

Dryland Pastures in Montana and Wyoming

*Species and Cultivars,
Seeding Techniques and
Grazing Management*

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Dryland Pastures in Montana and Wyoming

Species and Cultivars, Seeding Techniques and Grazing Management

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Dryland Pastures in Montana and Wyoming

Species and Cultivars, Seeding Techniques and Grazing Management

Profitable ranching depends upon the management of land, livestock, financial and human resources. To be economically and ecologically successful, ranchers must adapt to their environment and develop a well-balanced, year-round forage plan that satisfies livestock nutrient requirements and at the same time sustains forage resources. Forage resources include hayland, rangeland, crop aftermath and seeded pastures.

Seeded pastures can supply nutritious forage at times during the year when other sources are inadequate or unavailable. This requires integrating seeded pastures into the total ranch operation. To ensure a satisfactory return for each dollar invested, seeded species must be adapted to the site's soil, hydrology and climate, fit a rancher's needs and be properly established and managed.

Local experience, observations and research should be considered when planting and managing dryland pastures. A four-step process maximizes the effectiveness of dryland pasture seedings:

- 1) determine seeding objectives,
- 2) select the appropriate species and cultivar(s) for the site and the objectives,
- 3) use proper site preparation and seeding techniques, and
- 4) implement careful grazing management.

Seeding Objectives

When is forage needed from dryland pasture? How much forage is needed? One way to answer these questions is to review the current management system. Begin by calculating the monthly demand for forage/feed and then compare it with the monthly supply. The monthly demand for forage and feed should account for all grazing animals, including the brood herd, sires, replacements, offspring, horses and wildlife. The supply should include native rangeland, existing seeded pasture, crop aftermath, hay and grain produced for feed. Forage demand/supply relationships should be evaluated in both short- and long-term plans, allowing for emergency periods such as drought. This process for evaluating forage supply and demand is explained thoroughly in MSU Extension Bulletin EB 101, *A Guide for Planning, Analyzing and Balancing Forage Supplies with Livestock Demand*.

Evaluate a proposed dryland pasture seeding by asking the following questions:

Forage Needs

- Is my yearlong forage supply adequate?
- If not, can dryland pasture provide the additional forage?
- Is a seeding necessary or can I obtain additional forage in other ways (e.g., purchase, lease or improved management of existing resources)?
- Do I have special needs such as a breeding or calving pasture?
- Would the addition of dryland pasture provide opportunities to increase stocking rates or improve grazing management of native rangeland?
- How many acres of seeded dryland pasture are needed to satisfy forage demand or to achieve other management objectives?
- What is the expected longevity of the stand?

Site Selection

- Does the site's topography and soil depth allow it to be cultivated and planted with a drill? Is it too rough or steep? Is it subject to erosion by wind or water?
- Is the site accessible to livestock when forage is needed to meet forage demand?
- Are soils and precipitation adequate to produce the kind or amount of forage needed to meet forage demand?
- Are there sites with deep soils and ephemeral run-in or ground water to enhance forage yield and reliability?
- Are there invasive or noxious plants present?

Profitability

1. Anticipated benefits

- Will the seeding increase livestock production?
- Will the seeding reduce the need for hay and supplements?
- Will native plant communities, watershed functions, wildlife habitats or other resources benefit?
- Will the seeding reduce reliance on forage from leased pasture or rangeland?

2. Anticipated costs

- What are the costs of establishment (i.e., seedbed preparation, seed and planting)?
- What is the cost of grazing deferment to allow stand establishment?
- What are the construction and maintenance costs of additional water facilities and fences that may be needed?
- What is the cost of implementing a higher management level to optimize production and to lengthen the stand life?
- Will watershed, wildlife or other resources be adversely affected?

3. Cost/benefit analysis

- Re-examine the seeding objectives if expected costs exceed expected benefits within a selected time frame.
- Continue the planning process if expected benefits exceed costs.
- Consider benefit duration (longevity of seeding).

Selection of Species and Cultivars

Species differ in their requirements for moisture, nutrients, soils and light. Likewise, species vary in seed germination, establishment and persistence. Species are rated for these attributes in Tables 1-4. Evaluate the following factors to tailor adapted species to site conditions:

Soil

texture
depth
organic matter
stoniness
slope
salinity
pH
alkalinity
erosiveness

Moisture

mean annual precipitation
depth to water table
season of precipitation

Indigenous vegetation

Geophysiography

topography
elevation

Intended use

season of growth
pasture
hay
animal nutritional needs

Management intensity

Establishment ease

Stand longevity

Mixture compatibility

Season of Use

One criterion for selecting species is their ability to supply forage when it is needed (Tables 1-4). Perennials have different periods of plant growth and different nutritional value and palatability during their growing season and dormant periods. Most cool-season native and introduced grasses can provide forage in spring, summer, fall or winter, depending on their management. Introduced grasses generally are ready for grazing two to three weeks earlier than most native species. Grazing of native rangeland can be deferred when introduced grasses are available for early spring grazing and livestock can be removed from native

Table 1. Native cool-season grasses for dryland pastures in Montana and Wyoming.

Species	Mini- mum Precip. (in.)	Height/ Growth Type	Ease of Estab- lishment	Seeding Rate PLS* lb/ac	Seeds/sq. ft at 1 lb/ac	Soil Texture	Weed Sup- pres- sion	Acid/Salinity Tolerance	Season of Use			
									Spring	Summer	Fall	Winter
Sandberg bluegrass	6	v. short/ bunch	difficult	2	22	lt., med.	poor	good/fair	x			
Indian ricegrass	6	short/ bunch	moderate	6	3.5	lt., med., hvy.	poor	fair/good		x		
Streambank wheatgrass	6	med./ rhiz.	moderate	5	4	med., heavy	v. good	good/v. good	x	x	x	
Thickspike wheatgrass	7	tall/rhiz.	easy	6	3.5	lt., med.	excellent	good/v. good	x	x	x	
Bluebunch wheatgrass	8	med./ bunch	moderate	6	3.5	lt., med.	fair	good/good	x	x		
Big bluegrass	9	short/ bunch	easy	2	21	lt., med., hvy.	good	excel./fair	x			
Beardless wheatgrass	9	med./ bunch	moderate	6	3	lt., med., hvy.	fair	good/good	x	x		
Canby bluegrass	10	v. short/ bunch	difficult	2	21	lt., med.	fair	good/fair	x			
Slender wheatgrass	10	tall/bunch	easy	6	3	med., heavy	excellent	fair/excel.	x	x		
Basin wildrye	10	v. tall/ bunch	difficult	6	4	med., heavy	fair	good/good	x			x
Western wheatgrass	12	med./ rhiz.	moderate	8	2.1	med., heavy	excellent	fair/v. good		x	x	
Green needlegrass	13	tall/bunch	difficult	5	4	med., heavy	fair	poor/good		x	x	x
Idaho fescue	14	short/ bunch	difficult	3	9	lt., med., hvy.	fair	fair/fair	x	x	x	
Canada wildrye	14	med./ bunch	moderate	7	3	lt., med.	excellent	good/good	x	x		
Mountain bromegrass	15	med./ bunch	easy	10	2	lt., med., hvy.	good	fair/fair	x	x		
Blue wildrye	18	tall/bunch	easy	7	3	lt., med.	v. good	v. good/fair		x		

*PLS = pure live seed drilled rate. Abbreviations used above: v. = very; lt. = light; med. = medium; hvy. = heavy; rhiz. = rhizomatous; excel. = excellent

Table 2. Native warm-season grasses for dryland pastures in Montana and Wyoming.

