

Establishing and Maintaining Native Grasses, Forbs and Legumes

INTRODUCTION

This technical note may be used to guide prairie restoration seedings for the purposes of Wisconsin Natural Resources Conservation Service (NRCS) Field Office Technical Guide (FOTG) Conservation Practice Standards 327, Conservation Cover; 645, Wildlife Upland Habitat Establishment; 512, Forage and Biomass Planting, and occasionally 342, Critical Area Planting. Other ecological science and certain engineering standards may refer to this technical note. Each standard has a specific purpose and requirement for vegetation establishment.

BACKGROUND

A prairie is a diverse plant community characterized by the number of grass, legume, shrub, and forb species. In Wisconsin, a typical prairie averages six species per square foot. Exceptionally rich sites can average as many as eight species per square foot. High quality remnants of original prairie can harbor 40 to 80 species per acre.

Prairie restoration is the art and science of reconstructing a diverse native plant community. Constructing an exact copy of the tall grass prairie plant community is not very likely. However, the more common components of the prairie can be established and will evolve into a prairie with many of the same visual and ecological components of a natural undisturbed prairie.

The vast majority of native herbaceous plants are warm season species with the exception of a few cool season native grasses and forbs. Warm season plants (C4) produce most of their annual biomass during hot summer months from late June through early September. The growth of this group of plants does not begin until the minimum air temperature reaches 60 to 65 degrees Fahrenheit and soil temperatures reach 50 degrees Fahrenheit. Optimum biomass production occurs when daytime temperatures elevate to 85 degrees Fahrenheit. At higher temperatures C4 plants have a greater potential photosynthetic rate and use nitrogen and phosphorus more efficiently. Native plants survive and adapt better than introduced species under conditions of high temperatures.

TABLE OF CONTENTS

Description of Tables	2
Site Assessment	3
Prairie Soil Moisture Regimes And Site Conditions	3
Specie Selection And Seed Quality Information	3
Pure Live Seed (PLS)	4
Criteria For Seed Mixture Development	5
Standard 327 Conservation Cover.....	5
Standard 512 Forage And Biomass Planting.....	6
Standard 342 Critical Area Planting.....	6
Seeding Dates	6
Temporary Cover And Companion Crops	7
Special Erosion Control Measures	7
General Pre-Plant Seeding Recommendations	8
Pre-Planting Weed Control.....	8
Herbicide Carryover.....	8
Fertilizing.....	9
Seedbed Preparation.....	9
Planting Equipment And Seeding Methods.....	9

Drill Seeding	10
Broadcast Seeding	10
Frost Seeding	11
Dormant Seeding	11
Post-Planting Weed Control	11
Planting Year Post Emergence Weed Control Mowing – New Seedlings	11
Second Year Weed Control	11
Determining Success Of The Planting	11
Post Establishment Management	12
Spot Treatment By Clipping.....	12
Spot Treatment With Herbicide.....	12
Spot Treatment By Hand Pulling/Digging	12
Prescribed Burning – Established Cover.....	12
References	12

LIST OF TABLES

Table 1: Recommended Varieties of Warm Season Grasses	4
Table 2: Seeding Date/Ranges for Warm Season Native Mixtures	8
Table 3: Common Species and Recommended Seeding Rates	13
Table 4: Wisconsin NRCS Authorized Native Plant List (Grasses, Rushes, Sedges).....	13
Table 5: Wisconsin NRCS Authorized Native Plant List (Forbs, Legumes, Shrubs)	14
Table 6: Sample Seed Mix for Basic Dry Prairie (Seed Calculator Code 327-1)	17
Table 7: Sample Seed Mix for Basic Dry Mesic Prairie (Seed Calculator Code 327-2).....	17
Table 8: Sample Seed Mix for Basic Mesic Prairie (Seed Calculator Code 327-3).....	17
Table 9: Sample Seed Mix for Basic Wet Mesic Prairie (Seed Calculator Code 327-4).....	18
Table 10: Sample Seed Mix for Basic Wet Prairie (Seed Calculator Code 327-5).....	18
Table 11: Sample Seed Mix for Dry Prairie Restoration (Seed Calculator Code 327-6)	18
Table 12: Sample Seed Mix for Dry Mesic Prairie Restoration (Seed Calculator Code 327-7)	19
Table 13: Sample Seed Mix for Mesic Native Prairie Restoration (Seed Calculator Code 327-8).....	19
Table 14: Sample Seed Mix for Wet Mesic Prairie Restoration (Seed Calculator Code 327-9).....	20
Table 15: Sample Seed Mix for Wet Prairie Restoration (Seed Calculator Code 327-10).....	20
Table 16: Seed Mix for Dry Mesic Karner Blue Prairie Restoration (Seed Calculator Code 327-11).....	21
Table 17: Sample Seed Mix for Native Pollinator Seeding for Dry Mesic Sites (Seed Calculator Code 327-12).....	21
Table 18: Sample Seed Mix for Native Pollinator Seeding for Mesic Sites (Seed Calculator Code 327-13).....	22
Table 19: Sample Seed Mix for Native Pollinator Seeding for Wet Mesic Sites (Seed Calculator Code 327-14).....	22
Table 20: Seeding Chart for Native Grass Species	23
Table 21: Biomass Planting Recommendations	23
Table 22: Solid Native Grass Plantings (Seed Calculator Code 327-15 A to C, 512 H7 to H9).....	23
Table 23: Summary of Seeding Requirements for Standards 327, 342, and 512 (Native Species).....	24

SITE ASSESSMENT

Prairies are generally divided into five soil moisture regimes: Wet, Wet-Mesic, Mesic, Dry-Mesic, and Dry. There is often no sharp division between moisture regimes and one group may blend into another or multiple groups and should be considered when planning a successful prairie.

Some plant species are restricted to certain soil moisture regimes, while other plant species can be present on several if not all of the soil moisture regimes.

Wet organic soils are the most challenging when establishing most native plant species due to site conditions as well as competition from cool season and invasive plants. Wet organic soils pose issues with management activities such as mowing and spraying in a timely manner, a prerequisite to a successful planting.

PRAIRIE SOIL MOISTURE REGIMES AND SITE CONDITIONS

Wet Prairie

Wet prairies occur on mineral soils with poor drainage. They can also be found on some frequently flooded sites.

Wet-Mesic

Wet-Mesic Prairies are transitional between Wet Prairie and Mesic Prairies. Most Wet-Mesic Prairies occur on somewhat poorly drained mineral soils.

Mesic Prairie

Mesic Prairies will be found on most moderately well and well drained mineral soils that have moderate to very high Available Water Capacity. Mesic Prairies may occur on some somewhat poorly drained soils with low or very low Available Water Capacity or perched water tables.

Dry-Mesic Prairie

Dry-Mesic Prairies are transitional prairies between Dry Prairie and Mesic Prairie. They occur on some somewhat excessively drained and some well drained soils.

Dry Prairie

Dry Prairies occur mostly on well to excessively drained soils.

SPECIE SELECTION AND SEED QUALITY INFORMATION

- Evaluate the winter hardiness of species being selected for planting.
- Species identified as restricted or prohibited shall not be planted.
- Plant all the desired species at one time.
- Select species based on the site conditions for soil type and moisture regime.
- Seed as many forbs from the appropriate tables in this technical note as the budget will allow.
- If the objective is to create pollinator habitat, select species so that the prairie will be in flower throughout the growing season. Select at least three species from each bloom period (early, mid, late).
- Bunch grasses are recommended when pollinator habitat is planned.
- Due to the aggressive nature of the following plants, it is recommended to limit the seeding rates of the following species:
 - June Grass (2 oz/ac or 7 seeds/sq. ft.)
 - Switchgrass (16 oz/ac or 9 seeds/sq. ft.)
 - Blackeyed Susan (2 oz/ac or 5 seeds/sq. ft.)
 - Purple Coneflower (3 oz/ac or 2 seeds/sq. ft.)
 - Bergamot (2 oz/ac or 4 seeds/sq. ft.)
- Legumes must be inoculated with the appropriate bacteria for the specific species being planted. Inoculant must not be exposed to sunlight or allowed to dry out prior to planting native legumes.
- If more than 20 percent of the legume seed is hard seed, increase the seeding rate for legumes by the percent of hard seed in the seeding mixture.
- When using Standards 327, Conservation Cover; and 342, Critical Area Planting, Canada and Virginia Wildrye and Sideoats Grama, when combined, will not comprise of more than 20 percent of the total grass seed per square foot.
- The minimum seeding requirements are based on seeds per square foot.
- Increase seeds per square foot by 15 percent when dormant and frost seeding occurs.
- Use non-sod forming grass species in locations where shrubs and trees are planned.
- Where an existing native remnant prairie is near a planting site, it may be desirable to use locally harvested genotype seed. If this seed is

harvested locally it may be difficult to test for germination or purity in order to determine PLS. The use of locally harvested untested seed for USDA program participants must be approved by the Wisconsin NRCS State Agronomist.

