



MINNESOTA NRCS CONSERVATION PRACTICE 512
Technical Note #1
Design, Installation, and Checkout of Forage and
Biomass Plantings



TABLE OF CONTENTS

SECTION	PAGE
Introduction.....	3
Recommended Seed Mixtures.....	3
Species Selection and Mix Development	4
Liming and Fertilization	4
Seeding Dates.....	5
Variety Selection, Legumes, Invasives.....	6
Seeding Methods and Criteria for Pasture.....	7
Frost Seeding and Companion Crops.....	9
Seeding Methods and Criteria for Hayland.....	10
Evaluating Pasture, Hayland, and Biomass Stands.....	10
Fall Management of New Seedings.....	11
Practice Certification.....	11
References.....	27
Appendices:	
I- Seeding Equipment Characteristics and Calibration.....	11
II- Recommended Varieties.....	16
III- Selected Forage Species and Adapted Forage Suitability Groups....	17
IV- Species Characteristics Key.....	19
V- Seed Tool.....	22
VI- Seed Mixes for Biomass.....	23
VII- Annuals for Supplemental Forages.....	26

Introduction

Use this Technical Note with MN NRCS Conservation Practice Standard 512 Forage and Biomass Planting. Planning and application will be done in compliance with the MN NRCS Conservation Practice Standard 512 Forage and Biomass Planting and other required documentation as laid out in Section IV of eFOTG. The following information contains specific requirements, recommendations, references, and guidelines to fully develop and implement a successful pasture, hayland or biomass planting.

When selecting or developing a seeding mixture, planners must consider what kind and class of livestock will consume the planned forage stand.

For Hayland plantings the harvest method must also be considered. Some species do not dry down fast enough for dry hay and the producer must have access to harvest equipment and storage facilities that correspond to the forages planted. Forage species that meet nutrient needs and palatability requirements of the livestock shall be selected. Soil drainage class, Forage Suitability Groups, and nutrient status will determine which forage species are adapted to the site.

Appendix V, The Seed Tool, contains seeding mixes that are adapted to a variety of soils and livestock and specific to each area of Minnesota. These mixes should cover most situations and be the first choice of the planner.

Experienced livestock producers may have preferences for forages, and the planner should determine these. However, it is possible that the producer has overlooked some additional species that might meet their goals. Pasture and hay species such as annual ryegrass, perennial ryegrass, and festulolium, typically do not act like perennials in Minnesota, and seeding mixes should have relatively small amount of these species included.

The biomass planting recommendations were derived from recommendations from other states and the Plant Materials Center. Since this is a relatively new field, species selections will change based on whether the plant materials will be burned or fermented.

Recommended Mixes

[Appendix V and VI](#) contain recommended seed mixes classified by soil drainage class, pH, and NRCS area. Appendix V is for Pasture and Hayland while Appendix VI is for Biomass. **If a different seed mixture is substituted for a recommended mix, it will be preapproved by the Area Resource Conservationist, Grazing Specialist or field office staff with technical approval authority.**

Species Selection and Mix Development

If developing or approving a seeding mix other than those in Appendix V and VI, use reference material in [Appendix III and Appendix IV](#) or hand calculate and save calculations. **Do not use switchgrass in mixes consumed by sheep or horses. Do not use alsike clover in mixes consumed by horses.**

Fundamentally, a seed mix must provide sufficient perennial ground cover. A rate of **64-120 pure, live seeds per square foot of perennial species** will deliver enough coverage to achieve a dense stand for conservation, hay or biomass production and livestock utilization. The lower end of this range of seed concentration may be used when seedbed conditions are expected to be optimal. Use higher seeding rates when:

- the seedbed is not as well pulverized,
- is too loose,
- when the seedling vigor of the species in the mix is expected to be lower than ideal
- when broadcast seeding or into crop residue greater than 20%

Perennial ryegrass, Italian ryegrass, festulolium, annual ryegrass, and other annuals do not meet the 512 standard because they are not perennial.