Species	Minimum Precip. (in.)	Height/ Growth Type	Ease of Establishment	Seeding Rate PLS* lb/ac	Seeds/sq. ft at 1 lb/ac	Soil Texture	Weed Suppression	Acid/Salinity Tolerance	Season of Use				
									Spring	Summer	Fall	Winter	
Blue grama	5	short/ bunch	moderate	2	19	med., hvy.	excellent	poor/fair		x			
Galleta	9	v. short/ rhiz.	difficult	4	4	lt., med., hvy.	good	poor/fair		x			
Little bluestem	12	med./ bunch	difficult	4	6	lt., med.	poor	excel./good		x			
Sideoats grama	12	med./ bunch	moderate	5	4	lt., med.	fair	poor/good		x			
Sand bluestem	12	tall/rhiz.	difficult	7	3	lt., med.	fair	fair/poor		x		x	
Prairie sandreed	12	tall/rhiz.	moderate	4	6	lt., med.	good	fair/fair		x		x	
Switchgrass	13	tall/rhiz.	moderate	3	7	med., heavy	good	good/fair		x			
Big bluestem	15	tall/ bunch	difficult	6	3	med., heavy	fair	good/good		x		x	x
Indiangrass	15	tall/rhiz.	difficult	5	4	lt., med.	fair	good/poor		x		x	

*PLS = pure live seed drilled rate. Abbreviations used above: v. = very; lt. = light; med. = medium; hvy. = heavy; rhiz. = rhizomatous; excel. = excellent

Table 3. Introduced grasses for dryland pastures in Montana and Wyoming.

Species	Minimum Precip. (in.)	Height/ Growth Type	Ease of Estab- lishment	Seeding Rate PLS* lb/ac	Seeds/sq. ft at 1 lb/ac	Soil Texture	Weed Sup- pres- sion	Acid/ Salinity Tolerance	Season of Use			
									Spring	Summer	Fall	Winter
Siberian wheatgrass	7	short/bunch	easy	5	4	lt., med.	good	good/good	x			
Mammoth wildrye	7	v. tall/rhiz.	difficult	15	1	lt., med.	fair	fair/fair	x	x	x	x
Crested wheatgrass	9	med./bunch	easy	5	4	med., heavy	good	good/good	x		x	
Russian wildrye	9	tall/bunch	difficult	5	4	med., heavy	excellent	fair/v. good	x	x	x	x
Sheep fescue	10	short/bunch	moderate	2	16	med., heavy	good	good/fair		x		
Tall wheatgrass	12	v. tall/bunch	easy	10	2	med., heavy	excellent	fair/excel.	x	x	x	
Pubescent wheatgrass	13	tall/rhiz.	easy	10	2	lt., med., hvy.	excellent	fair/v. good	x	x	x	
Intermediate wheatgrass	14	tall/rhiz.	easy	10	2	med., heavy	excellent	fair/v. good	x	x	x	
Hard fescue	14	short/bunch	moderate	2	13	med., heavy	v. good	good/fair		x		
Altai wildrye	14	tall/rhiz.	difficult	12	2	med., heavy	v. good	good/v. good	x	x	x	x
'NewHy' hybrid wheatgrass	14	tall/weak rhiz.	easy	8	3	lt., med., hvy.	excellent	good/excel.	x	x	x	
Kentucky bluegrass	15	short/rhiz.	easy	2	48	med., heavy	excellent	excel./poor	x	x		
Smooth bromegrass	15	tall/rhiz.	easy	5	3	med., heavy	excellent	good/fair	x	x		
Beardless wildrye	15	tall/rhiz.	difficult	6	4	med., heavy	v. good	fair/excel.	x	x		
Tall fescue	15	tall/bunch	easy	4	5	med., heavy	v. good	good/good	x	x	x	
Meadow bromegrass	16	tall/weak rhiz.	easy	10	2	med., heavy	good	good/fair	x	x	x	
Orchardgrass	16	tall/bunch	easy	3	15	lt., med., hvy.	good	fair/fair	x	x	x	
Timothy	16	tall/bunch	easy	2	28	lt., med.	fair	good/fair	x	x	x	

*PLS = pure live seed drilled rate. Abbreviations used above: v. = very; lt. = light; med. = medium; hvy. = heavy; rhiz. = rhizomatous; excel. = excellent

Table 4. Forbs and shrubs for dryland pastures in Montana and Wyoming (Note: These species usually planted as a mixture component rather than a pure stand).

Species	Minimum Precip. (inches)	Growth Type	Plant Type	Ease of Establishment	Seeding rate ¹ PLS* lb/ac	Seeds/sq. ft at 1 lb/ac	Soil Texture	Weed Suppression	Acid/Salinity Tolerance	Season of Use			
										Spring	Summer	Fall	Winter
Yellow sweetclover	9	multistem crown	forb, legume	v. easy	4	6	lt., med., hvy.	fair	good/good	x	x		
White sweetclover	9	multistem crown	forb, legume	v. easy	4	6	lt., med., hvy.	fair	good/good	x	x		
Winterfat ²	9	multistem crown	shrub	difficult	8	3	lt., med., hvy.	poor	poor/excel.	x	x	x	x
Fourwinged saltbush ²	9	multistem crown	shrub	moderate	5**	1	med., hvy.	poor	poor/good			x	x
Alfalfa	10	multistem crown	forb, legume	easy	5	5	med., hvy.	good	fair/fair	x	x	x	
White & purple prairieclover ²	12	multistem crown	forb, legume	moderate	3	6	lt., med.	poor	fair/fair		x		
Sainfoin	12	multistem crown	forb, legume	easy	34	.5	lt., med.	fair	fair/fair	x	x		
Lewis flax ²	12	multistem crown	forb	easy	3	6	lt., med.	fair	fair/fair	x			x
Maximilian sunflower ²	13	multistem crown	forb	moderate	3	5	lt., med.	poor	poor/good			x	x
White clover	14	stoloniferous	forb, legume	easy	4	6	med., heavy	good	v. good/fair	x	x		
Red clover	14	multistem crown	forb, legume	easy	4	6	med., heavy	good	good/poor	x	x		
Small burnet	14	multistem crown	forb	easy	20	1	lt., med.	fair	fair/fair	x	x	x	x
Birdsfoot trefoil	15	decumbent	forb, legume	moderate	3	10	lt., med.	fair-good	good/fair		x	x	
Cicer milkvetch	15	rhizomatous	forb, legume	moderate	7	3	med., heavy	good	fair/good		x	x	

¹Seeding rate for pure stands. ²These species only recommended for components of native mixtures.

*PLS = pure live seed drilled rate. ** = dewinged. Abbreviations used above: v. = very; lt. = light; med. = medium; hvy. = heavy; rhiz. = rhizomatous; excel. = excellent

rangeland earlier in the fall when dryland seeded pastures are available. Introduced species such as Russian wildrye and crested or Siberian wheatgrass are especially well suited for early spring grazing. Altai wildrye and basin wildrye also initiate growth early, but do not tolerate successive early spring grazing. Pubescent and intermediate wheatgrasses are better suited for summer grazing. Russian or Altai wildrye usually provide some regrowth for fall grazing and remain palatable for winter grazing. Altai wildrye is more accessible to animals during winter because it grows more upright than Russian wildrye. Forage kochia, four-winged saltbush or winterfat can be included in mixtures to provide nutritious and palatable forage during late fall and winter.

Warm-season grasses produce more than 60 percent of their forage in mid-summer, while cool-season grasses produce most of their forage in spring and fall. Accordingly, warm-season grasses are better suited to grazing in mid- to late-summer when they can increase the availability of green, palatable and nutritious forage.

