United States Department of Agriculture

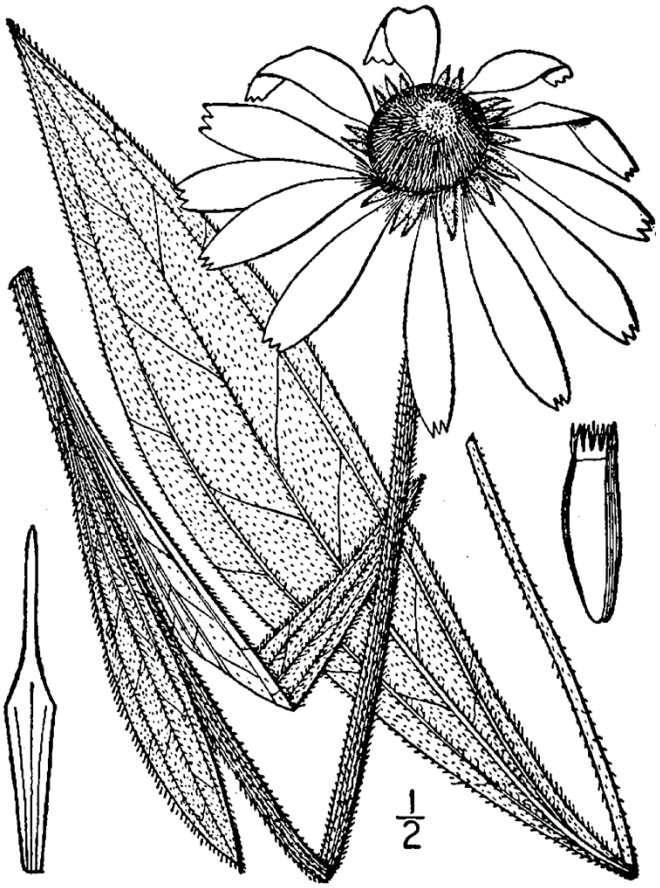
Natural Resources Conservation Service

Plant Materials Center, Bismarck, North Dakota

August 2015

Technical Report, 2014

Part 1 of 2: Grasses, Forbs, and Legumes



Narrow leaved purple coneflower
Echinacea angustifolia

Credit: USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *An illustrated flora of the northern United States, Canada and the British Possessions. 3 vols.* Charles Scribner's Sons, New York. Vol. 3: 476.

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United States Department of Agriculture
Natural Resources Conservation Service
Bismarck Plant Materials Center

Technical Report

Part I (Grasses, Forbs, and Legumes)

2014

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PART I

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INTRODUCTION

INTRODUCTION: TECHNICAL REPORT – 2014

Plant Materials Priorities and Needs

The USDA, Natural Resources Conservation Service (NRCS), Plant Materials Center (PMC), Bismarck, North Dakota, primarily serves the States of Minnesota, North Dakota, and South Dakota. Activities are directed toward meeting the needs and priorities set forth in the three States' long range programs.

Objectives and Functions

1. Identify, select, and improve plants to meet the resource conservation needs of the three States.

2. Determine cultural techniques for successful propagation and establishment of these plants.

3. Assemble and comparatively evaluate materials on and off the PMC.

4. Make comparative field plantings for final testing of promising plants and techniques with conservation districts and cooperators.

5. Work with universities, experiment stations, and other State and Federal agencies to cooperatively release improved conservation plants.

6. Produce limited quantities of foundation or foundation quality seed, which is made available to commercial seed growers for establishing seed increase fields.

7. Encourage conservation districts, commercial seed growers, and commercial and State nurseries to produce adapted plant materials and named cultivars.

8. Promote improved conservation plant materials in conservation programs.

Location

The Bismarck Plant Materials Center is located in south central North Dakota, near the center of the North American landmass. It is on the east bank of the Missouri River in a shallow basin 7 miles wide and 11 miles long. Elevation is 1,647 feet, latitude 46º46'N and longitude 100º45'W.

Physical Facilities and Evaluation Sites

The PMC does not own land but manages a total of approximately 60 acres on Lincoln-Oakes Nursery. Three off-center evaluation sites are located in Minnesota, South Dakota, and North Dakota.

1. Lincoln-Oakes Nurseries, Bismarck, North Dakota. The USDA Natural Resources Conservation Service, Plant Materials Center operates under a cooperative working agreement with the North Dakota Association of Soil Conservation Districts (NDASCD). The Association owns and operates the Lincoln-Oakes Nursery which in turn provides the PMC with 60 acres of land located on the nursery. This site is primarily used by the PMC for foundation quality grass seed production. The PMC shares a building site with the Nursery, with the NRCS buildings located on the north part of the acreage. Buildings include an office, greenhouse, lathhouse, old office/storage building, machine storage shed (housing tree and seed storage refrigeration units), seed cleaning building, chemical storage shed, and two equipment storage buildings with one including a shop.

2. Off-center evaluation sites in Minnesota, South Dakota and North Dakota. These three off-center evaluation sites, located in the three-State area, are cooperative with various State and Federal agencies. These locations provide long-term testing sites for plants evaluated under uniform culture and management. Refer to map, page 8.

Soils

At the PMC, the soil type is a Mandan silt loam. The Mandan series typically consists of deep, well-drained soils formed in silty sediments on uplands and terraces. The surface layer is dark grayish-brown and grayish-brown silt loam 20 inches thick. The subsoil is grayish-brown silt loam 9 inches thick. The underlying material is 28 inches of light brownish-gray silt loam over light brownish-gray loam. Slopes range 0 to 7 percent. Ordinarily, surface runoff is medium and fertility is high. Controlling erosion is the major concern in management. Both soil blowing and water erosion are hazards. This soil is well-suited to small grain, corn, and alfalfa. Capability unit IIe5, Conservation Tree and Shrub Group 3.

Climatological Information and 2014 Weather Summary

Climate of the area is semiarid, typically continental in character. During the summer, there are a few hot and humid days, but the winters are quite cold and fairly long. The relative humidity during the summer is generally low, and high temperature and high humidity are seldom experienced together.

Precipitation averages 17.80 inches per year. More than 75 percent of this falls during the six-month period of April through September, and 50 percent normally falls in May, June, and July. Most summer precipitation occurs during thunderstorms that occur about 34 days per year. Damaging hail occurs about once in 10 years. Refer to Table 1 for 2014 weather data.

The winter season begins in late November and continues until late March. Nearly all winter precipitation is snow, often associated with strong winds and low temperatures. Snow has been reported for all months except July and August. Occasional winter blizzards can be severe.

Temperatures range from an average mean of 6.7 degrees F in January to a mean of 70.4 degrees F in July. During short periods, the temperatures may climb as high as 100 degrees F in summer or drop as low as -44 degrees F in winter. Frequent clear and partly cloudy days contribute to a high percentage of possible sunshine, with the total annual average about 2,700 hours out of a possible 4,470 hours. The average wind speed is a little less than 11 miles

per hour, with a prevailing direction from the west-northwest in fall and winter and from the southeast in spring summer. April and May are the windiest months. The average freeze-free period is 134 days from mid-May to late September.

Table 1: 2014 Weather Summary - Official Station - Bismarck, North Dakota

	Mean Temperature (degrees Fahrenheit)		Precipitation (inches)		
			Actual		Deviation from Normal
Month	**2014**	**Normal***	**2014**	**Normal***	**2014**
January	13.8	12.8	0.38	0.43	-0.05
February	9.6	18.1	0.19	0.50	-0.31
March	27.2	29.9	0.82	0.86	-0.04
April	41.1	43.8	1.95	1.26	0.69
May	55.8	55.5	0.85	2.39	-1.54
June	63.4	64.6	3.02	3.16	-0.14
July	68.5	71.1	0.73	2.88	-2.15
August	68.7	69.5	4.75	2.27	2.48
September	60.2	58.5	0.37	1.59	-1.22
October	47.8	44.8	0.15	1.25	-1.10
November	21.5	29.2	0.60	0.71	-0.11
December	19.8	16.2	0.11	0.48	-0.37
Annual	**41.5**	**42.8**	**13.92**	**17.80**	**-3.86**

*National Climate Data Center 1981-2010 Monthly Normals

	2014
Last Frost (28 degrees)	17-May
First Frost (28 degrees)	3-Oct
Frost Free Period	138 days

REGIONAL DESCRIPTION

REGIONAL DESCRIPTION: TECHNICAL REPORT – 2014

Major Land Resource Areas

The three States served by the PMC, Minnesota, North Dakota, and South Dakota, include portions of 23 Major Land Resource Areas in four Land Resource Regions. They are the Northern Great Plains Spring Wheat Region, Western Great Plains Range and Irrigated Region, Northern Lake States Forest and Forage Region, and the Central Feed Grains and Livestock Region.

Potential Natural Vegetation

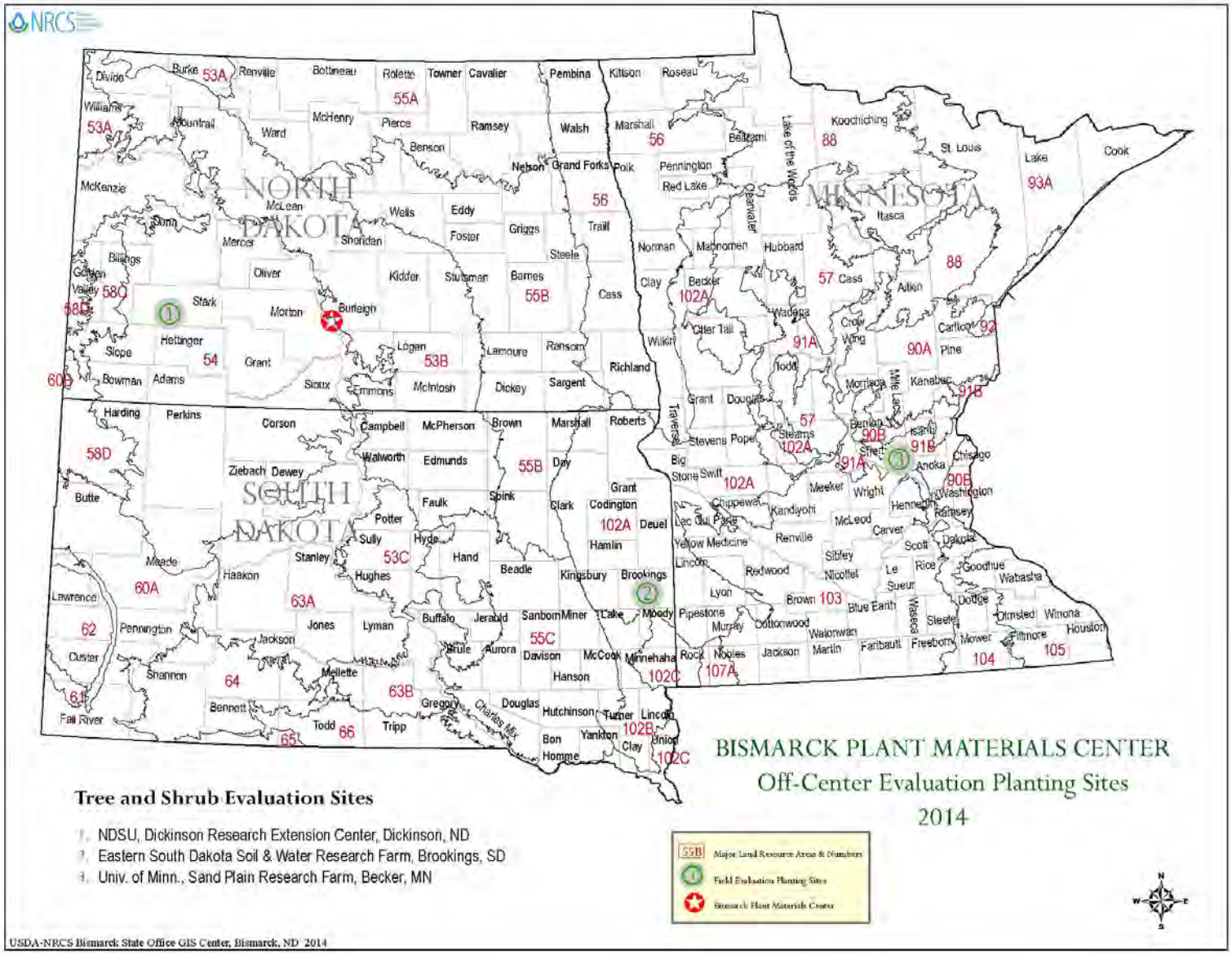
Most of central and western North and South Dakota support a mixed grass prairie of predominantly western wheatgrass (*Pascopyrum smithii*), green needlegrass (*Nassella viridula*), needleandthread (*Hesperostipa comata*), slender wheatgrass (*Elymus trachycaulus*), and prairie junegrass (*Koeleria macrantha*). Little bluestem (*Schizachyrium scoparium*), sideoats grama (*Bouteloua curtipendula*), plains muhly (*Muhlenbergia cuspidata*), sedge (*Carex*), and blue grama (*Bouteloua gracilis*) are the principal climax species on xeric soils, steeper eroded slopes or thin uplands. Prairie sandreed (*Calamovilfa longifolia*) is important on sandy soils throughout the region. Moist sites support such species as big bluestem (*Andropogon gerardii*) and prairie cordgrass (*Spartina pectinata*). Whitetop (*Scolochloa festucacea*), bulrushes (*Scirpus*), and common reed (*Phragmites australus*) are typical of lowland meadows and marshes. Western snowberry (*Symphoricarpos occidentalis*), rose (*Rosa*), buffaloberry (*Shepherdia argentea*), and chokecherry (*Prunus virginiana*) are abundant shrubs in draws and narrow valleys. Rocky Mountain juniper (*Juniperus scopulorum*) is common in the western Badlands. Eastern South Dakota, southern Minnesota, and the Red River Valley support vegetation dominated by tall grass prairie species; principally big bluestem, switchgrass (*Panicum virgatum*), and Indiangrass (*Sorghastrum nutans*). Other important species include little bluestem, prairie dropseed (*Sporobolus heterolepis*), porcupine grass (*Stipa spartea*), green needlegrass, and prairie cordgrass. Bur oak (*Quercus macrocarpa*), basswood (*Tilia americana*), hackberry (*Celtis occidentalis*), cottonwood (*Populus deltoides*), and willow (*Salix*) follow major draws and floodplains. Green ash (*Fraxinus pennsylvanica*) is found in all three states. In the western Dakotas it comprises up to 70 percent of the tall trees in forests. The presence of emerald ash borer (*Agrilus planipennis*) in Minnesota puts the ash resource at risk.

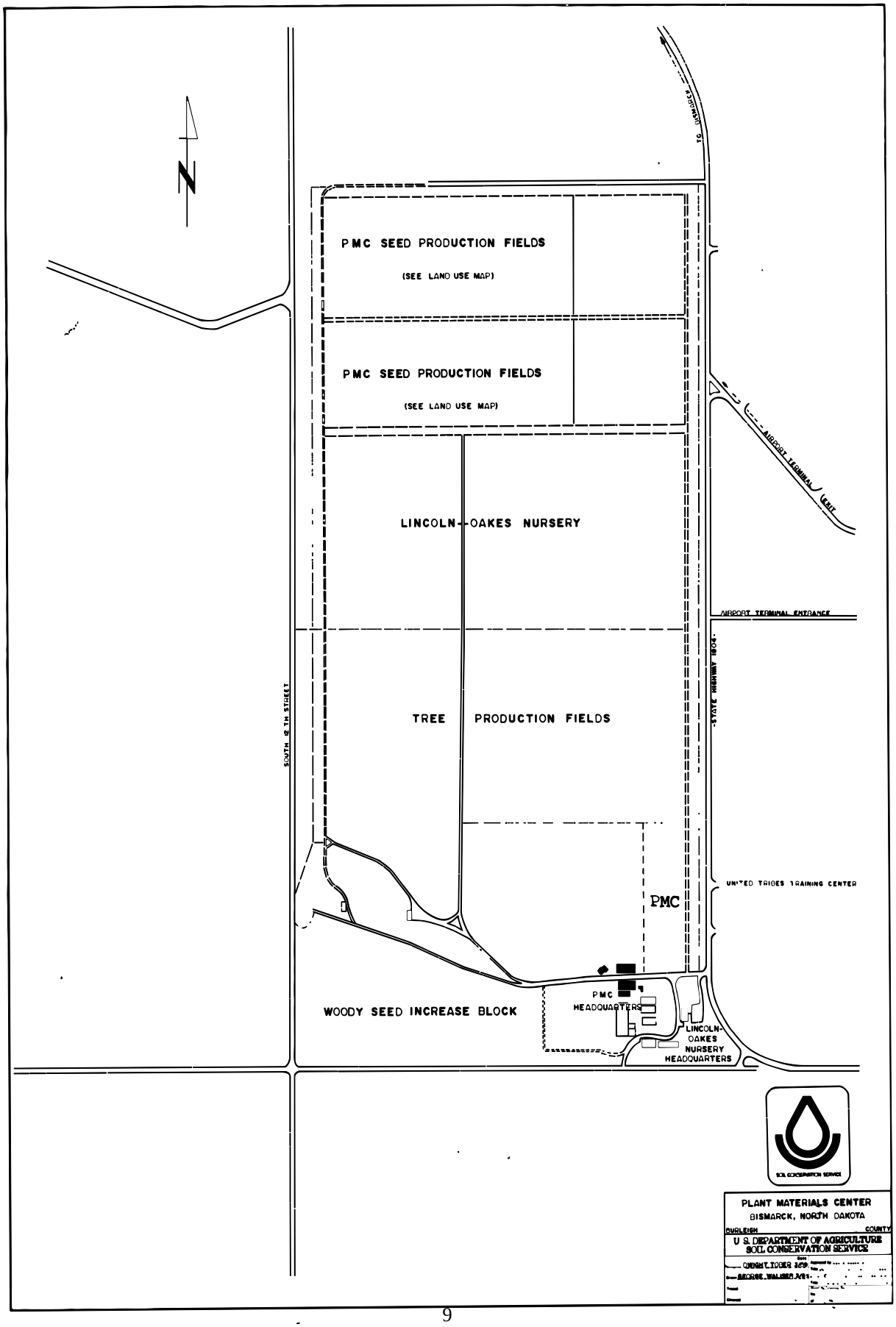
Two distinct forested regions occur within the three-State area. The first is the Black Hills of South Dakota where Ponderosa pine forest (*Pinus ponderosa*) and pine/oak savannas dominate. The second is the northern and eastern sections of Minnesota, which support mixed hardwood and conifer forests. Principal species include oak (*Quercus*), maple (*Acer*), elm (*Ulmus americana*), aspen (*Populus*), jackpine (*Pinus banksiana*), red pine (*Pinus resinosa*), and balsam fir (*Abies balsamea*). Black spruce (*Picea mariana*), tamarack (*Larix laricina*), and white cedar (*Thuja occidentalis*) are typical of lowlands and swamps.

Climate and Species Adaptation

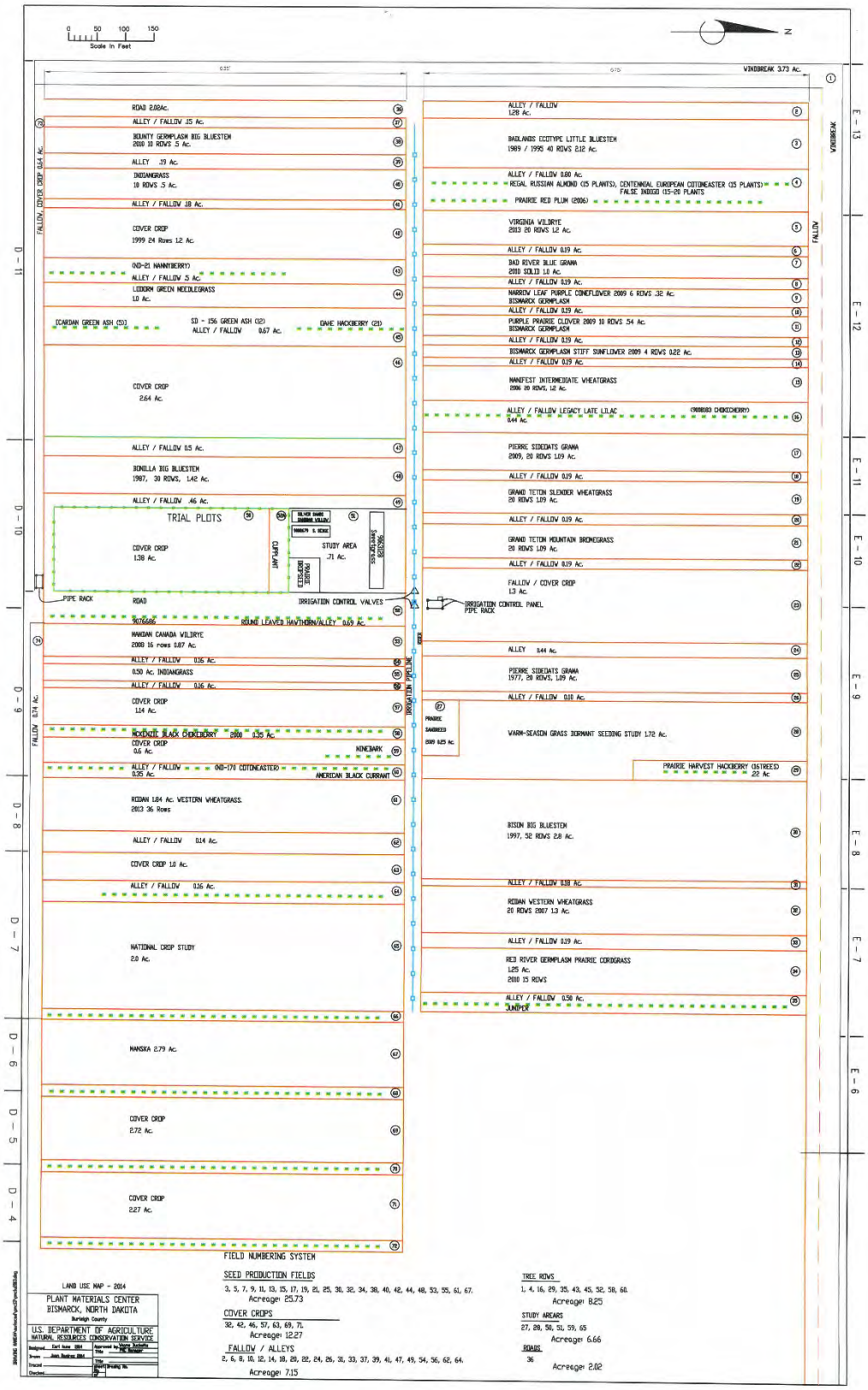
North Dakota and Minnesota are the two coldest States in the nation excluding Alaska. Mean annual temperatures range from 36 degrees F to 48 degrees F for all reporting stations. Plant hardiness zones (USDA) vary from 3 to 4 with mean minimum temperatures between -10 degrees F and -50 degrees F. Annual precipitation varies from 13 inches in western North Dakota to 30 inches or more in southeast Minnesota. Growing seasons are short, averaging from 110 to 150 days. The central and western Dakotas are principally semiarid in nature while the eastern Dakotas and Minnesota are considered subhumid.

MAPS

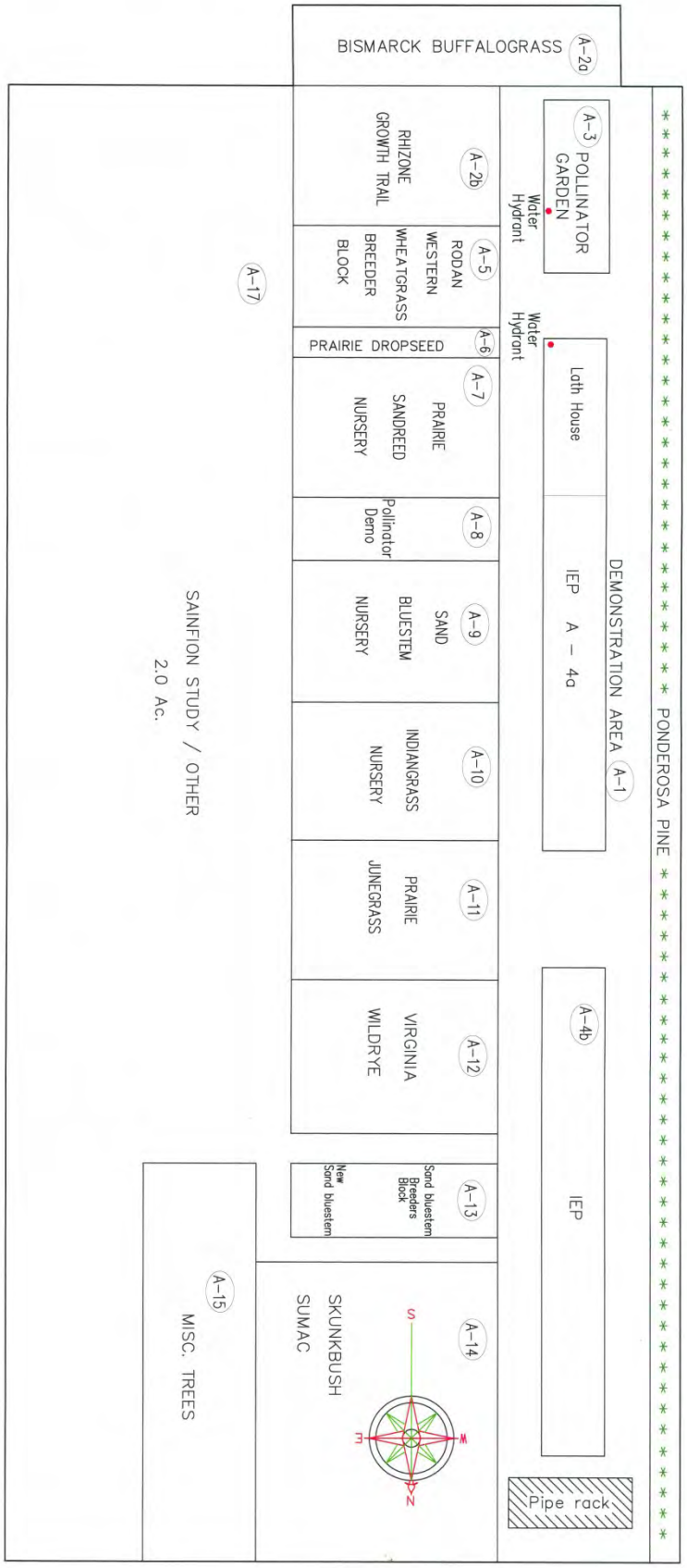

NRCS
NORTH DAKOTA
SOUTH DAKOTA
MINNESOTA
BISMARCK PLANT MATERIALS CENTER
Off-Center Evaluation Planting Sites
2014
Tree and Shrub Evaluation Sites
1. NDSU, Dickinson Research Extension Center, Dickinson, ND
2. Eastern South Dakota Soil & Water Research Farm, Brookings, SD
3. Univ. of Minn., Sand Plain Research Farm, Becker, MN
55B Major Land Resource Areas & Numbers
Field Evaluation Planting Sites
Bismarck Plant Materials Center
USDA-NRCS Bismarck State Office GIS Center, Bismarck, ND 2014


N
PMC SEED PRODUCTION FIELDS
(SEE LAND USE MAP)
PMC SEED PRODUCTION FIELDS
(SEE LAND USE MAP)
LINCOLN--OAKES NURSERY
TREE PRODUCTION FIELDS
PMC
WOODY SEED INCREASE BLOCK
PMC HEADQUARTERS
LINCOLN-OAKES NURSERY HEADQUARTERS
SOUTH 12TH STREET
STATE HIGHWAY 1804
TO DRAKOSE
AIRPORT TERMINAL EXIT
AIRPORT TERMINAL ENTRANCE
UNITED TRIBES TRAINING CENTER
SOIL CONSERVATION SERVICE
PLANT MATERIALS CENTER
BISMARCK, NORTH DAKOTA
BURLEIGH COUNTY
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PMC Land Use Map - 2014



PMC Land Use Map, Panel A - 2014



ACTIVE STUDIES

ACTIVE STUDIES: TECHNICAL REPORT 2014

Study Number	**NDPMC-P-0104-RA**
Title	**Native Grasses for Conservation: Prairie dropseed *Sporobolus heterolepis***
Objective	Evaluate adaptability and growth habit of prairie dropseed. If the collections produce seed and prove adaptable and useful as a conservation species, a northern hardy release will be the goal.
Duration	1998-2018
Cooperators	USDA, NRCS, Plant Materials Center, Bismarck, ND
Location	Bismarck Plant Materials Center
-----Soils	Mandan silt loam
-----MLRA	53B
-----Precip.	**Ave.** (1981-2010): 17.8 inches; **2013**: 26.75 inches; **2014**: 13.92 inches

Background information: Prairie dropseed is a warm-season perennial grass native to much of the US except western most and southern most states. It grows in circular tufts. It is palatable to livestock, decreasing with grazing pressure. It is desirable to wildlife for food and cover. The seed head is an open panicle. Flowering produces a vanilla-like odor. Seeds are small, round, and shiny. Leaves are narrow and radiate from the tuft. No northern hardy release for conservation is known.

Methods and Materials: The study consists of three parts. The first is the assembly and evaluation of the three collections. This will be named **ASSEMBLY**. The second part of the study is evaluation of germination of prairie dropseed as it relates to seed size and age. This will be named **GERMINATION TRIAL**. The third part related to the selection of the breeder population and seed increase. This will be named **BREEDER POPULATION.**

ASSEMBLY (seed collection began in 1998)

Seed Source	**Accessions:** 9082623(ND) , 9082741(MN) , 9092028(SD) (<50 grams of seed of each was collected)
-----Coll. Date	See Table PD-1.
-----Collector	See Table PD-1.
-----Location	See Table PD-1.
Propagation	Seed was cleaned with rub board, pan screens, and SD seedblower prior to planting in the greenhouse.
-----Greenhouse	Seed was planted to conetainers™ in soilless potting mix. Accession 9082623(ND) was planted in 2000 and in 2002 to extend field row; accession 9082741(MN) in 2002; and accession 9092028(SD) in 2006.
-----Field	Seedlings from the greenhouse were planted in the separate years that they were propagated. Approximately 30-50 plants were planted for each accession.
Assembly	Seedlings of each accession were planted into1 separate field row each in different years.
-----Location	Panel A (PMC)
-----Design	**No. of rows**: 3 (one per accession) **Row spacing**: 5' **Plant spacing**: 1-2'
Data Collection	Visual observation, measurement
-----Parameters	**2007**: Seed culms, culm height, leaf length **2001-2009**: seed harvest
-----Data	**Plant evaluations** (2007): See Table PD-2. **Seed harvest**: See Table PD-3.
Field Maintenance	Between rows were hand weeded and shallow tilled. No herbicide or fertilizer has been applied. 2014: no maintenance
-----Residue Removal	**2005-2006**: burned in early April 2005 and late fall 2006. **2008-2009**: hand clipped in early spring of 2008, 2009. 2009 residue was clipped in October 2009, 2014: no residue removal

Results and Discussion (Assembly)
Germination in the greenhouse was fair (> 50%) for all accessions. Growth of seedlings in the greenhouse and the first year in the field was slow. Plant height at the end of the first year for the North Dakota accession was 6 inches. Few seed culms were produced for any accessions the first year. Plants of the South Dakota accession were planted late due to greenhouse heating problems. Plants were very small when transplanted to the field. The plants remained very small the first year for the South Dakota accession due to extreme heat and drought stress. Field survival was 80% or greater for all accessions. Flowering time, mid-July, appeared similar for all accessions. Spring burning appeared to stimulate seed culm production. Plants of 9092028 (SD) were more upright and crowns less dense compared to the other accessions. Buildup of residue at the crown appears to reduce seed culm production as plants age. Clipping removes some residue, but burning removes it more completely. The size, height, and seed culm numbers vary within an accession, but the variations are not great. The North Dakota accession was slightly shorter and more compact than the other two accessions. The South Dakota accession was the tallest of the three accessions. but visually had less forage. Little or no insect or disease damage was noted. There was some die back in the crown as plants aged.

GERMINATION TRIAL (2008)

Seed Source	**Accessions:** 9082623, 9082741, 9092028 harvested from field rows at PMC (panel A)
-----Seed Lots	SCO-07-9082623, SCO-07-9082741, SCO-07-9092028
-----Cleaning	Office size fanning mill, once cleaned the seed was separated by weight with a SD seedblower, the smallest tube. Approximately ¼ teaspoon of seed was placed in the tube and blown for one minute. Air was opened to 3 cm. Seed remaining on the bottom of the tube after blowing was designated heavy seed. Seed that blew to the top of the column was separated by setting the column opening at 2 cm. This was designated medium weight. Light seed was discarded.
Comparisons	Germination comparison of heavy seed vs. medium weight seed, and germination related to storage conditions-cold storage vs room temperature.
Experimental Design	The experiment was run in 2008. Germination was counted for four boxes (100 seed each) of heavy seed and four boxes (100 seed each) of medium weight seed (as designated above). Four boxes of seed stored at room temperature and 4 boxes from cold storage were counted for storage portion of experiment. Seed was tested from storage just after harvest, at 6 months and after 1 year.
-----Germinator Conditions	Light and 30° C for 8 hours, alternated with darkness and 20°C for 16 hours. Duration of each test was 14, 21, and 28 days. Some differences in the number of days between counting occurred as a result of scheduling conflicts. Seedlings were counted at 33 days rather than 28 in April and October 2008.
-----Storage Conditions	Storage in the cooler was approximately 40° F and 40-50 % humidity. The exact conditions in the cooler were not recorded. Seed stored at room temperature experienced the fluctuations of temperature and humidity. Exact temperature and humidity were not recorded.
Data	
-----Germination Trials	See Table PD-4 for average germination of each treatment.

Results and Discussion (Germination Trial)
Mold became a severe problem in the plastic germinations boxes, particularly for the October 2008 counts. Nothing was done to the seed to disinfect it prior to germinating. Seed was considered germinated if it had a root and shoot. Roots were sometimes a challenge to distinguish. It appears that seed stored in the cooler after one year generally had higher germination than the newly harvested seed or 6 month old seed. When stored at room temperature, the germination was slightly less than the newly harvested seed in most cases. The slight increase in germination after 6 months compared to freshly harvested seed indicates that there is some dormancy that may break down after 6 month or one year, if stored in a controlled climate. Size showed slight differences in germination, but not as much as anticipated. The larger seed generally showed greater germination. Seed lots also were quite different in their germination, particularly the accession

9092028 (SD). These were very young plants compared to the Minnesota and North Dakota accessions. This may have contributed to the low overall germination. Preliminary indications do suggest that large seed, stored in cold storage will provide the greatest germination.

BREEDER POPULATION

Seed Source	A portion of selected seed lots harvested from the Field Plot in Panel A at PMC for accessions 9082623 (ND), 9082741 (MN), and 9092028 (SD).
-----9082623 (ND)	Seed was harvested from 2001-2009.
-----9082741(MN)	Seed was harvested from 2003-2009.
-----9092028 (SD)	Seed was harvested from 2008-2009.
Seed Selection	Four random samples of 1 tablespoon each were taken from each lot year for each accession. Each tablespoon of seed was blown in 3-inch tube of SD seedblower. Each sample was blown for 1 minute with the top air open to 10. The seed remaining in the bottom of each of the 4 samples from each lot was then mixed together. This was considered the heaviest seed. Less than 50 seeds of some lots were heavy, so 4 more samples were separated to get enough seed to plant.
Greenhouse Planting	Seeding was first made into small flats and then plants that emerged from the flats were planted into individual pots. A soilless potting mix was used for both types of plantings.
-----flats	50 'heavy seeds' from each seed lot were planted on 3/5/2010 into 2 small box flats (25 seeds/flat) each. Seedlings were counted 4/15/2010.
-----pots	Plants growing in the flats were transplanted to 3-inch pots (one plant per pot) on5/6/2010.
Field planting	Seedlings from greenhouse pots were planted to a PMC field. This was designated the breeder population.
-----Accessions	See Table PD-5.
-----Number/Date	226 seedlings were planted on 6/23/2010.
-----Location	Panel D-10 north of old deer fence at PMC.
-----Design	**No. of rows**: 9 rows **Row spacing**: 42 inches **Plant spacing**: 2 feet apart Plants of each accession were intermixed within the row and planted in a completely random order.
Field Maintenance	**2010-2013**: hand weed, shallow till, no fertilizer or herbicide has been applied except spot spraying of Canada thistle. **2014:** hand rogued**,** shallow till, no fertilizer or herbicide
-----Residue Removal	**2010**: hand clipped **2011**: residue from 2011 was burned in early spring of 2012 **2012**: residue from 2012 was burned in early spring of 2013 **2013**: residue standing over winter **2014:** residue burned May 2, 2014
-----Harvest (Breeder Seed)	**Method and amount**: See Table PD-6.

Results and Discussion (Breeder population)

Large seed was considered the criteria for developing a breeder population. Not all heavy seed that germinated in the greenhouse was surviving at field planting time. No seedlings were grown from the lighter seed. Generally, younger seed germinated and produced more seedlings in the greenhouse than the older seed. All seed had been stored in cold, dry storage prior to separation and planting. Overall, seedling growth was very slow in the greenhouse and the first year in the field.

2013: Plants continue to grow in width and produced more seed heads than in 2012. Plants were vigorous and showed no sign of disease. Once foliage of the plant canopies between the rows, very few weeds grow. Plans for 2014 include increasing the breeder field by seeding, rather than greenhouse plants. This will be a way to look at seedling vigor.

2014: Plants were vigorous and showed no sign of disease. Very few weeds grew after leaves canopied between rows. Visually, seed head productions appeared slightly less than in the previous year. Once again, some plants had the heads removed by unknown person before harvest was achieved. It will be important to again burn or remove residue very close to the base, as plants have a tendency to form dense crowns as the plants age which appear to inhibit seed head production.

Table PD-1. Collections - prairie dropseed *Sporobolus heterolepis*

Date	Accession	County	State	Location
10/1998; 9/8/1999 8/18/2000; 8/29/2001	9082623	Burleigh	ND	Russell Stuart Wildlife Management Area SE1/4 sec. 3-T144N-R78W
10/19/2001	9082741	Mahnomen	MN	Wambuck WMA - 5 1/2 mi. north of Mahnomen and 1 1/2 mi. east
9/27/2005	9092028	Day	SD	Pickerel Lake entrance (448th Ave.) sec. 23-T124N-R53W -large flat

Table PD-2. Plant evaluations - prairie dropseed *Sporobolus heterolepis*

Data collectors: Jensen, Duckwitz

Seed culm rating: 1=many culms 3=none or very few culms

Culm height: average height of culms

Leaf length: length of leaf measured from center of crown

Planting Date	Date of Data	Accession	Plant	seed culm rating (1-3)	culm height (inches)	leaf length (inches)	Comments
2000	10/3/2007	9082623	1	1	33	18	
2000	10/3/2007	9082623	2	1	27	19	
2000	10/3/2007	9082623	3	3	29	13	
2000	10/3/2007	9082623	4	2	20	12	
2000	10/3/2007	9082623	5	1	35	17	
2000	10/3/2007	9082623	6	1	28	17	
2000	10/3/2007	9082623	7	1	34	17	
2000	10/3/2007	9082623	8	1	28	19	
2000	10/3/2007	9082623	9	1	24	15	
2000	10/3/2007	9082623	10	1	26	19	
2000	10/3/2007	9082623	11	2	36	20	
2000	10/3/2007	9082623	12	2	26	16	
2000	10/3/2007	9082623	13	1	36	16	
2000	10/3/2007	9082623	14	2	26	12	
2000	10/3/2007	9082623	15	1	34	13	
2000	10/3/2007	9082623	16	1	38	21	
2000	10/3/2007	9082623	17	2	33	16	
2000	10/3/2007	9082623	18	1	30	16	
2000	10/3/2007	9082623	19	2	32	22	
2000	10/3/2007	9082623	20	1	33	16	
2000	10/3/2007	9082623	21	1	34	20	
2000	10/3/2007	9082623	22	1	42	20	
2000	10/3/2007	9082623	23	1	31	15	
2000	10/3/2007	9082623	24	1	34	19	
2000	10/3/2007	9082623	25	3	27	10	
2000	10/3/2007	9082623	26	1	40	20	many heads
2000	10/3/2007	9082623	27	1	32	14	
2000	10/3/2007	9082623	28	2	28	17	
2000	10/3/2007	9082623	29	2	25	18	
2000	10/3/2007	9082623	30	1	32	16	red stems
2000	10/3/2007	9082623	31	3	0	11	no heads
2000	10/3/2007	9082623	32	1	20	10	
2000	10/3/2007	9082623	33	1	28	13	
2000	10/3/2007	9082623	34	2	31	18	
2000	10/3/2007	9082623	35	1	34	16	
2000	10/3/2007	9082623	36	1	36	19	
2000	10/3/2007	9082623	37	1	36	21	yellow stems
2000	10/3/2007	9082623	38	3	0	19	
2000	10/3/2007	9082623	39	2	29	13	

Planting Date	Date of Data	Accession	Plant	seed culm rating (1-3)	culm height (inches)	leaf length (inches)	Comments
2000	10/3/2007	9082623	40	2	27	13	
2000	10/3/2007	9082623	41	3	0	11	
2000	10/3/2007	9082623	42	1	32	19	
2000	10/3/2007	9082623	43	2	24	14	
2000	10/3/2007	9082623	44	3	21	13	aborted heads
2000	10/3/2007	9082623	45	2	24	15	
2000	10/3/2007	9082623	46	2	16	15	
2000	10/3/2007	9082623	47	2	30	15	
2000	10/3/2007	9082623	48	1	25	13	
2000	10/3/2007	9082623	49	3	24	17	few heads
2002	10/3/2007	9082623	50	1	30	14	
2002	10/3/2007	9082741	1	1	32	26	
2002	10/3/2007	9082741	2	3	28	23	
2002	10/3/2007	9082741	3	2	36	22	
2002	10/3/2007	9082741	4	1	46	22	
2002	10/3/2007	9082741	5	1	27	8	
2002	10/3/2007	9082741	6	2	23	13	
2002	10/3/2007	9082741	7	2	17	16	
2002	10/3/2007	9082741	8	1	36	18	
2002	10/3/2007	9082741	9	1	36	20	
2002	10/3/2007	9082741	10	1	46	21	
2002	10/3/2007	9082741	11	3	27	22	
2002	10/3/2007	9082741	12	2	31	20	
2002	10/3/2007	9082741	13	1	38	19	
2002	10/3/2007	9082741	14	1	36	20	
2002	10/3/2007	9082741	15	1	29	19	
2002	10/3/2007	9082741	16	3	15	21	
2002	10/3/2007	9082741	17	1	38	21	
2002	10/3/2007	9082741	18	2	17	22	
2002	10/3/2007	9082741	19	2	13	9	
2002	10/3/2007	9082741	20	2	32	21	
2002	10/3/2007	9082741	21	3	12	24	
2002	10/3/2007	9082741	22	1	36	19	
2002	10/3/2007	9082741	23	1	24	20	
2002	10/3/2007	9082741	24	1	34	19	
2002	10/3/2007	9082741	25	3	8	23	no culms
2002	10/3/2007	9082741	26	3	8	23	no culms
2002	10/3/2007	9082741	27	1	46	21	
2002	10/3/2007	9082741	28	2	35	18	
2002	10/3/2007	9082741	29	1	36	20	
2002	10/3/2007	9082741	30	1	38	20	
2002	10/3/2007	9082741	31	1	34	17	
2002	10/3/2007	9082741	32	2	28	8	
2002	10/3/2007	9082741	33	2	28	10	
2002	10/3/2007	9082741	34	1	34	18	

Planting Date	Date of Data	Accession	Plant	seed culm rating (1-3)	culm height (inches)	leaf length (inches)	Comments
2002	10/3/2007	9082741	35	2	29	15	
2006	10/3/2007	9092028	1	1	28	8	
2006	10/3/2007	9092028	2	3	14	10	two heads
2006	10/3/2007	9092028	3	2	30	8	
2006	10/3/2007	9092028	4	3	0	1	very small
2006	10/3/2007	9092028	5	3	0	11	no heads
2006	10/3/2007	9092028	6	2	18	8	
2006	10/3/2007	9092028	7	1	25	12	
2006	10/3/2007	9092028	8	1	15	6	
2006	10/3/2007	9092028	9	2	19	8	
2006	10/3/2007	9092028	10	3	0	8	
2006	10/3/2007	9092028	11	1	24	11	
2006	10/3/2007	9092028	12	2	23	9	
2006	10/3/2007	9092028	13	3	14	7	one head
2006	10/3/2007	9092028	14	3	16	6	two heads
2006	10/3/2007	9092028	15	1	19	7	
2006	10/3/2007	9092028	16	3	0	5	
2006	10/3/2007	9092028	17	2	23	9	
2006	10/3/2007	9092028	18	3	0	8	
2006	10/3/2007	9092028	19	1	24	7	
2006	10/3/2007	9092028	20	1	33	11	
2006	10/3/2007	9092028	21	3	12	5	two heads
2006	10/3/2007	9092028	22	1	38	13	
2006	10/3/2007	9092028	23	3	0	5	
2006	10/3/2007	9092028	24	2	14	9	
2006	10/3/2007	9092028	25	1	36	10	
2006	10/3/2007	9092028	26	3	0	4	stressed
2006	10/3/2007	9092028	27	3	0	4	
2006	10/3/2007	9092028	28	3	0	2	very small
2006	10/3/2007	9092028	29	3	22	8	two heads
2006	10/3/2007	9092028	30	3	0	5	
2006	10/3/2007	9092028	31	3	16	6	two heads
2006	10/3/2007	9092028	32	3	0	5	
2006	10/3/2007	9092028	33	3	0	7	
2006	10/3/2007	9092028	34	3	26	8	two heads
2006	10/3/2007	9092028	35	3	0	6	
2006	10/3/2007	9092028	36	2	26	12	
2006	10/3/2007	9092028	37	1	32	12	
2006	10/3/2007	9092028	38	2	26	12	
2006	10/3/2007	9092028	39	3	0	4	
2006	10/3/2007	9092028	40	3	3	3	very small

Table PD-3. Seed harvest (Panel A) - prairie dropseed *Sporobolus heterolepis*

Accession*	State	Year	Date	Dirty	Clean bulk Yield (gm)		Cleaning Procedure**
9082623	ND	2001	09/10/01		45		
9082623	ND	2002	09/10/02		191		
9082623	ND	2003	09/22/03		211		
9082623	ND	2004	09/30/04		497		
9082623	ND	2005	09/21/05		1033		
9082623	ND	2006	09/28/06		245		
9082623	ND	2007	10/02/07	584	390		9 hole and blank, 1/4-1/2 air open, office mill, no debearder
9082623	ND	2008	09/29/08	518	344		
9082623	ND	2009	10/2009		284		
9082623	ND	2010	10/2010		477		
9082741	MN	2002	09/01/02		1.4	5 plants	
9082741	MN	2003	09/22/03		119		
9082741	MN	2004	10/01/04		357		
9082741	MN	2005	09/21/05		782		
9082741	MN	2006	09/28/06		250		
9082741	MN	2007	10/02/07	493	368		9 hole and blank, 1/4-1/2 air open, office mill, no debearder
9082741	MN	2008	09/29/08	331	195		
9082741	MN	2009	10/2009		206		
9082741	MN	2010	10/2010		165		
9092028	SD	2007	10/02/07	53	38		9 hole and blank, 1/4-1/2 air open, office mill, no debearder
9092028	SD	2008	09/29/08	592	359		
9092028	SD	2009	10/2009		560		
9092028	SD	2010	10/2010		688		

*Date plants were planted from the greenhouse to the field: June 2000 - 9082623 (ND); June 2002 - 9082741 (MN); June/July 2006 - 9092028 (SD)

**All seed was collected by hand stripping and cleaned using office debearder and office mill (unless noted)

Table PD-4. Average percent germination - prairie dropseed *Sporobolus heterolepis* germination study

	New Harvest* Oct-07	Six Months** Apr-08	One Year** Oct-08	
			room temp	cold storage
ND heavy	55	69	55	80
MN heavy	59	68	48	73
SD heavy	44	61	19	61
ND medium	58	60	47	75
MN medium	49	53	43	58
SD medium	30	33	3	32

*Average percent germination after approximately 28 days

**Average percent germination after 33 days

Table PD-5. Number of plants selected for breeder population from greenhouse seedlings -Prairie dropseed *Sporobolus heterolepis*

HV Year	9082623 (ND)	9082741 (MN)	9092028 (SD)
2001	0	x	x
2002	0	x	x
2003	4	6	x
2004	7	11	x
2005	1	0	x
2006	6	2	x
2007	15	8	x
2008	31	22	8
2009	44	30	32

x=no seed harvest, so no greenhouse pots planted

Table PD-6. Seed Harvest (Breeder Population D-10) - prairie dropseed *Sporobolus heterolepis*

Date	Method	Amount (clean bulk)
10/14/2010	Hand harvest	58 grams
9/26/2011	hand harvest	1062 grams
9/12/2012	combine (Wintersteiger)	5 pounds
9/23/2013	combine (Wintersteiger)	12.5 pounds
9/16/2014	combine (Wintersteiger)	7 pounds

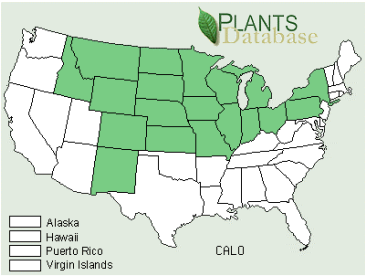
ACTIVE STUDIES: TECHNICAL REPORT 2014

Study NDPMC-P-0401-RA

Study Title: Native Grasses for Conservation
Prairie sandreed *Calamovilfa longifolia*

Introduction: Prairie sandreed is a warm-season native perennial grass of well-drained soils. It is very rhizomatous, making it a good soil stabilizer. It occurs naturally in the mid grass prairies. It is fair for forag*e* and hay, even with its coarse, tough textured leaves and stem. Species for stabilizing sandy soils are limited. Release of an adapted prairie sandreed would offer an additional species for these sites.

