow best on specific types of soil textures. For example, western wheatgrass is adapted to clay soils, prairie sandreed to sandy soils. Check with your local Natural Resources Conservation Service (NRCS) office to see a soils map that identifies soil textures of your land. A soils map of your land can also be created using the online NRCS Web Soil Survey located at <http://websoilsurvey.nrcs.usda.gov/>

Loamy soils provide the best medium for forage plant establishment; they have a balance of sand, silt, and clay particles. Plant establishment on sands can be difficult because precipitation may not be adequate to keep water near the soil surface for establishing roots. Once plants are established on sands, however, they produce more forage than any other dryland site. Clay soils tend to pack hard and plants will not establish easily if the soil surface is not loosened by mechanical cultivation prior to seeding.

Soils with a high salt content are known as saline soils. These have an electrical conductivity (EC) of 4.0 mmhos/cm or greater. Those with an EC of 12 or greater will support just a few forage species, such as tall wheatgrass, pubescent wheatgrass, alkali sacaton, and Russian wildrye.

Electrical conductivity is determined from a routine soil analysis conducted by soil testing laboratories. The greater the EC of a soil, the greater seed germination is inhibited and plant growth is retarded. No forages will grow on soils with an EC of 30 or more. For more information on saline soils, read the CSU Extension fact sheet no. 0.521, *Diagnosing Saline and Sodic Soil Problems*.

A small acreage pasture owner needs to know their intended land use before soil is revegetated. What kind of livestock or wildlife will graze it? If the pasture isn't grazed, do you want short grasses that require little or no mowing? Will the pasture be intensively managed for grazing? Will the forage be harvested for hay? The proper selection of forage species depends on answers to these questions.

Finally, forage species are selected based on how much water the site receives. Dryland species are needed for sites that receive only natural precipitation. A difference of only 2 inches of average annual precipitation is enough to change the species that will survive the best. Sites receiving 12 inches or less of moisture are limited to Russian wildrye and certain varieties of crested wheatgrass. Thickspike wheatgrass does better in areas receiving 12 to 13 inches of moisture than will its closely related cousin, western wheatgrass. Grass species options increase as precipitation rises above 14 inches per year.

Some pastures are subirrigated when underground water is within reach of plant roots. These sites are often near rivers, creeks, canals, or ponds. They are more productive than dryland sites and should be seeded with forage species that take advantage of the extra available water.

For irrigated pastures, determine how much irrigation water is available. Pastures are short of water if one or two irrigations are made in the spring and no (or limited) water is available in the summer. Different species are recommended for short-water versus adequate-water situations. Be sure to check the quality of your irrigation water by having it analyzed by a lab. The amount of salts and nitrates are of particular concern.

Bunch and Sod-Forming Grasses

Grasses differ in their growth habits; they are either bunchgrasses or sod-formers. Bunchgrasses exhibit a growth form that is true to their name; they grow in bunches or clumps. Crested wheatgrass and orchardgrass are examples of bunchgrasses.

Bunchgrasses typically have more leaves than sod-forming species. Many have leaves grouped near the plant base. Bunchgrasses typically produce more forage than sod-formers, but often need more intensive grazing management to optimize productivity. For example, the growth of some bunchgrasses is set back when their developing seed stalks are grazed. Some species raise their seed stalks earlier during the growing season than do others. However, some bunchgrass species such as orchardgrass, perennial ryegrass, and meadow brome continually initiate new tillers and their production is impacted little by defoliation.

Sod-forming grasses have underground stems, called rhizomes, which run parallel to the soil surface. Rhizomes tie the soil together and form a sod. New above-ground shoots are sent up from nodes located at regular intervals along the rhizomes. These shoots tend to fill in and cover bare spots on the soil. Examples of sod-formers are Kentucky bluegrass, western wheatgrass, and smooth brome.

Pastures dominated by sod-formers are not as rough as those dominated by bunchgrasses. Sod-formers typically are not as productive, but often are more grazing tolerant than bunchgrasses because they can send up new shoots from rhizomes. If well managed though, sod-formers like prairie sandreed and sand bluestem will out-produce most bunchgrasses.

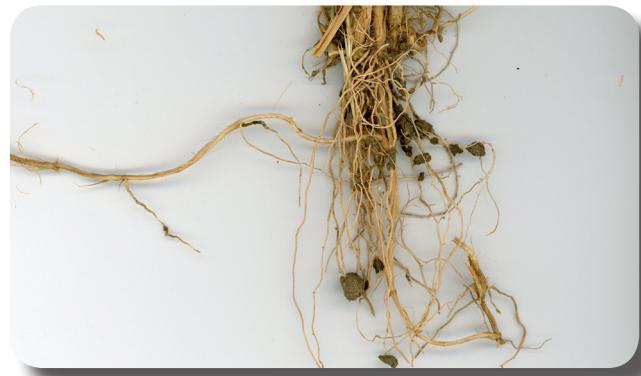
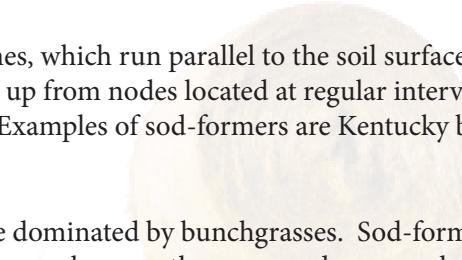
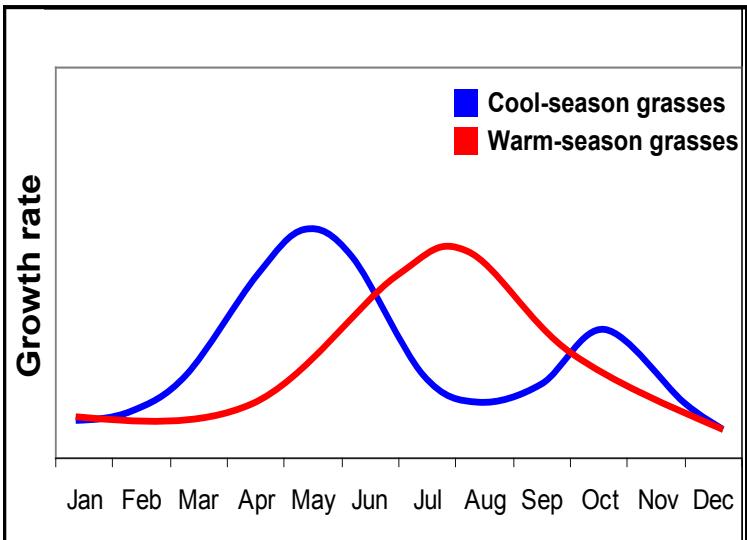


Figure 1: Rhizomes and roots of western wheatgrass.





Warm- and Cool-Season Grasses

Some grasses grow best when the weather is cool while others grow best when it is hot. Cool-season grasses grow best in the cool, moist months of spring. With adequate moisture, they will regrow in the fall. They typically go dormant in the heat of summer; however, some continue to grow with adequate moisture. Orchardgrass is an example of a cool-season grass. Warm-season grasses do not begin growth until about mid-May when soil temperatures reach 60°F. They are adapted to the hotter temperatures of summer and go dormant in the fall. Blue grama and the various bluestems are examples of warm-season grasses.

Native and Introduced Grasses

The most commonly available forage grasses are either native to North America or introduced from another country. Native grasses evolved with the climate and soils of the area. They typically live longer than introduced species and require little maintenance. They have the disadvantages of being more expensive per pound of seed and needing three to four years to establish before being grazed.

Introduced grasses evolved outside of North America and were brought here for their forage qualities. They establish faster than natives and can be ready for grazing within one to three years. Russian wildrye is an exception; it can take up to four years to establish. They respond better to fertilizer and irrigation than natives, and seed costs are lower. Introduced grasses may not have the longevity of native grasses.

Choosing between native and introduced grasses may come down to a personal preference. A wide selection of species exists from each origin. On extremely dry sites, the introduced 'Hycrest' crested wheatgrass may be the best choice to ensure establishment. For adequately irrigated pastures, introduced grasses have the highest yield potential.

Legumes

Legumes, such as clover, are broad-leaved plants (forbs) that have certain bacteria living in nodules (knots) on their roots. The bacteria (*Rhizobia* spp.) convert nitrogen from the air into a plant available form. This "fixed" nitrogen is provided to the legume plant with small amounts becoming available to any grass plants growing in the stand over time. Each legume requires a specific species and strain of *Rhizobia* for nodule formation. The nodulation process is insured by inoculating legume seeds with the appropriate *Rhizobia* before planting.

Mixing legumes and grasses in a pasture can increase total forage production by 30%. This response is dependent on adequate soil moisture and varies with the species of legume. Alfalfa usually fixes the most nitrogen; clovers and other legumes fix somewhat less.

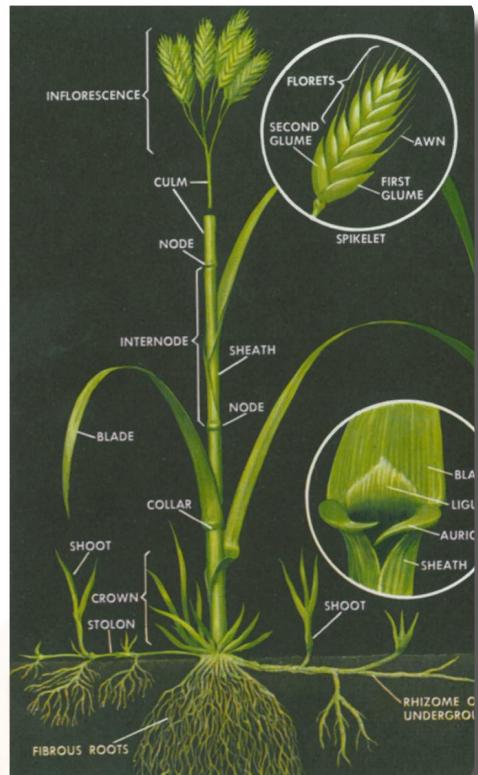


Figure 2: Principal parts of a grass plant.

Growing grasses and legumes together improves the seasonal distribution of forage. Legumes can make more growth in the summer than cool-season grasses. The addition of legumes usually improves the forage quality factors of palatability, digestibility, and nutrient content. The use of a less palatable legume like cicer milkvetch will have less of an impact on overall forage quality.

Solo and Mixed Seedings

Small acreage pastures can be reseeded to a single species (solo planting or monoculture) or a mix of species. Mixtures are more ecologically desirable because of stand diversity. They survive disease and insect problems better, and extremes in climatic conditions. Mixtures are more efficient users of available moisture, light, and nutrients through the growing season. An established stand of multiple species can be expected to provide better competition against weeds.

Mixtures can include various combinations of grasses and legumes. Mixing warm- and cool-season grasses, however, is not advised. While such mixtures will extend the grazing season of dryland pastures (less so on irrigated pastures), they are best seeded in separate pastures for ease of management. Use the cool-season pasture in the spring and again in the fall (moisture permitting). Use the warm-season pasture in the summer. These separate pastures may not be reasonable to establish and manage on small dryland parcels.

Mixed stands of cool- and warm-season grasses often become dominated by the cool-season species over time. The cool-season grasses get first use of spring moisture and nutrients; whereas warm-season grasses use whatever moisture is left over. Summer rains may be of little benefit as they are often inconsistent in timing and amount. Warm-season grasses will dominate if the cool-seasons are continually overgrazed in the spring.

Mixtures of native and introduced grasses are not advised because the introduced species will out-compete the natives. Mixtures of native species, on the other hand, interact well and are recommended. Make simple mixtures comprised of three or four species for irrigated pastures. Including more species is common for dryland situations. Mixtures may be useful where water tables, salt concentrations, and soil textures are variable. Each species will establish on the microsite to which it is best adapted.

Advantages of grass-legume mixtures are discussed in the "Legume" section of this publication. Legumes grow best with shorter and less aggressive grasses. If grass-legume stands are grazed by cattle or sheep, keep the percentage of legumes that cause bloat to 25% or less. These legumes cause gases to build up and become trapped in the rumen and can lead to rapid death. Bloating legumes are alfalfa and the various clovers. Grazing of mixed grass-legume stands requires particular attention to grazing management. Legumes often are preferred by livestock and will be grazed out of the pasture if not provided the opportunity to regrow sufficiently.

Mixed stands should have species similar in palatability (the degree of being desired by livestock), regrowth ability, time of maturity, and competitiveness. Livestock will favor and overgraze the more palatable species in unbalanced mixes. Balanced mixtures foster optimum forage quality when harvested for hay.

Dryland and irrigated pasture mixes are available on the retail market. These often contain combinations of native and introduced grasses, including perennial ryegrass. On dryland, the rapidly establishing ryegrass competes with the other grasses for water and nutrients, and then dies in three or four years. Select a mix of species adapted to the site and intended land use. Expect to pay a premium price for seed orders of less than 50 pounds.

While mixtures have their advantages, monocultures might be appropriate in some situations. Crested wheatgrass and Russian wildrye provide forage two to three weeks earlier than other grasses. They are best managed as monocultures. Pubescent wheatgrass and smooth brome work well as solo plantings. Tall fescue should be solo planted. Monocultures are easier to manage for forage regrowth rate and differences in palatability between species.

Whether you go with a mixture or monoculture, a primary rule is to select species adapted to your site and intended land use. Consult your local CSU Extension or NRCS office for assistance in selecting forage species.

Plant Varieties

A list of varieties (cultivars) is provided with the individually described plant species in this publication. A variety is a particular selection of a plant species (for example, 'Fairway' crested wheatgrass) that has distinct, improved characteristics because of a slightly different genetic make-up. Varieties will breed true and reproduce themselves from generation to generation. Examples of improved characteristics are: quicker establishment, increased seedling vigor and plant productivity, pest resistance, and drought tolerance. Varieties in this publication are listed more or less in order of preference, but site and situation will influence variety selections.

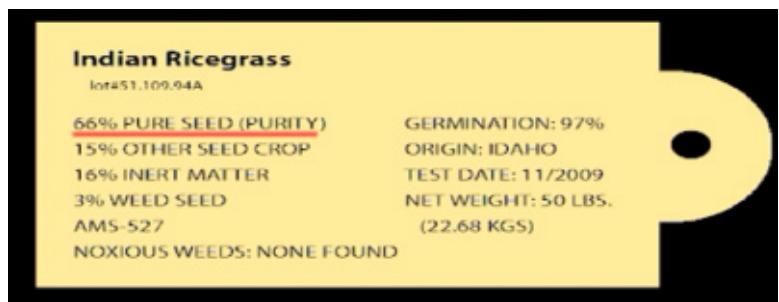


Figure 4: Example of a seed tag.