- The order of preference for seed source selection is:
 1. Local genotypes.
 2. Genotypes from the same latitude.
 3. A named variety from the same latitude.
 4. Other named varieties.
- Use of local genotypes is the first preference because plants grown on or near the restoration site will be best adapted to the conditions of the site. It is especially important to use local genotypes when working with remnant prairies; introducing species from other areas may contaminate the local native plant gene pool.
- Seed purchased should be harvested within a 250 mile radius of the area where the planting will occur.
- Ideally, 40 percent of the total seeds per square foot should consist of forbs and or legumes.
- Below are species with multiple scientific names. The underlined specie is the most recognized genus and specie in Wisconsin and is referenced in vegetative Standards 327, Conservation Cover; 342, Critical Area Planting; and 512, Forage and Biomass Planting.
 - **False Boneset:** Brickellia eupatorioides, Kuhnia eupatorioides
 - **Great St. John’s Wort:** Hypericum ascyron, Hypericum pyramidatum
 - **Heath Aster:** Symphotrichum ericoides, Aster ericoides
 - **Joe-Pye Weed:** Eutrochium maculatum, Eupatoriadelphus maculatus and Eupatorium maculatus
 - **Porcupinegrass:** Hesperostipa spartea, Stipa spartea
 - **Silky Aster:** Symphotrichum sericeum, Aster sericeus
 - **Smooth Blue Aster:** Symphotrichum laeve, Aster laevis
 - **Softstem Bulrush:** Schoenoplectus tabernaemontani, Scirpus validus

- **Stiff Goldenrod:** Oligoneuron rigidum, Solidago rigida
- **Upland Boneset/Tall Boneset:** Eupatorium sessifolium, Eupatorium altissimum
- **Wild Quinine:** Parthenium integrifolium, Parthenium auriculatum

Table 1
Recommended Varieties of Warm Season Grasses

Specie	Variety	Area of Adaptability
Big Bluestem	Bison	North
	Bonilla	Central
	Champ	South
	Pawnee	South
	Rountree	Central and South
Indiangrass	Holt	Central and South
	Rumsey	South
	Tomahawk	North
Switchgrass	Blackwell	South
	Cave-in-Rock	South
	Dacotah	North
	Forestburg	Central
	Nebraska 28	Central
	Pathfinder	South
	Sunburst	Central
Trailblazer	South	
Little Bluestem	Blaze	Statewide
	Aldous	South
	Camper	Central and South

PURE LIVE SEED (PLS)

PLS is a means of expressing seed quality. PLS is the percentage of seed (i.e. good viable seed) that has the potential to germinate for a measured one pound weight of any seed lot. Nearly all species recommended for conservation plantings by NRCS uses Pure Live Seed (PLS) expressed in pounds or ounces per acre which is calibrated to seeds per square foot as the basis for the calculation of seeding rates. PLS provides a basis for comparing the quality of seed lots of the same species that differ in purity and germination. PLS is calculated by multiplying the purity percentage by the total germination percentage.

Seeding rates in this Technical Note are shown in pounds or ounces of Pure Live Seed (PLS) and is calibrated to seeds per square foot. All seed shall be of high quality and labeled in accordance as required by the Wisconsin Seed Law. Seed should always be

purchased on a PLS basis. Seed tags should specify the percentage of Total Viable Seed (TVS) germination/dormant/hard and purity to determine the correct seeding rates as specified in the seeding plan.

Example: Pure Live Lupine seed

Lupine Lupinus perennis Harvest ID: 018040-01 Test Date: 2/24/2012	Pure Seed:	99.93%
	Inert Matter:	0.06%
	Other Crop:	0.01%
	Weed Seeds:	0.00%
	Germination:	11.00%
	Hard Seed:	0.00%
	Dormant Seed:	85.00%
	Tetrazolium:	0.00%
Name and # of Noxious Seed:	NONE FOUND	

Pure seed x TVS = PLS
 99.93% x 96.0% = 95.9%

The PLS for Lot Number 018040-01 is 95.9.

CRITERIA FOR SEED MIXTURE DEVELOPMENT

Seed mixtures developed from this section will be composed of a grass component only or a grass and forb/legume component, depending on the standard criteria and purpose of the planting.

It is important to reference program rules when determining seed mixtures. Some programs have preapproved required mixtures to meet program and cost requirements.

STANDARD 327 CONSERVATION COVER

NATIVE OR WARM SEASON PLANTINGS

1. Basic Prairie Plantings

- A minimum of 3 grasses seeded at a minimum rate of 20 grass seeds per square foot and a minimum of 3 forbs and or legumes seeded at a minimum rate of 2.0 seed per square foot.

2. Restoration of Native Prairie Plantings

- A minimum of 5 grasses consisting of a minimum of 15 grass seeds per square foot and a minimum of 10 forbs comprising of at least one legume in the mixture amounting to a minimum of 8 seeds per square foot.

3. Untested Local Genotype Seed

The use of local genotype seed for USDA program seedings must be approved by the NRCS State Agronomist. Approval will only be considered for sites where the use of local genotype seed is necessary to address or maintain the ecological value of an area as identified in a NRCS conservation plan or similar planning document.

In order to obtain the highest quality seed possible:

- The harvesting of seeds will be supervised by someone experienced in the harvest of native seeds.
- All seed will be cleaned.
- Seed will be separated and properly stored by specie so that it can be mixed later at the planned rates.
- Collected seed will be tested for germination and viability unless a variance is granted by the NRCS State Agronomist.
- Use the following guidance for locally collected prairie seed that is untested.
 - a) Seed will be planted at a minimum seeding rate of 50 seeds per square foot. Limit seeding rates so that one specie does not comprise more than 20 percent of the seeds/square foot. When a specie is seeded at a seeding rate so that its number of seeds planted per square foot makes up more than 20 percent of the total planted seeds per square foot; only the seeds per square foot that fall within the 20 percent requirement will be counted toward the total required number of seeds per square foot.

The seeding rate of plant species known to germinate aggressively in new plantings such as Switchgrass, Purple Cone Flower, Blackeyed Susan and Bergamot shall be limited to 15 percent or less of the total seed per square foot planted.
 - b) At least 25 seeds per square foot must be native grasses or sedges and a minimum of 10 seeds per square foot of forbs and legumes.
 - c) At least five species of grasses and 10 species of forbs and at least 1 legume must be seeded. In situations, where the number of species required are unavailable during the harvest of untested genotype, the

mixture may be supplemented with certified pure live seed to satisfy this requirement.

- d) A final list of the species planted and the ounces of each specie actually planted must be provided to the NRCS office for review and approval.

4. Pollinator Herbaceous Plantings

- At least 1 and a maximum of 2 bunch grass species seeded at a maximum rate of 10 seeds per square foot and a minimum of 9 forbs and or legumes consisting of at least 3 species from each bloom period (early, mid, late) seeded at a minimum rate of 30 seeds per square foot.

Short bunch grasses are preferred over tall bunch grasses.

Recommended short bunch grasses are: Sideoats Grama, Prairie Junegrass, Little Bluestem, Woolgrass, and Prairie Dropseed.

Recommended tall bunch grasses are: Switchgrass, Indiangrass and Big Bluestem.

STANDARD 512 FORAGE AND BIOMASS PLANTING

5. Warm Season Pasture and Hayland Plantings

- The minimum seeds per square foot by specie is as follows: Big Bluestem (42), Indiangrass (44), Switchgrass (63).

For pasture and hayland purposes, warm-season grasses will be established in stands of single species only.

6. Warm Season Biomass Plantings

- Switchgrass is currently the only approved specie for biomass production in Wisconsin. The minimum seeding rate is 63 seeds per square foot.

STANDARD 342 CRITICAL AREA PLANTING

7. Native Herbaceous Plantings on Critical Sites

- A minimum of 60 seeds per square foot for solid native grass plantings is required.
- For grass and forb/legume mixtures, a minimum of 40 seeds per square foot for the grass component and a minimum of 20 seeds per square foot for the forb/legume component is required. The minimum of 20

forb/legume seeds per square foot is not required when native grass seed per square foot is greater than or equal to 60.

Native species are generally not recommended for critical sites due to slow establishment and because native plants grow in clumps and are not sod forming.

SEEDING DATES

Native plantings can be seeded either late fall, winter(frost seeding) or spring .

Warm season plants require a soil temperature of at least 50 degrees Fahrenheit before they will germinate. Spring is the traditional time to seed these plants and plantings are successful when recommendations are followed. Spring conditions favor warm season grasses over forbs and legumes. Under normal spring conditions moisture conditions are considered ideal or adequate.

If site conditions in the spring are not adequate due to weather, fall seedings offer an excellent opportunity for seeding native species. Fall seedings favor forbs due the cold weather stratification. The majority of forbs are stratified before purchase of seed. Fall seeding of natives in Wisconsin is considered a dormant seeding and must be seeded after the growing season has ended to ensure that the seed does not germinate before freeze up.

Frost seeding in late winter is permissible in Wisconsin and has been proven successful. These seedings are made in late winter, mid-February to early March during the freeze and thaw cycle. Seedings should not occur when snow cover is greater than 2 inches. Frost seeding timeframes will vary according to weather conditions and from year to year.

Seeding shall be carried out within the dates specified for the appropriate planting zone. See **Figure 1** and **Table 2** to determine the recommended seeding dates.

Seeding outside of the established dates may be approved by the NRCS State Agronomist or Area Resource Conservationist. All variance requests shall provide documentation of the current soil moisture conditions and proposed timeframes for seeding to be completed.