Objective: The purpose of the study is to develop a named release of prairie sandreed that has a broad genetic parentage, and is adapted to the Northern Great Plains, particularly eastern North Dakota and South Dakota and western Minnesota. Selection criteria will include, but not be limited to leaf and stem disease tolerance, seed production, winter hardiness, and forage production. Releases currently available are 'Goshen', 'Pronghorn', and Koch Germplasm. At Bismarck, North Dakota, Goshen, originating from drier conditions in Wyoming, is susceptible to foliar diseases. ND-95, a germplasm from North Dakota, was also found susceptible to leaf rust. Pronghorn originated from Kansas and Nebraska sources, making its winter hardiness questionable in the more northern portions of the Northern Great Plains. Koch Germplasm has not been tested at Bismarck.



Cooperators: USDA, NRCS Plant Materials Center, Bismarck, North Dakota

Species Description/Distribution: Prairie sandreed is a warm-season perennial grass. It is native from portions of Canada, south to Kansas and Colorado, east to Illinois and Iowa, and west to Idaho. It is strongly rhizomatous and leaves are smooth, course and tough. The seed head is an open panicle. It grows naturally on dry, well-drained soils in sandy, gravelly, or rocky soils.

Materials and Methods

Initial Assembly

Collection: Seed collection began in the fall of 2003. Targeted locations included sites in Minnesota, and central and eastern South Dakota, and North Dakota. Table PS-1 is a list of collections for 2003. Seed was collected from more than 10 plants at a site. Seed quality of the collections was poor.

Propagation: Seeds were propagated in the greenhouse in March 2004. The late greenhouse planting was due to heating problems. Seed was planted to flats and then seedlings were planted to cone-tainers™. Seedlings were then hand transplanted to the field (Panel A) in July 2004. Seedlings were small at the time of transplanting. Seedlings were planted in a randomized complete block with three replications. Goshen and ND-95 were used as checks in the assembly. Koch Germplasm was not available at the time of planting.

Planting Date: Seedlings were transplanted to the field (Panel A) on 7/6/2004.

Site Location: Panel A. The site was tilled and free of growing weeds at the time of planting.
2014: The field is no longer maintained. The area has been mowed extensively and contaminated with other grass. It has become a solid turf. No individual plants can be distinguished.

Field Map: See Figure PS-1 for plot layout.

Maintenance: 2004-2013 (Evaluation Block)
Weed Control: Plots were hand hoed and shallow tilled using a garden tiller. Canada thistle was spot sprayed. No other herbicides have been applied to the plot.

Fertilizer/Irrigation: No fertilizer has been applied to the plot. Seedlings were hand watered throughout the first growing season to assist in establishment. Plants were irrigated in July of 2005 and 2006 to sustain plants during drought conditions. No other irrigation was applied.

Residue Management: Residue was hand clipped (2005-2007) or mowed with a sickle mower (2008) to a 3-4 inch stubble height in early spring of each year. Residue was removed by hand raking. Residue was removed by swathing and raking in November of 2009. Burning the residue of standing plants was attempted in November 2006. Most of the residue resisted burning and had to be hand clipped. The plot was mowed 2-3 times in 2010, 2011, 2012, and 2013 to keep weeds under control and to prevent any seed from forming and dispersing.

Evaluations: No data was collected in 2004; the year seedlings were transplanted to the field plot. Data was collected for each plant in the field plot from 2005-2008. See 2009 Technical Report for all plant data. An initial breeder population was selected in 2008 based on collected data. Forage quality was analyzed for the initially selected plants along with others from the field plot. Stalk strength was rated in April 2008 as an indicator for use in biomass projects. Plant data was reevaluated in late 2008 and early 2009. A decision was made to select plants only with Minnesota origins. Data for the final selections of the breeder population is found in Table PS-2.

Forage Analysis Sampling: Forage was sampled on 7/22/2008. Several stems were clipped from the middle of the plant. Twenty stems from each of the selected plants were used. The leaves were clipped from the top five nodes of each of the 20 stems. Stems were discarded. Leaves were oven dried at approximately 30 degrees C for 2-3 days. NIRS analysis was run by Oscar Olson Biochemistry Laboratories at South Dakota State University, Brookings. See Table PS-3 for analysis results and stalk strength ratings of selected breeder population plants.

Selection: Selections made in 2008 for the breeder population were changed in 2009 to include only Minnesota accessions. A map of 2009 selections is found in Figure PS-2. Selections were rated superior in 2007 for disease resistance. Secondary selection was based on leafiness and overall growth. Most had been selected in 2008, with only a few exceptions.

Breeder Population Field

Propagation: Portions of the selected plants (2009 selections) were dug on April 21, 2009 and April 23, 2009. The pieces were then planted into large black cone-tainers™ in the greenhouse in a potting soil mix. The pieces were generally large, as prairie sandreed has a coarse, tough rhizome that usually has a sharp shoot. Fifty rhizome/root pieces were planted for each of the selections. The plants were very slow to grow in the greenhouse from the root and rhizome pieces. The breeder population crossing block (E-9) was increased in size in 2010. Additional roots and rhizomes from the selected plants in the initial evaluation block were dug and propagated in the greenhouse. A total of 296 plants were added to the crossing block in 2010. The added plants consisted of approximately 30-50 plants from each of the seven selected parent plants.

Planting Date: June 23, 2009, June 23, 2010

Location: Panel E-9 at PMC

Planting Method/Design: The plants were spaced approximately 1-2 feet apart. Trenches were made with shanks and the plants were planted into these. The trenches were spaced approximately 42 inches apart. The plants were planted in a completely randomized fashion, in relation to accession. This was to try and get a more random pollination (crossing). Many of the plants did not have well developed roots. The planted root pieces were not decayed, were still imbibing water, and had some top growth. Irrigation was started the day of planting using overhead irrigation lines. Ten rows, approximately 40 feet long, were planted in 2009. Additional rows were added in 2010.

Maintenance:
2009: The field was hand rogued and spot sprayed for weeds. No seed harvest.
2010: The field was hand rogued and spot sprayed for weeds.

2011: The field was hand rogued for weed control. Seed was harvested.
2012: The field was hand rogued for weed control. Seed was harvested using a small plot combine.
2013: The field was burned May 2, 2013 to remove residue. The field was hand rogued. Seed was harvested using a small plot combine.
2014: The field was burned May 7, 2014, Atrazine applied 5/27/2014

Variety Trial

2012: A plot comparing the Bismarck PMC material (9094357) and the release, 'Koch' from the Michigan PMC were seeded into a black, firm seedbed on May 17, 2012, using a plot drill. Each plot was 5.5 feet x 80 feet. The planting was located in panel D-10 (old deer fence). Koch was the northernmost plot. Dry conditions and excessive weeds prevented adequate establishment. The plot area was sprayed with Cornerstone (Glyphosate) in 2014 to kill weeds in the area and any plants that may have emerged.

2014: A trial was planted on June 3, 2014 in Panel G-4 at the PMC. The varieties Koch, Goshen and ND95 (Bowman) were compared with 9094357 selection. They were planted in separate 60-foot X 5.5-foot plots to compare growth, performance, and longevity.

Results and Discussion

Initial Assembly

Plants within an accession did not always perform in a similar manner in the initial evaluation block. This was expected as plants were propagated from seed, making genetics different. Due to these differences, each plant was evaluated individually. Overall, plants were very slow to establish in greenhouse and field plantings.

Plants were very slow to establish and mortality was high in 2004. Plants that survived and grew in 2005 were vigorous and began spreading by rhizomes. Plants varied in their ability to spread. There was variation in leaf width and coarseness of the plant as well. In 2005, foliar and leaf diseases manifested in certain plants. Disease was not as noticeable in 2006 compared to 2005, but some plants did exhibit severe infestations by the end of the growing season. The dry climatic conditions of 2006 were likely contributing factors. Rhizome growth and vegetative growth were strong for both years. Disease in 2005 was noted, with some accessions severely affected with stem and leaf diseases.

2007: Plants were vigorous. The differences in size and color of plants were quite noticeable. Plant disease was prominent for some accessions, causing the plants to lodge and leaves and stems to blacken. Some plants showed very little disease. Selections based on visual observations were noted.
2008: Selections for the breeder population were based on various parameters. Date of flowering, disease, and overall plant size and form were the main criteria on selection. The population selected has flowering dates that were similar. This is necessary for seed production. The plants selected also exhibited less leaf and stem rust compared to other plants. Selected plants were generally leafy, upright, and somewhat dense in stem production.
2009: The breeder population was re-selected to include only Minnesota origin accessions.

Breeder Population Field

2009: Plant growth above ground was slow throughout the summer of 2009, but mortality was low. The plant height at freeze-up was 2 feet or less. Very few plants produced a seed head in 2009.
2010-2012: Plant growth continued to be slow. Little disease was noted.
2013: Leaf and stem rust was evident by September 24, 2013 on most plants. For most plants, the infection was slight. Prior to this time in 2013, very little rust or foliar disease was visible. The finer stemmed plants had less rust than the coarser, larger plants. Most plants in field produced seed heads in 2013. Plants overall were more vigorous than in previous years
2014: Plants are vigorous. Between row space has filled in with plants due to rhizome growth. Disease was present in 2014, but not as severe as in 2013. The west edge of the field has become contaminated with various cool-season species. Quackgrass was detected by the seed lab in 2014 harvested seed. Efforts will be made in 2015 to rid the field of the contaminants.

Seed Harvest: 2010: 85 gm 2011: 1.2 pounds 2012: 2.5 pounds 2013: 7 bulk (4 PLS) 2014: 2.8 pounds (bulk)

Variety Trial

The 2014 planting became very weedy. The plots were mowed 2-3 times throughout the season to reduce weed competition. If stand is not adequate in 2014 another trial will be planted. This is a way to determine if the selection 9094357 is worthy of further evaluation and eventual release.

Table PS-1. Collections - prairie sandreed *Calamovilfa longifolia*.

= Final selections (2009) are shaded

Accession	State	County	Location (Section-Township-Range)	Collector
2771	SD	Corson	29-T20N-R18E	Dennis Evenson
2772	ND	McHenry	13-T153N-R76E	Mike Knudson
2773	SD	Sanborn	31-T108N-R61W	Nancy Jensen
2774	SD	Roberts	19-T122N-R52W	Nancy Jensen
2775	ND	Ransom	14&23-T135N-R53W	Nancy Jensen
2776	SD	Pennington	13-T1S-R8E	Tom Warren
2777	ND	Morton	NW of Mandan	Wayne Duckwitz
2778	SD	Kingsbury	30-T112N-R56W	Nancy Jensen
2779	SD	Faulk	33-T117N-R69W	Nancy Jensen
2780	SD	Campbell	5-T125N-R76W	Nancy Jensen
2781	ND	Adams	11&14-T129N-R92	Jim Klein, Jodi Timm
2782	SD	Brookings	12-T112N-R48W (Oak Lake)	Nancy Jensen, Dwight Tober
2783	SD	Marshall	30-T127N-R59W	Nancy Jensen
2784	SD	Brown	25&26-T128N-R60W	Nancy Jensen
2786	SD	Sully	5-T113N-R81W	Nancy Jensen, Dwight Tober
2787	SD	Tripp	9-T99N-R78W	Nancy Jensen, Dwight Tober
2788	MN	Sherburne	24-T34N-R29W	Betsy Gullickson
2789	MN	Sherburne	16-T34N-R29W	Gina Hugo
2790	MN	Sherburne	31-T34N-R28W	Gina Hugo
2792	SD	Mellette	15-T40N-R29W	Lealand Schoon
2793	SD	Todd	2-T39N-R30W	Lealand Schoon
2794	SD	Todd	26-T36N-R31W	Lealand Schoon
2813	MN	Kittson	shore of Lake Bronson	Dwight Tober
2814	MN	Polk	Agassiz Dunes	Dwight Tober
2815	MN	Norman	Prairie Smoke Dunes	Dwight Tober
2816	MN	Clay	Bluestem Prairie	Dwight Tober
2817	MN	Ottertail	Inspiration Peak Wayside Park	Dwight Tober
2818	MN	Douglas	Lake Christina (Ashby, MN)	Dwight Tober
2820	MN	Chisago	8-T33N-R21W	Mark Oja
2821	MN	Anoka	2-T33N-R23W	Mark Oja
2822	MN	Chisago	8-T33N-R21W	Mark Oja
2823	MN	Anoka	1-T33N-R23W	Mark Oja
2825	ND	Oliver	north of Cross Ranch State Park	Dwight Tober
2826	ND	McHenry	2-T154N-R75W	Wayne Duckwitz
Goshen				
ND95				
No Seed Fill or Failed in Greenhouse				
2770	SD	Lyman	35-T107N-R72W	Dwight Tober, Nancy Jensen
2785	SD	Stanley	36-T6N-R30E	Dwight Tober, Nancy Jensen
2791	MN	Sherburne	34-T34N-R27W	Gina Hugo
2819	MN	Wabasha	7-T109N-R9W	Mark Oja

Figure PS-1. Plot layout - prairie sandreed *Calamovilfa longifolia.*

Location: Panel A

Planted: 7/6/2004

West ↑

Rep 1				Rep 2			Rep 3			
Row 1	**Row 2**	**Row 3**	**Row 4**	**Row 5**	**Row 6**	**Row 7**	**Row 8**	**Row 9**	**Row 10**	**Row 11**
ND95	2817	2818	Goshen	ND95	2789	2784	Goshen	2818	**p2 2788**	2820
p2 2820	2778	**p3 2815**	2816	2825	2813	2826	2773	2817	2783	ND95
2825	2776	2813	2782	2783	**p2 2818**	2774	2774	**p2 2814**	2784	2816(2)
2780	2771	2793	2823	2792	2775	2776	2771	2815	2781	2787(1)
2783	2774	2789	2822	**p3 2814**	2773	2817	2772	2813	2780	2786(2)
2788	2773	2784	2779(2)	2778	2772	2794	2775	2794	2825	2823(2)
2792	2772	2781	2790	2771	2777	2788	2776	2792	2826	2822(3)
2794	2775	2826	2787	2821	**p1 2815**	2780	2778	2793	2821	2786(1)
2814	2777	2821	2786	2781	2793	2820	2777	2789	Goshen	2790(1)
										2816(2)
										2787(1)

Final selections(2009) p = plant number (from west)

Seedlings were grown in the greenhouse. Seedlings were in very poor condition when field planted.

Row spacing: 3 1/2 feet between plants and 3 1/2 feet between rows

The prefix for each accession is 908.
Accessions are in 3 plant plots unless designated in ( ).

Figure PS-2. Minnesota map showing county origins of the selected prairie sandreed *Calamolvilfa longifolia* accessions.

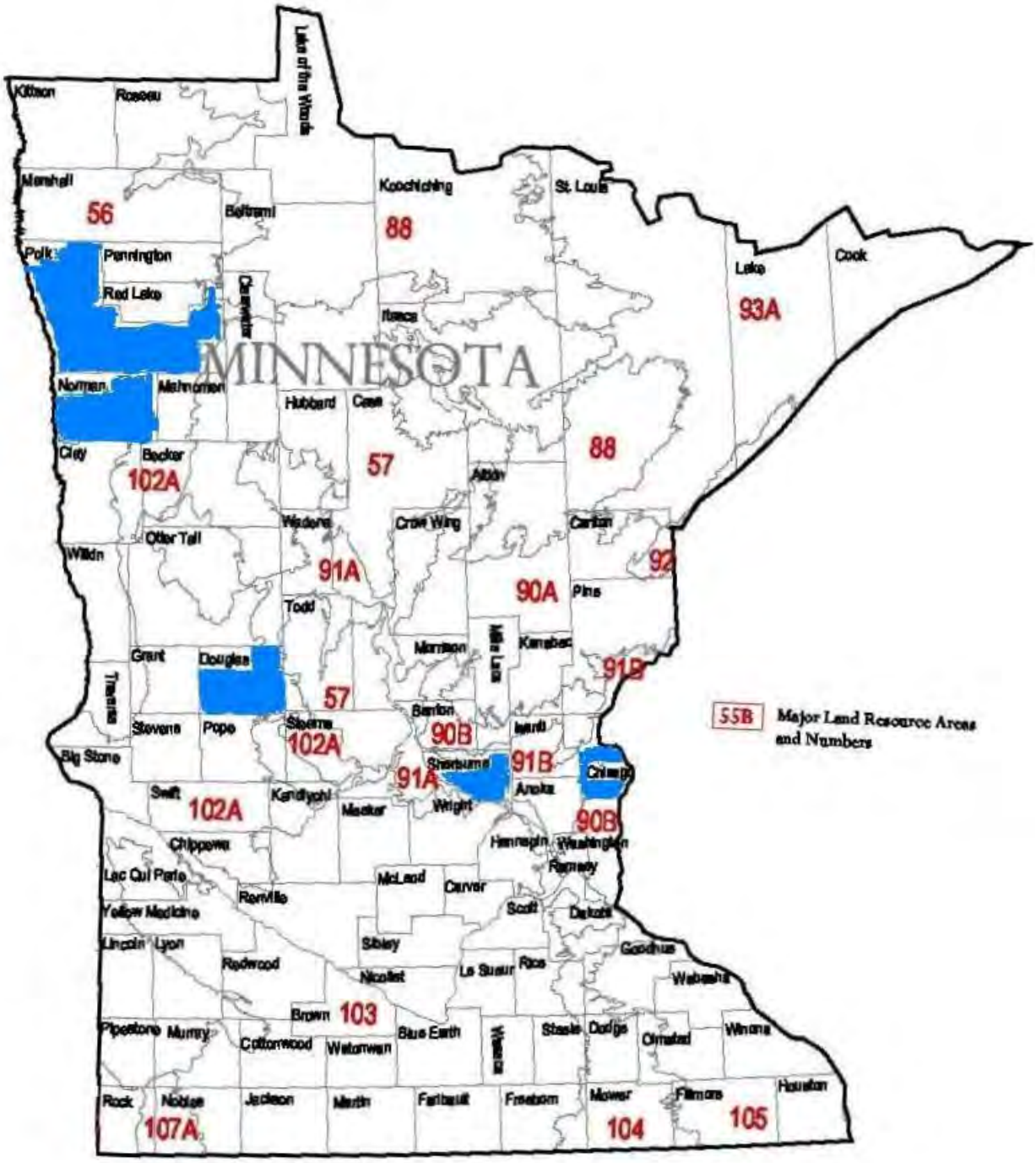


Table PS-2. Evaluation data 2005, 2006, and 2007 of Breeder Population - Prairie sandreed *Calamovilfa longifolia*.

Key: **1-3 rating scale**

Leaf width: 1=narrow, fine 3=wide, coarse
Leafiness: 1=many leaves 3=few leaves
Disease: 1=lack of disease 3=severe
Seed culms: 1=many 3=few or none
Lodging: 1=none 3=severe
Size: 1=large, robust 3=small

1-9 rating scale

Leafiness: 1=many leaves 9=few leaves
Disease: 1=lack of disease 9=severe
Vigor: 1=excellent vigor 9=poor vigor

EW=east-west spread (inches)
NS=north-south spread (inches)

*Accn=accession (908 prefix) **sel=selected for conservation in 2007 ***lsp sel=selected for landscaping in 2007

Date	908 Accn*	Row	Plant no.	(in.) Culm height	(in.) Veg. height	(in.) EW spread	(in.) NS spread	*rating* Leaf width	*rating* Leaf-iness	*rating* Di-sease	*rating* Seed culms	No. of culms	*rating* Vigor	*rating* Lodg-ing	*rating* Size	** sel	*** lsp sel	Comments
08/26/05	2788	10	2	34	18	7	8	2	3	2		3	4					
08/04/06	2788	10	2	69		24	27	3	2		1							short, wide
08/07/07	2788	10	2						1	1	1			2	1	x		
08/26/05	2814	5	3	73	13	5	9	3	2	2		17	3					
08/04/06	2814	5	3	77		29	23	1	2		1							fine leaves
08/07/07	2814	5	3						1	1	2			3	1			
08/26/05	2814	9	2	47	16	12	8	2	4	3		2	4					
08/04/06	2814	9	2	54		19	13	2	2		2							
08/07/07	2814	9	2						2	1	1			2	2	x		blue
08/26/05	2815	3	3	42	5	3	3	3	6	2		3	5					
08/04/06	2815	3	3	49		15	13	1	2		2							clean
08/07/07	2815	3	3						1	1	2			1	2			leafy, fine leaves
08/26/05	2815	6	1	0	20	9	3	3	5	4		0	5					
08/04/06	2815	6	1	45		15	13	2	1		3							blue, leafy
08/07/07	2815	6	1						1	1	2			1	2	x		
08/26/05	2818	6	2	46	9	10	7	2	4	5		8	4					
08/04/06	2818	6	2	52		23	17	2	2		1							leafy
08/07/07	2818	6	2						1	1	1			1	2	x		
08/26/05	2820	1	2	48	26	7	11	2	3	2		4	3					
08/04/06	2820	1	2	60		15	20	2	2		3							stressed, lodged
08/07/07	2820	1	2						2	1	3			2	2			

Table PS-3. Forage analysis, stalk strength, and phenology - Prairie sandreed *Calamovilfa longifolia*.

Test Date	908 Accn*	Row	Plant No.	Forage Quality Analysis**					*Rating* 4/3/2008 Stalk Strength***	7/28/2008 Phenology	Origin	
				CP	ADF	NDF	RFV	RFQ			State	County
8/7/2008	2788	10	2	13.6	40.7	75.1	71	89	3	late boot	MN	Sherburne
8/7/2008	2815	3	3	14.6	39.8	70.2	77	100	2	pre-anthesis	MN	Norman
8/7/2008	2820	1	2	13.7	35.5	65.6	87	129	--	late boot	MN	Chisago
8/7/2008	2814	9	2	16.1	35.5	68.6	83	127	--	--	MN	Polk
8/7/2008	2815	6	1	14.1	39.0	70.9	77	110	--	--	MN	Norman
8/7/2008	2818	6	2	15.9	38.1	71.5	77	102	--	--	MN	Douglas

plants selected for breeder population in 2009 (Accn # 2814 Row 5, Plant 3 was not clipped for forage analysis as it was selected after forage analysis)

* Accn=accession (908 prefix)

** Forage Quality: CP = crude protein, ADF = acid detergent fiber %, NDF = neutral detergent fiber %, RFV = relative feed value, RFQ = relative feed quality; forage was sampled 7/22/2008

*** Stalk strength: 1=upright, 3=lodged
Data for stalk strength and phenology were not recorded for all of the collections that had forage analysis. This was due to selection and 2 reselections before deciding a final selected population.

ACTIVE STUDIES: TECHNICAL REPORT 2014

Study Number	**NDPMC-P-0402-RA**
Title	**Sand Bluestem Seed Increase (*Andropogon hallii*)**
Objective	Develop a sand bluestem release from native collections from Minnesota, North Dakota, and South Dakota. Superior plants will be selected and the release would be intended for conservation plantings on sandy sites in Minnesota, North Dakota, and South Dakota. A priority of the release would include seed production.
Duration	2003-2016
Cooperators	USDA, NRCS, Bismarck Plant Materials Center, Bismarck, North Dakota
Location	Plant Materials Center, Bismarck, ND
-----Soils	Silt loam
-----MLRA	
----- Precip.	Normal: 17.80 inches 2013: 26.75 inches 2014: 13.92

Background information: Species available for stabilizing sandy soils are limited. Sand bluestem is a tall, perennial, warm-season grass native on sandy sites in the Great Plains. It has short rhizomes. The culms are solid. The seed heads are racemes forming a turkey foot shape and closely resembling big bluestem. It is distinguished from big bluestem by its dense yellow hairs on the seed head and its lack of hairs on the leaves. Its growth habit and forage quality are important attributes when used in conservation plantings. Current releases adapted to the Northern Great Plains are 'Garden' and 'Goldstrike'. They are marginally adapted in the northern portion of the Great Plains and production of seed is very inconsistent.

Methods and Materials

The study is divided into two sections. The sections are: **Initial Assembly** and **Breeder Population**. Seeds from the collections were grown in the greenhouse and planted to an initial assembly. Data was collected from plants in the initial assembly and superior plants, based on visual performance and seed set, were then selected to be part of the breeder population.

Initial Assembly

Seed Source	
-----Collection	See Table SB-1 for collection information (Date, location, collector, accession). Small amounts of seed were hand harvested from native plants for each collection.
Propagation	
-----Greenhouse	**2005:** Seed was planted into conetainers™ in February, soilless potting mix, hardened off in lath house.
Assembly	Seedlings grown in the greenhouse were planted into field.
-----Location	Panel A (southern end)
-----Date	5/24/2005
-----Design	Three replications, accessions in three-plant plots, accessions random within a replication. See Figure SB-1 for plot layout. Plants and rows were spaced 3.5 feet apart.
Field Maintenance	
-----Weed Control	Frequent shallow tilling each year with walk behind front tine garden tiller, no herbicide except spot spraying of Canada thistle, hand hoeing.
-----Irrigation	No irrigation except in 2005 at seedling transplant, and July2006 during severe drought.
-----Residue Removal	**2005:** hand clipped in November to a 3-inch stubble height. **2006:** attempted to burn but not successful. Hand clipped in November. **2007:** no residue removal. **2008:** hand clipped residue from 2007 growth in April 2008. **2009:** swathed and raked off residue in November. **2010:** residue left standing. **2011:** Residue from 2010 burned off in spring. **2012:** mowed and raked in November.

	2013: no residue removed. **2014:** Burned 2013 residue on May 7, 2014.
Data Collection	See Table SB-2 for collected data.
-----Parameters	Canopy spread, culm height, leaf width, leafiness, seed heads, lodging, overall size, stalk strength, phenology (flowering stage).
-----Data	See Table SB-2 for collected data. Data was collected from 2005-2008. See 2009 Technical Report for all data.

Breeder Population

Source	
-----Selections	Selections were based on flowering time, leafiness, and overall plant health. Some plants were also identified as big bluestem or hybrid and are labeled 'ANGE" in the table.
-----Propagation	Plants were propagated in 2011 from root and rhizome pieces. Portions of selected plants in the initial assembly were dug and planted the same day to the breeder population block.
-----Planting Date	May 6, 2011
Propagation	
-----Field	Each of the 10 selected plants were cut into 10 chunks and moved to breeder block on May 6, 2011.
Assembly	Superior plants were selected from initial assembly and chunks were planted May 6, 2011to form breeder block.
-----Location	Panel A (northern end)
-----Design	Selected accessions randomly assembled into 10 plants X 10 row plot. Plants spaced 3.5 feet apart.
Data Collection	See Table SB-2 for collected data.
Field Maintenance	
-----2012	Hand weeding, shallow tillage with garden tiller.
-----2013	Hand weeding, shallow tillage with garden tiller, removal of plants with big bluestem characteristics.
-----2014	Burned residue on May 7, 2014. Hand weeding, shallow tillage, remarked plants that have big bluestem characteristics

Results and Discussion

2012: Plants initially grew slow after transplanting. Plants that had the most typical color and hairiness of sand bluestem were flagged as selections from the population.

2013: Some plants exhibited big bluestem characteristics by the end of the growing season. Plants that did not appear to be big bluestem were reflagged. The big bluestem plants will be removed in 2014 and reselection will be made for the breeder population. Seed production will be greatly considered when selecting the final breeder population.

2014: Plant characteristics were again reevaluated. Many of the plants in the breeder block appeared to be big bluestem or a cross of big bluestem and sand bluestem. To be considered sand bluestem, the seed head had to be hairy, plants bluish in color, and some spread of plant by rhizomes. Upright, bunchy, little or no hair on seed head, and reddish colored plants were considered big bluestem or a cross. Contaminant plants were flagged in August and again in October for removal in 2015. Figure SB-2 is a map that will be used to help identify plants for 2015 spring removal. Data such as flowering date, plant size, and biomass production will be collected in 2015 on remaining plants.

Table SB-1. Collections – sand bluestem *Andropogon hallii*

Accession	State	County	Date	Legal Description	Collector
9082894	SD	Harding	09/14/03	Sec.30, T15N, R5E SE of N Crow Butte	L.Smith
9082803	ND	Adams	09/02/03	SW1/4 Sec.11 and NE1/4 of Sec.14, T129N, R92W Roadway	J.Klein, J.Timm
9082804	ND	Ransom	09/08/03	Sec. 14 and Sec.23, T135N, R53W Sheyenne Grasslands	N. Jensen
9082805	ND	McHenry	09/24/03	Sec.20, T158N, R75W, Mouse River State Forest	M.Knudson
9082806	ND	McHenry	09/24/03	Sec.13, T153N, R76W road ditch SE of George Lake	M.Knudson
9082807	SD	Corson	09/23/03	Sec.29, T20N, R18E flat area	D.Evenson
9082808	ND	Ransom	09/09/03	Sec.27,34 T135N, R53W 2mi N of Hwy 27 along 147 Ave. N	N. Jensen
9082809	SD	Brown	09/09/03	NE1/4 26, SW1/4 25, T128N, R60W 1mi from Brown/Marshall Co. line	N. Jensen
9082810	SD	Todd	09/19/03	SW1/4 19, T36N, R29W N of county road	L.Schoon
9082811	SD	Todd	09/19/03	NW1/4 Sec.25, T36N, R31W, 3/4mi W Hwy S of St. Francis	L.Schoon
9082812	SD	Todd	09/19/03	SE1/4 Sec.9, T36N, R28W 1/2 mi W of Hwy 83, N edge of county road	L.Schoon
9082824	ND	Billings	10/01/03	SW1/4 Sec.22, T139N, R103W along Little Missouri River	M.Humann
9082827	ND	McHenry	09/15/03	NW1/4 Sec.2, T75N, R154W east of farm	W.Duckwitz
9082881	MT		2003	Sec.25, T11N, R48E	T.Haughain, Kilian
9082904	ND	Burleigh	09/09/03	Sec.7, T137N, R77W Moffit Rd west of curve	Jensen, Bergsagel
9082905	ND	Emmons	09/23/04	4 mi S. of Glencoe Church, Hwy 1804, east side of road	D.Tober
Garden	KS			Received from Manhattan, KS PMC	
sher1	MN	Sherburne	09/04/03	Sec.27, T34N, R27W Sand Dunes State Forest, east exposure	G.Hugo
sher2	MN	Sherburne	09/04/03	Sec.4, T133N, R28W non-cropped pivot corner	B.Gullickson
sher3	MN	Sherburne	09/04/03	SESE Sec.15, T34N, R27W old Christmas tree plantation	G.Hugo
sher4	MN	Sherburne	09/04/03	Sec.24, T34N, R29W Oak Savannah Land preserve (county park)	B.Gullickson
sher5	MN	Sherburne	09/04/03	Sec.16, T34N, R29W & Sec.31, T34, R28 along railroad tracks	B.Gullickson

Figure SB-1. Plot layout - Sand Bluestem *Andropogon hallii*.

(Plants were started in conetainers in the greenhouse from collected seed)

Plant spacing: 42 inches (3.5 ft.)
Row spacing: 42 inches (3.5 ft.)
Plants Selected for Breeder Population

West

Garden	9082811	9082809	9082806	sher5	9082881
Garden	9082811	9082809	9082806	sher5	9082881
Garden	9082811	9082809	9082806	sher5	9082881
9082827	9082905	9082881	9082807	9082806	sher3
9082827	9082905	9082881	9082807	9082806	sher3
9082827	9082905	9082881	9082807	9082806	sher3
9082810	sher5	9082811	sher3	9082812	9082810
9082810	sher5	9082811	sher3	9082812	9082810
9082810	sher5	9082811	sher3	9082812	9082810
9082809	9082807	sher5	9082810	9082804	Garden
9082809	9082807	sher5	9082810	9082804	Garden
9082809	9082807	sher5	9082810	9082804	Garden
9082806	9082904	9082804	9082812	9082809	9082803
9082806	9082904	9082804	9082812	9082809	9082803
9082806	9082904	9082804	9082812	9082809	9082803
9082803	sher3	Garden	sher2	9082811	9082905
9082803	sher3	Garden	sher2	9082811	9082905
9082803	sher3	Garden	sher2	9082811	9082905
9082808	sher2	9082803	9082904	sher2	9082904
9082808	sher2	9082803	9082904	sher2	9082904
9082808	sher2	9082803	9082904	sher2	9082904
9082881	9082804	9082905	9082808	9082808	9082807
9082881	9082804	9082905	9082808	9082808	9082807
9082881	9082804	9082905	9082808	9082808	9082807
9082812	9082894	9082827	blank	9082827	9082824
9082812	9082894	9082827	blank	9082827	sher4
9082812	9082894	9082827	blank	9082827	sher1

Table SB-2. Evaluations of Selected Plants for Breeder Population- Sand bluestem *Andropogon hallii*.

Key

Canopy spread: width of plant, inches
Culm height: height of plant including seed culm, inches
Leaf width: 1=fine, narrow; 2=medium; 3=wide
Leafiness: 1=many leaves; 2=medium; 3=few leaves
Seed heads: 1=many; 2=medium; 3=few or none; y=yes; n=no
Lodging: 1=none, slight; 2=medium; 3=severe
Overall size: 1=large; 2=medium; 3=small
Stalk strength: 1=upright; 2=lodged; 3=severe lodging (after winter)
Phenology: flowering stage

Date	Accession	Row	Plant No.	(inches) Canopy spread	(inches) Culm height	*rating* Leaf width	*rating* Leafi-ness	*rating* Seed heads	*rating* Lodg-ing	*rating* Overall Size	*rating* Stalk strength	Phenology	*rating* Seed Fill	Comments
09/13/05	9082806	1	1					y						
08/04/06	9082806	1	1	29	48	2	1	1						
08/07/07	9082806	1	1				1	1	1	1				gray green
04/03/08	9082806	1	1								1			
07/29/08	9082806	1	1				2					boot		
08/21/09	9082806	1	1						1					
09/22/09	9082806	1	1										1	
09/13/05	9082806	1	3					y						leafy
08/04/06	9082806	1	3	21	51	2	1	1						very upright
08/07/07	9082806	1	3				1	1	1	1				gray green
04/03/08	9082806	1	3								1			
07/29/08	9082806	1	3				1					pre-anthesis		
09/13/05	sher4	6	1					y						
08/04/06	sher4	6	1	26	42	2	1	1						
08/07/07	sher4	6	1					1	1	1				yellow green
04/03/08	sher4	6	1								1			
07/29/08	sher4	6	1				1					pre-anthesis		
08/21/09	sher4	6	1						1					
09/22/09	sher4	6	1										1	
09/13/05	9082806	5	1					y						2 small culms

Date	Accession	Row	Plant No.	(inches) Canopy spread	(inches) Culm height	*rating* Leaf width	*rating* Leafi-ness	*rating* Seed heads	*rating* Lodg-ing	*rating* Overall Size	*rating* Stalk strength	Phenology	*rating* Seed Fill	Comments
08/04/06	9082806	5	1	8	48	2	3	1						
08/07/07	9082806	5	1				2	2	1	2				
04/03/08	9082806	5	1								1			
07/29/08	9082806	5	1				2					pre-anthesis		
09/13/05	9082807	4	3					y						flowering
08/04/06	9082807	4	3	26	51	2	3	1						
08/07/07	9082807	4	3				2	2	1	1				
04/03/08	9082807	4	3								1			
07/29/08	9082807	4	3				2					pre-anthesis		
08/21/09	9082807	4	3						1					
09/22/09	9082807	4	3										2	
09/13/05	9082808	1	1					y						
08/04/06	9082808	1	1	21	36	1	1	2						boot
08/07/07	9082808	1	1				1	1	1	1				yellow green
04/03/08	9082808	1	1								1			
07/29/08	9082808	1	1				1					boot		
08/21/09	9082808	1	1						1					
09/22/09	9082808	1	1										3	
09/13/05	9082808	1	2					n						
08/04/06	9082808	1	2	17	45	2	2	2						powder blue, boot
08/07/07	9082808	1	2				2	2	1	2				
04/03/08	9082808	1	2								1			
07/29/08	9082808	1	2				1					boot		
09/13/05	9082881	1	1					y						small
08/04/06	9082881	1	1	20	45	2	2	2						
08/07/07	9082881	1	1				2	2	2	2				
04/03/08	9082881	1	1								1			
07/29/08	9082881	1	1				2					anthesis		
09/13/05	9082881	6	1					n						
08/04/06	9082881	6	1	21	45	2	2	2						
08/07/07	9082881	6	1				2	2	2	2				

Date	Accession	Row	Plant No.	(inches) Canopy spread	(inches) Culm height	*rating* Leaf width	*rating* Leafi-ness	*rating* Seed heads	*rating* Lodg-ing	*rating* Overall Size	*rating* Stalk strength	Phenology	*rating* Seed Fill	Comments
04/03/08	9082881	6	1								2			
07/29/08	9082881	6	1				2					pre-anthesis		
08/21/09	9082881	6	1						1					
09/22/09	9082881	6	1										2	
09/13/05	9082905	6	3					y						
08/04/06	9082905	6	3	20	60	3	1	1						big bluestem?
08/07/07	9082905	6	3				1	1	1	1				coarse
04/03/08	9082905	6	3								1			
07/29/08	9082905	6	3				1					pre-anthesis		

Figure SB-2. Plants identified (x) for removal in 2015 - Sand Bluestem *Andropogon hallii*.

East

North

x	sb	x	sb	sb	x	x	x	x	sb
x sb small	sb	?	x	sb ?	x	x	sb+con	x ?	sb
sb	sb+con	?	sb	x	x	? X	sb	x ?	x
x	x	x	x	x	sb?	x	x	m	x
sb	x	x	sb?	x	sb	x	x	sb	sb+con
x	m	x	x	x	sb	x	x	x	x
?	x	x	x	x	x	x ?	m	sb	x
?	x	sb	x	x	x	x	?	x	x
x	x	x	sb	sb	x	sb	x	sb	x
sb	m	x	x	x	sb	sb	x	x	sb

ACTIVE STUDIES: TECHNICAL REPORT 2014

Study NDPMC-P-0404-RA

Study Title: Evaluation and Increase of Indiangrass *Sorghastrum nutans*

Objective: The objective of the study is to evaluate and release an Indiangrass with Minnesota origins that is adapted to Minnesota and the Dakotas. Its purpose will be for prairie, forage, and wildlife plantings. The initial purpose of this study was to identify and release an Indiangrass for use in urban and rural landscaping and to identify and release another population of Indiangrass for forage production and wildlife habitat. The objective was changed due to priorities of the PMC program and to changes in seed origin requirements and preferences in Minnesota.

Cooperators: USDA, NRCS, Bismarck Plant Materials Center; University of Minnesota; South Dakota State University, Brookings, South Dakota

Description**:** Indiangrass is a tall, native, warm-season grass that is bunchy, but has short, stout rhizomes. It grows 2-6 feet in height. The leaves are often a gray-green color and are somewhat stiff and straight. The attractive seedheads are panicles that are reddish gold and softly hairy.

Distribution**:** Indiangrass is most commonly associated with big bluestem and switchgrass in tallgrass prairies. It is found in southeast Canada, through much of the central and eastern United States, and into Mexico. It is not generally found west of the Great Plains. It prefers deep, well-drained floodplain soils and moister conditions than big bluestem.

Materials and Methods will be divided into four portions, based on the different plantings. These include: Initial Assembly, Breeder Population, Seed Increase Field, and Variety Trial.

Methods and Materials - Initial Assembly

Collection: Portions of plants were dug from an existing Indiangrass nursery at the north corner of the Agronomy Farm, South Dakota State University. The nursery had been planted in the 1970s-1980s from seedlings started from two seed collections, one from Aurora, east of Brookings, South Dakota, and one from an area around Yankton, South Dakota. Plants from the two sources could be distinguished by their leaf width and texture. The Yankton source, which is a more southern source had wider, coarser leaves than the Aurora source plants. Plants that were colorful or had unusual growth favorable for landscaping were flagged in the fall of 2004 by Dwight Tober and Nancy Jensen, PMC personnel; Dr. Mary Meyer, University of Minnesota; and Dr. Arvid Boe, South Dakota State University. Portions of the selected plants were dug the following spring on April 12, 2005, from the Brookings nursery. One portion of each selection was delivered to Dr. Mary Meyer at the University of Minnesota Arboretum, and the remaining portion was taken to the Plant Materials Center. Additional Indiangrass plants were collected at native sites in Minnesota. These were grown only at the PMC.