Buying Seed

State and Federal laws require seed dealers to label all seed offered for sale. The label must list seed origin, purity, species identity, percent germination, and weed seed content. It also must list the seed lot number and the company or person responsible for label content.

Origin. All seed lots offered for sale in Colorado must have the state of origin listed on the seed tag. If the origin is not known, that fact must be stated. Be cautious of buying seed of unknown origin. The closer the seed origin is to the location where it will be planted, the better.

Purity. Purity is the percent of the seed bag content that is seed from the desired species. Purity + inert matter + weed seed + other crop seed percentages must add up to 100%. Inert matter includes small sticks and stems, chaff, and infertile flowers. Most grass seed should contain no more than 10 to 15% inert matter or it will be difficult to plant. However, some native grasses like the bluestems, gramas, and Indiangrass will have higher inert matter percentages because they are hard to clean. Drills with seed-box agitators are needed to plant these seeds.

Weed Seed. The label should indicate that no prohibited noxious weed seeds are present. For other weed seeds, Colorado Seed Law states that they cannot total more than 2% by weight.

Germination. Total viable seed includes the percentage of all seed that germinates in a lab analysis, plus the amount of hard and dormant seed. Species vary with regard to the amount of hard and dormant seed. Do not consider these seeds undesirable; the higher the total germination, the better. Germination for most grass species should not be lower than 60%. Germination of chaffy seeds may be lower.

Species Identity. Forage seed is sold as Common, VNS (Variety Not Stated), or Certified. Certified seed is the most expensive of the three, but guarantees the variety that you order. It is sold in bags with a blue tag. When certified is not available, purchase seed of verifiable plant varieties. Some VNS seed may be from a high-quality blend (mixture of two or three) of varieties. Verification is the key. When neither certified nor verifiable seed varieties are available, purchase seed of known origin and adaptation to your area.

Species Suggestions

General species suggestions for various sites are listed in Appendix A. Every pasture site is unique in its soils, topography, microclimate, moisture availability, and intended land use. Your site description may not be listed in Appendix A. Be aware of which species combine well together and which ones are best seeded as monocultures. Also focus on whether the forage will be grazed by animals or harvested for hay. Once you select a species or mix of species, choosing an appropriate variety becomes the next important decision.

Use Appendix B: Characteristics of Grasses, Appendix C: Characteristics of Legumes, and the individual species descriptions in this publication to help you make selections. Seed cost and availability may affect which species comprise your final mix.

Pure Live and Bulk Seed

Because of differences in purity and germination between seed lots, seed is purchased on the basis of Pure Live Seed (PLS). PLS is figured by multiplying seed purity by seed germination. Use the decimal representation of a percent (proportion) when figuring bulk seeding rates. In other words, 70% purity equals 0.70.

Planting based on PLS seeding rates ensures that you plant the number of seeds of desired plants that will actually germinate and begin growth. PLS factors out the dead seeds, weed seeds, and inert matter in seed lots that will not produce desired plants.

From a PLS value, you then need to calculate how much bulk seed to buy. Bulk seed is the retail product in seed bags. The bag's weight includes that of Pure Live Seed, dead seeds, weed seeds, and inert matter.

If you want to plant 5 PLS pounds per acre of a grass on 10 acres, first calculate the PLS for the seed lot. For example, the seed lot label (Figure 4) indicates that the seed purity is 66% and the germination is 97%. The PLS, therefore, is 0.64 (calculated by multiplying 0.66 x 0.97). To figure pounds of bulk seed to buy and plant, work through the following process:

$$\begin{aligned}(\text{PLS lbs./acre}) \div (\text{PLS}) &= \text{bulk lbs./acre seeding rate} \\(5 \text{ PLS lbs./acre}) \div (0.64) &= 7.8 \text{ bulk lbs./acre} \\(7.8 \text{ bulk lbs./acre}) \times (10 \text{ acres}) &= 78 \text{ lbs. total bulk seed}\end{aligned}$$

Buy about 5 more pounds of seed if you are using a grass drill to ensure that the seed box does not go empty, and that you will have enough to push other seed down the seeding tubes.

Designing a Seed Mixture

If you decide to plant a mixture of species, calculate the seeding rate for each species. The rate is based on the PLS for each forage and its weighted proportion in the mix.

Solo PLS seeding rates for forage species are listed in Appendix D. Use these when figuring seeding mixture rates.

For example, three grasses will be planted: sideoats grama, 30% of the mix; big bluestem, 30%; and switchgrass, 40%. Use the following process to design the mix:

Step 1: Determine the PLS for each species.

	A	B	C
	Purity	Germination	PLS (AxB)
Sideoats grama	0.70	0.80	0.56
Big bluestem	0.60	0.80	0.48
Switchgrass	0.90	0.90	0.81

Step 2: Adjust the mixture for PLS pounds per acre.

	D	E	F
	Desired Mix (%)	Lbs. PLS/acre (solo planted)	Lbs. PLS/acre in mix (DxE)
Sideoats grama	30	4.5	1.4
Big bluestem	30	5.5	1.7
Switchgrass	40	3.0	1.2

Step 3: Adjust the mixture for bulk pounds per acre.

	F	G
	Lbs. PLS/acre	Lbs. Bulk Seed per acre (F÷C)
Sideoats grama	1.4	2.5
Big bluestem	1.7	3.5
Switchgrass	1.2	1.5

Total bulk seeding rate per acre = 7.5

PLANT ESTABLISHMENT

Before pastures are seeded, weeds need to be controlled and the soil should be analyzed. Sites that have had a heavy annual weed problem should have the weeds controlled for a full year prior to forage seeding. This is especially necessary in fields with heavy infestations of downy brome (cheatgrass) or volunteer rye, which are severe competitors of establishing forages. The best way to decrease annual weed populations is to prevent them from setting seed. Till or apply a registered herbicide to the weeds when they are in their early-growth stages. Follow herbicide label directions and be aware of required waiting intervals between herbicide application and seeding (e.g., 30 days for 2,4-D). Be careful of tilling large areas of sandy soils that are easily eroded by wind.



Figure 5: Canada thistle is a noxious weed.

The Colorado Noxious Weed Act requires that certain noxious weeds be controlled on all lands in the state. These weeds are considered noxious because they are aggressive and hard to control. Take advantage of the pre-seeding period to identify and manage the noxious weeds on your property. This will improve your chances of successful forage establishment.

Soil Testing

The amount of essential plant nutrients in the soil on your site is determined through soil analysis. Take at least 10 samples, mix the soil together in a bucket, and submit a pint quantity to a certified soil testing laboratory. The lab will provide fertilizer recommendations with the analysis results. Submit samples to the lab at least four weeks before seeding. Apply no more than 30 pounds per acre of nitrogen fertilizer for dryland seeding. More will only encourage annual weed growth. Adding phosphorus to the soil (20-80 lbs./acre) will improve seedling vigor and root growth.



Figure 6: Sterile sorghum is used as a cover crop.

Seedbed Preparation

Forages are planted in either clean-tilled or stubble-mulch seedbeds. Clean-tilled soils are first cultivated using a sweep, chisel, disc, or plow. For sites smaller than an acre, a power tiller is an option. Incorporate well-rotted or composted manure into sandy and clayey soils if economically possible. This will enhance the water-holding capacity and nutrient content of sandy soils, and the soil structure of clayey soils.

Plowed soils may need to be disced as a second operation. Smoothing and firming are accomplished with harrow, field cultivator, or roller/packer implements. The seedbed should be firm enough that a person's footprint does not sink deeper than one-half inch. Clods should not be over 2 to 3 inches in size.

Stubble-mulch seedbeds are advised for dryland soils to reduce soil erosion. Plant stubble (standing plant stems) protects establishing forages by buffering wind, improving soil moisture, and decreasing soil temperature and weed competition.

Plants to use for stubble-mulch on fields under 7,000 feet in elevation are forage sorghum and forage millet. These also are known as cover crops. A sterile sorghum variety will prevent seeds from forming, dropping to the ground, and growing new plants the next year. Cereal crops, such as oats, can also be used as stubble-mulches. Oats can be grown above 7,000 feet in elevation.

Plant sorghum or forage millet from late May to June 30, prior to when you plant the grass seed in the fall. Sorghum can be planted at 4 to 8 pounds per acre. Use lower rates for clay soils and drier conditions. Seed 8 pounds per acre on irrigated sites. Plant 25 to 30 pounds per acre of forage millet on irrigated land, and 8 to 10 pounds per acre on dryland sites.

Use a drill to plant the sorghum cover crop 1 to 1½ inches deep, and forage millet ¾ to 1 inch deep. In late summer or early fall, cut the cover crop for hay, leaving a 6- to 10-inch stubble height. Taller heights may be needed on sandy soils. Contact your local NRCS or CSU Extension office for more information on seeding cover crops.

Seeding Methods

Forages are seeded either with a grass drill or by broadcasting seed across the soil surface. Drilling is the method of choice for all grass seeding, and is essential for planting into stubble-mulches. Use drills with a seed-box agitator for fluffy seeds, double-disc openers, depth bands, and packer wheels. Small-seeded legume and grass seed can also be drilled. Put small-seeded legumes in a seed box separate from that for grass, so the flow rates can be adjusted independently.

Drills provide for proper seeding depth, good seed-to-soil contact, and protection of seed from climatic extremes and wildlife predation. If the drill does not have packer wheels, roll or drag the field after planting to increase seed-to-soil contact. Drill large-seeded grasses to a ½-inch depth. Place small-seeded grasses and legumes at a 1/8- or ¼-inch depth on loam and clay soils; ½- to 1-inch on sands. Coated alfalfa seed does well at a ½-inch depth on sands.

Seed in rows 7 to 12 inches apart. Cross-seeding pastures may give the pasture a more appealing look when seeding only bunchgrasses. Cross-seed by drilling 50% of the seed in one direction, the other 50% perpendicular to the previously seeded rows.

A disadvantage of drilling is that most small acreage landowners do not own a drill. Contact your local CSU Extension or NRCS office to see if a seed drill contractor serves your area.

Broadcast seeding is done with a Brillion or whirlybird seeder, or by hand. It is a good method for establishing small-seeded forages into clean-tilled seedbeds. A Brillion drops seed from seed boxes onto the soil surface, and then presses it into the soil with trailing rollers. Billions work well on clean-tilled seedbeds, but are not available to most small acreage landowners. After seeds are broadcasted by hand or with a whirlybird seeder, cover them by pulling drags, pipes, harrows, chains, or rollers across the soil.

Broadcasting requires twice the seeding rate of drilling. Seed covering efforts do not incorporate all seeds into the soil. Those that remain on the soil surface are eaten by rodents and birds, or dry out and die after germinating.

Time of Seeding

The seeding window for dormant forage seeding is November 15 to April 15. A dormant forage seeding is the best time to plant on dryland fields. Plant when the soil is not frozen. Planting before March 1 allows seed to be in the soil and ready to grow with spring rains. This avoids the problem of trying to plant either on wet soil or between rainstorms.

Grasses break dormancy when soil temperature and moisture are favorable. Cool-season grasses will germinate and emerge in March or April. Warm-season grass seeds will lay dormant longer and germinate in May.

If irrigation water is available, forage seeds can be planted 6 to 8 weeks before the first hard freeze, generally late August to early September.

EARLY STAND MANAGEMENT

As mentioned earlier, successful forage establishment on dryland is never guaranteed. A dry spring season may result in seedlings drying out and dying shortly after germination. As a result, the reseeding process may have to be repeated. But be patient. During the first year, grass attempts to establish a root system and thus most of its growing happens underground, not up in the leaves and stems. Many seedings that look like a failure the first year may actually do well the second and third years.

Newly established dryland grasses should not be grazed until after they set seed, which depends on soil moisture availability, climatic conditions, and individual species. Native plants do not establish quickly and will need two to four years of growth before being grazed. Introduced grasses on dryland will need at least one year from seeding before being ready for grazing. Irrigated grasses are ready to graze lightly during the seeding year when their roots cannot be pulled up by livestock. At least four leaves and one or two tillers should be showing. Some irrigated forages like birdsfoot trefoil establish slowly over two to three years. Irrigated stands can be harvested for hay during the establishment year if a 6-inch stubble is left.

Annual weeds can cause poor stand establishment because they compete for water, space, light, and nutrients. A moderate cover of weeds, however, can shade emerging forage plants and provide a protective environment. On most sites, weeds will need to be controlled during the forage establishment year and possibly during the second year. Mow weeds to 6 inches high, two or three times during the establishment year. Bale mowed material if it is thick enough to smother new plants. Herbicide options exist for grasses that have reached at least the three-leaf stage. Herbicides cannot be used on grass-legume mixtures because they will kill either the grass or legume, depending on the product.

GRAZING MANAGEMENT

Most small acreage landowners want to allow horses or other livestock to graze their pastures. They also want their pastures to maintain health and vigor over time. In other words, they want their forage to sustain animal grazing.

Good pasture management sustains forage production, encourages animal health, and discourages weed invasion. It protects soil and increases water infiltration rates and soil organic matter content.

Maintaining good pasture condition on small acreages is not an easy task. A grazing manager needs knowledge of the forage species present and their production potential, animal grazing habits, site characteristics, available moisture, and an awareness of plant growth changes caused by climatic variability. Intensively grazed pastures require increased time, resources, and manager dedication.

Many dryland pastures in Colorado receive an average of only 12 to 16 inches of precipitation annually. Average precipitation, however, is rarely received in a given year. Most years have precipitation totals below the average, and as little as 9 inches.

Often a major proportion of precipitation never enters the soil and is lost to evaporation or runoff. As a result, many dryland pastures in Colorado exist in a near-desert climate. This is a fragile environment for forage health and survival.

Overgrazing

Overgrazing is the main reason for pasture decline. It results from not allowing grazed plants adequate time for regrowth, and not reducing the grazing pressure (time and/or animal numbers) during drought. Overgrazing reduces plant health and eventually causes desirable forage plants to die. In addition, pastures degrade through increased soil erosion and loss of soil organic matter, reduced water infiltration, and increased weed invasion.

Small acreage dryland pastures, in particular, can fall rapidly into poor condition from overgrazing. Uninformed grazing managers often expect more from dryland pasture plants than what plants can actually produce.

