TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE
PLANT MATERIALS - 7 SPOKANE, WASHINGTON
FEBRUARY, 2005

SEED QUALITY, SEED TECHNOLOGY, AND DRILL CALIBRATION

This Technical Note is a compilation of portions of several old Technical Notes and Technical Notes from adjacent states that addressed seed quality, seed technology, and drill calibration.

This Technical Note #7 is subdivided into the following Sections:

Section 7.1 **Seed Quality**
Section 7.2 **Seed Technology – Rice Hulls, Cracked Grain, Granular Clay & Germination Enhancers**
Section 7.3 **Drill Calibration**

SECTION 7.1 Seed Quality

High quality seed germinates well, has a high purity standard, and is free of noxious weeds.

Purity, inert matter, weed seed, other crop seed and hard seed percentages are shown on the seed tag – they add up to 100%.

Purity is the percentage of seed without dirt, dust, chaff, straw, empty kernels, weed, other crops and other foreign matter.

Inert Matter is the percentage by weight of broken seeds one half or less in size and all other foreign matter.

Weed Seeds is the percentage by weight of seeds considered weeds by law.

Noxious Weeds are those weed species that are officially listed on the state noxious weed list by the Washington Department of Agriculture.

Other Crop Seeds are those other than the specified crop as labeled.

Hard Seeds are those of the labeled crop that remain sound but do not germinate at the end of the test periods. They may germinate later.

Germination is the percentage of the pure seed which has germinated by the end of the specified test period. Germination declines with the age of the seed and certain storage conditions – always check the date of the seed test printed on the tag. It is not legal to sell or offer certified seed for sale in Washington if the seed test is older than 15 months.

Pure Live Seed (PLS) considers both purity and germination and is a real indicator of seed quality. Pure Live Seed is the basis that seeding recommendations are provided in all seeding guides. It is determined by multiplying the purity times germination and dividing by 100.

(Purity x Germination) / 100 = percent Pure Live Seed

Use Good Seed!

Seed never reaches 100% PLS. Slight amounts of inert matter, other crop seed and even weed seed are the norm in every seed lot. Also, rarely do we encounter seed lots that have 100% germination. Good quality seed of MOST conservation species is generally above 95% purity and 85% germination.

(95 purity x 85 germination) / 100 = 80.75% PLS

Cleaning research seed. Photo courtesy of Fermilab Ecological Land Management Committee.

Seed of some conservation species and many native forbs and shrubs are very difficult to clean. Purities may be very low. For example, big sage (Artemisia tridentata) has very small seeds and is difficult to efficiently clean. Purities of big sage seed on the market might be in the 10-25% range. Germination may be quite low as well. Some native species have a high percentage of dormant seeds that will not germinate in the specified test period.

Seeding rates are almost always based upon Pure Live Seed percentages. Always adjust bulk seeding rates to reflect Pure Live Seed rates. The calculation is relatively simple:

(PLS seed rate / PLS percentage) x 100 = Bulk Seed Rate

Example: Sherman big bluegrass with 70% PLS, Desired seeding rate of 3 PLS lb/acre

(3 PLS / 70) x 100 = 4.3 lb/acre Bulk Seed Rate

SECTION 7.2 Seed Technology - Rice Hulls, Cracked Grain, Granular Clay & Germination Enhancers

<u>Seed Flow Improvement Agents /Seed Dilutants</u>
Seeds of many conservation plants do not flow well out of the drill. Odd shapes, small seed size, rough seed coats, and awns all interfere with flow. Seed mixes further complicate the situation.

Rice hulls, cracked grain, vermiculite, and granular clay products such as kitty litter and "Shop Dry" are common additives that can improve seed flow. Most seed dealers are happy to provide flow agents but they may require a little notice because some flow agents may need to be ordered.

Rice hulls are more-or-less the industry standard. They are inexpensive and easy to use. There are different grades of rice hulls. Number 1 hulls should be used. Lower grade hulls are trashy and can impede rather than improve seed flow.

Cracked grain is available at many vendors but usually more costly then rice hulls. Cracked grain can vary considerably in size which complicates calibration.

Expanded vermiculite was a pretty common insulation material and could be found at most lumber yards. Vermiculite was also fairly inexpensive. It is not a very good material for improving seed flow. Expanded vermiculite varies in size and the dust is not healthy to breathe.

Kitty litter and "Shop Dry" are granular clay products that have proven useful for improving seed flow. They flow well and are virtually eliminate bridging problems. Seed vendors that carry granular clay usually will mix seed and the clay at the warehouse, and provide suggestions for drill settings.

Seed flow additives that come in small containers such as graphite products are intended for use on agronomic crops. These products have limited use for improving seed flow of conservation species.