Tolerance to grazing also varies among species. Crested wheatgrass, one of the most tolerant species, can tolerate 60 to 70 percent utilization every spring. Bromegrasses, rhizomatous wheatgrasses and Russian wildrye are also considered grazing tolerant. Recommended levels of use vary by the length of grazing and rest periods, and by season of year. Utilization of most species during the growing season should be limited to 50 to 60 percent of the total current-year's growth. During plant dormancy, utilization can be increased to 80 percent of the total current-year's growth.

Precipitation

Seeded species must be adapted to local climatic conditions. As a rule, forage production is lower, establishment is more risky and management is more precarious at lower precipitation levels. Crested wheatgrass and Russian wildrye are the introduced species best adapted to sites receiving less than 12 inches of annual precipitation (Figure 1 and Table 3). Native species adapted to this lower precipitation zone include thickspike wheatgrass, basin wildrye and Indian ricegrass. Altai wildrye, pubescent wheatgrass and intermediate wheatgrass are well adapted to 13- to 15-inch precipitation sites. Green needlegrass and western wheatgrass are native species recommended for the 13- to 15-inch zone. Generally, thickspike wheatgrass is more drought-tolerant than western wheatgrass. Bromegrasses are best suited to sites that receive at least 16 inches of precipitation. Requirements for other species are summarized in Tables 1-4.

In addition to total precipitation, species should be chosen based on seasonal distribution of precipitation. For example, most warm-season species are best adapted to the eastern two-thirds of Montana and Wyoming where summer precipitation is more dependable.

Figure 1. Performance of commonly seeded species in different rainfall zones

Grasses	Annual Precipitation (inches)							
	6	8	10	12	14	16	18	20
Indian ricegrass								
Thickspike wheatgrass								
Bluebunch wheatgrass								
Russian wildrye								
Crested wheatgrass								
Basin wildrye								
Pubescent wheatgrass								
Tall wheatgrass								
Western wheatgrass								
Green needlegrass								
Intermediate wheatgrass								
Altai wildrye								
Smooth bromegrass								
Meadow bromegrass								

	= Optimal performance
	= Marginal performance
	= Not recommended

Figure 2. Performance of commonly used species in different soil types.

Grasses	Soil textures				
	Sand (light)	Sandy	Silty	Clayey	Clay (heavy)
Indian ricegrass					
Thickspike wheatgrass					
Bluebunch wheatgrass					
Russian wildrye					
Crested wheatgrass					
Basin wildrye					
Pubescent wheatgrass					
Tall wheatgrass					
Western wheatgrass					
Green needlegrass					
Intermediate wheatgrass					
Altai wildrye					
Smooth bromegrass					
Meadow bromegrass					

Soils

Soils influence plant establishment, productivity and longevity. Level or gently rolling sites with deep, fertile and medium-textured soils are best for seeding. Pastures are generally more difficult to establish and less productive on sandy or clayey soils. Western wheatgrass is best adapted to heavier soils, whereas Indian ricegrass performs best on sandier soils (Figure 2 and Table 1). Most other species are adapted to medium- or fine-textured soils (Tables 1-4)

Many Montana and Wyoming soils are saline and/or sodic. Plants may germinate in these soils, but the seedlings often succumb to extremely dry, saline conditions in early summer. It is advisable to have the soil tested when planning a seeding to diagnose any salt, sodium, pH or nutrient limitations. In many cases, species can be chosen that are more productive and better adapted to harsh conditions. For example, the most salt-tolerant grasses are 'NewHy' hybrid wheatgrass, tall wheatgrass, western wheatgrass, Altai wildrye and beardless wildrye (Tables 1-4).

Mixtures

In most situations, dryland pastures are best comprised of a simple mixture containing two or three species having similar palatability, season of growth, grazing tolerance, drought tolerance and regrowth rate. Complex mixtures of species with differing palatability often lead to overgrazing of some species in the mixture while others are under utilized. Complex mixtures are usually reduced to simple mixtures over time. Even simple mixtures make grazing management more difficult. The best option may be to have a series of dryland pastures, with one or more comprised of species suited for spring grazing, other pastures with species adapted to summer use and other pastures with species suited for fall grazing. Mixtures of warm and cool season species are not recommended, unless established in individual rows and an intensive management system is applied. Forage kochia can be successfully established with crested wheatgrass when forage kochia is broadcast seeded rather than planted within the same row.

Complex seed mixtures are sometimes used in revegetating native rangeland to help prevent weed invasion and provide diversity for wildlife. Mixtures that include several species of grasses and forbs tend to utilize nutrients, light and moisture throughout the growing season, thereby providing more widespread competition with weeds. However, a strongly competitive seeded species, such as crested wheatgrass or Russian wildrye, may be better able to compete against some weeds. Grass-legume mixtures are very productive. These mixtures generally produce more high quality forage than a grass seeded alone. For example, Russian wildrye seeded with alfalfa and sainfoin can double animal gain per acre compared with Russian wildrye seeded alone. Some legumes, such as alfalfa, have long taproots that draw water and nutrients from deep in the soil, enabling these legumes to grow productively in dry weather. Also, legumes increase the palatability and the levels of protein and energy in the forage. A preferred method for establishing each

component of grass-legume mixtures is to seed the grass and the legume in alternate rows or to cross-seed them. Grass-legume mixtures require intensive livestock and forage management. In most cases, the benefits of alfalfa in a grass mixture outweigh the potential risk of bloat. The bloat hazard can be reduced by replacing alfalfa with low-bloat potential legumes such as sainfoin, cicer milkvetch or birds-foot trefoil.

Cultivars

After selecting species that are best suited for site conditions and the pasture's intended season of use, an appropriate cultivar must be selected. The potential benefits of using an improved cultivar are high because cultivar adaptation and performance are proven. The Agricultural Experiment Stations in Montana and Wyoming and the Natural Resources Conservation Service conduct extensive trials for adaptation and performance of perennial dryland forage species and cultivars. Producers should choose cultivars that have performed well in research trials on sites similar to their own. Information on cultivar performance is available through local Extension Service offices, Agricultural Experiment Stations and Natural Resources Conservation Service. In addition, the experience of local ranchers and reputable seed dealers is invaluable when selecting species and cultivars. Cultivar attributes are compared in Appendix A (p. 23).

Seedling Establishment

Establishing a successful dryland pasture requires close attention to the following details.

Seed Source

Certified seed should be used when possible. This ensures genetic and mechanical purity, cultivar identity, uniformity and minimal risk of weed contamination, particularly noxious weeds. State and federal laws require dealers to label all seed offered for sale. The label lists the origin, purity, species identity, percent germination, other crops and weed seed content. Certified seed of a recommended cultivar that is produced in another state is acceptable, provided the species and cultivar are recommended for the site conditions and the intended season of use.

Seed of a given species that is collected from wild stands or cultivars grown without certification is termed "common." When buying common seed, it is important to know its origin because local environmental conditions (e.g., temperature, precipitation, day length, growing season, soil, etc.) alter plant genetics. Seed from a species grown in one environment may not perform well in another environment. Generally, non-certified, common seed can be planted successfully up to 500 miles south and 300 miles north of the collection site.

Precipitation levels and elevation strongly influence suitability of cultivars and species when moving east or west from the collection site.

Seeding Rates

Seeding rates in Tables 1-4 are given in pounds of pure live seed per acre. Pure live seed (PLS) of a seed lot is obtained by multiplying the percent purity times the percent germination and then dividing the product by 100. In the case of legumes, where “hard” seeds are counted, the percent of “hard” seed is added to the percent germination before multiplying it times the purity. The actual bulk pounds of seed needed for planting an acre is determined by dividing the recommended rate from Tables 1-4 by the percent pure live seed (PLS) in the seed lot. Plantings require more pounds of bulk seed than pure live seed (PLS) because seed germination and purity are always less than 100% (see sidebar). Seeding drills are calibrated using bulk seed rates.