Forages must have an opportunity to regrow and replenish their root and stem base food reserves (carbohydrates). They do this best by having enough leaf area left after grazing to capture sunlight and convert the light energy into food. In order for this to occur, the leaf area must be present when temperatures and soil moisture are adequate for plant growth. The food is then transported inside the plants to roots and new leaves.

Adequate plant regrowth does not occur when forages are either grazed continuously too close to the ground, or regrazed before reaching a target height. These situations can occur when too many animals graze a pasture for too long, or when animals are turned back into a pasture before adequate regrowth occurs. The time needed for adequate regrowth depends on the forage species, climate, soil moisture, and time of year. On dryland pastures, 30- to 90-day recovery periods may be needed; on irrigated land, 15 to 30 days. Cool-season grasses regrow best during cool weather; warm-season grasses during hot weather. Both groups of grasses require adequate soil moisture to support regrowth during the recovery period. Overgrazing can occur when grazing of cool-season grasses is not stopped before dry, hot weather comes in June. These grasses will go dormant and not regrow, leaving the plants with low root and stem base food reserves.

Sometimes pastures may be grazed non-uniformly during the rapid plant growth period of early spring when the stocking rate is not high enough and the forage “gets ahead of the animals.” In this scenario, the animals will return and regraze previously grazed plants, leaving the taller plants alone. The taller plants are not as tender and desirable as the fresh regrowth. If the regrowth is continuously regrazed, those plants will lose vigor and die if not allowed adequate regrowth periods during the growing season.

When precipitation is 75% of average or lower for at least several months, drought conditions exist. Drought can cause a decline in root and stem base carbohydrate (plant food) storage. Overgrazing during drought greatly increases the risk of grass mortality. To reduce this risk, it is recommended that grazing management be conservative during both the drought period and the growing season following drought. This means grazing fewer animals for shorter periods of time, leaving more leaves and stems for plant survival and regrowth.



Figure 7: Overgrazed pasture (left). Properly-grazed pasture (right).

Grazing Management Guidelines

A definition of grazing management is grazing at the right time and intensity to maintain sufficient plant cover, protect the soil, and maintain or improve the quantity and quality of forage. To take care of the pasture that you have or are reestablishing, proper grazing management techniques must be followed. These techniques require discipline and an understanding of the forages and animals that you have. They require “being on the ground” and aware of how your forage and animals are performing. Grazing management is both an art and a science.

A major consequence of poor grazing management is that desirable forages will die and be replaced by undesirable weeds like Russian thistle, downy brome, kochia, and bindweed. Using grazing management to return a poor-condition pasture back to one in good condition is a difficult, long-term process. This task can also be costly because interseeding and a reduction of livestock numbers may be necessary. Good grass and legume stands are difficult to reestablish under dryland conditions. A primary goal of grazing management should be to prevent your pastures from deteriorating in the first place.

To understand grazing management, certain terms must be defined and understood.

Stocking Rate. In basic terms, stocking rate is the number of animals that graze a pasture over a period of time. Stocking rate is a primary grazing management tool. It factors in the grazing animal, the available forage, and the length of grazing time.

Stocking rates need to be adjusted according to the amount of forage available at the beginning of a grazing period. Available forage changes throughout the year in response to climate, soil moisture, rest period length, and how the pasture was previously grazed. Stocking pastures too heavily will reduce forage regrowth opportunity, reduce animal performance, and initiate a decline in pasture condition.



Figure 8: A ruler or grazing stick is used to monitor grass height.

Table 1: Minimum stubble heights for various species after a pasture has been properly grazed.

Forage	Minimum Stubble Height (inches)
Cool-season grasses	
Most species	4
Crested wheatgrasses	3
Western wheatgrass	3
Tall wheatgrass	6
Warm-season grasses	
Tall species	6
Little bluestem	4
Sideoats grama	4
Blue grama	2
Irrigated grasses	
Most Species	4
Kentucky bluegrass	2
Legumes	
Alfalfa	3-4
Birdsfoot trefoil	4-6
Sainfoin	3-4
Clover (white)	2
Clover (alsike and red)	4

An example of a stocking rate is 0.5 Animal Unit Months per acre (AUMs/ac). This means that one acre will have enough forage to take care of one-half of an animal unit for one month. Put another way, one animal unit will be able to graze one acre for half of a month before it needs to be moved to another acre in order to avoid overgrazing.

One Animal Unit (AU) is equivalent to a 1,000 pound cow or five sheep, each weighing 200 pounds. Animal units for a particular species or category of animal are adjusted up or down based on their weight. For example, a cow weighing 1,300 pounds would be equivalent to 1.3 AUs. Basically, this is telling you that the 1,300 pound cow will eat 30% more forage compared to the 1,000 pound cow.

Proper Grazing Use. Proper grazing use refers to the amount of forage that must be left in a pasture to maintain plant vigor and regrowth potential. Once proper use is achieved, allow forages to regrow by moving animals immediately to another pasture or into a corral.

One approach to evaluate proper grazing use is to monitor the pasture currently being grazed for how much forage is left, as opposed to how much has been consumed. This involves looking at how uniform the plants are grazed, and the stubble height (how much growth is left standing) of the grazed plants. When grazing is evaluated correctly and animals are moved at the right time, plants have the best opportunity to regrow as rapidly as possible.

A properly grazed pasture will have an uneven look. Most plants will have been grazed to the minimum stubble height; a small percentage may be shorter. The remaining plants will be tall and either lightly grazed or ungrazed. A pasture is overgrazed if it continually looks like it has been mowed and the forage is uniformly short. Ungrazed plants or patches are normal and result from plants being trampled, fouled by dung or urine, or from natural grazing patterns.

Table 1 lists minimum stubble heights for various forage species after a pasture has been properly grazed. Tall, warm-season grasses include big bluestem, sand bluestem, prairie sandreed, and switchgrass. A small percentage of forages will have stubble heights either shorter or taller than those heights listed. Some of these exceptions are noted in Table 1.

If pastures are continuously grazed (never allowed a 30-day or more rest period), then double the listed stubble heights to achieve proper grazing. Smooth brome can occasionally be grazed down to 2 to 3 inches for the purpose of enhancing the persistence of alfalfa in alfalfa-smooth brome mixtures.

During the dormant season when plants are not growing, minimum stubble heights should still be maintained. Grazing too severely during dormancy can injure plant crowns and reduce stem base carbohydrate storage needed for spring growth. Maintaining minimum stubble heights through winter also allows the stubble to trap snow, protecting the plants and enhancing soil moisture in the spring.

Carrying Capacity. Carrying capacity is similar to stocking rate, but on a more refined level. Carrying capacity is the average number of livestock that can be sustained on a management unit compatible with management objectives for the unit. In addition to site characteristics, it is a function of management goals and management intensity.

Setting the carrying capacity is the most important grazing management decision. Carrying capacities are estimates based on expected forage production and performance. They are refined based on experience, grazing methods, and goals.

The amount of forage a pasture produces varies with available moisture, soil types, and pasture condition. Average total forage production (on an air-dry matter basis) ranges from 300 to 2,000 pounds per acre on most dryland pastures in Colorado. In contrast, irrigated pastures produce 1 to 6 tons per acre with 4 tons per acre being a good average for the state.

Not all of the forage produced in a year can be grazed. As discussed in the “Proper Grazing Use” section, minimum stubble heights must be left to allow plants to regrow and maintain plant vigor. Pastures that are grazed properly will have about 50% of their total forage left as stubble. An additional 25% will be lost to trampling, insects, rodents, and fouling. This leaves 25% of the forage for livestock consumption. A portion of the 25% wastage can be grazed beneficially in properly managed pasture rotation systems.

To estimate a pasture’s average carrying capacity, take the estimated average total annual forage production per acre and multiply by 0.25 (for 25 percent livestock consumption). Multiply the resulting figure by the number of acres in the pasture to give you weight of total available forage. One Animal Unit (AU) will eat 25 pounds of air-dry forage per day. Divide the total available forage by 25 to yield the number of days that one AU (or one 1,000-pound cow) can graze the pasture during the year. A 1,000-pound horse grazes and tramples more forage than a 1,000-pound cow, and is equivalent to 1.25 AUs. It will eat and trample 31 pounds of air-dry forage per day.

The following is an example of calculating carrying capacity. Assume a 30-acre pasture produces an average of 1,000 pounds of annual forage per acre. One 1,000-pound horse (1.25 AU) will graze it.

$$1,000 \text{ lbs./acre} \times 30 \text{ acres} = 30,000 \text{ lbs. of total forage}$$

$30,000 \text{ lbs.} \times 0.25 \text{ (25\% utilization)} = 7,500 \text{ lbs. of grazable forage}$ $7,500 \text{ lbs.} / 31 \text{ lbs. grazed per day by a 1,000 lbs. horse} = 242 \text{ days of grazing by one horse to achieve proper grazing use. Grazing two horses for 121 days also achieves proper grazing use in this scenario.}$

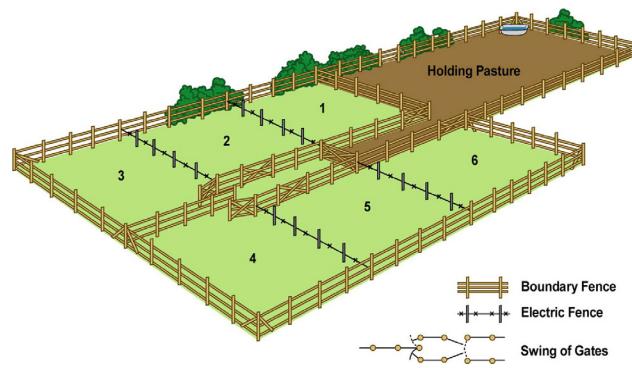
To convert to an actual carrying capacity value, divide 242 days by 30 acres. This means the carrying capacity is 8 horse days per acre (or 10 animal unit days/acre). In other words, enough forage exists on one acre of this pasture to meet the horse's needs for 8 days per year.

In the above example, instead of grazing 1 horse, the same 8 days of grazing on 1 acre will meet the needs of 6 sheep or twelve 100-pound animals since they are equivalent to 1 horse or 1.25 AUs. Similarly, one 1,000-pound cow can graze on 1 acre for 10 days which is equivalent to 5 sheep or ten 100-pound animals because they are equivalent to 1 cow or 1.00 AU.

Carrying capacities calculated in the above manner are estimates for average production years. Adjust these estimates based on experience, stubble height monitoring, animal weights, and for dry or wet years.

Table 2: An example of how land area and the number of animal units grazing a hypothetical dryland pasture in Colorado influence turnout times. This example considers only forage demand and forage supply, and assumes that 30 acres provides enough forage to meet the demands of one animal unit for 365 days while leaving adequate plant residual on site. The daily turnout times are not recommendations for grazing management as no consideration has been given to timing of plant growth, planning for adequate recovery (plant regrowth without grazing pressure), distribution of grazing use, and timing of grazing use.

Land Area				
Animal Units	30 Acres	10 Acres	5 Acres	2.5 Acres
1	24 hrs/day	8 hrs/day	4 hrs/day	2 hrs/day
2	12 hrs/day	4 hrs/day	2 hrs/day	1 hr/day
3	8 hrs/day	2.6 hrs/day	1.3 hrs/day	40 min/day
4	6 hrs/day	2 hrs/day	1 hr/day	30min/day
5	4.8 hrs/day	1.6 hrs/day	50 min/day	24 min/day
6	4 hrs/day	1.3 hrs/day	36 min/day	N/A
8	3 hrs/day	1 hr/day	30 min/day	N/A
10	2.4 hrs/day	50 min/day	24 min/day	N/A



General Pasture Management Guidelines

1. Know your pasture's carrying capacity and manage grazing accordingly. If a pasture supports a horse for only 300 days, do not graze it for 301 days unless moisture conditions provide additional grazable forage growth.
2. If you have more animals than the carrying capacity of the pasture, some must either be sold or removed and fed in a corral.
3. Overgrazing can occur in two ways: leaving your livestock on a pasture for too long, or not allowing enough time for the forage to regrow after grazing.
4. Properly manage livestock grazing in your pasture by monitoring minimum stubble heights (see Table 1) and the appearance of the whole pasture. Move animals off pasture when proper grazing use is realized. The pasture should not look mowed, but rough with areas of taller and shorter grasses. Allow regrazing only after the forage has had time to regrow adequately. A rule-of-thumb is to let the plants regrow to twice their minimum stubble heights before allowing regrazing.

Figure 9: Example of a rotational grazing design. Many small dryland pastures do not have enough forage to feed a horse for a year or even a month. As a result, rotate animals between the pastures and the feeding corral. Rotate animals into each pasture based on forage growth rather than the calendar.

5. Avoid grazing livestock when pastures are wet to minimize plant trampling and soil compaction, and potential damage to plant crowns.
6. Spring can be a critical time for forages as they are using root and stem base reserves for growth. Delay grazing until plants reach 5 or 6 inches in height (three to five leaves for grasses). Cool-season grasses can be grazed a little heavier than normal in spring because conditions are optimum for regrowth. The opportunity still must be provided to allow for adequate regrowth when the plants are not being grazed.
7. The health of pasture grasses is enhanced by managing grazing so plants are not being grazed at the same time every year, especially during the sensitive “boot stage” when grasses are elevating seed heads. Cool-season grasses head out in late spring; warm-season grasses in mid to late summer.
8. Rotational grazing systems allow you to manage your pasture more intensively. An increase in forage harvest efficiency will result if the system is managed correctly. A rotation system will require the pasture to be fenced off into at least two smaller paddocks, but a minimum of 4 is often recommended. Animals are rotated between the paddocks in time intervals which depend on the season, weather conditions, soil type, and forage condition. Typical rest periods are 30 days to 90 days, depending on the time of year and the amount of water available. Restricting the animal’s grazing area by tethering also may be a rotational tool. Seek advice for design and implementation of a rotational grazing plan.
9. Restrict animal access to rivers, creeks, and ponds to protect water quality.

Ungrazed Pastures

If you have an established pasture that will not be grazed, ensure pasture health using certain maintenance tasks. Mow the pasture every other year to recycle nutrients and increase light penetration of the canopy to aide in the production of new leaves. However, to sustain ungrazed pastures during drought, no mowing is needed. Poor forage growth, and the death of some plants, especially taller grasses, often occur in ungrazed pastures that are not maintained.