TEMPORARY COVER AND COMPANION CROPS

Temporary Cover

All land will be established to permanent vegetative cover during the first year of the land use conversion when possible. Temporary cover, during the first year, may be used if: 1) required seeds or plant stock are not available, 2) the normal planting period for species has passed or 3) where chemical residue will not allow establishment of permanent cover immediately. If temporary cover is used, the permanent vegetative cover must be established by the end of the normal planting period of the following year.

Temporary Seeding Recommendations

1. Fields where planting is delayed due to lack of suitable seed or late planting, select one of the following species:
 - Forage sorghum – ½ bu./ac. (5/15 - 7/15)
 - Sorghum - Sudangrass hybrid – 1 bu./ac. (5/15 - 7/15)
 - Sudangrass – 1 bu./ac. (5/15 - 7/15)
 - Winter wheat - 2 bu./ac. (8/1-10/1)
 - Winter cereal rye - 2 bu./ac. (8/1-10/15)
 - Oats - 2 bu./ac. (4/1-9/1)
 - Annual ryegrass - 20 lbs/ac. (4/1-9/1)

A temporary cover will typically not be necessary on those areas where at least 50 percent of the ground is covered with either crop residue or vegetative cover.

Temporary cover crops must be clipped or destroyed before plants develop a viable seed, preventing excessive competition to the permanent seeding. Winter wheat and winter cereal rye must be terminated by tillage or herbicides before planting the permanent seeding.

2. For fields with triazine herbicide carryover, select one of the following species:
 - Forage sorghum – ½ bu./ac. (5/15 - 7/15)
 - Sorghum - Sudangrass hybrid – 1 bu./ac. (5/15 - 7/15)
 - Sudangrass – 1 bu./ac. (5/15 - 7/15)

A bioassay test may be used to better determine chemical carryover.

Companion Crops

Companion crops can be used to reduce the amount of erosion on critical sites. The companion crops listed below are compatible with most native grass and forb plantings; will grow quickly under cooler conditions, suppress weeds and will not compete with the slower growing grasses and forbs.

Canada wildrye (*Elymus canadensis*) for mesic sites or Virginia wildrye (*Elymus virginicus*) for wet sites can be seeded at a rate of 1.0 pound PLS/acre. In addition, sideoats grama (*Bouteloua curtipendula*) can be seeded as a companion crop at a rate of 1.0 - 2.0 pounds PLS/acre on dry to dry mesic and mesic sites.

Sideoats grama or the wildrye species seeded as companion crops for the purpose of wildlife habitat and critical area plantings can be counted toward the minimum seeds per square foot, up to 20 percent of the required grass seed per square foot.

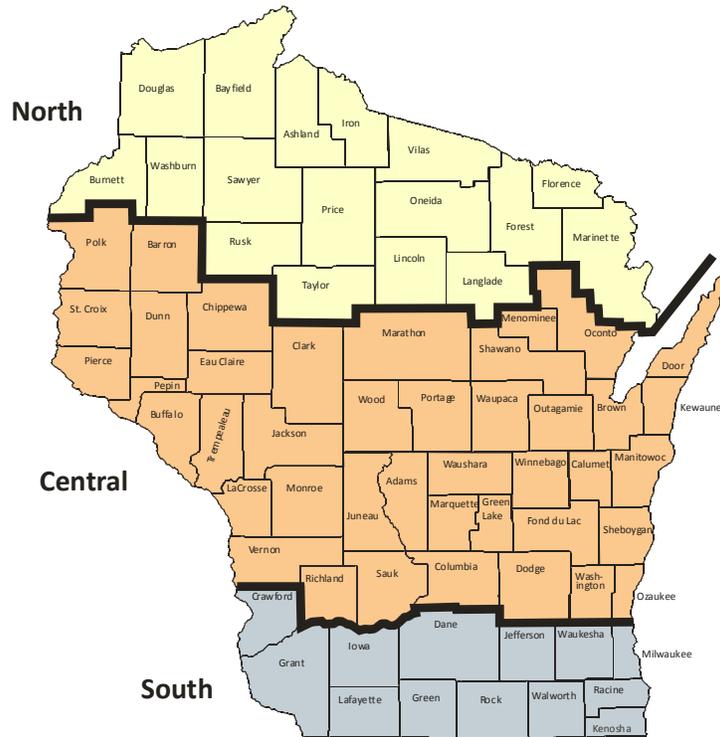
Oats (2 bu/ac) can be used as an alternative companion crop and is recommended on critical erosive sites that can be mowed before boot stage. Winter wheat or winter cereal rye is not the preferred companion crop due to the aggressive tillering nature of these plants.

SPECIAL EROSION CONTROL MEASURES

Since warm-season plants may be slow to establish, special erosion control measures will be needed on certain sites due to landscape conditions.

- Temporary cover crops may be seeded to obtain the required cover, prior to seeding.
- Seed site using no-till seeding methods.
- Divert surface water from location until vegetation has been established.
- Tillage and planting should occur on the contour only.
- Increase seeding rates by 25 percent to expedite cover establishment.
- Surface apply a mulch or solid manure on critical areas.
- Use a small grain companion crop.
- Plant species identified as aggressive in this technical note located in the section “Species Selection and Seed Information”.

**Figure 1
Planting Zone Map**



**Table 2
Seeding Date/Ranges for
Warm Season Native Mixtures**

Zone	Spring Seeding	Fall Dormant Seeding*
Northern	Thaw - 7/15	10/8 - Freeze Up
Central	Thaw - 6/30	10/15 - Freeze Up
Southern	Thaw - 6/30	10/20 - Freeze Up

*Dormant seeding is not allowed when using Practice Standard 342, Critical Area Planting.

GENERAL PRE-PLANT SEEDING RECOMMENDATIONS

Pre-Planting Weed Control

Pre-plant weed control is a critical step in the establishment of native plant materials. Weeds compete with seedlings for moisture, light and nutrients. Inadequate weed control causes more stand failures than any other single factor. Ideally, 6

months to a year prior to planting native species, consider this window as a pre plant weed control year. During that year a concerted effort should be made to control persistent perennials such as Canada thistle or knapweed. During the pre-plant weed control time period, evaluate the seed bed for the presence of weed seedlings. Where a significant number of weeds or invasive plants emerge consider tillage summer fallow, herbicide summer fallow, or a combination of tillage and herbicide summer fallow. Herbicide summer fallow is recommended for sites prone to erosion. For sites not susceptible to erosion, tillage or in combination with herbicide are recommended. The most effective strategy involves the integrated use of two or more weed control activities during the same growing season. Perennial weeds cannot be controlled effectively with herbicides after natives are planted.

Herbicide Carryover

Prior to planting check to ensure that any herbicides used on the previous crop will not “carry over” and

negatively impact newly seeded prairie plants. Residues of some herbicides such as Atrazine may prevent the establishment of some native plant materials for up to two years. If the residual effects of herbicides are possible, delay planting until after the recommended interval to allow residual herbicide levels to dissipate.

Fertilizing

For establishment of native species, soil testing and application of soil amendments is not a requirement; however, for maximum forage production (nutritional forage quality) and maximum biomass production for bio-energy, the application of nutrients will be based on the guidelines below.

The recommendations in this section are based on native grasses planted for hay, pasture, biomass production, and not for wildlife purposes. For pasture and hay land plantings of natives, a soil test is recommended prior to establishing vegetation. A current soil test is defined as test results no older than 4 years from the time last tested to the date of the planned seeding. Guidelines for soil testing can be found in Publication A2100, Sampling Soils for Testing. All nutrients will be applied following Wisconsin NRCS FOTG, Section IV, Standard 590, Nutrient Management.

Nitrogen should not be applied to warm season plantings until the second growing season to avoid stimulating weed growth. Applications of nutrients should not be made until spring growth has reached four to six inches.

Seedbed Preparation

When native materials are planted into undisturbed ground, the crop residue should be uniformly distributed over the soil surface prior to planting to minimize the smothering of new seedlings and to provide conditions for the operation of planting equipment. Planting native material into undisturbed soybean residue is preferred. Soybeans produce a moderate amount of crop residue that can be effectively managed and tend to leave the soil in a mellow condition that is well suited to no-till planting of prairie plants. Native material planted into undisturbed corn residue has proven successful at times. It is recommended that soil disturbance is necessary to ensure uniform germination by exposing soil, orienting and burying the corn residue, leaving 50-70 percent residue prior to planting.

Ground that has been tilled will require a firm seedbed prior to planting. A firm seedbed is

important when planting native material. A firm seedbed helps conserve moisture evenly and ensures good seed to soil contact. Recently tilled ground should be firmed with a roller packer. The seedbed is firm enough when a footprint penetrates ¼ to ½ inch deep.

Sites tilled and packed are normally in a suitable condition for most seeding methods and with most types of native seed planters.

Seeding into existing sod will present special challenges. While the root and top growth of the old vegetation provide excellent erosion control, this biomass can make it difficult to achieve good seed placement. When planting native material into existing sod comprising of introduced species, the introduced species should be totally eradicated. The options available for eradicating introduced species include: tillage, tillage and herbicide, burn and herbicide, grazing, and mowing. Anytime tillage is performed, a firm seedbed is strongly recommended.