How to calculate amount of bulk seed needed for specified seeding rate:

Seed Source

80% Purity

85% Germination

Seeding Rate: 10 lbs. PLS/acre calculations:

$$\frac{10 \text{ lbs.}}{(.80 \times .85)} = 14.7 \text{ lbs. bulk seed per acre}$$

Site Preparation

Dryland forages are best established on a “conventional” (i.e., cultivated) seedbed—land that is firm, mellow, moist and free of weeds, debris or large clods. Rough and fluffy seedbeds result in slow and erratic stand establishment, weed encroachment risks increase, and the eventual use of the dryland pasture is delayed. In contrast, overly worked seedbeds left smooth on the surface, particularly on sandy soils, can suffer excessive wind erosion and seedlings “blowout.” Tillage usually can be done in the fall so that the land is ready for planting in the early spring. Preferably, the ground should be fallowed or chem-fallowed for a year prior to planting to conserve moisture. Periods of extended drought may force planting to be delayed a year or two until soil moisture levels have recovered. If a crop is grown the prior year, winter precipitation must be at or above normal and weeds (including volunteer grain) and stubble must be managed. No-till into herbicide-killed sods and other interseeding techniques may work in some situations, but are not currently recommended for dryland pastures in Montana or Wyoming.

Areas with the combination of high winds and erosive soils may require perennial forages to be seeded into the stubble of a cereal grain crop (e.g., wheat, triticale, oats, barley or foxtail millet). The annual crop can be planted deeper, tolerates looser soil, establishes quicker and, if weeds need additional control, a labeled herbicide can be applied to “clean up” the field prior to the forage planting. The annual crop is first hayed, grazed or harvested for grain, followed by seeding the perennial forage into the stubble. The residual stubble provides a firm seedbed for proper seed placement and helps protect the emerging seedlings of perennial forage

species. In clayey soils, stubble decreases soil crusting which aids seedling emergence.

Nurse or companion crops are not recommended with grass seeding.

Timing of Seeding

Proper seeding techniques and equipment are critical to all forage seedings, but are most critical under dryland conditions. Dryland pasture seeding should occur in early spring to capitalize on potential late snows and early rains. “Dormant” seeding of grasses (but not legumes) is successful in the late fall or winter, as long as winter annual weeds (e.g., cheatgrass) are not abundant and soil temperatures remain too low for seed germination until the following spring. Late-summer seedings should only be planted if supplemental moisture is available from stored soil moisture or irrigation. A minimum of 2 feet of moist soil is needed for successful plant establishment. Seeding at other times should be avoided due to unreliable precipitation.

Row Spacing

Proper seedling density leads to faster establishment, weed suppression and optimum forage production under dryland conditions. Generally, most grasses and legumes are sown in 12- to 14-inch rows, whereas Russian wildrye performs best in 18- to 24-inch rows. Row spacing can be controlled on conventional drills by blocking several of the openings above the seed tubes. Using wide row spacings may require clipping and/or use of labeled herbicides for establishment-year weed control. When planting grass/legume mixtures, alternate rows of legume and grass are recommended.

Seed Placement

Seeding technique can influence seedling establishment much more than inherent differences among species. Most forage species have small seeds that require precise, shallow placement. In addition, most forage species germinate and emerge slower than cereal grains. Others have dormant seed requiring over-winter stratification. Crested wheatgrass and intermediate wheatgrass are among the easiest species to establish, while Russian and Altai wildrye are generally more difficult. Indian ricegrass and green needlegrass have dormant seed, are slow to establish and do best when dormant seeded in the late fall. Forage seeds should be planted at the appropriate seeding rate into a firm seedbed and at a depth of less than one-half inch. This is best accomplished with a drill that has depth bands, a seed agitator and packer wheels. Rice hulls or cracked corn can be used as a carrier to assist seed flow through the drill for uniform seed distribution.

Fertilizer

Adding fertilizer during the year of establishment is generally not recommended unless soil tilth is very low. Another exception is wherever soil phosphorus is low. In these cases, application of 50 pounds per acre of ammonium phosphate (16-20-0) at the time of seeding can significantly increase seedling establishment. Nitrogen fertilizer should not be applied during the year of establishment because it usually benefits weeds more than forage seedlings.

Weed Control

New seeded strands commonly become infested with annual weeds. During the year of establishment, the most cost-effective method of weed control is to mow the field above the height of the young forage seedlings. Labeled herbicides can be used to control weeds in subsequent years, although few herbicides are available for use on grass-legume mixtures.

Established Stand Management

Good management practices can sustain dryland pasture productivity for many years. Compaction, overgrazing and heavy manure loads accumulate in areas where livestock congregate for water or winter feeding. In many cases, additional fencing can be used in these areas of heavy concentration to provide for alternating years of rest and use. Manure should be distributed around the pasture with a drag harrow in the spring or when livestock are moved. Early spring is also a good opportunity to reseed bare areas within a pasture to prevent weed encroachment and erosion. Ungrazed dried standing stems can be clipped in early spring to promote new shoots and to encourage more uniform grazing during the growing season.

Long-term pasture production of cool-season forages will be correlated to winter and spring precipitation. Even with adequate stands and good conditions, productivity of many perennial species declines over time. For example, rhizomatous species such as pubescent wheatgrass can become sodbound, which limits production. There are many management practices that can revitalize older stands, such as fertilization, aeration, harrowing and light disking. However, the benefits of these options on dryland pastures should be evaluated critically to ensure that they are economically viable. For example, under irrigated or high rainfall conditions, 20 pounds of nitrogen should be applied annually per every ton of grass anticipated. Fertilization is not generally recommended for dryland pastures that receive less than 14 inches of annual precipitation. In these situations, planting a legume in combination with grass to add nitrogen to the soil is usually more cost-effective for dryland pastures. If a seeded pasture shows signs of nutrient deficiency, the soil should be analyzed. Fertilizer can then be applied in a test strip to evaluate pasture response.

Weeds, particularly noxious weeds, are a major concern in the West. Poorly managed grazing lands have been heavily infested with noxious weeds. In contrast, good stands of properly managed dryland pastures can limit the encroachment and

spread of noxious weeds. Dryland pastures should be inspected annually, and any noxious weed infestations should be controlled by grazing or by using appropriate herbicides. Eliminating or reducing small, isolated weed infestations is much more cost-effective than attempting to control widespread weed infestations. Be sure to follow pesticide label instructions for rates, safety and re-entry period for grazing livestock.

Good dryland pasture management is a major component of integrated weed management, and there is currently much research being conducted on this subject. In terms of noxious weed management, some of the perceived “cost-prohibitive” strategies of reseeded, new fencing, water development, tillage, fertilization, etc. may in fact become very cost-effective if they improve a dryland pasture so that it becomes more resistant to noxious weed invasion. Dryland pastures are major assets for ranchers in Montana and Wyoming. Producers should manage their improved dryland pastures to optimize profitability and long-term sustainability.

Grazing Management

Well-managed livestock grazing will extend the productive life of dryland seeded pastures and improve their economic returns. Seeded pastures should be fenced separately from native rangeland, and seedings of different species or mixtures should also be fenced separately from each other. This is advisable because of the differences in maturity, palatability and grazing tolerance among plant species. Separate pastures enable the plants to be grazed when they are most palatable and nutritious, or when their use best complements the other forage resources of a ranch.

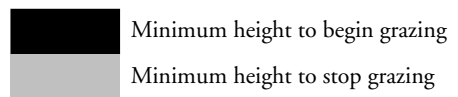
Timing of Grazing

New seedings must be protected from grazing until they are well established. Generally, grazing should be deferred at least until the first seed crop has matured. It may be necessary for the non-use period to exceed one year if seedling establishment was slow due to poor weather, weeds or other factors.