Regardless of whether a seed flow improvement agent is added to the seed or not, it is imperative to not over-fill the drill! Never fill a drill more than 1/3 - ½ full. Filling a drill to the top is a leading cause for bridging and separation of seed. Seed box agitators don't always function well so it is wise to periodically stir the contents. A hoe works well for this task and is easily attached to the drill with a bungee cord.

<u>Germination Enhancers</u>
Seed germination can be improved for many species by treating the seed. One of the most common seed treatments is seed scarification.

Seed scarification is a process that is used to improve water uptake. Seeds are rubbed against an abrasive surface to nick the seed coat. Many legumes have hard seed coats and scarification is needed for improved germination. Scarification can be detrimental to the seed storage life so the seed should be planted soon after scarification.

Stratification is a process that is used to break seed dormancy. Seeds are wetted and introduced to specific storage temperatures. For example, some alpine species require the wetted seed to be stored for several weeks at near freezing temperatures. Shrubs and trees frequently require stratification for high levels of germination.

Osmoconditioning and *Matriconditioning* are processes that are used to decrease the amount of time required for high levels of germination. Seeds are treated with chemicals that allow a controlled amount of water to enter the seed but not allow germination to occur. The treated seeds are seeded to the field and germination occurs very soon afterwards. Osmoconditioning has fallen into disfavor since the development of matriconditioning technology. Commercial vegetable growers employ matriconditioning on a regular basis. It is fairly expensive and the protocols are species specific so few protocols have been developed for grasses.

Seed Coatings are products that are added to seed to provide specific benefits. Fungicides, polymers, and amorphous clay are some of the more common seed coatings. Fungicides are very commonly added to seeds of conservation species to prevent smuts and other diseases. Polymers are becoming popular in areas where germination needs to be delayed. For example, a wax-based polymer is added to certain grasses that are fall seeded in New England. This prevents the seed from germinating in the fall and dying. Seeds over-winter, the polymer degrades, and the seed germinates in the spring when conditions are too wet for seeding operations. Amorphous clay coatings more-or-less increase the size of the seed. These products are useful for seeds that are easily damaged by traditional seeding operations.

SECTION 7.3   Drill Calibration

CALIBRATING A SEED DRILL FOR CONSERVATION PLANTINGS

Loren St. John, PMC Team Leader, Aberdeen, Idaho
Dan Ogle, Plant Materials Specialist, Boise, Idaho
Larry Holzworth, Plant Materials Specialist, Bozeman, Montana
Mark Stannard, PMC Manager, Pullman, Washington
Jim Cornwell, State Range Conservationist, Boise, Idaho

USDA NRCS OCTOBER 2005

Introduction

Many species of grasses, forbs, legumes and shrubs are planted to help solve resource problems. Some examples include seeding highly erodible cropland to permanent vegetative cover, seeding forages for irrigated pasture or hay, establishing permanent perennial vegetation on rangeland and planting critical areas such as roadsides, winter feedings areas or grassed waterways. To achieve the desired outcome of a seeding practice, an important step is calibration of the seeding equipment so that the recommended amount of seed is uniformly planted.

Seeding rate recommendations are often given in pounds of Pure Live Seed (PLS) per acre. PLS seeding rates must be converted to bulk pounds per acre in order to calibrate planting equipment. Planting equipment varies considerably among cooperators so it is also important to become familiar with the equipment being used.

General rules of thumb are used in setting PLS seeding rates. Seed mixtures commonly have both large and small seeded species. The following rules are used to establish those rates:

Large seed < 500,000 seeds/lb – 20-30 seeds/ft^2 = 12 seeds/ft at 6" row spacing
= 24 seeds/ft at 12" row spacing

Small seed > 500,000 seeds/lb – 40-50 seeds/ft^2 = 24 seeds/ft at 6" row spacing
= 48 seeds/ft at 12" row spacing

Critical area plantings – use 1.5 to 2 times the drill seeding rates shown above.

There are different methods to calibrate a drill.

Method #1: Determine the seeds per foot of row.

Method #2: Run the drill a given distance, weigh the seed dropped, then convert to pounds per acre.

Method #3: Determine the drive wheel circumference, turn it a given number of times, weigh the seed dropped, then convert to pounds per acre.

Rice Hulls. Photo courtesy of University of Arkansas.

Method #4: Fill the drill with a weighed amount of seed, seed a measured area, reweigh what is left in the drill, then calculate the pounds per acre.

Method #5: Calculate a rice hull to seed ratio, then set the drill for seeding barley.

Method #6: Consult the seed chart on the inside of the drill cover.

Most people try to use Method #6 because drills generally have a handy chart glued to the inside of the cover and it will list some species, along with seeding rates and drill settings. The charts work well for crops like barley, wheat and sorghum. Unfortunately, the charts DO NOT work well for conservation seedings. Many conservation seedings are mixtures of species. These mixtures have different sized seeds. Some species flow better than others and many times we need to add dilutants such as rice hulls or cracked grain to the seed mix in order for the drill to operate efficiently.