Monitor your pasture on a yearly basis for noxious weeds and control them when found. Areas with low densities of desirable vegetation will likely have heavy annual weed infestations. Control these weeds using herbicides or mechanical treatments before seed set. Reseed these weedy areas at the appropriate time to get a good forage stand that will prevent future weed infestations.

SOURCES OF ADDITIONAL HELP

Additional help concerning much of the information in this publication is available through local offices for CSU Extension, NRCS, County Weed and Pest, or seed dealers. Available information includes publications on saline and sodic soils, irrigation water quality, soil sampling, fertilizer recommendations, grass and weed identification, pasture establishment, and grazing management. Also, specific questions can be answered regarding these topics, in addition to species and variety details, weed and pasture management, estimated forage yields, and more.

GRASS SPECIES AND VARIETIES

Bluegrass, Kentucky

Kentucky bluegrass (*Poa pratensis*) is a cool-season grass that originated from Europe and has naturalized in many Colorado locations. It is an aggressive, palatable sod-former. Bluegrass needs irrigation or subirrigation to maintain summer growth, or it will go dormant after daily maximum temperatures reach 90°F. It regrows in the fall with adequate moisture. Stems are 1 to 2 feet



Figure 10: Kentucky bluegrass

tall, with leaves 2 to 7 inches long. Seed 1 to 5 pounds per acre with a legume. Kentucky bluegrass has the disadvantage of not being a high-forage producer, so it is not commonly planted in Colorado.

Use for Hay. Not a good hay grass because of low-growing leaves.

Use for Pasture. Kentucky bluegrass provides good grazing and tolerates trampling but is not highly productive. Overgrazing or undergrazing bluegrass for short periods is not harmful. Because it tolerates trampling and overgrazing, it works well as a component of horse pastures. Keep between a height of 2 and 6 inches. Crude protein can be 20% at maturity. White clover combines well with bluegrass in pastures.

Variety:

'Troy' is a 1955 release from Montana; withstands grazing well; tall, erect growth habit.

Bluestem, Big

Big bluestem (*Andropogon gerardii*) is a native, warm-season grass that grows 3 to 6 feet in height, with 4-to-20 inch long leaves. It is known as "turkey-foot" because of the arrangement of the three seed heads that occur at the top of stalks. It is slightly sod-forming and heads out in late summer. Plant on dryland sites, although it responds fairly well to irrigation. This species mixes well with switchgrass, little bluestem, and yellow Indiangrass.

Use for Hay. This grass makes good hay if cut before seedheads form.

Use for Pasture. Big bluestem is tough and unpalatable after maturity. Otherwise, it is relished by all livestock classes. If not managed well, it quickly will be grazed out of pastures.

Varieties:

1. 'Kaw': medium-late in maturity; a 1950 Kansas release; best seed availability.
2. 'Pawnee': moderately long, dark green leaves; seedhead hairiness varies; a 1963 Nebraska release.
3. 'Champ': matures 7 to 10 days earlier than 'Pawnee'; leafy; a 1963 Nebraska release.
4. 'Bonilla': excellent winter hardiness because of its northern origin; a 1987 North Dakota release; forage production exceeds 'Bison', but not as much as 'Champ' and 'Kaw'; limited seed availability.
5. 'Bison': matures 30 to 48 days earlier than 'Kaw', 'Champ' and 'Pawnee'; shorter height; a 1989 North Dakota release; limited seed availability.

Bluestem, Little

Little bluestem (*Schizachyrium scoparium*) is a native, warm-season bunchgrass that grows 18 to 40 inches tall, with leaves 3 to 10 inches long. It is adapted to most soils and heads out in late summer. Plant on dryland sites receiving 14 inches or more of precipitation. It is more drought resistant than big bluestem. This bluestem mixes well with big bluestem, sideoats grama, prairie sandreed, and sand bluestem.

Use for Hay. Hay yields from little bluestem range from $\frac{3}{4}$ to 2 tons per acre, depending on soils and moisture. Cut before the heading stage.



Figure 11: Big bluestem

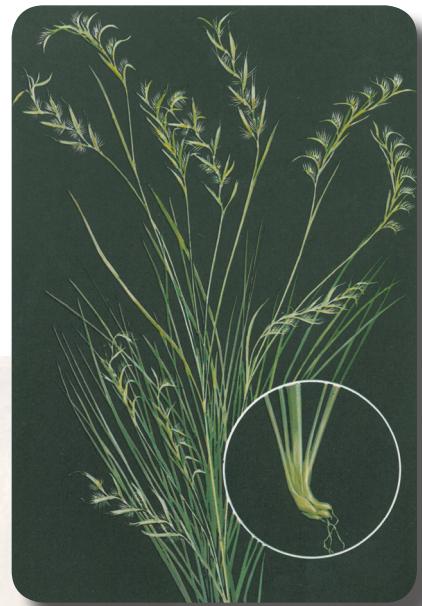


Figure 12: Little bluestem

Use for Pasture. Little bluestem is less palatable than big bluestem, which allows for somewhat more relaxed grazing management. Not preferred by livestock after heads appear. Not preferred by sheep. Best palatability is in early summer.

Varieties:

1. 'Cimarron': a 1979 release from southwest Kansas; improved forage production; can grow on 12 inch precipitation sites; good seed availability.
2. 'Blaze': leafy, late-maturing; named for the brilliant red color it holds through winter; a 1967 release from Nebraska; seed availability best early in the year.
3. 'Camper': long and narrow leaves; a 1973 Nebraska release; more adapted to the plains northeast of Colorado; seed availability is best early in the year.
4. 'Aldous': mid-Kansas origin; tall, leafy and vigorous; medium-late in maturity; good seed availability.
5. Native VNS: native “Variety Not Stated” little bluestem seed can often be the most available. Seed source usually has adaptability to the eastern plains of Colorado.
6. 'Pastura': a variety that is rated highly; however, seed is very difficult to find; a 1963 release from a low rainfall area in New Mexico; good seedling vigor; average herbage production; seedheads less hairy.

Bluestem, Sand

Sand bluestem (*Andropogon hallii*) is a native, warm-season grass that grows 3 to 8 feet tall. Leaves grow 8 to 12 inches long. It is adapted to sandy soils and helps bind them with its sod-forming growth habit. Sand bluestem looks similar to big bluestem, but has a hairier seedhead with shorter awns, and a greater spreading habit via rhizomes.

Use for Hay. A high producer when mixed with other grasses adapted to sandy soils.

Use for Pasture. Sand bluestem provides good summer grazing and is relished by all classes of livestock. It has only fair palatability in the winter.

Varieties:

1. 'Garden': from panhandle of Nebraska; vigorous, tall and leafy; a good choice for hay production.
2. 'Woodward': a 1955 Oklahoma release; more adapted to the southern Great Plains; individual plant characteristics may vary within a stand.
3. 'Goldstrike': variable in plant height and rhizome length; a 1973 Nebraska release; limited seed availability.
4. 'Elida': a highly rated variety, but seed supply is limited; it originated from east central New Mexico; recommended for 14 inch or more precipitation areas; released in 1963.

Brome, Meadow

Meadow brome (*Bromus biebersteinii*) is a cool-season grass that originated in Southeast Asia. It is a bunchgrass with short rhizomes and grows 24 to 48 inches tall. Meadow brome is adapted to irrigated sites with silt to clay soil. It has some drought tolerance to withstand less than full-season irrigation.



Figure 13: Sand bluestem



Figure 14: Meadow brome

Meadow brome establishes rapidly and is more winter hardy than other irrigated grasses like orchardgrass.

Meadow brome is a good competitor, but is not as aggressive as smooth brome. It recovers faster than smooth brome from haying or grazing. Meadow brome is highly desired by livestock and wildlife.

Use for Hay. Compared to smooth brome, it has a higher leaf-to-stem ratio, better fall regrowth, and matures 7 to 10 days earlier. Heads have longer awns than smooth brome. Most appear in the first cutting and the first two years after establishment. Allow 6 inches of fall regrowth before a killing frost to encourage winter hardiness. It mixes well with alfalfa.

Use for Pasture. Meadow brome is well suited to grazing on irrigated pastures and mixes well with other grasses such as orchardgrass, smooth brome, and perennial ryegrass.

Varieties:

1. 'Cache' is a relatively new variety developed in Utah. It establishes quickly due to its strong seedling vigor.
2. 'Fleet' and 'Paddock' are two varieties from Canada that grow well under Colorado conditions.
3. 'Regar': earlier heading than 'Manchar' smooth brome; seeds germinate rapidly; has good regrowth after being cut or grazed.

Brome, Smooth

Smooth brome (*Bromus inermis*) is a cool-season grass that originated in Eurasia. It is a mid-height grass that grows 2 to 4 feet tall with leaves 6 to 16 inches long. It is an aggressive sod-former that can become sod bound if not adequately fertilized with nitrogen. Growth of sod-bound stands can sometimes be improved by tilling (i.e. ripping) the soil. Smooth brome has good spring growth, but goes dormant in the summer under short-water conditions. It regrows in the fall with adequate moisture. This brome is fair on dryland and has some drought tolerance. Unique to this brome is that it has no awns (beards) on its seedheads. Smooth brome leaves have a distinctive "W" wrinkling located a short distance below their tips. It provides high quality livestock forage.

Use for Hay. This is an excellent grass for hay fields that are short on irrigation water. Cut it for hay when seedheads emerge for best quality and quicker regrowth. Expect only one cutting per year; two cuttings with adequate irrigation water. When mixed with alfalfa, hay yields often are triple those of smooth brome alone. If not mixed with a legume like alfalfa, it requires annual applications of nitrogen fertilizer to remain productive.

Use for Pasture. Smooth brome is fair as a pasture grass since leaves are located high on the plants. When these leaves are grazed, plants regrow slowly by using their root reserves. Optimal use of this grass is in the spring. To encourage continued growth in the spring, graze lightly.

Varieties:

1. 'Lincoln- 2. 'Manchar': "Northern Type"; weaker sod-former than 'Lincoln'; leaves are mostly on the stems; shorter and finer stemmed; matures earlier; hardier, recovers rapidly after cutting, the better choice when mixed with alfalfa.



Figure 15: Smooth brome

Fescue, Tall

Tall fescue (*Festuca arundiaceae*) is a cool-season grass that originated in Europe and grows 3 to 4 feet tall. It forms multi-leaved bunches that cover the soil better than some sod-forming grasses. Tall fescue prefers clay or clay loam soils. Its tough leaves have only fair palatability to livestock. This means it must be managed carefully for optimum use and feed quality. Tall fescue is adapted to irrigated or subirrigated land. It is tolerant of poorly drained and saline sites.

Many tall fescue stands in the United States are infested with an endophyte fungus that lives inside the plants. The fungus produces an alkaloid that is toxic to livestock and can be detected only by laboratory analysis. The toxin can cause fescue foot in cattle and summer fescue toxicosis in cattle, sheep, and horses. The toxin also can cause weight loss, lower pregnancy rates, and problems with reproduction and milk production. High soil nitrogen levels seem to enhance the toxicity. Fescue lameness is more common in late fall and winter. Toxicosis risk increases when air temperatures are over 75 to 80°F. The severity of the symptoms can change from field to field and year to year.

The toxin is most concentrated in seeds and is transmitted from field to field by infected seed. It benefits the grass by providing insect, drought, and heat resistance. Infected fields cannot be cured with a fungicide application.

The fungus is only transmitted in the seed, so plant endophyte-free seed to ensure having non-infected tall fescue. Toxicosis and fescue foot have not been found to be major concerns in Colorado fescue stands even though endophyte-infected seed has been planted. To minimize toxicity potential, keep plants young and vegetative, don't use the grass during hot weather, or dilute it with other grasses or legumes. Mares in their last trimester of pregnancy or when lactating should not consume tall fescue.

If you want to test your tall fescue for the fungus toxin (ergovaline), clip grass samples from 20 random locations and combine them into one lot. Air-dry the sample lot away from direct sunlight. Seal it in a polyethylene freezer bag and label it with your name, phone number, and sample identification. Send sample to: 139 Oak Creek Building, Endophyte Service Laboratory, College of Agricultural Sciences, Oregon State University, Corvallis, OR 97331. Contact the laboratory at 541-737-2872 or at <http://oregonstate.edu/endophyte-lab/>. A cost is involved. Check the website for the price per sample.

Use for Hay. Best fescue hay quality is acquired by harvesting at the boot stage or very first sign of heading. Hay quality is good, but palatability is fair to poor.

Use for Pasture. Tall fescue is productive season-long with adequate moisture and is a high yielder of pasture forage. Tall fescue establishes relatively slowly and new stands can be seriously damaged by either overgrazing or grazing too soon. It has a tough root system which withstands trampling. Best utilization is achieved by grazing monocultures to a 2- to 4-inch stubble height with a rotational plan to encourage regrowth and maintain palatability. Tall fescue loses quality and palatability rapidly after heading. In mixed species pastures, a heavy stocking rate is needed to ensure tall fescue is grazed. Livestock will select and grub out other forages first, if allowed the chance.

Newer, Endophyte-Free Varieties: examples are 'Forager', 'Fuego', 'Johnstone', 'Mozark', 'Martin' and 'Penngrazer'. Check with your seed dealer about seed availability and adaptability to your location and situation. 'Fuego', for example, has lax leaves that allow for increased compatibility with legumes.

Traditional Varieties:

1. 'Fawn': improved early growth and seedling vigor compared with 'Kentucky 31' and 'Alta'; earlier maturing; a 1964 release; more suited to cooler regions. Endophyte-free seed is available.
2. 'Phyter': similar in maturity to 'Kentucky 31'; a 1988 release; seed may be hard to find.

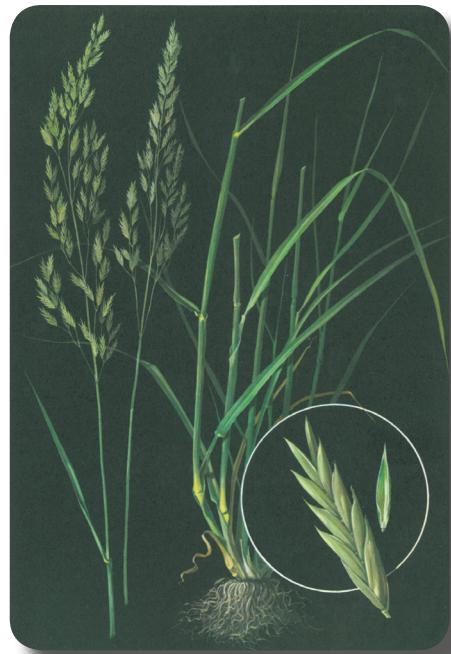


Figure 16: Tall fescue

3. 'Kentucky 31': less palatable than 'Fawn'; used more in hotter regions.
4. 'Alta': oldest of developed varieties; lower yielding; low seed availability and higher seed cost.