Plant height is a good indicator of when a seeded pasture is ready for grazing and when livestock should be removed (Figure 3). Most species that are commonly seeded for dryland pasture are ready for grazing when plants reach 6-8 inches high and grazing should cease when 3-4 inches of plant height remains. Basin wildrye is one exception—grazing should not begin until plants reach 11-12 inches high and grazing should cease when 8 inches of plant height remains. The time it takes for plants to regrow and recover before they can be grazed again depends on the plant species, weather and soil fertility. Also, plants with abundant leaves remaining after grazing will recover more quickly than closely grazed plants. A minimum recovery period of 21-30 days is usually needed when growing conditions are optimal in spring. Recovery periods of two to three months may be required after grazing in summer or early fall.

Figure 3. Minimum leaf or stubble height at the beginning and end of grazing during the growing season.

Species	Height (inches)							
	1	2	3	4	5	6	7	8
Crested wheatgrass	Minimum height to begin grazing				Minimum height to stop grazing			
Russian wildrye	Minimum height to begin grazing						Minimum height to stop grazing	
Intermediate or pubescent wheatgrass	Minimum height to begin grazing				Minimum height to stop grazing			



Crested wheatgrass and Russian wildrye are two species that tolerate grazing in early spring. They attain maximum growth 4-5 weeks earlier than native rangeland. For these species, initiation of spring grazing should be based on livestock performance more than grass plant health. Livestock will perform better if grazing is delayed until the amount of forage standing in the pasture (new growth plus last year's carryover grass still standing in the field) reaches 200-300 pounds per acre. Substantial amounts of carryover grass will reduce grass tetany and permit an earlier grazing start than if little or no standing residue is present. Grazing can begin when the current year's growth comprises $\frac{1}{3}$ to $\frac{1}{2}$ of the existing standing forage. Another guideline is to delay grazing at least until individual plants have grown three leaves and each of these leaves has reached at least $2\frac{1}{2}$ inches in length. When crested wheatgrass and Russian wildrye are grazed in early spring, it is best to remove livestock while some soil moisture remains. This will help the plants recover from grazing and regrow before weather conditions become too hot and dry. Crested wheatgrass and Russian wildrye produce more palatable forage when light or moderate spring grazing is combined with grazing in fall. Forage production, forage quality and livestock performance all improve compared with grazing at light or moderate intensities for a single grazing event.

Close grazing during fall green-up can be very damaging to all plant species. The last grazing period of fall regrowth should preferably end about three weeks before the first grass-killing frost. If this is not feasible, more than 3-4 inches of residual forage height should remain after early-fall grazing. Rotational grazing programs are another way to help seeded pasture plants better withstand grazing during fall green-up. Once plants enter winter dormancy, grazing impacts are minimal. However, residual standing forage in winter does insulate plants from cold temperatures, helps trap snow and increases grass yield during the next grow-

ing season. Plants also begin growth earlier in the spring and produce more tillers (shoots) per plant when some stubble remains from the previous year. A protein-carotene supplement is usually needed if livestock graze seeded pastures when plants are dormant.

Grazing Intensity

Well-managed seeded pastures can usually be stocked at higher rates than adjacent native rangeland. Table 5 presents initial suggested stocking rates for several grasses and crop aftermath. Seeded pastures grazed annually at the same time of year for only a brief period (i.e., less than three weeks) do not benefit much from rotational grazing.

Table 5. Stocking rate guidelines for dryland pastures and crop aftermath.

Pasture	Precipitation Zone (inches)	AUM Per Acre	Acre Per AUM
Crested wheatgrass	10–14	0.67	1.5
	15–18	1.00	1.0
Russian wildrye	10–14	0.50	2.0
	15–18	1.00	1.0
Pubescent wheatgrass	13–14	0.75	1.3
	15–18	1.25	0.8
Intermediate wheatgrass	14–18	1.50	0.7
Meadow brome	16–18	1.50	0.7
Timothy	16–18	1.25	0.8
Orchardgrass	16–18	1.50	0.7
Grain aftermath	10-14	0.20*	5.0*
	15-18	0.30*	3.3*
Hay aftermath	10-14	0.40	2.5
	15-18	0.50	2.0

**Do not graze if insufficient stubble remains to protect the soil from wind or water erosion.*

Rotational Grazing

Some dryland seedings contain plant species that can be used in either spring or fall (Tables 1-4). These seedings can benefit from two-pasture or three-pasture grazing programs. In a two-pasture program, the seeding is separated into two pastures, with one pasture grazed during spring and the other grazed during fall (Table 6). The grazing season (spring or fall) is then rotated between the two pastures annually. Grazing in the fall season pasture should be adjusted to leave about 50 percent of the standing forage for consumption in the following spring.

A three-pasture program subdivides the spring grazing season into two halves.

The three grazing seasons (early spring, late spring and fall) are rotated annually among the three pastures. For plant species that do not readily become coarse and unpalatable, the pasture that is grazed in the fall is not grazed again until late spring the following year (Table 7).

For species that grow quickly and readily become coarse and unpalatable when ungrazed (e.g., crested wheatgrass, Russian wildrye, or tall wheatgrass), the grazing sequence in a three-pasture program is altered so that the pasture grazed in the fall is grazed in early spring the following year (Table 8). This schedule best prevents the plants from becoming too coarse.

Grazing Selectivity

Livestock make choices when grazing and select those plant species, individual plants and plant parts they find the least objectionable. Stock density (i.e., number of animals per unit area of pasture) can affect how selectively livestock graze. Individual animal performance will be maximized when stock density is low and livestock are allowed to be very selective in choosing their forage. Individual animal performance will drop below maximum whenever livestock are forced to graze less selectively at higher stock densities.

Less selective grazing is appropriate in seeded pastures when the objective is to achieve uniform use across the pasture and prevent plants from becoming too coarse or “wolfy”. Less selective grazing usually requires smaller pastures grazed for short time periods with a large number of animals. Stock densities of three to five cows (or their equivalent) per acre may be needed for grazing periods of seven days or less per pasture.

Questions about the materials in this publication can be directed to any of the authors, or to your local NRCS or Extension agent.

Table 6. A two-pasture rotational grazing program.

Year	Pasture 1	Pasture 2
1	Spring	Fall
2	Fall	Spring
3	Spring	Fall

Table 7. A three-pasture rotational grazing program for non-coarse plant species.

Year	Pasture 1	Pasture 2	Pasture 3
1	Early Spring	Late Spring	Fall
2	Fall	Early Spring	Late Spring
3	Late Spring	Fall	Early Spring
4	Early Spring	Late Spring	Fall

Table 8. A three-pasture rotational grazing program for “coarse” plant species.