The plant/root remained dormant in a cool, dark tree cooler prior to greenhouse planting. Plantlets were separated from root chunks collected at SDSU and native locations. Each individual plantlet was planted into Miracle Grow Potting Mix in cone-tainers™ and placed in the greenhouse on April 25, 2005. Propagules were planted on June 7, 2005, to a field plot in panel A. The plants in the greenhouse were very slow to grow in size. Plants were hardened off in the lath house for two weeks prior to planting in the field.

Assembly: See Table IG-1 for accession information.

Planting Plan: Plantlets were planted to a field north of the sand bluestem in Panel A at the PMC. Each accession was planted in a three-plant plot. The accessions were randomized within the three replications. Plants were spaced 42 inches apart and rows were 42 inches apart. See Figure IG-1 for field plot map.

Site Preparation: The field was black fallowed for a few years, then tilled and packed within a week of planting. Previous plant material in the field was *Carex atherodes*.

Planting Method: Plants were hand planted using a specially made dibble bar that produces holes the size and length of roots within the cone-tainers™.
Field Planting Date: 4/12/2005

Maintenance: Weeds have been controlled from 2005-2009 by shallow tilling with a small walk-behind tiller when weeds are small (less than 3 inches) and hand rogueing. The plot has received no fertilizer. Irrigation has been minimal. Plants were irrigated in July and on September 23, 2005, and once in July 2006. Plants were not irrigated in 2007-2009. Herbicide was applied only as a spot spray on small Canada thistle patches in 2005 and 2006. The herbicides used were Curtail and Roundup.

Data Collection: Notes on survival and a few comments on color were noted in 2005. This was the transplant year, so no extensive data was collected. Data collected in 2006 included plant height, leafiness, and culms produced. Data was collected twice in 2007. Data collected in September 2007 indicated seed ripeness. Growth stage was rated in 2008. See Table IG-2 for data. Preliminary selections were made for a landscaping population and a forage population. Plants were flagged. The breeder population was reselected in 2009. A decision was made to select only Minnesota origin plants. Data from previous years, flowering date, and overall plant performance in 2009 of Minnesota plants were considered when making plant selections. Growth stage was recorded August 5, 2009. See Table IG-3. The standard of comparison was the variety Tomahawk.

Methods and Materials - Breeder Population (Accession 9094358)

All selected accessions for the breeder population are of Minnesota origins. Selected plants (see Table IG-3) were propagated in the greenhouse. A portion from each selected plant growing in the initial assembly (Panel A)was dug in April 2010 and the root material split into small plantlets. These were planted in conetainers and grown in the greenhouse until planting to the breeder field (field D-11). The number of plants propagated and planted to the breeder field for each selected accession is found in Table IG-3. Plantlets were space planted on 6/7/2010. Rows were spaced 42 inches apart and plants within the rows were planted approximately 2 feet apart. A total of 10 rows (approximately 100 feet long) were planted. There was little or no mortalitiy of plants in the breeder block in 2010. The selected accessions appear leafier than Tomahawk Indiangrass and flowering is 1-2 weeks earlier than Tomahawk.

A small amount of seed was hand harvested in 2010. A total of 978 grams bulk of clean seed remained after cleaning 6.77 pounds of dirty seed.

In 2011, plants that had ripe seed in early and mid August were considered to be early flowering. These plants were individually sprayed with glyphosate on September 21, 2011. Once the plants died, they were dug and removed from the field. Approximately 10-20 % of the total number of plants in the field were removed. As selected accessions were randomly planted when the breeder field was established, there is no way to determine the exact origin of each removed plant.

Maintenance:

April 25, 2102	Burned 2011 residue
May 1, 2012	Atrazine at 2 pints/acre applied
May 16, 2012	Fertilizer 46-0-0 at 73 lb N/ac applied
June 12, 2012	2,4-D at 1 oz/gal
Throughout growing season	Hand rogueing
September 10, 2012	Seed was combine harvested
May 2, 2013	Burned 2012 residue
May 5, 2013	Sprayed Atrazine and Plateau at 2 pt/ac
May 9, 2013	Fertilized with 46-0-0 at 79 lb N/ac
June 6, 2013	Sprayed Curtail at 2 pt/ac
June 27, 2013	Buctril at 1 pt/ac

May 7, 2014	Burned 2013 residue
May 27, 2014	Moxy 1.5 pt/ac
May 28, 2014	Atrazine+Plateau 2pt + 2 oz/ac

Seed Harvest

2012	38 bulk pounds (17 PLS)
2013	43 bulk pounds (26 PLS)
2014	14 bulk pounds (7.7 PLS)

Methods and Materials - Seed Increase Field

Seed harvested in 2012 from the Breeder Population was planted in 2013 to start a seed increase field. The field is adjacent and to the south of the breeder field. It consists of 10 rows. Seed was harvested from these rows in 2014. It was mixed with the breeder seed at harvest.

Maintenance

May 2, 2013	Burned 2012 weeds and residue
May 5, 2013	Atrazine+Plateau
May 9, 2013	Fertilized at 79 lb N/ac
June 6, 2013	Curtail
June 27, 2013	Moxy
June 3, 2014	Atrazine 4L
2014	tilled between rows in late June, hand rogued July, August

Methods and Materials - Variety Trial

A variety trial was planted on June 3, 2014 in Panel G-4 at the Plant Materials Center. Chief, Tomahawk and 9094358 (PMC selection) were planted in separate 60-foot X 5.5-foot plots to compare growth and longevity.

Results and Discussion - Initial Assembly

Plant survival in the greenhouse and field in 2005 was greater than 90 percent. Some color differences between plants were displayed. Plant growth was excellent in 2006, despite drought conditions. Differences in phenology and growth characteristics were exhibited. A few accessions produced viable seed before a killing frost. Some plants displayed an upright stature and color variation, making them desirable for landscaping. Plants that were leafy and had finer leaves showed potential for forage production. Size, color, and leaf width were variable between accessions in 2008. Attempts to measure stalk strength by rating lodging after overwintering was not possible. All plants were standing on 4/3/2008. A major factor in selection of a forage population is expected flowering date, which is important for seed production. The plants were leafy and vigorous. See Table IG-2 for data.

The primary use for Indiangrass will be Minnesota and portions of eastern North Dakota and eastern South Dakota. Minnesota requirements mandating the use of Minnesota origin seed for state funded and other seedings impacted the selection process. Plants selected are leafy and vigorous. Smut, which has not been noticed in past years, was present on many seed heads throughout the evaluation block. Plants with noticeable smut were not selected.
The assembly in Panel A still remained in 2014. It has become contaminated with various weeds and other grass species.

Results and Discussion - Breeder Population

The plants that remain after removing the very early maturing maintained some variation in flowering dates. The plants also exhibited variation in a number of plant characteristics including leaf width, and plant height. Seed harvested in 2012 was 67 pounds of dirty seed, which cleaned out to 38 bulk pounds. The 2012 seed only had 47% germination, which is quite low. In 2013, seed harvested was 110 pounds of dirty seed (from combine). Clean amount is pending. The cause of low germination is not known. It may be due to poor conditions for pollination or may be due to chemical application. Data will be collected on flowering, leafiness, and seed production.
Plants in 2013 were vigorous. In 2014, the plants were extremely yellow and appeared stunted when they began to grow. It is not known if there was an accidental spraying that could have caused the abnormal growth and color. Later in the summer, the plants regained a darker green color and plants grew to an average size.

Results and Discussion - Seed Increase Field

Very few seedlings could be found at the end of 2013 in the field. In 2014, there were many more seedlings, but it was difficult to find complete rows. Green foxtail became a very severe problem. The four most eastern rows were hand rogued in 2014. Plants in these rows grew much larger than rows not rogued.

Results and Discussion - Variety Trial

The plots became very weedy in 2014. They were mowed 2-3 times to open the canopy so any seedlings present could grow. It may need to be replanted in 2015.

Table IG-1. Collections - Indiangrass *Sorghastrum nutans* .

ID No.	Accession	State	County	Location
A1	9091979			A1 - A12 Vegetative material dug 4/12/2005 from Dr. Arvid Boe's assembly at SDSU Agronomy Farm east of campus, just west of I-29 and at SDSU Research Farm near Aurora, east of I-29. Original material had been collected by Dr. Ross of SDSU in the 1970's from the Aurora Prairie east of Brookings.
A2	9091980			
A3	9091981			
A4	9091982			
A5	9091983			
A6	9091984			
A7	9091985			
A8	9091986			
A9	9091987			
A10	9091988			
A11	9091989			
A12	9091990			
Y1	9091991			Y1 - Y14 Vegetative material dug 4/12/2005 from Dr. Arvid Boe's assembly at SDSU Agronomy Farm east of campus, just west of I-29 and at SDSU Research farm near Aurora, east of I-29. Original material had been collected by Dr. Ross of SDSU in the 1970's from a site near Yankton, South Dakota.
Y2	9091992			
Y3	9091993			
Y4	9091994			
Y5	9091995			
Y6	9091996			
Y7	9091997			
Y8	9091998			
Y9	9091999			
Y10	9092000			
Y11	9092001			
Y12	9092002			
Y13	9092003			
Y14	9092004			
L1	9092005	MN	Redwood	U of M SW Outreach and Research Center, Lamberton, near Cottonwood River in native prairie
L2	9092006	MN	Redwood	U of M SW Outreach and Research Center, Lamberton, near Cottonwood River in native prairie
L3	9092007	MN	Redwood	U of M SW Outreach and Research Center, Lamberton, near Cottonwood River in native prairie
K1	9092008	MN	Douglas	near Kensington, MN between road and railroad
P1	9092009	MN	Redwood	coll. 4/13/2005 Lamberton Twp, Sec.29, 2 miles from Revere along Pell Cr., Brian Pfarr landowner
P2	9092010	MN	Redwood	coll. 4/13/2005 Lamberton Twp, Sec.29, 2 miles from Revere along Pell Cr., Brian Pfarr landowner
E1	9092011	MN	Sherburne	coll. 4/13/2005 Elk River FO, Gina Hugo, T33N. R27 NW1/4of SW1/2 sec14
E2	9092012	MN	Sherburne	coll. 4/13/2005 Elk River FO, Gina Hugo, T33N. R27 NW1/4of SW1/2 sec14
E3	9092013	MN	Sherburne	coll. 4/13/2005 Elk River FO, Gina Hugo, T33N. R27 NW1/4of SW1/2 sec14
KN10	9092017	MN	Kittson	SW1/4 SE1/4 Sec.10 T160N R 46W(Norway Township) fine and medium sands, Al Gustafson
KN15	9092018	MN	Kittson	NW1/4 NE1/4 Sec.15 T160N. R46W(Norway Township) loamy fine sand, Al Gustafson
KN30	9092019	MN	Kittson	NE1/4 SE1/4 Sec.30 T160N. R46W(Norway Township) Arveson fine sandy loam, Al Gustafson
Tom1	9092014	ND		PMC field
Tom2	9092015	ND		PMC field
Tom3	9092016	ND		PMC field
Holt		NE		seed from KS PMC, started in the Greenhouse
H1	NONE	MN	Pine	Hinkley FO, Julie Lindner, SCT, Pine Co., MN SE1/4 of NE1/4 Sec.20 T39N R21W - poor root sample

Figure IG-1. Plot layout - Indiangrass *Sorghastrum nutans*.

Species: **Indiangrass** *Sorghastrum nutans*
Location: **Panel A**
Planting Date: 6/7/2005
Spacing between rows = 42 inches (3.5 feet)
Spacing between plants = 42 inches (3.5 feet)
Shading indicates selected plants

N ←

East

		TOM3		Y3		A6		Y14		Y2		A3		A4				KN10		L1		Y6		A9
		TOM3		Y3		A6		Y14		Y2		A3		A4				KN10		L1		Y6		A9
		TOM3		Y3		A6		Y14		Y2		A3		A4				KN10		L1		Y6		A9
		E2		A4		Y14		A6		HOLT		Y9		L2				E3		Y14		Y5		A8
		E2		A4		Y14		A6		HOLT		Y9		L2				E3		Y14		Y5		A8
		E2		A4		Y14		A6		HOLT		Y9		L2				E3		Y14		Y5		A8
		L3		HOLT		A1		L1		P1		KN30		E3				E2		Y13		Y4		A7
Y8		L3		HOLT		A1		L1		P1		KN30		E3				E2		Y13		Y4		A7
L1		L3		HOLT		A1		L1		P1		KN30		E3				E2		Y13		Y4		A7
K1		E3		A12		Y2		Y5		A1		A5		Y3		HOLT		E1				Y3		A6
Y9		E3		A12		Y2		Y5		A1		A5		Y3		HOLT		E1		Y12		Y3		A6
E1		E3		A12		Y2		Y5		A1		A5		Y3		HOLT		E1		Y12		Y3		A6
Y4		A5		Y5		Y7		Y4		Y6		L3		TOM2		TOM3		P2				Y2		A5
Y6		A5		Y5		Y7		Y4		Y6		L3		TOM2		TOM3		P2		Y11		Y2		A5
Y6		A5		Y5		Y7		Y4		Y6		L3		TOM2		TOM3		P2		Y11		Y2		A5
Y1		A8		A2		A9		KN10		E2		A2		E1		TOM2		P1		Y10		Y1		A4
Y1		A8		A2		A9		KN10		E2		A2		E1		TOM2		P1		Y10		Y1		A4
A10		A8		A2		A9		KN10		E2		A2		E1		TOM2		P1		Y10		Y1		A4
A10		TOM1		A7		A3		A11		Y8		Y7		K1		TOM1		K1		Y9		A12		A3
L2		TOM1		A7		A3		A11		Y8		Y7		K1		TOM1		K1		Y9		A12		A3
L2		TOM1		A7		A3		A11		Y8		Y7		K1		TOM1		K1		Y9		A12		A3
KN10		A11		P1		Rep 3		A7		A12		A9		Y1		KN30		L3		Y8		A11		A2
KN10		A11		P1				A7		A12		A9		Y1		KN30		L3		Y8		A11		A2
KN10		A11		P1		P2		A7		A12		A9		Y1		KN30		L3		Y8		A11		A2
KN30		TOM2		KN15		KN15		TOM1		A10		TOM3		A8		KN15		L2		Y7		A10		A1
KN30		TOM2		KN15		KN15		TOM1		A10		TOM3		A8		KN15		L2		Y7		A10		A1
KN30		TOM2		KN15		KN15		TOM1		A10		TOM3		A8		KN15		L2		Y7		A10		A1
Row13		**Row12**		**Row11**		**Row10**		**Row9**		**Row8**		**Row7**		**Row6**		**Row5**		**Row4**		**Row3**		**Row2**		**Row1**

South

Sand Bluestem

Hard Fescue Alley

Table IG-2. Evaluation data, 2006-2009 - Indiangrass *Sorghastrum nutans*.

Key: **Ratings**

Leaf width: 1=narrow; 2=medium; 3=wide
Texture: 1=fine leaves, stem 2=medium 3=coarse leaves, stem
Leafiness: 1=many leaves; 2=some leaves; 3=few leaves
Seed culms: 1=many culms; 2=some culms; 3=few culms
Phenology: 1=seed forming; 2=flowering; 3=boot
Growth Stage as related to flowering/seed production
Lodging: 1=no lodging; 2=some lodging; 3=severe lodging
Plant Size: 1=large, robust; 2=medium to large; 3=small
Color: 1=very colorful, showy; 2=some color; 3=not showy

Culm Ht.: seed culm height (inches)
Spread: width of plant crown (inches)
Select: L=landscape, F=forage potential selections

Date	Acces-sion	ID No.	Row	Plt. No.	Leaf Width	Tex-ture	Leafi-ness	Seed Culms	Culm Ht. (in.)	Phen-ology	Growth Stage	Mature Seed	Spread (in.)	Lodg-ing	Plt. Size	Color	Se-lect	Comments
08/04/06	9092005	L1	3	3	3		1	3	45				24					boot
08/07/07	9092005	L1	3	3			2			2				2	1	2		
09/25/07	9092005	L1	3	3								1						
07/30/08	9092005	L1	3	3		3					boot							
08/9/09	9092005	L1	3	3							No heads							
08/04/06	9092005	L1	13	1	3		1	1	48				35					upright
08/07/07	9092005	L1	13	1			2			2				2	1	1		
09/25/07	9092005	L1	13	1								2						
07/30/08	9092005	L1	13	1		3					boot							
08/09/09	9092005	L1	13	1							No heads							
08/04/06	9092006	L2	4	2	2		1	2	39				34					boot
08/07/07	9092006	L2	4	2			1			3				2	1	2		
09/25/07	9092006	L2	4	2								1						light colored heads
07/30/08	9092006	L2	4	2		2					vegetative							
08/09/09	9092006	L2	4	2							No heads							
08/04/06	9092006	L2	6	2	3		1	2	39				30					boot
08/07/07	9092006	L2	6	2			1			3				1	1	2	F	late
09/25/07	9092006	L2	6	2								1						slight bluegreen
07/30/08	9092006	L2	6	2		2					boot							

Date	Acces-sion	ID No.	Row	Plt. No.	Leaf Width	Tex-ture	Leafi-ness	Seed Culms	Culm Ht. (in.)	Phen-ology	Growth Stage	Mature Seed	Spread (in.)	Lodg-ing	Plt. Size	Color	Se-lect	Comments
08/09/09	9092006	L2	6	2							No heads							
08/04/06	9092006	L2	13	1	2		1	2	39				22					boot
08/07/07	9092006	L2	13	1			1			3				2	1	2	F	late
09/25/07	9092006	L2	13	1								1						bluegreen, leafy
07/30/08	9092006	L2	13	1		2					early boot							
08/09/09	9092006	L2	13	1							boot							
08/04/06	9092007	L3	4	3	2		1	2	45				38					boot
08/07/07	9092007	L3	4	3			2			2				2	1	2		
09/25/07	9092007	L3	4	3								1						
07/30/08	9092007	L3	4	3		2					vegetative							
08/09/09	9092007	L3	4	3							No heads							
08/04/06	9092007	L3	7	1	2		1	2	30				29					boot
08/07/07	9092007	L3	7	1			2			2				2	2	2		
09/25/07	9092007	L3	7	1								1						very fine leaf, leafy
07/30/08	9092007	L3	7	1		2					vegetative							
08/09/09	9092007	L3	7	1							No heads							
08/04/06	9092007	L3	12	2	3		1	2	42				28					
08/07/07	9092007	L3	12	2			2			2				2	2	2		
09/25/07	9092007	L3	12	2								1						upright, leafy
07/30/08	9092007	L3	12	2		2					vegetative							
08/09/09	9092007	L3	12	2							No heads							
08/04/06	9092008	K1	4	3	2		2	2	51				34					
08/07/07	9092008	K1	4	3			1			2				2	1	2	F	
09/25/07	9092008	K1	4	3								1						
07/30/08	9092008	K1	4	3		2					vegetative							
08/09/09	9092008	K1	4	3							No heads							
08/04/06	9092008	K1	6	2	2		1	2	54				34					
08/07/07	9092008	K1	6	2			2			2				2	1	2		
09/25/07	9092008	K1	6	2								1						
07/30/08	9092008	K1	6	2		2					boot							
08/09/09	9092008	K1	6	2							No heads							
08/04/06	9092009	P1	4	1	3		1	3	33				37					boot
08/07/07	9092009	P1	4	1			1			2				2	1	2	F	
09/25/07	9092009	P1	4	1								1						

Date	Acces-sion	ID No.	Row	Plt. No.	Leaf Width	Tex-ture	Leafi-ness	Seed Culms	Culm Ht. (in.)	Phen-ology	Growth Stage	Mature Seed	Spread (in.)	Lodg-ing	Plt. Size	Color	Se-lect	Comments
07/30/08	9092009	P1	4	1		2					early boot							
08/09/09	9092009	P1	4	1							No heads							
08/04/06	9092009	P1	8	1	3		1	2	30				39					boot
08/07/07	9092009	P1	8	1			2			3				2	1	2	F	late
09/25/07	9092009	P1	8	1								1						
07/30/08	9092009	P1	8	1		2					vegetative							
08/09/09	9092009	P1	8	1							No heads							
08/04/06	9092009	P1	11	1	3		1	2	42				27					boot
08/07/07	9092009	P1	11	1			1			3				2	1	2	F	
09/25/07	9092009	P1	11	1								2						
07/30/08	9092009	P1	11	1		2					early boot							
08/09/09	9092009	P1	11	1							No heads							
08/04/06	9092010	P2	4	2	3		2	3	39				26					boot
08/07/07	9092010	P2	4	2			2			3				2	2	2		
09/25/07	9092010	P2	4	2								2						
07/30/08	9092010	P2	4	2		2					early boot							
08/09/09	9092010	P2	4															
08/04/06	9092011	E1	4	1	2		2	1	63				18					
08/07/07	9092011	E1	4	1			2			2				2	2	2		
09/25/07	9092011	E1	4	1								1						
07/30/08	9092011	E1	4	1		2					late boot							
08/09/09	9092011	E1	4	1														
08/04/06	9092011	E1	6	1	1		1	2	60				26					
08/07/07	9092011	E1	6	1			2			2				2	2	2		
09/25/07	9092011	E1	6	1								1						
07/30/08	9092011	E1	6	1		2					late boot							
08/09/09	9092011	E1																
08/04/06	9092012	E2	4	2	3		2	2	66				18					
08/07/07	9092012	E2	4	2			1			2				2	1	2	F	upright
09/25/07	9092012	E2	4	2								1						
07/30/08	9092012	E2	4	2		2					early anthesis							
08/09/09	9092012	E2																
08/04/06	9092012	E2	12	3	2		1	1	63				18					

Date	Acces-sion	ID No.	Row	Plt. No.	Leaf Width	Tex-ture	Leafi-ness	Seed Culms	Culm Ht. (in.)	Phen-ology	Growth Stage	Mature Seed	Spread (in.)	Lodg-ing	Plt. Size	Color	Se-lect	Comments
08/07/07	9092012	E2	12	3			1			1				1	1	2	F	upright, early
09/25/07	9092012	E2	12	3								1						
07/30/08	9092012	E2	12	3		2					late boot							
08/09/09	9092012	E2	12	3														
08/04/06	9092013	E3	12	3	3		2	2	63				22					
08/07/07	9092013	E3	12	3			2			2				2	1	2		
09/25/07	9092013	E3	12	3								1						few leaves
07/30/08	9092013	E3	12	3		2					first anthesis							
08/09/09	9092013	E3	12	3														
08/04/06	9092017	KN10	9	2	2		2	2	48				28					
08/07/07	9092017	KN10	9	2			2			1				2	2	2		black seed
09/25/07	9092017	KN10	9	2								1						bluegreen, fine leaf
07/30/08	9092017	KN10	9	2		1					anthesis							
08/09/09	9092017	KN10	9	2														
08/04/06	9092017	KN10	13	3	3		2	2	45				30					
08/07/07	9092017	KN10	13	3			2			1				2	2	1		black seed, blue leaves
09/25/07	9092017	KN10	13	3								1						fine leaf, basal
07/30/08	9092017	KN10	13	3		1					anthesis							
08/09/09	9092017	KN10	13	3														
08/04/06	9092018	KN15	10	2	2		2	2	51				28					
08/07/07	9092018	KN15	10	2			2			1				1	2	2		
09/25/07	9092018	KN15	10	2								1						short, leaves basal
07/30/08	9092018	KN15	10	2		1					anthesis							
08/09/09	9092018	KN15	10	2														
08/04/06	9092018	KN15	11	3	2		3	2	48				23					
08/07/07	9092018	KN15	11	3			2			1				2	2	2		
09/25/07	9092018	KN15	11	3								1						leaves basal
07/30/08	9092018	KN15	11	3		1					anthesis							
08/09/09	9092018	KN15	11	3														
08/04/06	9092019	KN30	7	3	1		2	2	42				26					
08/07/07	9092019	KN30	7	3			2			1				2	2	2		
09/25/07	9092019	KN30	7	3								1						
07/30/08	9092019	KN30	7	3		1					anthesis							

Date	Acces-sion	ID No.	Row	Plt. No.	Leaf Width	Tex-ture	Leafi-ness	Seed Culms	Culm Ht. (in.)	Phen-ology	Growth Stage	Mature Seed	Spread (in.)	Lodg-ing	Plt. Size	Color	Se-lect	Comments
08/09/09	9092019	KN30	7	3							anthesis							
08/04/06	9092019	KN30	13	2	2		1	2	42				31					
08/07/07	9092019	KN30	13	2			2			2				2	2	2		
09/25/07	9092019	KN30	13	2								1						
07/30/08	9092019	KN30	13	2		1					anthesis							
09/22/09	9092019	KN30	13	2							½ anthesis							

Table IG-3. Selections – Indiangrass *Sorghastrum nutans*

Indiangrass Selections 9/22/2009

*plant 1=west most plant of accession
Selections made on appearance, size, seed heads
Breeder block planted 6/7/2010

Accession	ID No.	MN County	Row	Plant*	Total Planted 2010
9092011	E1	Sherburne	4	1	25
9092011	E1	Sherburne	6	1	23
9092012	E2	Sherburne	4	2	25
9092012	E2	Sherburne	12	3	20
9092013	E3	Sherburne	12	3	18
9092008	K1	Douglas	4	3	23
9092008	K1	Douglas	6	2	22
9092017	KN10	Kittson	9	2	25
9092017	KN10	Kittson	13	3	24
9092018	KN15	Kittson	10	2	19
9092018	KN15	Kittson	11	3	21
9092019	KN30	Kittson	7	3	25
9092019	KN30	Kittson	13	2	22
9092005	L1	Redwood	3	3	17
9092005	L1	Redwood	13	1	19
9092006	L2	Redwood	4	2	25
9092006	L2	Redwood	6	2	23
9092006	L2	Redwood	13	1	20
9092007	L3	Redwood	4	3	14
9092007	L3	Redwood	7	1	22
9092007	L3	Redwood	12	2	22
9092009	P1	Redwood	4	1	19
9092009	P1	Redwood	8	1	22
9092009	P1	Redwood	11	1	15
9092010	P2	Redwood	4	2	21

ACTIVE STUDIES: TECHNICAL REPORT 2014

Study: NDPMC-P-0604-RA

Study Title: Evaluation of Prairie Junegrass (*Koeleria macrantha*)

*This study was **DISCONTINUED** in 2013 after the death of most plants. The plot was not tilled and became a somewhat solid turf in 2014. Seed was harvested in 2012 from plants that did not die. The seed was cleaned, bulked and assigned accession 9094408. It is approximately 100 grams of seed.*

Introduction: Prairie junegrass is a cool-season native grass that grows in small tufts. It has been described as excellent forage for livestock, deer, and elk early in the spring. As the grass is small, its production is low. The quality declines at maturity. It is one of the earliest grasses to begin vegetative growth in the spring. It is easily overgrazed and decreases with increased grazing pressure. It is a component of many native plant communities. No adapted release of prairie junegrass is currently available for revegetation and native seedings in the Northern Great Plains.

Objective: The purpose of this study is to evaluate, identify and assemble a population of prairie junegrass from Minnesota, North Dakota, and South Dakota origins into a public release for conservation seedings in the Northern Great Plains.

Cooperators: USDA, NRCS, Bismarck Plant Materials Center, Bismarck, North Dakota

Description: Prairie junegrass is a short to medium lived, cool-season, perennial bunchgrass that is 6-20 inches tall. The roots are fibrous. Leaves are mostly basal. The seed head is a condensed panicle that opens slightly during flowering. Growth in the spring is usually completed by mid-June.

Distribution: Junegrass is native to most of North America, except the far southeast. It is also native to Europe and Northern Asia. It is very common in mixed grass and shortgrass prairie, meadows, open forest, mountain foothills, and rangeland. It is best adapted to well-drained soils in 12-20 inch precipitation areas.

Methods and Materials

Collection/Assembly: Seed heads were collected in 2006 and 2007 by NRCS employees from Minnesota, North Dakota, and South Dakota. See Table PJ-1 for collection and origin information. Seed heads were clipped at maturity and sent to the Plant Materials Center where they were accessioned and placed in the seed cooler for storage until seed was separated and planted in the greenhouse. Seed was planted into a soilless potting mix in cone-tainers™. Seedlings were planted from the greenhouse to a field plot (Panel A) on 5/21/2008. Seedlings were hand planted using a custom made dibble bar. See Figure PJ-1 for a map of the planting. Some collections did not have viable seed or emerge in the greenhouse. Plants were irrigated after planting to fill any space around the roots.

Maintenance:
2009: Weeds were controlled by shallow tilling between the rows with a garden tiller and hand hoeing around plants.
2010: Weeds were controlled by shallow tillage between rows, and hand hoeing around plants
2011: Weeds were controlled by shallow tillage between rows, and hand hoeing around plants. Plant residue was removed by mowing in early fall.
2012: Mowing between rows was used to control weeds.

Data Collection:
2009: Superior looking plants were grouped into categories based on growth habit and the use of the plant. The categories included landscaping, prairie/range or both. These are indicated in Table PJ-2.
2010: Data was collected in June for each plant. Plants were rated for height, number of culms, leafiness, and growth stage. Data for all plants is found in the previous Technical Report (2010).

2011: Plants that were dead or had poor vigor, disease, or flowered very early or very late were dug and removed from the planting. Superior plants of the remaining plants were noted and categorized as forage or landscape type plants. The removed plants are indicated on the map (Figure PJ-1) All data for the plants that remained after 2011 selection are recorded in Table PJ-2.

2012: Most of the stand was dead in the spring of 2012. As rows within the planting could not be identified, individual remaining plants could not be identified by accession. Seed was hand harvested from the remaining plants in the late summer of 2012. The amount of clean seed harvested was 0.29 bulk pounds.
2013: Seed harvested in 2012 was cleaned and is being stored in seed cooler for any future evaluation. The assembly area in Panel A was mowed. Seed that had fallen in previous years germinated and produced a healthy solid turf where the spaced plants had previously been assembled.

Results and Discussion

Seed fill is difficult to determine in prairie junegrass. Plants in the greenhouse were small to handle, but transplanting from flats to cone-tainers™ was very successful. Seedling survival after planting to the field was greater than 90 percent. Most of the plants flowered or had seed heads in 2009. Plants showed an array of sizes. Wide variability in size exists among the plants. Some plants are also very hairy on the leaves and stem, while others are smooth.

The loss of the stand in 2012 was very unexpected. Lack of snow cover and extreme cold in the winter of 2011 may have been a contributing factor. Mowing in the fall of 2011 may contributed to the loss as well.

The exact origin of the seed harvested in 2012 is not known. Based on accessions removed in 2011, it is known which collections are not included in the harvest.

Future plans are pending.

Table PJ-1. Collections - Prairie junegrass *Koeleria macrantha*.

Accession	Collector	Date	State	County	Location	Other
9092070	Knudson, Aune	7/19/06	ND	Ward	SE1/4SW1/4 sec 2, T152N, R84W	
9092071	D. Tober	8/16/06	ND	Oliver	MLRA 54, Arroda Lakes GMA	
9092072	D. Tober	8/16/06	ND	Dunn	1/2 mi. W. of Missouri River State Park Hdqrtrs	
9092073	A. Berg	8/4/06	ND	Bowman	sec 22, T130N, R104W	S exp., MLRA 54, cobbart compl.
9092074	D. Teske	7/19/06	ND	Sioux	sec 22, T129N, R83W	Daglum soils
9092075	D. Teske	7/17/06	ND	Sioux	sec 9, T132N, R79W	Prairie Knight Casino entrance
9092076	Anderson, Simonsen	7/11/06	ND	Stutsman	sec 2, T141N, R64W	
9092077	C. Roth	6/27/06	ND	Bottineau	sec 16, T162N, R 75W	
9092078	L. Huether	7/5/06	ND	Mountrail	sec 35, T 92N, R 154W	Fred Evans, native range
9092079	L. Huether	7/5/06	ND	Mountrail	sec 17, T 92N, R 157W	Dustin Roise, lightly grazed
9092080	S. Sieler	7/20/06	ND	McLean	SE1/4 sec 16, T 147N, R 79W	MLRA 53B, state school land
9092081	S. Sieler	7/20/06	ND	McLean	SW1/4 sec 16, T 149N, R 79W	state school land
9092082	W. Duckwitz	7/25/06	ND	Grant	S1/2 sec 14, T 135N, R 88W	Heart Butte Dam, hilltop (2 samples)
9092083	Area 1-Thief River FO	7/20/06	MN	Kittson	Norway Dunes TNC, 4 mi to Halma	north end of unit
9092084	D. Teske	7/12/06	ND	Sioux	N1/2 NW1/4 sec 36, T 131N, R 84W	
9092085	D. Tober, R. Jones	7/21/06	ND	Wells	8 mi N. of Hurdsfield, Wells Co. GMA	
9092086	D. Teske	7/12/06	ND	Sioux	SW NE1/4 sec 27, T 130N, R 83 W	
9092087	L. Huether	7/5/06	ND	Mountrail	sec 20, T92N, R154W	
9092088	L. Huether	7/5/06	ND	Mountrail	sec 30, T 92N, R 156W	Curt Trulson land
9092089	L. Huether	7/5/06	ND	Mountrail	sec 21, T 92N, R 159W	Denny Farhart
9092090	W. Duckwitz	6/29/06	ND	Morton	NE1/4 sec 1, T82N, R 140W	north of buildings
9092091	R. Jones	7/25/06	ND	Morton	sec 16, T 139N, R 85W	right behind New Salem Sue
9092092	Forman, Gustafson	7/10/06	ND	Rolette	SE1/4 NW1/4 sec 1, T160N, R 72W	
9092093	D. Teske	7/8/06	ND	Morton	SW SW1/4, sec 14, T138N, R 81W	Teske acreage, Co. Rd. 138
9092094	D. Teske	8/7/06	SD	Corson	sec 13-T20-R27 by EQIP well/tank site	Reeder Loam
9092095	Jensen, Bergsagel	8/9/06	SD	Spink	N1/2 sec 21, T116N, R 65W	Bald Mtn. near Redfield (2 samples)
9092096	D. Teske	7/18/06	SD	Corson	SE1/4 sec 9, T18N, R 21E	Cottonwood Creek
9092097	Jensen, Bergsagel	8/10/06	SD	Deuel	NE1/4 sec 16, T116N, R49W	8 mi N. of Clear Lake along GMA fence
9092098	Jensen, Bergsagel	8/9/06	SD	Faulk	sec 28, 33 T117N, R69W	8 mi south Faulkton
9092099	Jensen, Bergsagel	8/10/06	SD	Codington	sec 13, T119N, R51W	along hwy 20
9092100	Yapp, Schoon	7/12/06	SD	Todd	SE Harrington, 5 mi, 20 mi SW of Rosebud	

Accession	Collector	Date	State	County	Location	Other
9092101	Teske	7/18/06	SD	Corson	SE1/4 sec 8, T18N, R21E	Cottonwood Creek
9092102	Woods, Sommer	7/11/06	SD	Hutchinson	sec 9, T99N, R57W	Harvey Wall-owner
9092103	R. Jones	7/18/06	MN	Ottertail	Inspiration Peak, 12 mi NE of Ashby	
9092104	Rennolet, Woods	7/11/06	SD	Hutchinson	8 mi SE of FO, Dennis Farst, landowner	(2 samples)
9092105	R. Jones	7/17/06	MN	Clay	TNC Bluestem Prairie, 10 mi E. of Moorhead	
9092106	S. Runyan	7/7/06	SD	Hyde	sec 6, T111N, R72W	section line fence
9092107	Jensen, Harding 4-H	7/10/06	SD	Harding	North Cave Hills	
9092108	R. Jasken	summer 06	MN	Becker	sec 18, T142N, R41W	
9092109	Hanson, Bronder	7/14/06	MN	Sherburne	SW1/4 SW1/4 sec 26, T34N, R27W	
9092110	R. Jones	7/18/06	MN	Douglas	TNC Seven Sisters, 3 mi E of Ashby	
9092111	D. Tober	7/24/06	MN	Pope	Ordway Prairie TNC 9 mi se of Brooten, MN	NE of rest stop
9092112	Area 1-Thief River FO	7/20/06	MN	Kittson	Norway Dunes TNC, 4 mi to Halma	south end of unit
9092113	L. Alveshere	7/18/06	ND	McKenzie	NENW sec 15, T152N, R101W	Donald Lindvig
9092114	Blessum, Forman	7/5/06	ND	McHenry	sec 15, T157N, R78W	
9092115	L. Alveshere	8/16/06	ND	McKenzie	NENE sec 16, T149N, R99W	Gene Traustrom
9092116	Jones, Tober	7/20/06	MN		Agassis Dunes TNC 3 mi S. of Fertile	
9092117	L. Alveshere	7/19/06	ND	McKenzie	SWNE sec 25, T149N, R 95W	Arnold Peterson
9092118	L. Alveshere	7/6/06	ND	McKenzie	SESE sec 5, T150N, R96W	Tank Ranch
9092119	L. Alveshere	7/24/06	ND	McKenzie	NESE sec 19, T146N, R103W	John Quinnel, Milt Madison
9092120	Gustafson, Jones	7/20/06	MN		Skull Lake WMA 14 mi N. of Lake Bronson	
9092121	D. Tober	9/26/06	ND	Burleigh	McDowell Dam	from 15 plants
9092123	D. Tober	9/26/06	ND	Stutsman	10 mi N. Medina, WPA, W. side of highway	
9092124	D. Tober	9/12/06	MN	Big Stone	4 mi W. of Beardsley Paradise Retreat Dev.	
9092125	D. Tober	9/26/06	ND	Burleigh	WMA N. of Apple Valley Housing Dev.	
9092126	D. Tober	10/2/06	ND	Grant	across from Crappie Creek, Lake Tschida	
9092133	M. Rose	7/25/06	MN	Renville	sec 21, T113N, R35W Cnty. Rd. 15	native bedrock, MN River
9092134	M. Rose	7/25/06	MN	Redwood Falls	NE1/4 sec 23, T112N, R34W	native pasture (rock outcrops)
9092135	L. Voigt	7/3/06	ND	Dunn	SWNE sec 30-T147-R93,w. saltbox	Andrew Voigt Ranch
9092136		7/24/06	SD	Brown	SW sec 2-T125-R63	1330 ft. elev. Slope2%
9092177	D. Tober	8/31/07	ND	Ransom	Sheyenne National Grasslands, north trail	147th Ave.(co.53) 2 mi N. of Hwy 27
9092178	D. Tober	8/31/07	ND	Ransom	S. of McLeod approx. 1 mi.,Sheyenne Grasslands	west side of gravel road
9092179	D. Tober	8/30/07	MN	Pope	near Ordway Prairie SNA, TNC	W. of Brooten 7 mi.
9092180	D. Tober	8/30/07	MN	Polk	near Agassiz Dunes SNA, TNA	
9092181	D. Tober	8/30/07	MN	Clay	Regional Science Center	4 mi. E. of Glyndon

Accession	Collector	Date	State	County	Location	Other
9092182	D. Tober	9/26/07	WY	Cook	NFS campgrounds, 3 mi NE of Sundance, WY	BHNF trailhead Bearlodge MT.
9092183	D. Tober	9/26/07	WY	Cook	Bearlodge MT. BHNF Cook Lake Rec. Area	1 mi down Cliff Swallow Trail
9092184	D. Tober	9/26/07	WY	Cook	3mi. S. of Beulah, WY Sand Creek Access	
9092185	D. Tober	9/26/07	WY	Cook	Bearlodge MT. BHNF Warren Peak Lookout Tower 6656'	
9092186	D. Tober	9/26/07	WY	Cook	4 mi NW Sundance, BHNF BearLodge Mts.	Reuter Trailhead
9092187	D. Tober	9/28/07	ND	Dunn	1/4 mi S. from maintenance sign to Killdeer Mtns	GMA west side of road
9092188	D. Tober	9/25/07	SD	Meade	summit of Bear Butte E. of Sturgis	N. facing slope
9092189	D. Tober	9/25/07	SD	Meade	2/3 up Bear Butte, E. of Sturgis north facing slope	4200 ft
9092190	D. Tober	9/27/07	ND	Slope	near entrance to Burning Coal Vein, in pines	
9092191	D. Tober	9/27/07	ND	Slope	12 mi W. of Amidon on Burning Coal Vein Rd.	
9092192	D. Tober	9/27/07	ND	Billings	S. of Medora along Little Missouri River bank	
9092193	D. Tober	9/27/07	SD	Harding	Slim Butte Rest Stop, USFS	Hwy 20 W of Reva, SD
9092194	M. Knudson	8/12/07	ND	Slope	sec 25-T134N-R101W	N side of White Butte
9092195	D. Teske	7/12/07	ND	Sioux	sec 26&27-T130-R83	6 mi. W of Selfridge
9092196	C. Dixon	7/1/07	ND		Sully's Hill Native Prairie	
9092197	M. Bellon	7/15/07	ND	Burleigh	sec. 17- T138N-R79W 1mi s. of Lincoln Rd.	1.5 mi E.
9092198	W. Duckwitz	9/6/07	ND	Stark	NE1/4NE1/4sec 16-T141-R91	Rick Schwartz land
9092199	C.Stange, W.Duckwitz	9/6/07	ND	Stark	SW1/4SE1/4 sec 4-T141-R91	Rick Schwartz land
9092200	D. Granbois	8/27/07	SD	Brookings	NE1/4 sec.18-T112N-R47W	Lake Hendricks Township
9092201	J. Dylla, V. DeVine	8/29/07	SD	Clark	sec1-T118-R56	
9092202	Yankton FO	7/1/07	SD	Yankton		
9092203	A. Boltjes	7/19/07	SD	Hyde	sec16-T115N-R73W	
9092204	L. Schoon	8/23/07	SD	Todd	SW1/4 sec10-T38N-R33W	Elk Valley, Inc.
9092205	N. Jensen, D. Tober	7/23/07	SD		Emergency Spillway W. of Oahe Dam	northwest of Pierre, SD
9092206	N. Jensen, D. Tober	7/24/07	SD		Sage Creek Road, SD Badlands	
9092207	L. Schoon	8/15/07	SD	Todd	SW1/2 29-T36N-R25W	Casey Foster Land, sands
9092208	D. Blaha	8/1/07	SD	Sully	sec. 26 T116N-R80W	.5 mi SE of river
9092209	T. Heck	8/1/07	SD	Potter	sec. 28-T117N-R79W	adj to north facing riparian area
9092210	B Woods, T. Sommer	7/13/07	SD	Hutchinson	sec. 31-T99-R58	south of barn
9092211	D.Tober, M. Knudson	10/11/07	MT	Powder River	2 mi. W of Diamond Butte Lookout, W.of Broadus	
9092214	M. Falk	8/24/07	SD	Hand	sec 9-T116-R67	silt loam, 0-2%slope
9092225	Paul Hoversten	9/1/07	MN	Lyon	E1/2 NE1/4 Sec 22 Island Lake Township	

Figure PJ-1. Plot layout – Prairie junegrass *Koeleria macrantha*.