This technical note provides information on preferred calibration methods (Methods #1 thru #5) and the steps required to calibrate seeding equipment for each. It also provides examples to assist the planner and cooperator with drill calibration to complete successful seedings that help solve resource problems.

Preliminary Steps in Calibration

Preliminary Step 1 - become familiar with the drill(s) being used. Perform necessary maintenance and check to ensure the drill is in proper operating condition. You can expect to find rusty openers that inhibit seed flow, overzealous greasing and oiling that will interfere with seed flow, and tubes clogged with nesting materials from field mice. Ask the cooperator what species, rates and settings they have used previously or refer to the seed chart with the drill for settings. If the seed mix includes rice hulls, a setting for barley will be a good starting point as mixtures with rice hulls generally flow about the same as barley. This information will provide a good starting point to begin calibration.

Check drill gates or flaps to ensure they are in the proper position for the size and kind of seed being planted and start calibration from a wide-open position and close down to the desired position.

Preliminary Step 2 - determine the bulk seeding rate per acre. Based on the PLS seeding recommendation from the Field Office Technical Guide, Idaho Plant Materials Technical Note No. 24, determine the PLS seeding rates for the mixture. PLS information (purity and viability) will be on the seed tag or seed analysis report. If a carrier such as rice hulls is being used, the amount of rice hulls in the seed mix also needs to be known.

Refer to Idaho Plant Materials Technical Notes: No. 4, Reading Seed Packaging Labels and Calculating Seed Mixtures; No. 7, Grass Legume–Forb Seed Dilution with Rice Hulls; No. 14, Seed Production Standards for Conservation Plants in the Intermountain West; and No. 24, Grass, Grass-Like, Forb, Legume and Woody Species for the Intermountain West for details in determining bulk seeding rates.

To calculate bulk seeding rate use the following formula:

PLS pounds per acre ÷ percent PLS = Bulk seeding rate per acre

Example:

A seeding recommendation for a grass/alfalfa mix is 7.5 pounds PLS/ac meadow brome and 1.25 pounds PLS/ac alfalfa. Percent PLS for meadow brome as determined from the seed tag is 85 % and alfalfa is 90 %. (PM TN No. 4)
Meadow brome
7.5 pounds PLS per acre ÷ 85 % PLS = 8.8 bulk pounds per acre

Alfalfa
1.25 pounds PLS per acre ÷ 90 % PLS = 1.4 bulk pounds per acre

Rice hulls needed for this mix is 5.1 pounds per acre (PM TN No. 7)

Calibration Methods

Method 1 - Seed per Linear Row Foot

First calculate a row spacing factor based upon the row spacing of the drill. The row spacing factor converts square feet into linear feet based upon the drill spacing. The row spacing factor is calculated as follows:

$$\text{Row spacing factor} = \frac{\text{522,720 linear inches of row/ac at 12 inch spacing}}{\text{Drill spacing (inches)}}$$

Example:

Using a drill with 7 inch row spacing, the row spacing factor is

$$\frac{522{,}720}{7} = 74{,}674$$

Next, calculate the number of seeds per linear row foot with the following formula:

$$\frac{\text{Pounds bulk seed/ac x no. seeds per pound}}{\text{Row spacing factor}}$$

The pounds bulk seed per acre will have been previously calculated based upon the seeding recommendation and the number of seeds per pound can be found in Table 1 in this document as well as Plant Materials Technical Note No. 24, Grass, Grass-Like, Forb, Legume and Woody Species for the Intermountain West.

Example:

Meadow brome 8.8 pounds bulk per acre, 93,000 seeds per pound

$$\frac{8.8 \times 93{,}000}{74{,}674} = 10.9 \text{ (round to 11) seeds per foot with 7 inch row spacing}$$

Alfalfa 1.4 pounds bulk per acre, 200,000 seeds per pound

$$\frac{1.4 \times 200{,}000}{74{,}674} = 3.7 \text{ (round to 4) seeds per foot with 7 inch row spacing}$$

Once the desired number of seeds per foot of drill row has been calculated for each species in the mixture, set the initial setting on the drill. The initial setting will be based upon the drill seeding chart or discussion with the cooperator. Release tension on the disks on the drill, and run the drill for at least 20 feet on a clean hard surface protected from wind at the normal planting speed. Make sure that all the drill flutes are feeding properly. Stop the drill and count seed from each species along a distance of 5 feet from 4 rows (two on each side of the drill) to get an average of the number of seeds of each species per foot. Make adjustments to the drill and repeat the above procedure until seed counts are within 10 percent of the desired rate. Check results with one more trial at the same setting.

If a seeding project is using different drills or with different row spacing, calibration will need to be done for each drill. If row spacing is different among drills, the number of seeds per foot will also need to be calculated for each drill with different row spacing. If during the calibration process, one species is consistently short, check to make sure the seed mixture is thoroughly mixed. Be sure to record the drill settings for future reference.

