PLANT MATERIALS TECHNICAL NOTE

Perennial Vegetation Establishment Guide for Conservation Seedings in Wyoming: Species, Seeding Rates, and Selections

Introduction

Many conservation practices rely on seeding as part of the conservation remedy. There are several factors that influence the seeding success to consider when developing a seeding mix. One factor is seeding rate, based on the desired number of live seeds per linear distance (foot) or per unit area (square foot) and expressed as Pure Live Seed (PLS) pounds per acre. This technical note provides the number of seeds per pound of many conservation plant species, the target number of seeds per square foot needed for a full stand seeding, the resultant number of PLS pounds per acre recommended for a full stand of that species, and other useful information on seeding dates and seedbed preparation. It should be used in conjunction with other technical notes and references as noted in the *Resources* section. This information can be used to plan seedings for Conservation Cover (CPS 327), Critical Area Plantings (CPS 342), Pasture and Hay Planting (CPS 512), Range Planting (CPS 550), Field Borders (CPS 386), pollinator seedings, and more.

Figure 1. Planting a reclamation site using a rangeland no-till drill.

Species Selection

When planning a seeding and developing a seed mix, it is critical to select species that meet the landowner's objectives, address the resource concern, and are suited to the site conditions. Conduct an inventory to assess the site's climate, landscape position, soil, and vegetation to select appropriate species for site conditions.

- Climate: growing season length, high and low temperatures, and precipitation amount, precipitation timing, irrigation availability
- Landscape position: elevation, slope, aspect, hydrology, flooding potential
- Soil: soil type, depth, texture, drainage, water holding capacity, chemistry (salinity, pH, nutrients)

- Vegetation: Major Land Resource Area (MLRA), Ecological Site Description (ESD), existing vegetation and weeds on site

Table 1 of this document lists native and introduced plant species chosen for their proven ability to work well in various conservation practices in Wyoming. These species tend to be commercially available, cost-effective, and lend themselves to direct seeding. The plants are organized by grasses, forbs and legumes, shrubs, cover crops, and companion crops. Table 1 also provides information on whether the species is a warm-season or cool-season plant, if it is best grown under irrigated or dryland conditions, the preferred planting season, and proven selections for Wyoming. Proven selections include cultivars, tested-class, selected-class, and germplasm level plant releases to the commercial market which have undergone research to assess their characteristics and establishment success for addressing resource concerns.

Table 2 includes species, seeds per pound, and full stand seeding rates for additional species known to exist in Wyoming's Ecological Sites that may be included in conservation seedings. However, use caution when selecting these species for conservation seedings because they do not have proven selections for Wyoming (i.e., their establishment success and pedigree is not known at this time). These species may be added to a seed mix to improve site diversity; however, they may be slow or poor at establishing, have limited commercial seed availability, and/or limited seed quantities available (i.e., seed available in gram amounts/seed packets only).

It is important to note that although some shrubs can be successfully planted as seed, most woody plants establish best as seedlings. In addition, wetland species are often established from potted container stock, 10 cubic inch plugs, cuttings, or transplants for conservation plantings in Wyoming. Species that establish best as seedlings are provided in Table 3 along with their number of seeds per pound, full stand seeding rates, and recommended selections; however, seed availability may be limited for most species.

Seeding Rates

Seeding rates are expressed as the desired amount of pure live seed (PLS) per unit area (lb/ac; Tables 1 through 3). Pure live seed is the percent of viable seed in a seed lot. It is the percent of seed that will germinate plus hard or dormant seed and excludes any inert materials, weeds, or other crop material in the lots. The recommended PLS pounds of seed per acre for each species is calculated from the target number of seeds desired per linear foot or square foot and the number of seeds per pound for the species. The number of seeds per pound is typically an average of at least 3 counts of separate seed lots for the species and its selections. It is important to note that the PLS pounds per acre needed for a full stand drill seeding are based on 12-inch between row spacing and must be adjusted when the between-row spacing is greater than 12-inches.

The rule-of-thumb is to use 20 to 25 seeds per square foot for most single species seedings, although the target number varies with seed size (number of seeds per pound), type of seeding equipment, and conservation practice (Figure 2). Small seeds are seeded at slightly higher number of seeds per unit area because they generally have less carbohydrate reserves and perish more easily than large seeds, and they have a greater potential to be planted too deep where they will not emerge. Large-seeded species are seeded at slightly lower number of seeds per unit area because they often produce larger, more competitive seedlings that tend to survive well and require more growing space, and their seeds become logistically difficult to sow in high numbers because of their large size. Tables 1 through 3

provide the desired number of pure live seeds per square foot when planted at the full stand drill seed rate.

Seed Size Class	Number of PLS Seeds/lb	Target Number PLS Seeds/Foot
small	>800,000	30 to 50
medium	80,000 to 800,000	20 to 25
large	<80,000	15 to 20

Figure 2. Target number of seeds per foot based on seed size with illustrations of seed size classes: large seed (left) to small seed (right).

Seeding rate also varies with the equipment used. The seeding rate for broadcast seeders (as opposed to drill seeders) is *twice* the full stand drill seeding rate listed in Tables 1 and 2. Drill seeding provides excellent seed-to-soil contact and has a higher likelihood of seedling germination and establishment. In contrast, broadcast seeders scatter seed on the soil surface (i.e., less optimal seed-to-soil contact) leaving them more vulnerable to the elements and predation. Thus, doubling the seed rate improves the potential of establishing the desired number of seedlings. Additionally, the seeding rate can vary with the conservation practice. For Critical Area Plantings (CPS 342), the seeding rate is up to *twice* the recommended broadcast or drill seed rate. See Field Office Technical Guide (eFOTG), Section IV, Practice Standards and Supporting Documents for required seeding rates by conservation practice and use WY-ECS-25 spreadsheet to calculate seeding mixes.

When calculating seed rates and ordering seed:

- Always order seed in PLS. PLS purchased for the conservation practice must be within 10% of the planned seeding rate for certification.
- Purchase proven selections and certified seed, when available.
- Ensure legume species have appropriate inoculant (see PM Tech Note 5 in *Resources* section).

Seeding Dates

Seeding dates are based on climatic records, research, experience, and represent optimum periods for grass, forb, legume, and/or shrub establishment. In Wyoming, seeding dates vary from north to south and east to west with variation in soil temperatures and moisture conditions. Figure 3 details precipitation zones in Wyoming, and Table 4 provides dryland seeding date recommendations by precipitation zone. In addition, Table 5 details irrigated pasture and hayland seeding date recommendations for Wyoming locations.