Location: Panel A (PMC)

Planting Date: 5/21/2008

Between Row Spacing = 42 inches

Between Plant Spacing = 42 inches

removed in 2011

N

Row31	2092	2092	2092	2095	2095	2095	2079	2079	2079	2124	2124	2124	2114	2114	2114	2125	2125	2125	2183	2183	2204	2181			
Row30	2196	2196	2196	2115	2115	2115	2126	2126	2126	2111	2111	2111	2077	2077	2077	2192	2192	2192	2080	2080	2080	2110	2110	2110	2203	2203	2203
Row29	2210	2210	2210	2193	2193	2193	2207	2207	2207	2102	2102	2102	2179	2179	2179	2078	2078	2078	2113	2113	2113	2104	2104	2104	2093	2093	2093
Row28	2073	2073	2073	2178	2178	2178	2184	2184	2184	2081	2081	2081	2185	2185	2185	2135	2135	2135	2107	2107	2107	2198	2198	2198	2083	2083	2083
Row27	2116	2116	2116	2097	2097	2097	2101	2101	2101	2109	2109	2109	2180	2180	2180	2206	2206	2206	2103	2103	2103	2202	2202	2202	2091	2091	2091
Row26	2120	2120	2120	2098	2098	2098	2200	2200	2200	2188	2188	2188	2209	2209	2209	2071	2071	2071	2118	2118	2118	2201	2201	2201	2082	2082	2082
Row25	2133	2133	2133	2225	2225	2225	2070	2070	2070	2108	2108	2108	2090	2090	2090	2194	2194	2194	2189	2189	2189	2105	2105	2105	2187	2187	2187
Row24	2117	2117	2117	2177	2177	2177	2099	2099	2099	2197	2197	2197	2214	2214	2214	2119	2119	2119	2208	2208	2208	2089	2089	2089	2191	2191	2191
Row23	2076	2076	2076	2211	2211	2211	2084	2084	2084	2205	2205	2205	2199	2199	2199	2134	2134	2134	2121	2121	2121	2106	2106	2106	2072	2072	2072
Row22	2087	2087	2087	2136	2136	2136	2100	2100	2100	2195	2195	2195	2112	2112	2112	2182	2182	2182	2075	2075	2075	2085	2085	2085	2186	2186	2186
Row21	2073	2073	2073	2072	2072	2072	2071	2071	2071	2070	2070	2070	2200	2200	2200	2199	2199	2199	2198	2198	2198	2088	2088	2088	2190	2190	2190
Row20	2076	2076	2076	2075	2075	2075	2183	2183	2183	2184	2184	2184	2185	2185	2185	2186	2186	2186	2118	2118	2118	2117	2117	2117	2116	2116	2116
Row19	2113	2113	2113	2112	2112	2112	2119	2119	2119	2120	2120	2120	2121	2121	2121	2088	2088	2088	2087	2087	2087	2085	2085	2085	2084	2084	2084
Row18	2191	2191	2191	2190	2190	2190	2189	2189	2189	2188	2188	2188	2187	2187	2187	2090	2090	2090	2089	2089	2089	2115	2115	2115	2114	2114	2114
Row17	2193	2193	2193	2192	2192	2192	2097	2097	2097	2095	2095	2095	2093	2093	2093	2092	2092	2092	2091	2091	2091	2111	2111	2111	2110	2110	2110
Row16	2194	2194	2194	2180	2180	2180	2181	2181	2181	2182	2182	2182	2109	2109	2109	2108	2108	2108	2107	2107	2107	2106	2106	2106	2105	2105	2105
Row15	2103	2103	2103	2104	2104	2104	2126	2126	2126	2125	2125	2125	2124	2124	2124	2123			2197	2197	2197	2196	2196	2196	2195	2195	2195
Row14	2078	2078	2078	2077	2077	2077	2211	2211	2211	2225	2225	2225	2098	2098	2098	2099	2099	2099	2100	2100	2100	2101	2101	2101	2102	2102	2102
Row13	2207	2207	2207	2208	2208	2208	2209	2209	2209	2210	2210	2210	2083	2083	2083	2082	2082	2082	2081	2081	2081	2080	2080	2080	2079	2079	2079
Row12	2203	2203	2203	2202	2202	2202	2201	2201	2201	2179	2179	2179	2177	2177	2177	2136	2136	2136	2204	2204	2204	2205	2205	2205	2206	2206	2206
Row11	2203	2203	2203	2202	2202	2202	2123	2123	2123	2204	2204	2204	2133	2133	2133	2178	2178	2178	2214	2214	2214	2135	2135	2135	2134	2134	2134
Row10	2116	2116	2116	2114	2114	2114	2206	2206	2206	2179	2179	2179	2117	2117	2117	2205	2205	2205	2113	2113	2113	2115	2115	2115	2201	2201	2201
Row9	2225	2225	2225	2177	2177	2177	2211	2211	2211	2178	2178	2178	2200	2200	2200	2186	2186	2186	2198	2198	2198	2118	2118	2118	2199	2199	2199
Row8	2085	2085	2085	2076	2076	2076	2188	2188	2188	2187	2187	2187	2086	2086	2086	2071	2071	2071	2197	2197	2197	2181	2181	2181	2098	2098	2098
Row7	2124	2124	2124	2100	2100	2100	2196	2196	2196	2090	2090	2090	2088	2088	2088	2073	2073	2073	2184	2184	2184	2112	2112	2112	2207	2207	2207
Row6	2092	2092	2092	2089	2089	2089	2075	2075	2075	2070	2070	2070	2185	2185	2185	2119	2119	2119	2079	2079	2079	2095	2095	2095	2195	2195	2195
Row5	2110	2110	2110	2107	2107	2107	2194	2194	2194	2104	2104	2104	2099	2099	2099	2125	2125	2125	2108	2108	2108	2097	2097	2097	2109	2109	2109
Row4	2081	2081	2081	2190	2190	2190	2087	2087	2087	2072	2072	2072	2183	2183	2183	2120	2120	2120	2208	2208	2208	2078	2078	2078	2080	2080	2080
Row3	2093	2093	2093	2106	2106	2106	2180	2180	2180	2126	2126	2126	2214	2214	2214	2103	2103	2103	2192	2192	2192	2105	2105	2105	2091	2091	2091
Row2	2182	2182	2182	2193	2193	2193	2111	2111	2111	2077	2077	2077	2189	2189	2189	2084	2084	2084	2121	2121	2121	2209	2209	2209	2082	2082	2082
Row1	2136	2136	2136	2210	2210	2210	2133	2133	2133	2102	2102	2102	2191	2191	2191	2083	2083	2083	2134	2134	2134	2135	2135	2135	2101	2101	2101

Table PJ-2. 2010 Evaluation Data and 2011 Selection - Prairie junegrass *Koeleria macrantha*

***** **Height: 1=tall, 3=short**
****** **Culms: 1=many, 3=few or none**
******* **Leafiness: 1=leafy, 3=few leaves**
******** **Maturity: H=heading, A=anthesis, B=boot, V=vegetative, X=no plant**

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092070	6	1	6/7/2010	2	1	1	H		
9092070	6	3	6/7/2010	2	1	1	H		
9092070	21	1	6/7/2010	2	1	1	H		
9092070	21	2	6/7/2010	2	3	3	H		
9092070	21	3	6/7/2010	2	1	1	H		
9092070	25	1	6/7/2010	2	1	1	H		
9092070	25	2	6/7/2010	2	2	2	H		
9092070	25	3	6/7/2010	2	1	1	H		
9092071	8	1	6/7/2010	2	2	3	H	thrips	
9092071	8	2	6/7/2010	1	2	2	H	leaf disease	
9092071	8	3	6/7/2010	1	1	1	H	nice plant	
9092071	21	1	6/7/2010	1	2	2	H	thrips	
9092071	21	2	6/7/2010	1	2	2	H		
9092071	21	3	6/7/2010	1	2	2	H		
9092071	26	1	6/7/2010	2	2	2	H		
9092071	26	2	6/7/2010	2	2	2	A		
9092071	26	3	6/7/2010	1	1	1	H		
9092072	4	1	6/7/2010	1	1	2	H		
9092072	4	3	6/7/2010	2	2	2	H		
9092072	21	1	6/7/2010	1	1	1	H		
9092072	21	2	6/7/2010	2	2	3	H		
9092072	21	3	6/7/2010	1	2	2	H		
9092072	23	2	6/7/2010	1	1	1	H		forage
9092072	23	3	6/7/2010	1	1	2	H		
9092073	7	1	6/7/2010	2	2	1	H		
9092073	7	2	6/7/2010	2	2	3	H		
9092073	7	3	6/7/2010	1	1	1	H		
9092073	21	2	6/7/2010	2	2	3	H		
9092073	28	1	6/7/2010	2	2	2	H		
9092073	28	2	6/7/2010	2	1	2	H		
9092073	28	3	6/7/2010	1	1	1	A		
9092075	6	2	6/7/2010	2	2	2	H		
9092075	6	3	6/7/2010	1	1	1	H		
9092075	20	1	6/7/2010	1	2	2	H		
9092075	20	2	6/7/2010	2	1	1	H		
9092075	20	3	6/7/2010	1	2	2	H	Insects	
9092075	22	1	6/7/2010	2	1	2	H		
9092075	22	2	6/7/2010	2	1	2	H		
9092075	22	3	6/7/2010	2	1	2	H		

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092076	8	1	6/7/2010	2	2	3	H		
9092076	8	2	6/7/2010	3	2	3	H		
9092076	8	3	6/7/2010	2	1	2	H		
9092076	20	1	6/7/2010	2	2	2	H		
9092076	20	2	6/7/2010	2	2	3	H		
9092076	20	3	6/7/2010	2	2	2	H		
9092076	23	1	6/7/2010	2	3	3	H		
9092076	23	2	6/7/2010	2	1	2	H	insects	
9092076	23	3	6/7/2010	1	1	2	H	leaf disease	
9092077	2	1	6/7/2010	1	1	2	H	diseased	
9092077	2	2	6/7/2010	1	2	2	H		
9092077	2	3	6/7/2010	3	3	3	H	stressed	
9092077	14	1	6/7/2010	2	1	1	H		
9092077	14	3	6/7/2010	1	1	2	H		
9092077	30	1	6/7/2010	2	1	1	H		
9092077	30	2	6/7/2010	2	2	2	H		
9092077	30	3	6/7/2010	2	2	2	H		
9092078	4	1	6/7/2010	1	1	1	A		
9092078	4	2	6/7/2010	2	1	2	H		
9092078	4	3	6/7/2010	1	1	2	H		turf
9092078	14	1	6/7/2010	2	1	1	H		
9092078	14	2	6/7/2010	2	2	2	H		
9092078	14	3	6/7/2010	2	1	1	H		
9092078	29	1	6/7/2010	1	1	2	H		
9092078	29	2	6/7/2010	1	1	2	H		turf
9092078	29	3	6/7/2010	1	2	2	H		
9092079	6	1	6/7/2010	1	2	2	H		
9092079	6	2	6/7/2010	2	1	2	H		
9092079	13	1	6/7/2010	2	1	3	H	diseased	
9092079	13	2	6/7/2010	1	1	1	H		
9092079	13	3	6/7/2010	2	1	2	H		
9092079	31	1	6/7/2010	2	2	2	A		
9092079	31	2	6/7/2010	1	2	2	H		
9092079	31	3	6/7/2010	2	1	1	H		
9092080	4	1	6/7/2010	1	1	2	H		
9092080	4	2	6/7/2010	2	1	1	H		
9092080	4	3	6/7/2010	3	2	2	H	diseased	
9092080	13	1	6/7/2010	2	2	2	H		
9092080	13	2	6/7/2010	1	2	1	H		turf
9092080	13	3	6/7/2010	2	2	2	A		
9092080	30	3	6/7/2010	2	1	1	H		
9092081	4	1	6/7/2010	3	2	3	H		
9092081	13	1	6/7/2010	2	2	1	H		
9092081	13	2	6/7/2010	2	2	2	H		
9092081	13	3	6/7/2010	2	2	3	H		

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092081	28	1	6/7/2010	2	2	2	H		
9092081	28	2	6/7/2010	2	2	2	H		
9092081	28	3	6/7/2010	2	2	1	H		turf
9092082	2	1	6/7/2010	2	2	3	H	diseased	
9092082	2	2	6/7/2010	3	3	2	H		
9092082	2	3	6/7/2010	1	1	2	H		
9092082	13	1	6/7/2010	1	2	2	H		
9092082	13	3	6/7/2010	1	1	1	H		forage
9092082	26	1	6/7/2010	1	2	2	H		
9092082	26	2	6/7/2010	1	2	1	H		
9092082	26	3	6/7/2010	1	1	1	H		
9092083	1	1	6/7/2010	1	1	2	H		
9092083	1	2	6/7/2010	2	2	2	H		
9092083	1	3	6/7/2010	3	3	3	H		
9092083	13	1	6/7/2010	2	2	2	H		
9092083	13	2	6/7/2010	2	1	2	H		
9092083	13	3	6/7/2010	2	1	2	H		
9092083	28	1	6/7/2010	1	1	2	H		
9092083	28	2	6/7/2010	1	2	1	H		forage
9092083	28	3	6/7/2010	1	2	2	H		
9092084	2	2	6/7/2010	1	1	1	H		forage
9092084	2	3	6/7/2010	2	2	3	H		
9092084	19	1	6/7/2010	1	2	2	H		
9092084	19	2	6/7/2010	2	2	2	H	leaf disease	
9092084	19	3	6/7/2010	2	2	2	H		
9092084	23	1	6/7/2010	1	2	2	H		
9092084	23	2	6/7/2010	3	3	3	H		
9092084	23	3	6/7/2010	1	1	1	H		
9092085	8	1	6/7/2010	2	2	2	H		
9092085	8	2	6/7/2010	2	3	2	H	Insects	
9092085	8	3	6/7/2010	3	3	3	H		
9092085	19	1	6/7/2010	2	2	1	H		
9092085	19	2	6/7/2010	2	1	1	H		forage
9092085	19	3	6/7/2010	2	2	2	H	insects and disease	
9092085	22	1	6/7/2010	2	2	2	H		
9092085	22	2	6/7/2010	2	3	3	H		
9092085	22	3	6/7/2010	2	1	2	H		
9092086	8	1	6/7/2010	2	2	2	H		
9092086	8	2	6/7/2010	2	2	1	H		
9092086	8	3	6/7/2010	2	3	3	H		
9092087	4	1	6/7/2010	2	1	1	H		
9092087	4	2	6/7/2010	2	2	3	H		
9092087	4	3	6/7/2010	1	2	1	H		
9092087	19	1	6/7/2010	2	2	2	H		
9092087	19	2	6/7/2010	2	2	2	H		

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092087	19	3	6/7/2010	2	1	1	H		
9092087	22	1	6/7/2010	2	2	2	H		
9092087	22	2	6/7/2010	3	3	2	H		
9092087	22	3	6/7/2010	3	3	3	H		
9092088	7	1	6/7/2010	1	2	3	H		
9092088	19	1	6/7/2010	1	1	1	H		
9092088	19	2	6/7/2010	2	2	1	H		
9092088	19	3	6/7/2010	2	2	2	H		
9092088	21	1	6/7/2010	2	2	2	H		
9092088	21	2	6/7/2010	2	1	1	H	bluegrass contaminant	
9092088	21	3	6/7/2010	2	2	2	H		
9092089	6	1	6/7/2010	3	3	3	H		
9092089	6	2	6/7/2010	3	3	3	H		
9092089	6	3	6/7/2010	3	1	2	H		turf
9092089	18	1	6/7/2010	2	1	1	H		
9092089	18	2	6/7/2010	3	3	3	H		
9092089	18	3	6/7/2010	2	2	2	H		
9092089	24	1	6/7/2010	2	1	2	H		
9092089	24	2	6/7/2010	1	1	1	H		turf
9092089	24	3	6/7/2010	2	1	1	H		
9092090	7	1	6/7/2010	2	2	1	H		
9092090	7	2	6/7/2010	1	1	1	H		forage
9092090	7	3	6/7/2010	1	1	1	H		
9092090	18	1	6/7/2010	2	1	2	H		
9092090	18	2	6/7/2010	1	1	2	H		
9092090	18	3	6/7/2010	2	2	2	H		
9092090	25	1	6/7/2010	2	1	2	H		
9092090	25	2	6/7/2010	2	1	1	H		
9092090	25	3	6/7/2010	2	1	2	H		
9092091	3	1	6/7/2010	1	1	1	H	upright	
9092091	3	2	6/7/2010	2	2	2	H		
9092091	3	3	6/7/2010	2	1	2	H		
9092091	17	1	6/7/2010	1	1	2	H	diseased	
9092091	17	2	6/7/2010	3	3	2	V		
9092091	17	3	6/7/2010	3	2	2	H		
9092091	27	1	6/7/2010	1	1	1	H		
9092091	27	2	6/7/2010	2	1	2	H		turf
9092091	27	3	6/7/2010	1	1	1	H		
9092092	6	1	6/7/2010	2	3	3	H		
9092092	6	2	6/7/2010	2	1	2	H		
9092092	6	3	6/7/2010	2	3	2	H		
9092092	17	1	6/7/2010	2	2	1	H	leafy turf type	turf
9092092	17	3	6/7/2010	1	1	2	H		
9092092	31	1	6/7/2010	0	0	0	X		

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092092	31	3	6/7/2010	0	0	0	X		
9092093	3	1	6/7/2010	1	2	3	H		
9092093	3	2	6/7/2010	2	2	3	H		
9092093	3	3	6/7/2010	1	1	2	H		
9092093	17	1	6/7/2010	1	2	2	H		forage
9092093	17	2	6/7/2010	2	2	2	H		
9092093	17	3	6/7/2010	2	2	2	H		
9092093	29	1	6/7/2010	2	2	2	H		
9092093	29	2	6/7/2010	2	1	1	H		
9092093	29	3	6/7/2010	1	1	2	H		
9092095	6	1	6/7/2010	1	2	2	H		
9092095	6	2	6/7/2010	2	2	2	H		
9092095	17	1	6/7/2010	2	2	2	H		
9092095	17	2	6/7/2010	2	3	2	H		
9092095	17	3	6/7/2010	2	2	3	H		
9092095	31	1	6/7/2010	1	2	1	H		
9092095	31	2	6/7/2010	3	3	2	H		
9092095	31	3	6/7/2010	2	3	3	H		
9092097	5	1	6/7/2010	3	1	2	H		
9092097	17	1	6/7/2010	2	2	2	H		
9092097	17	2	6/7/2010	2	1	2	H		
9092097	17	3	6/7/2010	2	2	2	H		
9092097	27	1	6/7/2010	2	1	2	H		
9092097	27	2	6/7/2010	2	2	2	H		
9092097	27	3	6/7/2010	2	2	2	H		
9092098	8	1	6/7/2010	2	2	2	H		
9092098	8	2	6/7/2010	2	1	1	H		
9092098	8	3	6/7/2010	3	2	3	H		
9092098	14	1	6/7/2010	2	2	2	H		
9092098	14	2	6/7/2010	3	2	2	H		
9092098	14	3	6/7/2010	3	2	2	H		
9092098	26	1	6/7/2010	2	1	1	H		
9092098	26	2	6/7/2010	2	2	2	H		
9092098	26	3	6/7/2010	2	1	1	H		
9092099	5	1	6/7/2010	2	2	3	H		
9092099	5	2	6/7/2010	3	3	3	H		
9092099	5	3	6/7/2010	2	3	3	H		
9092099	14	1	6/7/2010	2	2	3	H		
9092099	14	2	6/7/2010	2	2	2	H		
9092099	14	3	6/7/2010	2	2	2	H		
9092099	24	1	6/7/2010	2	1	2	H		
9092099	24	2	6/7/2010	2	1	1	H		
9092099	24	3	6/7/2010	2	2	2	H		
9092100	7	1	6/7/2010	2	3	3	H		
9092100	7	2	6/7/2010	2	2	2	H		

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092100	7	3	6/7/2010	0	0	0	X		
9092100	14	1	6/7/2010	2	2	2	H		
9092100	14	2	6/7/2010	2	2	2	H		
9092100	14	3	6/7/2010	2	2	2	H		
9092100	22	1	6/7/2010	2	1	1	H		
9092100	22	2	6/7/2010	2	1	1	H		
9092100	22	3	6/7/2010	2	2	2	H		
9092101	1	2	6/7/2010	1	2	2	H		
9092101	1	3	6/7/2010	2	2	1	H		
9092101	14	1	6/7/2010	1	1	1	H		
9092101	14	2	6/7/2010	2	2	1	H		
9092101	14	3	6/7/2010	2	2	1	H		
9092101	27	1	6/7/2010	1	1	2	H		
9092101	27	2	6/7/2010	1	2	2	H		
9092101	27	3	6/7/2010	1	1	2	H		
9092102	1	1	6/7/2010	2	2	2	H	some disease	
9092102	1	2	6/7/2010	3	3	3	H		
9092102	14	1	6/7/2010	2	2	2	H		
9092102	14	2	6/7/2010	2	3	1	V	veg, no heads	
9092102	14	3	6/7/2010	2	2	2	B		
9092102	29	1	6/7/2010	1	1	1	H		
9092102	29	2	6/7/2010	1	1	1	H		forage
9092102	29	3	6/7/2010	2	2	1	H		turf
9092103	3	1	6/7/2010	2	2	3	H		
9092103	3	2	6/7/2010	1	1	2	H		
9092103	3	3	6/7/2010	2	2	3	H		
9092103	15	1	6/7/2010	1	1	2	H		
9092103	15	2	6/7/2010	2	2	2	H		
9092103	15	3	6/7/2010	2	1	2	H	diseased	
9092103	27	1	6/7/2010	1	1	2	H		
9092103	27	2	6/7/2010	1	1	1	H		
9092103	27	3	6/7/2010	1	2	2	H		
9092104	5	1	6/7/2010	1	2	2	H		
9092104	5	3	6/7/2010	2	2	1	H		
9092104	15	1	6/7/2010	2	2	1	H		
9092104	15	2	6/7/2010	2	1	1	H		
9092104	15	3	6/7/2010	2	2	1	H		
9092104	29	1	6/7/2010	2	1	2	H		
9092104	29	2	6/7/2010	1	1	1	H		forage
9092104	29	3	6/7/2010	1	1	1	H		
9092105	3	2	6/7/2010	3	3	3	H		
9092105	3	3	6/7/2010	2	1	2	H		
9092105	16	1	6/7/2010	2	2	2	H		
9092105	16	2	6/7/2010	2	2	2	H		
9092105	16	3	6/7/2010	2	2	2	H		

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092105	25	1	6/7/2010	1	2	2	H		
9092105	25	2	6/7/2010	1	2	2	H		
9092105	25	3	6/7/2010	1	1	2	H		
9092106	3	1	6/7/2010	2	3	3	H		
9092106	3	3	6/7/2010	2	2	2	H		
9092106	16	1	6/7/2010	2	2	2	H		
9092106	16	2	6/7/2010	2	2	2	H		
9092106	16	3	6/7/2010	2	2	2	H		
9092106	23	1	6/7/2010	2	1	2	H		
9092106	23	2	6/7/2010	2	3	3	H		
9092106	23	3	6/7/2010	2	2	2	H		
9092107	5	1	6/7/2010	1	1	2	H		
9092107	5	2	6/7/2010	1	2	2	H		
9092107	5	3	6/7/2010	1	1	1	H	diseased	
9092107	16	1	6/7/2010	2	2	2	H		
9092107	16	2	6/7/2010	2	2	1	H		
9092107	16	3	6/7/2010	2	2	2	H		
9092107	28	1	6/7/2010	1	2	1	H		
9092107	28	3	6/7/2010	2	1	2	H		
9092108	5	1	6/7/2010	1	2	2	H		
9092108	5	2	6/7/2010	1	1	2	H		
9092108	5	3	6/7/2010	1	1	1	H		turf
9092108	16	1	6/7/2010	2	2	2	H		
9092108	16	2	6/7/2010	2	1	2	H		
9092108	25	1	6/7/2010	1	1	2	H		
9092108	25	2	6/7/2010	1	2	2	H		
9092108	25	3	6/7/2010	2	2	2	H		
9092109	5	1	6/7/2010	1	2	2	H		forage
9092109	5	2	6/7/2010	2	2	2	H	insects	
9092109	5	3	6/7/2010	1	2	2	H		
9092109	16	1	6/7/2010	1	2	1	H		
9092109	16	2	6/7/2010	1	1	2	H		
9092109	16	3	6/7/2010	2	1	1	H		
9092109	27	1	6/7/2010	1	1	1	H		forage
9092109	27	2	6/7/2010	1	1	2	H		
9092109	27	3	6/7/2010	1	1	2	H		
9092110	5	1	6/7/2010	2	3	3	H	partially dead	
9092110	5	2	6/7/2010	2	2	2	H		
9092110	5	3	6/7/2010	0	0	0	X		
9092110	17	1	6/7/2010	2	2	2	H		
9092110	17	2	6/7/2010	1	1	2	H		
9092110	17	3	6/7/2010	1	1	2	H		
9092110	30	2	6/7/2010	2	2	3	H		
9092110	30	3	6/7/2010	2	1	2	H		
9092111	2	1	6/7/2010	1	3	3	H		

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092111	2	3	6/7/2010	2	1	1	H	diseased	
9092111	17	1	6/7/2010	2	2	3	H		
9092111	17	2	6/7/2010	2	1	1	H	Insects	
9092111	17	3	6/7/2010	2	2	3	H		
9092111	30	1	6/7/2010	2	2	2	H		
9092111	30	2	6/7/2010	1	2	2	H		
9092111	30	3	6/7/2010	1	1	2	H		
9092112	7	2	6/7/2010	2	3	3	H		
9092112	19	1	6/7/2010	2	2	3	H		
9092112	19	2	6/7/2010	2	2	2	H		
9092112	19	3	6/7/2010	2	2	2	H		
9092112	22	1	6/7/2010	1	1	2	H		
9092112	22	2	6/7/2010	3	3	3	H	partially dead	
9092113	10	1	6/7/2010	2	2	2	H		
9092113	10	2	6/7/2010	2	1	1	A		
9092113	10	3	6/7/2010	3	3	3	A		
9092113	19	1	6/7/2010	2	2	2	H		
9092113	19	2	6/7/2010	2	2	2	H		
9092113	29	1	6/7/2010	1	1	1	H		
9092113	29	2	6/7/2010	1	1	1	H		
9092114	10	1	6/7/2010	2	3	2	H		
9092114	10	3	6/7/2010	2	1	1	H		forage
9092114	18	1	6/7/2010	1	1	2	H		
9092114	18	2	6/7/2010	2	2	2	H		
9092114	18	3	6/7/2010	2	1	1	H		forage
9092114	31	1	6/7/2010	1	1	1	H		
9092114	31	2	6/7/2010	1	1	2	H		
9092114	31	3	6/7/2010	1	1	1	H		
9092115	10	1	6/7/2010	2	2	2	H		
9092115	10	2	6/7/2010	2	1	2	H		
9092115	10	3	6/7/2010	2	1	2	H		
9092115	18	1	6/7/2010	1	2	2	H		
9092115	18	3	6/7/2010	2	3	3	H		
9092115	30	1	6/7/2010	2	2	2	H		
9092115	30	2	6/7/2010	1	1	1	H		
9092115	30	3	6/7/2010	2	1	1	H		
9092116	10	1	6/7/2010	1	1	1	H		
9092116	10	2	6/7/2010	1	1	2	H		
9092116	10	3	6/7/2010	2	2	2	H		
9092116	20	1	6/7/2010	1	2	1	H	turf type	
9092116	20	2	6/7/2010	2	1	1	H		
9092116	20	3	6/7/2010	2	1	1	H		
9092116	27	3	6/7/2010	1	1	3	H		
9092117	10	1	6/7/2010	1	1	2	H		
9092117	10	2	6/7/2010	2	2	2	H	diseased	

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092117	10	3	6/7/2010	2	2	2	H		
9092117	20	1	6/7/2010	2	2	2	H		
9092117	20	3	6/7/2010	1	2	2	H		
9092117	24	1	6/7/2010	2	2	2	H		
9092117	24	2	6/7/2010	1	1	2	H		
9092117	24	3	6/7/2010	3	2	2	H		
9092118	9	1	6/7/2010	2	3	3	H		
9092118	9	2	6/7/2010	2	1	1	H		turf
9092118	9	3	6/7/2010	1	2	2	H		
9092118	20	1	6/7/2010	1	1	2	H		forage
9092118	20	2	6/7/2010	1	2	1	H		
9092118	20	3	6/7/2010	2	3	2	H		
9092118	26	1	6/7/2010	1	2	2	H		
9092118	26	2	6/7/2010	1	1	1	H		
9092118	26	3	6/7/2010	2	2	2	H		
9092119	6	2	6/7/2010	2	1	2	H		
9092119	6	3	6/7/2010	2	2	2	H		
9092119	19	1	6/7/2010	2	2	2	H		
9092119	19	2	6/7/2010	1	2	1	H		
9092119	19	3	6/7/2010	1	1	2	H		
9092119	24	1	6/7/2010	1	1	1	H		
9092119	24	2	6/7/2010	1	2	2	H		
9092119	24	3	6/7/2010	1	1	1	H		
9092120	4	1	6/7/2010	2	2	2	H		
9092120	4	2	6/7/2010	2	2	2	H		
9092120	4	3	6/7/2010	2	3	3	H		
9092120	19	1	6/7/2010	2	1	2	H		
9092120	19	2	6/7/2010	2	1	1	H		
9092120	19	3	6/7/2010	2	2	3	H	diseased	
9092120	26	1	6/7/2010	3	3	2	H		
9092120	26	2	6/7/2010	1	1	2	H		
9092120	26	3	6/7/2010	2	1	2	H		
9092121	19	1	6/7/2010	2	2	1	H		forage
9092121	19	2	6/7/2010	2	2	2	H		
9092121	19	3	6/7/2010	2	2	2	H	Insects	
9092121	23	1	6/7/2010	2	3	3	H		
9092121	23	2	6/7/2010	2	2	3	H		
9092121	23	3	6/7/2010	2	3	3	H		
9092123	11	1	6/7/2010	2	2	2	H		
9092123	11	2	6/7/2010	2	2	2	H		
9092123	11	3	6/7/2010	2	2	2	H		
9092123	15	1	6/7/2010	2	2	2	H		turf
9092124	7	1	6/7/2010	2	2	3	H		
9092124	7	3	6/7/2010	2	3	3	H		
9092124	15	1	6/7/2010	1	2	2	H		

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092124	15	2	6/7/2010	1	2	2	H		
9092124	15	3	6/7/2010	2	2	2	H		
9092124	31	2	6/7/2010	2	3	3	H		
9092124	31	3	6/7/2010	1	1	2	H		
9092125	5	1	6/7/2010	1	2	2	H		
9092125	5	2	6/7/2010	1	2	1	H		
9092125	5	3	6/7/2010	1	1	1	H		
9092125	15	1	6/7/2010	3	2	3	H		
9092125	15	2	6/7/2010	1	2	2	H		
9092125	15	3	6/7/2010	3	3	3	H		
9092125	31	1	6/7/2010	1	2	3	H		
9092125	31	2	6/7/2010	2	2	1	H		
9092125	31	3	6/7/2010	2	2	2	H		
9092126	3	1	6/7/2010	2	1	2	H		
9092126	3	2	6/7/2010	3	3	3	H		
9092126	15	1	6/7/2010	2	2	1	H		
9092126	15	3	6/7/2010	2	2	2	H		
9092126	30	1	6/7/2010	2	1	2	H		
9092126	30	2	6/7/2010	2	2	2	H		
9092126	30	3	6/7/2010	1	1	2	H		
9092133	1	1	6/7/2010	3	3	3	H	almost dead	
9092133	1	3	6/7/2010	2	2	2	H		
9092133	11	1	6/7/2010	2	1	1	H		
9092133	11	2	6/7/2010	1	1	1	H	nice plant	turf
9092133	11	3	6/7/2010	2	2	1	H		turf
9092133	25	1	6/7/2010	2	1	3	H		
9092134	1	2	6/7/2010	3	3	3	H		
9092134	11	1	6/7/2010	2	3	3	H		
9092134	11	2	6/7/2010	0	0	0	X		
9092134	11	3	6/7/2010	3	2	2	H		
9092134	23	1	6/7/2010	1	2	2	H		
9092135	1	2	6/7/2010	1	1	1	H		turf
9092135	1	3	6/7/2010	1	2	2	H		
9092135	11	2	6/7/2010	1	1	1	H	partially dead	
9092135	11	3	6/7/2010	2	1	2	H		
9092135	28	1	6/7/2010	1	1	1	H		
9092135	28	2	6/7/2010	1	2	2	H		
9092136	1	1	6/7/2010	2	3	2	H		
9092136	1	3	6/7/2010	2	3	3	H		
9092136	12	1	6/7/2010	2	2	2	H		
9092136	12	2	6/7/2010	2	1	2	H		
9092136	12	3	6/7/2010	3	3	3	H	almost dead	
9092136	22	1	6/7/2010	2	2	2	H		
9092136	22	2	6/7/2010	3	3	2	H		
9092136	22	3	6/7/2010	3	2	2	H		

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092177	9	1	6/7/2010	2	2	2	H		
9092177	9	2	6/7/2010	1	2	2	H		
9092177	9	3	6/7/2010	2	2	2	H		
9092177	12	1	6/7/2010	1	1	1	H		
9092177	12	2	6/7/2010	1	2	1	H		forage
9092177	12	3	6/7/2010	2	2	2	H		
9092177	24	1	6/7/2010	1	2	2	H		forage
9092177	24	2	6/7/2010	2	3	3	H		
9092177	24	3	6/7/2010	1	1	1	H		
9092178	9	1	6/7/2010	2	2	1	H		
9092178	9	2	6/7/2010	2	2	2	H		
9092178	9	3	6/7/2010	2	2	2	H	thrips	
9092178	11	1	6/7/2010	1	2	2	H		
9092178	11	2	6/7/2010	1	2	2	H		
9092178	11	3	6/7/2010	2	2	2	H		
9092178	28	1	6/7/2010	1	1	2	H		
9092178	28	2	6/7/2010	1	2	2	H		
9092178	28	3	6/7/2010	1	2	2	H		
9092179	10	1	6/7/2010	2	2	2	H		
9092179	10	2	6/7/2010	2	2	2	H	diseased	
9092179	10	3	6/7/2010	2	2	3	H	diseased	
9092179	12	1	6/7/2010	2	1	2	H		
9092179	12	2	6/7/2010	2	1	1	H	diseased	
9092179	29	1	6/7/2010	1	1	1	H		
9092179	29	2	6/7/2010	1	2	2	H		
9092179	29	3	6/7/2010	2	2	2	H		
9092180	3	2	6/7/2010	2	2	2	H		
9092180	3	3	6/7/2010	3	3	3	H		
9092180	16	1	6/7/2010	2	2	2	H		
9092180	16	2	6/7/2010	1	1	1	H		forage
9092180	16	3	6/7/2010	2	3	3	H		
9092180	27	1	6/7/2010	2	2	2	H		
9092180	27	2	6/7/2010	2	2	3	H		
9092180	27	3	6/7/2010	3	3	3	H		
9092181	8	1	6/7/2010	3	3	3	H		
9092181	8	2	6/7/2010	1	1	2	H	nice plant	
9092181	8	3	6/7/2010	2	2	2	H		
9092181	16	1	6/7/2010	3	2	3	H		
9092181	16	2	6/7/2010	1	1	2	H		
9092181	16	3	6/7/2010	2	2	3	H		
9092181	31	1	6/7/2010	1	1	2	H		
9092182	2	1	6/7/2010	1	2	2	A		
9092182	16	1	6/7/2010	1	1	1	H	nice plant	
9092182	16	3	6/7/2010	1	1	1	H		
9092182	22	1	6/7/2010	1	1	2	A		

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092182	22	2	6/7/2010	1	1	1	A		
9092182	22	3	6/7/2010	1	1	1	A		
9092183	4	1	6/7/2010	3	2	2	A		turf
9092183	4	3	6/7/2010	2	2	3	A		
9092183	20	1	6/7/2010	1	1	2	H	Insects	
9092183	20	2	6/7/2010	2	2	2	H		
9092183	31	1	6/7/2010	2	2	2	H		
9092183	31	2	6/7/2010	1	1	2	A		
9092184	7	1	6/7/2010	1	1	1	H		
9092184	7	3	6/7/2010	1	1	1	A		
9092184	20	2	6/7/2010	1	2	1	A		
9092184	20	3	6/7/2010	1	2	2	H		
9092184	28	2	6/7/2010	1	1	2	A		
9092185	6	1	6/7/2010	2	1	2	H		
9092185	6	2	6/7/2010	1	1	2	H		
9092185	6	3	6/7/2010	3	2	2	H		
9092185	20	1	6/7/2010	3	2	1	H		
9092185	20	2	6/7/2010	2	1	2	H	Insects	
9092185	20	3	6/7/2010	3	3	2	A		
9092185	28	1	6/7/2010	2	2	2	A		
9092185	28	2	6/7/2010	1	1	1	A		
9092185	28	3	6/7/2010	1	2	2	A		
9092186	9	3	6/7/2010	1	1	1	H	thrips	
9092186	20	1	6/7/2010	1	3	3	H		
9092186	20	3	6/7/2010	1	1	1	H		
9092186	22	1	6/7/2010	1	1	2	H		
9092186	22	2	6/7/2010	1	1	1	H		
9092186	22	3	6/7/2010	1	1	1	H		
9092187	8	1	6/7/2010	2	1	2	H		
9092187	8	2	6/7/2010	2	1	1	H		
9092187	8	3	6/7/2010	2	1	1	H	thrips	
9092187	18	1	6/7/2010	2	2	2	H		
9092187	18	2	6/7/2010	2	2	2	H		
9092187	18	3	6/7/2010	1	1	2	H		forage
9092187	25	1	6/7/2010	1	1	1	H		
9092187	25	2	6/7/2010	1	1	2	H		
9092187	25	3	6/7/2010	2	2	2	H		
9092188	8	1	6/7/2010	2	1	1	H		
9092188	8	3	6/7/2010	2	1	1	H	fine heads	
9092188	18	1	6/7/2010	2	1	1	B		
9092188	18	2	6/7/2010	3	1	2	H		
9092188	18	3	6/7/2010	2	2	3	H		
9092188	26	1	6/7/2010	3	2	1	H		
9092189	18	1	6/7/2010	3	1	1	H		turf
9092189	18	2	6/7/2010	3	2	2	H		

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092189	18	3	6/7/2010	2	2	1	H		
9092189	25	1	6/7/2010	2	2	2	H		
9092189	25	2	6/7/2010	2	2	2	H		
9092189	25	3	6/7/2010	3	3	3	H		
9092190	4	1	6/7/2010	2	3	3	H		
9092190	4	2	6/7/2010	3	3	3	A		
9092190	18	1	6/7/2010	1	2	2	H		
9092190	18	2	6/7/2010	2	2	2	H		
9092190	18	3	6/7/2010	2	2	3	H		
9092190	21	1	6/7/2010	2	1	1	H		
9092190	21	2	6/7/2010	3	2	3	H	Insects	
9092190	21	3	6/7/2010	2	2	3	H		
9092191	1	1	6/7/2010	1	3	3	A		
9092191	1	2	6/7/2010	1	1	2	H		
9092191	18	1	6/7/2010	1	2	2	H		
9092191	18	2	6/7/2010	1	2	2	H		
9092191	18	3	6/7/2010	1	2	1	H		
9092191	24	1	6/7/2010	1	2	2	A		
9092191	24	2	6/7/2010	2	2	2	H		
9092191	24	3	6/7/2010	2	1	2	H		
9092192	3	1	6/7/2010	1	2	2	H		
9092192	17	1	6/7/2010	2	2	3	H		
9092192	17	2	6/7/2010	2	2	3	H		
9092192	17	3	6/7/2010	2	1	1	H		
9092192	30	1	6/7/2010	1	1	1	H		forage
9092192	30	2	6/7/2010	2	2	2	H		
9092192	30	3	6/7/2010	1	1	1	H		
9092193	2	3	6/7/2010	1	2	2	H		
9092193	17	1	6/7/2010	3	2	2	H		
9092193	17	2	6/7/2010	3	2	2	H	Insects	
9092193	17	3	6/7/2010	2	2	2	H		
9092193	29	1	6/7/2010	1	2	1	H		
9092193	29	2	6/7/2010	2	1	1	H		
9092193	29	3	6/7/2010	2	1	2	H		
9092194	5	1	6/7/2010	2	1	2	H		
9092194	5	2	6/7/2010	2	2	1	H		
9092194	5	3	6/7/2010	2	2	3	H		
9092194	16	1	6/7/2010	3	2	2	H		
9092194	16	2	6/7/2010	3	2	1	H		
9092194	16	3	6/7/2010	1	1	1	H		
9092194	25	1	6/7/2010	1	1	1	H		turf
9092194	25	2	6/7/2010	1	1	1	H		forage
9092194	25	3	6/7/2010	2	1	1	H		
9092195	6	1	6/7/2010	1	2	2	H		
9092195	6	2	6/7/2010	3	3	3	H		

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092195	6	3	6/7/2010	2	1	1	H	upright, nice plant	
9092195	15	1	6/7/2010	1	1	1	H	thrips	forage
9092195	15	2	6/7/2010	3	2	2	H		
9092195	15	3	6/7/2010	2	2	2	H		
9092195	22	1	6/7/2010	2	1	1	H		
9092195	22	2	6/7/2010	1	2	1	H	very leafy	
9092195	22	3	6/7/2010	2	1	1	H		
9092196	7	1	6/7/2010	1	2	2	H		
9092196	7	2	6/7/2010	3	3	2	H		
9092196	7	3	6/7/2010	2	2	1	H		
9092196	15	1	6/7/2010	2	2	2	H		turf
9092196	15	2	6/7/2010	2	1	2	H		
9092196	15	3	6/7/2010	2	2	2	H		
9092196	30	1	6/7/2010	2	2	2	H		
9092196	30	2	6/7/2010	2	1	1	H		
9092196	30	3	6/7/2010	1	1	2	H		
9092197	8	1	6/7/2010	2	3	3	H		
9092197	8	3	6/7/2010	1	1	1	H		forage
9092197	15	1	6/7/2010	2	2	1	H		
9092197	15	2	6/7/2010	2	1	1	H		
9092197	15	3	6/7/2010	2	1	2	H		
9092197	24	1	6/7/2010	1	1	2	H		
9092197	24	2	6/7/2010	2	2	2	H		
9092197	24	3	6/7/2010	1	1	1	H		
9092198	9	1	6/7/2010	2	2	2	H		
9092198	9	2	6/7/2010	1	2	2	H		
9092198	21	1	6/7/2010	2	2	2	H		
9092198	21	2	6/7/2010	2	2	3	H		
9092198	21	3	6/7/2010	2	1	1	H		
9092198	28	1	6/7/2010	2	2	1	H		
9092198	28	2	6/7/2010	2	2	1	H		
9092198	28	3	6/7/2010	2	2	2	H		
9092199	9	1	6/7/2010	1	1	1	H		forage
9092199	9	2	6/7/2010	1	1	1	H		turf
9092199	9	3	6/7/2010	2	1	1	H		
9092199	21	1	6/7/2010	1	2	1	H	Insects	
9092199	21	2	6/7/2010	2	2	2	H		
9092199	23	1	6/7/2010	3	3	2	H		
9092199	23	2	6/7/2010	2	1	2	H		
9092199	23	3	6/7/2010	1	1	2	H		
9092200	9	1	6/7/2010	2	2	2	H		
9092200	9	2	6/7/2010	3	3	3	H		
9092200	9	3	6/7/2010	1	2	2	H		
9092200	21	1	6/7/2010	2	1	2	H		turf
9092200	21	2	6/7/2010	2	2	1	H		

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092200	21	3	6/7/2010	2	2	2	H		
9092200	26	1	6/7/2010	1	1	1	H		forage
9092200	26	2	6/7/2010	2	1	2	H		
9092200	26	3	6/7/2010	2	2	1	H		
9092201	10	1	6/7/2010	3	1	2	H		
9092201	10	2	6/7/2010	2	2	2	H		
9092201	10	3	6/7/2010	3	1	1	H	turf type	turf
9092201	12	1	6/7/2010	2	2	3	H		
9092201	12	2	6/7/2010	2	1	1	H		
9092201	12	3	6/7/2010	2	1	1	H	turf type	turf
9092201	26	1	6/7/2010	2	2	2	H		
9092201	26	2	6/7/2010	1	1	1	H		
9092202	11	1	6/7/2010	1	2	1	H		
9092202	11	2	6/7/2010	2	3	3	H	Insects	
9092202	11	3	6/7/2010	2	1	2	H	diseased	
9092202	12	1	6/7/2010	1	1	2	H		
9092202	12	2	6/7/2010	1	2	2	H		
9092202	12	3	6/7/2010	1	2	3	H		
9092202	27	1	6/7/2010	2	2	2	H		
9092202	27	2	6/7/2010	2	2	2	H		
9092202	27	3	6/7/2010	2	1	1	H		
9092203	11	1	6/7/2010	2	2	3	H		
9092203	11	2	6/7/2010	1	2	2	H	Insects	
9092203	11	3	6/7/2010	2	2	2	H		
9092203	12	1	6/7/2010	2	2	2	H		
9092203	12	2	6/7/2010	3	3	3	H	almost dead	
9092203	12	3	6/7/2010	1	2	2	H		
9092203	30	1	6/7/2010	1	1	1	H		
9092203	30	2	6/7/2010	2	1	1	H		
9092203	30	3	6/7/2010	2	1	2	H		
9092204	11	1	6/7/2010	2	1	1	H		
9092204	11	2	6/7/2010	2	2	2	H		
9092204	11	3	6/7/2010	2	1	1	H		
9092204	12	2	6/7/2010	2	3	2	H		
9092204	12	3	6/7/2010	2	1	1	H		forage
9092204	31	1	6/7/2010	2	2	2	H		
9092205	10	1	6/7/2010	2	2	1	H		
9092205	10	2	6/7/2010	2	1	1	H		
9092205	10	3	6/7/2010	2	2	2	H		
9092205	12	1	6/7/2010	2	2	3	H		
9092205	12	2	6/7/2010	1	2	1	H		
9092205	12	3	6/7/2010	1	1	1	H	turf type	
9092205	23	1	6/7/2010	1	1	1	H		
9092205	23	3	6/7/2010	1	1	1	H		
9092206	10	1	6/7/2010	2	2	2	H		

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092206	10	2	6/7/2010	1	1	1	H	upright	
9092206	10	3	6/7/2010	2	2	1	H		
9092206	12	1	6/7/2010	2	2	2	H	Insects	
9092206	12	2	6/7/2010	1	2	1	H		
9092206	12	3	6/7/2010	2	1	1	H	Insects	
9092206	27	1	6/7/2010	3	3	3	V		
9092206	27	2	6/7/2010	2	2	2	A		
9092206	27	3	6/7/2010	3	3	3	H		
9092207	7	1	6/7/2010	2	3	3	H		
9092207	7	2	6/7/2010	1	1	2	A		
9092207	7	3	6/7/2010	2	2	2	H		
9092207	13	1	6/7/2010	1	2	2	H		
9092207	13	2	6/7/2010	2	1	2	H		
9092207	13	3	6/7/2010	2	2	2	H		
9092207	29	1	6/7/2010	2	2	2	H		
9092207	29	2	6/7/2010	1	2	2	H		
9092207	29	3	6/7/2010	2	2	2	H		
9092208	4	1	6/7/2010	2	2	2	H		
9092208	4	2	6/7/2010	2	2	1	B		
9092208	13	1	6/7/2010	2	2	2	H		
9092208	13	2	6/7/2010	1	2	2	H		
9092208	13	3	6/7/2010	2	1	1	H		
9092208	24	1	6/7/2010	2	2	3	H		
9092208	24	2	6/7/2010	2	2	1	H		
9092208	24	3	6/7/2010	2	2	1	H		
9092209	2	1	6/7/2010	2	2	1	H		
9092209	2	2	6/7/2010	2	3	3	H		
9092209	2	3	6/7/2010	2	1	2	H	diseased	
9092209	13	1	6/7/2010	2	2	1	H		
9092209	13	2	6/7/2010	2	2	2	H		
9092209	13	3	6/7/2010	1	1	1	H		
9092209	26	1	6/7/2010	2	2	1	H		
9092209	26	2	6/7/2010	1	2	2	H		
9092210	1	1	6/7/2010	2	3	3	H		
9092210	1	2	6/7/2010	1	1	2	H	upright	
9092210	1	3	6/7/2010	3	2	2	H		
9092210	13	2	6/7/2010	2	3	2	H	leaf disease	
9092210	13	3	6/7/2010	3	2	1	H	Insects	
9092210	29	1	6/7/2010	2	2	3	H		
9092210	29	2	6/7/2010	2	1	2	H		
9092211	9	1	6/7/2010	1	2	2	A		
9092211	9	3	6/7/2010	1	1	1	A		
9092211	14	1	6/7/2010	2	1	2	A		
9092211	14	2	6/7/2010	1	2	2	A		
9092211	23	1	6/7/2010	3	2	2	A		

Accession	Row	Plant	Date	* rating Height	** rating Culms	*** rating Leafiness	**** Maturity	Remarks	2011 Selection
9092211	23	2	6/7/2010	1	1	2	A		
9092211	23	3	6/7/2010	1	1	1	A		
9092214	3	1	6/7/2010	3	3	3	H		
9092214	3	2	6/7/2010	2	2	2	H		
9092214	3	3	6/7/2010	1	1	1	H		
9092214	11	1	6/7/2010	0	0	0	X		
9092214	11	2	6/7/2010	2	2	3	H		
9092214	11	3	6/7/2010	3	2	2	H		
9092214	24	1	6/7/2010	1	1	1	H		
9092214	24	2	6/7/2010	2	1	2	H		
9092214	24	3	6/7/2010	1	2	2	H		
9092225	9	1	6/7/2010	2	2	2	H		
9092225	9	2	6/7/2010	2	2	2	H		
9092225	9	3	6/7/2010	3	3	3	H		
9092225	14	1	6/7/2010	3	1	2	H		
9092225	14	2	6/7/2010	2	1	1	H		turf
9092225	14	3	6/7/2010	2	2	2	H		
9092225	25	1	6/7/2010	2	2	2	H		
9092225	25	2	6/7/2010	2	1	1	H		
9092225	25	3	6/7/2010	1	2	1	H		turf

ACTIVE STUDIES: TECHNICAL REPORT 2014

Study NDPMC-P-0601-RA

Study Title: Native Forbs/Legumes for Conservation
Fourwing saltbush *Atriplex canescens*

The study was DISCONTINUED in 2014. There is 100+ bulk pounds of seed of accession 9082680 that is being stored in the seed cooler at the Plant Materials Center. This is 2002-2013 seed harvests from field D-10 (deer fence). The fourwing saltbush plants were destroyed after seed harvest.