Method 2 - Seed Weight-Distance

First compute the area of a 100 foot test run based upon the drill width of the drill to be used for the seeding.

$$\frac{\textbf{Drill width (feet) x 100 foot test run}}{\textbf{43,560 ft}^2\textbf{/ac}} = \textbf{acreage of test run}$$

Example:

$$\frac{\text{10 foot drill x 100 foot test run}}{43{,}560 \text{ ft}^2/\text{ac}} = 0.02 \text{ ac}$$

Next, calculate the amount of seed mixture required for test run.

Meadow brome	8.8 bulk pounds per acre
Alfalfa	1.4
Rice hulls	5.1
Total	15.3 bulk pounds per acre

15.3 x 0.02 ac = 0.306 pounds of seed mix for test run

Then, determine the amount of seed that will be delivered through each drill spout during the test run.

Pounds of mix for test run = pounds of mix per spout
Number of spouts on drill

0.306 pounds of seed mix for test run = 0.0306 pounds mix per spout
10 spouts on drill

Since a small amount of seed is being weighed, it is desirable to convert the amount to grams (0.0306 pounds x 454 grams/pound = 13.89 grams per spout for 100 foot test run).

Then, you need to measure and stake off 100 feet and run the drill for at least 6 feet before coming to the first stake. Stop and remove the drill spouts to be weighed from the disks and place a container under the spouts to collect the seed. Drive at a constant speed (the same speed that seeding will take place). Measure a minimum of 2 spouts on each side of drill. Stop and weigh seed from each of the spouts and check with calculated amount. Make necessary adjustments in the drill settings. As with the previous method, make adjustments to the drill and repeat the above procedure until seed weight is within 10 percent of the desired rate. Check results with one more trial at the same setting. If during the calibration process, one species is consistently short, check to make sure the seed mixture is thoroughly mixed. Be sure to record the drill settings for future reference.

A modification to this method, known as the catch-all method, basically involves removing all the spouts and collecting seed from each spout during the calibration trial. The target rate would be the total pounds of seed mix for the test run as shown above (0.306 pounds).

Method 3 - Wheel Circumference

Photo courtesy of University of Arkansas Department of Agronomy.

This method involves measuring the drill drive wheel or coulter circumference (perimeter) in feet and determining the number of revolutions the wheel must turn to equal the distance equivalent to 1/100 of an acre. This method only works on drills where the drive wheel can be turned by hand without pulling the drill.

First, determine the distance needed to cover 1/100 of an acre use the following equation:

$$\mathbf{\frac{0.01\ ac \times 43{,}560\ ft^2/ac}{drill\ width\ (feet)} = distance\ of\ test\ run}$$

Example:

$$\frac{0.01\ ac \times 43{,}560\ ft^2/ac}{10\ foot\ drill} = 43.6\ feet$$

Once the distance of the test run is determined, you need to measure the circumference (perimeter) of the drive-wheel and determine the number of revolutions the drill drive wheel must turn to equal the distance of the test run. The calculation for determining the number of rotations is:

$$\mathbf{\frac{Distance\ of\ test\ run\ (feet)}{Wheel\ circumference\ (feet)} = number\ of\ drive\ wheel\ rotations\ for\ test\ run}$$

Example:

$$\frac{43.6\ feet}{4.7\ feet} = 9.3\ wheel\ rotations\ for\ test\ run$$

Note: measurements of test run length and wheel circumference should be to the nearest tenth of a foot to insure reasonable accuracy.

Then, remove several spouts from the disk openers and turn the drive wheel or coulter until all of the spouts are dropping seed uniformly.

Turn the drive wheel the number of rotations that were calculated, catch the seed in cans or other clean containers and weigh the collected seed.

Calculate the amount of seed mixture required for test run:

Meadow brome	8.8 bulk pounds per acre
Alfalfa	1.4
Rice hulls	5.1
Total	15.3 bulk pounds per acre

15.3 x 0.01 ac = 0.153 pounds of seed mix for test run

Determine the amount of seed that should be delivered through each drill spout during the test run.

$$\frac{Pounds\ of\ mix\ for\ test\ run}{Number\ of\ spouts\ on\ drill} = pounds\ of\ mix\ per\ spout$$

Example:

$$\frac{0.153\ pounds\ of\ seed\ mix\ for\ test\ run}{10\ spouts\ on\ drill} = 0.0153\ pounds\ mix\ per\ spout$$

Since a small amount of seed is being weighed, it is desirable to convert the amount to grams (0.0153 pounds x 454 grams/pound = 6.94 grams per spout for test run).

As with previous methods, make adjustments to the drill and repeat the above procedure until seed weight is within 10 percent of the desired rate. Check results with one more trial at the same setting. If during the calibration process, one species is consistently short, check to make sure the seed mixture is thoroughly mixed. Be sure to record the drill settings for future reference.