Adjustments to the actual seeding rate going through the seeding device must be made to account for the germination and purity of the seed. Use [Appendix V](#) Seeding Plan and Record or hand calculate the pure, live seeds per square foot with the seed tags. Make certain the mix meets the nutrient requirements of the kind and class of animal and the level of performance desired by the producer, the harvest and storage method available to the producer and the needs of biomass production if applicable. Native, warm season grasses usually require special seeding equipment. See [Appendix I](#) for details on equipment characteristics and calibration methods.

Seed Quality

All seed used must be of good quality and meet the requirements of the Minnesota State Seed law. Information on Minnesota State seed law is available at the following link: <http://www.mda.state.mn.us/en/licensing/licensetypes/fsmsrp.aspx>

Liming and Fertilization

Soil tests will be taken prior to seeding to determine the soil nutrient status and need for any liming materials and fertilizer. All liming and fertilizer recommendations will be made in accordance with MN NRCS Conservation Practice 590 Nutrient Management. **Amounts of**

Variety Selection

Use varieties from the University of Minnesota list of recommended varieties, Plant Materials Center varietal selections, or University recommended varieties from states adjacent to Minnesota. Appendix II lists some recommended varieties. Other varieties that are adapted to Minnesota and listed as recommended in the Extension publications of states adjacent to Minnesota are acceptable. From these sources select varieties that:

- have resistance for insects or diseases that may be present,
- that match the harvest schedule and method of the producer,
- match the intended livestock species, class, and utilization method,
- are adapted to climatic and microclimatic conditions in the area to be seeded
- fit the method of biomass utilization if applicable

Some seed tags list “Variety Not Stated”. These will not be considered as counting toward the total number of pure live seeds per square foot when they originate outside of the States of Minnesota, Wisconsin, North Dakota, South Dakota, and Iowa. Exceptions to this may be given on a case by case basis by the Area Resource Conservationist or the Area Grazing Specialist.

Legumes

Use pre-inoculated legume seed with the rhyzobia species specific to the legume(s) in the seed mix. If there are two kinds of legumes, each one will be inoculated with its specific rhyzobia species.

Legumes will have hard seed, seeds that do not germinate during the first year, and the amount of hard seed will be specified on the seed tag. If there are more than 20% hard seed adjust the seeding rate up to achieve the desired pure, live seed coverage. Do not recommend seeding alfalfa following alfalfa due to problems with autotoxicity. Pasture mixes should not contain more than 50% legumes on a pure live seed basis to avoid bloat in livestock.

Potentially Invasive Species

Ask for prior approval from the Area Resource Conservationist or Grazing Specialist before recommending reed canarygrass, birdsfoot trefoil, crested wheatgrass, or smooth brome grass. These may be considered invasive if adjacent to restored native warm season grass stands or prairie remnants.

Seeding Methods and Criteria for Pasture

Interseeding no-till into existing stands

Before planting the new seed, the existing species must be suppressed. In the summer and fall before seeding, graze heavily or clip to a height of one inch or in the spring apply a burn down herbicide at a suppression rate just prior to seeding when the existing plants reach about 4 inches in height. Use a no-till drill to seed into the sod at depth of ¼ to ½ inch. It is better to seed when the soil is slightly moist but not wet, especially when seeding inoculated legumes. Adjust the coulters and packing wheels of the drill to cover the seed based on the soil texture, moisture, and condition of the surface residue. Do not recommend interseeding alfalfa into existing alfalfa stands due to autotoxicity.

Periodic flash grazing during the establishment year is essential to controlling competition of existing grasses with the new seeding. Test to see if the young seedlings can be easily pulled out by hand before turning livestock in. The soil must be settled enough and moisture content low enough so that the young seedlings aren't easily pulled out by the animals grazing.