Introduction: Fourwing saltbush is a perennial shrub that offers potential for conservation plantings. It grows under low rainfall, can tolerate alkaline and saline conditions, and is palatable and nutritious to most livestock.

Objective: The purpose of this study is to evaluate adaptability and produce seed of this species. A South Dakota collection of this species will be evaluated. If the species proves adaptable and useful as a conservation plant, a public release will be the goal.

Cooperators: USDA, NRCS Plant Materials Center, Bismarck, North Dakota
USDA, ARS Northern Great Plains Research Service, Mandan, North Dakota

Description: Fourwing saltbush is a long-lived perennial shrub. It has a deep, extensive root system. It is an evergreen gray shrub that grows from 2-6 feet tall. It has many branches. Leaves are alternate, and narrowly oblong. Leaves are scurfy on both sides. Male and female flowers are on separate plants. Flowers are in spikes that form dense panicles. It blooms in late summer. Fruiting bracts have four flat wings from which the plant gets its name. It is palatable to browse and grazing animals. Other common names include fourwing shadscale, white greasewood, salt sage, box brush. Fourwing saltbush differs from Nuttall saltbush. Its most noticeable difference is its four wings on the fruit, as opposed to the warty bracts enclosing the fruit of Nuttall saltbush.

Distribution: Fourwing grows on a wide range of soils, from clays to sands, and can tolerate high lime and saline conditions. It is highly drought and heat tolerant. It is native from western North Dakota south to Texas and Mexico, and west to Washington.

Methods and Materials

The study is divided into four parts. These will be listed as:

1) Field Trial - PMC
2) Source Comparison Trial
3) Field Planting - Golden Valley County
4) Lincoln-Oakes Nursery Trial

The primary seed source being evaluated is accession 9082680 from South Dakota.

Seed Sources:
Accession 9082680 is an *Atriplex canescens*. Seed was collected from several plants at the SDSU Cottonwood Range and Livestock Research Center in Jackson County, South Dakota, by Ron Haigh in 1999. The collection site is in Major Land Resource Area 060A Pierre Shale Plains and Badlands. Its legal description is SE¼SW¼ Sec.16-T1S-R19E. Its latitude is 43º56’57” N and the longitude is 101º51’30” W. The seed was collected in an exclosure area that excluded cattle and wildlife. No other plants of the species are growing in the nearby vicinity except adjacent to the exclosure. These plants are grazed each year, and appear to have abundant regrowth each spring, according to Ron Haigh. A small envelope of seed was given to the PMC in 2000 by Scot Kronberg, USDA, ARS, Mandan, North Dakota. Seed was propagated in the greenhouse for the Field Trial - PMC and Source Comparison Trial. Seed produced from this accession in the Field Trial - PMC was distributed for Field Planting - Golden Valley County and to Lincoln-Oakes Nursery Trial.

Accession 9082855 Natrona is an *Atriplex canescens* selection from Wind River Seed Company, Manderson, WY. Seed was propagated in the greenhouse for a Source Comparison Trial. Seed was distributed for Field Planting - Golden Valley County.

Accession 346419 Wytana is an *Atriplex aptera* release from the Bridger, Montana PMC. Seed was propagated in the greenhouse for the Source Comparison Trial.

Propagation in the greenhouse was in cone-tainers™, using a soilless potting mix. Seed germinated with no pretreatment. Seedlings of all accessions were vigorous and growth was abundant. Plants were hardened off in a lath house prior to planting in the field.

See sections below for information related to each type of trial or planting.

1. Field Trial - PMC

This is located in Panel D10 inside deer fence. Seedlings (25-27) were planted from east to west in a single row on 5/24/2001. The plants were spaced approximately 2 feet apart. Conditions at the time of planting were dry. An additional 4 rows were planted on June 5, 2003, to the north of the 2001 planting. Spacing between the rows was approximately 7 feet. The field was relatively free of growing weeds at the time of planting.

Maintenance:

Weed Control: Hand weeding was done around plants. Thistles were spot sprayed and borders were sprayed with glyphosate. Spraying and mowing between rows has been used to control weeds since 2004. Primary weeds have been kochia, pigweed, lambsquarters, foxtail and some Canada thistle.

Residue Management: No residue was clipped after harvest in 2001, 2002, 2003, 2005, or 2007. Residue was clipped to a 4-8 inch height in November after harvest in 2004, 2006, 2008, 2009, and 2011. Residue from 2007 was clipped in early spring of 2008. After harvest in 2008, residue for the three north rows was clipped. The residue from 2010 was not clipped, and plants remained standing.

Seed Harvest:

Seed has been hand harvested from 2002-2012. Seed was harvested 10/24/2002 and in mid-October through November for all other years. Seed was harvested from a single 50-foot row in 2002 and 2003 and from all rows in 2004-2012.

Seed Cleaning:

2002: Pan screens, a hammer mill with the largest hole screen and a clipper office sized fanning mill with a blank screen on the bottom, 25/64 to 28/64 size screens on top.

2003: Office-sized debearder equipped with rubber corrugation covering the inside, and pan screens.

2004-2012: Debearder and fanning mill.

Evaluation:

Visual observations have been made on plant growth. Seed production has been recorded each year (Table FW-1) and forage quality was tested in 2002 (Table FW-2).

Forage Quality: Forage samples were collected for analysis on 11/6/2002. The tips of top and side branches were clipped on randomly selected plants. The length of the samples averaged 12-15 inches. The samples were then cut into two sections. The top 6 inches, including stem and leaf, were cut and bulked as a sample named TIPS6. Leaves were stripped from the lower remaining 6-9 inches of the original sample and named LF12. Samples were analyzed for ADF, NDF, and Crude Protein by Oscar E. Olson Biochemistry Laboratories at South Dakota State University.

2. Source Comparison Trial

A small trial to compare performance of different sources of fourwing saltbush was planted 6/12/2003. Five plants each of three accessions were planted on the north end of panel A in the previous IEP area. Seedlings were grown in the greenhouse and planted to the field on 6/12/2003. Row spacing was 6-7 feet apart. Spacing between plants in the row was approximately 4 feet. Accessions compared were 9082680 (South Dakota), Natrona (Wyoming) and Wytana (Montana). The southernmost row is the Wyoming source, the center row is

the South Dakota source, and the northernmost row is Wytana. Size data was collected on growth of each of the sources on 9/24/2003 and on 9/8/2004 (Table FW-3). The trial was removed in 2009.

3. Field Planting NDPMS-F-0808-RA - Golden Valley County; Cooperator: Scot Steele

Seed of 9082680 harvested from the Field Trial - PMC and Natrona, purchased from Wind River Seed, were distributed to the Beach, North Dakota, NRCS Field Office for a field planting trial. The Field Planting Number is NDPMS-F-0808-RA. It was seeded with a drill on 5/13/2008 as 20 percent of a range seeding mix in Golden Valley County. Each accession was seeded on 4-5 acres of the total seeding area. Data collection began in the fall of 2008 and will continue for 3-5 years.

4. Lincoln – Oakes Nursery Trial

Approximately 1.8 PLS pounds (3 bulk pounds) of 9082680 produced from the Field Trial - PMC was distributed to Lincoln-Oakes Nursery for production of seedlings. Seed was planted in late fall of 2008 in a field bed. The seeding failed to produce a stand.

Results and Discussion

1. Field Trial – PMC (Deer fence)

Plants in the field were vigorous and were 2-3 feet tall on 9/30/2001. Conditions were dry during the growing season of 2001. No seed was produced the first year of growth. Plants were vigorous in 2002. Height on 8/13/2002 averaged 40 inches for the leafy plants which are males. The females which make up about 1/3 of the plants were extremely heavy with seed pods and reached a height of 30 inches. The seed covering had a green tint at harvest, which was after a hard frost. Conditions in 2003 were very dry, but plants were again quite vigorous. Seedlings planted to extend the field in 2003 were not harvested in 2003. Seed production in 2005 was very poor. Plant residue had been clipped in 2004. The plants were large and woody at the time. It appears that the older the plant when residue is removed, the slower the regrowth. Seed production in 2006 was good and poor in 2007. Plants thought to be females in 2006 were flagged. Some of the flagged plants did not produce seed in 2007. It is not known if they produced pollen as a male plant instead, or if seed set was just poor. Seed production was good in 2008. Plants that did not have the 2007 residue removed produced seed, but were difficult to harvest. Seed production in 2009 was very good and plants were vigorous. Harvests in 2011, 2012, and 2013 were fair. Fewer plants remain in the trial. Gophers and herbicide may have contributed to plants dying. Clipping residue every year or every other year produced the greatest seed harvests. Plants were less woody with only one year of growth. Table FW-1 lists amount of seed harvested each year. Currently, no mechanical harvest method has been found. This is the greatest challenge in seed production. The plants were removed and destroyed in 2014. The field was leveled.

2. Source Comparison Trial

Data collected on 9/24/2003 indicated differences in growth form among the three accessions (see Table FW-3). Overall, plants of Wyoming origin (9082855) were more upright and had less lateral spread and branching than the South Dakota source (9082680). Wytana was not vigorous and showed little growth in 2003. Plants continued to display these growth habits from 2004-2008. The South Dakota source remained slightly larger. Seed production on plants in this trial was sporadic, as it had been in the Field Trial - PMC. Seed was produced on all accessions in 2005 and 2006. Only a few plants within each accession appear to be female and produce seed. Drought in 2006 did not appear to affect plant size. Seed production in 2007 was poor. Size difference between the three accessions was less noticeable in 2007 and 2008. Lack of clipping may have affected growth. The source originating from South Dakota (9086280) continued to be more vigorous in 2008.

3. Field Planting NDPMS-F-0808-RA - Golden Valley County; Cooperator: Scot Steele

The accessions 9082680 and Natrona showed little difference in stand establishment. The estimated stand was less than 1 plant per square foot in each planting on 9/19/2008. Records indicating the specific accession planted in a plot are questionable. The Beach Field Office recorded plants as more robust, more branched, and taller in the plot they thought was planted with 9086280. The accessions performed very similar to each other in 2009-2012. Plant vigor was rated good. There was little or no seed production. Evaluations taken by the Beach Field Office in 2010-2012 showed a vigor rating of 1. Moisture conditions this spring and summer were favorable for good growth.

Table FW-1. Seed Production – fourwing saltbush *Atriplex canescens*.

Year	Amount Harvested(clean bulk lbs)
2002	5.5
2003	3.5
2004	6.0
2005	0.5
2006	20.0
2007	5.0
2008	20.0
2009	32.0
2010	7.0
2011	16.0
2012	9.0
2013	21.0

Table FW-2. Forage analysis data-2002 - fourwing saltbush *Atriplex*.

Sample	%Total Moisture	%Crude Protein	%Acid Detergent Fiber	%Neutral Detergent Fiber
LF2	0	22.3	15.2	27.0
LF2	16.5	18.6	12.7	22.5
TIP6	0	18.1	26.3	39.7
TIP6	24.1	13.7	20.0	30.1

Table FW-3. Evaluation data 2003-2004 - fourwing saltbush *Atriplex*.

Accession	Date	Plant No.	Height	Spread	Fruit 2004
9082855	09/24/03	1	7	31	
9082855	09/08/04	1	33	62	
9082855	09/24/03	2	4	11	
9082855	09/08/04	2	19	30	
9082855	09/24/03	3	16	22	
9082855	09/08/04	3	31	50	
9082855	09/24/03	4	12	16	
9082855	09/08/04	4	26	47	
9082855	09/24/03	5	13	18	
9082855	09/08/04	5	18	50	yes
9082680	09/24/03	1	12	27	
9082680	09/08/04	1	38	49	
9082680	09/24/03	2	3	29	
9082680	09/08/04	2	31	43	yes
9082680	09/24/03	3	5	26	
9082680	09/08/04	3	28	51	
9082680	09/24/03	4	6	42	
9082680	09/08/04	4	36	50	
9082680	09/24/03	5	15	18	
9082680	09/08/04	5	36	48	yes
Wytana	09/24/03	1	3	20	
Wytana	09/08/04	1	23	46	yes
Wytana	09/24/03	2	3	6	
Wytana	09/08/04	2	dead	x	
Wytana	09/24/03	3	2	4	
Wytana	09/08/04	3	11	14	
Wytana	09/24/03	4	2	5	
Wytana	09/08/04	4	5	23	
Wytana	09/24/03	5	7	3	
Wytana	09/08/04	5	13	23	yes

ACTIVE STUDIES: TECHNICAL REPORT 2014

Study Number	**NDPMC-P-0801-RA**
Title	**Virginia Wildrye** *Elymus virginicus*
Objective	Develop a broad genetic based northern origin release of Virginia wildrye for use in the Northern Great Plains. Conservation uses could include pasture and hayland planting, wildlife habitat, range seeding, riparian planting and conservation cover
Duration	2008-2016
Cooperators	USDA, NRCS Bismarck Plant Materials Center, Bismarck, North Dakota
Location	Bismarck, ND Plant Materials Center
-----Soils	Mandan silt loam
-----MLRA	**53B**
-----Precip. (inches)	**2010:** 23.18**, 2011:** 23.22 **, 2012:**14.9, **2013:** 26.75 **2014**: 13.92

Background information: Virginia wildrye is a native, cool-season, perennial bunchgrass with a height of 2-3 feet. It prefers moist soils. Prime habitat includes bottomlands, low prairies, streambanks, and edges or under trees. It will tolerate both sun and shade. Its heavy horseshoe shaped glumes distinguish it from Canada wildrye. It is a mostly self-pollinating species. It is native throughout most of the United States and Canada.

Methods and Materials: Seed was collected from various locations in SD, ND, and MN in 2008 and 2009. Plants were propagated in the greenhouse and planted to an evaluation block. Data collected and visual observations were used to select plants for breeder population. Plants NOT selected were removed from plot. Seed has been harvested from evaluation block and is considered the breeder seed. A foundation seed field has been planted from breeder seed.

Initial Assembly and Breeder Population

Seed Source	**See Table VW-1** for collection dates, collector, and location.
Collections	Years: 2008 and 2009. Collections were from a wide array of sites in SD, ND, MN.
Propagation	Greenhouse to field
-----Greenhouse	Seed planted February 2010 into soilless potting mix in cone-tainers™ (yellow) (1-2 seeds each)
-----Field Evaluation Plot	Seedlings grown in greenhouse were planted on 5/20/2010 to field plot.
-----Location	Panel A
-----Design	Each accession was planted in 3-plant plots and in 3 replications. See **Figure VW-1** for map.
Data Collection	2010-2012
-----Parameters	Plants were evaluated based on growth habit and size. See **Table VW-2**.
-----Data	**2010:** Superior looking plants were rated for their potential use as a forage plant or as a landscape plant. Fifteen heads were collected from each preselected plant so seed would be available quicker if chosen as part of a release. **2011**: Plants were reselected for the breeder population. Plant material collected in 2010 was discarded. Plants were visually compared when vegetative and again just prior to flowering. Plants of small stature, extremely early or late flowering, diseased, poor vigor, and poor overall plant size were dug and removed from the assembly. Plants from all but three accessions were included in the remaining population which is considered the breeder population. See **Table VW-3** for a list of accessions included in the breeder population.
Field Maintenance	**2010**: Shallow tilling between rows and hand weeding. Residue removed by mowing the plants in the fall. **2011-2014**: Weeds controlled by mowing between rows and hand weeding. Seed that dropped before harvest in 2010 formed a dense mat for mowing. No chemical has been applied to plot.
Seed Harvest	Breeder seed from Panel A has been harvested from 2011-2014 using a combine. **2011:** 78 bulk pounds (66.5 PLS) **2012:** 55 bulk pounds **2013**: 11 bulk pounds **2014:** 12 bulk pounds (10.6 PLS)

Seed Cleaning	Fanning mill, no debearding is required.

Foundation Seed Increase Field

Location	Bismarck PMC Field E-12
Planting Date	May 2013
Size	20 rows – row spacing 42 inches (approx.. 1.2 acres)
Field Maintenance	9/22/2014: Curtail 2 pts/ac for Canada thistle control 10/27/2014: Trust 4 pts/ac
Seed Harvest and Seed Cleaning Method	9/03/2014: straight combine fanning mill used for cleaning seed
Seed Harvest Amount after cleaning	634 bulk pounds (574 PLS)
Data Collected	**2013:** none **2014**: leaf/stem ratio, plants sampled on 8/14/2014 **Leaf/stem ratio method:** Plants from portions of various random rows throughout the field were clipped within 1-2 inches of the ground. Leaves were separated from the stems. The separated stems and leaves were oven dried and weighed. The head was separated but not weighed as part of the leaf or stem. Seed was forming, but was not ripe when samples were clipped for leaf/stem ratio measurement. See **Table VW-4** for 2014 data.

Variety Trial

Accessions	**'Omaha'; 9094359; 'Mandan' (Canada wildrye)**
Seed Sources	**'Omaha': lot SCO-11, Stock Seed Farm** **9094359: lot SBR-12-PanelA, Bismarck PMC**
Planting Location	Panel G4 at Bismarck PMC just east of gravel road and tree row
Seeding Date	June 3, 2014
Seeding equipment	Plot drill Truax/Kincaid cone seeder (8 rows per pass) width of drill approx. 5.4 feet
Plot size	Approx. 5.4 ft wide X 60 ft. long for each accession
Plot layout	See map **Figure VW-2.** No space between plots, planted in field with prairie sandreed entries and Indiangrass entries
Field Maintenance	Mowing (2-3 times) during 2014 growing season to control weeds. Herbicides: 2 pints/acre Curtail® applied 9/22/14 and 4 pints/acre Trust® on 10/27/14

Results and Discussion - Assembly

Virginia wildrye grows in diverse conditions and locations. As the species is mostly self-pollinated, parent plants from a variety of locations would provide a diverse population. Though many of the collections were from shady sites, the plants appeared to thrive in direct sun at the PMC. The plants were very vigorous and many produced seed in 2010, the year of transplanting. Seed production was good in 2011 and 2012, but poor in 2013. Drought in 2012 may have caused stress in the plants in 2013. The species also is known to be fairly short lived. In 2014, plants were small and not very vigorous. It appeared they were at the end of their life span.

Results and Discussion - Foundation Seed Production Field

The foundation field planted in the spring of 2013 was vigorous and stand was good by the end of the growing season. The stand in 2014 was thicker than in 2013 and plants had abundant foliage. Leaf to stem ratio was taken for plants in the production field. Leaf to stem ratio provides an indication of forage quality (digestibility). Determining leaf/stem ratio at different growth stages in years to come will help determine when quality of the species is the greatest.

Results and Discussion - Variety Trial

The variety trial was very weedy and had to be clipped 2-3 times throughout the growing season. No data was collected. Data collection will begin in 2015.

Table VW-1. Collections – Virginia wildrye *Elymus virginicus*

Accession	State	County	Collector	Coll. Date	Other
9092245	ND	Richland	Tober	08/08/08	Sheyenne National Grasslands
9092246	ND	Cass	Tober	08/08/08	Conservancy Park on S. Univ. St., Fargo
9092247	MN	Clay	Tober	08/08/08	Regional Science Center 10 mi E of Fargo
9092248	ND	Ransom	Tober	08/08/08	Little Yellowstone Park - east end
9092249	ND	Morton	Jensen	08/11/08	Fort Lincoln State Park, walking trail
9092250	MN	Aitkin	Kopp	08/18/08	8-9 mi E of Hill City on Hwy 200
9092251	MN	Mille Lacs	Tober, Kopp	08/18/08	city park in NW Milaca along Rum River
9092252	ND	Walsh	Tober	08/18/08	Tom Silewski EWP, Exit 172 off I-29
9092253	MN	Aitkin	Tober, Kopp	08/18/08	Hwy 200 E of Hill City, boat ramp
9092254	MN	Sherburne	Tober	08/20/08	Hwy 24 S of Clearwater, Miss. River access
9092255	MN	Sherburne	Kopp	08/20/08	Hwy 24 public access, Miss. River
9092256	MN	Aitkin	Tober, Kopp	08/18/08	Big Sandy Lake Rec Area, Hwy 200 N entrance
9092257	SD	Beadle	Brannan, Yapp	08/20/08	James River Access boat ramp parking lot
9092258	ND	Oliver	Soil Con Training	08/28/08	Smith Grove, along trail to Big Trees
9092259	ND	Emmons	Jensen, Bergsagel	09/13/08	Seeman Park, E of Linton, Hwy 13
9092260	ND	Logan	Bergsagel, Jensen	09/13/08	Beaver Lake State Park, near obelisk
9094261	MN	Rice	Coffman	09/08/08	Jct Co 29 & MN 3, SW side of MN 3
9094262	ND	Morton	Duckwitz	09/06/08	NE1/4 sec 31-T81-R140 below dam
9094263	SD	Clay	Jensen	09/10/08	sec8-T93N-R52W log cabin on bluff road
9094264	SD	Clay	Jensen	09/10/08	Clay Co. Park sec 20-T92N-R52W
9094265	SD	Yankton	Jensen	09/10/08	Clay Creek, S of Volin, sec26-T94N-R54W
9094266	SD	Union	Jensen	09/10/08	Union Grove State Park ,sec32-T94N-R50W
9094267	ND	Oliver	Jensen, Bergsagel	09/13/08	Arroda Lakes - west entrance
9094268	ND	Mercer	Bergsagel, Jensen	09/16/08	Stanton City Park along Knife River
9094269	ND	Mercer	Jensen, Bergsagel	09/13/08	Sakakawea Estates; S of Lake Sakakawea
9094270	ND	Dunn	Bergsagel, Jensen	09/16/08	Killdeer Mt WMA drainage area, NW parking lot
9094271	ND	Stark	Jensen, Bergsagel	09/16/08	Schnell Ranch -Woodland Trail (OWLS)
9094272	ND	Barnes	Jensen	10/02/08	Conservancy Park along Sheyenne River S of Valley City, woods - north end
9094273	SD	Hanson	Adams, Gilb	08/22/08	James River banks 8-T101N-R58W
9094274	SD	Dewey	Richter, Beer, Boltjes	10/02/08	Virgin Creek, 28-T15N-R29E
9094275	ND	Kidder	Jensen, Tober	10/08/08	Lake Isabel, E side, 26-T139N-72W
9094276	ND	Griggs	Tober	10/08/08	Red Willow Lake Resort Rd to Heifer Stadium
9094277	MN	Polk	Jensen	10/08/08	Roger Wagner Nursery, Red Lake River bottoms

9094278	ND	Nelson	Tober, Jensen	10/08/08	Stump Lake Recreation Area
Accession	**State**	**County**	**Collector**	**Coll. Date**	**Other**
9094283	MN	Marshall	Gustafson,Rivard,Kaul	09/01/09	sec30-T157N-R50W EWP
9094284	MN	Marshall	Gustafson,Rivard,Kaul	09/01/09	sec27-T157N-R50W EWP
9094285	MN	Red Lake	Shawnn Balstad	08/24/09	Riverside Park, north of watergrazing station
9094286	SD	Corson	Jensen, Bergsagel	09/08/09	South of Little Eagle along SD 63, Sec 29 T20N R27E
9094287	SD	Jackson	Jensen, Bergsagel	09/10/09	Hwy 44 Bear in the Lodge Creek; 12-T41N-R38W, W of Wanblee, SD
9094288	SD	Custer	Jensen, Bergsagel	09/09/09	Beaver Creek in Wind Cave National Park
9094289	SD	Harding	Jensen, Bergsagel	09/08/09	Slim Buttes (Reva campgrounds)
9094290	SD	Shannon	Jensen, Bergsagel	09/10/09	11 mi N Oglala along Hwy 41, White River bridge
9094291	SD	Mellette	Jensen, Bergsagel	09/10/09	Off Hwy 44, 5 1/2 E of SD Hwy 63, woody draws
9094292	SD	Perkins	Jensen, Bergsagel	09/08/09	Humphrey Draw, Grand River National Grasslands
9094293	SD	Fall River	Jensen, Bergsagel	09/10/09	Brookside Park in city of Hot Springs
9094294	SD	Stanley	Jensen, Bergsagel	09/11/09	Off Hwy 1806 near Oahe Dam, mile mark 191
9094295	SD	Butte	Jensen, Bergsagel	09/09/09	T8N-R2E City of Belle Fourche walking trail
9094296	SD	Lawrence	Jensen, Bergsagel	09/09/09	Rough Lock Falls Trail Head, campground
9094297	SD	Roberts	Tober	09/17/09	Siche Hollow, scattered locations along trail
9094298	SD	Roberts	Tober	09/17/09	Browns Valley, MN COE Rec area north of Lake Traverse(city)
9094299	SD	Big Stone	Tober	09/17/09	Graceville, MN - west end of Toqua Park
9094300	MN	Douglas	Tober	09/16/09	Spruce Hill Park N of Alexandria 20 mi., drainage from picnic shelters, footbridge
9094301	MN	Wadena	Tober	09/16/09	Old Wadena along Crow Wing River by canoe landing and picnic area
9094302	MN	Beltrami	Tober	09/14/09	6 mi S of Blackduck on Hwy 39; Gilstad Lake boat ramp area in trees
9094303	MN	Norman	Tober	09/14/09	Bosworth Park along Marsh River at Ada, MN
9094304	SD	Hutchinson	Jensen	09/21/09	Walz GMA; 7 mi N of Menno, SD along 431st Av - woody draws
9094305	SD	Hand	Jensen	09/17/09	St. Lawrence Nature Park east side of town by old pavilion
9094307	MN	Carlton	Jensen, M. Oja	09/30/09	Cloquet Forest, cut forest area by global warming trial
9094308	SD	Grant	Jensen, Bergsagel	10/07/09	S of Twin Brooks, from Hwy 20, 1 mi N to 156st, E 1 mi, then S on 473 Av 1/10 mi
9094309	ND	McHenry	Jensen, Bergsagel	10/08/09	Velva City Park, along Mouse River riparian area near horseshoe pit
9094310	ND	McLean	Jensen, Bergsagel	10/08/09	Ft Mandan, in trees N of Seeman sculpture
9094311	MN	Yellow Medicine	Jensen, Bergsagel	10/07/09	N of Canby at Yellow Medicine/Lac Qui Parle Co line; 280 Av 1/2 mi E of Hwy 75
9094312	MN	Lac Qui Parle	Jensen, Bergsagel	10/07/09	S of Madison, MN, on 211 Ave near bridge #37513
9094313	MN	Sherburne	Tober	09/28/09	Princeton, MN Riverside Park (Hwy 95) along Rum River
9094314	SD	Brookings	Jensen, Bergsagel	10/07/09	S of Brookings, off of Co. Rd 77, at Conservation Park along Big Sioux River
9094315	SD	Minnehaha	Jensen, Bergsagel	10/06/09	Dell Rapids City Park by old Bath House along Big Sioux River
9094316	MN	Pipestone	Jensen, Bergsagel	10/06/09	Pipestone National Monument trail near headquarters
9094317	MN	Murray	Jensen, Bergsagel	10/06/09	Lime Lake Park (Murray Co. Park) W of Avoca, MN; along dam face

9094318	MN	Cottonwood	Jensen, Bergsagel	10/06/09	High Water Creek along Hwy 10, just E of Co. Rd 5, baseball area at bridge
Accession	**State**	**County**	**Collector**	**Coll. Date**	**Other**
9094319	MN	Redwood	Jensen, Bergsagel	10/06/09	Plum Creek Co. Park 2 mi S of Walnut Grove, near foot bridge
9094320	MN	Lyon	Jensen, Bergsagel	10/06/09	Garvin Park N of Hwy 14; 280th Av & Co. Rd 69, picnic area along creek
9094321	MN	Lincoln	Jensen, Bergsagel	10/06/09	Lake Benton; Hole in Mountain Co. Park, outer edge of hills and draws
9094322	SD	Marshall	Jensen, Bergsagel	10/05/09	GF&P walk in area, 2 mi W of Veblen, SD(Hwy 25) along creek in draw
9094323	ND	McKenzie	Bergsagel	10/04/09	Bennie Peer Rd, 3.3 mi W of Hwy 16; E of Tim Dwyer place (Little Mo. Grasslands)
9094324	ND	Golden Valley	Bergsagel	10/04/09	Buffalo Gap Campground, along I-94, sites 20, 22 in center of Hidatsa Loop
9094325	ND	Burleigh	Jensen, Bergsagel	09/02/09	Sibley Park south of Bismarck, east end of park, west of boat ramp, woods
9094326	MN	Lac Qui Parle	L. Kvidera	10/13/09	Sec 21-T117N-R44W, N side of Lac Qui Parle River, Co. Rd. #37
9094327	ND	Renville	Jensen, Bergsagel	10/19/09	Upper Souris National Wildlife Refuge, N of Mouse River Co Prk, W of Mohall
9094328	ND	Bottineau	Jensen, Bergsagel	10/19/09	Lake Metigoshe State Park - Day Use and Tent Loop
9094329	ND	Mountrail	Jensen, Bergsagel	10/19/09	1.7 mi S of Hwy 2, W of White Earth Rest Area
9094330	ND	Ward	Jensen, Bergsagel	10/19/09	Oak Park in Minot, at Camp Owetti along trail along Mouse River (Souris)

Figure VW-1. Plot layout of initial assembly– Virginia wildrye *Elymus virginicus* (page 1 of 3)

Location: Panel A
Planting Date: 5/20/2010

row 1	row 2	row 3	row 4	row 5	row 6	row 7	row 8	row 9	row 10
9092245	9092254	9094263	9094272	9094285	9094294	9094303	9094313	9094322	Cuivre
9092245	9092254	9094263	9094272	9094285	9094294	9094303	9094313	9094322	Cuivre
9092245	9092254	9094263	9094272	9094285	9094294	9094303	9094313	9094322	Cuivre
9092246	9092255	9094264	9094273	9094286	9094295	9094304	9094314	9094323	EWP
9092246	9092255	9094264	9094273	9094286	9094295	9094304	9094314	9094323	EWP
9092246	9092255	9094264	9094273	9094286	9094295	9094304	9094314	9094323	EWP
9092247	9092256	9094265	9094274	9094287	9094296	9094305	9094315	9094324	9094276
9092247	9092256	9094265	9094274	9094287	9094296	9094305	9094315	9094324	9094276
9092247	9092256	9094265	9094274	9094287	9094296	9094305	9094315	9094324	9094276
9092248	9092257	9094266	9094275	9094288	9094297	9094307	9094316	9094325	9094317
9092248	9092257	9094266	9094275	9094288	9094297	9094307	9094316	9094325	9094317
9092248	9092257	9094266	9094275	9094288	9094297	9094307	9094316	9094325	9094317
9092249	9092258	9094267	9094276	9094289	9094298	9094308	9094317	9094326	9094288
9092249	9092258	9094267	9094276	9094289	9094298	9094308	9094317	9094326	9094288
9092249	9092258	9094267	9094276	9094289	9094298	9094308	9094317	9094326	9094288
9092250	9092259	9094268	9094277	9094290	9094299	9094309	9094318	9094327	9092256
9092250	9092259	9094268	9094277	9094290	9094299	9094309	9094318	9094327	9092256
9092250	9092259	9094268	9094277	9094290	9094299	9094309	9094318	9094327	9092256
9092251	9092260	9094269	9094278	9094291	9094300	9094310	9094319	9094328	9094267
9092251	9092260	9094269	9094278	9094291	9094300	9094310	9094319	9094328	9094267
9092251	9092260	9094269	9094278	9094291	9094300	9094310	9094319	9094328	9094267
9092252	9094261	9094270	9094283	9094292	9094301	9094311	9094320	9094329	9094290
9092252	9094261	9094270	9094283	9094292	9094301	9094311	9094320	9094329	9094290
9092252	9094261	9094270	9094283	9094292	9094301	9094311	9094320	9094329	9094290
9092253	9094262	9094271	9094284	9094293	9094302	9094312	9094321	9094330	9094285
9092253	9094262	9094271	9094284	9094293	9094302	9094312	9094321	9094330	9094285
9092253	9094262	9094271	9094284	9094293	9094302	9094312	9094321	9094330	9094285

Figure VW-1. Plot Layout – Virginia wildrye *Elymus virginicus* (continued - page 2 of 3)

Location: Panel A
Planting Date: 5/20/2010

row 11	row 12	row 13	row 14	row 15	row 16	row 17	row 18	row 19	row 20
9094329	9094283	9094299	9094278	9094289	9094326	9094325	9092250	9094268	9094271
9094329	9094283	9094299	9094278	9094289	9094326	9094325	9092250	9094268	9094271
9094329	9094283	9094299	9094278	9094289	9094326	9094325	9092250	9094268	9094271
9094293	9094295	9092252	9094312	9094321	9094323	9092254	9092258	9094308	9094287
9094293	9094295	9092252	9094312	9094321	9094323	9092254	9092258	9094308	9094287
9094293	9094295	9092252	9094312	9094321	9094323	9092254	9092258	9094308	9094287
9092249	9092247	9094277	9094330	9094305	9094316	9094315	9092245	9094307	9092258
9092249	9092247	9094277	9094330	9094305	9094316	9094315	9092245	9094307	9092258
9092249	9092247	9094277	9094330	9094305	9094316	9094315	9092245	9094307	9092258
9094266	Cuivre	9092260	9094298	9094265	9094324	9094273	9094294	9094309	9092259
9094266	Cuivre	9092260	9094298	9094265	9094324	9094273	9094294	9094309	9092259
9094266	Cuivre	9092260	9094298	9094265	9094324	9094273	9094294	9094309	9092259
9094275	9094284	9094272	9094297	9094264	9094263	9094269	9092257	9094317	9094325
9094275	9094284	9094272	9094297	9094264	9094263	9094269	9092257	9094317	9094325
9094275	9094284	9094272	9094297	9094264	9094263	9094269	9092257	9094317	9094325
9094318	9094302	EWP	9094303	9094292	9094270	9094261	9094287	9094283	9094310
9094318	9094302	EWP	9094303	9094292	9094270	9094261	9094287	9094283	9094310
9094318	9094302	EWP	9094303	9094292	9094270	9094261	9094287	9094283	9094310
9094313	9092248	9094300	9094319	9094322	9094314	9094327	9094328	9094316	9094300
9094313	9092248	9094300	9094319	9094322	9094314	9094327	9094328	9094316	9094300
9094313	9092248	9094300	9094319	9094322	9094314	9094327	9094328	9094316	9094300
9094296	9094291	9094274	9094304	9094286	9092255	9092253	9094262	9092257	9094321
9094296	9094291	9094274	9094304	9094286	9092255	9092253	9094262	9092257	9094321
9094296	9094291	9094274	9094304	9094286	9092255	9092253	9094262	9092257	9094321
9092246	9094301	9092251	9094310	9094271	9092259	9094320	9094311	9094292	9094266
9092246	9094301	9092251	9094310	9094271	9092259	9094320	9094311	9094292	9094266
9092246	9094301	9092251	9094310	9094271	9092259	9094320	9094311	9094292	9094266

Figure VW-1. Plot Layout – Virginia wildrye *Elymus virginicus* (continued - page 3 of 3)

Location: Panel A
Planting Date: 5/20/2010

row 21	row 22	row 23	row 24	row 25	row 26	row 27	row 28
9094276	9094275	9094261	9092248	9094323	9094318	9092254	9094270
9094276	9094275	9094261	9092248	9094323	9094318	9092254	9094270
9094276	9094275	9094261	9092248	9094323	9094318	9092254	9094270
9094312	9092245	9094326	9094298	9094328	9094305	9094300	9092252
9094312	9092245	9094326	9094298	9094328	9094305	9094300	9092252
9094312	9092245	9094326	9094298	9094328	9094305	9094300	9092252
9092255	9094327	9094267	9094286	9094262	9094295	Cuivre	9094301
9092255	9094327	9094267	9094286	9094262	9094295	Cuivre	9094301
9092255	9094327	9094267	9094286	9094262	9094295	Cuivre	9094301
9094308	9094288	9094294	9094320	9094303	9094274	9094265	9094296
9094308	9094288	9094294	9094320	9094303	9094274	9094265	9094296
9094308	9094288	9094294	9094320	9094303	9094274	9094265	9094296
9094329	9094273	9094324	9094313	9092260	9094297	9094264	9094269
9094329	9094273	9094324	9094313	9092260	9094297	9094264	9094269
9094329	9094273	9094324	9094313	9092260	9094297	9094264	9094269
9094289	9094263	9094304	9094322	9092251	9094268	EWP	9094290
9094289	9094263	9094304	9094322	9092251	9094298	EWP	9094290
9094289	9094263	9094304	9094322	9092251	9094268	EWP	9094290
9094314	9092253	9094302	9092250	9094278	9094319	9094272	
9094314	9092253	9094302	9092250	9094278	9094319	9094272	
9094314	9092253	9094302	9092250	9094278	9094319	9094272	
9092247	9094309	9094284	9092256	9094277	9094299	9092249	
9092247	9094309	9094284	9092256	9094277	9094299	9092249	
9092247	9094309	9094284	9092256	9094277	9094299	9092249	
9094315	9094293	9094285	9094291	9092246	9094307	9094311	
9094315	9094293	9094285	9094291	9092246	9094307	9094311	
9094315	9094293	9094285	9094291	9092246	9094307	9094311	

Figure VW-2. Plot layout of variety trial – Virginia wildrye *Elymus virginicus*

Seeding Date: June 3, 2014
Site Prep: Tilled and packed
Seeding Tool: 8-row Truax/Kincaid cone seeder
Plot size: 6 feet x 60 feet (drill set for 30 feet, seed dropped twice)
Plot location: G4, along west gravel road near trees
Plot layout: 60-foot length is south to north, no space between species or varieties
Seeding method: 8-row Truax/Kincaid cone seeder

North ↑

Mandan Canada wildrye	60 feet
PMC Virginia wildrye	
Omaha Virginia wildrye	
Chief Indiangrass	
Tomahawk Indiangrass	
9094358 Indiangrass	
Koch prairie sandreed	
9094357 prairie sandreed	
Goshen prairie sandreed	
ND95 prairie sandreed	

← 6 feet →

Table VW-2. 2010 Evaluation data – Virginia wildrye *Elymus virginicus*

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
1	1	9092245		2	
1	2	9092245		2	
1	3	9092245		2	
1	1	9092246		2	
1	2	9092246		2	
1	3	9092246		2	
1	1	9092247	x	1	
1	2	9092247		1	
1	3	9092247		1	
1	1	9092248		3	x
1	2	9092248		3	x
1	3	9092248		3	x
1	1	9092249		2	
1	2	9092249		2	
1	3	9092249		2	
1	1	9092250	x	1	
1	2	9092250	x	1	
1	3	9092250		1	
1	1	9092251		1	
1	2	9092251		1	
1	3	9092251	x	1	
1	1	9092252		1	
1	2	9092252		1	
1	3	9092252	x	1	
1	1	9092253		1	
1	2	9092253		1	
1	3	9092253		1	
		ROW 2			
2	1	9092254		1	
2	2	9092254		1	
2	3	9092254	x	1	
2	1	9092255	x	1	
2	2	9092255	x	1	
2	3	9092255	x	1	
2	1	9092256		2	
2	2	9092256		2	
2	3	9092256		1	
2	1	9092257		1	
2	2	9092257		1	
2	3	9092257		1	
2	1	9092258		3	
2	2	9092258		3	x
2	3	9092258		3	x
2	1	9092259		2	
2	2	9092259		2	
2	3	9092259		2	
2	1	9092260		2	
2	2	9092260		2	

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
2	3	9092260		2	
2	1	9094261		1	
2	2	9094261		2	
2	3	9094261	x	1	
2	1	9094262		2	
2	2	9094262		2	
2	3	9094262		2	
		ROW 3			
3	1	9094263		2	
3	2	9094263		2	
3	3	9094263		2	
3	1	9094264		3	
3	2	9094264		3	
3	3	9094264		3	
3	1	9094265		1	
3	2	9094265	x	1	
3	3	9094265		1	
3	1	9094266		3	x
3	2	9094266		1	
3	3	9094266		2	
3	1	9094267		2	
3	2	9094267		2	
3	3	9094267		2	
3	1	9094268		1	
3	2	9094268		1	
3	3	9094268		2	
3	1	9094269		2	
3	2	9094269		2	
3	3	9094269		2	
3	1	9094270		2	
3	2	9094270		2	
3	3	9094270		2	
3	1	9094271		3	
3	2	9094271		3	
3	3	9094271		2	
		ROW 4			
4	1	9094272		2	
4	2	9094272		3	
4	3	9094272	x	2	
4	1	9094273		3	
4	2	9094273		3	
4	3	9094273		2	
4	1	9094274		2	
4	2	9094274		2	
4	3	9094274		2	
4	1	9094275		2	
4	2	9094275		2	
4	3	9094275		2	
4	1	9094276		3	

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
4	2	9094276		3	
4	3	9094276		3	
4	1	9094277		1	
4	2	9094277	x	1	
4	3	9094277		2	
4	1	9094278		2	
4	2	9094278		2	
4	3	9094278		1	
4	1	9094283	x	1	
4	2	9094283		1	
4	3	9094283	x	1	
4	1	9094284		1	
4	2	9094284	x	1	
4	3	9094284		2	
		ROW 5			
5	1	9094285		2	
5	2	9094285		2	
5	3	9094285	x	1	
5	1	9094286		1	
5	2	9094286		1	
5	3	9094286		2	
5	1	9094287		3	x
5	2	9094287		3	x
5	3	9094287		3	x
5	1	9094288		2	
5	2	9094288		2	
5	3	9094288		2	
5	1	9094289		3	
5	2	9094289		2	
5	3	9094289		2	
5	1	9094290		1	
5	2	9094290		2	
5	3	9094290		2	
5	1	9094291		1	
5	2	9094291		2	
5	3	9094291		2	
5	1	9094292		2	
5	2	9094292		2	
5	3	9094292		2	
5	1	9094293		1	
5	2	9094293		1	
5	3	9094293		1	
		ROW 6			
6	1	9094294		2	
6	2	9094294		1	
6	3	9094294		1	
6	1	9094295		1	
6	2	9094295		2	
6	3	9094295		2	