Dryland seedings in Wyoming are usually accomplished in the late fall or early spring to make use of available soil moisture. Dormant fall seedings are installed when soil temperatures two inches below the soil surface are 40 degrees for ten consecutive days and before soil freezing. The cool soil temperatures will prevent germination. Alternatively, early spring seedings may be installed as soon as the soil is workable (i.e., not frozen or saturated). Some species need a winter cold period before they will emerge; know the species preferred seeding time when planning seedings (Tables 1 through 3). See the Conservation Practices Standards and Specifications for details on required seeding dates per conservation practice.

Cover or Companion Crop

A cover crop is an annual residue-producing crop planted the growing season before seeding perennial vegetation. The purpose is to provide vegetative cover and residue for reducing weed competition, trapping snow and moisture, and providing soil protection from wind and water erosion. A cover crop is

terminated at a six-inch height by mowing, grazing, spraying, or frost. The standing residue of a cover crop provides an excellent micro-environment for the new seedlings without compromising the seedling's growth. It is important to consider that small grains and warm season grasses such as rye, sudangrass, and sorghum may create allelopathic (toxic) environments for new seedlings. However, when incorporated into a multi-species mix at appropriate rates their fibrous root system and above ground production may help mitigate specific resource concerns. Of the small grains, oats exhibit the least amount of allelopathic effect. In addition, warm season cover crop species such as sudangrass, sorghum, or millet can work effectively to combat annual grass competition.

A companion crop is an annual species planted with perennial species to provide a micro-environment of protection to nurse new perennial seedlings. Companion crops are generally discouraged on dryland sites because they are often seeded at too high a rate resulting in competition with new perennial seedlings for soil moisture and sunlight. When adding a companion crop in a dryland seeding, seeding rates should not exceed amounts provided in Table 1. Companion crops may be less damaging to perennial seedlings under irrigated conditions if they are seeded at low rates (i.e., less than half of the normal production crop seeding rate).

Seedbed Preparation

Seedbed preparation is the most important step in the seeding process. The ideal seedbed is uniformly firm, has soil moisture near the surface, is free from competing vegetation, well-firmed, and has small surface clods or light mulch (residue) to prevent erosion. The ideal soil is firm enough to allow good seed-to-soil contact and loose enough to allow seed to sprout and penetrate the soil. For example, an adult walking over the prepared seedbed should leave footprints approximately ¼ to ½ inch deep.

The presence of existing vegetation and weed populations, especially noxious weeds and/or annual grasses, will impact seedbed preparation. Each field should be evaluated for weed pressure and for fields with significant weed populations, seeding should be delayed until weeds are controlled. The most frequent cause of seeding failure and slow establishment is poor weed control. In addition, interseeding with no control of existing vegetation is not recommended because the existing plant competition usually leads to seeding failure. Weeds and existing vegetation may be controlled with herbicides, cover crops, grazing, and/or burning. When using herbicides, the previous two-year history of herbicide applications prior to seeding should be reviewed to determine any potential herbicide residual that may impact the seeding. Legumes and forbs are especially vulnerable to herbicide carryover. Delaying the seeding, establishing a cover crop and/or changing species are alternatives for addressing herbicide carryover.

Table 1. Species, seeds per pound, full stand seeding rates, and recommended selections for conservation seedings in Wyoming. All seeding rates are based on pure live seed (PLS) and 12-inch row spacings.

Common Name	Scientific Name	Origin[1]	Seeds/lb	Full Stand Drill Seed Rate[2] (PLS lb/ac)	PLS/sq. or linear foot[3]	Season[4] Site Timing	Proven Selections[5] / Notes
Grasses							
alkaligrass, Nuttall's	*Puccinellia nuttalliana*	N	2,100,000	1.0	48	C/I/NP	
alkali sacaton	*Sporobolus airoides*	N	1,750,000	1.0	40	W/D/NP	
barley, meadow	*Hordeum brachyantherum*	N	150,000	7.0	24	C/W/NP	
bentgrass, rough	*Agrostis scabra*	N	5,000,000	0.5	57	C/D/NP	
bluegrass, big	*Poa secunda* (*P. ampla*)	N	882,000	2.0	40	C/D/NP	Sherman
bluegrass, Canada	*Poa compressa*	I	1,600,000	1.5	55	C/I/NP	Reubens, Talon
bluegrass, Canby	*Poa secunda* (*P. canbyi*)	N	925,000	2.0	42	C/D/NP	Canbar
bluegrass, Kentucky	*Poa pratensis*	I	2,150,000	1.0	49	C/I/NP	Troy, Park, Newport
bluegrass, Nevada	*Poa secunda* (*P. nevadensis*)	N	1,029,000	2.0	47	C/D/NP	Opportunity
bluegrass, Sandberg	*Poa secunda* (*P. sandbergii*)	N	900,000	2.0	41	C/D/NP	High Plains, Reliable
bluestem, big	*Andropogon gerardii*	N	130,000	8.0	24	W/D/S	Bison, Bonilla, Champ, Pawnee
bluestem, little	*Schizachyrium scoparium*	N	260,000	4.0	24	W/D/S	Badlands, Blaze, Camper
bluestem, sand	*Andropogon hallii*	N	113,000	9.0	23	W/D/S	Garden, Goldstrike
brome, meadow	*Bromus biebersteinii*	I	93,000	10.0	21	C/E/NP	Cache, Fleet, MacBeth, Regar, Paddock
brome, mountain	*Bromus marginatus*	N	80,000	10.0	18	C/D/NP	Bromar, Garnet
brome, smooth	*Bromus inermis*	I	125,000	8.0	23	C/E/NP	Lincoln, Manchar
buffalograss	*Bouteloua dactyloides*	N	48,000	15.0	17	W/D/NP	Bison, Plains, Texoka, Cody, Bismarck
cordgrass, prairie	*Spartina pectinata*	N	183,000	6.0	25	W/I/NP	Red River
dropseed, sand	*Sporobolus cryptandrus*	N	5,680,000	1.0	130	W/D/NP	
fescue, hard	*Festuca brevipila*	I	565,000	2.0	26	C/D/NP	Durar
fescue, Idaho	*Festuca idahoensis*	N	450,000	2.5	26	C/D/NP	Joseph, NezPurs, Winchester
fescue, sheep	*Festuca ovina*	N	680,000	2.0	31	C/D/NP	Covar
fescue, tall[T]	*Schedonorus arundinaceus*	I	242,000	4.0	22	C/E/NP	Alta, Kenmont, Fawn
foxtail, creeping	*Alopecurus arundinaceus*	I	720,000	2.0	33	C/I/NP	Garrison, Retain
galleta grass	*Pleuraphis jamesii*	N	159,000	3.5	13	W/D/S	Viva
grama, blue	*Bouteloua gracilis*	N	825,000	2.0	38	W/D/S	Alma, Bad River, Birdseye
grama, sideoats	*Bouteloua curtipendula*	N	191,000	6.0	26	W/D/S	Butte, Pierre, Trailways, Killdeer
hairgrass, tufted	*Deschampsia cespitosa*	N	2,500,000	0.75	43	C/D/NP	Peru Creek
Indiangrass	*Sorghastrum nutans*	N	170,000	6.0	23	W/D/NP	Tomahawk
Indian ricegrass	*Achnatherum hymenoides*	N	235,000	5.0	27	C/D/np	Rimrock, Nezpar, Paloma, White River
needleandthread	*Hesperostipa comata*	N	115,000	9.0	24	C/D/NP	
needlegrass, Columbia	*Achnatherum nelsonii*	N	180,000	5.0	21	C/D/F	