Seedbed preparation for frost seeding must occur before freeze-up. The fall before seeding occurs, evaluate the seedbed conditions to ensure that the remaining crop residue is well distributed and soil surface is level following tillage. Packing is not necessary; the weight of winter precipitation such as rain, ice and snow will naturally pack the soil, firming the seedbed. Undisturbed soybean residue is an ideal scenario for frost seeding. Frost seeding should not occur on existing sod or undisturbed corn ground. The corn stubble must be fall tilled to bury at least 30 percent of the residue and expose soil followed by a leveling tool.

A site that contains a significant remnant native plant population, consideration should be given to managing the site that would favor maintaining the species rather than eliminating them and reseeded. Stand improvement of existing natives will require a management program that allows the new seedlings to become established while maintaining the existing vegetative stand. Options available include: mowing and removing the biomass and interseeding, burn and interseed with persistent mowing until new seedlings become established. These options will require patience and persistence.

Planting Equipment and Seeding Methods

The equipment used to seed native materials should provide a consistent rate of seed flow and place the seed at a uniform depth in close contact with the soil. The characteristics of some native seeds require the use of specialized equipment or modification of

standard agricultural equipment such as grain drills. Some native seed are awned, light, fluffy, smooth, small, large and irregular in shape. Little Bluestem, Indiangrass, Big Bluestem all have light fluffy chaffy seed. Switchgrass has a small hard seed that will have several hundred thousand seeds per pound and Eastern Gamagrass has a large irregularly shaped seed and has about 8,000 seeds per pound. Any of these seed characteristics can result in uneven rates of seed flow and undesirable skips in seed rows in standard gravity fed grain drills. This makes it extremely important for the producer to understand planting methods commonly used and the need to have specialized equipment available to properly plant native species.

Whether a person is using conventional or no-till seeding methods, planting depth for native seeds should not exceed $\frac{1}{4}$ of an inch in depth. Either technique will be successful if specific guidelines are followed. There are advantages and disadvantages for using either seeding method.

Conventional seeding normally entails seedbed preparation involving some degree of tillage. The new planting is established by broadcasting or drilling into a partial or clean seedbed. The advantages and disadvantages of conventional seeding methods are:

- Advantages: may incorporate nutrients and provide the opportunity to destroy perennial weeds.
- Disadvantages: soil erosion increases greatly, erosion can wash new seedlings out or sediment can bury them, higher field preparation cost, weed competition can be greater especially from annual weeds, the need of a companion crop for erosion control and reduce weed competition.

No-till seeding is the planting of grasses, forbs and or legumes in the absence of tillage using planting tools capable of drilling into an undisturbed soil surface, interseeding into existing herbaceous cover or prior year crop residue. The advantages and disadvantages of no-till planting are:

- Advantages: soil erosion is minimized, reduced energy usage, no companion crop required, greater moisture availability, can seed under adverse conditions, carbon sequestrating approves, and proper seed placement ensured.
- Disadvantages: increased herbicide use, no-till drill required, nutrients cannot be incorporated.

Drill Seeding

Drill seeding is probably the most commonly used method of planting seed of any type. Seed is metered out from multiple seed boxes containing specialized components to mix, stir and meter seed, each adapted to planting different seed types. The soil opening and planting operation is followed by a set of packers, with no further soil preparation after seeding is completed. Drills may be classified as conventional or no-till type. A prepared seedbed is needed when using a conventional planter or drill. A no-till type drill can operate under both disturbed and undisturbed site conditions.

Whether a conventional or no-till type drill is used, prior to planting, calibrate the drill or seeder according to the manufacturer's instructions. Use a carrier material (or a small amount of seed if the carrier is not used) to test and adjust the seeding rate, distribution pattern, and planting depth.

Broadcast Seeding

Broadcast seeding is the planting or sowing seeds across an area by scattering seed either by mechanical means or by hand. Most common used mechanical broadcast planters are the rotary, cyclone and fertilizer cart with a spinning plate to evenly distribute seed material. Aerial seeding using an airplane or helicopter are common methods by which seed is broadcasted.

Broadcast planters work on the principle of centrifugal force and the inherent weight of the seed to distribute the seed uniformly across the site. When planting light, fluffy and chaffy seed, a carrier should be mix with the seed such as pelletized lime, fertilizer, damp sand, cracked corn, saw dust, vermiculite, etc. When fertilizer is used as a seed carrier, the seed must be spread immediately after mixing to prevent "salt effect" damage to the seed.

A prepared seedbed is critical to guaranteeing good seed to soil contact for uniform germination. Before and after seeding, a cultipacker or similar tool should be used to help incorporate, improve seed to soil contact and improve germination. Under certain conditions, broadcasting in an undisturbed seedbed can be successful for example on soybean stubble, when frost seeding, or fall dormant seedings. Broadcasting seed onto undisturbed ground consisting of large amounts of non-fragile residue is not recommended.

Calibration of broadcast spreaders is not as accurate as with drill seeding. To calibrate a broadcast seeder

determine your bulk seeding rate per acre and convert to an anticipated seeds per square foot. Place several tarps at multiple locations across the path of the seeder. Operate the seeder across the tarps and check each tarp for the average seed count per square foot, increasing or decreasing the rate of seed flow.

Frost Seeding

Frost seeding is the broadcasting of seed late winter through early spring. In Wisconsin, frost seeding normally should occur mid February to early March. The exact seeding date is not predetermined and will vary from year to year depending on climate.

Seed surface applied, absence of snow or onto snow cover of less than 2 inches. Seeding onto snow cover greater than 2 inches increases the risk for seeding failure. Frost seeding should not occur immediately before a predicted thaw event that could produce significant runoff. The soil surface is usually “honeycombed” with small cracks at this time during the year. The freeze/thaw cycles that occur at this time of year will embed the seed into the soil where it can germinate as growing conditions become more favorable. When the freeze-thaw cycle ends, seed according to the recommended spring seeding dates.

Frost seeding is allowed when using Practice Standards 327, Conservation Cover; and 512 Forage and Biomass Planting. Frost seeding is not allowed when using Standard 342, Critical Area Planting.

Dormant Seeding

Seed is broadcasted, no-tilled or conventional drilled into an undisturbed or disturbed partial or clean seedbed after the growing season and before freeze-up. The seed remains dormant until the following spring. A firm seedbed is required for disturbed or tilled sites. The advantages and disadvantages are:

- Advantages: seeding at a time of year when labor is more available, seedlings take advantage of early spring moisture, soil erosion is minimized.
- Disadvantage: seeding rates should be increased.

Dormant seeding is allowed when using Practice Standards 327, Conservation Cover; and 512, Forage and Biomass Planting. Dormant seeding is not allowed when using Standard 342, Critical Area Planting.

POST-PLANTING WEED CONTROL

Planting Year Post Emergence Weed Control Mowing – New Seedlings

Mesic and wet sites in particular are prone to weed competition. Currently, there are limited herbicides available to control weeds in a prairie restoration planting without potentially impacting native legumes and most forbs. To combat this problem, repeated mowing is essential throughout the establishment period.

The first year following seeding, mow growing plants to a height of 7 inches whenever the canopy reaches a height of 12 inches. Depending on rainfall and growing conditions, three mowings may be required. In a normal growing season, mowing should occur around the middle of June, early to mid July as well as the first part of August. It may be necessary to remove the clippings to avoid smothering the seedlings. Utilize a rotary mower or flail chopper to uniformly distribute mowed material over the field surface. It is essential to monitor the canopy height to avoid the accumulation of excess clipped material over top of seedlings and to ensure sunlight reaches the soil surface for the new seeding. Use of this mowing strategy will stress the weeds and will not harm the prairie plants in this first year.

Second Year Weed Control

Routinely evaluate the stand in the second year to determine if mowing for weed control is necessary. When necessary to control weed canopy, mow the planting to a height of 7 inches as often as required. The strategy in year two will mirror year one maintenance activities. Establishment of your native planting will have precedent over nesting season concerns. Once the prairie is established, wildlife habitat concerns should be mitigated with seasonal or spot treatment activities that will minimally impact wildlife.

DETERMINING SUCCESS OF THE PLANTING

In determining stand adequacy, there are two major considerations: 1) adequate protection of the soil resource, and 2) adequate stand for the planned purpose.

It may be difficult to determine if the prairie restoration is successful, particularly during the seeding year. Most native species are long-lived, but develop slowly. It may take two to five years for a

stand to be fully successful. For native plantings determined to be questionable or inadequate, a final evaluation deciding whether to reseed should not be done until after the third growing season. It is often said prairie sleeps the first year (sets root structure), creeps the second year (starts to spread slowly) and leaps in the third year (distinct and prominent). Patience is a virtue.

POST ESTABLISHMENT MANAGEMENT

Any planned maintenance (except for noxious weed control) after the establishment period, should be done before May 15 or after August 1 to protect nesting cover and reduce disruption of nesting activities.

Spot Treatment By Clipping

Spot clipping can be used to control annual weeds and to suppress other weeds. Spot clipping must be done before the target plant forms viable seed and must continue throughout the growing season. Spot clipping is not an effective control for biennial and perennial weeds but can be used to contain these plants until other control treatments can be implemented.