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
6	1	9094296		2	
6	2	9094296		2	
6	3	9094296		2	
6	1	9094297		2	
6	2	9094297		1	
6	3	9094297		2	
6	1	9094298	x	1	
6	2	9094298	x	1	
6	3	9094298	x	1	
6	1	9094299		2	
6	2	9094299		2	
6	3	9094299		2	
6	1	9094300	x	1	
6	2	9094300		1	
6	3	9094300		2	
6	1	9094301	x	1	
6	2	9094301		1	
6	3	9094301		2	
6	1	9094302		1	
6	2	9094302		1	
6	3	9094302		1	
		ROW 7			
7	1	9094303		2	
7	2	9094303		2	
7	3	9094303		2	
7	1	9094304		2	
7	2	9094304		2	
7	3	9094304		2	
7	1	9094305		2	x
7	2	9094305		3	x
7	3	9094305		2	x
7	1	9094307		2	
7	2	9094307		2	
7	3	9094307		1	
7	1	9094308		2	
7	2	9094308		2	
7	3	9094308		2	
7	1	9094309		2	
7	2	9094309		1	
7	3	9094309		2	
7	1	9094310		1	
7	2	9094310	x	1	
7	3	9094310		1	
7	1	9094311	x	1	
7	2	9094311		1	
7	3	9094311		1	
7	1	9094312	x	1	
7	2	9094312	x	2	
7	3	9094312	x	1	

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
		ROW 8			
8	1	9094313		2	
8	2	9094313	x	1	
8	3	9094313	x	1	
8	1	9094314	x	1	
8	2	9094314		2	
8	3	9094314	x	1	
8	1	9094315		2	
8	2	9094315		2	
8	3	9094315		2	x
8	1	9094316		2	
8	2	9094316		1	
8	3	9094316		1	
8	1	9094317		2	
8	2	9094317		2	
8	3	9094317		2	
8	1	9094318	x	1	
8	2	9094318	x	1	
8	3	9094318	x	1	
8	1	9094319		1	
8	2	9094319		1	
8	3	9094319		1	
8	1	9094320		2	
8	2	9094320		1	
8	3	9094320		3	
8	1	9094321		2	x
8	2	9094321		2	x
8	3	9094321		2	x
		ROW 9			
9	1	9094322		3	
9	2	9094322		2	
9	3	9094322		2	
9	1	9094323		2	
9	2	9094323		2	
9	3	9094323		3	
9	1	9094324		3	
9	2	9094324		2	
9	3	9094324		2	
9	1	9094325		1	
9	2	9094325		1	
9	3	9094325		1	
9	1	9094326		1	
9	2	9094326	x	1	
9	3	9094326	x	1	
9	1	9094327		1	
9	2	9094327		2	
9	3	9094327		2	
9	1	9094328		3	
9	2	9094328		3	

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
9	3	9094328		3	
9	1	9094329		1	
9	2	9094329		1	
9	3	9094329		3	
9	1	9094330		2	
9	2	9094330		3	
9	3	9094330		2	
		ROW 10			
10	1	Cuivre		2	
10	2	Cuivre		1	
10	3	Cuivre		1	
10	1	EWP		1	
10	2	EWP		1	
10	3	EWP	x	1	
10	1	9094276		3	
10	2	9094276		3	
10	3	9094276		3	
10	1	9094317		2	
10	2	9094317		3	
10	3	9094317		3	
10	1	9094288		3	
10	2	9094288		2	
10	3	9094288		1	
10	1	9092256		1	
10	2	9092256		1	
10	3	9092256	x	1	
10	1	9094267		2	
10	2	9094267		2	
10	3	9094267		2	
10	1	9094290		2	
10	2	9094290		1	
10	3	9094290		3	
10	1	9094285		3	
10	2	9094285		3	
10	3	9094285		1	
		ROW 11			
11	1	9094329		3	
11	2	9094329		3	
11	3	9094329		2	
11	1	9094293		1	
11	2	9094293		2	
11	3	9094293		2	
11	1	9092249		3	
11	2	9092249		3	
11	3	9092249		3	
11	1	9094266		1	
11	2	9094266		1	
11	3	9094266		3	
11	1	9094275		3	

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
11	2	9094275		3	
11	3	9094275		2	
11	1	9094318		1	
11	2	9094318		1	
11	3	9094318	x	1	
11	1	9094313		1	
11	2	9094313	x	1	
11	3	9094313		1	
11	1	9094296		2	
11	2	9094296		2	
11	3	9094296		2	
11	1	9092246		1	
11	2	9092246		1	
11	3	9092246		1	
		ROW 12			
12	1	9094283		2	
12	2	9094283		1	
12	3	9094283	x	1	
12	1	9094295		1	
12	2	9094295	x	1	
12	3	9094295		2	
12	1	9092247	x	1	
12	2	9092247		1	
12	3	9092247		1	
12	1	Cuivre		1	
12	2	Cuivre		2	
12	3	Cuivre		2	
12	1	9094284		1	
12	2	9094284	x	1	
12	3	9094284	x	1	
12	1	9094302		1	
12	2	9094302		1	
12	3	9094302	x	1	
12	1	9092248		2	x
12	2	9092248		2	x
12	3	9092248		2	x
12	1	9094291		2	
12	2	9094291		3	
12	3	9094291		2	
12	1	9094301	x	1	
12	2	9094301	x	1	
12	3	9094301		1	
		ROW 13			
13	1	9094299		3	
13	2	9094299		3	x
13	3	9094299		2	
13	1	9092252		1	
13	2	9092252	x	1	
13	3	9092252		1	

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
13	1	9094277	x	1	
13	2	9094277		1	
13	3	9094277		1	
13	1	9092260		3	
13	2	9092260		3	
13	3	9092260		2	
13	1	9094272	x	1	
13	2	9094272		2	
13	3	9094272		2	
13	1	EWP		1	
13	2	EWP	x	1	
13	3	EWP		1	
13	1	9094300		1	
13	2	9094300		1	
13	3	9094300		1	
13	1	9094274		3	
13	2	9094274		2	x
13	3	9094274		1	
13	1	9092251		1	
13	2	9092251		1	
13	3	9092251		1	
		ROW 14			
14	1	9094278		2	
14	2	9094278		2	
14	3	9094278		2	
14	1	9094312	x	1	
14	2	9094312	x	1	
14	3	9094312		1	
14	1	9094330		2	
14	2	9094330		2	x
14	3	9094330		2	x
14	1	9094298		1	
14	2	9094298	x	1	
14	3	9094298		1	
14	1	9094297		1	
14	2	9094297		1	
14	3	9094297		1	
14	1	9094303		1	
14	2	9094303		1	
14	3	9094303	x	1	
14	1	9094319		1	
14	2	9094319		1	
14	3	9094319		1	
14	1	9094304		2	
14	2	9094304		2	
14	3	9094304		3	
14	1	9094310		1	
14	2	9094310		1	
14	3	9094310		1	

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
		ROW 15			
15	1	9094289		3	
15	2	9094289		3	
15	3	9094289		2	
15	1	9094321		2	
15	2	9094321		2	
15	3	9094321		2	
15	1	9094305		3	x
15	2	9094305		3	x
15	3	9094305		3	x
15	1	9094265		1	
15	2	9094265		1	
15	3	9094265		1	
15	1	9094264		2	
15	2	9094264		2	
15	3	9094264		2	
15	1	9094292		2	
15	2	9094292		2	
15	3	9094292		2	
15	1	9094322		2	
15	2	9094322		2	
15	3	9094322		2	
15	1	9094286		1	
15	2	9094286		1	
15	3	9094286		1	
15	1	9094271		2	
15	2	9094271		2	
15	3	9094271		2	
		ROW 16			
16	1	9094326		1	
16	2	9094326		1	
16	3	9094326	x	1	
16	1	9094323		1	
16	2	9094323	x	1	
16	3	9094323		2	
16	1	9094316		2	
16	2	9094316		2	
16	3	9094316		2	
16	1	9094324		2	
16	2	9094324		2	
16	3	9094324		2	
16	1	9094263		1	
16	2	9094263		2	
16	3	9094263		2	
16	1	9094270		2	
16	2	9094270		2	
16	3	9094270		1	
16	1	9094314		1	
16	2	9094314	x	1	

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
16	3	9094314		2	
16	1	9092255		1	
16	2	9092255	x	1	
16	3	9092255		1	
16	1	9092259		2	
16	2	9092259		1	
16	3	9092259		2	
		ROW 17			
17	1	9094325		2	
17	2	9094325		1	
17	3	9094325		1	
17	1	9092254		1	
17	2	9092254		2	
17	3	9092254	x	1	
17	1	9094315		2	
17	2	9094315		2	x
17	3	9094315		2	x
17	1	9094273		1	
17	2	9094273		1	
17	3	9094273		1	
17	1	9094269		2	
17	2	9094269		1	
17	3	9094269		2	
17	1	9094261		1	
17	2	9094261		1	
17	3	9094261		1	
17	1	9094327		2	
17	2	9094327		2	
17	3	9094327		3	
17	1	9092253		1	
17	2	9092253		1	
17	3	9092253		1	
17	1	9094320		1	
17	2	9094320		1	
17	3	9094320		1	
		ROW 18			
18	1	9092250		2	
18	2	9092250		1	
18	3	9092250		1	
18	1	9092258		2	
18	2	9092258		2	x
18	3	9092258		2	x
18	1	9092245		2	x
18	2	9092245		2	x
18	3	9092245		2	
18	1	9094294		1	
18	2	9094294		2	
18	3	9094294		1	
18	1	9092257	x	2	

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
18	2	9092257		2	
18	3	9092257		3	
18	1	9094287		3	x
18	2	9094287		3	x
18	3	9094287		3	x
18	1	9094328		3	
18	2	9094328		3	
18	3	9094328		3	
18	1	9094262		2	
18	2	9094262		2	
18	3	9094262		2	
18	1	9094311		1	
18	2	9094311		1	
18	3	9094311	x	1	
		ROW 19			
19	1	9094268		2	
19	2	9094268		1	
19	3	9094268		1	
19	1	9094308		1	
19	2	9094308		2	
19	3	9094308		2	
19	1	9094307		3	x
19	2	9094307		2	
19	3	9094307		2	
19	1	9094309		2	x
19	2	9094309		2	
19	3	9094309		2	
19	1	9094317		2	
19	2	9094317		2	x
19	3	9094317		2	x
19	1	9094283		1	
19	2	9094283	x	1	
19	3	9094283	x	1	
19	1	9094316		1	
19	2	9094316		1	
19	3	9094316		1	
19	1	9092257		1	
19	2	9092257		1	
19	3	9092257		1	
19	1	9094292		2	
19	2	9094292		2	
19	3	9094292		2	
		ROW 20			
20	1	9094271		3	
20	2	9094271		2	
20	3	9094271		2	
20	1	9094287		2	
20	2	9094287		2	
20	3	9094287		2	x

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
20	1	9092258		2	
20	2	9092258		2	
20	3	9092258		2	
20	1	9092259		2	
20	2	9092259		2	
20	3	9092259		1	
20	1	9094325		1	
20	2	9094325		1	
20	3	9094325		1	
20	1	9094310		3	
20	2	9094310		2	
20	3	9094310		1	
20	1	9094300	x	2	
20	2	9094300		1	
20	3	9094300		1	
20	1	9094321		2	x
20	2	9094321		2	x
20	3	9094321		2	
20	1	9094266		1	
20	2	9094266		1	
20	3	9094266		2	
		ROW 21			
21	1	9094276		3	
21	2	9094276		3	
21	3	9094276		2	
21	1	9094312	x	1	
21	2	9094312	x	1	
21	3	9094312	x	1	
21	1	9092255		1	
21	2	9092255		1	
21	3	9092255	x	1	
21	1	9094308		2	
21	2	9094308		2	
21	3	9094308		2	
21	1	9094329		2	
21	2	9094329		2	
21	3	9094329		3	
21	1	9094289		2	
21	2	9094289		2	
21	3	9094289		2	
21	1	9094314		1	
21	2	9094314		2	x
21	3	9094314		2	x
21	1	9092247		3	
21	2	9092247		3	
21	3	9092247		2	
21	1	9094315		2	x
21	2	9094315		2	x
21	3	9094315		1	

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
		ROW 22			
22	1	9094275		2	
22	2	9094275		2	
22	3	9094275		2	
22	1	9092245		2	
22	2	9092245		2	
22	3	9092245		3	
22	1	9094327		2	
22	2	9094327		2	
22	3	9094327		1	
22	1	9094288		2	
22	2	9094288		2	
22	3	9094288		2	
22	1	9094273		2	
22	2	9094273		3	
22	3	9094273		2	
22	1	9094263		2	
22	2	9094263		1	
22	3	9094263		1	
22	1	9092253		1	
22	2	9092253		1	
22	3	9092253		1	
22	1	9094309		2	
22	2	9094309	x	2	
22	3	9094309	x	2	
22	1	9094293		1	
22	2	9094293		1	
22	3	9094293		1	
		ROW 23			
23	1	9094261		3	
23	2	9094261		2	
23	3	9094261	x	1	
23	1	9094326		1	
23	2	9094326		1	
23	3	9094326	x	1	
23	1	9094267		2	
23	2	9094267		2	
23	3	9094267		dead	
23	1	9094294		2	
23	2	9094294		2	
23	3	9094294		3	
23	1	9094324		2	
23	2	9094324		2	
23	3	9094324		2	
23	1	9094304		2	
23	2	9094304		2	
23	3	9094304		2	
23	1	9094302		1	
23	2	9094302	x	1	

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
23	3	9094302	x	1	
23	1	9094284		1	
23	2	9094284		1	
23	3	9094284	x	1	
23	1	9094285		1	
23	2	9094285		2	
23	3	9094285		1	
		ROW 24			
24	1	9092248		3	
24	2	9092248		2	x
24	3	9092248		2	x
24	1	9094298		1	
24	2	9094298	x	1	
24	3	9094298	x	1	
24	1	9094286		1	
24	2	9094286		1	
24	3	9094286		1	
24	1	9094320		2	
24	2	9094320		2	
24	3	9094320		1	
24	1	9094313		1	
24	2	9094313	x	1	
24	3	9094313		2	
24	1	9094322		2	
24	2	9094322		2	
24	3	9094322		2	
24	1	9092250		2	
24	2	9092250		1	
24	3	9092250	x	1	
24	1	9092256		1	
24	2	9092256		1	
24	3	9092256		2	
24	1	9094291		1	
24	2	9094291		1	
24	3	9094291		1	
		ROW 25			
25	1	9094323		2	
25	2	9094323		2	
25	3	9094323		2	
25	1	9094328		2	
25	2	9094328		2	
25	3	9094328	x	1	
25	1	9094262		2	
25	2	9094262		1	
25	3	9094262		1	
25	1	9094303		1	
25	2	9094303	x	1	
25	3	9094303		2	
25	1	9092260		2	

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
25	2	9092260		2	
25	3	9092260		2	
25	1	9092251		2	
25	2	9092251		2	
25	3	9092251		2	
25	1	9094278		1	
25	2	9094278		1	
25	3	9094278		2	
25	1	9094277		3	
25	2	9094277		3	
25	3	9094277		3	x
25	1	9092246		2	
25	2	9092246		2	
25	3	9092246		3	
		ROW 26			
26	1	9094318		2	
26	2	9094318		2	
26	3	9094318		2	
26	1	9094305		2	x
26	2	9094305		2	x
26	3	9094305		2	x
26	1	9094295		2	
26	2	9094295		1	
26	3	9094295		1	
26	1	9094274		2	
26	2	9094274		2	
26	3	9094274		2	
26	1	9094297		1	
26	2	9094297		1	
26	3	9094297		1	
26	1	9094268		2	
26	2	9094268		2	
26	3	9094268		3	
26	1	9094319		3	
26	2	9094319		3	
26	3	9094319		1	
26	1	9094299		2	
26	2	9094299		2	x
26	3	9094299		2	x
26	1	9094307	x	1	
26	2	9094307	x	1	
26	3	9094307		2	
		ROW 27			
27	1	9092254		1	
27	2	9092254	x	1	
27	3	9092254	x	1	
27	1	9094300		3	
27	2	9094300		3	x
27	3	9094300		3	

Row	Plant	Accession	2010 Forage preselect	9/27/2010 Height rating 1=tall 3=short	2010 HV turf/short preselect
27	1	Cuivre		2	
27	2	Cuivre		2	
27	3	Cuivre		2	
27	1	9094265		2	
27	2	9094265		1	
27	3	9094265		1	
27	1	9094264		2	
27	2	9094264		2	x
27	3	9094264		2	
27	1	EWP		1	
27	2	EWP		1	
27	3	EWP		1	
27	1	9094272		2	
27	2	9094272		1	
27	3	9094272		1	
27	1	9092249		2	
27	2	9092249		2	
27	3	9092249		2	
27	1	9094311		2	
27	2	9094311		1	
27	3	9094311		1	
		ROW 28			
28	1	9094270		2	
28	2	9094270		2	
28	3	9094270		2	
28	1	9092252	x	1	
28	2	9092252		1	
28	3	9092252	x	1	
28	1	9094301		1	
28	2	9094301		1	
28	3	9094301		1	
28	1	9094296		2	
28	2	9094296		2	
28	3	9094296		2	
28	1	9094269		1	
28	2	9094269		2	
28	3	9094269		2	
28	1	9094290		2	x
28	2	9094290		1	
28	3	9094290		2	

Table VW-3. Breeder population selected from initial assembly of Virginia wildrye

Acc.	State	County	# plants	Acc.	State	County	# plants	Acc.	State	County	# plants
9092247	MN	Clay	9	9092257	SD	Beadle	9	9092245	ND	Richland	1
9092250	MN	Aitkin	9	9094263	SD	Clay	4	9092246	ND	Cass	3
9092251	MN	Mille Lacs	9	9094264	SD	Clay	6	9092249	ND	Morton	9
9092253	MN	Aitkin	9	9094265	SD	Yankton	9	9092252	ND	Walsh	6
9092254	MN	Sherburne	9	9094266	SD	Union	7	9092259	ND	Emmons	8
9092255	MN	Sherburne	9	9094273	SD	Hanson	8	9092260	ND	Logan	7
9092256	MN	Aitkin	8	9094274	SD	Dewey	3	9094262	ND	Morton	8
9094261	MN	Rice	9	9094286	SD	Corson	9	9094267	ND	Oliver	8
9094277	MN	Polk	5	9094287	SD	Jackson	3	9094268	ND	Mercer	9
9094283	MN	Marshall	9	9094288	SD	Custer	7	9094269	ND	Mercer	9
9094284	MN	Marshall	9	9094289	SD	Harding	7	9094270	ND	Dunn	8
9094285	MN	Red Lake	3	9094290	SD	Shannon	8	9094271	ND	Stark	9
9094300	MN	Douglas	10	9094291	SD	Mellette	7	9094275	ND	Kidder	9
9094301	MN	Wadena	9	9094292	SD	Perkins	8	9094276	ND	Griggs	9
9094302	MN	Beltrami	9	9094293	SD	Fall River	9	9094278	ND	Nelson	9
9094303	MN	Norman	6	9094294	SD	Stanley	8	9094309	ND	McHenry	4
9094307	MN	Carlton	9	9094295	SD	Butte	9	9094310	ND	McLean	9
9094311	MN	Yellow Medicine	9	9094296	SD	Lawrence	9	9094323	ND	McKenzie	9
9094312	MN	LacQuiParle	8	9094297	SD	Roberts	8	9094324	ND	Golden Valley	9
9094313	MN	Sherburne	9	9094298	SD	Roberts	9	9094325	ND	Burleigh	9
9094316	MN	Pipestone	9	9094299	SD	Big Stone	2	9094327	ND	Renville	8
9094317	MN	Murray	2	9094304	SD	Hutchinson	2	9094328	ND	Bottineau	9
9094318	MN	Cottonwood	9	9094305	SD	Hand	4	9094329	ND	Mountrail	6
9094319	MN	Redwood	9	9094308	SD	Grant	1	9094330	ND	Ward	2
9094320	MN	Lyon	6	9094314	SD	Brookings	6	EWP			9
9094321	MN	Lincoln	8	9094315	SD	Minnehaha	6				
9094326	MN	Lac Qui Parle	9	9094322	SD	Marshall	3	Cuivre	MI		4

Table VW-4. Leaf/stem data, Virginia wildrye *Elymus virginicus*

Sample Date	Sample	Stems	Stem* wt (gm)	Leaves wt (gm)	Stem/Leaf (ratio)	Leaf/Stem (ratio)	Heads	Heads total wt (gm)	Head wt (gm)
8/14/2014	1	32	47.7	13.2	3.61	0.2767	32	20.6	0.64
8/14/2014	2	35	62.6	13.7	4.57	0.2188	35	26.1	0.75
8/14/2014	3	31	46.2	10.8	4.28	0.2338	31	17.0	0.55
8/14/2014	4	37	49.9	12.9	3.87	0.2585	37	21.5	0.58
8/14/2014	5	20	39.0	10.1	3.86	0.2590	20	17.4	0.87
8/14/2014	6	18	33.8	7.4	4.57	0.2189	18	12.2	0.68
8/14/2014	7	42	69.2	14.9	4.64	0.2153	42	28.7	0.68
8/14/2014	8	50	85.1	17.2	4.95	0.2021	50	32.0	0.64
8/14/2014	9	62	94.6	19.2	4.93	0.2030	62	36.7	0.59
8/14/2014	10	51	91.9	20.5	4.48	0.2231	51	34.5	0.68
8/14/2014	11	50	92.2	23.4	3.94	0.2538	50	40.5	0.81

* weight of stems does not include seed heads

ACTIVE STUDIES - TECHNICAL REPORT 2014

Study No. NDPMC-S-0704-CR

Study Name: Theodore Roosevelt National Park

Introduction**:** The Bismarck Plant Materials Center (PMC) entered into a cooperative agreement May 2007 to provide seed and technical information needed for revegetation of areas disturbed by construction activities in the North Unit Scenic Route 10 of the Theodore Roosevelt National Park (THRO) in western North Dakota. The agreement is between the National Park Service, Theodore Roosevelt National Park of the U.S. Department of Interior, and the USDA Natural Resources Conservation Service. The agreement expired on March 15, 2015. The Bismarck Plant Materials Center (PMC) originally agreed to produce native grass seed of six species collected in the Park by Park personnel and PMC staff. The new agreement terminates the production of slender/thickspike wheatgrass and green needlegrass because goaled seed amounts have been met. The seed produced at the PMC will be distributed to the Park for revegetation projects.

Targeted Species and Goaled Seed Amounts for Contract Period 2007-2014

Accession Number	Species	Common name	PLS pounds
9092172	*Pascopyrum smithii*	western wheatgrass	550
9092175	*Elymus trachycaulus*	slender wheatgrass	260
9092171	*Nassella viridula*	green needlegrass	240
9092174	*Bouteloua curtipendula*	sideoats grama	220
9092173	*Bouteloua gracilis*	blue grama	54
9092176	*Koeleria macrantha*	prairie junegrass	29

Accomplishments: Three seed production fields were managed and maintained using herbicides and hand rogueing for weed control. The fields were not irrigated in 2014. All fields produced seed and were harvested by straight combining. Seed was cleaned at the PMC and tested for purity and germination by the North Dakota State Seed Lab. Seed was distributed to the park on July 23, 2014.

Seed Production and Distribution

Species	Date Planted	Field Size	2014 Seed Production (PLS lbs.)	2014 Seed Harvest Date	Seed Test Date	Seed Distribution to Park in 2014 (PLS lbs.)	Inventory Remaining as of 5/1/2015 (PLS lbs.)
Western wheatgrass	2008	0.57	113	8/14/2014	2/6/2015	243	113
Slender wheatgrass	Field removed	0	NA	NA	NA	576	266
Green needlegrass	Field removed	0	NA	NA	NA	340	0
Sideoats grama	2012	0.3	117	9/4/2014	4/29/2015	194	120
Blue grama	2012	0.3	30	9/12/2014	5/1/2015	218	30
Prairie junegrass	Field removed	0	NA	NA	NA	5.3	4

Seed from a previous agreement with Little Bighorn National Battlefield (LIBI) was also distributed to THRO for their use on July 23, 2014. The species and amounts distributed from LIBI were 8 PLS pounds blue grama, 111 PLS pounds sideoats grama, 104 PLS pounds bluebunch wheatgrass and 268 PLS pounds green needlegrass.

Technology Development**:** All seed harvesting and cleaning protocols have been recorded and are available from the PMC.

ACTIVE STUDIES - TECHNICAL REPORT 2014

Study No. NDPMC-S-1004-CR

Study Name: Grand Teton National Park

Introduction**:** On June 1, 2010, the Natural Resources Conservation Service (NRCS), Plant Materials Center (PMC), Bismarck, North Dakota entered into an interagency agreement with the National Park Service (NPS), Grand Teton National Park (GTNP) to grow and produce seed of bluebunch wheatgrass (*Pseudoroegneria spicata*), slender wheatgrass (*Elymus trachycaulus*) and mountain bromegrass (*Bromus marginatus*) for use in revegetating Kelly Hay Fields. Fields were established at the PMC in 2010 with seed originating from the Park. The original contract period was 2010 thru 2012. The contract was extended for 2013 and 2014. At this time, it was agreed to grow the slender wheatgrass and mountain bromegrass and discontinue growing the bluebunch wheatgrass due to poor performance at this location. Seed harvested from these fields will be distributed to the Park for reclamation activities. The contract expired on December 31, 2014.

Targeted Species and Goaled Seed Amounts

Accession Number	Species	Common Name	Seed Amount (PLS lbs/year)
9094353	*Elymus trachycaulus*	slender wheatgrass	720
9094354	*Bromus marginatus*	mountain bromegrass	520

Accomplishments**:** Seed production was good for both slender wheatgrass and mountain bromegrass. There was no evidence of smut in the mountain bromegrass field. The fields were direct combined and dried prior to cleaning. The mountain bromegrass and slender wheatgrass seed was tested at the North Dakota State Seed Department.

Seed from the 2011, 2012 and 2013 seed lots were distributed to the park on September 15, 2014. The following seed amounts were shipped: 1,939 PLS pounds slender wheatgrass; 1,219 PLS pounds mountain bromegrass; and 0.27 pounds bluebunch wheatgrass.

Species	Date Planted	Seeding Rate (lbs PLS/ac)	Field Size (ac)	2014 Seed Production (lbs PLS)	2014 Seed Harvest Date	Seed Test Date	Seed Distribution to Park in 2014 (lbs PLS)	Inventory Remaining as of 5/1/2015 (lbs PLS)
Slender wheatgrass	5/26/2010	5.5	1.0	266	7/30	4/6/2015	1,939	266
Mountain Bromegrass	5/26/2010	10.0	1.0	295	7/29	5/11/2015	1,219	295
Bluebunch wheatgrass	Field removed		0	0	0	0	0.27	0

Technology Development: Combine settings, seed cleaning procedures and seed tests have been documented and are available from the PMC.

ACTIVE STUDIES - TECHNICAL REPORT 2014

Study No. NDPMC-S-1304-CR

Study Name: Mount Rushmore National Memorial

Introduction**.** On August 30, 2013, the USDA Natural Resources Conservation Service (NRCS), Plant Materials Center (PMC), Bismarck, North Dakota entered into an interagency agreement with the USDI National Park Service (NPS), Mount Rushmore National Memorial (MORU). The agreement period is from August 30, 2013 to September 30, 2017. The PMC agrees to increase seed for use in rehabilitation of social trails at the Mount Rushmore National Memorial. Seed will be collected by NPS staff of germplasm from populations as closely related as possible, both genetically and ecologically, to Park populations. NRCS will clean, test, and seed this material to seed production fields on the NRCS Bismarck Plant Materials Center (PMC). The seed harvested from these fields will be cleaned, tested, and distributed to MORU for reclamation projects. The following species and amounts have been agreed upon by both parties.

Common Name	Scientific Name	Acres of Seed Production	Seed Amount PLS lbs/year (2015-2017)
Big bluestem	*Andropogon gerardii*	0.8	80
Little bluestem	*Schizachyrium scoparium*	0.8	80

Accomplishments: Seed was collected during the fall of 2013 by park employees. The seed was picked up by the PMC staff on March 19, 2014, and brought to the PMC. The seed was initially weighed, cleaned and accessioned. The clean seed was analyzed for germination and purity at the North Dakota State Seed Lab. On May 27, 2014, 0.8-acre fields of big bluestem and little bluestem were planted in panel A-4 at the PMC. The fields were irrigated and broadleaf weeds were controlled in 2014. The big bluestem field established very well while the little bluestem was slow to establish. The little bluestem field will be observed in the spring of 2015 to determine if the stand is acceptable.

2013 Seed collected by park staff used to establish production fields at PMC

Common Name	Scientific Name	Accession Number	Collection Date	Quantity of Material Received	Quantity of Clean Seed
Big bluestem	*Andropogon gerardii*	9094438	Fall 2013	13.5 lbs	4.1 lbs PLS
Little bluestem	*Schizachyrium scoparium*	9094437	Fall 2013	6.5 lbs	1.6 lbs PLS

Technology Development: All seed harvesting and cleaning protocols have been recorded and are available from the PMC.

ACTIVE STUDIES: TECHNICAL REPORT 2014

Study NDPMC-T-0105-CP

Study Title: Plant Materials for Saline Sites

Introduction: Salinity is a soil property referring to the amount of soluble salt in the soil. It is generally a problem of arid and semiarid regions. Electrical conductivity (EC) is the most common measure of soil salinity and is indicative of the ability of an aqueous solution to carry an electric current. By agricultural standards, soils with an EC greater than 4 dS/m are considered saline. In actuality, salt-sensitive plants may be affected by conductivities less than 4 dS/m and salt tolerant species may not be impacted by concentrations of up to twice this maximum agricultural tolerance limit.

Objective: Compare establishment and forage production of perennial grasses and legumes over salinity gradients.

Cooperators: Carrington Research Extension Center, Carrington, North Dakota The USDA Natural Resources Conservation Service Plant Materials Center, Bismarck North Dakota, Foster and Stutsman County Soil Conservation Districts

Location: Three sites located near Barlow, Buchanan, and Carrington, North Dakota

Major Land Resource Area: The study is located in MLRA 53B.

Soils:
Barlow: G211A, Fram-Wyard loams, 0 to 3 percent slopes
G229A, Heimdal-Emrick loams, 0 to 3 percent slopes

Buchanan: 18, Hamerly-Svea loams, 0 to 3 percent slopes
24, Svea-Barnes loams, 0 to 3 percent slopes

Carrington: G119A, Vallers-Hamerly loams, saline, 0 to 3 percent slopes
G230B, Heimdal-Esmond loams, 3 to 6 percent slopes

Materials and Methods

Planting Plan: Three off-center demonstration plots were seeded the spring of 2010. Two of the plots are located in close proximity of the Carrington Research and Extension Center in central North Dakota. See **Figure CA-1** for plot layout at the pasta plant location. The third is located east of Buchanan, North Dakota. The plots were not replicated but each species was planted through a recorded salinity gradient. All plots were laid out in the same order. Data collection is as follows:

1. Plant germination and stand establishment counts across the gradient for each species.
2. Stand health and progression or regression across the gradient, measured annually.
3. EC measured at intervals across the gradient with an EM 38 machine at planting and annually to map changes in salinity throughout the plots over time.
4. Plant herbage production across the gradient for each species to determine potential yield of each species at differing salinities on dates deemed most appropriate for optimum forage harvest. Grasses clipped once per season. Alfalfa and legume species clipped twice per year if regrowth sufficient after the first cutting.
5. Forage quality analysis on all grass species in the trial.

Common Name	Cultivar
Smooth bromegrass	Lincoln
Tall wheatgrass	Alkar
Hybrid wheatgrass	NewHy
Manystem wildrye	Shoshone
Creeping foxtail	Garrison
Green wheatgrass	AC Saltlander

Slender wheatgrass	Revenue
Western wheatgrass	Rodan
Canada wildrye	Mandan
Switchgrass	Forestburg
Prairie cordgrass	Red River
Prairie cordgrass	CREC Germplasm
Commercial Mix	50% AC Saltlander green wheatgrass, 25% slender wheatgrass, 25% Courtenay tall forage fescue
Alfalfa	12 varieties/lines
Strawberry clover	O'Conners
Forage kochia	2 sources

Site Preparation: The sites were tilled prior to seeding

Planting Method: Each plot is 10 feet wide by 200 feet long. A plot drill was used to seed all the plots.

Planting Date: Carrington and Barlow, May 22, 2010 and Buchanan, June 10, 2010

Irrigation: The fields are not irrigated.

Figure CA-1. Plot layout of salinity demonstration at the Pasta Plant location near Carrington, North Dakota

Results and Discussion

A considerable amount of information in this report has been provided by Ezra Aberle, Agronomy Research Specialist with the Carrington Research Extension Center.

2010: Plant germination and stand establishment counts were taken across the gradient for each species. Seedlings emerged in most of the test areas, however, many succumbed to the harsh environment in the more saline areas. This season the wheatgrasses provided thicker and more consistent stands across the gradient from non-saline to saline soil than the other grasses tested. This may change over time. There appears to be no clear differences in establishment of the alfalfas tested. This demonstration will track salinity, stand, and forage production over several seasons to help determine the most appropriate species for various salinity levels and targeted end uses by personnel, landowners, and/or renters. See **Table CA-1** for 2010 stand evaluation data.

2011: Plots received above normal precipitation this year, with some areas subjected to short term flooding. Plots of each species that had adequate stands were harvested on July 7th, the approximate stage for hay production. The prairie cordgrass plots were not harvested due to minimal, inconsistent, stands throughout the gradients. However, they may be harvested in the future if the stand improves. Harvested forage was weighed to determine yield and sampled for forage quality analysis. EC readings were taken in plots the same day they were harvested for yield. The Barlow site was clipped this year, but abandoned in the fall due to excessively saturated soils which resulted in loss of stand. Forage production and stand counts across increasing salinity levels at the Pasta Plant and Buchanan locations are combined in **Table CA-2** averages. Tall wheatgrass, Canada wildrye, Shoshone many-stem wildrye, most wheatgrasses, and salt tolerant crosses and mixes performed well, even in EC readings as high as 8 dS/m. Tall

wheatgrass, Shoshone many-stem wildrye, NewHy and the forage mix appeared to tolerate the highest saline conditions. Alfalfa production dropped off considerably in most entries, as EC ratings approached 5 dS/m. **Table CA-3** indicates the average of the combined forage quality of the grass species at the Pasta Plant and Buchanan locations across different salinity gradients. The forage mix, wheatgrass crosses and western wheatgrass displayed the highest combination of protein and relative feed value of the grasses, and tall wheatgrass was consistently on the lower end of the quality scale.

2012: Plots received considerably less precipitation this growing season and salinity level readings are generally lower as well. The wheatgrasses and Shoshone wildrye continue to provide stable yields across the salinity gradient. The wheatgrasses (with the exception of tall), the bromegrasses, and the wildryes provided forage with quality to maintain a dry or early gestation beef cow. The drop in salinity levels this year may have been a result of drier conditions. **Table CA-4** includes the combined average production of the cool season grasses at the Pasta Plant and Buchanan locations at different salinity gradients. **Table CA-5** includes the combined averages of the forage quality data from the Pasta Plant and Buchanan sites at different salinity gradients.

2013: Plots received good moisture in the early part of the growing season followed by an abnormally dry period in the July-August period. The Pasta Plant and Buchanan cool season grass plots were clipped on July 17. Due to schedule conflicts, this was at least one week later than what would normally be the approximate stage for hay production for most of these species. Results were fairly consistent with previous years as to differences in quality and production for different species and salinity gradients. Combined average production from both the Buchanan and Pasta Plant locations is shown in **Table CA-6. Table CA-7** is a 3-year summary of combined average production from both locations and all salinity gradients from 2011-2013. The numbers in bold indicate which species had greater production than the average of all species at each salinity gradient. Tall wheatgrass, NewHy, AC Saltlander, and the forage mix again provided the highest amounts of biomass. **Table CA-8** includes the combined averages of the forage quality data from the Pasta Plant and Buchanan sites at different salinity gradients. **Table CA-9** is a summary of forage quality averages from the previous table. Shoshone wildrye had the highest crude protein, but fell below the average in overall feed value, along with the tall and the slender wheatgrass varieties. The remaining species had RFV greater than the average of all. Comparing both production and forage quality together, it appears that AC Saltlander, NewHY, and AC Saltlander commercial mix perform best in the observed salinity gradients. **Figure CA-2** indicates saline tolerance of each grass species and provides confirmation that the varieties developed for saline tolerance perform well under typical field conditions, both in productivity and forage quality.

2014: Growing season precipitation averaged about 75% of normal and production was less than normal as a result. The alfalfa plots at both locations were clipped for production on June 17 and July 22. The cool season grass plots at both locations were clipped for production on July 8. **Table CA-10** provides a summary of average annual production of each species for the past 4 years under variable salinity gradients. **Table CA-11** provides the average of 4 years production for each species under different salinity gradients. July 8 visual observation notes for each species at each plot location are shown on **Table CA-12.** The Buchanan location has a greater percentage of the plots area that is highly saline. Thus, the soils/saline environment presents a greater challenge for long term stand survival of several species, and foxtail barley continues to encroach into those species that are typically shorter-lived and/or less saline tolerant. These species are disappearing from these plots and foxtail barley is replacing them. The more saline tolerant species continue to maintain a good to excellent stand where the salinity is not excessively high. The grass mix plot has reverted to mostly AC Saltlander. At the Pasta Plant location, most species that established well are still maintaining a good stand, although there increasing encroachment of some species (like tall wheatgrass) that are more saline tolerant, into those less tolerant species. The Canada wildrye plot is considerably thinner than previous years and Canada thistle is increasing in this plot. The Shoshone wildrye continues to persist well and increase in spots where it established originally. Listed here are definitions of abbreviations used in the following tables.

Abreviations Key

AP	=	Available Protein,%	**NDF**	=	Neutral Detrgent Fiber,%
ADF	=	Acid detergent Fiber,%	**NFC**	=	Non-Fiber Carbohydrates.,%
Ca	=	Calcium (Ca),%	**NEL**	=	Net Energy for maintenance, MCAL/LB
CF	=	Crude Fiber,%	**NEM**	=	Net Energy for Lactation ,MCAL/LB
CP	=	Crude Protein,%	**NEG**	=	Net Energy for Gain, MCAL/LB
DDM	=	Ddigestible Dry matter,%	**P**	=	Phosphous (P),%
HDP	=	Heat Damaged Protein,%	**RFV**	=	Relative feed Value
K	=	Potassium (K),%	**TDN**	=	Total Digestible Nutrients EST.,%
Mg	=	Magnesium (Mg),%			

Table CA-1. 2010 stand counts (plants/ft^2) for all locations

2010 Stand information assembled by location														
Location	Carrington Salinity Trial Initial Stand Counts from 3 Plot locations *(Plants per square foot at various salinity levels)*													
	PMC prairie cordgrass		slender wheatgrass		Creeping Foxtail		Smooth bromegrass		meadow bromegrass		Canada wildrye		beardless wildrye	
	Plants per Sq. Ft.	EC Reading	Plants per Sq. Ft.	EC Reading	Plants per Sq. Ft.	EC Reading	Plants per Sq. Ft.	EC Reading	Plants per Sq. Ft.	EC Reading	Plants per Sq. Ft.	EC Reading	Plants per Sq. Ft.	EC Reading
Pasta Plant	0	1.12	12	0.74	30	1.13	23	0.93	36	1.11	7	1.03	17	1.09
	0	1.36	14	1.12	43	1.15	37	0.96	30	1.29	11	1.43	8	1.13
	1	2.24	26	1.26	1	1.38	6	1.19	18	1.40	12	1.49	17	1.25
	0	2.40	23	1.32	13	1.40	44	1.36	26	1.52	25	1.52	38	1.32
	0	2.54	29	1.35	14	1.67	25	1.58	15	1.66	22	1.53	14	1.46
	0	2.55	16	1.58	12	1.99	17	1.68	44	1.81	15	1.63	24	1.78
	1	2.55	48	1.70	4	2.27	8	2.34	24	1.90	0	1.74	15	1.89
	1	3.42	6	2.30	3	2.33	0	2.48	0	1.95	6	1.86	5	2.19
	1	3.46	11	2.53	0	2.50	15	2.58	10	2.34	4	2.39	3	2.40
	0	3.46	4	3.05	3	2.60	1	2.60	2	2.47	2	2.49	2	2.48
	0	3.48	18	3.85	23	2.73	17	2.98	28	3.12	11	2.60	3	2.49
	0	4.14	4	3.89	6	3.24	12	3.21	0	3.49	15	3.06	43	2.65
	0	4.62	6	4.37	9	4.96	5	3.22	12	3.67	1	3.33	7	3.61
	0	4.98	19	5.18	0	4.96	1	3.55	8	4.11	0	3.33	23	7.43
	0	4.98	0	5.18	0	5.57	3	3.55	5	4.11	4	4.14	0	7.43
Barlow			12	0.74	30	1.13	23	0.93	36	1.11	7	1.03	8	1.13
			14	1.12	1	1.38	37	0.96	15	1.66	12	1.49	17	1.25
			26	1.26	13	1.40	6	1.19	44	1.81	25	1.52	24	1.78
			6	2.30	0	2.50	0	2.48	0	1.95	0	1.74	15	1.89
			4	3.05	6	3.24	15	2.58	12	3.67	4	2.39	3	2.40
Buchanan	0	1.36	23	1.32	43	1.15	44	1.36	30	1.29	11	1.43	17	1.09
	1	2.24	16	1.58	14	1.67	25	1.58	18	1.40	22	1.53	38	1.32
	0	2.40	48	1.70	12	1.99	17	1.68	26	1.52	15	1.63	14	1.46
	0	2.54	11	2.53	3	2.33	8	2.34	10	2.34	6	1.86	5	2.19
	0	3.48	4	3.89	3	2.60	1	2.60	2	2.47	2	2.49	2	2.48

Location	western wheatgrass		NewHy wheatgrass		AC Saltlander		AC Saltlander mix		Forestburg switchgrass		Travois Alfalfa		tall wheatgrass	
	Plants per Sq. Ft.	EC Reading	Plants per Sq. Ft.	EC Reading	Plants per Sq. Ft.	EC Reading	Plants per Sq. Ft.	EC Reading	Plants per Sq. Ft.	EC Reading	Plants per Sq. Ft.	EC Reading	Plants per Sq. Ft.	EC Reading
Pasta Plant	16	0.71	56	0.64	2	0.68	6	0.56	9	0.82	23	1.01	16	0.71
	24	0.79	16	0.83	31	0.88	52	0.56	29	0.86	20	1.05	26	0.99
	4	0.91	29	1.21	32	0.96	16	0.81	13	0.86	16	1.23	28	1.42
	13	1.19	18	1.27	12	1.03	56	0.82	27	1.15	4	1.27	5	1.44
	11	1.22	27	1.30	29	1.16	42	1.62	68	1.15	21	1.74	23	1.50
	28	1.42	33	1.47	27	1.23	12	1.71	20	1.83	43	1.82	33	1.62
	15	1.45	2	1.65	34	1.38	50	1.74	10	2.19	1	1.83	23	1.75
	3	1.90	22	1.75	18	1.53	30	2.70	6	2.43	25	2.46	2	1.80
	10	2.32	6	2.50	11	2.70	30	2.80	14	2.57	4	2.46	26	2.47
	31	2.47	9	3.13	7	2.83	16	2.95	1	2.65	14	2.53	16	2.97
	15	2.80	13	3.36	2	3.31	32	3.42	1	2.69	2	2.77	18	3.41
	6	2.80	0	3.61	11	3.61	26	3.82	1	3.07	8	3.01	27	3.44
	9	3.56	3	4.27	11	4.52	12	3.92	17	3.22	4	3.04	20	5.98
	2	4.13	28	4.29	0	4.52	7	3.92	1	3.22	34	3.38	15	5.98
	3	4.60	4	4.29	4	5.45	4	3.98	0	4.30	18	4.37	4	1.88
Barlow	16	0.71	16	0.83	2	0.68	6	0.56	9	0.82	20	1.05	16	0.71
	4	0.91	18	1.27	31	0.88	52	0.56	29	0.86	16	1.23	5	1.44
	13	1.19	27	1.30	12	1.03	16	0.81	13	0.86	4	1.27	33	1.62
	3	1.90	2	1.65	29	1.16	12	1.71	10	2.19	1	1.83	2	1.80
	10	2.32	6	2.50	7	2.83	32	3.42	1	2.69	2	2.77	4	1.88
Buchanan	24	0.79	56	0.64	32	0.96	56	0.82	27	1.15	23	1.01	26	0.99
	28	1.42	33	1.47	27	1.23	50	1.74	20	1.83	21	1.74	28	1.42
	15	1.45	22	1.75	18	1.53	30	2.70	6	2.43	14	2.53	23	1.50
	31	2.47	9	3.13	11	2.40	16	2.95	14	2.57	8	3.01	16	2.97
	2	4.13	3	4.27	2	3.31	4	3.98	1	2.65	4	3.04	18	3.41