Control perennial and biennial broadleaf weeds with appropriate herbicide the year before sod seeding. (Organic producers will not have this option available to them.) Complete control often requires more than one application. **Some broadleaf herbicides can have residual effects lasting several years, please be aware of these herbicides and how they will affect your planning.** Refer to the MN NRCS Conservation practice standard 595 Pest Management and University of Minnesota Extension website <http://appliedweeds.cfans.umn.edu/>. **Always read and follow label directions and precautions when applying herbicides.**

When interseeding, the existing species are not killed, only suppressed to allow establishment of more productive grasses and legumes. Interseeding is most effective in over utilized Kentucky bluegrass sod. Forage production from pastures can be improved by the inclusion of more productive grasses (bromegrass, orchard grass, etc.) and legumes. Reduce competition between existing smooth bromegrass and other tall grasses that compete with the newly seeded grasses by using suppression rates of herbicide and/or graze heavily the fall before seeding. Red clover is the easiest legume to interseed into a suppressed tall grass sod. No-till seeding should be used on existing pastures that lack diversity, either in grasses or legumes, on existing pastures that contain species unsuited to the kind and/or class of livestock utilizing the pasture, to improve the nutritional value of an existing pasture, and on most existing pastures or grasslands that contain little debris, rocks, or boulders.

Interseeding with tillage into existing stands

If a no-till drill is not available, it is still possible to interseed legumes into an existing grass stands by using tillage and a conventional grain drill. Disturb the existing sod with a light

disc harrow or a harrow/field cultivator combination. If there is an old dense stand of Kentucky bluegrass and quackgrass, fall tillage will help to reduce competition before spring planting. Use enough tillage passes to expose at least 50% bare soil. If the surface is rough after the initial tillage use a drag harrow to level prior to seeding with the drill. Avoid seeding into a “dustbed”, and seed into moist but not wet soil. The drill should be equipped with drag chains, or immediately after drilling, the soil should be run over with a cultipacker.

No-Till seeding into either sod or cropland

Use a no-till drill to plant at a depth of ¼ to ½ inch.

More desirable forage species are seeded into the old sod or existing crop residue. This should be the first choice on steep, highly erodible soils.

On land currently in grass, all existing vegetation is killed with herbicides, preferably in the fall prior to planting. Quackgrass and many broadleaf weeds are easier to control when herbicides are fall applied rather than spring applied. On cropland, leave the existing crop residue.

With fall herbicide application, an additional burndown chemical may be needed in the spring prior to planting to kill any weeds and regrowth.

Some broadleaf herbicides can have residual effects lasting several years, please be aware of these herbicides and how they will affect your planning. Read and follow label directions of the previously applied herbicide to determine compatibility with the planned seeding.

Conventional seeding

A seedbed will be prepared that is free of all competing vegetation and is not subject to erosion. All existing vegetation will be killed prior to or during seedbed preparation with tillage and/or herbicides. Seeding on fields with significant weed populations will be delayed until weeds are controlled. If chemical methods are used, multiple applications may be required to achieve satisfactory results. **Some broadleaf herbicides can have residual effects lasting several years, please be aware of these herbicides and how they will affect your planning.** A firm, moist seedbed will be provided in all cases. As a general rule, seedbed is considered firm when the foot tracks left by an adult are not deeper than one-half inch. Grasses and legumes shall be seeded immediately following seedbed preparation. Grasses and legumes shall be drilled uniformly over the area at a depth of ¼ to ½ inch using a grass drill, grain drill with press wheels, cultipacker seeder or by broadcasting the seed.

When a cyclone or endgate type seeder is used, light, fluffy seeds will be sown as a separate operation from legume or dense smooth seeds. Seedbeds that are too soft may be firmed by harrowing, packing with two or more passes with an empty drill, or cultipacker. Cultipacker seeders most consistently assure shallow seed placement. If a grain drill with a

legume box is used, seed tubes should be positioned to deposit seed behind the coulters or openers which seed small grains. For more information see [Appendix I](#), “Seeding Equipment Characteristics and Calibration”.