Year	Pasture 1	Pasture 2	Pasture 3
1	Early Spring	Late Spring	Fall
2	Late Spring	Fall	Early Spring
3	Fall	Early Spring	Late Spring
4	Early Spring	Late Spring	Fall

Appendix A. (continued)

Mayak	Superior to Sawki in forage and seed yield; Canada 1971.
Swift	Synthetic release selected for seed size and seedling vigor; easier to establish than previous cultivars; Canada 1978.
Bozoisky-Select	Synthetic, selected for seed size and seedling vigor; easier to establish and more productive than Vinall; Utah 1985.
Mankota	Improved stand establishment, plant vigor and higher yields than Vinall; North Dakota, 1991.
<hr/>	
Siberian wheatgrass	<i>Bunchgrass; similar to standard crested wheatgrass; best adapted to south-western Montana; fine leafy stems.</i>
P-27	Longer green period than standard crested wheatgrass; Idaho 1953.
Vavilov	Very drought tolerant; produces more forage than P-27; less likely to cause grass tetany (magnesium deficiency in grazing animals); Utah 1994.
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Mammoth wildrye	<i>Cool season sod former; very drought resistant; coarse broad leaves unpalatable except in early spring; effective for sand dune stabilization.</i>
Volga	Selected for vigorous vegetative reproduction and soil stabilization. Slow to establish and non-competitive; Washington 1949.
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Introduced Legumes

Alfalfa *Excellent legume; can cause bloat at high densities; creeping (root-proliferating) or grazing types are more tolerant to grazing and persist better than crown-type cultivars.*

Use alfalfa cultivars known to perform well in Montana* and Wyoming. Several include:

Ladak 65	Crown type; slow recovery after cutting; very winterhardy; Montana 1965.
Shaw, Cooper	Crown types; very fast regrowth; high disease resistance; Montana 2000.
Rambler, Rangelander	Creeping root; slow cutting recovery; excellent winter-hardiness; Canadian releases.
Spredor 3	Creeping root type; fast recovery after cutting; excellent winter-hardiness; good disease resistance; private cultivar.
Travois	Root-proliferating type; moderate recovery after cutting; excellent winter-hardiness; South Dakota release.
Alfagraze, XGrazer, MagnaGraze and others	Grazing types bred for tolerance to continuous intensive grazing; fast recovery after cutting; good winter-hardiness and disease resistance; private cultivars.

**View the most recent Alfalfa Performance Summaries at your local Extension Service office, or online at <http://animalrangeextension.montana.edu/Articles/Forage/Main-Varieties.htm>*

Sweetclover *Biennial with yellow or white blossoms; yellow type is finer stemmed; may be grazed or used as hay; forage quality comparable in palatability and feeding value to alfalfa; hay must be properly cured to prevent mold and potential animal toxicity; several cultivars; use locally available and adapted source.*

Native Cool-Season Grasses

Bluebunch wheatgrass *Drought tolerant bunchgrass; slow to establish; adapted to shallow and gravelly soils.*

Secar	More drought tolerant than Whitmar beardless wheatgrass; early maturing; persistent; Washington 1980. (Newer common name is Snake River wheatgrass.)
Goldar	Good seedling vigor; leafier and better drought tolerance than Secar; Idaho and Utah 1989.

Appendix A. (continued)

P-7	Seven western state polycross intended to provide genetic diversity within a single germplasm for semi-arid and wetter sites; Utah 2002.
Streambank wheatgrass	<i>Most drought tolerant wheatgrass; poor forage production; adapted to all soils from loam to clayey.</i>
Sodar	More drought tolerant than Critana thickspike wheatgrass; dense sod for erosion control and xeriscapes; competitive to weeds; Idaho 1971 .
Thickspike wheatgrass	<i>Excellent seedling vigor; adapted to soils from loam to sand.</i>
Critana	Excellent seedling vigor; forms a tight sod for erosion control; forage type in less than 10-inch rainfall areas; Montana 1971.
Bannock	Better forage yields in higher rainfall zones and taller than Critana; Idaho 1995.
Schwendimar	Same characteristics and adaptation as other thickspike cultivars; Washington 1994.
Slender wheatgrass	<i>Short-lived (3-5 years) bunchgrass; excellent seedling vigor.</i>
Revenue	Saline tolerant; good forage quality and yield; quick establishment; 1970 Canadian release.
San Luis	High elevation origin; good seedling vigor and stand establishment; Colorado 1984.
Pryor	Longer-lived; larger seed size and more saline tolerant than other slender wheatgrasses; Montana 1988.
Big bluegrass	<i>Bunchgrass; adapted to shallow soils; drought hardy.</i>
Sherman	Early spring growth—earlier than crested wheatgrass; fall regrowth with moisture; short-lived; 1945 release from Oregon, Washington and Idaho.
Canby bluegrass	<i>Bunchgrass; closely related to Sandberg bluegrass; useful as a mixture component in bunchgrass communities.</i>
Canbar	Moderately saline tolerant; low forage production; difficult to establish; Oregon, Washington and Idaho 1979.
Sandberg bluegrass	<i>Cool-season bunchgrass; early maturity; pioneer species; useful in mixtures.</i>
High Plains	Broad genetic base adapted to Montana, Wyoming, western Dakotas and southern Idaho; Montana 2000.
Indian ricegrass	<i>Bunchgrass; adapted to sandy soils; dormant seed requires fall planting.</i>
Paloma	Selected for stand vigor and forage production; adapted to southeastern Montana, Wyoming, New Mexico and Colorado; origin southern Colorado, 1974.
Nezpar	Less seed dormancy than Paloma; good vegetative characteristics; adapted to Montana and Wyoming; origin west-central Idaho; Idaho 1978.
Rimrock	Selected for seed retention resulting in higher seed production and wildlife benefit; Montana 1997.
Sheep fescue	<i>Short bunchgrass; drought tolerant; slow to establish; low palatability.</i>
Covar	Fine-leaved; drought tolerant; introduced dwarf plant with extensive root system for erosion control; poor forage producer; Oregon, Washington and Idaho 1977.
Basin wildrye	<i>Large bunchgrass; moderately saline tolerant; adapted to overflow and upland sites.</i>
Magnar	Weakly rhizomatous; slow to establish; valuable winter forage; intolerant of overgrazing; Idaho 1979.
Trailhead	Longer-lived and more drought tolerant than Magnar in dry intermountain environments; Montana 1991.

Appendix A. (continued)

Native Warm-Season Grasses

<i>Little bluestem</i>	<i>Erect bunchgrass adapted to eastern Montana and Wyoming shallow foothills soils.</i>
Badlands	Good seed viability; early maturity and overall plant vigor; North Dakota 1998.
Blaze	Selected for seedling vigor and green leaf character; late maturity; Nebraska 1967.
Camper	Selected for leafiness, seed production, stand establishment and late maturity; Nebraska 1973.
<i>Sand bluestem</i>	<i>Large rhizomatous grass resembling big bluestem; blue-green foliage; greater lateral spread than big bluestem; grows on sandy soils; adapted to eastern third of Montana and Wyoming.</i>
Garden	Vigorous; tall and leafy type; good seed yields; Kansas 1960.
Goldstrike	Typical sand bluestem characterized by short to long rhizomes; Nebraska 1973.
<i>Sideoats grama</i>	<i>Slightly spreading medium stature bunchgrass adapted to shallow, well drained soils in the eastern thirds of Montana and Wyoming.</i>
Butte	Winter-hardy; long-lived; early maturing; adapted to short growing seasons; excellent seedling vigor and seed producer; Nebraska 1958.
Killdeer	Outstanding vigor; leafiness and persistence in cold, semi-arid environments; origin North Dakota; North Dakota 1960.
Pierre	Similar to Killdeer; origin South Dakota; North Dakota 1960.
<i>Blue grama</i>	<i>Drought tolerant bunchgrass adapted to fine-textured soils; poor forage production but good forage quality; used for prairie restoration and xeriscapes.</i>
Alma	Synthetic cultivar bred for better seedling vigor, field emergence, seed and forage production as compared to Hachita and Lovington cultivars; New Mexico and Colorado selection.
Bad River	Tall and leafy; establishes readily; North Dakota 1998.
Birdseye	Good seed production; good vigor; adapted to northern latitudes; Wyoming 1999.
<i>Galleta</i>	<i>Slightly spreading grass found in southwestern Wyoming; palatable during summer growing season, but unpalatable when dormant; drought resistant and tolerant of heavy grazing.</i>
Viva	Selected from native ecotypes for seedling vigor, herbage production and seed yield; useful for range seeding, reclamation and other disturbances; New Mexico.