Novel Endophyte Varieties:

'MaxQ' is a newer variety that contains a novel or friendly endophyte that does not cause animal health problems. It confers drought, insect, and heat resistance to the plants similar to the older, endophyte-infected varieties, but does not produce the alkaloid that is harmful to livestock. Additional varieties with this trait are currently being developed.

Grama, Blue

Blue grama (*Bouteloua gracilis*) is a native, warm-season grass that is prevalent in the shortgrass prairie. It is a short grass with seed stalks 8 to 24 inches tall, and curly leaves 2 to 6 inches long. Blue grama prefers silt to clay soils and can either grow in bunches or tight sods (i.e. sod-former). It is one of the best drought tolerant grasses and mixes well with buffalograss, sideoats grama, western wheatgrass, and green needlegrass.

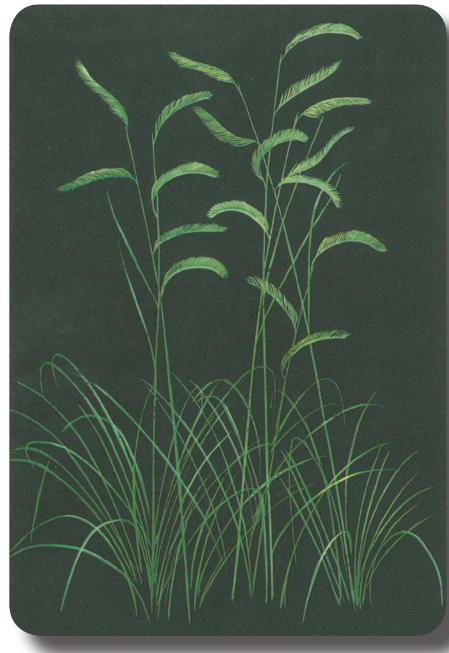


Figure 17: Blue grama

Use for Hay. Blue grama is not suitable for hay as a result of short leaf growth.

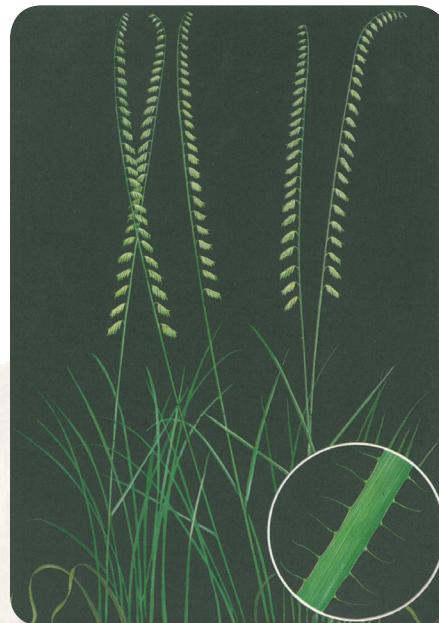
Use for Pasture. Blue grama withstands trampling and grazing very well. Because leaves grow short, it is not very productive, but supplies excellent summer or winter pasture feed. Do not graze this grass to less than 2 inches tall. A main reason for its drought tolerance is that it will go dormant with extended dry soil conditions. Because of this self-preservation tactic, it recovers from drought better than other grasses.

Varieties:

1. 'Hachita': a 1980 release from New Mexico; superior forage producer; better than average drought tolerance; good seed availability.
2. 'Lovington': a 1963 New Mexico release; good seedling vigor; leafy; better establishment under drought; seed in short supply.
3. 'Alma': better seedling emergence, and similar forage productivity and crude protein content compared to 'Hachita'.

Grama, Sideoats

Sideoats grama (*Bouteloua curtipendula*) is a native, warm-season bunchgrass. It is a mid-height plant with seed stalks that grow 1 to 3 feet tall and leaves 2 to 8 inches long. Its name comes from the way individual flowers hang from one side of the seed stalks. Stiff hairs exist along the margins of the leaf blades. Sideoats grama turns a brownish-red color in the fall and is adapted to a wide range of soils, except loose sands and dense clays. Its drought tolerance is less than blue grama, but more than big bluestem. It mixes well with blue grama and the bluestems.



Use for Hay. Sideoats grama is suitable for hay when cut at the early-heading stage. It provides moderate yields with good quality.

Use for Pasture. This grama grass is palatable when green to all livestock. However, it does not take heavy grazing well. It is a good summer and fall forage. It cures moderately well on the ground to provide fair winter forage.

Figure 18: Sideoats grama

Varieties:

1. 'El Reno': good leafiness, vigor, production potential, and winter hardiness; a 1944 release by Kansas; not as adapted to Colorado, but seed is commonly available.
2. 'Vaughn': good seedling vigor, drought tolerant; an easy establisher; low palatability; a 1940 New Mexico release; good seed availability.
3. 'Niner': winter hardy; matures more evenly than 'Vaughn'; a 1984 New Mexico release; seed supply may be limited.
4. 'Butte': winter hardy and long lived; earlier maturing; better for areas with short growing seasons; a 1958 Nebraska release.
5. 'Pierre': exceeds in vigor and leafiness; weakly rhizomatous; good stand persistence; a 1960 release from South Dakota; more adapted to areas north and east of Colorado.

Indiangrass, Yellow

Yellow Indiangrass (*Sorghastrum nutans*) is a native, warm-season grass that is a moderate sod-former. Stems grow 3 to 5 feet tall from leafy clumps, with leaves up to 2 feet long. Seedheads are grey-hairy to golden-brown. It is adapted to sandy soils and needs additional moisture on loamy soils. Indiangrass tolerates periodic flooding and high water tables.

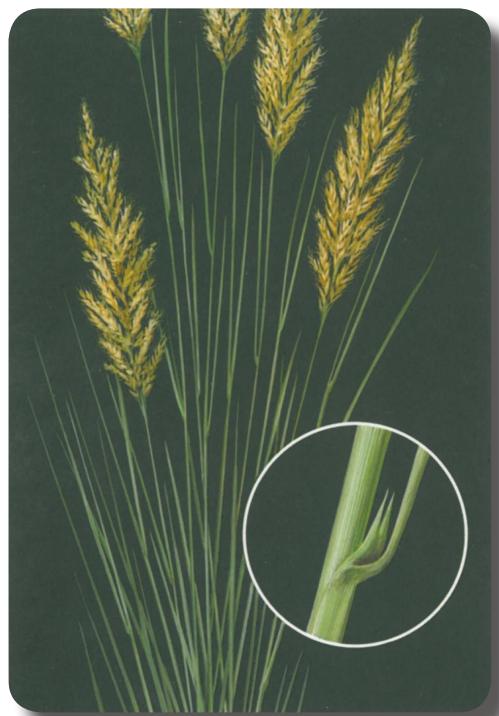


Figure 19: Yellow Indiangrass

Yellow Indiangrass matures in late summer to fall, later than big bluestem. It responds well to nitrogen fertilizer and supplemental water. Salt tolerance is moderate. It is compatible with the bluestems and switchgrass.

Use for Hay. Yellow Indiangrass provides excellent hay when cut before heading. Production potential is similar to big bluestem.

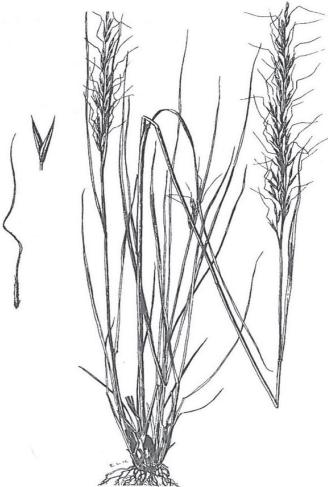


Figure 20: Green needlegrass

Use for Pasture. Indiangrass palatability is high in the summer and declines with maturity. It does not tolerate close summer grazing.

Varieties:

1. 'Cheyenne': late maturing; good forage type; Oklahoma origin; more adapted to eastern Colorado border, but dominates seed availability.
2. 'Nebraska 54': good seedling vigor; tall, leafy and moderately late-maturing; Nebraska origin; good seed availability.
3. 'Llano': origin is northeastern New Mexico; a highly rated variety, but seed availability is low to non-existent
4. 'Holt': a fine-leafy type adapted to eastern Colorado; seed availability is limited.

Needlegrass, Green

Green needlegrass (*Nassella viridula*) is a native, cool-season bunchgrass associated with blue grama on clayey, dryland soils. It has an abundance of palatable basal leaves that recover well after being grazed or cut.

Although green needlegrass has awns (beards), they are not typically troublesome to livestock. Its seed dormancy percentage can be high with some seed germinating two to three years after planting.

Green needlegrass is a mid-height grass with stems that grows 2 to 3 feet tall and leaves 3 to 12 inches long. A relatively early spring grower, it heads in June and matures in July. It mixes well with western wheatgrass and blue grama.

Use for Hay. Although green needlegrass has mostly basal leaves, it provides good quality hay and is worthwhile cutting.

Use for Pasture. Green needlegrass can maintain palatability and good nutrient quality through the summer with good soil moisture. It is more palatable to cattle and horses than to sheep and goats. Let fully-developed awns fall before continuing grazing.

Varieties:

1. 'Lodorm': selected for low seed dormancy; a North Dakota release.

Orchardgrass

Orchardgrass (*Dactylis glomerata*) is a high quality, cool-season grass that originated in Europe. It grows 2 to 5 feet tall, has leaves 4 to 16 inches long, and has one-sided seedhead clusters. Orchardgrass produces numerous leafy stems and recovers rapidly from grazing or cutting. It is adapted to irrigated or high moisture sites and needs adequate soil moisture to survive winters. Orchardgrass does not tolerate flooded conditions. Choose early maturing varieties for improved winter hardiness. It combines well with legumes since it is a bunchgrass; many varieties mature about the same time as alfalfa.

Use for Hay. Orchardgrass is an excellent hay grass that can produce more than six tons per acre of high quality hay. Higher yields are expected when mixed with alfalfa. Cut for hay when plants are in the boot stage or shortly thereafter.

Use for Pasture. Orchardgrass is palatable to livestock. Graze 8- to 9-inch tall plants down to a 4-inch stubble. Proper grazing will reduce the development of seed stalks. Orchardgrass provides excellent regrowth in the summer with adequate soil moisture. It does not tolerate close and continuous grazing, but is adapted to frequent grazing. Rotational grazing is needed to prevent it from being selectively grazed. Orchardgrass has a low tolerance to trampling.

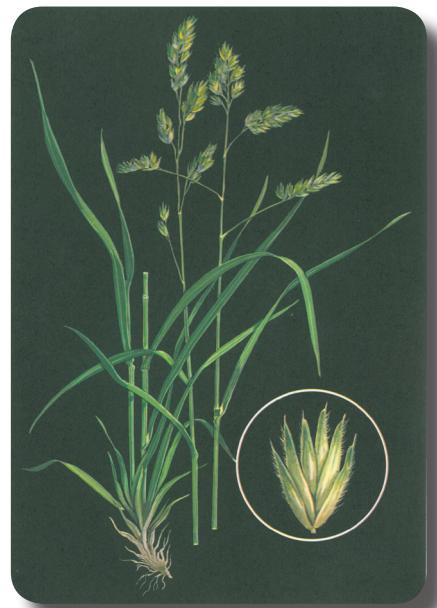


Figure 21: Orchardgrass

Dryland Variety:

1. 'Paiute': can produce 15 to 18 inch tall plants on dryland; it has the ability to be long-lived, but has survived for only three years on sites with 17 inches of precipitation; although drought tolerant, dry, open winters increase winter kill risk; a 1983 release from Idaho.

Irrigated Varieties:

1. 'Latar': a good, leafy, late maturing variety; leaves are low in lignin content and have high digestibility; matures the same time as alfalfa; good forage producer; recovers quickly after cutting; good winter hardiness; a 1957 release.
2. 'Dawn': matures 3 to 4 days later than 'Latar'; more winter hardy and a better yielder than 'Potomac'; a 1989 release; this is a proprietary variety that may have limited seed availability.
3. 'Potomac': early maturing; lower producer; compatible with clovers; a 1954 release.

Other Varieties:

1. New orchardgrass varieties are being developed rapidly; examples are 'Able', 'Benchmark', 'Comer', 'Hallmark', 'Haymate', and 'Rancho'. A number of varieties from Canada have potential for doing well in Colorado. Consult your seed dealer for seed availability and additional information.

Sacaton, Alkali

Alkali sacaton (*Sporobolus airoides*) is a warm-season, native bunchgrass that can form wide bunches. It is adapted to salty sites with soil electrical conductivity of more than 12 mmhos/cm and less than about 25 mmhos/cm. It is long-lived and grows 2 to 3 feet tall. Alkali sacaton prefers fine-textured soils and can be hard to establish. Broadcast seeding has worked the best because sacaton is very small seeded. It withstands high water tables and frequent flooding. Sacaton mixes well with western wheatgrass and switchgrass on sites with soil electrical conductivity of 8 to 14 mmhos/cm.

Use for Hay. Alkali sacaton produces hay of fair quality if cut at early heading.

Use for Pasture. Cattle and horses graze alkali sacaton freely before the plants reach maturity. As it matures, sacaton becomes coarse, tough, and unpalatable. Sacaton has good grazing tolerance; keep grazing down to maintain quality. It does not cure into good winter feed.

Varieties:

Most seed is available as Variety Not Stated (VNS).

1. 'Salado': good forage production and improved seedling vigor; a 1982 New Mexico release; limited seed availability.
2. 'Saltalk': good germination and establishment on saline sites; improved palatability; withstands flooding; a 1981 Oklahoma release; limited seed availability.

Sandreed, Prairie

Prairie sandreed (*Calamovilfa longifolia*) is a native, warm-season grass that is adapted to sandy sites. It is a sod-former that grows 2 to 5 feet tall and is a good soil stabilizer. Leaves are 4 to 20 inches long. Typical of native grasses, prairie sandreed can take two to four years to become established. Sandreed mixes well with sand and little bluestems.

Use for Hay. Prairie sandreed hay quality is fair to good. Cut at the heading stage.