Frost seeding

Graze to a very low stubble height the season before seeding, use a suppression rate of herbicide or mow very short(< 2” tall). Broadcast the legume seed on top of the ground in late winter (late February or March) or early spring when freezing and thawing help to incorporate the seed into the soil. Do not seed on snow cover, especially on steeper soils. Snow melt may carry the seed away in runoff. Frost seeding also works well on small disturbed areas within a pasture. Use this method where it is impractical or impossible to use conventional seeding equipment such as steep slopes, rough terrain, and rock outcrops. Red clover and white clover are vigorous and competitive with existing sods and are the ideal species for adding legumes to grass pastures. Use flash grazing after seeding to suppress the grasses and allow legumes to establish.

Companion Crops

Companion crops consist of small grains and ryegrasses that protect soils from erosion and to some extent reduce weed competition. The seeding rate of the companion crop will be less than the normal rate of seeding for that crop. Remove companion crops at the boot stage or early head. NRCS does not allow companion crops to be seeded with native grass plantings. They may not work in the SW area of the state because of average annual precipitation and a dominance of better drained soils. Companion crops are competition for moisture and sunlight. Early maturing varieties of oats with good lodging resistance are desirable.

Crop	Seeding Rate BU/acre
Oats	3/4- 1.25
Barley	½-1
Wheat	1/2
Ryegrass*	< 2.5#/Ac.
Cereal Rye**	Not recommended

*Ryegrass is extremely difficult to dry down after cutting. Haylage is the preferred method of storage.

**Cereal Rye can have allelopathic effects on competing species and is not recommended as a companion crop. Do not remove small grain companion crops for grain.

Seeding Methods and Criteria for Hayland

Seeding methods for hayland are very similar to pasture. However, hay seeding mixes usually consist of fewer species and contain species with similar maturities. Typically hay fields are seeded in after an annual crop such as corn, soybeans, or small grain using either conventional or no-till methods listed above. A smooth, level seedbed provides a better platform for machinery field operations during the life of the hay stand. Appendix V has recommended hay land seeding mixes.

No-Till seeding

Use a no-till drill to plant at a depth of ¼ to ½ inch. On cropland, leave the existing crop residue. With fall herbicide application, an additional burndown chemical may be needed in the spring prior to planting to kill any weeds and regrowth.

Some broadleaf herbicides can have residual effects lasting several years, please be aware of these herbicides and how they will affect your planning. Read and follow label directions of the previously applied herbicide to determine compatibility with the planned seeding.

Conventional Seeding

Refer to Page 7 of this technical note.

Seed Mixes for Hayland

Plantings may consist of pure stands of legumes or grasses, or a mixture of the two. For ease of management hay plantings with no more than two grass species are recommended. Refer to [Appendix V](#) for recommended hayland mixes based on different soil drainage classes.

Evaluating Pasture, Hayland, and Biomass Stands

Use Agronomy Technical Note 17 , Guidelines for Herbaceous Stand Evaluation, to determine if the stand is adequate.

Fall Management of New Seedings

Avoid grazing or haying new seedings in the month of September and leave a minimum of six inches of residual height going into the winter. Do not graze new seedings until the next

growing season. If hay was harvested from legume fields, particularly alfalfa, add potassium to replace the amount removed in the harvested hay.

Practice Certification

Use [Appendix V](#) to determine the number of pure, live seeds per square foot applied. This number should be no less than 64 seeds per square foot of **species that will be reliable perennials** when grazing management allows the plants to fully recover or hay cutting allows perennial legumes such as alfalfa to bloom one cutting per year. Annual ryegrass, perennial ryegrass, Italian ryegrass, festulolium, teff grass, sorghum grass, sudangrass, millets, and sorghum sudangrass hybrids are annuals or not reliable perennials in Minnesota. Do not include these species when calculating the number of pure live seeds per square foot in a mixture. Make copies of the soil tests from an approved soil testing laboratory that were used as the basis for fertilizer and lime application (Soil tests must be four years old or less.). Obtain fertilizer application records and confirm that fertilizer and lime was applied based on these tests.

Appendix I: Seeding Equipment Characteristics and Calibration

Source: South Dakota Range Technical Note #4

Seeding Equipment

Seeding equipment that ensures proper seed placement and good seed–soil contact will be used. Modern grass seeding attachments that allow for proper seed flow, seed placement, and soil packing are needed to ensure a successful seeding.