Common Name	Scientific Name	Origin[1]	Seeds/lb	Full Stand Drill Seed Rate[2] (PLS lb/ac)	PLS/sq. or linear foot[3]	Season[4] Site Timing	Proven Selections[5] / Notes
needlegrass, green	*Nassella viridula*	N	186,000	6.0	26	C/D/F	Lodorm, Cucharas, AC Mallard
orchardgrass	*Dactylis glomerata*	I	464,000	2.5	27	C/I/NP	Chinook, Latar, Paiute, Potomac
prairie Junegrass	*Koeleria macrantha*	N	2,300,000	1.0	53	C/D/NP	
prairie sandreed	*Calamovilfa longifolia*	N	273,000	4.0	25	W/D/S	Goshen, Pronghorn
reed canarygrass[T]	*Phalaris arundinaceae*	N	602,000	2.0	28	C/I/NP	Loreed, Vantage, Castor, Palaton
ryegrass, perennial[T]	*Lolium perenne*	I	247,000	4.0	23	C/E/NP	Friend, Linn
squirreltail, bottlebrush	*Elymus elymoides*	N	192,000	5.0	22	C/D/NP	Fish Creek, Sand Hollow, Wapiti
switchgrass	*Panicum virgatum*	N	389,000	3.0	27	W/I/S	Dacotah, Forestburg, Sunburst
timothy	*Phleum pratense*	I	1,300,000	1.5	45	C/I/NP	Climax, Drummond, Engmo
wheatgrass, beardless	*Pseudoroegneria spicata* spp. *inermis*	N	145,000	7.0	23	C/D/NP	Whitmar
wheatgrass, bluebunch	*Pseudoroegneria spicata*	N	139,000	7.0	22	C/D/NP	Anatone, Goldar, P7
wheatgrass, crested (fairway)	*Agropyron cristatum*	I	200,000	5.0	23	C/D/NP	Ephraim, Fairway, Parkway, Roadcrest, Ruff
wheatgrass, crested desert	*Agropyron desertorum*	I	175,000	6.0	24	C/D/NP	Douglas, Nordan, Summit
wheatgrass (fairway x standard)	*Agropyron x hybrid*	I	175,000	6.0	24	C/E/NP	Hycrest, CD II, Hycrest II
wheatgrass, intermediate	*Thinopyrum intermedium*	I	79,000	10.0	18	C/E/NP	Greenar, Manifest, Oahe, Rush, Reliant
wheatgrass, pubescent	*Thino. intermedium* spp. *barbulatum*	I	80,000	10.0	18	C/E/NP	Luna, Manska, Greenleaf
wheatgrass, Siberian	*Agropyron fragile* (*A. sibericum*)	I	170,000	6.0	23	C/D/NP	P-27, Vavilov
wheatgrass, slender	*Elymus trachycaulus*	N	140,000	7.0	22	C/D/NP	Copperhead, Pryor, Revenue, San Luis, First Strike; also use as companion crop
wheatgrass, Snake River	*Elymus wawawaiensis*	N	135,000	7.0	22	C/D/NP	Secar
wheatgrass, streambank	*Elymus lanceolatus* spp. *riparius*	N	152,000	7.0	24	C/D/NP	Sodar
wheatgrass, tall	*Thinopyrum ponticum*	I	79,000	10.0	18	C/E/NP	Alkar, Jose, Largo, Orbit
wheatgrass, thickspike	*Elymus lanceolatus* spp. *lanceolatus*	N	152,000	7.0	24	C/D/NP	Critana, Bannock
wheatgrass, western	*Pascopyrum smithii*	N	93,000	10.0	21	C/E/NP	Rosana, Rodan
wildrye, Altai	*Leymus angustus*	I	80,000	10.0	18	C/D/NP	Ejay, Pearl, Prairieland
wildrye, basin	*Leymus cinereus*	N	144,000	7.0	23	C/D/NP	Trailhead, Washoe, Continental, Magnar
wildrye, beardless	*Leymus triticoides*	I	172,000	7.0	27	C/D/F	Shoshone
wildrye, blue	*Elymus glaucus*	N	134,000	7.0	22	C/E/NP	