Table CA-2 Average production and stand of Carrington plots – 2011

Table CA-2		2011 Carrington Average Production and Stand									
Variety/ Species	**Plot**	**plants/ ft2**	**EC**	**DM**	**Yield Dry T/acre**	**Variety/ Species**	**Plot**	**plants/ ft2**	**EC**	**DM**	**Yield Dry T/acre**
Garrison Creeping Foxtail	1	29.1	4.4	56%	3.3	**Revenue Slender Wheatgrass**	1	32.5	2.7	47%	4.2
	2	9.5	5.2	37%	2.5		2	15.6	3.9	48%	5.1
	3	8.1	4.7	36%	2.9		3	10.8	3.3	47%	4.2
	4	2.0	6.0	35%	2.2		4	7.4	4.9	48%	5.7
	5	2.0	5.6	39%	1.3		5	2.7	8.2	50%	2.0
	Averages-->	**10.2**	**5.2**	**41%**	**2.4**		**Averages-->**	**13.8**	**4.6**	**48%**	**4.2**
Lincoln Smooth Bromegrass	1	29.8	4.0	33%	1.8	**Rodan Western Wheatgrass**	1	16.3	2.3	44%	3.6
	2	16.9	4.4	53%	3.8		2	10.2	4.7	45%	3.0
	3	11.5	4.9	46%	3.3		3	19.0	3.7	48%	2.6
	4	5.4	5.3	52%	1.0		4	21.0	5.4	44%	3.1
	5	0.7	5.1	60%	1.2		5	1.4	8.2	51%	1.3
	Averages-->	**12.9**	**4.8**	**49%**	**2.2**		**Averages-->**	**13.5**	**4.9**	**46%**	**2.7**
Fleet Meadow Bromegrass	1	20.3	2.6	42%	2.5	**NewHy Hybrid Wheatgrass**	1	37.9	3.0	45%	3.5
	2	17.6	3.8	51%	2.0		2	22.3	4.7	44%	4.0
	3	12.2	3.3	44%	2.5		3	14.9	3.9	43%	3.6
	4	6.8	4.9	53%	2.8		4	6.1	5.6	42%	3.4
	5	1.4	5.1	66%	1.2		5	2.0	9.6	47%	2.7
	Averages-->	**11.6**	**3.9**	**51%**	**2.2**		**Averages-->**	**16.7**	**5.4**	**44%**	**3.5**
Mandan Canada Wildrye	1	14.9	3.4	43%	3.0	**AC Saltlander Green Wheatgrass**	1	21.7	1.7	46%	3.7
	2	7.4	3.5	40%	4.1		2	18.3	4.8	45%	4.2
	3	10.2	3.0	39%	3.9		3	12.2	3.8	45%	4.3
	4	4.1	4.7	41%	3.1		4	7.4	7.0	45%	5.1
	5	1.4	4.9	41%	2.6		5	1.4	10.0	46%	2.5
	Averages-->	**7.6**	**3.9**	**41%**	**3.3**		**Averages-->**	**12.2**	**5.5**	**45%**	**4.0**
Shoshone Beardless Wildrye	1	25.7	3.7	46%	1.1	**Saltlander Forage Grass Mix 50% AC Saltlander gwg 25% Revenue swg 25% Courtenay tff**	1	37.9	2.4	42%	4.8
	2	11.5	3.6	37%	3.4		2	33.9	4.1	42%	4.1
	3	9.5	3.8	46%	2.1		3	20.3	5.1	40%	4.1
	4	3.4	5.0	28%	2.5		4	10.8	4.6	41%	4.5
	5	1.4	5.8	44%	4.6		5	2.7	5.2	42%	3.8
	Averages-->	**10.3**	**4.3**	**40%**	**2.7**		**Averages-->**	**21.1**	**4.3**	**41%**	**4.2**
Alkar Tall Wheatgrass	1	17.6	3.5	34%	4.7						
	2	19.0	3.5	31%	5.3						
	3	15.6	4.2	36%	3.9						
	4	12.2	5.7	31%	7.7						
	5	10.8	10.7	36%	5.7						
	Averages-->	**15.0**	**5.5**	**34%**	**5.4**						

Table CA-3 Average forage quality of Carrington plots – 2011

Variety	Plot	CP	HDP	AP	NFC	ADF	NDF	CF	TDN EST.	NEL	NEM	NEG	DDM	(Ca)	(P)	(K)	(Mg)	RFV
Garrison creeping foxtail	1	5.9	0.67	5.7	18.9	44.2	63.9	35.4	52.2	0.53	0.47	0.22	54.5	0.47	0.20	1.75	0.17	79
	2	7.9	0.72	7.8	14.8	44.3	66.0	35.4	52.1	0.53	0.48	0.23	54.4	0.47	0.23	1.87	0.22	77
	3	8.7	0.69	8.7	16.5	42.7	63.5	34.2	53.9	0.55	0.50	0.25	55.7	0.51	0.25	2.09	0.21	82
	4	12.2	0.82	12.2	12.3	41.9	64.2	33.5	54.8	0.56	0.52	0.26	56.3	0.57	0.27	1.98	0.26	82
	5	5.8	0.67	5.6	16.6	45.3	66.3	36.2	50.9	0.51	0.46	0.21	53.6	0.41	0.20	1.81	0.16	75
Average--->		8.1	0.71	8.0	15.8	43.7	64.8	34.9	52.8	0.53	0.48	0.23	54.9	0.48	0.23	1.90	0.20	79
Lincoln smooth bromegrass	1	8.7	0.58	8.7	19.6	39.6	60.4	31.7	57.4	0.59	0.56	0.30	58.0	0.60	0.18	1.51	0.23	89
	2	7.6	0.51	7.6	17.7	39.5	63.4	31.6	57.5	0.59	0.56	0.30	58.1	0.42	0.13	1.12	0.19	85
	3	8.4	0.57	8.4	17.1	40.0	63.1	32.0	56.9	0.58	0.55	0.30	57.7	0.49	0.17	1.32	0.23	85
	4	5.2	0.54	5.2	19.5	40.0	64.0	32.0	57.0	0.58	0.55	0.29	57.7	0.35	0.11	1.00	0.15	84
	5	6.3	0.50	6.3	22.2	37.8	60.1	30.2	59.5	0.61	0.59	0.33	59.5	0.40	0.12	0.94	0.17	92
Average--->		7.3	0.54	7.2	19.2	39.4	62.2	31.5	57.6	0.59	0.56	0.30	58.2	0.45	0.14	1.17	0.19	87
Fleet meadow bromegrass	1	7.6	0.57	7.6	15.8	43.2	65.2	34.6	53.3	0.54	0.49	0.24	55.2	0.45	0.18	1.57	0.20	79
	2	5.8	0.64	5.6	16.1	42.2	66.9	33.8	54.4	0.55	0.51	0.26	56.0	0.35	0.15	1.28	0.16	78
	3	3.9	0.37	3.9	8.0	20.5	32.5	16.4	27.9	0.29	0.27	0.14	28.5	0.25	0.08	0.57	0.11	41
	4	7.4	0.70	7.4	14.9	40.8	66.4	32.6	56.0	0.57	0.54	0.28	57.1	0.40	0.18	1.30	0.19	80
	5	6.5	0.69	6.4	14.6	41.0	67.6	32.8	55.8	0.57	0.53	0.28	57.0	0.32	0.16	1.26	0.18	79
Average--->		7.8	0.74	7.7	17.3	46.9	74.6	37.6	61.8	0.63	0.58	0.30	63.4	0.44	0.19	1.49	0.21	89
Mandan Canada wildrye	1	5.9	0.52	5.9	13.3	43.6	69.5	34.8	52.9	0.54	0.49	0.24	55.0	0.36	0.17	1.26	0.20	74
	2	9.0	0.56	9.0	10.2	43.3	69.4	34.6	53.2	0.54	0.50	0.24	55.2	0.45	0.20	1.45	0.24	74
	3	7.4	0.54	7.4	13.8	43.2	67.5	34.5	53.4	0.54	0.49	0.24	55.3	0.43	0.18	1.34	0.20	76
	4	8.6	0.59	8.6	10.5	42.7	69.6	34.1	53.9	0.55	0.51	0.25	55.7	0.43	0.19	1.40	0.21	75
	5	8.5	0.57	8.5	10.7	43.1	69.5	34.4	53.5	0.54	0.50	0.24	55.4	0.40	0.17	1.35	0.21	74
Average--->		7.9	0.55	7.9	11.7	43.1	69.1	34.5	53.4	0.54	0.49	0.24	55.3	0.41	0.18	1.36	0.21	75
Shoshone manystem wildrye	1	6.7	0.61	6.7	15.4	42.6	66.5	34.1	53.9	0.55	0.51	0.25	55.7	0.33	0.18	1.87	0.13	78
	2	11.9	0.73	11.9	11.4	42.2	65.5	33.8	54.4	0.55	0.51	0.26	56.0	0.52	0.26	2.22	0.23	80
	3	6.1	0.71	5.9	13.1	44.3	69.5	35.4	52.1	0.53	0.47	0.23	54.4	0.35	0.19	1.93	0.14	73
	4	11.8	0.75	11.8	10.0	41.3	66.9	33.1	55.4	0.56	0.53	0.27	56.7	0.49	0.23	2.09	0.21	80
	5	10.1	0.75	10.1	7.4	44.9	71.2	35.9	51.4	0.52	0.47	0.22	53.9	0.43	0.25	2.24	0.22	71
Average--->		9.3	0.71	9.3	11.5	43.1	67.9	34.5	53.4	0.54	0.50	0.24	55.3	0.42	0.22	2.07	0.18	76

Variety	Plot	CP	HDP	AP	NFC	ADF	NDF	CF	TDN EST.	NEL	NEM	NEG	DDM	(Ca)	(P)	(K)	(Mg)	RFV
Alkar tall wheatgrass	1	7.2	0.53	7.2	7.0	47.7	74.5	38.1	48.2	0.48	0.41	0.17	51.8	0.26	0.22	1.86	0.18	65
	2	8.9	0.52	8.9	6.5	47.5	73.3	38.0	48.4	0.49	0.42	0.17	51.9	0.30	0.26	2.18	0.21	66
	3	5.6	0.52	5.5	6.8	48.5	76.3	38.8	47.2	0.47	0.40	0.15	51.1	0.19	0.20	1.79	0.15	62
	4	11.9	0.56	11.9	6.3	45.6	70.4	36.5	50.5	0.51	0.45	0.20	53.4	0.39	0.29	2.30	0.28	71
	5	9.3	0.50	9.3	6.5	45.8	72.9	36.6	50.4	0.51	0.45	0.20	53.2	0.29	0.26	2.09	0.22	68
Average--->		8.6	0.53	8.6	13.2	47.0	73.5	37.6	48.9	0.49	0.42	0.18	52.3	0.28	0.24	2.04	0.21	66
Revenue slender wheatgrass	1	6.3	0.69	6.2	7.0	47.9	75.4	38.3	48.0	0.48	0.41	0.16	51.6	0.30	0.14	1.20	0.15	64
	2	9.6	0.71	9.6	8.1	44.4	70.9	35.5	52.0	0.53	0.47	0.22	54.3	0.41	0.20	1.48	0.22	71
	3	7.6	0.69	7.6	5.3	46.1	73.0	36.9	50.0	0.50	0.44	0.19	53.0	0.37	0.15	1.32	0.18	68
	4	8.3	0.70	8.2	8.2	45.9	72.2	36.7	50.2	0.51	0.45	0.20	53.2	0.38	0.17	1.21	0.18	69
	5	9.4	0.66	9.4	7.4	43.5	71.8	34.8	53.0	0.54	0.49	0.24	55.0	0.38	0.16	1.25	0.21	71
Average--->		8.3	0.69	8.2	7.2	45.5	72.7	36.4	50.6	0.51	0.45	0.20	53.4	0.37	0.16	1.29	0.19	69
Rodan western wheatgrass	1	8.7	0.56	8.7	12.8	42.8	67.2	34.3	53.7	0.55	0.50	0.25	55.5	0.42	0.20	1.49	0.19	77
	2	9.7	0.52	9.7	12.0	41.1	67.0	32.9	55.7	0.57	0.53	0.28	56.9	0.35	0.18	1.35	0.19	79
	3	8.2	0.52	8.2	14.6	41.2	65.9	32.9	55.6	0.57	0.53	0.27	56.8	0.42	0.17	1.25	0.17	80
	4	8.5	0.56	8.5	14.3	41.5	65.9	33.2	55.2	0.57	0.52	0.27	56.6	0.44	0.19	1.35	0.22	80
	5	10.2	0.48	10.2	14.7	38.7	63.8	31.0	58.4	0.60	0.57	0.32	58.7	0.46	0.18	1.20	0.24	86
Average--->		9.1	0.53	9.1	13.7	41.1	66.0	32.9	55.7	0.57	0.53	0.28	56.9	0.42	0.18	1.33	0.20	80
NewHy hybrid wheatgrass	1	6.7	0.59	6.7	15.7	44.1	66.3	35.3	52.3	0.53	0.48	0.23	54.6	0.42	0.19	1.55	0.18	77
	2	6.9	0.59	6.9	17.3	42.7	64.4	34.1	53.9	0.55	0.51	0.25	55.7	0.43	0.18	1.49	0.19	80
	3	10.8	0.62	10.8	12.6	41.8	65.3	33.5	54.9	0.56	0.52	0.26	56.3	0.51	0.24	1.89	0.25	81
	4	10.5	0.61	10.5	13.6	41.7	64.6	33.4	55.0	0.56	0.52	0.27	56.4	0.51	0.24	1.75	0.26	81
	5	8.6	0.59	8.6	14.9	41.7	65.2	33.3	55.1	0.56	0.52	0.27	56.5	0.40	0.20	1.58	0.20	81
Average--->		8.7	0.60	8.7	14.8	42.4	65.2	33.9	54.2	0.55	0.51	0.25	55.9	0.45	0.21	1.65	0.22	80
AC Saltlander green wheatgrass	1	6.9	0.68	6.9	13.2	45.0	68.6	36.0	51.3	0.52	0.46	0.21	53.9	0.39	0.19	1.61	0.18	73
	2	6.9	0.53	6.9	20.3	40.2	61.5	32.2	56.7	0.58	0.55	0.29	57.6	0.49	0.17	1.36	0.20	87
	3	9.4	0.65	9.4	16.3	41.2	63.0	32.9	55.6	0.57	0.53	0.27	56.8	0.56	0.22	1.59	0.24	84
	4	10.6	0.60	10.6	16.0	39.4	62.1	31.5	57.6	0.59	0.56	0.31	58.2	0.56	0.21	1.44	0.26	87
	5	10.1	0.57	10.1	14.0	40.6	64.6	32.5	56.2	0.57	0.54	0.29	57.3	0.48	0.23	1.56	0.24	83
Average--->		8.8	0.60	8.8	16.0	41.3	63.9	33.0	55.5	0.56	0.53	0.27	56.7	0.50	0.20	1.51	0.22	83

Variety	Plot	CP	HDP	AP	NFC	ADF	NDF	CF	TDN EST.	NEL	NEM	NEG	DDM	(Ca)	(P)	(K)	(Mg)	RFV
Saltlander forage mix	1	7.8	0.63	7.8	16.1	42.4	64.8	33.9	54.2	0.55	0.51	0.25	55.9	0.49	0.20	1.54	0.21	80
	2	9.5	0.70	9.5	12.9	42.4	66.3	33.9	54.2	0.55	0.51	0.26	55.9	0.50	0.22	1.68	0.24	78
	3	11.6	0.69	11.6	13.1	40.8	64.0	32.6	56.0	0.57	0.54	0.28	57.1	0.59	0.25	1.85	0.31	83
	4	11.5	0.67	11.5	12.8	40.9	64.3	32.8	55.9	0.57	0.53	0.28	57.0	0.55	0.24	1.68	0.30	82
	5	10.8	0.55	10.8	14.4	39.8	63.4	31.8	57.2	0.59	0.55	0.30	57.9	0.48	0.23	1.69	0.27	85
Average--->		10.3	0.65	10.3	13.9	41.3	64.6	33.0	55.5	0.57	0.53	0.27	56.8	0.52	0.22	1.69	0.27	82

Table CA-4. Average production of Carrington plots – 2012

Variety & Species	Plot	EC 1:1 @ 3"	EC 1:1 @6"	DM	Yield Dry T/A	Variety & Species	Plot	EC 1:1 @ 3"	EC 1:1 @6"	DM	Yield Dry T/A
Garrison creeping foxtail	1	4.11	5.07	0.56	2.98	Revenue slender wheatgrass	1	3.01	3.40	0.55	2.83
	2	5.98	5.44	0.59	2.50		2	5.92	5.95	0.57	3.31
	3	6.27	5.71	0.62	2.46		3	4.45	5.47	0.59	3.08
	4	5.23	4.48	0.59	2.46		4	6.54	6.43	0.56	3.11
	5	5.04	5.85	0.46	2.41		5	7.13	8.99	0.57	2.94
Average->		**5.33**	**5.31**	**0.57**	**2.56**	**Average->**		**5.41**	**6.05**	**0.57**	**3.05**
Lincoln smooth bromegrass	1	4.49	4.52	0.58	2.67	Rodan western wheatgrass	1	2.82	4.18	0.58	2.78
	2	6.00	5.81	0.60	2.70		2	5.14	6.00	0.60	2.92
	3	5.69	5.36	0.68	2.80		3	6.85	6.74	0.56	2.55
	4	3.98	4.20	0.58	2.60		4	5.78	6.41	0.63	3.36
	5	6.16	3.72	0.79	1.43		5	8.36	6.82	0.60	2.52
Average->		**5.26**	**4.72**	**0.65**	**2.44**	**Average->**		**5.79**	**6.03**	**0.59**	**2.82**
Fleet meadow bromegrass	1	3.57	3.88	0.68	3.13	NewHy hybrid wheatgrass	1	2.14	2.67	0.63	2.98
	2	4.96	5.37	0.70	2.64		2	4.89	5.65	0.65	3.17
	3	5.78	4.78	0.86	1.54		3	5.40	6.29	0.57	2.94
	4	4.79	4.46	0.75	1.42		4	6.54	5.38	0.63	3.20
	5	5.70	4.14	0.87	1.42		5	9.66	10.04	0.60	2.71
Average->		**4.96**	**4.52**	**0.77**	**2.03**	**Average->**		**5.73**	**6.00**	**0.62**	**3.00**
Mandan Canada wildrye	1	4.43	4.13	0.51	2.76	AC Saltlander green wheatgrass	1	2.31	2.97	0.60	2.81
	2	4.95	5.15	0.58	3.31		2	5.65	5.71	0.62	3.05
	3	4.06	4.55	0.65	3.13		3	7.33	7.16	0.58	3.29
	4	5.49	5.81	0.61	1.63		4	7.02	5.35	0.58	3.10
	5	5.75	4.74	0.65	1.26		5	7.38	7.69	0.61	1.47
Average->		**4.94**	**4.88**	**0.60**	**2.42**	**Average->**		**5.94**	**5.78**	**0.59**	**2.75**

Variety & Species	Plot	EC 1:1 @ 3"	EC 1:1 @6"	DM	Yield Dry T/A
Shoshone manystem wildrye	1	2.86	4.07	0.56	2.74
	2	6.16	7.21	0.55	3.62
	3	4.75	7.25	0.52	2.53
	4	5.31	5.90	0.57	3.26
	5	7.61	7.61	0.55	3.29
Average->		**5.34**	**6.41**	**0.55**	**3.09**
Alkar tall wheatgrass	1	2.89	1.90	0.43	3.37
	2	5.42	5.55	0.56	3.67
	3	5.80	7.82	0.51	3.05
	4	5.11	5.15	0.43	2.92
	5	7.51	8.48	0.43	2.47
Average->		**5.35**	**5.78**	**0.47**	**3.10**

Variety & Species	Plot	EC 1:1 @ 3"	EC 1:1 @6"	DM	Yield Dry T/A
Saltlander forage mix	1	2.26	2.39	0.58	2.90
	2	4.05	6.56	0.63	3.43
	3	7.26	5.07	0.60	3.17
	4	8.54	8.38	0.59	3.28
	5	8.59	7.59	0.64	3.52
Average->		**6.14**	**6.00**	**0.61**	**3.26**

Table CA-5. Average forage quality of Carrington plots at increasing salinity gradients – 2012

Variety & Species	Plot	CP	HDP	AP	NFC	ADF	NDF	CF	TDN	NEL	NEM	NEG	DDM	Ca	P	K	Mg	RFV
Garrison creeping foxtail	1	4.0	0.59	3.7	23.4	41.6	61.3	33.3	55.1	0.56	0.52	0.27	56.5	0.51	0.13	1.15	0.11	86
	2	2.3	0.54	1.9	23.9	41.4	62.5	33.1	55.3	0.56	0.52	0.27	56.6	0.36	0.10	0.90	0.04	84
	3	3.2	0.53	2.9	25.7	39.1	59.8	31.3	58.0	0.60	0.57	0.31	58.5	0.48	0.10	0.83	0.08	92
	4	3.5	0.61	3.1	19.5	42.8	65.7	34.2	53.8	0.55	0.50	0.25	55.6	0.37	0.11	1.11	0.08	80
	5	5.1	0.55	5.0	20.3	42.4	63.3	33.9	54.2	0.55	0.51	0.25	55.9	0.39	0.15	1.25	0.10	82
Average->		**3.6**	**0.56**	**3.3**	**22.5**	**41.5**	**62.5**	**33.2**	**55.3**	**0.56**	**0.52**	**0.27**	**56.6**	**0.42**	**0.12**	**1.05**	**0.08**	**85**
Lincoln smooth bromegrass	1	5.3	0.51	5.3	24.9	38.7	58.5	30.9	58.5	0.60	0.57	0.32	58.8	0.57	0.09	0.82	0.15	93
	2	4.8	0.55	4.7	22.3	38.8	61.7	31.0	58.3	0.60	0.57	0.31	58.7	0.42	0.09	0.74	0.11	89
	3	4.0	0.51	3.9	24.9	39.0	59.8	31.2	58.1	0.60	0.57	0.31	58.6	0.51	0.07	0.79	0.11	92
	4	6.5	0.52	6.5	20.8	38.9	61.4	31.1	58.2	0.59	0.57	0.31	58.6	0.45	0.12	1.02	0.13	89
	5	4.4	0.47	4.4	22.1	41.1	62.2	32.9	55.6	0.57	0.53	0.27	56.9	0.35	0.10	0.83	0.11	85
Average->		**5.0**	**0.51**	**4.9**	**23.0**	**39.3**	**60.7**	**31.4**	**57.8**	**0.59**	**0.56**	**0.30**	**58.3**	**0.46**	**0.09**	**0.84**	**0.12**	**90**
Fleet meadow bromegrass	1	4.5	0.69	4.1	17.7	42.8	66.5	34.3	53.7	0.55	0.50	0.25	55.5	0.43	0.14	1.24	0.12	78
	2	4.7	0.70	4.4	18.3	42.2	65.7	33.8	54.4	0.55	0.51	0.26	56.0	0.53	0.11	1.10	0.14	80
	3	1.4	0.37	1.1	7.1	21.8	35.8	17.4	26.4	0.27	0.25	0.12	27.5	0.12	0.04	0.47	0.03	36
	4	3.7	0.70	3.2	14.3	43.3	70.7	34.7	53.1	0.54	0.49	0.24	55.1	0.28	0.10	0.79	0.09	73
	5	2.6	0.58	2.1	17.3	41.8	68.8	33.5	54.9	0.56	0.52	0.27	56.3	0.30	0.08	0.66	0.09	76
Average->		**3.4**	**0.60**	**3.0**	**15.0**	**38.4**	**61.5**	**30.7**	**48.5**	**0.49**	**0.45**	**0.22**	**50.1**	**0.33**	**0.09**	**0.85**	**0.09**	**69**
Mandan Canada wildrye	1	4.5	0.48	4.5	17.5	41.4	66.7	33.1	55.4	0.56	0.53	0.27	56.7	0.45	0.10	0.80	0.16	80
	2	4.6	0.45	4.6	18.2	41.1	65.9	32.9	55.7	0.57	0.53	0.28	56.9	0.41	0.09	0.75	0.15	80
	3	4.3	0.52	4.1	18.1	41.4	66.4	33.1	55.4	0.56	0.52	0.27	56.7	0.38	0.09	0.80	0.13	79
	4	5.5	0.47	5.5	18.2	41.2	65.0	33.0	55.6	0.57	0.53	0.28	56.8	0.42	0.12	0.89	0.16	82
	5	5.1	0.42	5.1	21.3	39.8	62.3	31.8	57.2	0.59	0.56	0.30	57.9	0.46	0.12	0.89	0.16	87
Average->		**4.8**	**0.47**	**4.7**	**18.6**	**41.0**	**65.3**	**32.8**	**55.9**	**0.57**	**0.53**	**0.28**	**57.0**	**0.42**	**0.10**	**0.82**	**0.15**	**82**

Variety & Species	Plot	CP	HDP	AP	NFC	ADF	NDF	CF	TDN	NEL	NEM	NEG	DDM	Ca	P	K	Mg	RFV
Shoshone manystem wildrye	1	5.1	0.71	4.8	15.1	43.2	68.5	34.5	53.3	0.54	0.49	0.24	55.3	0.38	0.15	1.49	0.10	75
	2	8.0	0.80	7.9	9.8	45.7	70.9	36.5	50.5	0.51	0.45	0.20	53.3	0.36	0.20	1.88	0.13	70
	3	7.7	0.73	7.5	13.3	42.3	67.7	33.8	54.4	0.55	0.51	0.26	56.0	0.46	0.17	1.61	0.15	77
	4	4.8	0.70	4.5	14.0	43.8	69.8	35.1	52.6	0.53	0.48	0.23	54.8	0.30	0.14	1.35	0.09	73
	5	7.3	0.70	7.2	12.7	42.2	68.7	33.8	54.4	0.56	0.51	0.26	56.0	0.38	0.19	1.66	0.15	76
Average->		**6.6**	**0.73**	**6.4**	**13.0**	**43.4**	**69.1**	**34.7**	**53.0**	**0.54**	**0.49**	**0.24**	**55.1**	**0.38**	**0.17**	**1.59**	**0.12**	**74**
Alkar tall wheatgrass	1	5.5	0.56	5.4	8.5	47.5	74.7	38.0	48.4	0.49	0.42	0.17	51.9	0.19	0.18	1.49	0.12	65
	2	3.8	0.53	3.6	12.4	46.1	72.5	36.9	49.9	0.51	0.44	0.19	53.0	0.20	0.12	1.10	0.10	68
	3	4.4	0.53	4.2	13.3	45.2	71.0	36.2	51.0	0.52	0.46	0.21	53.7	0.23	0.13	1.12	0.10	70
	4	4.7	0.57	4.5	9.8	48.0	74.2	38.4	47.8	0.48	0.41	0.16	51.5	0.19	0.15	1.38	0.10	65
	5	7.9	0.50	7.8	9.6	44.2	71.2	35.4	52.1	0.53	0.47	0.23	54.4	0.24	0.19	1.47	0.14	72
Average->		**5.2**	**0.54**	**5.1**	**10.7**	**46.2**	**72.7**	**37.0**	**49.9**	**0.50**	**0.44**	**0.19**	**52.9**	**0.21**	**0.15**	**1.31**	**0.11**	**68**
Revenue slender wheatgrass	1	4.7	0.62	4.5	15.4	41.0	68.6	32.8	55.8	0.57	0.54	0.28	57.0	0.41	0.10	0.74	0.12	77
	2	6.4	0.62	6.3	12.4	41.5	70.0	33.2	55.2	0.56	0.53	0.27	56.6	0.37	0.12	0.78	0.13	75
	3	5.2	0.65	5.0	14.3	41.6	69.2	33.2	55.2	0.56	0.52	0.27	56.5	0.39	0.10	0.73	0.12	76
	4	6.5	0.62	6.5	13.4	41.0	68.8	32.8	55.8	0.57	0.53	0.28	57.0	0.37	0.13	0.97	0.14	77
	5	8.6	0.57	8.6	13.5	39.3	66.7	31.5	57.7	0.59	0.56	0.30	58.3	0.40	0.15	0.98	0.18	81
Average->		**6.3**	**0.62**	**6.2**	**13.8**	**40.9**	**68.6**	**32.7**	**55.9**	**0.57**	**0.53**	**0.28**	**57.1**	**0.38**	**0.12**	**0.84**	**0.14**	**77**
Rodan western wheatgrass	1	5.0	0.47	5.0	21.2	38.7	62.6	31.0	58.4	0.60	0.57	0.31	58.8	0.46	0.11	0.73	0.13	87
	2	5.8	0.56	5.7	19.6	38.5	63.3	30.8	58.6	0.60	0.58	0.32	58.9	0.46	0.11	0.65	0.14	87
	3	8.1	0.46	8.1	18.3	37.7	62.2	30.2	59.5	0.61	0.59	0.33	59.5	0.49	0.14	0.96	0.19	89
	4	7.4	0.57	7.4	17.3	38.4	64.0	30.7	58.7	0.60	0.58	0.32	59.0	0.42	0.12	0.76	0.13	86
	5	9.0	0.52	9.0	16.2	38.4	63.5	30.7	58.8	0.60	0.58	0.32	59.0	0.49	0.18	1.17	0.20	87
Average->		**7.1**	**0.52**	**7.0**	**18.5**	**38.4**	**63.1**	**30.7**	**58.8**	**0.60**	**0.58**	**0.32**	**59.0**	**0.46**	**0.13**	**0.85**	**0.16**	**87**

Variety & Species	Plot	CP	HDP	AP	NFC	ADF	NDF	CF	TDN	NEL	NEM	NEG	DDM	Ca	P	K	Mg	RFV
NewHy hybrid wheatgrass	1	3.6	0.44	3.4	25.7	38.1	59.4	30.5	59.1	0.60	0.58	0.32	59.2	0.44	0.08	0.71	0.11	93
	2	4.2	0.54	4.0	23.1	39.1	61.4	31.3	57.9	0.59	0.57	0.31	58.4	0.46	0.10	0.79	0.11	88
	3	4.5	0.49	4.5	23.2	38.8	60.9	31.1	58.3	0.60	0.57	0.31	58.7	0.42	0.10	0.81	0.12	90
	4	3.7	0.51	3.5	22.7	39.3	62.3	31.4	57.8	0.59	0.56	0.31	58.3	0.40	0.09	0.82	0.10	87
	5	6.7	0.51	6.6	21.0	37.8	61.0	30.2	59.5	0.61	0.59	0.33	59.5	0.48	0.13	0.97	0.18	91
Average->		**4.5**	**0.49**	**4.4**	**23.1**	**38.6**	**61.0**	**30.9**	**58.5**	**0.60**	**0.57**	**0.31**	**58.8**	**0.44**	**0.10**	**0.82**	**0.12**	**90**
AC Saltlander green wheatgrass	1	3.8	0.50	3.6	24.4	37.9	60.5	30.3	59.4	0.61	0.59	0.33	59.4	0.44	0.10	0.77	0.09	91
	2	4.2	0.48	4.1	24.4	37.7	60.0	30.2	59.5	0.61	0.59	0.33	59.5	0.48	0.10	0.81	0.11	92
	3	6.8	0.47	6.8	20.1	38.3	61.8	30.7	58.8	0.61	0.58	0.32	59.0	0.39	0.13	1.07	0.14	89
	4	6.9	0.52	6.9	20.2	38.5	61.7	30.8	58.6	0.60	0.58	0.32	58.9	0.43	0.13	1.03	0.15	89
	5	6.8	0.53	6.8	21.8	36.9	60.1	29.5	60.5	0.62	0.60	0.34	60.2	0.50	0.14	0.91	0.19	93
Average->		**5.7**	**0.50**	**5.6**	**22.2**	**37.9**	**60.8**	**30.3**	**59.4**	**0.61**	**0.59**	**0.33**	**59.4**	**0.44**	**0.12**	**0.92**	**0.14**	**91**
Saltlander forage mix	1	4.6	0.53	4.4	23.4	39.2	60.7	31.4	57.8	0.59	0.56	0.31	58.3	0.48	0.13	1.14	0.13	89
	2	4.7	0.51	4.6	24.1	38.0	59.9	30.4	59.3	0.61	0.59	0.33	59.3	0.48	0.10	0.87	0.13	92
	3	5.4	0.52	5.4	20.0	39.1	63.2	31.3	57.9	0.59	0.57	0.31	58.4	0.35	0.12	0.95	0.12	86
	4	8.6	0.52	8.6	18.9	36.3	61.2	29.0	61.2	0.63	0.61	0.35	60.7	0.46	0.15	1.05	0.17	92
	5	7.6	0.52	7.5	18.7	38.5	62.4	30.8	58.6	0.60	0.58	0.32	58.9	0.47	0.15	1.14	0.17	88
Average->		**6.2**	**0.52**	**6.1**	**21.0**	**38.2**	**61.5**	**30.6**	**59.0**	**0.60**	**0.58**	**0.32**	**59.1**	**0.45**	**0.13**	**1.03**	**0.14**	**90**

Table CA-6. Carrington production average, 2011-2013

Species	Plot	EC 1:1 @ 3"	EC 1:1 @6"	DM	Yield Dry T/A		Species	Plot	EC 1:1 @ 3"	EC 1:1 @6"	DM	Yield Dry T/A
Garrison creeping foxtail	1	5.02	0.00	50%	2.37		Revenue slender wheatgrass	1	1.07	0.00	58%	2.44
	2	5.07	0.00	46%	2.22			2	2.32	0.00	58%	2.64
	3	6.22	0.00	49%	2.24			3	4.31	0.00	57%	2.49
	4	6.99	0.00	47%	2.55			4	3.15	0.00	57%	2.60
	5	6.31	0.00	46%	2.31			5	3.46	0.00	56%	2.72
Averages-->		5.92	0.00	48%	2.34		Averages-->		2.86	0.00	57%	2.58
Lincoln smooth bromegrass	1	5.97	0.00	57%	3.04		Rodan western wheatgrass	1	0.74	0.00	56%	2.45
	2	5.81	0.00	42%	1.89			2	1.70	0.00	57%	2.59
	3	5.25	0.00	54%	2.34			3	2.68	0.00	55%	2.36
	4	2.78	0.00	56%	2.82			4	5.26	0.00	55%	2.53
	5	4.99	0.00	63%	1.43			5	3.38	0.00	54%	2.60
Averages-->		4.96	0.00	54%	2.30		Averages-->		2.75	0.00	55%	2.50
Fleet meadow bromegrass	1	4.80	0.00	57%	2.44		NewHy hybrid wheatgrass	1	1.71	0.00	54%	2.39
	2	3.79	0.00	72%	2.88			2	3.45	0.00	56%	2.67
	3	6.13	0.00	89%	0.21			3	4.69	0.00	54%	2.69
	4	2.78	0.00	80%	1.24			4	5.03	0.00	54%	2.58
	5	2.31	0.00	71%	1.14			5	4.01	0.00	53%	3.00
Averages-->		3.96	0.00	74%	1.58		Averages-->		3.78	0.00	54%	2.67
Mandan Canada wildrye	1	2.18	0.00	52%	2.27		AC Saltlander green wheatgrass	1	1.07	0.00	53%	2.31
	2	3.77	0.00	51%	2.29			2	3.49	0.00	53%	2.70
	3	4.03	0.00	50%	1.94			3	3.53	0.00	54%	2.83
	4	3.68	0.00	51%	2.36			4	5.29	0.00	53%	2.77
	5	2.48	0.00	63%	1.53			5	4.21	0.00	55%	3.11
Averages-->		3.23	0.00	53%	2.08		Averages-->		3.52	0.00	54%	2.74

Species	Plot	EC 1:1 @ 3"	EC 1:1 @6"	DM	Yield Dry T/A
Shoshone Manystem Wildrye	1	1.12	0.00	54%	2.28
	2	1.29	0.00	52%	2.42
	3	4.17	0.00	52%	2.48
	4	5.82	0.00	50%	2.49
	5	4.81	0.00	48%	2.62
Averages-->		3.44	0.00	51%	2.46
Alkar Tall Wheatgrass	1	1.00	0.00	44%	2.50
	2	3.69	0.00	45%	2.64
	3	2.43	0.00	47%	2.93
	4	2.96	0.00	42%	3.05
	5	1.90	0.00	44%	3.09
Averages-->		2.39	0.00	44%	2.84

Species	Plot	EC 1:1 @ 3"	EC 1:1 @6"	DM	Yield Dry T/A
Saltlander Forage Mix	1	0.90	0.00	40%	1.80
	2	1.13	0.00	55%	2.83
	3	3.06	0.00	56%	2.97
	4	4.08	0.00	52%	2.89
	5	6.39	0.00	53%	3.13
Averages-->		3.11	0.00	51%	2.72

Table CA-7. 3-year average forage production at Carrington, 2011-2013

Variety/Species	Clip 1		Clip 2		Clip 3		Clip 4		Clip 5		AVG EC @ 2" dS/m	AVG Yield T/A
	EC @ 2" dS/m	Dry Tons/ Acre	EC @ 2" dS/m	Dry Tons/ Acre	EC @ 2" dS/m	Dry Tons/ Acre	EC @ 2" dS/m	Dry Tons/ Acre	EC @ 2" dS/m	Dry Tons/ Acre		
Garrison creeping foxtail	4.5	**2.9**	5.1	2.4	5.7	2.3	6.2	2.2	5.8	1.9	**5.4**	**2.4**
Lincoln smooth bromegrass	4.6	2.4	5.3	**3.4**	4.9	2.8	4.3	2.1	5.4	1.7	**4.9**	**2.5**
Fleet meadow bromegrass	3.6	2.5	3.9	2.6	4.7	1.4	4.1	2.0	4.2	1.6	**4.1**	**2.0**
Mandan Canada wildrye	3.4	2.5	4.0	3.6	3.6	3.1	4.4	2.4	4.3	2.0	**4.0**	**2.7**
Shoshone beardless wildrye	2.5	2.3	4.0	3.0	3.9	1.9	5.5	2.2	6.1	**3.2**	**4.4**	**2.5**
Alkar tall wheatgrass	2.6	**3.6**	4.0	**4.1**	4.5	**3.6**	5.0	**4.3**	6.6	**4.1**	**4.6**	**3.9**
Revenue slender wheatgrass	2.3	**3.0**	3.8	**3.8**	3.9	**3.1**	4.8	**3.3**	6.4	**2.6**	**4.2**	**3.2**
Rodan western wheatgrass	1.9	2.8	3.8	2.7	4.3	2.2	5.2	2.6	7.0	2.3	**4.5**	**2.5**
NewHy hybrid wheatgrass	2.3	**3.2**	4.2	**3.3**	4.4	**2.9**	5.7	**3.0**	7.8	**3.1**	**4.9**	**3.1**
AC Saltlander green wheatgrass	1.9	**3.2**	4.3	**3.3**	4.8	**3.6**	6.5	**3.8**	7.3	2.5	**5.0**	**3.3**
Saltlander Forage Grass Mix	2.0	**3.6**	3.1	**3.4**	4.8	**3.5**	5.9	**3.6**	7.6	**3.7**	**4.7**	**3.6**
Mean -->	2.9	2.9	4.1	3.2	4.5	2.8	5.2	2.9	6.2	2.6	4.6	2.9

Siemens	
Unit system	SI derived unit
Unit of	Electric conductance
Symbol	S
Named after	Werner von Siemens
In SI base units:	$1\ S = 1\ kg^{-1} \cdot m^{-2} \cdot s^{3} \cdot A^{2}$

- EC dS/m = measurement of electrical conductance.
- Higher numbers indicate increasing soil salinity.
- Readings > 4 indicate highly saline situation.
- Numbers in **bold** indicate higher forage production than the average of all species

Table CA-8. Forage quality (plot averages) at Carrington - 2013

Variety / Species	Plot	CP	HDP	AP	NFC	ADF	NDF	CF	TDN	NEL	NEM	NEG	DDM	(Ca),%	(P),%	(K),%	MAG (Mg),%	RFV
Garrison creeping foxtail	1	4.1	0.59	3.8	20.8	43.5	63.8	34.8	53.0	0.54	0.49	0.24	55.0	0.48	0.14	1.38	0.13	80
	2	3.8	0.58	3.5	20.6	43.7	64.3	35.0	52.7	0.54	0.49	0.23	54.8	0.49	0.14	1.32	0.13	80
	3	4.3	0.60	4.0	21.5	42.0	62.9	33.6	54.7	0.56	0.52	0.26	56.2	0.50	0.14	1.26	0.15	83
	4	4.4	0.60	4.1	18.2	45.1	66.1	36.0	51.2	0.52	0.46	0.21	53.8	0.43	0.17	1.69	0.15	76
	5	4.2	0.57	4.0	19.7	43.9	64.8	35.1	52.5	0.53	0.48	0.23	54.7	0.48	0.14	1.43	0.14	79
Averages-->		4.2	0.59	3.9	20.2	43.6	64.4	34.9	52.8	0.53	0.49	0.23	54.9	0.47	0.14	1.42	0.14	80
Lincoln smooth bromegrass	1	4.3	0.54	4.1	21.5	42.3	62.9	33.8	54.3	0.55	0.51	0.26	56.0	0.52	0.07	0.88	0.15	83
	2	4.7	0.46	4.7	22.4	40.9	61.6	32.7	55.9	0.57	0.54	0.28	57.0	0.55	0.10	1.07	0.19	86
	3	4.2	0.44	4.2	22.7	41.3	61.7	33.1	55.4	0.56	0.53	0.28	56.7	0.55	0.08	0.94	0.18	85
	4	4.6	0.46	4.6	22.5	41.1	61.5	32.9	55.6	0.57	0.53	0.28	56.8	0.53	0.10	1.10	0.18	87
	5	5.7	0.52	5.7	20.1	42.3	62.8	33.8	54.4	0.56	0.51	0.26	56.0	0.54	0.12	1.18	0.20	83
Averages-->		4.7	0.48	4.7	21.8	41.6	62.1	33.3	55.1	0.56	0.52	0.27	56.5	0.54	0.09	1.03	0.18	85
Fleet meadow bromegrass	1	5.9	0.59	5.9	18.3	44.5	64.4	35.6	51.8	0.52	0.47	0.22	54.2	0.65	0.15	1.51	0.21	79
	2	5.2	0.52	5.1	19.3	42.7	64.3	34.1	53.9	0.55	0.50	0.25	55.7	0.58	0.12	1.25	0.20	81
	3	4.5	0.59	4.3	15.7	44.7	68.5	35.8	51.6	0.52	0.46	0.21	54.1	0.48	0.09	1.02	0.16	73
	4	5.9	0.57	5.9	18.4	43.6	64.5	34.9	52.9	0.53	0.49	0.23	55.0	0.67	0.15	1.48	0.24	79
	5	7.0	0.58	7.0	20.2	42.4	61.5	33.9	54.2	0.55	0.51	0.25	55.9	0.79	0.18	1.63	0.27	85
Averages-->		5.7	0.57	5.6	18.4	43.6	64.6	34.9	52.9	0.53	0.49	0.23	55.0	0.63	0.14	1.38	0.21	79
Mandan Canada wildrye	1	6.0	0.53	6.0	15.1	41.7	67.7	33.4	55.0	0.56	0.52	0.27	56.4	0.49	0.10	0.87	0.19	78
	2	5.5	0.50	5.5	17.0	41.5	66.2	33.2	55.3	0.56	0.53	0.27	56.6	0.47	0.10	0.81	0.18	80
	3	5.3	0.52	5.3	18.0	40.4	65.3	32.3	56.5	0.58	0.55	0.29	57.5	0.51	0.10	0.87	0.17	82
	4	5.6	0.53	5.5	16.9	41.4	66.2	33.1	55.3	0.56	0.53	0.27	56.6	0.50	0.11	0.86	0.19	80
	5	5.8	0.51	5.8	17.9	40.8	64.9	32.6	56.0	0.57	0.54	0.28	57.1	0.48	0.11	0.81	0.17	82
Averages-->		5.6	0.52	5.6	17.0	41.2	66.1	32.9	55.6	0.56	0.53	0.27	56.8	0.49	0.10	0.84	0.18	80