Slower seeding speeds should be used for fluffy or rough-coated seed species. Three to five miles per hour should be the seeding speed for most types of grass drills. Seeding speeds in excess of six miles per hour may result in uneven or inconsistent grass and legume stands.

If a carrier is needed to help feed seed through the drill, cracked corn or rolled oats may be added to the mixture.

Drill calibration should be completed for both grass and grain drills prior to seeding. Please refer the drill calibration section below for guidance in completing drill calibration.

Small Grain Drill

Free-flowing grass seed (i.e., wheatgrasses,) and legume seed can be successfully planted with a small grain drill, provided proper seeding depth can be maintained throughout the field. Seeding depth is the most limiting factor to seeding success and contributes to most of the seeding failures when using a grain drill. It is extremely important to have a firm seedbed when using a grain drill. Periodic inspections should be done to check seeding depth especially when seeding across different soil types. Seeding depth will vary under actual planting conditions. Checking the drill frequently and hand mixing the seed is essential to achieving a properly blended seed mix and helps ensure that seeds of different sizes are seeded evenly across the field. Periodic feeder mechanism adjustments are usually necessary to ensure proper seeding rates. A separate legume box is desirable for seeding small seeded species (i.e., switchgrass, hard fescue, reed canarygrass, alfalfa and other legumes). Ensure that the grain drill's drop tubes are placed in front of the packer wheels to allow for proper seed-soil contact.

Chaffy or awned seeds (i.e., bluestems, Indiangrass, and blue grama,) are extremely difficult to plant with a grain drill. Proper agitation is needed to prevent “bridging” of seed in the seed box and the feeder mechanism must be capable of metering a uniform flow of seed at the desired rate. Very few grain drills have this capability. Use of debearded seeds is strongly recommended when considering seeding chaffy or awned seeds in a grain drill. It is recommended that a grass drill be used for these types of fluffy seeded grasses.

Grass Drill

Grass drills are specifically designed and equipped to properly meter and place various grass, legume, and/or forb seed. Different seed boxes are normally required to handle the three types of grass seed commonly used. This includes the relatively clean, smooth seed characteristic of many cool-season grasses, the chaffy or trashy seed characteristic of many warm-season grasses, and fine, smooth seed, characteristic of legumes or grasses such as switchgrass, hard fescue, or reed canarygrass.

Seed boxes having the capability of seeding chaffy or awned grasses (i.e., blue grama, bluestems, and Indiangrass,) are needed, only if such species are planned in the seeding mixture; likewise, fine seed or legume seed boxes are needed, only if such species are to be seeded. Agitators or similar mechanisms prevent bridging of chaffy or trashy seed. They ensure a constant flow of seed at the desired rate. Seed is uniformly mixed. Feeder mechanisms (picker wheels, fluted feed, etc.,) ensure uniform flow of all types of grass seed either separately or in a mixture. Oversized feeder tubes that allow constant flow of chaffy or trashy type seed from boxes to placement point (if such seed is used). Individually mounted, adjustable, spring loaded, double-disc openers, depth bands or other depth control systems provide positive seed placement over varying degrees of seedbed firmness for a final planting depth of one-fourth to three quarters of an inch. Press/packer wheels provide adequate covering and firming of soil over and around the seed for necessary seed to soil contact after proper seed placement. They can be mounted individually on each furrow opener or independently to follow behind each opener. Press/packer wheels are not intended to provide the basic "firm seedbed." The firm seedbed must exist before the drilling operation begins.

Broadcast Seeder

Broadcast seeding may only be used when slope, soil conditions, and/or size of the area to be seeded make the use of a drill impractical. Obtaining proper seed depth and accurately applying the proper amount of seed is very difficult with broadcast seeders. To avoid over or under application of seed, calibrate the equipment using a known area and a trial run of the broadcast seeder with a known amount of seed. Adjust travel speed and gate setting on the broadcast seeder to achieve the planned seeding rate. All broadcast seedings will have an operation which incorporates the seed into the soil (i.e., covering operation using a drag harrow, cultipacker, roller packer, or other suitable implement to cover and press the seed into the soil surface).