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wildrye, Canada	*Elymus canadensis*	N	115,000	8.0	21	C/D/NP	Mandan
wildrye, Dahurian	*Elymus dahuricus*	I	88,000	10.0	20	C/D/NP	Arthur, James
wildrye, mammoth	*Leymus racemosus*	I	47,000	15.0	16	C/D/NP	Volga
wildrye, manystem	*Leymus multicaulis*	I	181,000	6.0	25	C/E/NP	Shoshone
wildrye, Russian[6]	*Psathyrostachys juncea*	I	170,000	6.0	23	C/D/NP	Bozoisky-Select, Mankota, Swift, Bozoisky II
wildrye, Virginia	*Elymus virginicus*	N	74,000	15.0	26	C/D/NP	Tober
Forbs / Legumes							
alfalfa[7, T]	*Medicago sativa*	I	225,000	5.0	26	E/NP	
alfalfa, yellow	*Medicago sativa* ssp. *falcata*	I	211,000	5.0	24	E/NP	
beeplant, Rocky Mountain	*Cleome serrulata*	N	64,000	13.5	20	E/F	
beeplant, yellow	*Cleome lutea*	N	101,000	11.0	25	D/F	
bergamot (bee-balm)	*Monarda fistulosa*	N	1,272,500	1.0	29	D/NP	
birdsfoot trefoil[T]	*Lotus corniculatus*	I	418,000	3.0	29	E/NP	Empire, Leo
black-eyed Susan	*Rudbeckia hirta*	N	1,746,000	0.8	32	E/NP	
blanketflower	*Gaillardia aristata*	N	186,000	6.0	26	D/NP	Meriwether
buckwheat, sulphur flower	*Eriogonum umbellatum*	N	140,500	9.0	29	E/NP	
clover, alsike[T]	*Trifolium hybridum*	I	700,000	1.5	24	E/NP	
clover, berseem	*Trifolium alexandrinum*	I	206,900	12.0	57	E/NP	
clover, crimson	*Trifolium incarnatum*	I	150,000	5.0	17	E/NP	
clover, red[T]	*Trifolium pratense*	I	275,000	4.0	25	E/NP	
clover, strawberry	*Trifolium fragiferum*	I	300,000	4.0	28	E/NP	
clover, white[T]	*Trifolium repens*	I	262,000	4.0	24	E/NP	
flax, blue[T]	*Linum perenne*	I	278,000	3.5	24	D/NP	
flax, Lewis[T]	*Linum lewisii*	N	294,000	3.5	24	D/NP	
globemallow, scarlet	*Sphaeralcea coccinea*	N	500,000	2.0	23	D/F	
goldeneye, showy	*Heliomeris multiflora*	N	1,000,000	1.0	23	D/F	
lupine, silky[T]	*Lupinus sericeus*	N	20,000	20.0	9	D/F	
lupine, silver[T]	*Lupinus argenteus*	N	126,000	8.6	25	D/F	
milkvetch, Canada[T]	*Astragalus canadensis*	N	270,000	4.0	25	D/F	
milkvetch, cicer[T]	*Astragalus cicer*	I	124,000	8.0	23	E/NP	Lutana, Monarch, Windsor
milkweed, showy[T]	*Asclepias speciosa*	N	75,000	15.0	26	E/NP	
penstemon, firecracker[T]	*Penstemon eatonii*	N	315,000	3.0	22	D/F	Richfield
penstemon, fuzzytongue[T]	*Penstemon eriantherus*	N	358,000	3.0	25	D/F	Old Works
penstemon, Palmer's[T]	*Penstemon palmeri*	N	294,000	2.0	20	D/F	Cedar

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penstemon, Rocky Mountain[T]	*Penstemon strictus*	N	478,000	2.0	22	D/F	Bandera
penstemon, Venus[T]	*Penstemon venustus*	N	1,090,000	2.0	50	D/F	Clearwater
phacelia, lacy	*Phacelia tanacetifolia*	I	245,000	4.0	22	E/NP	
phacelia, silverleaf	*Phacelia hastata*	N	153,000	7.0	24	D/F	
prairie clover, purple	*Dalea purpurea*	N	317,000	3.5	25	D/NP	Kaneb, Bismarck
prairie clover, white	*Dalea candida*	N	278,000	4.0	26	D/NP	Antelope
prairie coneflower	*Ratibida columnifera*	N	600,000	2.0	28	D/NP	Stillwater
purple coneflower	*Echinacea angustifolia*	N	128,000	9.0	26	D/F	
sainfoin (without pods)	*Onobrychis viciifolia*	I	30,240	21.0	14	E/NP	Eski, Melrose, Remont, Shoshone, Delaney
sainfoin (with pods)	*Onobrychis viciifolia*	I	18,500	34.0	14	E/NP	
small burnet	*Sanguisorba minor*	I	55,000	15.0	19	D/NP	Delar
sunflower, annual[T]	*Helianthus annuus*	N	81,000	13.0	22	D/NP	
sunflower, Maximilian[T]	*Helianthus maximiliani*	N	250,000	4.0	23	D/NP	Prairie Gold, Medicine Creek
sweetclover, yellow[T]	*Melilotus officinalis*	I	262,000	4.0	24	E/NP	
sweetclover, white[T]	*Melilotus alba*	I	258,000	4.0	24	E/NP	
sweetvetch, northern	*Hedysarum boreale*	N	34,000	25.0	19	D/NP	Timp
tansyaster, hoary	*Machaeranthera canescens*	N	1,300,000	1.0	29	D/NP	Amethyst
vetch, America	*Vicia americana*	N	33,000	33.0	25	D/F	
vetch, hairy[T]	*Vicia villosa* subsp. *villosa*	I	16,300	27.0	10	E/F	
yarrow, western	*Achillea millefolium*	N	2,850,000	0.25	25	D/NP	Great Northern
Shrubs							
kochia, forage (Immigrant)	*Bassia prostrata* spp. *vivescens*	N	400,000	2.0	18	D/NP	Immigrant
kochia, forage (Snowstorm)	*Bassia prostrata* spp. *grisea*	N	324,000	1.5	11	D/NP	Snowstorm
rabbitbrush, green (yellow)	*Chrysothamnus viscidiflorus*	N	782,000	1.0	18	D/NP	
rabbitbrush, rubber	*Ericamera nauseosa*	N	693,000	1.0	16	D/NP	
sagebrush, basin big[T]	*Artemisia tridentata* ssp. *tridentata*	N	2,400,000	0.5	28	D/NP	
sagebrush, big[T]	*Artemisia tridentata*	N	2,500,000	0.5	29	D/NP	
sagebrush, Wyoming big[T]	*Artemisia tridentata* ssp. *wyomingensis*	N	2,400,000	0.5	28	D/NP	
sagebrush, black	*Artemisia nova*	N	952,700	0.5	11	D/NP	
sagebrush, little	*Artemisia arbuscula*	N	972,000	1.0	22	D/NP	
sagebrush, silver	*Artemisia cana*	N	850,000	1.0	20	D/NP	
saltbush, four wing (de-winged)[T]	*Atriplex canescens*	N	44,000	4.0	4	D/F	

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saltbush, four wing (winged) [T]	*Atriplex canescens*	N	22,000	8.0	4	D/F	
saltbush, Gardner's[T]	*Atriplex gardneri*	N	111,500	1.0	3	D/F	
saltbush, trident (basin) [T]	*Atriplex tridentata*	N	65,000	5.0	7	D/F	
spiny hopsage	*Grayia spinosa*	N	347,000	1.0	8	D/F	
winterfat (naked)	*Krascheninnikovia lanata*	N	93,000	3.0	6	D/F	
winterfat (fluffy)	*Krascheninnikovia lanata*	N	54,000	6.0	6	D/F	
yucca	*Yucca glauca*	N	25,000	8.0	5	D/F	
Cover Crops						**Seeding Date / Notes**	
Austrian winter pea	*Pisum sativum*	I	2,000	100.0	5	March 15 to June 1	
Barley	*Hordeum vulgare*	I	11,223	36.0	9	April 1 to July 1; Aug 15 to Sept 1	
Millet	*Panicum* or *Pennisetum* spp.	I	81,000	10.0	19	May 15 to July 15	
Oats, spring or winter	*Avena sativa*	I	15000	24.0	8	April 15 to June 1; Aug 15 to Sept 1	
Sorghum, grain	*Sorghum bicolor*	I	16711	8.0	3	May 15 to July 15	
Sudangrass	*Sorghum bicolor var.*	I	17,300	8.0	8	May 15 to July 15	
Triticale or QuickGuard	*Triticum aestivum x Secale*	I	13000	35.0	10	Aug 15 to Sept 15	
Triticale, Regreen	*Triticum aestivum x Elytrigia*	I	11000	25.0	6	Aug 15 to Sept 15	
Wheat, spring or winter	*Triticum aestivum*	I	11400	36.0	10	April 1 to June 1; Aug 15 to Sept 1	
Companion Crops							
Barley	*Hordeum vulgare*	I	11,223	10.0	3	April 1 to July 1; Aug 15 to Sept 1	
Oats, spring or winter	*Avena sativa*	I	15,000	10.0	3	April 15 to June 1; Aug 15 to Sept 1	
Wheat, spring or winter	*Triticum aestivum*	I	11,400	15.0	4	April 1 to June 1; Aug 15 to Sept 1	
wheatgrass, slender	*Elymus trachycaulus*	N	140,000	1.0	3	See Precipitation / Zone Timing (Figure 3, Table 4)	