Method 4 - Acreage Weight Method

This method basically involves seeding a known area (less than 1 acre), weighing the amount of seed used and making adjustments to the drill. You can either use the acreage gauge on the drill, if there is one and it is in working condition, or measure the distance traveled multiplied by the drill width. Weigh an amount of seed mix, fill the drill and plant the measured area. Remove the seed remaining in the drill and weigh it. Make adjustments to the drill and repeat the above procedure until seed weight is within 10 percent of the desired rate. Be sure to record the drill settings for future reference.
Example:

Determine acreage of test run and the amount of seed needed for test run.
Using a 10 foot drill and a test run of 1000 feet:

$$\frac{10 \text{ feet x } 1000 \text{ feet}}{43{,}560 \text{ ft}^2/\text{ac}} = 0.23 \text{ acres for test run}$$

15.3 pounds seed mixture x 0.23 acres = 3.5 pounds

Weigh an amount of seed greater than needed for test run (perhaps 5 pounds in this example) and load into drill and seed a test run. Remove remaining seed from drill and weigh.

Initial weight minus seed used should be within 10 percent of recommended rate (3.2 to 3.9 pounds in this example for the test run).

This method is less desirable because all the seed used for the calibration could be basically lost until the calibration is within the recommended rate.

Method 5 – Calculate rice hull to seed ratio

This method is fairly simple but is less precise because it assumes seed bushel weights do not vary much. Rice hulls are a good dilutant because they are inexpensive, flow well in most drills, aid with feeding small and/or fluffy seeds, and most seed suppliers have rice hulls in stock. You should recommend using #1 Grade rice hulls. Poor quality rice hulls do not flow as well and are less effective in carrying small or fluffy seeds.

First, set the drill at the 2 bushels per acre for barley. Test the setting by running the drill with a small amount of barley and counting the total number of seeds per running foot for 10 rows. Divide the total by ten to obtain the average number of barley seeds in a foot of row. The number of barley seeds per foot can be easily converted to bushel weights using the following table. In all likelihood, the drill setting will be off and will need a little fine-tuning to get an accurate 2 bushel setting. Now is good time to pull out your "Sharpie" and write down the "measured 2 bushel setting" along side the drill's chart.

Converting 2 bushels of Barley to seeds per linear foot

Drill Row Spacing	Barley seeds/ linear foot
6 inches	15.0
7 inches	17.5
8 inches	20.0
9 inches	22.5
12 inches	30.0
14 inches	34.5

Barley research seed. Photo courtesy of une.edu.au/~agronomy/

Second, convert your seeding weights to bushels for each component of the seed
The following table provides average bushel weights of common conservation sp
and rice hulls:

Average bushel weights for common conservation plant materials

Fairway crested wheatgrass	24.5	Smooth brome	21.3
Nordan crested wheatgrass	25.8	Meadow brome	21.7
Tall wheatgrass	18.3	Basin wildrye	17.3
Intermediate wheatgrass	21.2	Orchardgrass	19.5
Pubescent wheatgrass	23.4	Creeping foxtail	10.6
Beardless wheatgrass	21.4		
Siberian wheatgrass	24.2	Cicer milkvetch	63.2
Snake River wheatgrass	20.0	Sainfoin	28.6
Bluebunch wheatgrass	33.0	Birdsfoot trefoil	63.5
Big bluegrass	16.7	Proso millet	52.6
Canby bluegrass	18.5	Small burnet	21.6
Sheep fescue	23.5	Alfalfa	60.0
Tall fescue	24.5	Blue flax	47.5
Indian ricegrass	42.8		
Rice Hulls	9.0	Barley	48.0

Note: you can also weigh a bushel of each component of your seed mixture prior to the mixing process and use that figure if the species is not listed here.

Example:

The plan is to seed 8 pounds of Snake River wheatgrass, 2 pounds of blue flax, and 3 pounds of big bluegrass per acre (bulk weight).

Snake River Wheatgrass	8 lb per ac	÷ 20.0 lb per bushel	=	0.40 bu
Blue flax	2	÷ 47.5	=	0.04
Big bluegrass	3	÷ 16.7	=	0.18
Subtotal	13		=	0.62 bu

2 bushels - 0.62 bushels seed = 1.38 bushels of rice hulls

1.38 bushels x 9 lb per bushel rice hulls = 12.42 lb hulls

You will need 12.42 lb rice hulls per acre. The hulls and seed are mixed before placing them in the drill which has been set to seed 2 bushels of barley per acre.

References

Calibrating a Drill. USDA NRCS Plant Materials Technical Note No. 30, Bozeman, MT May 1985.

Grass, Grass-Like, Forb, Legume, and Woody Species for the Intermountain West. USDA NRCS Plant Materials Technical Note No. 24, Boise, ID; Bozeman, MT; Spokane, WA January 2003.