Airseeders

Some airseeders and similar types of equipment may be used to seed free flowing grass seed (i.e., wheatgrasses,) and legume seed if proper seeding depth can be obtained. The shallow planting depths for grasses and legumes can be difficult to maintain with this type of equipment. The equipment must be able to provide a uniform flow of seed at the desired rate. Use packer wheels or other suitable packing implement to press soil firmly around the seeds.

Drill Calibration

Grass or grain drills may be calibrated using the following methods.

Bulk weight method:

Raise the drill's drive wheel and measure its circumference in **feet**. Next, measure the distance between seed spouts or disc openers. Use **Table A** below to determine the number of revolutions (R) to turn the drive wheel for the row spacing and wheel circumference in feet (C) for your drill.

Table A		
Row Spacing in Inches	# of Seed Spouts to Use	Turns Of Drive Wheel
6	4	96/C=R
7	4	82/C=R
8	3	96/C=R
10	3	77/C=R
12	2	96/C=R
24	1	96/C=R
30	1	77/C=R
36	1	64/C=R
42	1	55/C=R
48	1	48/C=R

Place enough seed in the box to cover spouts from which you will collect seed. Turn the drive wheel until all spouts are feeding. Place a container under the correct number of seed spouts (as determined from the table) and turn the drive wheel the number of revolutions previously determined. Weigh the sample in grams. Multiply this weight by 0.5. The result is the pounds per acre at that setting. Make adjustments in the drill setting and continue trials until the desired seeding rate is obtained. **Remember:** Seeding rates as determined by this method are in terms of **bulk seed**. You need to convert your seeding rate from pure live seed per acre to bulk seed per acre when using this calibration method.

Example:

Row spacing = 7 inches

Number of seed spouts = 4

Circumference of drive wheel = 6.8 feet

Revolutions of drive wheel (R) = 82/C

R = 82/6.8 = 12 revolutions

Bulk seeding rate is 15.1 lbs./ac. The drill is properly set when the 4 seed spouts yield 30 grams of seed after 12 revolutions of the drive wheel.

30 grams X 0.5 = 15 lbs./acre

Seeds per row foot method:

This method of determining the amount of seed being distributed by the seeding equipment is to count the number of seeds per foot of drill row while the machine is in operation. Fill the drill with seed, make setting, and drive equipment over a hard ground surface such as concrete, asphalt or canvas. Count the number of seeds per foot of row and adjust until proper seeding rate is attained. Use Table B to determine the linear foot of row necessary to equal one square foot planted.

Table B	
Row Spacing In Inches	Linear Foot of Row Equal to 1 sq. ft.
6	2
7	1.7
8	1.5
10	1.2
12	1.0

To determine the proper number of seeds per foot of drill row for a specific seeding mixture; Use the Seed Tool(see link on Page 5), calculate the number of seeds per square foot (ft²).

Example: The seed tool calculates the mix has 80 seeds per square foot. The drill you are using has a row spacing of 8 inches. Table B shows that for a row spacing of 8 inches, 1.5 linear feet of row is equal to 1 square foot. You hand count the number of seeds and the total seeds you count is 93. Therefore you are getting adequate coverage. If you know your seeds you can count the kinds of seeds separately to get the number of seeds per square foot of each.

Appendix II: Recommended Varieties

RECOMMENDED INTRODUCED SPECIES				
MEADOW BROME	SMOOTH BROME	ORCHARD GRASS	*TALL FESCUE	INTERMEDIATE WHEATGRASS
Paddock	Superior	Potomac	Courtenay	Oahe
Fleet	Manchar	Orion	Select	Manska
	Carlton	Ambassador		
CREEPING FOXTAIL	Jubilee		**REED CANARY GRASS	TALL WHEATGRASS
Garrison	Saratoga	TIMOTHY	Palaton	Alkar
Retain	Polar	Climax	Chieftan	
	Bravo	Colt	Venture	PUBESCENT WHEATGRASS
	Alpha			
				MEADOW FESCUE
				Pradel