[1]Origin: N = Native, I = Introduced.

[2] Recommended full stand (monoculture) seeding rate to result in the desired number of seeds per linear or square foot. Seed rate is in pure live seed (PLS) per acre where PLS = % seed purity x % seed germination (aka viability). All seeding rates are for 12-inch row spacing.

[3] Desired amount of pure live seed (PLS) per square foot is based on the size class of seed. Since 12-inch row spacings are used, the rate per square foot is the same as the rate per linear foot. Adjust the seeding rate if other row spacings are used (see WY-ECS-25 to adjust seed rate by row spacing).

[4] *Season*: W = warm season species, C = cool season species; *Site*: I = Irrigated, D = Dryland, E = either irrigated or dryland, W = wetland; *Preferred Seed Timing*: S = spring, F = fall, NP = no preference.

[5] Proven Selections include cultivars, tested-class, selected-class, and germplasm level plant releases to the commercial market. These have undergone research to assess their characteristics and establishment success for addressing resource concerns.

[6] Minimum row-spacing (width) is 18 inches.

[7] Alfalfa should have a fall dormancy rating of three (3) or less. See the latest Certified Alfalfa Seed Council Fall Dormancy and Pest Resistance ratings.

[T] Species with known toxic properties. See *Plants Poisonous to Livestock in Montana and Wyoming, Considerations for Reducing Production Losses* for more information.

Table 2. Species, seeds per pound, and full stand seeding rates for species known to exist in Wyoming's Ecological Sites that may be included in conservation seedings. However, use caution when selecting these species for conservation seedings because they do not have proven selections for Wyoming (i.e., their establishment success and pedigree is not known at this time). These species may be added to a seed mix to improve site diversity; however, they may be slow or poor at establishing, have limited commercial seed availability, and/or limited seed quantities available (i.e., seed available in gram amounts/seed packets only).

Common Name	Scientific Name	Origin[1]	Seeds/lb	Full Stand Drill Seed Rate[2] (PLS lb/ac)	PLS/sq. or linear foot[3]	Season[4] Site Timing	Notes[5]
Grasses							
bluegrass, fowl	*Poa palustris*	N	1,900,000	0.5	22	C/I/NP	
bluegrass, mutton	*Poa fendleriana*	N	890,000	2.0	41	C/D/F	
cordgrass, alkali	*Spartina gracilis*	N	105,000	5.0	12	C/W/S	
dropseed, prairie	*Sporobolus heterolepis*	N	1,200,000	1.0	28	W/D/F	
fescue, rough	*Festuca campestris*	N	171,000	6.0	24	C/D/NP	
fescue, Rocky Mountain	*Festuca saximontana*	N	450,000	1.0	10	C/D/NP	
fescue, spike	*Leucopoa kingii*	N	200,000	7.0	23	C/D/NP	
foxtail, meadow	*Alopecurus pratensis*	I	500,000	2.5	29	C/I/NP	
grama, hairy	*Bouteloua hirsuta*	N	800,000	1.5	28	W/D/S	
lovegrass, sand	*Eragrostis trichodes*	N	1,500,000	1.0	35	W/D/S	
mannagrass, American	*Glyceria grandis*	N	1,280,000	1.0	37	C/W/F	
mannagrass, tall	*Glyceria striata*	N	1,600,000	1.0	37	C/W/F	
muhly, alkali	*Muhlenbergia asperifolia*	N	1,500,000	0.75	26	C/W/S	
muhly, mountain	*Muhlenbergia montana*	N	1,500,000	0.75	26	C/W/S	
needlegrass, Letterman's	*Achnatherum lettermanii*	N	225,000	5.0	26	C/D/F	
reedgrass, bluejoint	*Calamagrostis canadensis*	N	3,800,000	0.5	26	C/W/F	
reedgrass, northern	*Calamagrostis stricta*	N	3,500,000	0.5	40	C/W/F	
sloughgrass, American	*Beckmannia syzigachne*	N	238,000	5.0	28	C/W/F	
timothy, alpine	*Phleum alpinum*	N	1,044,690	1.0	24	C/W/F	
Forbs / Legumes							
aster, gray	*Eurybia glauca*	N	800,000	1.0	18	D/NP	
aster, hairy golden	*Heterotheca villosa*	N	336,500	3.2	25	D/NP	
aster, New England	*Symphyotrichum novae-angliae*	N	1,100,000	1.4	35	E/NP	
balsamroot, arrowleaf	*Balsamorhiza sagittata*	N	58,400	11.0	15	D/F	
balsamroot, cutleaf	*Balsamorhiza macrophylla*	N	55,000	18.0	22	D/F	
balsamroot, Hooker's	*Balsamorhiza hookeri*	N	55,000	18.0	22	D/F	
biscuitroot, fernleaf	*Lomatium dissectum*	N	45,000	24.0	25	D/F	
biscuitroot, Gray's	*Lomatium grayi*	N	45,000	24.0	25	D/F	