Spot Treatment With Herbicide

It is often necessary to spot treat invasive plants in a prairie. Introduced grasses and legumes and other aggressive weeds can severely impact a prairie when these undesirable plants are not controlled. The timing of herbicide product application is an important factor to protect prairie plants. Improper herbicide selection or application timing can severely damage a prairie planting. Early spring spot treatment with herbicides is often highly effective in addressing aggressive weeds while native plants are dormant. Spot treatment should be timed to treat weeds during active growth periods. Effective herbicide spot treatment can prevent the target plants from setting seed and spreading in the prairie.

Spot Treatment By Hand Pulling/Digging

Hand pulling or digging can be an effective control if the entire root is removed from the soil. Hand pulling/digging is most effective in the spring when the soil is moist and loose from the winter freeze/thaw cycles.

Prescribed Burning – Established Cover

Burning is a good tool for long-term stand management of native vegetation. Burning may be used to manage weeds once the prairie has been established if there is enough material to carry a fire. Time of burning and frequency will impact the species that are present on the site. Fall burns and to a lesser extent early spring burns, will tend to promote forbs. Late spring burns tend to stimulate the growth of warm season grasses and suppress cool season plants. Burn when the cool season plants are growing and the warm season plants are dormant or starting to grow to control cool season species. Do not conduct sequential prescribed burns on a given site at the same time of year. This tends to reduce stand diversity and can create a negative impact on desirable prairie plants. For longevity and plant diversity, burning should be conducted periodically, every other year to every fifth year.

REFERENCES

Curtis, J. T., 1959. *The Vegetation of Wisconsin: an ordination of plant communities*. University of Wisconsin Press, Madison.

Henderson, R. A., 1995. *Plant Species Composition of Wisconsin Prairies: an Aid to Selecting Species for Plantings and Restorations Based Upon University of Wisconsin-Madison Plant Ecology Laboratory Data..* Wisconsin Department of Natural Resources Technical Bulletin No. 188.

Nichols, S. and Entine, L., 1976. *Prairie Primer*. University of Wisconsin - Extension G2736.

Rock, H. W., 1971. *Prairie Propagation Handbook*. Boerner Botanical Gardens.

**Table 3
Common Species and Recommended Seeding Rates**

Name	Scientific Name	Moisture Regime	Single Species Seeding Rate (PLS)		
			Lbs./Ac.	Seeds/Lb.	Seeds/Ft ² /Lb./Ac.
Native Grasses					
Big Bluestem	Andropogon gerardii	D, DM, M, WM	11	165,000	3.8
Canada Wildrye	Elymus canadensis	DM, M, WM	12	83,200	1.9
Fowl Mannagrass	Glyceria striata	WM, W	0.5	2,560,000	58.7
Indiangrass	Sorghastrum nutans	D, DM, M, WM, W	10	192,000	4.4
Little Bluestem	Schizachyrium scoparium	D, DM, M	8	240,000	5.5
Prairie Cordgrass	Spartina pectinata	M, WM, W	8	105,600	2.4
Prairie Dropseed	Sporobolus heterolepis	D, DM, M	3	256,000	5.9
Prairie Junegrass	Koeleria macrantha	D, DM, M	0.5	2,308,672	53
Sideoats Grama	Bouteloua curtipendula	D, DM, M	8	127,000	2.9
Switchgrass	Panicum virgatum	D, DM, M, WM, W	7	389,000	8.9
Virginia Wildrye	Elymus virginicus	M, WM, W	17	67,200	1.5
Rush			Oz./Ac.	Seeds/Oz.	Seeds/Ft.²/Oz./Ac.
Woolgrass	Scirpus cyperinus	W	1.5	1,700,000	39

**Table 4
Wisconsin NRCS Authorized Native Plant List
(Grasses, Rushes, Sedges)**

Plant Type	Common Name	Scientific Name	Seeds/oz	Seeds/sq ft @ 1 oz/ac	Moisture Regime
Grass	Big Bluestem	Andropogon gerardii	10,313	0.24	D, DM, M, WM
Grass	Bluejoint	Calamagrostis canadensis	280,004	6.428	WM, W
Grass	Canada Wildrye	Elymus canadensis	5,200	0.12	DM, M, WM
Grass	Fowl Mannagrass	Glyceria striata	159,996	3.673	WM, W
Grass	American Mannagrass	Glyceria grandis	79,976	1.836	WM, W
Grass	Hairy Grama	Bouteloua hirsuta	70,000	1.607	D, DM
Grass	Indiangrass	Sorghastrum nutans	12,000	0.28	D, DM, M, WM, W
Grass	Prairie Junegrass	Koeleria macrantha	144,292	3.312	D, DM, M
Grass	Little Bluestem	Schizachyrium scoparium	15,000	0.344	D, DM, M
Grass	Porcupinegrass	Hesperostipa spartea	11,000	0.253	D, DM
Grass	Prairie Cordgrass	Spartina pectinata	6,600	0.152	M, WM, W
Grass	Prairie Dropseed	Sporobolus heterolepis	16,000	0.37	D, DM, M
Grass	Sand Dropseed	Sporobolus cryptandrus	332,125	7.625	D, DM, M
Grass	Sideoats Grama	Bouteloua curtipendula	7,938	0.183	D, DM, M
Grass	Switchgrass	Panicum virgatum	24,313	0.562	D, DM, M, WM, W
Grass	Virginia Wildrye*	Elymus virginicus*	4,200	0.096	M, WM, W
Rush	Common Rush	Juncus effusus	1,000,007	22.957	WM, W
Rush	Green Bulrush	Scirpus atrovirens	459,994	10.56	WM, W
Rush	River Bulrush	Schoenoplectus fluviatilis	4,299	0.0987	M, WM, W
Rush	Softstem Bulrush	Schoenoplectus tabernaemontani	31,015	0.712	WM, W
Rush	Woolgrass	Scirpus cyperinus	1,700,000	39.027	W
Sedge	Longhair Sedge	Carex comosa	30,013	0.689	WM, W
Sedge	Fox Sedge	Carex vulpinoidea	99,970	2.295	WM, W
Sedge	Bottlebrush Sedge	Carex hystericina	30,013	0.689	WM, W

*Virginia wildrye (*Elymus virginicus*) is better adapted than Canada wildrye (*Elymus canadensis*) for wet site condition seedings in the south planting zone (Figure 1).

Table 5
Wisconsin NRCS Authorized Native Plant List
(Forbs, Legumes, Shrubs)

Plant Type	Common Name	Scientific Name	Seeds/oz	Seeds/sq ft @ 1 oz/ac	Moisture Regime	Blooming Period
Forb	Angelica	Angelica atropurpurea	5401	0.124	W	Middle
Forb	Bergamot	Monarda fistulosa	77,800	1.786	DM, M, WM	Middle – Late
Forb	Biennial Beeblossom	Gaura biennis	2,700	0.062	M	Middle – Late
Forb	Bird's Foot Violet	Viola pedata	26,000	0.597	D, DM	Early, Middle, Late
Forb	Black-Eyed Susan	Rudbeckia hirta	99,600	2.287	D, DM, M, WM	Middle – Late
Forb	Blue Vervain	Verbena hastata	93,000	2.134	WM, W	Middle – Late
Forb	Blue-Eyed Grass	Sisyrinchium campestre	45,000	1.033	D, DM, M	Early – Middle
Forb	Boneset	Eupatorium perfoliatum	160,000	3.67	WM, W	Middle – Late
Forb	Bottle Gentian	Gentiana andrewsii	280,000	6.428	M	Middle – Late
Forb	Butterfly Milkweed	Asclepias tuberosa	3,480	0.08	D, DM, M	Middle
Forb	Cardinal Flower	Lobelia cardinalis	400,000	9.18	WM, W	Middle – Late
Forb	Common Ironweed	Vernonia fasciculata	20,000	0.459	WM, W	Late
Forb	Common Milkweed	Asclepias syriaca	4,000	0.09	DM, M	Middle - Late
Forb	Compass Plant	Silphium laciniatum	650	0.015	DM, M, WM	Middle – Late
Forb	Culver's Root	Veronicastrum virginicum	750,000	17.218	M, WM, W	Middle
Forb	Cupplant	Silphium perfoliatum	1,400	0.032	M, WM, W	Middle – Late
Forb	Downy Gentian	Gentiana puberulenta	435,000	9.986	DM, M	Late
Forb	Downy Wood Mint	Blephilia ciliata	400,000	9.18	DM, M, WM	Middle – Late
Forb	Evening Primrose	Oenothera biennis	90,000	2.07	D, DM, M	Late
Forb	False Boneset	Brickellia eupatorioides	24,000	0.551	D, DM	Middle – Late
Forb	False Toadflax	Comandra umbellata	700	0.016	D, DM, M, WM	Early – Middle
Forb	Few Leaf Sunflower	Helianthus occidentalis	12,960	0.298	DM, M	Middle – Late
Forb	Flowering Spurge	Euphorbia corollata	8,000	0.184	D, DM, M, WM	Middle – Late
Forb	Foxglove Beard Tongue	Penstemon digitalis	115,000	2.64	M, WM	Early – Middle
Forb	Giant Hyssop	Agastache foeniculum	65,000	1.49	DM, M	Middle - Late
Forb	Giant Sunflower	Helianthus giganteus	10,938	0.25	DM, M	Middle - Late
Forb	Goat's Rue	Tephrosia virginiana	2,500	0.057	D, DM	Early – Middle
Forb	Golden Alexanders	Zizia aurea	11,000	0.25	M, WM, W	Early
Forb	Golden Ragwort	Packera aurea	73,000	1.68	M, WM, W	Early – Middle
Forb	Great Blue Lobelia	Lobelia siphilitica	500,000	11.478	W	Middle – Late
Forb	Great St. Johnswort	Hypericum ascyron	200,000	4.59	M, WM	Middle
Forb	Green Milkweed	Asclepias viridiflora	3,600	0.083	D, DM	Early – Middle
Forb	Grooved Yellow Flax	Linum sulcatum	94,000	2.158	D, DM	Early, Middle, Late
Forb	Harebell	Campanula rotundifolia	900,000	20.66	D, DM	Middle – Late
Forb	Harelequin Blue Flag Iris	Iris versicolor	1,300	0.029	W	Early – Middle
Forb	Heath Aster	Symphotrichum ericoides	140,000	3.214	D, DM, M, WM	Late
Forb	Hoary Vervain	Verbena stricta	32,000	0.734	D, DM	Middle – Late
Forb	Joe-Pye Weed	Eutrochium maculatum	95,000	2.18	W	Middle – Late
Forb	Large Beard Tongue	Penstemon grandiflorus	14,000	0.321	DM	Middle
Forb	Marsh Milkweed	Asclepias incarnata	4,800	0.11	W	Middle
Forb	Meadow Anemone	Anemone canadensis	8,000	0.184	M, WM	Early – Middle
Forb	Mountain Mint	Pycnanthemum virginianum	220,000	5.05	DM, M, WM, W	Middle – Late
Forb	New England Aster	Symphotrichum novae-angliae	69,900	1.605	M, WM	Late
Forb	Nodding Beggartick	Bidens cernua	21,000	0.482	WM, W	Late
Forb	Nodding Wild Onion	Allium cernuum	7,680	0.176	DM, M	Middle
Forb	Ox-Eye Sunflower	Heliopsis helianthoides	6,480	0.149	M	Middle – Late