Grass-Legume-Forb Seed Dilution with Rice Hulls. USDA NRCS Plant Materials Technical Note No. 7, Boise, ID October 1990.

Reading Seed Packaging Labels and Calculating Seed Mixtures. USDA NRCS Plant Materials Technical Note No. 4, Boise, ID October 2002.

Seed Production Standards for Conservation Plants in the Intermountain West. USDA NRCS Plant Materials Technical Note No. 14, Boise, ID December 2001.

Seeding Rate and Row Spacing Calculations for Rangeland Plantings. USDA NRCS Range Technical Note No. 30, Boise, ID March 1985.

Setting a Drill for Seed Increase Plantings. USDA NRCS Plant Materials Technical Note No. 19, Boise, ID October 1990.

Table 1
PLANT ADAPTATION and SEEDING RATES
from Plant Materials Technical Note No. 4

Common Name	Longevity	Seedling Vigor	Character	Seeds/Lb	1 lb/Acre Seeds/ft[2]	Precip	Soil	Depth	PLS Rate
GRASSES									
Bentgrass, Redtop	Long	Low-Med.	Sod	4,990,000	115	+18	wet	0-1/4	0.5
Bluegrass, Big	Medium	Low-Med.	Bunch	925,000	21	+ 9	cl-sl	0-1/4	2
Bluegrass, Canby	Long	Low-Med.	Bunch	925,000	21	+ 9	c-sl	0-1/4	2
Bluegrass, Canada	Long	Low-Med.	Sod	1,600,000	36	+18	cl-sl	1/4-1/2	1
Bluegrass, Kentucky	Long	Low-Med.	Sod	2,200,000	50	+18	cl-sl	0-1/4	2-4 sod
Bluegrass, Sandberg	Long	Low-Med.	Bunch	925,000	21	+ 8	l-cl	0-1/4	2
Brome, Meadow	Long	Med.-Rapid	Bunch	93,000	2	+14	c-sl	1/4-1/2	10
Brome, Mountain	Short	Med.-Rapid	Bunch	80,000	2	+16	c-sl	1/4-1/2	10
Brome, Smooth	Long	Very Rapid	Sod	145,000	3	+14	cl-sl	1/4-1/2	6
Canarygrass, Reed	Long	Med.-Rapid	Sod	506,000	12	+18	c-sl	1/4-1/2	4
Dropseed, Sand	Long	Low	Bunch	5,298,000	122	+ 7	fsl-s	0-1/4	0.5
Fescue, Hard	Long	Low	Bunch	560,000	13	+14	c-sl	0-1/4	4
Fescue, Idaho	Long	Very Low	Bunch	450,000	10	+16	cl-sl	1/4-1/2	4
Fescue, Red	Long	Low	Sod	614,000	14	+18	c-sl	0-1/4	4
Fescue, Sheep	Long	Low	Bunch	680,000	16	+10	c-sl	0-1/4	4
Fescue, Tall	Long	Medium	Bunch	205,000	5	+18	saline	1/4-1/2	5
Foxtail, Creeping	Long	Low	Sod	750,000	17	+18	c-l	1/8-1/4	3
Hairgrass, Tufted	Long	Low	Bunch	2,500,000	57	+18	c-sl	0-1/4	1
Junegrass, Prairie	Medium	Low-Med.	Bunch	2,315,000	53	12-20	sil-s	1/4-1/2	1
Needlegrass species	Long	Low	Bunch	180,000	3-4	8-20	cl-sl	1/4-1/2	6
Orchardgrass	Long	Medium	Bunch	540,000	12	+16	c-sl	1/4-1/2	4
Ricegrass, Indian	Long	Medium	Bunch	235,000	5	+10	l-s	1/2-3	6
Ryegrass, Perennial	Short	V. Rapid	Bunch	247,000	6	+15	cl-sl	1/4-1/2	5
Sacaton, Alkali	Long	Low-Med.	Bunch	1,700,000	39	+10	wet	1/8-1/2	2
Squirreltail, B.	Long	Medium	Bunch	192,000	4	+8	cl-sl	1/4-1/2	7
Switchgrass	Long	V. Low	Sod	426,000	10	+16	sil-sl	1/4-1/2	4
Timothy	Long	Medium	Bunch	1,230,000	28	+18	c-sl	1/8-1/4	3
Wheatgrass, Beardless	Long	Medium	Bunch	145,000	3	+12	c-sl	1/4-1/2	7
Wheatgrass, Bluebunch	Long	Medium	Bunch	139,000	3	+12	cl-sl	1/4-1/2	7
Wheatgrass, Crested AGCR	Long	Rapid	Bunch	175,000	4	+10	c-sl	1/4-1/2	5
Wheatgrass, Crested AGDE2	Long	Rapid	Bunch	165,000	4	+8	c-sl	1/4-1/2	5
Wheatgrass, Crested X	Long	Rapid	Bunch	165,000	4	+9	c-sl	1/4-1/2	5