Common Name	Scientific Name	Origin[1]	Seeds/lb	Full Stand Drill Seed Rate[2] (PLS lb/ac)	PLS/sq. or linear foot[3]	Season[4] Site Timing	Notes[5]
biscuitroot, nineleaf	*Lomatium triternatum*	N	42,000	24.0	25	D/F	
blazing star, dotted	*Liatris punctata*	N	136,000	7.5	23	D/NP	
blazingstar, ten-petal	*Mentzelia decapetala*	N	328,500	3.3	25	D/F	
buckwheat, parsnipflower	*Eriogonum heracleoides*	N	170,000	7.0	27	D/F	
buckwheat, whorled	*Eriogonum heracleoides*	N	135,700	4.0	13	D/F	
columbine, Colorado blue	*Aquilegia coerulea*	N	368,000	3.0	24	W/F	
crownvetch	*Coronilla varia*	I	140,000	8.0	26	E/NP	
curlycup gumweed[T]	*Grindelia squarrosa*	N	410,000	3.0	28	D/F	
dustymaiden, Douglas	*Chaenactis douglasii*	N	342,500	3.0	24	D/F	
evening primrose, common	*Oenothera biennis*	N	1,376,000	1.4	44	D/NP	
evening primrose, pale	*Oenothera pallida*	N	700,000	1.5	24	D/NP	
evening primrose, tufted	*Oenothera caespitosa*	N	1,300,000	1.0	30	D/F	
geranium, sticky	*Geranium viscosissimum*	N	55,000	1.4	2	D/F	
giant hyssop, nettleleaf	*Agastache urticifolia*	N	1,400,000	1.0	32	E/NP	
globemallow, Munro's	*Sphaeralcea munroana*	N	365,800	2.0	23	D/F	
golden pea[T]	*Thermopsis montana*	N	30,600	7.3	5	D/F	
goldenrod, Canada	*Solidago canadensis*	N	4,600,000	0.5	53	E/NP	
goldenrod, gray	*Solidago nemoralis*	N	4,800,000	0.5	55	E/NP	
goldenrod, Missouri	*Solidago missouriensis*	N	2,000,000	1.0	46	E/NP	
goldenrod, stiff	*Oligoneuron rigidum*	N	735,000	1.4	24	D/F	
iris, Rocky Mountain[T]	*Iris missouriensis*	N	20,000	10.0	5	D/F	
Indian paintbrush, Wyoming[T]	*Castilleja linariifolia*	N	4,915,000	0.3	34	No Data	
leadplant	*Amorpha canescens*	N	90,000	1.0	2	E/NP	
milkweed, common	*Asclepias syriaca*	N	68,000	17.0	27	D/F	
milkweed, swamp	*Asclepias incarnata*	N	153,761	15.0	53	D/F	
penstemon, beardtongue[T]	*Penstemon grandiflorus*	N	550,000	4.0	51	D/NP	
penstemon, narrowleaf [T]	*Penstemon angustifolius*	N	313,000	3.5	25	D/F	
penstemon, littleflower[T]	*Penstemon procerus*	N	600,000	2.0	28	No Data	
scarlet gilia	*Ipomopsis aggregata*	N	360,000	6.0	50	D/F	
sunflower, Nuttall's[T]	*Helianthus nuttallii*	N	125,000	9.0	26	D/NP	
sunflower, oneflower[T]	*Helianthella uniflora*	N	41,000	26.0	25	D/F	
sunflower, stiff[T]	*Helianthus pauciflorus*	N	85,000	12.8	25	D/F	

Common Name	Scientific Name	Origin[1]	Seeds/lb	Full Stand Drill Seed Rate[2] (PLS lb/ac)	PLS/sq. or linear foot[3]	Season[4] Site Timing	Notes[5]
sweetvetch, silver	*Hedysarum boreale* spp. *mackenziei*	N	34,000	24.0	19	D/NP	
Shrubs							
ceanothus, snowbrush	*Ceanothus velutinus*	N	124,275	1.0	3	D/F	
sagebrush, mountain big[T]	*Artemisia tridentata* ssp. *vaseyana*	N	2,000,000	0.5	23	D/NP	
sagewort, cudweed[T]	*Artemisia ludoviciana*	N	4,500,000	0.25	26	D/NP	
sagewort, fringed[T]	*Artemisia frigida*	N	4,500,000	0.25	26	D/NP	
sagewort, green[T]	*Artemisia dracunculus*	N	4,500,000	0.25	26	D/NP	
saltbush, moundscale (de-winged) [T]	*Atriplex aptera*	N	49,000	4.0	5	D/F	
saltbush, moundscale (winged) [T]	*Atriplex aptera*	N	24,500	8.0	5	D/F	
saltbush, shadscale[T]	*Atriplex confertifolia*	N	61,000	5.0	7	D/F	

[1] Origin: N = Native, I = Introduced.

[2] Recommended full stand (monoculture) seeding rate to result in the desired number of seeds per linear or square foot. Seed rate is in pure live seed (PLS) per acre where PLS = % seed purity x % seed germination (aka viability). All seeding rates are for 12-inch row spacing.

[3] Desired amount of pure live seed (PLS) per square foot is based on the size class of seed. Since 12-inch row spacings are used, the rate per square foot is the same as the rate per linear foot. Adjust the seeding rate if other row spacings are used (see WY-ECS-25 to adjust seed rate by row spacing).

[4] *Season*: W = warm season species, C = cool season species; *Site*: I = Irrigated, D = Dryland, E = either irrigated or dryland, W = wetland; *Preferred Seed Timing*: S = spring, F = fall, NP = no preference.

[5] Notes: space provided for conservation planner notes.

[T] Species with known toxic properties. See *Plants Poisonous to Livestock in Montana and Wyoming, Considerations for Reducing Production Losses* for more information.

Table 3. Species typically established from potted container stock, 10 cubic inch plugs, cuttings, or transplants for conservation plantings in Wyoming. Seeds per pound, full stand seeding rates, and recommended selections are provided for reference. Seed availability may be limited for most species.