Native Shrubs

<i>Fourwing saltbush</i>	<i>Long-lived perennial shrub; excellent winter browse; maintains good nutritional value; adapted to moderate saline clayey soils.</i>
Wytana	Selected for mechanical seed harvest; used in reclamation and range mixtures in northern Great Plains; Montana 1976.

Appendix A. (continued)

Winterfat	<i>Native cool-season shrub or half-shrub; excellent browse for livestock and wildlife, especially in winter; long lived; intolerant of overgrazing, shade, excess water; fire tolerant; excellent restoration species.</i>
Hatch	Originated in Utah. New Mexico release. May be adapted to southwestern Wyoming.
Open Range	A northern-adapted composite release of three ecotypes; excellent seedling vigor; adapted to the High Plains; Montana 2002.

Forbs

Lewis flax	<i>Short-lived; showy; drought tolerant; perennial native forb; reestablishes from seed.</i>
Appar	Selected for its vigor, beauty and competitiveness; used as a component of reclamation or range mixture; origin Black Hills region of South Dakota; Idaho 1990.

Small burnet	<i>Introduced; hardy; evergreen; long-lived perennial forb; excellent foliage and seed for upland birds and big game.</i>
Delar	Outstanding forage and seed production and good palatability for livestock and wildlife; Idaho 1981.

Maximilian sunflower	<i>Native perennial warm-season forb with rhizomes.</i>
Prairie Gold	Upright stems 3-6 feet tall with showy large yellow flowers; spreads by root-stalks; excellent wildlife food; Kansas 1998.
Medicine Creek germplasm	Germplasm selected from 52 other ecotypes; northern source; North Dakota 2000.

13-15 Inches Precipitation

Introduced Cool-Season Grasses

Pubescent wheatgrass	<i>Sod-forming; prefers well-drained coarser soils.</i>
Mandan 759	High forage yield and more persistent than other cultivars; best adapted to the eastern part of the Northern Great Plains; North Dakota selection.
Manska	Replacement for Mandan 759; more uniform; better forage regrowth, production and quality; North Dakota and Nebraska 1992.
Luna	Excellent seedling vigor and establishment; forage production less than other cultivars on favorable sites; New Mexico 1963.
Greenleaf	Selected for creeping tendency and seedling vigor; superior to Mandan 759 in northern Montana; 1966 Canadian release.

Tall wheatgrass	<i>Bunchgrass; high water table and saline/sodic soil tolerant; requires high level of management for production; excellent wildlife habitat.</i>
Jose	Leafy; medium tall; foliage less coarse and more palatable than other tall wheatgrass cultivars; New Mexico 1965.
Alkar	Good seedling vigor; tall; late-maturing; stemmy; Oregon, Washington and Idaho 1951.
Largo	Large, coarse and deeply rooted; late maturing; New Mexico 1961.

Appendix A. (continued)

<i>Hybrid wheatgrass</i>	<i>Hybrid between quackgrass and bluebunch wheatgrass.</i>
NewHy	Hybrid combines the vigor, productivity and salinity tolerance of quackgrass with the drought tolerance and forage quality of bluebunch wheatgrass; as saline tolerant as tall wheatgrass; does not spread like quackgrass; easier to manage and more palatable than tall wheatgrass; nutritional quality higher than quackgrass; Utah 1989.

Native-Cool Season Grasses	
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<i>Beardless wheatgrass</i>	<i>Bunchgrass; long-lived; adapted to sites similar to those of bluebunch wheatgrass; best adapted to western Montana and Wyoming foothills.</i>
Whitmar	Good seedling vigor; retains feed value and palatability late into summer; ready for grazing three weeks later than crested wheatgrass; 1946 release from Washington, Oregon and Idaho.

<i>Western wheatgrass</i>	<i>Sod-former; moderately saline tolerant; cured foliage retains good nutrition.</i>
Rosana	Originates in Rosebud County, Montana; selected for seedling vigor, ease of establishment and rate of spread; Montana 1972.
Rodan	Vigorous, leafy type adapted to same areas as Rosana; similar in forage yield to Rosana; does not develop sod as quickly as Rosana; North Dakota 1983.
Ariba	Originates in southern Colorado; released for dryland hay, grazing and conservation; adapted to southern Wyoming; 1973 release from New Mexico and Colorado.
Barton	Intermediate between northern and southern types; strongly rhizomatous; leafy erosion control type; Kansas 1970.
Walsh	Long-lived; leafy with good vigor; forage yields similar to Rosana; 1982 Canadian release.

<i>Green needlegrass</i>	<i>Bunchgrass; dormant seed requires dormant fall planting; slow to establish; rapid regrowth and good palatability; prefers loam to clayey soils.</i>
Lodorm	Selected for low seed dormancy; suited for mixtures with western wheatgrass; Montana, South Dakota and North Dakota 1970.

<i>Canada wildrye</i>	<i>Cool-season bunchgrass; tall with coarse foliage; short-lived but quick to establish; should be cut or grazed early for best palatability; used to increase forage production in forage mixtures with slower establishing species.</i>
Mandan	Selected for leafiness, fineness of leaves and short stature; good quick erosion control plant, especially on sandy blowouts; low forage production; North Dakota 1946.

<i>Mountain bromegrass</i>	<i>Tall perennial bunchgrass; short lived; very quick establishing species on disturbed forest sites.</i>
Bromar	Selected from native collections for head smut resistance; Washington 1946.
Garnet germplasm	Selected from native northern Rocky Mountain collections for less head smut than Bromar; longer lived than Bromar; Montana, Wyoming and Colorado 2000.

<i>Blue wildrye</i>	<i>Cool-season bunchgrass common on timber harvest or burned-over forested sites; shade tolerant, short lived; no cultivars available; use local ecotypes.</i>
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<i>Hard fescue</i>	<i>Densely tufted perennial bunchgrass; extensive fibrous root system provides excellent erosion control; shade tolerant; stiff foliage palatable to domestic and bighorn sheep.</i>
Durar	Produces more forage than sheep fescue; erosion control and revegetation of disturbed sites; introduced ecotype; Idaho, Washington and Oregon 1949.

Appendix A. (continued)

Native Warm-Season Grasses

<i>Prairie sandreed</i>	<i>Rhizomatous; adapted to sandy soil; excellent erosion control.</i>
Goshen	Good early summer forage; good seed production; coarse-stemmed; adapted to eastern Montana and Wyoming; Montana 1976.
Pronghorn	Selected for rust resistance; Nebraska 1988.
<i>Big bluestem</i>	<i>Large bunchgrass growing best on relatively fertile, well drained loam soils in eastern Montana and Wyoming.</i>
Bison	Earlier in maturity than Bonilla and other southern cultivars; shorter height at maturity; North Dakota and Minnesota 1989.
Bonilla	Winter-hardy and persistent; forage production greater than Bison; North Dakota, South Dakota and Minnesota 1987.
Pawnee	Produces good forage yields in Nebraska; superior to native strains originating farther north and west; adapted to southeastern Wyoming; Nebraska 1963.
Sunnyview	Selected for leafiness, vigor and seed yield; later maturing than Bison and Bonilla; South Dakota 1998.
<i>Indiangrass</i>	<i>Large bunchgrass growing on fertile bottomlands; palatable early in the season; easily damaged by overgrazing.</i>
Tomahawk	Earlier maturity and superior winter hardiness and persistence as compared to other cultivars; North Dakota, South Dakota and Minnesota 1988.
<i>Switchgrass</i>	<i>Sod-former growing on relatively moist fertile soils; forage quality good during growing season but low at maturity.</i>
Dacotah	A drought tolerant northern upland type with good seed production; leafy; matures early; North Dakota and Minnesota 1989.
Forestburg	Superior winter-hardiness, persistence and earlier maturity than other cultivars; forage production in northern latitudes exceeds Dacotah; North Dakota, South Dakota and Minnesota 1987.
Sunburst	Selected for seed size, height, vigor and leafiness; South Dakota 1998.