Common Name	Longevity	Seedling Vigor	Character	Seeds/Lb	1 lb/Acre Seeds/ft^2	Precip	Soil	Depth	PLS Rate
GRASSES									
Wheatgrass, Intermediate	Long	Rapid	Sod	80,000	2	+13	cl-sl	1/4-1/2	8
Wheatgrass, Newhy	Long	Medium	Sod	139,000	3	+14	saline	1/4-1/2	8
Wheatgrass, Pubescent	Long	Rapid	Sod	80,000	2	+11	l-s	1/4-1/2	8
Wheatgrass, Siberian	Long	Medium	Bunch	160,000	4	+8	c-sl	1/4-1/2	6
Wheatgrass, Slender	Short	Rapid	Bunch	135,000	3	+10	c-sl	1/2-3/4	6
Wheatgrass, Snake River	Long	Medium	Bunch	139,000	3	+8	c-sl	1/4-1/2	7
Wheatgrass, Streambank	Long	Medium	Sod	135,000	3	+8	c-l	1/4-1/2	6
Wheatgrass, Tall	Long	V. Rapid	Bunch	78,000	2	+14	saline	1/4-3/4	10
Wheatgrass, Thickspike	Long	Medium	Sod	135,000	3	+8	l-s	1/4-1/2	6
Wheatgrass, Western	Long	Medium	Sod	115,000	3	+12-14	cl-sl	1/4-1/2	6
Wildrye, Altai	Long	Low	Bunch	73,000	2	+14	saline	1/4-1/2	10
Wildrye, Basin	Long	Low	Bunch	130,000	3	+8	sil-sl	1/4-3/4	7
Wildrye, Beardless	Long	V. Low	Sod	150,000	4	+14	saline	0-1/4	6
Wildrye, Blue	Medium	Medium	Bunch	145,000	3	+16	cl-sl	1/4-1/2	7
Wildrye, Canada	Short	Rapid	Bunch	115,000	3	+15	l-s	1/4-1/2	7
Wildrye, Mammoth	Long	V. Low	Sod	55,000	1	+12	ls-s	1/4-1/2	15
Wildrye, Russian	Long	Low	Bunch	170,000	4	+8	c-sl	1/4-1/2	6

Common Name	Longevity	Seedling Vigor	Character	Seeds/Lb	1 lb/Acre Seeds/ft[2]	Precip	Soil	Depth	PLS Rate
FORBS and LEGUMES									
Alfalfa	Medium	Medium	Erect	200,000	5	+14	sil-sl	1/8-1/2	5
Aster	Medium	Low	Erect	800,000	18	+12	cl-sil	0-1/2	2
Balsamroot, Arrowleaf	Long	V. Low	Erect	55,000	1	+10	sil-sl	0-1/3	20
Burnet, Small	Medium	Medium	Erect	42,000	1	+14	c-sl	1/4-1/2	20
Clover, Alsike	Short	Medium	Erect	700,000	16	+18	wet	1/8-1/4	3
Clover, Red	Short	Medium	Erect	275,000	6	+18	sil-sl	1/4-1	6
Clover, Strawberry	Short	Medium	Prostrate	300,000	7	+18	wet/saline	1/8-1/4	4
Clover, White	Med.-Long	Medium	Erect	800,000	18	+18	wet/cl-sil	1/8-1/4	3
Crownvetch	Long	Medium	Prostrate	98,000	2	+15	sil-sl	1/4-1/2	13
Flax, Blue	Short	Low-Med.	Erect	278,000	6	+10	sil-sl	0-1/8	4
Globemallow	Long	Low	Erect	750,000	17	+7	saline	1/8-1/4	3
Milkvetch, Cicer	Long	Low	Erect	130,000	3	+15	c-l	1/4-1/2	7
Penstemon, Venus	Medium	V. Low	Erect	1,090,000	25	+16	cl-sl	0-1/8	2
Penstemon, Firecracker	Short	V. Low	Erect	315,000	7	+10	cl-sl	0-1/8	4
Penstemon, Palmer	Medium	V. Low	Erect	294,000	7	+10	cl-sl	0-1/8	4
Penstemon, Rocky Mtn.	Medium	V. Low	Erect	286,000	7	+18	cl-sl	0-1/8	4
Sagewort, Louisiana	Short-Med.	Medium	Erect	3,750,000	86	+12	cl-sl	0-1/4	1
Sainfoin	Medium	Low-Med.	Erect	18,500	0.4	+14	sil-s	1/4-3/4	34
Sweetclover	Short	Med.-Rapid	Erect	262,000	6	+9	c-sl	1/8-1/2	4
Sweetvetch species	Medium	Low	Erect	70,000	2	+10	cl-sl	1/8-3/4	18
Trefoil, Birdsfoot	Long	Low	Erect	375,000	9	+18	c-s	1/4-1/2	5
Yarrow, Western	Medium	Low	Prostrate	4,124,000	95	+8	cl-sl	0-1/4	0.25