Common Name	Scientific Name	Origin[1]	Seeds/lb	Full Stand Drill Seed Rate[2] (PLS lb/ac)	PLS/sq. or linear foot[3]	Proven Selections[5] / Notes
Grasses						
bulrush, alkali	*Bolboschoenus maritimus*	N	162,600	8.0	30	
bulrush, chairmaker's	*Schoenoplectus americanus*	N	179,800	7.0	29	
bulrush, hardstem	*Schoenoplectus acutus*	N	377,600	4.0	35	
bulrush, panicled	*Schoenoplectus microcarpus*	N	4,500,000	0.5	52	
bulrush, softstem	*Schoenoplectus tabernaemontani*	N	550,000	2.0	25	
cattail	*Typha latifolia*	N	1,000,000	1.0	23	Seed collected locally and scattered
rush, Baltic	*Juncus balticus*	N	10,900,000	0.1	25	
rush, swordleaf	*Juncus ensifolius*	N	2,914,000	0.5	33	
saltgrass, inland	*Distichlis spicata*	N	519,000	4.0	48	Rhizome plantings
sedge, meadow	*Carex praegracilis*	N	664,900	1.5	23	
sedge, Nebraska	*Carex nebrascensis*	N	534,100	2.0	25	
sedge, slough	*Carex obnupta*	N	567,000	2.0	26	
sedge, water	*Carex aquatilis*	N	450,000	2.0	33	
sedge, wooly	*Carex pellita*	N	312,075	5.0	36	
spikerush, common	*Eleocharis palustris*	N	620,000	2.0	29	
Shrubs and Trees						
ash, green	*Fraxinus pennsylvanica*	N	17,260	N/A	N/A	Cardan
bitterbrush, antelope	*Purshia tridentata*	N	15,400	5.0	2	
boxelder	*Acer negundo*	N	13,400	N/A	N/A	
buffaloberry, silver	*Shepherdia argentea*	N	4,000	N/A	N/A	Sakakawea, Mill Creek
cinquefoil, shrubby	*Dasiphora fruticosa*	N	1,500,000	0.5	17	
chokecherry [T]	*Prunus virginiana*	N	4,800	10.0	1	
cottonwood, black	*Populus balsamifera* ssp. *trichocarpa*	N	no inform.	N/A	N/A	
cottonwood, narrowleaf	*Populus angustifolia*	N	1,000,000	N/A	N/A	
cottonwood, plains	*Populus deltoides* ssp. *monilifera*	N	364,500	N/A	N/A	
dogwood, redosier	*Cornus sericea*	N	18,500	2.0	1	
hawthorn, black	*Crataegus douglasii*	N	22,600	N/A	N/A	
juniper, common	*Juniperus communis*	N	36,500	N/A	N/A	
juniper, horizontal	*Juniperus horizontalis*	N	29,500	2.0	1	
juniper, Rocky Mountain	*Juniperus scopulorum*	N	27,100	N/A	N/A	Bridger-Select
mountain mahogany, curl-leaf [T]	*Cercocarpus ledifolius*	N	30,000	1.5	1	
oak, bur	*Quercus macrocarpa*	N	75	N/A	N/A	Ekalaka

plum, American	*Prunus americana*	N	870	N/A	N/A	
pine, ponderosa [T]	*Pinus ponderosa*	N	12,600	N/A	N/A	Hunter
rose, Wood's	*Rosa woodsii*	N	50,000	4.0	5	
serviceberry, Saskatoon	*Amelanchier alnifolia*	N	82,000	1.0	2	
silverberry [T]	*Elaeagnus commutata*	N	3,800	N/A	N/A	Dupuyer Streambank, Pondera
spirea, Douglas	*Spiraea douglasii*	N	1,030,400	N/A	N/A	
snowberry, common	*Symphoricarpos albus*	N	76,000	3.0	5	
snowberry, western	*Symphoricarpos occidentalis*	N	74,400	3.0	5	
sumac, skunkbush	*Rhus trilobata*	N	20,300	2.0	1	
willow	*Salix* spp.	N	2,500,000	N/A	N/A	

[1]Origin: N = Native, I = Introduced.

[2] Recommended full stand (monoculture) seeding rate to result in the desired number of seeds per linear or square foot. Seed rate is in pure live seed (PLS) per acre where PLS = % seed purity x % seed germination (aka viability). All seeding rates are for 12-inch row spacing.

[3] Desired amount of pure live seed (PLS) per square foot is based on the size class of seed. Since 12-inch row spacings are used, the rate per square foot is the same as the rate per linear foot. Adjust the seeding rate if other row spacings are used (see WY-ECS-25 to adjust seed rate by row spacing).

[4] *Season*: W = warm season species, C = cool season species; *Site*: I = Irrigated, D = Dryland, E = either irrigated or dryland, W = wetland; *Preferred Seed Timing*: S = spring, F = fall, NP = no preference.

[5] Proven Selections include cultivars, tested-class, selected-class, and germplasm level plant releases to the commercial market. These have undergone research to assess their characteristics and establishment success for addressing resource concerns.

[T] Species with known toxic properties. See *Plants Poisonous to Livestock in Montana and Wyoming, Considerations for Reducing Production Losses* for more information.