RECOMMENDED LEGUMES		RECOMMENDED NATIVE GRASSES		
ALFALFA	KURA CLOVER	RECOMMENDED NATIVE GRASSES	*SWITCH GRASS	SIDE OATS GRAMA
Vernal			Dacotah	Killdeer
any winterhardy grazing varieties	BIRDSFOOT TREFOIL		Summer	Pierre
	Roseau	BIG BLUESTEM	Sunburst	Trailway
		Bison	Blackwell	WESTERN WHEATGRASS
WHITE CLOVER	CICER MILKVETCH	Sunnyview	Pathfinder	Rodan
Ladino		LITTLE BLUESTEM		
alice	FORAGE CHICKORY	Itasca Germplasm	INDIAN GRASS	
		Badlands Ecostype	Tomahawk	
ALSIKE CLOVER	RED CLOVER	Alduous	Holt	
		Blaze	Osage	
		Cimmaron		

Varieties recommended in Minnesota and adjacent states may be selected. Follow the links below to access them.
<http://www.uwex.edu/ces/forage/> <http://www.maes.umn.edu/10varietaltrials/> <http://www.ag.ndsu.edu/pubs/plantsci/hay/r794w.htm>
<http://www.ag.ndsu.edu/pubs/plantsci/hay/r794.pdf>

Appendix III: Selected Forage Species and Adapted Forage Suitability Groups

INTRODUCED GRASSES							
Soil Drainage Conditions	Very Poorly Drained	Poorly Drained	Somewhat Poorly Drained	Moderately Well Drained	Well Drained	Somewhat Excessively Drained	Excessively Drained
Forage Suitability Group #s	13,14	1,3,5,7,9,11,16 20,21	1,3,5,7,9,11,16 20,21	2,4,6,8,10,12, 15,17,19,22,23	2,4,6,8,10,12,15 17,18,19,22,23	4,8,18,19, 22,23	8,18,19, 22,23
MEADOW BROME	N	N	Y	Y	Y	Y	Y
SMOOTH BROME	N	N	Y	Y	Y	Y	Y
ORCHARDGRASS	N	N	Y	Y	Y	N	N
TIMOTHY	N	Y	Y	Y	Y	N	N
CREeping FOXTAIL	Y	Y	N	N	N	N	N
TALL FESCUE	N	Y	Y	Y	Y	Y	Y
REED CANARYGRASS	Y	Y	Y	Y	Y	Y	Y
INTERMEDIATE WHEATGRASS	N	N	Y	Y	Y	Y	Y
TALL WHEATGRASS	N	N	Y	Y	Y	Y	Y
PUBESCENT WHEATGRASS	N	N	Y	Y	Y	Y	Y
MEADOW FESCUE	N	Y	Y	Y	Y	Y	N

NATIVE GRASSES

Soil Drainage Conditions	Very Poorly Drained	Poorly Drained	Somewhat Poorly Drained	Moderately Well Drained	Well Drained	Somewhat Excessively Drained	Excessively Drained
Forage Suitability Group #s	13,14	1,3,5,7,9,11,16,20,21	1,3,5,7,9,11,16,20,21	2,4,6,8,10,12,15,17,19,22,23	2,4,6,8,10,12,15,17,18,19,22,23	4,8,18,19,22,23	8,18,19,22,23
BIG BLUESTEM	N	Y	Y	Y	Y	N	N
LITTLE BLUESTEM	N	N	N	Y	Y	Y	Y
SWITCHGRASS	N	Y	Y	Y	Y	N	N
INDIANGRASS	N	Y	Y	Y	Y	N	N
SIDE OATS GRAMMA	N	N	N	Y	Y	Y	Y
WESTERN WHEATGRASS	N	Y	Y	Y	Y	Y	N