Common Name	Longevity	Seedling Vigor	Character	Seeds/Lb	1 lb/Acre Seeds/ft^2	Precip	Soil	Depth	PLS Rate
SHRUBS									
Bitterbrush, A.	Long	Low	Shrub	15,400	0.4	+10	cl-sl	1/2-1.0	1.0 (1/4*)
Buffaloberry, Silver	Long	Low	Shrub	40,000	0.9	12-20	sc	1/2	plants
Ceanothus/Snowbrush	Long	Low	Shrub	94,000	2.2	+16	sil-s	1/4-1/2	1.0 (1/4*)
Chokecherry	Long	Low	Shrub	4,790	0.1	+12	sil-s	1/2-1.0	1.0 (1/4*)
Cinquefoil, Shrubby	Long	Low	Shrub	1,000,000	23.0	+18	wet-all	surface	plants
Clematis	Long	Low	Creeping Vine	315,000	7.2	+10	moist	-----	plants
Current, Golden	Long	Low	Shrub	233,000	5.4	+12	sil-sl	1/16-1/4	1.0 (1/4*)
Current, Wax	Long	Low	Shrub	251,000	5.8	+12	sil-sl	1/16-1/4	1.0 (1/4*)
Dogwood, Redosier	Long	Low	Shrub	18,500	0.4	+16	moist	-----	cuttings
Elderberry, Blue/Red	Medium	Low	Shrub	205,000	4.7	+18	gravelly	-----	plants
Hawthorn, Black	Long	Low	Sm. Tree	22,600	0.5	+12	cl-sl	0-1/4	plants
Kinnikinnick	Long	Low	Creeping Shrub	40,000	0.9	+18	cl-sl	-----	plants
Kochia, Forage	Long	Low	Half-Shrub	395,000	9.0	+8	cl-sl	0-1/16	1.0 (1/40*)
Mountain Mahogany	Long	Low	Shrub	48,000	1.1	+14	rocky	0-1/2	1.0 (1/4*)
Oregongrape	Long	Low	Creeping Shrub	45,000	1.0	+15	moist	1/4-1/2	1/4*/plants
Rabbitbrush, Green	Long	Low	Shrub	782,000	17.9	+10	sil-s	surface	<1.0 (1/40*)
Rabbitbrush, Rubber	Long	Low	Shrub	693,000	15.9	+10	sil-s	surface	<1.0 (1/40*)
Rose, Woods	Long	Low	Shrub	50,000	1.1	+12	l-sl	1/2	1.0 (1/4*)
Sagebrush, Big spp.	Long	Low	Shrub	1,700,000	39.0	8-18	cl-sl	0-1/8	<1.0 (1/40*)
Sagebrush, Black	Long	Low	Shrub	907,000	20.8	+10	limy	0-1/8	<1.0 (1/40*)
Saltbush, Fourwing	Long	Low	Shrub	52,000	1.2	8-16	l-s	1/4-3/4	1.0 (1/4*)
Saltbush, Gardner	Long	Low	Shrub	114,000	2.6	6-16	l-s	1/4-3/4	0.5 (1/4*)
Serviceberry	Long	Low	Shrub	82,000	1.9	+14	sil-sl	1/4-1/2	1.0 (1/4*)
Silverberry	Long	Low	Shrub	3,800	0.1	+14	sil-sl	0-3/4	2.0 (plants)
Snowberry	Long	Low	Shrub	76,000	1.7	+14	sil-sl	0-1/2	1.0 (1/4*)
Snow Buckwheat	Medium	Low	Half-Shrub	500,000	11.5	+7	rocky	0-1/4	0.5*
Sumac, Skunkbush	Long	Low	Shrub	20,300	0.5	+14	rocky	1/2-1.0	1.0 (1/4*)
Syringa (Mockorange)	Long	Low	Shrub	8,000,000	183.7	+18	moist	-----	plants
Winterfat	Long	Low	Half-Shrub	123,000	2.8	+7	limy	0-1/8	<1.0 (1/40*)

* This rate is the recommended mix rate per acre and not the 100% pure seed rate per acre. Recommended rates are based on targeting the establishment of 400 plants per acre for optimal wildlife habitat in a seed mix.

Soil: vfsl = very fine sandy loam; fsl = fine sandy loam; sl = sandy loam; l = loam; sil = silty; lfs = loamy fine sand; ls = loamy sand; cl = clay loam; s = sand; c = clay; sc = sandy clay; wet = saturated; moist = moist-well drained; limy = high calcium content; rocky = 2” plus rock; gravel = 1/8 – 2” rock.