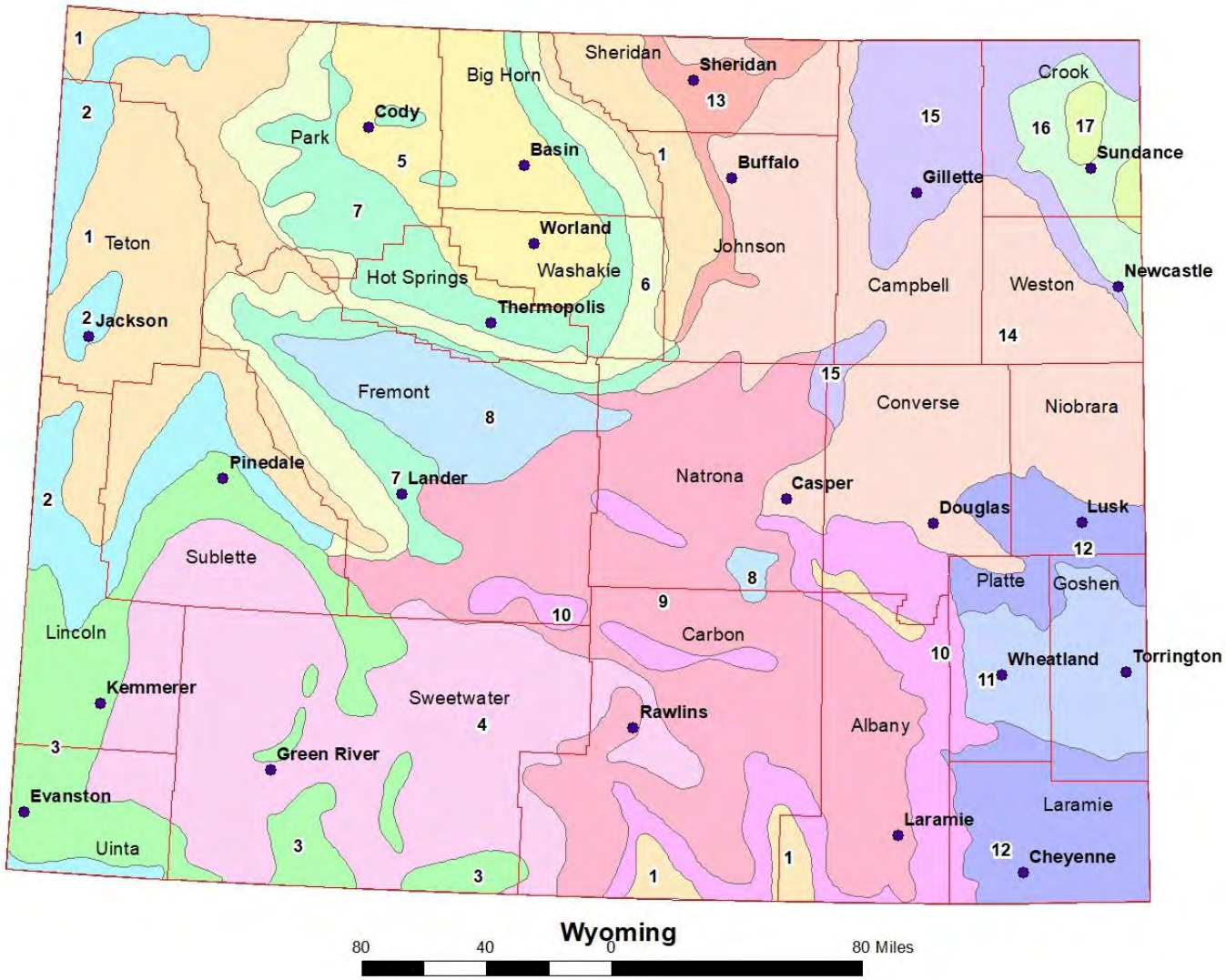

Figure 3. Precipitation zones for dryland seeding dates, USDS-NRCS, Wyoming.

Table 4. Dryland seeding dates by precipitation zone reflecting the earliest calendar date to seed in fall and latest date to seed in spring. Consider local weather patterns when selecting a seeding date within the seeding date ranges below. For example, during a warm, dry fall in Zones 14 or 15, seeding may be delayed until November as long as the ground is not frozen.

Precipitation Zone	Precipitation (inches)	Seeding Dates
1	20+	Anytime except 6/20 to 9/20
2	15 – 19	Anytime except 6/20 to 9/20
3	10 – 14	10/15 to 5/20
4	7 – 9	10/15 to 5/1
5	5 – 9	10/15 to 4/15
6	15 – 19	10/1 to 5/15
7	10 – 14	10/1 to 5/15
8	5 – 9	10/15 to 4/15
9	10 – 14	10/1 to 5/15
10	15 – 19	Anytime except 6/20 to 9/20
11	12 – 14	10/25 to 5/1
12	15 – 17	10/15 to 5/10
13	15 – 19	10/25 to 5/20
14	10 – 14	10/25 to 5/20
15	15 – 17	10/25 to 5/20
16	15 – 19	10/15 to 5/25
17	20 – 24	Anytime except 6/20 to 9/20

Table 5. Irrigated pasture and hayland seeding dates. Seeding date is approximately six weeks prior to fall 32°F mean temperature. Data from: Wyoming Climate Atlas, Water Resources Data System and State Climatic Office in cooperation with Wyoming Water Resources Center, University of Wyoming.

Location	Anytime Except:
Afton	August 1 to September 20
Baggs	August 1 to September 20
Buffalo	August 5 to October 25
Casper	August 5 to October 1
Cheyenne	August 15 to October 15
Cody	August 5 to October 15
Cokeville	August 1 to September 20
Douglas	August 5 to October 25
Dubois	August 5 to October 1
Farson	August 1 to September 20
Ft. Washakie	August 15 to October 1
Gillette	August 10 to October 25
Greybull	August 10 to October 15
Jackson	August 1 to September 20
Kaycee	August 1 to October 25
Lander	August 15 to October 1
Laramie	August 1 to September 20
Lovell	August 10 to October 15
Lusk	August 5 to October 15
Lyman	August 1 to September 20
Medicine Bow	August 1 to October 1
Newcastle	August 15 to October 25
Pinedale	August 1 to September 20
Powell	August 10 to October 15
Riverton	August 15 to October 15
Rock Springs	August 1 to September 20
Saratoga	August 1 to September 20
Sheridan	August 10 to October 25
Sundance	August 5 to October 15
Thermopolis	August 10 to October 15
Torrington	June 1 to Aug 10; Sep 1 to Oct 25
Wheatland	June 1 to Aug 10; Sep 1 to Oct 25
Worland	August 10 to October 25

Resources for Perennial Vegetation Establishment

All Montana-Wyoming Plant Materials Technical Notes can be found in Wyoming electronic Field Office Technical Guide (eFOTG) Section 1 (https://efotg.sc.egov.usda.gov/#/state/WY) and on the Montana - Wyoming Plant Materials Program website at:
https://www.nrcs.usda.gov/wps/portal/nrcs/mt/plantsanimals/nrcs144p2_057491/

Species Selection

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Conservation Plant Species for the Intermountain West. Plant Materials Technical Note PM-24. https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmstn10793.pdf

Dryland Pasture in Montana and Wyoming, Species and Cultivars, Seeding Techniques and Grazing Management. 2001 Booklet. https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/mtpmspu1138.pdf

Forage Suitability Groups, located Wyoming eFOTG, Section II, https://efotg.sc.egov.usda.gov/#/state/WY

Plant Species Suited for Revegetation by Ecological Site in Wyoming, 2019 Range Technical Note WY-3. https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/mtpmstn13483.pdf

Seed Source Selection, Use of Certified Seed, and Appropriate Seed Release Class Improve Conservation Planting Success. 2011 Plant Materials Technical Note MT-67. https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/mtpmctn10429.pdf

Standard and Preferred Forage and Reclamation Plants for Use in Montana and Wyoming. 2011 Plant Materials Technical Note MT-69. https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/mtpmctn10704.pdf

Web Soil Survey and Ecological Site Descriptions. http://websoilsurvey.nrcs.usda.gov.

Seed Rate and Seeding Date

Calculating Seeding Rates When Using Alternate-Row and Cross-Seeded Planting Techniques. 2014 Plant Materials Technical Note MT-78 https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/mtpmctn11274.pdf

How Seed Certification Improves the Success of NRCS Conservation Plantings. 2017 Plant Materials Technical Note MT-118. https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/mtpmctn13204.pdf

Guide for Understanding Seed Labels for Seeding Certification. 2021 Plant Materials Technical Note MT-125. https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/mtpmctn13828.pdf

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Using the Appropriate Legume Inoculant for Conservation Plantings. 2021 Plant Materials Technical Note 5. https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/natpmtn13723.pdf

Reading Seed Packaging Labels and Calculating Seed Mixtures, 2002 Plant Materials Technical Note PM-4. https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmstn04265.pdf

Seedbed Preparation

Pasture and Range Seedings: Planning, Installation, Evaluation, and Management. 2011 Plant Materials Technical Note PM-10. https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=nrcseprd401859&ext=pdf

Principles of Seedbed Preparation for Conservation Seedings, Plant Materials Technical Note PM-13. https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmctn10748.pdf