LEGUMES/FORBBS

Soil Drainage Conditions	Very Poorly Drained	Poorly Drained	Somewhat Poorly Drained	Moderately Well Drained	Well Drained	Somewhat Excessively Drained	Excessively Drained
Forage Suitability Group #s	13,14	1,3,5,7,9,11,16,20,21	1,3,5,7,9,11,16,20,21	2,4,6,8,10,12,15,17,19,22,23	2,4,6,8,10,12,15,17,18,19,22,23	4,8,18,19,22,23	8,18,19,22,23
ALFALFA	N	N	N	Y	Y	Y	Y
WHITE CLOVER	N	N	Y	Y	Y	N	N
ALSIKE CLOVER	Y	Y	Y	Y	Y	N	N
KURA CLOVER	N	Y	Y	Y	Y	N	N
BIRDSFOOT TREFOIL	N	Y	Y	Y	Y	Y	Y
CICER MILKVETCH	N	Y	Y	Y	Y	Y	Y
FORAGE CHICORY	N	N	N	Y	Y	N	N
RED CLOVER	N	N	Y	Y	Y	N	N

Appendix V; Seed Tool

<http://www.mn.nrcs.usda.gov/technical/ecs/TechNotes/Grazing/grazing.html>

Seeding Mixes for Biomass Production

Biomass Plantings

Very Poorly to Somewhat Poorly Drained Soils (Frequent ponding or flooding)

Seed Species	Seeds/lb	PLS Rate Planned /ac	Seeds/Sqft	% in Mixture
Creeping Foxtail	900,000	3.0	62.0	65.9%
Alsike Clover	700,000	2.0	32.1	34.1%
Total		5.0	94.1	

Seed Species	Seeds/lb	PLS Rate Planned /ac	Seeds/Sqft	% in Mixture
Western wheatgrass	112,000	20.0	51.4	51.6%
Alsike Clover	700,000	3.0	48.2	48.4%
Total		23.0	99.6	

Seed Species	Seeds/lb	PLS Rate Planned /ac	Seeds/Sqft	% in Mixture
Switchgrass	400,000	11.0	101.0	100.0%
Total		11.0	101.0	

Moderately Well
to Well Drained
Soils

		(ph >6.5)		
Seed Species	Seeds/lb	PLS Rate Planned /ac	Seeds/Sqft	% in Mixture
Intermediate Wheatgrass	80,000	18.0	33.1	38.3%
Tall Wheatgrass	80,000	18.0	33.1	38.3%
Alfalfa	220,000	4.0	20.2	23.4%
Total		40.0	86.3	

		PLS Rate Planned /ac		
Seed Species	Seeds/lb	PLS Rate Planned /ac	Seeds/Sqft	% in Mixture
Switchgrass	400,000	7.0	64.3	68.0%
Big Bluestem	165,000	8.0	30.3	32.0%
Total		15.0	94.6	

**Somewhat
Excessively
Drained to
Excessively
Drained Soils**

Seed Species	Seeds/lb	PLS Rate Planned /ac	Seeds/Sqft	% in Mixture
Green Needlegrass	180,000	4.0	16.5	17.5%
Little Bluestem	255,000	8.0	46.8	49.5%
Prairie Sandreed	274,000	3.0	18.9	20.0%
Sand Bluestem	125,000	5.0	14.3	15.2%
Total		20.0	96.6	

Appendix VII: Annuals for Supplemental Forage

ANNUALS FOR SUPPLEMENTAL FORAGE		
Species	PLS/Ac.	Seeding Dates
Pearl Millet	25-30#	North: 6/1-7/15 South: 5/20-7/1
Sorghum-Sudan**	25-30#	North: 6/1-7/15 South: 5/20-7/1
Teff	8-10#	North: 6/1-7/15 South: 5/20-7/1
Winter Cereal Rye	90-120#	8/15-9/15
Forage Brassicas*	1.5-2#	North: 4/15-7/15 South: 4/1-8/1

*Forage brassicas include turnips, kale, rape, and swedes. They are often sown with oats at a rate of 2 bushels(64 pounds) per acre. Slowly acclimate livestock to eating them due to bloat potential.

**Sorghum-Sudangrass hybrids may accumulate prussic acid, a poisonous cyanide containing substance, after frost.

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