Use for Pasture. Prairie sandreed provides good summer grazing but is susceptible to trampling despite its rhizomatous nature. This grass will become coarse and woody if allowed to grow too tall under grazing. It has some value as a winter forage and more grazing tolerance than bluestems.

Varieties:

1. 'Goshen': late maturing, moderately spreading and drought tolerant; a 1976 Montana release.
2. 'Pronghorn': superior leaf rust resistance compared to 'Goshen'; a 1988 Nebraska-Kansas release.

Switchgrass

Switchgrass (*Panicum virgatum*) is a native, warm-season, moderately sod-forming grass. It is adapted to a wide range of soil types, but does not tolerate high water tables. Switchgrass performs best on sites receiving 16 inches or more of annual precipitation, or more than 14 inches on sandy soils. Seed stalks grow 2 to 5 feet tall; leaves 1 to 2 feet long. It cures to a colorful reddish-brown by winter. Switchgrass seed is smooth and plants easily. Pure stands of switchgrass respond well to nitrogen fertilizer. Compatible grasses are big bluestem, little bluestem, and yellow Indiangrass.

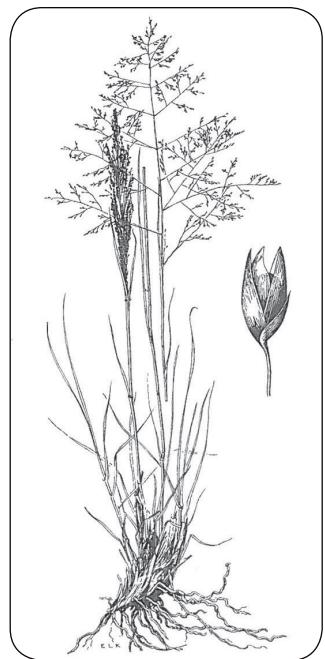


Figure 22: Alkali sacaton

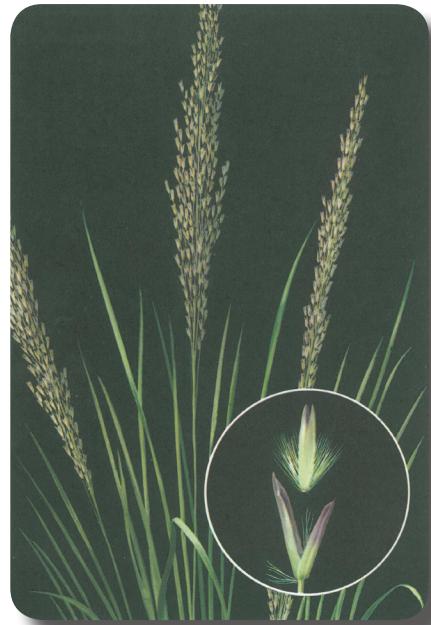


Figure 23: Prairie sandreed

Use for Hay. Switchgrass has many leaves on upright stems and makes good hay on sites with adequate moisture. Hay quality declines rapidly after heading.

Use for Pasture. Switchgrass is palatable to all livestock, but as stems mature in late summer, nutrient content and palatability decline rapidly. It is vulnerable to close grazing in late spring and early summer as it raises its seed stems.

Varieties:

1. 'Blackwell': wide range of adaption; good seedling vigor, leafy, good producer; a 1944 Kansas release; most commonly available variety.
2. 'Nebraska 28': fine stemmed, early maturing; adaptability to diverse soils, a 1949 Nebraska release, seed availability is fair to good.
3. 'Trailblazer': greater digestibility than 'Pathfinder'; similar in maturity length; a 1984 Nebraska release; seed availability is fair to good.
4. 'Pathfinder': late maturing; easy to establish; winter hardy; leafy; a 1967 Nebraska release; seed availability is fair to good.

Wheatgrass, Crested

Crested wheatgrass (*Agropyron cristatum*) is a cool-season grass that originated in Russia. All but one variety are bunchgrasses and they are adapted to a wide range of soils. All are drought tolerant, some more than others. Plants grow 8 to 30 inches tall; leaves 2 to 8 inches long. Crested wheatgrasses provide forage two to three weeks earlier than most other grasses, but become dormant with hot temperatures in early June. Pure stands can be infested by black grass bugs in the spring. Plants can become unthrifty in dense stands without persistent legumes or nitrogen fertilization.

Use for Hay. Crested wheatgrass provides good quality hay if cut soon after heading. Its fine stems cure quickly and well. However, it is rarely harvested for hay.

Use for Pasture. Crested wheatgrass is very tolerant of grazing. Graze it during April and May before the grass turns brown in early June. Forage quality is poor from June through August. Stocking rate can be 1 AUM/ac in the spring, depending on stand productivity and management. Plants will be grazed out if utilized heavily through spring, on an annual basis. Seventy percent of spring growth can be grazed if good soil moisture and time exists for regrowth to occur before June. Graze during the establishment year after frost to remove growth that inhibits spring grazing.

Varieties:

1. 'Ephraim': moderately spreading but poor productivity; a good, mid-height, low maintenance ground cover; good for stabilizing disturbed areas and for around farm buildings; a 1983 release.
2. 'Hycrest': a cross between 'Nordan' and 'Fairway'; compared to these parents, 'Hycrest' yields 15 to 20% more forage, has more and finer leaves, is quicker establishing, and emerges from a deeper planting depth; more stemmy than other crested wheatgrasses; 12-inch rows have held out cheatgrass; adapted to 12 inches or more of annual moisture; a 1984 release.
3. 'Nordan': also known as standard crested wheatgrass (*Agropyron desertorum*); more productive and remains greener under drought than 'Fairway'; tends to have more open stands; withstands close grazing and trampling; needs 12 inches or more of precipitation; may need nitrogen fertilization to revitalize stands; good on clay soils.
4. 'Fairway': thickens in stands better than 'Nordan'; leafier and finer stemmed than other varieties; establishes slower and grows shorter; flowering heads taper towards tip; cures earlier than 'Nordan'; needs 10 inches or more of annual moisture
5. 'Douglas': leafier 'Fairway' type; a Canada release.

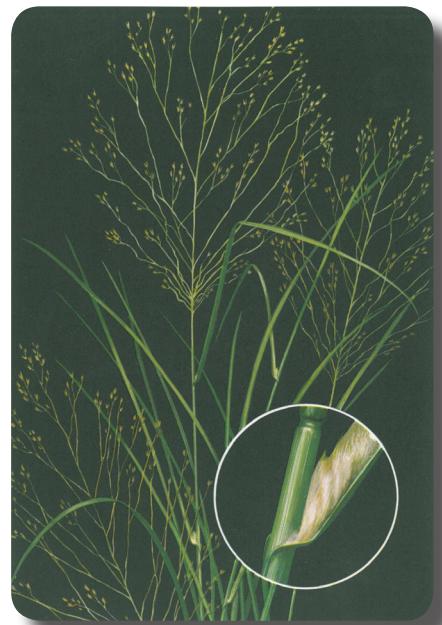


Figure 24: Switchgrass



Figure 25: Crested wheatgrass

Wheatgrasses, Intermediate and Pubescent

Intermediate and pubescent wheatgrasses (*Elytrigia intermedia*) are cool-season grasses that originated in Eurasia. They are closely related to each other, and are weakly sod-forming with short rhizomes. A small percentage of intermediate plants can display pubescent (short hairy or fuzzy) heads, making intermediate and pubescent varieties hard to differentiate from each other.

These grasses grow 2.5 to 3.5 feet tall and leaves are 4 to 16 inches long. They have more drought resistance and regrowth ability than smooth brome. Most varieties need 15 or more inches of annual moisture. ‘Luna,’ a pubescent variety, requires 14 inches of moisture. These wheatgrasses have good salt tolerance, but will experience a 50% decline in yield on soils with an electrical conductivity of 13 to 18 mmhos/cm. Stands of these grasses respond well to nitrogen fertilizer.

Use for Hay. Intermediate and pubescent wheatgrasses are tall and produce good hay yields. Quality is good if cut before flowering. These are good grasses for acreages short of irrigation water. Intermediate varieties respond better to supplemental water. They are compatible with alfalfa.

Use for Pasture. These grasses provide good spring to late summer forage. Keep grazed to 4- to 8-inch height for best quality and livestock acceptance. Stands of intermediate varieties can decline after five years of close grazing on dryland. Growth usually begins earlier than native grasses. They do not freeze back as easily as smooth brome in the fall and some regrowth can be grazed at this time.

Intermediate Varieties:

1. ‘Oahe’: vigorous and leafy, but coarse stemmed; drought tolerant, winter hardy, good yield capability, rapid sod-forming type; a 1961 South Dakota release, this variety dominates seed availability.
2. ‘Amur’: selected for seedling vigor and resistance to drought; leafy, sod formation is slow, does not have the productive capacity of ‘Oahe’; improved stand longevity; heads not pubescent; a 1952 New Mexico release; limited seed availability.
3. ‘Reliant’: medium height; sustained yields; matures two to three days later than other varieties; a 1991 North Dakota release; not recommended for sites with less than 14 inches of precipitation; moderate tolerance to soil salinity.
4. ‘Slate’: not tolerant of alkaline soils; strongly spreading heads may be slightly pubescent; more adapted to eastern Nebraska.
5. ‘Tegmar’: an Idaho release; late maturing with a shorter than average height; strongly sod-forming.

Pubescent Varieties:

1. ‘Luna’: seed heads mostly pubescent with short stiff hairs; good seedling vigor and fast establisher; high producer, better adapted than intermediate varieties to lower moisture and fertility sites; does not respond to irrigation as well as intermediate varieties; basal leaf blades are hairy; tends to be longer-lived than intermediate varieties, a 1963 New Mexico release; excellent seed availability.
2. ‘Manska’: 15% more digestible than ‘Oahe’ intermediate wheatgrass, with similar or better drought resistance; adapted to coarse and fine-textured soils; a 1992 North Dakota release; limited seed availability.
3. Other Varieties: ‘Topar’, a Pacific Northwest release with a dense sod-forming habit. ‘Mandan 759’, a North Dakota release with good seedling vigor.



Figure 26: Intermediate wheatgrass

Wheatgrass, NewHy

'NewHy' wheatgrass is a cross between quackgrass and bluebunch wheatgrass. 'NewHy' is the variety name and it was released in 1995. It combines the vigor, productivity, salinity tolerance and persistence of quackgrass with drought resistance, low-growing growth habit and forage quality of bluebunch wheatgrass. 'NewHy' has performed well on 20 mmhos/cm saline soils and is a more palatable alternative to tall wheatgrass on these sites. Only certified seed is sold to protect it from being confused with quackgrass seed. As a result, seed cost is more expensive than average. 'NewHy' does not have the overly aggressive rhizome development of quackgrass.

Use for hay. The somewhat upright growth habit makes it harvestable as hay. It responds well to two irrigations per growing season. Fertilize with 50 to 75 pounds per acre of nitrogen per year on irrigated sites. 'NewHy' is compatible with alfalfa.

Use for pasture. 'NewHy' has good palatability, digestibility and protein content.

Wheatgrass, Tall

Tall wheatgrass (*Thinopyrum ponticum*) is a tall, cool-season bunchgrass that originated in Eurasia. Stems grow 2 to 5 feet tall with leaves 8 to 16 inches long. Tall wheatgrass starts growth and matures three weeks later than western wheatgrass. This wheatgrass is adapted to saline and poorly drained sites, and to those where up to seven weeks of spring flooding occurs. It withstands 25% more salts in soils than pubescent wheatgrass but still experiences a 50% decline in yield on soils with an electrical conductivity of 18 to 19 mmhos/cm. For an introduced grass, it is slow to establish.

Use for Hay. Tall wheatgrass makes only fair hay quality because of coarse stems and leaves. Hay yields can be large. Cut before or at early heading when it is higher in crude protein and total digestible nutrients than other wheatgrasses.

Use for Pasture. Tall wheatgrass provides a long grazing period with good summer regrowth. With moisture, some fall regrowth will occur. Seed it in monoculture to allow for optimum management. Keep it grazed down to maintain best palatability, but not below a 6-inch stubble height. Cattle use it well before heading; sheep will graze it in patches. Old coarse growth can prevent livestock from grazing plant regrowth.

Varieties:

1. 'Jose': leafy and medium-tall; earlier maturing; improved palatability; a 1956 New Mexico release; most commonly available variety.
2. 'Alkar': late maturing; good seedling vigor; stemmy; fair palatability; a 1951 release; most adapted to areas west of Colorado; limited seed availability.
3. 'Largo': late maturing; a 1961 release; limited seed availability.
4. 'Platte': winter hardy with short rhizomes; flowers in July; a 1972 release; poor seed availability.

Wheatgrass, Thickspike

Thickspike wheatgrass (*Elymus lanceolatus*) is a mid-height, cool-season, native grass. It is closely related to western wheatgrass, but is more adapted to sandy and silty sites. It is a good sod-former, drought resistant and salt tolerant. It also begins growth and matures three weeks earlier. Graze this palatable grass from spring to early fall. It is moderately tolerant to grazing and tends to become wiry with maturity.

Variety:

1. 'Critana' has excellent seedling vigor and abundant fine leaves; produces less forage than western wheatgrass, but is more salt tolerant; a 1971 release.



Figure 27: Tall wheatgrass

Wheatgrass, Western

Western wheatgrass (*Pascopyrum smithii*) is a cool-season, native sod-former and a major grass on the eastern plains. It grows 1 to 2 feet tall, with leaves 4 to 12 inches long. It is adapted to dryland silty to clayey sites where it is often found with blue grama. Western wheatgrass withstands flooding and silting in lowland sites. It requires two years of growth before hardy top growth is seen. This grass mixes well with native bunchgrasses such as blue grama, green needlegrass, and sideoats grama by filling in bare spaces.

Use for Hay. Western wheatgrass is a common hay grass in drainages of the eastern plains. Hay quality is good. Cut it in the early-bloom stage for best quality.

Use for Pasture. Western wheatgrass is resistant to grazing and provides good forage from spring through summer. It cures well when standing and can be used for winter grazing. Despite stiff leaves, it rarely becomes coarse enough to prevent sheep from grazing. Like all cool-season grasses, it needs to have an opportunity to regrow after being heavily grazed in the spring. Western wheat will be grazed out with annual, close grazing in the spring.