Native Legumes

<i>Slender white prairieclover</i>	<i>Perennial herbaceous legume; multiple stemmed with taproot; prefers gravelly, rocky and shallow soils in eastern Montana and Wyoming.</i>
Antelope	Selected for use in prairie restoration; good seedling vigor and excellent seed production; Montana and North Dakota 2000.
<i>Purple prairieclover</i>	<i>Herbaceous perennial legume with taproot; prefers deep soils.</i>
Kaneb	Selected for use in native mixtures for range improvement and soil stabilization; best adapted to southeastern Montana into eastern Wyoming; Kansas 1975.
Bismarck germplasm	Compared with 11 other accessions for vigor, forage abundance and seed production; northern source; not evaluated in Montana or Wyoming; North Dakota 2000.

Appendix A. (continued)

Introduced Legumes

Sainfoin	<i>Nonbloat; susceptible to crown and root rot; short-lived (three to five years on most sites); must allow seed set to perpetuate and maintain stands; excellent palatability.</i>
Eski	Dryland type released from Montana State University; short-lived; susceptible to crown rot.
Melrose	Dryland type; better growth and regrowth into summer than Eski; Canadian release.
Nova	Similar to Melrose and Eski; better spring vigor and taller than Melrose and Eski; Canadian release.

14-15 Inches Precipitation

Introduced Cool-Season Grasses

Intermediate wheatgrass	<i>Weak sod-former; prefers loam to clayey soils.</i>
Oahe	Selected for high seed set and forage yield; good drought tolerance; South Dakota 1961.
Greenar	Good spring and fall recovery; less drought tolerant than Oahe; Washington 1945.
Amur	Strong seedling vigor; leafy; used at high elevations; New Mexico 1952.
Rush	Excellent seedling emergence and vigor; as productive as other cultivars; drought tolerant as pubescent wheatgrass; Idaho 1994.
Reliant	Superior seedling establishment; sustained productivity under hay management; compatible with legumes; North Dakota 1991.
Smooth bromegrass	<i>Strong sod-former; southern types—good erosion control; northern types—leafy, good in legume/grass mixtures.</i>
Lincoln	Aggressive sod-forming type (southern type); good seedling vigor and easy to establish; Nebraska 1942.
Magna	Intermediate type between northern and southern varieties; hay and seed yields similar to southern types; Canada 1968.
Rebound	Polycross selected for tolerance of foliage and root diseases; vigor and leafiness similar to southern types; seed quality similar to northern strains; South Dakota 1962.
Altai wildrye	<i>Slightly rhizomatous; seedlings slow to establish; does well on run-in or overflow sites, especially with high water tables; saline tolerant.</i>
Prairieland	Deep-rooted; retains good nutrition into fall and winter; Canada 1976.
Pearl	Selected for high seed and forage yield and good emergence; Agriculture Canada 1989.
Eejay	Similar to Prairieland; Agriculture Canada 1989.
Tall fescue	<i>Bunchgrass for pasture or hay; easy to establish; fast regrowth; tolerates heavy grazing, trampling, flooding and high water table and moderate salinity. Due to a fungal endophyte, “fescue foot” toxicity can occur from tall fescue – only use seed of cultivars verified as “low-endophyte” or “endophyte-free.”</i>
Alta	Drought tolerant and winterhardy; previous seed sources had low endophyte; Oregon 1940.
Fawn	Earlier maturing and better regrowth than Alta; early seed sources had low endophyte; Oregon 1964.
Forager	Higher production than Alta or Fawn; endophyte-free seed is currently available; Indiana 1980.

Appendix A. (continued)

Native Cool-Season Grasses

<i>Idaho fescue</i>	<i>Bunchgrass common in 15- to 19-inch precipitation zone; prefers well drained soils; poor seedling vigor.</i>
Nezpurs	Quite variable and shorter than Joseph; equals Durar hard fescue and exceeds Covar sheep fescue in forage production; Idaho release.
Joseph	Taller than Nezpurs and more uniform; better forage production than Covar sheep fescue or Durar hard fescue; Idaho release.

16-18 inches precipitation

Introduced Cool-Season Grasses

<i>Meadow brome</i>	<i>Slightly rhizomatous; less apt to be sod bound than smooth brome; excellent regrowth; compatible with legume component.</i>
Regar	Rapid seed germination; lax basal leaves; good regrowth; excellent hay or pasture; Idaho 1966.
Fleet	Superior seedling vigor, seed quality and production as compared to Regar; Agriculture Canada 1987.
Paddock	Similar forage yields to Fleet and Regar; lower seed yield than Fleet; Agriculture Canada 1987.
Montana	Fast recovery after cutting; higher seed yield than Regar; Montana 2000.
MacBeth	Fast regrowth; higher seed yield than Regar or Paddock; Montana 2002.
<i>Timothy</i>	<i>Bunchgrass with a bulblike base; often used following timber harvest.</i>
Climax	Tall; fine stemmed; leafy; regrowth excellent under good fertility; Canada 1947.
Drummond	Later maturing; slightly inferior to Climax in mid-summer regrowth; Canada 1940.
<i>Orchardgrass</i>	<i>Bunchgrass, very palatable forage; pasture or hay; easy to establish; excellent regrowth; poor winter hardiness without snow cover; late and early maturing cultivars; cultivar selection should be based on environment and maturity should coincide with legume component of mix.</i>
Latar	Often used following timber harvest or burn; late maturity date corresponds with alfalfa hay; excellent irrigated cultivar; winter hardy where snow cover lasts the entire winter; Idaho and Washington 1957.
Potomac	Preferred in higher elevations with short growing seasons; early maturity matches legumes; Oregon 1954.
<i>Kentucky bluegrass</i>	<i>Introduced cool-season, sod-forming grass; primarily used for recreational turf and erosion control; low forage production; withstands heavy grazing use.</i>
Troy	Introduced from Turkey; upright forage type bluegrass; earlier than crested wheatgrass or Russian wildrye but not as productive in spring pastures; Montana.

Introduced Legumes

<i>Birdsfoot trefoil</i>	<i>Nonbloat; very slow to establish; adapted to soils with poor internal drainage; yields less than alfalfa.</i>
Tretana	Winter survival equals Leo; slow spring/rapid mid-season growth; high yield; Montana release.
Empire	Semi-erect; fine stemmed; very winter hardy; late maturing; New York release.
Leo	Earlier maturing like Tretana; yield equals Tretana; better winter survival than Empire; Canadian release.
Dawn	Comparable to Empire for maturity and growth, but has greater resistance to root rots and leaf and stem diseases; Michigan release.
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<i>Cicer milkvetch</i>	<i>More frost and high water table tolerant than alfalfa; non-bloat; cutting recovery slower than alfalfa; good replacement for alfalfa at higher elevations; hay slow to cure.</i>
Lutana	Rhizomatous; decumbent; forage yield slightly less than alfalfa; Montana 1969.
Monarch	Improved seedling vigor and better stand establishment than Lutana; Colorado.
Windsor	Improved seedling vigor and cold tolerance; Colorado.
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<i>Red clover</i>	<i>Short-lived, upright biennial; can be planted with other legumes or grasses; protein content of hay is slightly lower than alfalfa; high in magnesium which aids in the prevention of grass tetany in grazing animals; medium, multicut and mammoth types; use locally available and adapted sources.</i>
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<i>White clover</i>	<i>Short-lived, biennial perpetuating itself by root systems at each node along horizontal creeping stems; used primarily with grasses for pasture; tall, medium and large types; Ladino belongs to the large group; use locally available and adapted sources.</i>