Plant Type	Common Name	Scientific Name	Seeds/oz	Seeds/sq ft @ 1 oz/ac	Moisture Regime	Blooming Period
Forb	Pale Purple Coneflower	Echinacea pallida	4,580	0.105	DM, M	Middle
Forb	Pale Spiked Lobelia	Lobelia spicata	900,000	20.661	D, DM, M, WM	Middle
Forb	Panicled Aster	Symphotrichum lanceolatum	141,570	3.25	M, WM, W	Late
Forb	Partridge Pea	Chamaecrista fasciculata	3,800	0.087	D, M	Middle - Late
Forb	Pasque Flower	Pulsatilla patens	18,000	0.413	D, DM	Early
Forb	Prairie Alum-Root	Heuchera richardsonii	750,000	17.22	D, DM, M, WM	Early – Middle
Forb	Prairie Blazing Star	Liatris pycnostachya	11,970	0.275	D, DM, M, WM	Middle – Late
Forb	Prairie Cinquefoil	Potentilla arguta	200,000	4.591	D, DM, M	Middle – Late
Forb	Prairie Dock	Silphium terebinthinaceum	1,110	0.025	DM, M, WM	Middle – Late
Forb	Prairie Loosestrife	Lysimachia quadriflora	90,000	2.07	M, WM, W	Middle
Forb	Prairie Milkweed	Asclepias sullivantii	4,500	0.103	D, DM, M, WM	Early – Middle
Forb	Prairie Parsley	Polytaenia nuttallii	4,000	0.0918	D, DM, M, WM	Early – Middle
Forb	Prairie Phlox	Phlox pilosa	19,000	0.436	DM, M	Early – Middle
Forb	Prairie Smoke	Geum triflorum	27,000	0.62	D, DM	Early
Forb	Prairie Sunflower	Helianthus pauciflorus	4,580	0.105	D, DM, M	Middle – Late
Forb	Prairie Tickseed	Coreopsis palmata	11,970	0.275	D, DM	Middle – Late
Forb	Prairie Violet	Viola pedatifida	28,000	0.643	D, DM, M	Early, Middle, Late
Forb	Purple Coneflower	Echinacea purpurea	6,600	0.15	D, DM, M	Middle
Forb	Purple Meadow-Rue	Thalictrum dasycarpum	11,000	0.252	M, WM, W	Middle
Forb	Rattlesnake Master	Eryngium yuccifolium	7,980	0.183	DM, M, WM	Middle – Late
Forb	Rosinweed	Silphium integrifolium	3,990	0.092	DM, M, WM	Middle – Late
Forb	Rough Blazing Star	Liatris aspera	13,470	0.309	D, DM, M	Late
Forb	Sawtooth Sunflower	Helianthus grosseserratus	15,000	0.344	D, DM, M, WM, W	Middle – Late
Forb	Shootingstar	Dodecatheon meadia	75,000	1.722	D, DM, M, WM	Early
Forb	Showy Goldenrod	Solidago speciosa	95,000	2.18	D, DM, M	Late
Forb	Silky Aster	Symphotrichum sericeum	56,000	1.29	D, DM	Late
Forb	Sky-Blue Aster	Symphotrichum oolentangiense	82,000	1.882	D, DM, M	Late
Forb	Smooth Blue Aster	Symphotrichum laeve	47,830	1.098	DM, M, WM	Late
Forb	Sneezeweed	Helenium autumnale	130,000	2.98	WM, W	Middle – Late
Forb	Spiderwort	Tradescantia ohiensis	7,980	0.183	D, DM, M, WM	Early – Middle
Forb	Spotted Jewelweed	Impatiens capensis	1,600	0.037	M, WM, W	Middle – Late
Forb	Spotted Mint	Monarda punctata	93,700	2.151	D, DM	Middle – Late
Forb	Stiff Goldenrod	Oligoneuron rigidum	45,850	1.053	D, DM, M	Late
Forb	Sweet Black-Eyed Susan	Rudbeckia subtomentosa	45,850	1.053	DM, M, WM	Middle – Late
Forb	Tall Bellflower	Campanula americana	170,000	3.9	M, WM	Middle - Late
Forb	Thimbleweed	Anemone cylindrica	20,000	0.459	D, DM	Early – Middle
Forb	Turk's Cap Lily	Lilium superbum	5,000	0.115	M, WM	Middle
Forb	Upland Boneset	Eupatorium sessilifolium	50,000	1.15	M	Late
Forb	Whorled Milkweed	Asclepias verticillata	4,000	0.092	D, DM	Middle – Late
Forb	Wild Garlic	Allium canadense	560	0.013	M, WM	Middle
Forb	Wild Quinine	Parthenium integrifolium	6,790	0.156	DM, M, WM	Middle – Late
Forb	Winged Loosestrife	Lythrium alatum	3,000,000	68.87	WM, W	Middle – Late
Forb	Wood Betony	Pedicularis canadensis	33,000	0.758	D, DM, M	Early
Forb	Yellow Cone Flower	Ratibida pinnata	26,940	0.618	D, DM, M, WM	Middle – Late
Forb	Yellow Star Grass	Hypoxis hirsuta	80,000	1.837	DM, M, WM	Early, Middle, Late
Legume	Canada Milk Vetch	Astragalus canadensis	15,960	0.366	M, WM	Middle
Legume	Cream Wild Indigo	Baptisia bracteata	1,700	0.039	M	Early
Legume	Illinois Tick Trefoil	Desmodium illinoense	4,500	0.103	DM, M	Early – Middle
Legume	Leadplant	Amorpha canescens	16,950	0.389	D, DM, M	Middle
Legume	Purple Prairie Clover	Dalea purpurea	19,950	0.458	D, DM, M	Early, Middle, Late

Plant Type	Common Name	Scientific Name	Seeds/oz	Seeds/sq ft @ 1 oz/ac	Moisture Regime	Blooming Period
Legume	Round-Headed Bush-Clover	<i>Lespedeza capitata</i>	9,960	0.229	D, DM	Late
Legume	Showy Tick-Trefoil	<i>Desmodium canadense</i>	4,500	0.103	M	Middle – Late
Legume	White Prairie Clover	<i>Dalea candida</i>	15,850	0.364	D, DM, M	Middle
Legume	White Wild Indigo	<i>Baptisia alba</i>	1,585	0.036	DM, M, WM	Middle
Legume	Wild Lupine	<i>Lupinus perennis</i>	990	0.023	D, DM, M	Early – Middle
Shrub	New Jersey Tea	<i>Ceanothus americanus</i>	7,000	0.161	DM, M	Middle - Late

Table 6
Sample Seed Mix for Basic Dry Prairie
(Seed Calculator Code 327-1)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Stiff Goldenrod	<i>Oligoneuron rigidum</i>	1.00	1.0
Yellow cone flower	<i>Ratibida pinnata</i>	1.00	0.6
Purple prairie clover	<i>Dalea purpurea</i>	2.00	0.9
Big bluestem	<i>Andropogon gerardii</i>	16.00	3.8
Little bluestem	<i>Schizachyrium scoparium</i>	28.00	9.6
Indiangrass	<i>Sorghastrum nutans</i>	16.00	4.4
Sideoats grama	<i>Bouteloua curtipendula</i>	28.00	5.1