Varieties:

1. 'Arriba- 2. 'Barton- 3. 'Flintlock- 4. 'Rosana

Wildrye, Russian

Russian wildrye (*Psathyrostachys juncea*) is a cool-season, dryland bunchgrass that originated in central Asia. Stems grow 1 to 3 feet high with many basal leaves 6 to 18 inches long. It has high digestibility and an exceptionally long season of use. Russian wildrye is very drought tolerant and is adapted to 12 inches or more of annual precipitation. It is difficult to establish and will winter kill on sandier soils. This grass begins growth two weeks later than crested wheatgrass, but has better fall regrowth and summer availability, if soil moisture is available.

Russian wildrye is salt tolerant on soils up to an electrical conductivity of 18 mmhos/cm.

This wildrye performs better when seeded in 16- to 21-inch rows. Interseeded legumes work well, but such a mixed pasture must be managed well due to the high palatability of the legume.

Use of Hay. Russian wildrye is poor as a hay species because its basal leaves are largely unharvestable.

Use of Pasture. Russian wildrye is an excellent dryland pasture grass that is palatable to all livestock. It tolerates close grazing better than most grasses and regrows quickly. A good strategy is to graze lightly in the spring, saving regrowth for late summer and fall when other grasses are not available.

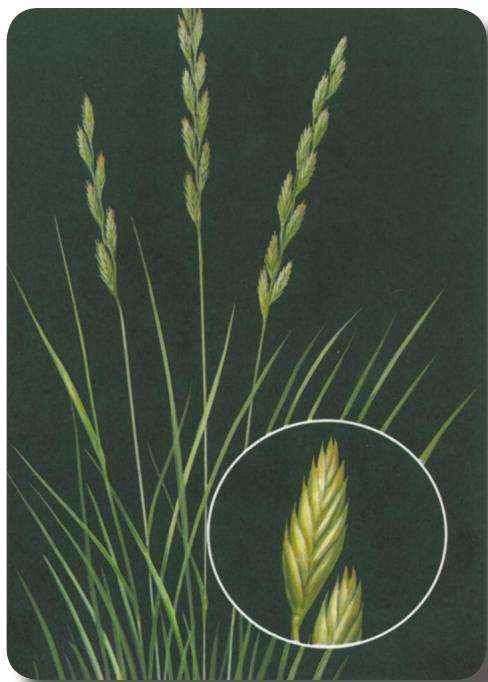


Figure 28: Western wheatgrass



Figure 29: Russian wildrye

Varieties:

1. 'Bozoisky-Select': significantly more productive and establishes more vigorously than 'Vinall'; establishes from a deeper seeding depth than 'Vinall' and 'Swift'; a 1985 release.
2. 'Mankota': Greater yield than 'Vinal'; seed emerges from a 2 ½-inch planting depth; a 1992 North Dakota release; limited seed availability.
3. 'Vinal': Poor seedling vigor; a 1960 release.
4. 'Swift': More adapted to the cooler northern Great Plains; a 1978 release.

LEGUME SPECIES AND VARIETIES

Alfalfa

Alfalfa (*Medicago sativa* or crosses with *M. falcata*) is the well known "Queen of Forages." Plants have trifoliate (three branched) leaves and purple colored pea-shaped flowers. The flowers grow in tight bunches called racemes; some are yellow or white in color. Plant crowns produce many stems that can grow 3 feet tall with good moisture. Taproots can be 10 to 30 feet in length.

Alfalfa is adapted to a wide range of soils that must be well drained. It tolerates some soil alkalinity and salinity. Dryland and irrigated varieties exist as well as varieties for grazing (with creeping growth forms). Dryland varieties have not been improved for some time. It is a common addition with warm- and cool-season grasses. On sandy sites, coated seed can establish better.

Use for Hay. Approximately 6 inches of water are needed to produce one ton of cured alfalfa hay. Cut plants at the 1/10th bloom stage (every 30 to 35 days) to foster stand longevities of six to eight years. Weeds must be controlled to also extend stand life. Three to four cuttings can be expected on irrigated land and one on dryland. The average irrigated hay yield in the area is 5 tons per acre. Alfalfa weevil can be a seriously destructive insect pest in May. Read CSU Extension fact sheet no. 5.500, *Alfalfa Weevil*, for more information on this insect.

Use for Pasture. Alfalfa is highly desired by all livestock. Do not graze closer than 4 to 6 inches to the ground. It will not persist with moderate to heavy grazing unless at least 30-day rest periods occur. Can cause bloat in cattle and sheep, which results from gases trapped in the main stomach. If left untreated, it will cause death. Refer to the "Legume" section of this publication for information on managing bloat.



Figure 30: Alfalfa

Varieties:

A. Dryland: Upright and semi-upright varieties are generally used for hay.

- 'Vernal' does well on higher pH soils; fine stemmed and leafy; recovers moderately well after cutting; good establisher with grass competition; winter hardy.
- 'Ladak' is yellow flowered and semi-prostrate; has ability to produce heavy first cutting, but slow recovery; adapted to wetter sites; winter hardy.
- 'Ranger' has higher yield potential than 'Vernal' and 'Ladak'; tends to have bigger stems; susceptible to stem nematode; adequate winter hardiness.

B. Dryland: Spreading type varieties are used in pastures.

- 'Spredor 4' is a Northrup King release; resistant to root rot; winter hardy; fair to good drought resistance.
- 'Rhizoma' is mostly yellow flowered; good yield potential; winter hardy; seed availability can be erratic.
- 'Roamer' and 'Rambler' are slow to recover from grazing; persist well with grasses; mostly spring producers; winter hardy; seed availability can be erratic.
- 'Travois' has rapid recovery from grazing; winter hardy; seed can be hard to find.

C. Irrigated: Irrigated alfalfa varieties are being improved constantly. Hay and grazing varieties exist. Blends of two or three varieties are available that are good producers of high quality hay. Contact your local extension agent or seed dealer for current recommendations.

Clover, Red

Red clover (*Trifolium pratense*) is a short-lived (two to four years) legume that self-reseeds easily. Three to ten hollow, hairy stems grow from a thick crown to a length of two feet. Each leaf is divided into three leaflets (clover type), each with a halo or light colored spot in the middle. Flowers are rose-purple in color. Red clover is adapted to medium to fine-textured soils. It has a high production capacity. Most roots are in the top 12 inches of soil and require irrigation and moderate temperatures to survive.

Compared to alfalfa, red clover is more tolerant of acid and poorly drained soils, less tolerant of soil salinity, and similar in bloat hazard. Horses that consume clovers can come down with the "slobbers" as a result of a fungus found on the plants. Seed availability usually is low since red clover has not been planted much in Colorado.

Use for Hay. Red clover combines well with irrigated grasses to make quality hay. Cut at the early-bloom stage for best yield and quality. High yields and stem moisture from red clover dominated stands can make cut plants hard to cure. Its tendency towards poor color preservation can result in hay that looks to have poorer quality than it really has. Compared with alfalfa, red clover hay has about two-thirds as much protein, and slightly more digestible nutrients and net energy. Delay the first cutting until 80 days after emergence (late-flower stage).

Use for Pasture. Red clover is suited for livestock grazing. Manage similar to alfalfa to reduce bloat hazard. To encourage rapid regrowth, avoid heavy defoliation, especially of early growth.

Varieties:

1. Single-cut: also known as late flowering or mammoth red clover; most common to high altitude meadows above 6,500 feet; produces a heavy flush of shoots; regrows well enough after its one cutting to provide good fall pasture.
2. Double-cut: also known as early flowering or medium red clover; it provides two cuttings per year and tends to be shorter-lived; reseeds well; adapted more to lower elevations than single-cut; better regrowth after cutting.

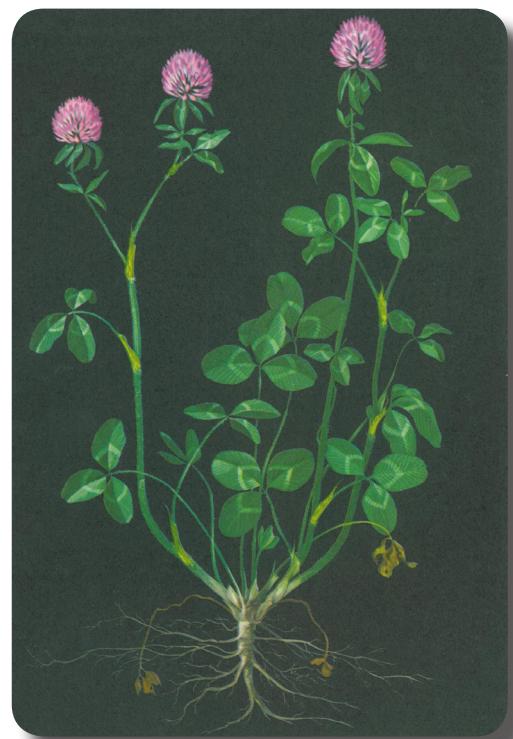


Figure 31: Red clover

Clover, White

White clover (*Trifolium repens*) is a true clover with three leaflets per stem. It originated in the eastern Mediterranean or in Asia Minor and is white-flowered. White clover is rather shallow rooted and spreads via stolons (above ground horizontal shoots). It needs moisture to persist and prefers well-drained soils. Leaves usually have V-shaped white marks in the middle. White clover is not tolerant of saline or alkaline soils (a pH of 5 to 7 is best), but is tolerant of summer heat. Inoculate white clover seed with appropriate rhizobia before planting for best growth.

Mix white clover with irrigated grasses for best pasture use. Seed four to six weeks before the dry, hot season arrives. More than 50% white clover in a pasture can cause bloat in cattle and sheep. Frequent grazing of cool-season grasses in the spring favors clover growth and maintenance in mixed stands. White clover contains estrogens that may induce female animal reproductive problems.

Ladino: This “giant” form of white clover grows 8 to 12 inches tall, which is two to four times taller than the intermediate type. It is the most commonly sold white clover for forage. Ladino makes good hay that is low in stems and high in protein and digestibility. Ladino is not tolerant of close grazing. Leave 3 inches of stubble with grass and allow regrowth to an 8 inch height. Seed at one pound per acre with grass to keep bloat hazard low. Ladino will winter kill somewhat in dry soils and it requires high soil phosphorus.

Intermediate: This type also is known as common or White Dutch. Its height can vary between tall and small. Commonly tends to persist only two to three years. ‘Grassland Huia’ is an improved intermediate variety from New Zealand with limited seed availability.

Small Type: This type also is known as a low-growing or wild type and is commonly found in lawns. The small type is well suited to pastures although it will be shaded out by tall grasses. It regrows rapidly but is too short for hay fields. Because it is low-growing, it is not a heavy producer but it persists well under heavy and continuous grazing. The small type grows fairly early in the spring while summer growth tends to be fair. ‘Kent Wild’ is an improved variety from New Zealand with limited seed availability.

Milkvetch, Cicer

Cicer milkvetch (*Astragalus cicer*) is a native of Europe that is very long-lived perennial with vigorous, creeping rhizomes. Leaves are divided into over 21 small (1 to 2 inch), sparsely-hairy leaflets that are located opposite each other along stems. Stems are less than 3 feet long; flowers are pale yellow to white. Seed pods are initially green to red-green and become black and leathery as the seeds mature. Stems are upright when young, 4 to 10 feet in height, and bend over with increasing height.

Cicer milkvetch adapts to well-drained soil textures and subirrigated conditions with water 3 to 6 feet below the soil surface. It has some drought tolerance and is adapted to dryland areas receiving 16 inches or more of precipitation. Cicer responds well to irrigation and has good winter hardiness. It is tolerant of soil alkalinity (to a pH of 9.8) and moderately tolerant to acidity and salinity. Disease and insect problems are uncommon.

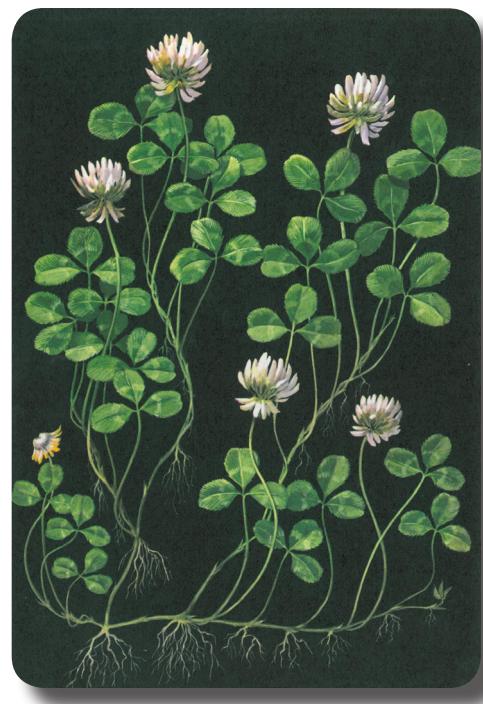


Figure 32: White clover

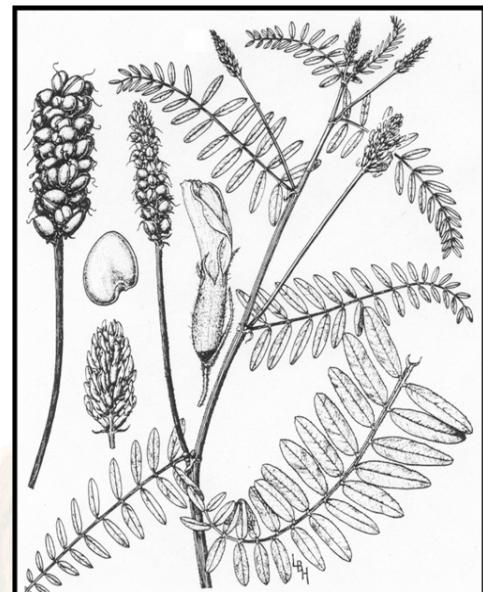


Figure 33: Cicer milkvetch

A limitation of this legume is that seedlings are weak and require two to three years to establish. With time, however, it can be so aggressive as to comprise 80% of a pasture. Plant seeds in alternate rows with a cool-season grass to decrease competition from grasses. Seed must be scarified adequately to ensure germination; inoculate with proper bacteria (rhizobia) before seeding.

Compared with alfalfa, cicer begins spring growth and matures two weeks later and is more tolerant of late spring and early fall frosts. It has good summer regrowth potential and mixes well with smooth brome, orchardgrass, and tall fescue.

Use for Hay. Cicer milkvetch is well suited for hay, but expect a maximum of two crops. At harvest, cicer's moisture content is 4 to 8% greater than alfalfa and sainfoin. Windrows in fields with alternate rows of grass and cicer dry faster. Crimping also helps speed dry-down time. Leaf losses during baling are low and plants have a 40% higher leaf-to-stem ratio than alfalfa. Despite the high nutritive value of cicer, it is not as palatable to livestock when compared to other legumes.

Use for Pasture. Cicer is tolerant of grazing and does not cause bloat in grazing animals. However, it is not eaten readily by livestock and heavy grazing pressure is needed to ensure grazing use. It is reported to have caused some photosensitization problems in sheep. Cicer recovers well from grazing as new growth is stimulated in buds of rhizomes. Graze plants carefully towards the end of the establishment year and during the second year. Graze 8- to 12-inch regrowth down to a 4-inch stubble height.

Varieties:

- 'Windsor', 'Monarch', 'Lutana'.

Sainfoin

Sainfoin (*Onobrychis viciaefolia*) originated in Europe and Asia and is a deep-rooted legume with 20 to 50 pink flowers per head. Blossoms appear one to two weeks before those of alfalfa. Leaves are divided into 11 to 27 small leaflets that are located opposite each other on stems. This is a very robust legume that can grow 3 feet tall. Stems are semi-erect, hollow, coarse, and succulent. It has a tendency to bolt quickly (sends up a tall stalk with a few leaves).

Sainfoin adapts well to all soil textures and high pH sites (up to a pH of 8). It is heat, drought, and cold resistant. It is not adapted to saline or acidic soils (less than a pH of 6). It also does not thrive in wet areas, frequently irrigated areas, or areas with high water tables. This legume is often difficult to establish. Consistently effective nitrogen fixing bacteria (rhizobia) have not been found, which may require nitrogen fertilization of established plants. Expect stand lives of three years. Sainfoin begins growth two weeks earlier than alfalfa, but summer regrowth is lower. It is compatible with bunchgrasses, less so with sod-formers.

Use for Hay. Sainfoin is well suited to hay harvesting as it grows upright and is cut easily. Since regrowth is poor, cut at about the half to full bloom stage. Sainfoin cures well even though cut plants have slightly greater water content than alfalfa. First cutting yield is usually greater than for alfalfa. Alfalfa yields better from second and third cutting. Sainfoin protein is slightly less than alfalfa. Seed in alternate rows with grass for best stand establishment and longevity.

Use for Pasture. Sainfoin works well in pastures and is grazed in preference to alfalfa. It does not cause bloat. Grazing in the bud or early bloom stage and keeping the grazing height above 8 inches (or 30% of the plant left as stubble) will extend stand life. Sainfoin grows ahead of alfalfa in the spring (in March) to provide early, high protein grazing.



Figure 34: Sainfoin

Varieties:

1. 'Eski- 2. 'Remont- 3. 'Renumex- 4. 'Shoshone- 5. 'Delaney

Trefoil, Birdsfoot

Birdsfoot trefoil (*Lotus corniculatus*) is native to Europe and parts of Asia. It is a long-lived perennial with a deep taproot and many lateral roots. It is leafy with fine stems that are prostrate to erect and 1 to 2 feet in length. Flowers are bright yellow with orange to red-tinged areas. Trefoil performs much better than alfalfa on poorly-drained, clay soils. It is winter hardy and is a good performer on low fertility and alkaline soils having a pH less than 8. Established stands naturally reseed themselves well, even if closely grazed.

However, developing seedlings require two years to become established and should be used lightly during this time, as well as protected from weedy growth. Seeds are very small and sensitive to seeding depth (1/4 to 1/2 inch). The minimum annual moisture requirement for pastures with established trefoil is 12 to 13 inches.

Birdsfoot trefoil grows best as a monoculture because it is shade sensitive. It can perform reasonably well with non-aggressive grasses such as orchardgrass or meadow brome. Seed in alternate rows with grasses for best stand establishment and longevity.

Use for Hay. Erect variety types of trefoil are suited to hay harvesting and generally yield about two-thirds as much as alfalfa. Semi-erect types are easily hayed when grown with grasses. Hay quality is similar to that of alfalfa when cut at the early-bloom stage. Because regrowth is initiated from auxiliary buds on stems, a taller stubble needs to be left at cutting. Cut for hay before tall and rank growth lodges.

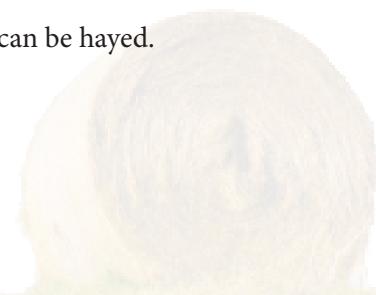
Use for Pasture. Birdsfoot trefoil is highly palatable and does not cause bloat in livestock. It withstands grazing better than most other legumes, but because regrowth must come from auxiliary buds on stems, pastures must be managed for taller stubble heights and adequate regrowth time. Trefoil has the advantage of being a good producer throughout the grazing season. Allow four to six weeks between grazing to obtain regrowth of 6 to 10 inches.

Varieties:

1. **Lower Growing/Semi-Erect Types:** tolerate close grazing better than erect types. 'Norcen', 'Leo' and 'Empire' are typical varieties.
2. **Erect Type:** 'Viking'. 'Empire' is a semi-erect variety that can be hayed.



Figure 35: Birdsfoot trefoil



Appendix A: Species Suggestions for Various Sites

Site and Species	Growth Habit*	Season of Growth	Origin**
<i>Clay and Loam Soils</i>			
Crested wheatgrass	B	Cool	I
Russian wildrye	B	Cool	I
Green needlegrass	B	Cool	N
Western wheatgrass	S	Cool	N
Int/Pub wheatgrass	S	Cool	I
Sideoats grama	B	Warm	N
Little bluestem	B	Warm	N
Big bluestem	S	Warm	N
Switchgrass	S	Warm	N
Blue grama	S	Warm	N
Yellow Indiangrass	S	Warm	N
Alfalfa			
<i>Sandy Soils</i>			
Thickspike wheatgrass	S	Cool	N
Prairie sandreed	S	Warm	N
Switchgrass	S	Warm	N
Big bluestern	S	Warm	N
Sideoats grama	B	Warm	N
Yellow Indiangrass	S	Warm	N
Sand bluestem	S	Warm	N
Little bluestem	B	Warm	N
Alfalfa			
<i>Saline Soils</i>			
Tall wheatgrass	B	Cool	I
Int/Pub wheatgrass	S	Cool	I
Alkali sacaton	B	Warm	N
Russian wildrye	B	Cool	I
Western wheatgrass	S	Cool	N
Sideoats grama	B	Warm	N
Green needlegrass	B	Cool	N
Switchgrass	S	Warm	N
'NewHy' wheatgrass	S	Cool	I
<i>Gravelly Foothills</i>			
Big bluestem	S	Warm	N
Little bluestem	B	Warm	N
Crested wheatgrass	B	Cool	I
Sideoats grama	B	Warm	N
Thickspike wheatgrass	S	Cool	N
Western wheatgrass	S	Cool	N
Prairie sandreed	S	Warm	N
Alfalfa			

*S = sod-former, B = bunchgrass, **N = native, I = introduced

Site and Species	Growth Habit*	Season of Growth	Origin**
<i>Subirrigated</i>			
Smooth brome	S	Cool	I
Western wheatgrass	S	Cool	N
Int/Pub wheatgrass	S	Cool	I
Tall wheatgrass	B	Cool	I
Switchgrass	S	Warm	N
Big bluestem	S	Warm	N
Yellow Indiangrass	S	Warm	N
Alfalfa			
Birdsfoot trefoil			
<i>Irrigated - Adequate Water</i>			
Orchardgrass	B	Cool	I
Meadow brome	B	Cool	I
Kentucky bluegrass	S	Cool	I
Tall fescue	B	Cool	I
Alfalfa			
Clovers			
Cicer milkvetch			
<i>Irrigated - Short Water</i>			
Smooth brome	S	Cool	I
Intermediate wheatgrass	S	Cool	I
Big bluestem	S	Warm	N
Int/Pub wheatgrass	S	Cool	I
Yellow Indiangrass	S	Warm	N
Switchgrass	S	Warm	N
Alfalfa			
Cicer milkvetch			
Sainfoin			
<i>Low Maintenance Areas (short grass; not grazed)</i>			
Blue grama	S	Warm	N
Buffalograss	S	Warm	N
'Ephraim' crested wheat*	S	Cool	I

*S = sod-former, B = bunchgrass, **N = native, I = introduced

Appendix B: Characteristics of Grasses

Plant Species	Growth Habit	Growth Season	Origin	Moisture Minimum	Soil Adaption	Seedling Vigor	Yield Potential	Longevity	Drought Tolerance	Grazing Tolerance	Recovery Rate	Salt Tolerance
Bluegrass	sod	cool	Europe	irrigated	si,c	fair	low	exc.	fair	good	good	fair
Bluestem Big Little Sand	sod bunch sod	warm warm warm	native native native	14" 14" 14"	s,c s,si,c s	fair fair fair	high high high	exc. exc. exc.	fair fair fair	fair fair fair	fair f/g good	f/p f/p poor
Brome Meadow Smooth	bunch sod	cool cool	Eurasia Europe	irrigated 16"	s,si,c s,si,c	exc. good	medium medium	good f/g.	fair fair	good fair	good f/p	poor fair
Fescue, tall	bunch	cool	Europe	irrigated	s,si,c	good	high	good	fair	good	good	good
Grama Blue Sideoats	sod bunch	warm warm	native native	10" 12"	s,si,c si,c	fair fair	low medium	exc. good	exc. good	good fair	good f/g	fair f/g
Indiangrass Yellow	sod	warm	native	14"-18"	s,si,c	fair	medium	good	fair	f/g	fair	fair
Needlegrass Green	bunch	cool	native	12"	si,c	fair	medium	good	fair	fair	fair	f/g
Orchardgrass	bunch	cool	Eurasia	irrigated	s,si,c	good	medium	fair	fair	fair	exc.	fair
Sacaton Alkali	bunch	warm	native	12"	si,c	poor	medium	good	poor	f/g	f/g	exc.
Sandreed Prairie	sod	warm	native	10" -16"	sand	f/p	high	good	fair	fair	good	poor
Switchgrass	sod	warm	native	14"-16"	s,si,c	g/m	good	exc.	fair	fair	good	fair
Wheatgrass Crested Int/pub NewHy Tall Thickspike Western	bunch sod sod bunch sod sod	cool cool cool cool native cool	Asia Eurasia mixed Eurasia 12" native	8"-12" 12"-15" 13" 15" 12" 14"	s,si,c s,si,c si,c s,si,c s,si s,si,c	exc. good f/g f/p fair fair	medium high medium high medium medium	good fair exc. good g/f good	exc. f/g f/g fair exc. exc.	good f/g good f/g good good	exc. good good fair exc. good	fair good exc. exc. fair fair
Wildrye Russian	bunch	cool	N. Asia	8"	s,si,c	f/p	medium	exc.	exc.	good	exc.	good

s = sand, si = silt, c = clay, f = fair, g = good, p = poor, exc. = excellent

Appendix C: Characteristics of Legumes

Plant Species	Moisture Requirement	Seedling Vigor	Yield Potential	Stand Longevity	Recovery Rate	Drought Tolerance	Poor Drainage Tolerance	Causes Bloat	Salt Tolerance
Alfalfa	a	good	high	good	a	a	a	yes	fair
Clover Red White	high high	exc. exc.	high a	p/f good	fair good	poor poor	good fair	yes yes	poor poor
Milkvetch Cicer	low	poor	high	exc.	fair	fair	fair	no	fair
Sainfoin	l/m	good	medium	good	f/p	fair	poor	no	poor
Trefoil Birdsfoot	low	poor	medium	fair	f/p	fair	good	no	f/p

a = depends on variety, b = poor if shaded, f = fair, g = good, p = poor, exc. = excellent, l = low, m = medium

Appendix D: Seeding Rates for Selected Pasture Plants

PLANT	ESTIMATED ¹ PLS%	PLS/ACRE ² DRYLAND	PLS/ACRE ² IRRIGATED
GRASSES			
Bluegrass			
Kentucky	76	NR	1.0
Bluestem			
Big	56	5.5(4) ³	11(8) ³
Little	50	3.5(2) ³	NR
Sand	65	8.0(6) ³	NR
Brome			
Meadow	85	NR	17(7) ³
Smooth	85	6.5(4) ³	10(6) ³
Fescue, tall	85	NR	8(6) ³
Grama			
Blue	32	1.5	NR
Sideoats	64	4.5(2) ³	NR
Indiangrass			
Yellow	64	5.0(3) ³	NR
Needlegrass, green	76	5.0(3) ³	NR
NewHy	75	10.0(7) ³	15(7) ³
Orchardgrass	85	NR	12-14(10) ³
Sacaton, alkali	81	1.0	1.5
Sandreed, prarie	32	3.5(2) ³	NR
Switchgrass	88	3.0(2) ³	5.0(3) ³
Wheatgrass			
Ephraim	85	5.0(4) ³	NR
Fairway	77	3.0(2) ³	NR
Hycrest	80	8.0(6) ³	15(8) ³
Int/pub	90	10.0(7) ³	15(8) ³
Nordan	77	5.0(4) ³	NR
Tall	86	11.0(8) ³	17(10) ³
Thickspike	77	5.5(4) ³	NR
Western	77	8.0(6) ³	NR
Wildrye, Russian	77	6.0(6) ³	NRS
LEGUMES			
Alfalfa	89	8(2) ⁴	10 to 15
Clover			
Red	85	NR	6(5) ⁴
White	85	NR	4(2) ⁴
Milkvetch, Cicer	85	NR(2) ⁴	NR(2) ⁴
Sainfoin	84	25(2) ⁴	35(2) ⁴
Trefoil, Birdfoot	79	NR	4(2) ⁴

¹These are Pure Live Seed (PLS) percentages which can be associated with the forages. The percentages will vary with each seed lot. When buying seed, figure exact PLS by multiplying the percentage germination by the percent purity numbers on the seed bag tag.

²Figure the pounds of bulk seed to buy and plant by dividing the PLS pounds per acre by the PLS. Example: 5.5 pounds PLS for big bluestem, divided by 56% PLS (0.56), results in 9.8 pounds of bulk seed needed to be purchased and planted per acre.

NR – not recommended.

NRS = not recommended as solo planting.

³ Use the seeding rate in parentheses when planting with a legume.