Table 7
Sample Seed Mix for Basic Dry Mesic Prairie
(Seed Calculator Code 327-2)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Purple prairie clover	<i>Dalea purpurea</i>	2.00	0.9
Bergamot	<i>Monarda fistulosa</i>	1.00	1.8
Yellow cone flower	<i>Ratibida pinnata</i>	1.00	0.6
Big bluestem	<i>Andropogon gerardii</i>	8.00	1.9
Little bluestem	<i>Schizachyrium scoparium</i>	24.00	8.3
Indiangrass	<i>Sorghastrum nutans</i>	16.00	4.4
Switchgrass	<i>Panicum virgatum</i>	8.00	4.5
Sideoats grama	<i>Bouteloua curtipendula</i>	16.00	2.9

Table 8
Sample Seed Mix for Basic Mesic Prairie
(Seed Calculator Code 327-3)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Yellow cone flower	<i>Ratibida pinnata</i>	1.00	0.6
Blackeyed Susan	<i>Rudbeckia hirta</i>	1.00	2.2
Bergamot	<i>Monarda fistulosa</i>	1.00	1.8
Big bluestem	<i>Andropogon gerardii</i>	16.00	3.8
Switchgrass	<i>Panicum virgatum</i>	8.00	4.5
Little bluestem	<i>Schizachyrium scoparium</i>	20.00	6.9
Indiangrass	<i>Sorghastrum nutans</i>	16.00	4.4
Canada wildrye	<i>Elymus canadensis</i>	16.00	1.9

Table 9
Sample Seed Mix for Basic Wet Mesic Prairie
(Seed Calculator Code 327-4)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Bergamot	<i>Monarda fistulosa</i>	1.00	1.8
Yellow cone flower	<i>Ratibida pinnata</i>	1.00	0.6
New England aster	<i>Symphyotrichum novae-angliae</i>	1.00	1.6
Switchgrass	<i>Panicum virgatum</i>	16.00	8.9
Prairie cordgrass	<i>Spartina pectinata</i>	8.00	1.2
Big bluestem	<i>Andropogon gerardii</i>	24.00	5.8
Virginia wildrye	<i>Elymus virginicus</i>	16.00	1.5
Indiangrass	<i>Sorghastrum nutans</i>	16.00	4.4

Table 10
Sample Seed Mix for Basic Wet Prairie
(Seed Calculator Code 327-5)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Common ironweed	<i>Vernonia fasciculata</i>	1.00	0.5
Cupplant	<i>Silphium perfoliatum</i>	2.00	0.1
Blue vervain	<i>Verbena hastata</i>	1.00	2.1
Switchgrass	<i>Panicum virgatum</i>	16.00	8.9
Prairie cordgrass	<i>Spartina pectinata</i>	8.00	1.2
Big bluestem	<i>Andropogon gerardii</i>	16.00	3.8
Indiangrass	<i>Sorghastrum nutans</i>	16.00	4.4
Virginia wildrye	<i>Elymus virginicus</i>	20.00	1.9

Table 11
Sample Seed Mix for Dry Prairie Restoration
(Seed Calculator Code 327-6)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Prairie cinquefoil	<i>Potentilla arguta</i>	0.50	2.3
Silky Aster	<i>Symphyotrichum sericeum</i>	1.00	1.3
Leadplant	<i>Amorpha canescens</i>	1.00	0.4
Spotted mint	<i>Monarda punctata</i>	0.50	1.1
Prairie tickseed	<i>Coreopsis palmata</i>	1.00	0.3
Stiff Goldenrod	<i>Oligoneuron rigidum</i>	1.00	1.0
Hoary vervain	<i>Verbena stricta</i>	1.00	0.7
Yellow cone flower	<i>Ratibida pinnata</i>	1.00	0.6
Spiderwort	<i>Tradescantia ohiensis</i>	2.00	0.4
Purple prairie clover	<i>Dalea purpurea</i>	4.00	1.8
Big bluestem	<i>Andropogon gerardii</i>	4.00	1.0
Sideoats grama	<i>Bouteloua curtipendula</i>	24.00	4.4
Little bluestem	<i>Schizachyrium scoparium</i>	24.00	8.3
Indiangrass	<i>Sorghastrum nutans</i>	8.00	2.2
Prairie June Grass	<i>Koeleria macrantha</i>	2.00	6.6
Sand dropseed	<i>Sporobolus cryptandrus</i>	2.00	15.3

Table 12
Sample Seed Mix for Dry Mesic Prairie Restoration
(Seed Calculator Code 327-7)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Prairie cinquefoil	Potentilla arguta	0.25	1.1
Leadplant	Amorpha canescens	1.00	0.4
Silky Aster	Symphyotrichum sericeum	1.00	1.3
Purple prairie clover	Dalea purpurea	3.00	1.4
Rough blazing star	Liatris aspera	0.50	0.2
Roundheaded Bushclover	Lespedeza capitata	3.00	0.7
Bergamot	Monarda fistulosa	1.00	1.8
Yellow cone flower	Ratibida pinnata	1.00	0.6
Stiff Goldenrod	Oligoneuron rigidum	1.00	1.1
Spiderwort	Tradescantia ohiensis	1.00	0.2
Little bluestem	Schizachyrium scoparium	24.00	8.3
Indiangrass	Sorghastrum nutans	8.00	2.2
Prairie June Grass	Koeleria macrantha	2.00	6.6
Prairie dropseed	Sporobolus heterolepis	2.00	0.7
Switchgrass	Panicum virgatum	4.00	2.2
Sideoats grama	Bouteloua curtipendula	24.00	4.4

Table 13
Sample Seed Mix for Mesic Native Prairie Restoration
(Seed Calculator Code 327-8)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Yellow cone flower	Ratibida pinnata	0.50	0.3
Blackeyed Susan	Rudbeckia hirta	0.50	1.1
Sky blue aster	Aster oolentangiense	0.50	0.9
Ox-eye sunflower	Heliopsis helianthoides	1.00	0.1
Bergamot	Monarda fistulosa	0.50	0.9
Culvers root	Vernonia virginicum	0.25	4.3
Purple prairie clover	Dalea purpurea	1.00	0.5
Rosinweed	Silphium integrifolium	1.00	0.1
Prairie blazing star	Liatris pycnostachya	1.00	0.3
New england aster	Symphyotrichum novae-angliae	0.50	0.8
Big bluestem	Andropogon gerardii	16.00	3.8
Switchgrass	Panicum virgatum	8.00	4.5
Little bluestem	Schizachyrium scoparium	24.00	8.3
Canada wildrye	Elymus canadensis	8.00	1.0
Indiangrass	Sorghastrum nutans	16.00	4.4

Table 14
Sample Seed Mix for Wet Mesic Prairie Restoration
(Seed Calculator Code 327-9)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Blackeyed Susan	<i>Rudbeckia hirta</i>	1.00	2.2
Bergamot	<i>Monarda fistulosa</i>	1.00	1.8
Yellow cone flower	<i>Ratibida pinnata</i>	1.00	0.6
Prairie blazing star	<i>Liatris pycnostachya</i>	1.00	0.4
Common Ironweed	<i>Vernonia fasciculata</i>	1.00	0.5
Cupplant	<i>Silphium perfoliatum</i>	4.00	0.1
Golden Alexanders	<i>Zizia aurea</i>	1.00	0.3
Great St John's Wort	<i>Hypericum ascyron</i>	0.25	1.1
White wild indigo	<i>Baptisia alba</i>	1.50	0.1
New England aster	<i>Symphyotrichum novae-angliae</i>	1.00	1.6
Switchgrass	<i>Panicum virgatum</i>	16.00	8.9
Prairie cordgrass	<i>Spartina pectinata</i>	4.00	0.6
Big bluestem	<i>Andropogon gerardii</i>	20.00	4.8
Canada wildrye	<i>Elymus canadensis</i>	16.00	1.9
Indiangrass	<i>Sorghastrum nutans</i>	12.00	3.4

Table 15
Sample Seed Mix for Wet Prairie Restoration
(Seed Calculator Code 327-10)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Culver's root	<i>Veronicastrum virginicum</i>	0.25	4.3
Common ironweed	<i>Vernonia fasciculata</i>	0.50	0.2
Cupplant	<i>Silphium perfoliatum</i>	2.00	0.1
Marsh milkweed	<i>Asclepias incarnata</i>	2.00	0.2
Joe pye weed	<i>Eutrochium maculatum</i>	1.00	2.2
Blue vervain	<i>Verbena hastata</i>	2.00	4.3
Showy tick trefoil	<i>Desmodium canadense</i>	3.00	0.3
Boneset	<i>Eupatorium perfoliatum</i>	0.50	1.8
Golden alexanders	<i>Zizia aurea</i>	2.00	0.5
Switchgrass	<i>Panicum virgatum</i>	8.00	4.5
Prairie cordgrass	<i>Spartina pectinata</i>	4.00	0.6
Big bluestem	<i>Andropogon gerardii</i>	4.00	1.0
Canada wildrye	<i>Elymus canadensis</i>	8.00	1.0
Indiangrass	<i>Sorghastrum nutans</i>	4.00	1.1
Fowl mannagrass	<i>Glyceria striata</i>	4.00	14.7
Fox sedge	<i>Carex vulpinoidea</i>	4.00	9.2

Table 16
Seed Mix for Dry Mesic Karner Blue Prairie Restoration
(Seed Calculator Code 327-11)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Prairie cinquefoil	Potentilla arguta	0.50	2.2
Leadplant	Amorpha canescens	1.00	0.4
Silky Aster	Symphyotrichum sericeum	1.0	1.3
Purple prairie clover	Dalea purpurea	4.00	1.8
Rough blazing star	Liatris aspera	1.00	0.3
Wild lupine	Lupinus perennis	6.00	0.1
Bergamot	Monarda fistulosa	0.50	0.9
Yellow cone flower	Ratibida pinnata	1.00	0.6
Stiff Goldenrod	Oligoneuron rigidum	1.00	1.1
Pale Purple Coneflower	Echinacea pallida	2.00	0.2
Sideoats grama	Bouteloua curtipendula	20.00	3.7
Little bluestem	Schizachyrium scoparium	24.00	8.3
Indiangrass	Sorghastrum nutans	8.00	2.2
Prairie June Grass	Koeleria macrantha	1.00	3.3
Prairie dropseed	Sporobolus heterolepis	2.00	0.7
Switchgrass	Panicum virgatum	4.00	2.2

Table 17
Sample Seed Mix for Native Pollinator Seeding for Dry Mesic Sites
(Seed Calculator Code 327-12)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Square Foot
Little Bluestem	Schizachyrium scoparium	16	5.5
Sideoats Grama	Bouteloua curtipendula	16	2.9
Illinois Tick Trefoil	Desmodium illinoense	5	0.5
Spiderwort	Tradescantia ohiensis	5	0.9
Purple Prairie Clover	Dalea purpurea	6	2.7
Yellow Coneflower	Ratibida pinnata	1	0.6
Prairie Blazing Star	Liatris pycnostachya	3	0.8
Rattlesnake Master	Eryngium yuccifolium	6	1.1
Showy Goldenrod	Solidago speciosa	4	8.7
Stiff Goldenrod	Oligoneuron rigidum	3	3.2
Smooth Blue Aster	Symphyotrichum laeve	2	2.2
Prairie Cinquefoil	Potentilla arguta	2	9.2

Table 18
Sample Seed Mix for Native Pollinator Seeding for Mesic Sites
(Seed Calculator Code 327-13)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Square Foot
Little Bluestem	Schizachyrium scoparium	16	5.5
Sideoats Grama	Bouteloua curtipendula	16	2.9
Foxglove Beardtongue	Penstemon digitalis	4	10.6
Spiderwort	Tradescantia ohiensis	6	1.1
Golden Alexanders	Zizia aurea	6	1.5
Yellow Coneflower	Ratibida pinnata	1	0.6
Purple Prairie Clover	Dalea purpurea	6	2.7
Prairie Blazing Star	Liatris pycnostachya	4	1.1
Rattlesnake Master	Eryngium yuccifolium	6	1.1
New England Aster	Symphotrichum novae-angliae	3	4.8
Stiff Goldenrod	Oligoneuron rigidum	3	3.2
Smooth Blue Aster	Symphotrichum laeve	3	3.3

Table 19
Sample Seed Mix for Native Pollinator Seeding for Wet Mesic Sites
(Seed Calculator Code 327-14)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Square Foot
Big Bluestem	Andropogon gerardii	16	3.8
Indiangrass	Sorghastrum nutans	16	4.4
Foxglove Beardtongue	Penstemon digitalis	4	10.6
Spiderwort	Tradescantia ohiensis	6	1.1
Golden Alexanders	Zizia aurea	5	1.3
Yellow Coneflower	Ratibida pinnata	1	0.6
Prairie Blazing Star	Liatris pycnostachya	3	0.8
Rattlesnake Master	Eryngium yuccifolium	6	1.1
New England Aster	Symphotrichum novae-angliae	3	4.8
Blue Vervain	Verbena hastata	4	8.5
Common Ironweed	Vernonia fasciculata	3	1.4
Cupplant	Silphium perfoliatum	3	0.1

Table 20
Seeding Chart for Native Grass Species

Grass	Percent of Mixture	Pure Stand Seeding Rate	Seeds per Square Foot
Big Bluestem, <i>Andropogon gerardii</i>	0-100	11 lbs/ac	42
Canada Wildrye, <i>Elymus canadensis</i>	0-20	12 lbs/ac	23
Indiangrass, <i>Sorghastrum nutans</i>	0-100	10 lbs/ac	44
Little Bluestem, <i>Schizachyrium scoparium</i>	0-20	8 lbs./ac	44
Sideoats Grama, <i>Bouteloua curtipendula</i>	0-20	8 lbs/ac	23
Switchgrass, <i>Panicum virgatum</i>	0-100	7 lbs/ac	63
Virginia Wildrye, <i>Elymus virginicus</i>	0-20	17 lbs/ac	26
Prairie Junegrass, <i>Koeleria macrantha</i>	0-20	0.5 lbs/ac	26
Hairy Grama, <i>Bouteloua hirsuta</i>	0-25	1 lb/ac	26

Canada Wildrye, Virginia Wildrye and Sideoats Grama when combined will not comprise of more than 20 percent of the total grass seeds per square foot. Pure stand seeding rates for Big Bluestem and Indiangrass must be increased by 5 lbs/acre to meet the minimum seeds per square foot as required by this standard. Refer to Table 3 for suggested moisture regimes per specie.

Table 21
Biomass Planting Recommendations

Forage Suitability Group	Species	Lbs. PLS/Acre	Seeds per Square Foot
Biomass/Biofuel			
Group: 1-9	Switchgrass Varieties:		
	Blackwell	7	63
	Cave-in-Rock	7	
	Pathfinder	7	
	Sunburst	7	

Table 22
Solid Native Grass Plantings
(Seed Calculator Code 327-15 A to C, 512 H7 to H9)

Seed Calculator Code	Mixtures	Pounds PLS per Acre	Seeds per Square Foot	Moisture Regime
327-15A, 512-H7	Switchgrass (<i>Panicum virgatum</i>)	7.0	63	DM-WM
327-15B, 512-H8	Big Bluestem (<i>Andropogon gerardii</i>)	11.0	42	
327-15C, 512-H9	Indiangrass (<i>Sorghastrum nutans</i>)	10.0	44	

Table 23
Summary of Seeding Requirements for Standards 327, 342, and 512 (Native Species)

Standard 327 - Conservation Cover									
Mix Type	Grasses		Forbs/Legumes^a		Seeding Periods				Notes
	No.	Seeds/Ft²	No.	Seeds/Ft²	Spring	Late Summer	Dormant^b	Frost^b	
Basic Prairie ^c	≥3	≥20	≥3	≥2	X	NR	X	X	At least 50% of mix must be grasses (mix can have up to 20% Canada and Virginia Wildrye and Sideoats Grama).
Prairie Restoration ^c	≥5	≥15	≥10	≥8	X	NR	X	X	At least 1 forb must be legume and at least 50% of seeds per square foot must be grasses (mix can have up to 20% Canada and Virginia Wildrye and Sideoats Grama).
Pollinator Habitat	1-2	≤10	≥9	≥30	X	NR	X	X	- At least 3 early, 3 mid, and 3 late blooming forbs. - Grasses must be bunch-type and maximum of 10 seeds per square foot.
Untested Local Genotype Seed	≥5	≥25	≥10	≥10	X	NR	X	X	- At least 50 seeds per square foot total. - Grasses must be at least 50% of mix. - If single specie makes up more than 20% of mix, only count 20% towards the total seeds per square foot. - At least 1 forb must be legume.

(a) If more than 20% of legumes are hard seed, increase rate by % hard seed.

(b) Increase rate 15% for frost and dormant seedings.

(c) Maximum rates/acre for the following species: Switchgrass (1 lb.), Prairie Junegrass (2.0 oz.), Black-eyed Susan (2.0 oz.), Bergamot (2.0 oz.), or Purple Coneflower (3.0 oz.)

Standard 342 - Critical Area Planting									
Mix Type	Grasses		Forbs/Legumes		Seeding Periods				Notes
	No.	Seeds/Ft²	No.	Seeds/Ft²	Spring	Late Summer	Dormant	Frost	
Grasses Only	≥1	≥60			X	NR	NR	NR	Limit Canada Wildrye, Virginia Wildrye, and Sideoats Grama to 20% of the total grasses.
Mixtures	≥1	≥40	≥1	≥20	X	NR	NR	NR	- Mix must be at least 60 seeds per square foot total. - Grasses must be at least 50% of the mix (can have up to 20% Canada and Virginia Wildrye and Sideoats Grama).

Standard 512 - Forage and Biomass Planting									
Mix Type	Grasses		Forbs		Seeding Periods				Notes
	No.	Seeds/Ft²	No.	Seeds/Ft²	Spring	Late Summer	Dormant^a	Frost^a	
Pasture/Hayland	1	See Notes			X	NR	X	X	- Big Bluestem: 42 seeds per square foot. - Indiangrass: 44 seeds per square foot. - Switchgrass: 63 seeds per square foot.
Biomass Seeding	1	≥60			X	NR	X	X	Only Switchgrass is approved.

(a) Increase rate 15% for frost and dormant seedings.