Variety / Species	Plot	CP	HDP	AP	NFC	ADF	NDF	CF	TDN	NEL	NEM	NEG	DDM	(Ca),%	(P),%	(K),%	MAG (Mg),%	RFV
Shoshone manystem wildrye	1	6.9	0.79	6.7	12.9	43.1	68.9	34.5	53.4	0.54	0.50	0.24	55.3	0.48	0.19	1.72	0.16	75
	2	6.4	0.78	6.2	12.8	42.6	67.8	34.9	52.9	0.54	0.49	0.24	55.0	0.44	0.19	1.73	0.14	74
	3	7.1	0.76	7.0	11.6	43.5	70.0	34.8	53.0	0.54	0.49	0.24	55.0	0.44	0.18	1.68	0.15	73
	4	8.0	0.79	8.0	11.0	43.9	69.7	35.1	52.5	24.45	0.51	0.35	28.1	0.49	0.20	1.83	0.17	73
	5	7.2	0.78	7.1	12.3	43.4	69.2	34.7	53.0	0.54	0.49	0.24	55.1	0.47	0.21	1.92	0.17	74
Averages-->		7.1	0.78	7.0	12.1	43.3	69.1	34.8	53.0	5.32	0.49	0.26	49.7	0.46	0.19	1.77	0.16	74
Alkar tall wheatgrass	1	6.1	0.52	6.1	9.5	46.8	73.1	37.4	49.2	0.49	0.43	0.18	52.4	0.30	0.16	1.19	0.16	67
	2	5.0	0.51	5.0	10.9	46.7	72.7	37.3	49.3	0.50	0.43	0.18	52.5	0.30	0.15	1.13	0.17	67
	3	4.9	0.57	4.8	10.1	48.2	73.6	38.5	47.6	0.48	0.41	0.16	51.4	0.28	0.15	1.18	0.16	65
	4	6.4	0.48	6.4	10.6	45.9	71.7	36.7	50.3	0.51	0.45	0.20	53.2	0.34	0.18	1.43	0.18	69
	5	6.4	0.47	6.4	10.1	45.7	72.2	36.6	50.4	0.51	0.45	0.20	53.3	0.35	0.18	1.41	0.20	69
Averages-->		5.8	0.51	5.7	10.2	46.6	72.7	37.3	49.4	0.49	0.43	0.18	52.6	0.31	0.16	1.26	0.17	67
Revenue slender wheatgrass	1	5.7	0.52	5.7	14.1	41.0	68.9	32.8	55.8	0.57	0.54	0.28	57.0	0.43	0.10	0.70	0.16	77
	2	6.5	0.63	6.4	13.5	40.6	68.7	32.5	56.2	0.58	0.54	0.28	57.2	0.46	0.11	0.83	0.16	78
	3	5.3	0.65	5.1	14.9	41.7	68.5	33.4	55.0	0.56	0.52	0.26	56.4	0.45	0.10	0.75	0.15	77
	4	5.6	0.68	5.4	11.6	43.7	71.5	35.0	52.7	0.53	0.49	0.23	54.8	0.42	0.12	0.92	0.14	71
	5	6.0	0.67	5.9	11.9	43.5	70.8	34.8	53.0	0.54	0.49	0.24	55.0	0.39	0.12	0.83	0.14	72
Averages-->		5.8	0.63	5.7	13.2	42.1	69.7	33.7	54.5	0.55	0.51	0.26	56.1	0.43	0.11	0.81	0.15	75
Rodan western wheatgrass	1	5.3	0.41	5.3	17.9	39.7	65.5	31.8	57.2	0.58	0.56	0.30	57.9	0.51	0.09	0.63	0.18	82
	2	5.3	0.43	5.3	16.4	40.6	67.0	32.5	56.3	0.58	0.54	0.29	57.3	0.41	0.10	0.74	0.17	80
	3	4.2	0.41	4.1	17.4	41.1	67.1	32.9	55.7	0.56	0.52	0.27	56.9	0.44	0.08	0.59	0.17	79
	4	5.5	0.42	5.5	17.0	40.1	66.1	32.1	56.9	0.58	0.55	0.29	57.7	0.48	0.11	0.69	0.18	81
	5	5.5	0.45	5.5	16.5	40.6	53.8	50.1	55.4	0.55	0.52	0.27	56.7	0.46	0.11	0.82	0.18	79
Averages-->		5.1	0.42	5.1	17.1	40.4	63.9	35.9	56.3	0.57	0.54	0.28	57.3	0.46	0.09	0.69	0.17	80

Variety / Species	Plot	CP	HDP	AP	NFC	ADF	NDF	CF	TDN	NEL	NEM	NEG	DDM	(Ca),%	(P),%	(K),%	MAG (Mg),%	RFV
NewHy Hybrid Wheatgrass	1	4.8	0.48	4.7	22.8	39.8	61.1	31.8	57.2	0.58	0.55	0.30	57.9	0.49	0.12	0.99	0.15	88
	2	4.5	0.54	4.3	22.4	40.4	61.8	32.3	56.5	0.58	0.54	0.29	57.4	0.50	0.13	1.14	0.15	86
	3	4.2	0.55	4.0	21.9	40.9	62.6	32.7	56.0	0.57	0.53	0.28	57.1	0.50	0.13	1.22	0.15	85
	4	3.8	0.54	3.6	21.5	41.6	63.3	33.3	55.1	0.56	0.52	0.27	56.5	0.47	0.13	1.19	0.15	83
	5	7.0				40.5	62.8	32.4	56.4	0.57	0.54	0.29	57.4	0.51	0.18	1.45	0.21	85
Averages-->		4.9	0.53	4.2	22.1	40.6	62.3	32.5	56.2	0.57	0.54	0.28	57.3	0.49	0.14	1.20	0.16	85
AC Saltlander Green Wheatgrass	1	6.1	0.58	6.1	21.6	38.6	61.0	30.9	58.6	0.60	0.58	0.32	58.9	0.53	0.15	1.19	0.16	90
	2	4.2	0.56	4.0	21.7	40.9	62.8	32.7	56.0	0.57	0.54	0.28	57.1	0.49	0.12	1.15	0.14	85
	3	3.7	0.55	3.4	22.4	41.0	62.6	32.8	55.8	0.57	0.53	0.28	57.0	0.49	0.10	1.12	0.12	85
	4	4.5	0.53	4.4	22.8	39.6	61.3	31.7	57.4	0.59	0.56	0.30	58.0	0.45	0.12	1.12	0.13	88
	5	6.2	0.57	6.1	18.0	41.5	64.5	33.2	55.2	0.56	0.53	0.27	56.5	0.48	0.15	1.29	0.18	82
Averages-->		5.0	0.55	4.8	21.3	40.3	62.4	32.3	56.6	0.58	0.54	0.29	57.5	0.49	0.13	1.17	0.14	86
Saltlander Forage Mix	1	5.6	0.70	5.4	19.3	42.1	63.8	33.7	54.6	0.56	0.52	0.26	56.1	0.56	0.19	1.62	0.23	82
	2	4.7	0.59	4.4	22.2	40.6	61.9	32.5	56.2	0.58	0.54	0.29	57.3	0.55	0.14	1.31	0.17	86
	3	4.1	0.57	3.9	22.6	40.9	61.9	32.8	55.9	0.57	0.54	0.28	57.0	0.50	0.12	1.23	0.15	86
	4	5.8	0.56	5.8	20.5	40.3	62.5	32.3	56.6	0.58	0.54	0.29	57.5	0.48	0.16	1.41	0.17	86
	5	6.9	0.54	6.8	21.6	38.8	60.2	31.0	58.3	0.60	0.57	0.31	58.7	0.53	0.17	1.32	0.22	91
Averages-->		5.4	0.59	5.2	21.2	40.6	62.0	32.4	56.3	0.57	0.54	0.28	57.3	0.52	0.15	1.38	0.18	86

Table CA-9. Forage quality summary (all locations and salinity levels) at Carrington – 2013

Variety and Species	CP	ADF	NDF	CF	TDN	RFV
Garrison creeping foxtail	4.15	43.63	64.37	34.91	52.80	**79.74**
Lincoln smooth bromegrass	4.71	41.58	62.11	33.27	**55.14**	**84.82**
Fleet meadow bromegrass	**5.70**	43.60	64.60	34.90	52.90	**79.00**
Mandan Canada wildrye	**5.64**	41.15	66.07	**32.92**	**55.63**	**80.09**
Shoshone manystem wildrye	**7.13**	43.29	69.12	34.79	52.97	73.76
Alkar tall wheatgrass	**5.77**	46.64	72.66	37.31	49.37	67.36
Revenue slender wheatgrass	**5.81**	42.11	69.66	33.69	**54.54**	74.98
Rodan western wheatgrass	5.15	**40.42**	**63.91**	35.86	**56.30**	**80.26**
NewHy hybrid wheatgrass	4.85	**40.63**	**62.33**	**32.50**	**56.23**	**85.48**
AC Saltlander green wheatgrass	4.95	**40.31**	**62.44**	**32.25**	**56.59**	**85.77**
saline forage mix	**5.42**	**40.55**	**62.04**	**32.44**	**56.32**	**86.09**
Averages->	**5.40**	**40.93**	**64.04**	**33.14**	**53.10**	**77.23**

** Numbers in **Bold** indicate **quality** that is better than the plot averages; CF, ADF, NDF, and CF values below the average indicate better quality

Figure CA-2. Observed Salinty Tolerance at Carrington, North Dakota - 2013

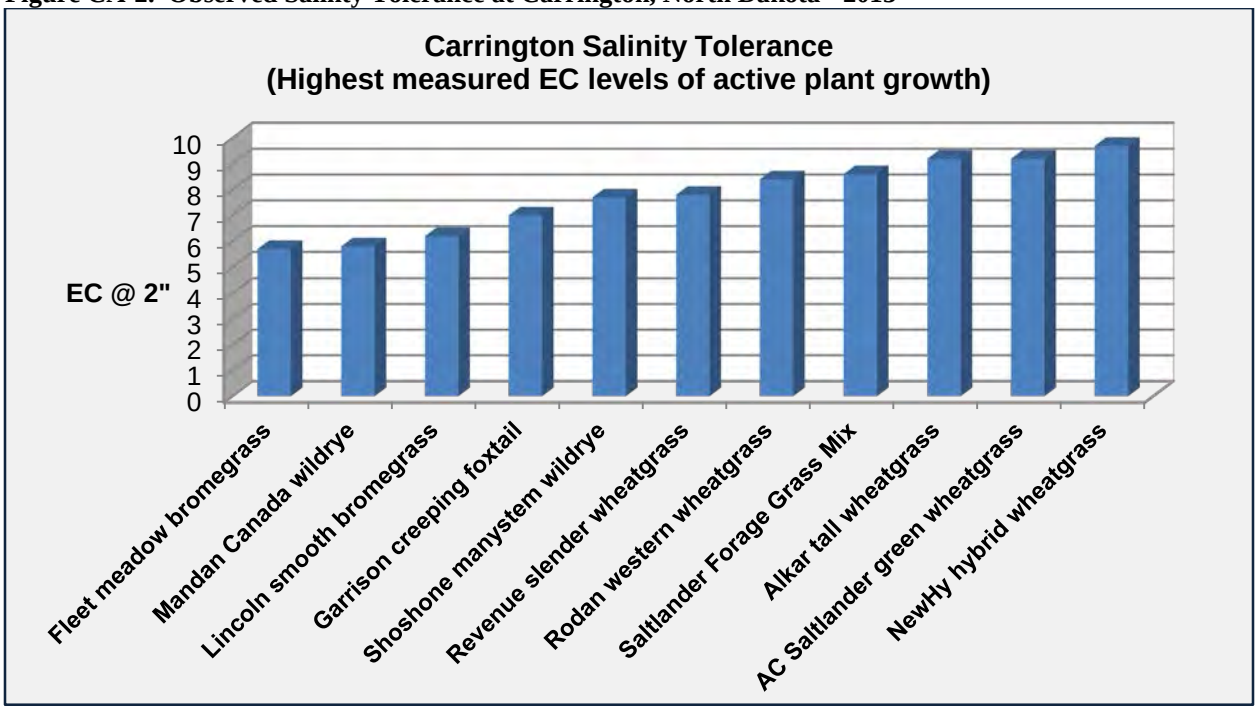


Table CA-10. Annual herbage production, 2011-2014 (averages of both sites combined) under variable salinity gradients

Year	Species	Variety	EC 1 @2" dS/m	Yield 1 Dry T/acre	EC 2 @2" dS/m	Yield 2 Dry T/acre	EC 3 @2" dS/m	Yield 3 Dry T/acre	EC 4 @2" dS/m	Yield 4 Dry T/acre	EC 5 @2" dS/m	Yield 5 Dry T/acre
2011	creeping foxtail	Garrison	4.4	3.1	4.6	2.5	4.9	2.3	6.2	1.9	6.0	1.4
2012	creeping foxtail	Garrison	4.2	3.0	6.0	2.5	6.3	2.5	5.3	2.5	5.1	2.4
2013	creeping foxtail	Garrison	5.0	2.4	5.1	2.2	6.2	2.2	7.0	2.6	6.3	2.3
2014	creeping foxtail	Garrison	2.4	2.0	2.9	1.2	3.0	2.1	2.9	2.1	5.0	1.3
2011	smooth bromegrass	Lincoln	3.8	1.7	4.4	4.9	4.1	3.0	5.5	1.4	5.2	2.1
2012	smooth bromegrass	Lincoln	4.5	2.7	6.0	2.7	5.7	2.8	4.0	2.6	6.2	1.4
2013	smooth bromegrass	Lincoln	6.0	3.1	5.8	1.9	5.3	2.4	2.8	2.8	5.0	1.5
2014	smooth bromegrass	Lincoln	3.0	2.5	2.9	1.4	3.2	2.2	2.6	1.2	4.1	1.2
2011	meadow bromegrass	Fleet	2.8	2.2	3.3	2.3	3.1	2.1	4.6	2.9	4.4	1.9
2012	meadow bromegrass	Fleet	3.6	3.1	5.0	2.7	5.8	1.6	4.8	1.5	5.7	1.4
2013	meadow bromegrass	Fleet	4.8	2.5	3.8	2.9	6.2	0.2	2.8	1.3	2.3	1.2
2014	meadow bromegrass	Fleet	1.7	2.2	2.9	1.1	2.3	2.0	2.5	2.2	3.7	1.0
2011	Canada wildrye	Mandan	3.6	2.5	3.6	4.6	3.0	3.9	4.2	2.9	4.5	2.9
2012	Canada wildrye	Mandan	4.5	2.8	5.0	3.3	4.1	3.2	5.5	1.7	5.8	1.3
2013	Canada wildrye	Mandan	2.2	2.3	3.8	2.3	4.1	2.0	3.7	2.4	2.5	1.5
2014	Canada wildrye	Mandan	2.4	1.3	2.1	1.2	2.2	2.1	3.3	2.2	4.8	1.0
2011	manystem wildrye	Shoshone	3.3	1.9	4.4	2.9	3.2	1.2	5.5	1.4	5.9	3.5
2012	manystem wildrye	Shoshone	2.9	2.8	6.2	3.6	4.8	2.6	5.3	3.3	7.7	3.3
2013	manystem wildrye	Shoshone	1.2	2.3	1.3	2.4	4.2	2.5	5.8	2.5	4.8	2.6
2014	manystem wildrye	Shoshone	1.8	1.2	2.0	2.2	2.4	1.1	4.0	2.3	4.1	2.7
2011	tall wheatgrass	Alkar	3.5	4.4	3.2	5.4	5.1	4.4	6.3	6.0	9.2	5.9
2012	tall wheatgrass	Alkar	2.9	3.4	5.5	3.7	5.8	3.1	5.2	2.9	7.5	2.5
2013	tall wheatgrass	Alkar	1.0	2.5	3.7	2.7	2.4	3.0	3.0	3.1	1.9	3.1
2014	tall wheatgrass	Alkar	1.7	2.4	2.4	2.2	2.5	2.1	4.4	2.2	4.7	3.0
2011	slender wheatgrass	Revenue	2.7	3.4	3.3	4.9	3.3	3.4	4.8	4.0	7.8	2.3
2012	slender wheatgrass	Revenue	3.0	2.9	6.0	3.3	4.5	3.1	6.6	3.2	7.2	3.0
2013	slender wheatgrass	Revenue	1.1	2.5	2.3	2.7	4.3	2.5	3.2	2.6	3.5	2.8
2014	slender wheatgrass	Revenue	1.7	2.4	1.9	2.5	3.2	1.3	4.0	2.2	3.8	2.3
2011	western wheatgrass	Rodan	2.1	3.1	4.4	2.6	3.8	1.8	4.8	2.0	8.4	2.0
2012	western wheatgrass	Rodan	2.8	2.8	5.2	3.0	6.9	2.6	5.8	3.4	8.4	2.5
2013	western wheatgrass	Rodan	0.8	2.5	1.7	2.6	2.7	2.4	5.3	2.6	3.4	2.6
2014	western wheatgrass	Rodan	1.3	2.4	1.5	2.5	3.5	1.3	3.0	2.3	4.2	2.6
2011	hybrid wheatgrass	NewHy	2.9	3.8	4.2	3.8	3.5	3.1	5.5	3.0	9.1	3.4
2012	hybrid wheatgrass	NewHy	2.2	3.0	4.9	3.2	5.4	2.9	6.6	3.2	9.7	2.8
2013	hybrid wheatgrass	NewHy	1.7	2.4	3.5	2.7	4.7	2.7	5.0	2.6	4.0	3.0
2014	hybrid wheatgrass	NewHy	1.5	2.2	1.7	2.3	3.2	2.4	3.2	1.9	4.2	2.7
2011	green wheatgrass	AC Saltlander	2.1	4.0	4.0	4.0	4.1	4.3	6.9	4.9	9.2	2.7
2012	green wheatgrass	AC Saltlander	2.3	2.9	5.7	3.1	7.4	3.3	7.0	3.1	7.4	1.5
2013	green wheatgrass	AC Saltlander	1.1	2.3	3.5	2.7	3.5	2.9	5.3	2.8	4.2	3.1
2014	green wheatgrass	AC Saltlander	1.6	2.3	1.2	2.4	3.1	2.4	3.4	2.9	3.3	2.8
2011	Saltlander Forage Grass Mix		2.5	5.3	3.8	3.8	4.3	4.1	5.4	4.4	7.7	4.3
2012	Saltlander Forage Grass Mix		2.3	2.9	4.1	3.5	7.3	3.2	8.6	3.3	8.6	3.5
2013	Saltlander Forage Grass Mix		0.9	1.8	1.1	2.9	3.1	3.0	4.1	2.9	6.4	3.2
2014	Saltlander Forage Grass Mix		1.5	2.2	1.6	2.3	2.8	2.6	3.0	2.7	3.2	2.8
		Mean	**2.6**	**2.7**	**3.7**	**2.8**	**4.2**	**2.5**	**4.7**	**2.7**	**5.6**	**2.4**
		C.V.	**36.8**	**30.9**	**42.4**	**27.9**	**44.9**	**41.5**	**44.0**	**45.9**	**35.0**	**49.4**
		LSD 0.05	**1.8**	**1.6**	**3.0**	**1.6**	**3.5**	**2.0**	**4.0**	**2.4**	**3.8**	**2.3**

Table CA-11. Combined 4-year average production of each species under variable salinity gradients (both sites)

Species	Variety	EC 1 @2" dS/m	Yield 1 Dry T/acre	EC 2 @2" dS/m	Yield 2 Dry T/acre	EC 3 @2" dS/m	Yield 3 Dry T/acre	EC 4 @2" dS/m	Yield 4 Dry T/acre	EC 5 @2" dS/m	Yield 5 Dry T/acre
creeping foxtail	Garrison	4.0	2.7	4.6	2.2	5.1	2.3	5.4	2.2	5.6	1.8
smooth bromegrass	Lincoln	4.2	2.4	4.7	3.0	4.5	2.6	3.9	1.9	5.1	1.6
meadow bromegrass	Fleet	3.1	2.5	3.7	2.2	4.2	1.5	3.8	2.0	4.1	1.4
Canada wildrye	Mandan	3.2	2.2	3.6	3.0	3.3	2.9	4.2	2.3	4.4	1.8
manystem wildrye	Shoshone	2.4	2.0	3.6	2.8	3.6	1.8	5.2	2.2	5.6	3.1
tall wheatgrass	Alkar	2.4	3.3	3.6	3.7	4.1	3.3	4.9	3.8	6.2	3.9
slender wheatgrass	Revenue	2.2	2.8	3.4	3.5	3.7	2.7	4.6	3.1	5.8	2.5
western wheatgrass	Rodan	1.8	2.7	3.3	2.6	4.1	2.0	4.7	2.5	6.4	2.4
hybrid wheatgrass	NewHy	2.1	2.9	3.6	3.1	4.1	2.8	5.1	2.7	7.0	3.0
green wheatgrass	AC Saltlander	1.9	3.3	2.8	3.2	4.3	3.3	5.3	3.4	6.6	3.5
forage grass mix	saline mix	1.8	3.0	3.6	3.1	4.5	3.3	5.8	3.6	6.4	2.5
Mean		2.7	2.7	3.7	2.9	4.1	2.6	4.8	2.7	5.7	2.5
C.V.		36.8	30.9	42.4	27.9	44.9	41.5	44.0	45.9	35.0	49.4
LSD 0.05		0.9	0.8	1.5	0.8	1.8	1.0	2.0	1.2	1.9	1.2

Table CA-12. Visual observations of individual species at both plot locations on July 8, 2014.

Species	Variety	Buchanan Site	Pasta Plant Site
prairie cordgrass	CREC Germplasm	No plants observed	Some of the stand is visible
Creeping foxtail	Garrison	Considerable foxtail barley and prickly lettuce where the stand was present; most saline areas have no stand	Good stand except in the higher salinity portion
Smooth bromegrass	Lincoln	Considerable foxtail barley and prickly lettuce where the stand was present; most saline areas have no stand	Good stand except in the higher salinity portion
Meadow bromegrass	Fleet	Most of the stand is gone; full of foxtail barley	Good stand except in the higher salinity portion
Canada wildrye	Mandan	Considerable stand loss; replaced with foxtail barley	Mostly poor stand, especially where Canada thistle is present
Manystem wildrye	Shoshone	Stand is much more persistent where plants originally established	Mostly good stand with some brome invasion
Tall wheatgrass	Alkar	Perfect stand with no invaders	Good stand with no invaders
Slender wheatgrass	Revenue	Stand is greatly reduced from last year and foxtail barley is moving in	Good stand
Western wheatgrass	Rodan	80% persistent stand, 20% foxtail barley	Good stand
Hybrid wheatgrass	NewHy	Perfect stand with no invasive plants	Good stand
Green wheatgrass	AC Saltlander	Perfect stand with no invasive plants	Good stand
Forage Grass Mix	Commercial saline mix	Mostly AC Saltlander	East side is all fescue; rest is mostly AC Saltlander
prairie cordgrass	Red River	No plants observed	
switchgrass	Forestburg	No plants observed	

ACTIVE STUDIES: TECHNICAL REPORT 2014

Study Number	**NDPMC-T-1201**
Title	**Rhizome Growth Comparison of AC Saltlander, NewHy, Quackgrass, and Smooth Brome**
Objective	Compare rhizome spread, seed production and overall growth of AC Saltlander and NewHy to quackgrass and smooth brome.
Duration	2012-2014
Cooperators	USDA, NRCS Bismarck Plant Materials Center
Location	Bismarck, ND PMC
-----Soils	Mandan silt loam
-----MLRA	53B
-----Precip.	**Ave.**(1981-2010): 17.8 inches **2013**: 26.75 inches

Background information: Palatable forage species are needed for planting on saline sites. Available species for planting these sites are limited. Recent releases, AC Saltlander and NewHy are adapted to saline conditions. Seed is available in the seed market. Both releases are quackgrass hybrids. Quackgrass is a noxious weed in many states. It is strongly rhizomatous and can become invasive. Though the literature indicates that these releases have a more bunch-type growth than quackgrass, questions have been raised about their invasiveness in the Dakota's and Minnesota. The effects that rhizome spread and seed production may have on land adjoining the area where AC Saltlander and NewHy may be planted is of concern. Data from this study will be considered when determining the inclusion or exclusion of these releases in the ND NRCS Field Office Technical Guide. In this study, AC Saltlander and NewHy are compared with quackgrass and smooth brome. Smooth brome is also a very rhizomatous species that can become invasive.

AC Saltlander was developed by researchers in Utah and Saskatchewan. Its parental origin is Turkey. It is a natural hybrid between the Eurasian bluebunch wheatgrass complex (*Pseudoroegneria strigosa, P. geniculate, P. stififolia*) and quackgrass (*Elymus repens*). Its common name is green wheatgrass and the species name of the cross is *Elymus hoffmannii*. The physical characteristics of the seed are similar to quackgrass but it is genetically different from quackgrass. Plants from the original collection were selected for bunchy growth, vegetative vigor, leafiness, seed set, uniform plant color and freedom from pests. It was further selected for resistance to root zone salinity, winter hardiness, and other desirable traits. It is documented to have a limited degree of rhizomatous growth.

NewHy was developed by USDA forage breeders in Utah. It was synthetically developed by crossing quackgrass with the native North American bluebunch wheagrass (*Pseudoroegneria spicata*). Field trials in Utah, Idaho, and Montana suggest it is suitable for sites with moderate to severe salinity which receive at least 13 inches of moisture.

Methods and Materials

Seed Source	AC Saltlander, NewHy, Rebound smooth brome, quackgrass
Propagation	Seed planted to cone-tainers in the greenhouse, then seedlings planted to field bed
-----Greenhouse	**Planting Date:** March 2012 **Pots:** Ray Leach cone-tainers™ (2" x 7") **Soil:** Miracle Grow Potting Mix
-----Field	**Planting Date:** May 21, 2012 **Planting Method:** By hand with dibble bar **Conditions**: soil firm and slightly moist, black and free of growing weeds
Assembly	See **Figure RH-1** for plot layout
-----Location	Bismarck Plant Materials Center, Panel A **USDA Hardiness Zone (2012):** 4a
-----Design	Randomized complete block **Reps:** 4; each of the four species were planted in blocks of 10 plants for each replication.
Data Collection	**Dates:** 7/20/2012, 9/12/2012, 5/16/2013, 7/12/2013
-----Parameters	**2012:** height, width, vigor, no. of culms, rhizome spread, plant size **2013:** biomass, height, rhizome spread, stand
-----Methods	Measurements and Ratings. Biomass was clipped to a 4-6"stubble height using a REM forage harvester. Samples were dried to determine biomass; based on number of plants clipped.
-----Data	See **Table RH-1** for data for all parameters except biomass. See **Table RH-2** for biomass data for clipped forage amounts.

Field Maintenance	
-----2012	Weeding, spot sprayed glyphosate on strawberry clover and Canada thistle
-----2013	Hand weeding, spot spraying of Canada thistle

Results and Discussion

2012: Plant growth was good for all species. The dry, hot conditions for 2012 probably slowed growth on all plants in the study. Only a few plants died from transplanting. As first year transplants, plants were becoming established and plant growth was not consistent. Quackgrass height, overall, was shorter compared to the other entries. Rhizome growth appeared to start later in the season. Visual observations of the plots after the September data collection showed tremendous rhizome spread for some plants. This growth will be captured with 2013 measurements. Strawberry clover was previously planted in the field used for this study. It was controlled in 2012, but may become a problem if it is not closely managed.

2013: Growth was measured in May and July of 2013. Plants continued to grow taller and wider as the year progressed. Height and widths averaged across all replications for a species showed quackgrass to have the greatest spread and the shortest stature when measured in July 2013. Spread for NewHy and AC Saltlander was greater than for smooth brome, but less than quackgrass.

2014: No data was collected. Plots were mowed between the rows to keep weeds from going to seed. The area has become contaminated with various grassy species. It did not appear that any of the entries being tested were spreading outside the boundaries of the plots. Visually, the quackgrass appeared to be spreading the most, which is expected. It is recommended that the plots be destroyed in 2015. Based on observations since planting, the AC Saltlander and the NewHy did not spread aggressively by rhizomes in an untilled plot.

Figure RH-1. Plot layout of rhizome growth comparison of ACSaltlander, NewHy, quackgrass, and smooth brome

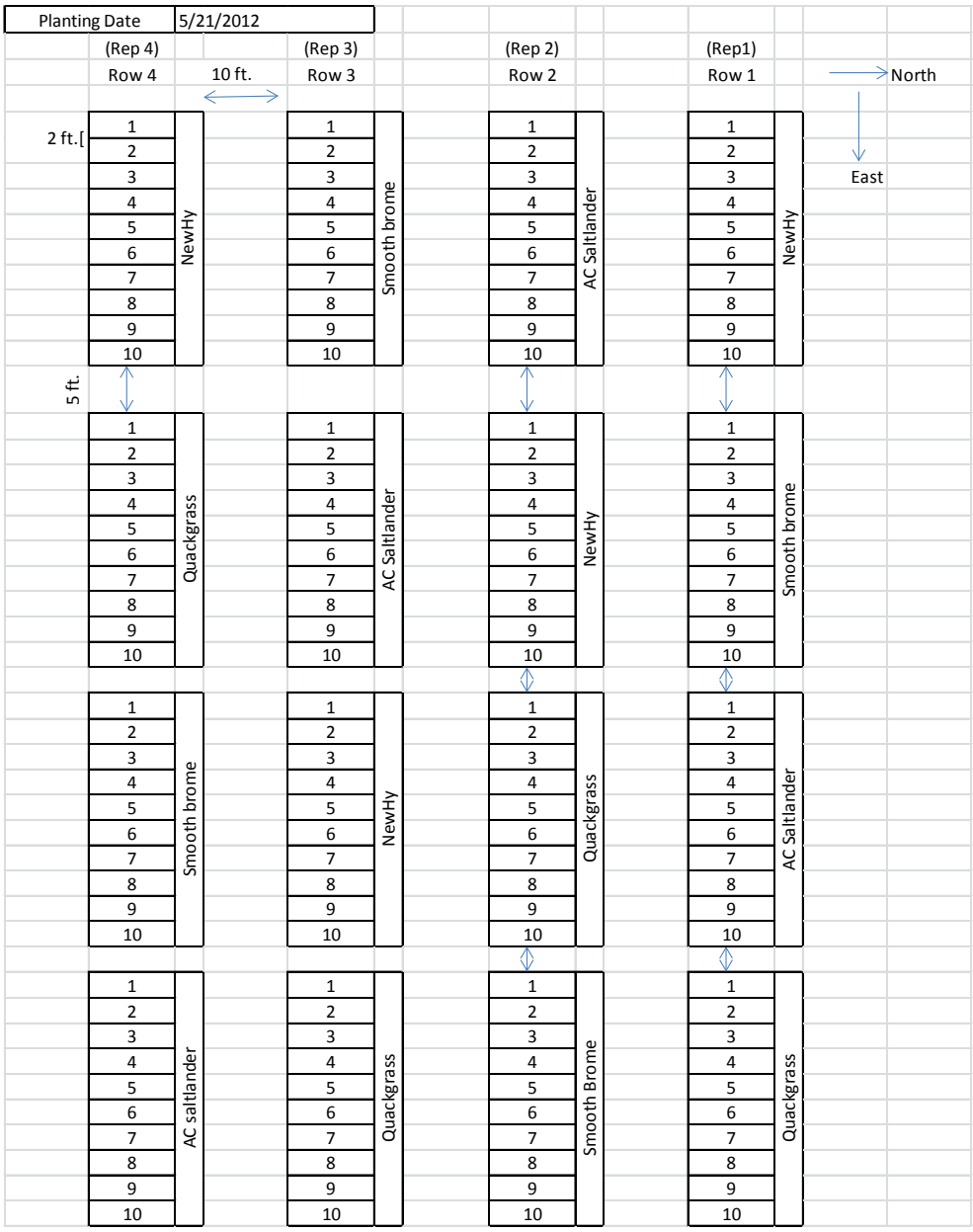


Table RH-1. 2012-2013 data from rhizome growth comparison of AC Saltlander, NewHy, quackgrass, and smooth brome

Ratings

spread:	1=excellent, 9=poor	size:	1=large, 9=small
vigor:	1=excellent, 9=poor	stand:	1=excellent, 3=poor
culms:	1=many, 9=none		

Species	Rep	Date	Height (in.)	Spread rating	Width (in.)	Vigor rating	Culms rating	Size rating	seedheads (no.)	new shoots (no.)	Stand rating
ACSalt	1	7/20/12		5.7				3.7	5.6	6.6	
ACSalt	1	9/12/12	14.3		29.6	4.9	7.8				
ACSalt	1	5/16/13	15.4		29.1						1.7
ACSalt	1	7/12/13	50.0		37.5						
ACSalt	2	7/20/12		4.5				3.3	3.7		
ACSalt	2	9/12/12	16.0		34.3	4.0	7.0				
ACSalt	2	5/16/13	14.9		31.8						1.7
ACSalt	2	7/12/13	53.0		57.1						
ACSalt	3	7/20/12		3.0				3.1	6.3		
ACSalt	3	9/12/12	21.0		32.3	3.1	6.5				
ACSalt	3	5/16/13	14.0		34.6						2.2
ACSalt	3	7/12/13	50.0		32.1						
ACSalt	4	7/20/12		6.1				3.2	13.1		
ACSalt	4	9/12/12	12.1		28.3	3.6	6.0				
ACSalt	4	5/16/13	15.5		35.5						1.6
ACSalt	4	7/12/13	53.0		32.7						
Brome	1	7/20/12		3.2				2.5	7.0	21.3	
Brome	1	9/12/12	22.6		29.7	4.7	5.3				
Brome	1	5/16/13	15.4		27.0						1.8
Brome	1	7/12/13	51.0		40.2						
Brome	2	7/20/12		3.4				3.9	6.2		
Brome	2	9/12/12	19.6		23.9	4.7	5.9				
Brome	2	5/16/13	15.8		23.0						1.8
Brome	2	7/12/13	53.0		30.2						
Brome	3	7/20/12		4.2				4.0	3.1		
Brome	3	9/12/12	19.7		28.7	4.4	6.6				
Brome	3	5/16/13	15.7		23.8						1.8
Brome	3	7/12/13	53.0		28.1						
Brome	4	7/20/12		5.0				3.8	5.6		
Brome	4	9/12/12	22.9		22.2	3.6	7.0				
Brome	4	5/16/13	16.6		25.0						1.5
Brome	4	7/12/13	53.0		24.1						
NewHy	1	7/20/12		4.7				2.2	13.8	4.0	
NewHy	1	9/12/12	19.1		35.0	3.7	6.3				
NewHy	1	5/16/13	13.9		32.5						2.1
NewHy	1	7/12/13	53.0		41.2						
NewHy	2	7/20/12		4.0				2.7	18.5		
NewHy	2	9/12/12	18.4		33.4	3.7	5.1				
NewHy	2	5/16/13	15.9		30.4						1.9
NewHy	2	7/12/13	50.0		38.1						

Species	Rep	Date	Height (in.)	Spread rating	Width (in.)	Vigor rating	Culms rating	Size rating	seedheads (no.)	new shoots (no.)	Stand rating
NewHy	3	7/20/12		6.0				3.4	10.3		
NewHy	3	9/12/12	19.7		28.6	3.7	5.7				
NewHy	3	5/16/13	19.3		27.0						1.7
NewHy	3	7/12/13	50.0		26.8						
NewHy	4	7/20/12		3.9				2.6	8.2		
NewHy	4	9/12/12	15.4		30.7	4.3	7.0				
NewHy	4	5/16/13	14.4		35.5						1.9
NewHy	4	7/12/13	54.0		32.9						
Quack	1	7/20/12		6.0				5.4	0.7	2.9	
Quack	1	9/12/12	7.4		27.0	6.2	8.4				
Quack	1	5/16/13	8.0		38.6						2.4
Quack	1	7/12/13	45.0		57.7						
Quack	2	7/20/12		5.4				3.9	2.3		
Quack	2	9/12/12	11.3		29.9	5.4	7.7				
Quack	2	5/16/13	10.8		44.4						1.8
Quack	2	7/12/13	48.0		52.3						
Quack	3	7/20/12		5.3				4.5	4.2		
Quack	3	9/12/12	10.6		32.3	4.7	7.2				
Quack	3	5/16/13	12.7		37.7						1.8
Quack	3	7/12/13	48.0		41.1						
Quack	4	7/20/12		7.8				4.4	6.8		
Quack	4	9/12/12	9.9		25.5	4.7	5.9				
Quack	4	5/16/13	8.4		34.5						2.1
Quack	4	7/12/13	44.0		36.6						

Table RH-2. 2013 Biomass data for clipped forage amounts of AC Saltlander, NewHy, quackgrass, and smooth brome

Variety	Rep	Date	Rep	No. Plants	Total Plot dry kg
ACSalt	1	7/12/2013	1	10	2.62
ACSalt	2	7/12/2013	2	10	2.96
ACSalt	3	7/12/2013	3	8	3.67
ACSalt	4	7/12/2013	4	10	3.25
Brome	1	7/12/2013	1	10	2.73
Brome	2	7/12/2013	2	10	2.98
Brome	3	7/12/2013	3	10	2.68
Brome	4	7/12/2013	4	10	3.20
NewHy	1	7/12/2013	1	10	2.74
NewHy	2	7/12/2013	2	9	3.10
NewHy	3	7/12/2013	3	10	3.40
NewHy	4	7/12/2013	4	10	3.51
Quack	1	7/12/2013	1	10	2.75
Quack	2	7/12/2013	2	10	3.44
Quack	3	7/12/2013	3	9	3.62
Quack	4	7/12/2013	4	6	3.50

ACTIVE STUDIES: TECHNICAL REPORT 2014

Study Number	**NDPMC-T-1202**
Title	**Cupplant Evaluation, northern origin (*Silphium perfoliatum*)**
Objective	Evaluate performance of northern origin cupplant and evaluate species attributes for bioengineering, riparian, pollinators, and others. Release and technology is the goal.
Duration	2012-2020
Cooperators	USDA, NRCS Bismarck Plant Materials Center
Location	Bismarck, ND PMC
-----Soils	Mandan silt loam
-----MLRA	53B
-----Precip.	**Ave** (1981-2010): 17.8 inches **(2013)**: 26.75 inches **(2014):** 13.92 inches

Background information: Cupplant is a tall, warm-season species native to the tall grass prairie. It has a taproot and underground rhizomes. Its cup forming leaves are important for pollinator species. It prefers moist sites. Native northern sources of the species are not readily found. The PMC is evaluating a northern origin source (or sources if more are found).

Methods and Materials

The planting in 2012 consisted of one seed origin.

Seed Source	**Accession:** 9094396
-----Coll. Date	September 19, 2011
-----Collector	Jeff Printz
-----Location	T135N R56W sec 30 Ransom County, ND approx. 4 miles NW of Lisbon off of Valley Road, landowner: Andy Hoenhause **USDA Hardiness Zone** (2012): 4a
Propagation	Seed planted to cone-tainers™ in the greenhouse, then seedlings planted to field bed
-----Greenhouse	**Planting Date**: February 2012 **Pots**: Ray Leach cone-tainers™(2 "x 7") **Soil:** Miracle Grow Potting Mix
-----Field	**Planting Method**: Holes dug with shovel and garden trowel **Planting Conditions**: Soil firm and slightly moist , black and free of growing weeds, freshly tilled **Planting Date:** June 11, 2012
Assembly	**NO MAP**
-----Location	Bismarck Plant Materials Center, Panel D10 (old deer fence) **USDA Hardiness Zone (2012):** 4a
-----Design	**No. of Rows:** 5 **Row spacing:** 7-10' **Plant Spacing:** 2'-3'
Data Collection	None in 2012
-----Parameters	2012: none
-----Data	2012: none 2013: seed production 2014: seed production
Field Maintenance	Weed control, residue removal
-----2012	Hand weeding, tillage between rows, no residue removal, no herbicide, no irrigation
-----2013	planted oats between rows, mowed before heading, residue was mowed to 6-10" stubble after harvest.
-----2014	planted barley between rows, mowed before heading, the biomass was not mowed after harvest of cupplant seed
Seed Harvest	
-----2013	Combined on 10/26/2013; 108 pounds dirty (45 pounds cleaned, 25 PLS)
-----2014	Combined in October 2014 58 pounds dirty(43 pounds cleaned, 30.8 PLS)

Results and Discussion

2012: Plants were vigorous and appeared healthy throughout the growing season, even though the summer was hot and dry. Plants had only basal, rosette type growth this first year of growth.

2013: Weeds were suppressed by oat planting. Plants grew to approximately 6 feet. Seed heads were produced on most, if not all of the plants. There was no sign of predation from insects or disease on the seed heads. The plants showed drought stress on the leaves, but it was slight. Plants were vigorous overall.

2014: Weeds were suppressed by planting barley between the rows. Plants grew to 6 feet tall or greater. Seed heads were produced on almost all plants. Observations on July 23, when approximately 75% of the plants were flowering, insects that looked like corn rootworm beetles were abundant. They appeared to eat the petals. It did not appear to greatly affect the seed production. No other predators were noted. Plants were vigorous and produced abundant biomass. No foliar diseases were noted.

ACTIVE STUDIES: TECHNICAL REPORT 2014

Study Number	**NDPMC-T-1203**
Title	**Effects of Mixed Species Cover Crops on Soil Health**
Objective	Evaluate the effects of different cover crop species mixes, and seeding rates on soil health
Duration	2012-2014+ (extension of study is probable, depending on outcomes)
Cooperators	Plant Materials Program, NRCS National Soil Health Team, ,USDA-NRCS National Soil Survey Center (Lincoln, NE, Kellog Soil Survey Lab),USDA-ARS (Temple, TX)
Location	Field D-7 Bismarck, ND Plant Materials Center
---Soils	Mandan silt loam, **See Figure CC-1 for Soils Mapping Units**
---MLRA	53B
---Ave. Precip.	**Overall (1981-2010)** = 17.8 inches; **2012 overall** = 14.9 inches **2012 cover crop planting to termination**=2.08 inches **2013 overall:** 26.75 **2014 cover crop planting to termination:** 5.27 inches **2014 overall:** 13.92 inches
---Lat./Long.	Latitude=46°46', Longitude=100° 45W, Elev.=1647
Other Locations w/ Similar Study	Plant Materials Centers in CA, FL, MD, MO,WA

Background information: This is a National Plant Materials project evaluating the effect of different cover crop species and seeding rates on soil health. There are six Plant Materials Centers participating in this study. The commodity crop to be planted by ND and WA PMC is barley. Corn will be planted by all other PMC's. Protocols for designing the experiment and data collection were compiled by Regional Specialists of the Plant Materials Program. This information is filed in the Cover Crop study binder.

Materials and Method

Experimental Design	Randomized complete block; Replications: 4
---Plot size	Each plot: 30' x 50' Total plots: 40 **See Figure CC-2 for Plot Map**
Cover Crop	
---Mixes	**2 species**: triticale, red clover **4 species**: triticale, red clover, hairy vetch, radish **6 species**: triticale, red clover, hairy vetch, radish, oats, rapeseed **No species**: no cover crop (control).
---Seed source	Pulse USA, Bismarck ND
---Seeding rates	20 seeds/ft^2; 40 seeds/ft^2; 60 seeds/ft^2 **See Table CC-1** for lb/ac seeded
---Site Preparation before cover crop planting	**2012:** **2013:** none other than baling off barley residue **2014:** Cornerstone 5-plus (glyphosate) applied at 2pt/acre on 8/11/2014 before planting covercrop mix on 8/12/2014.
---Seeding method	**2012**: No-till plot drill (Great Plains) borrowed from ARS, used boxes for seeding in; **2013**: used cone for seeding mixes; **2014:** no-till revised Great Plains plot drill
---Seeding date	August 2, 2012; August 20, 2013; August 12, 2014
---Termination	September 21, 2012; October 30, 2013; October 24, 2014
---Termination method	Natural freezing
Commodity Crop	
---Species	Barley: Rawson 2 row
---Seed source	2012: none; 2013: Pulse USA, Bismarck ND (Rawson 2-row barley); **2014**: same seed as in 2013
---Site preparation before commodity crop planting	**2012: 2013-2014: none**

---Seeding rate	**2013:** 90 lb/ac
---Seeding Method	2013: No-till plot drill (Great Plains) , used cone for seeding 2014: no till revised Great Plains plot drill
---Seeding date	5/8/2013
---Termination	8/6/2013
---Termination Method	**2013**: Swathed and baled off forage and seed, no seed harvest other than sampling within plot **2014**: swathed on 7/23/2014 and combined on 7/30/2014
Maintenance	sprayed outside alleys 5/22/2014 and 6/3/2014 with Cornerstone5 Plus

Data Collection: Unless otherwise indicated Cover Crop Mixes on data tables are as listed below:

220 =2 species, 20 seeds/ft^2	420 =4 species, 20 seeds/ft^2	620 =6 species, 20 seeds/ft^2
240 =2 species, 40 seeds/ft^2	440 =4 species, 40 seeds/ft^2	640 =6 species, 40 seeds/ft^2
260 =2 species, 60 seeds/ft^2	460 =4 species, 60 seeds/ft^2	660 =6 species, 60 seeds/ft^2
1000=check		

Methods for data collection are found in *Sampling Methods for Plant Materials Program Soil Health Study* in the Cover Crop Study Binder.

Sample area	A portion of the plot was sampled.
Data Parameters	Soils, Vegetative for cover crop (the portion of the plot sampled was approx. 17'X30'), Yield for Barley.

All plots were divided into three sections for the three years of data collection. This is indicated on the plot map. A different section will be sampled each of the three years. All data, unless indicated otherwise, will be taken from the designated section.
---**2012**: Dates of sampling generally indicate at cover crop planting, at 30 days from planting, and/or cover crop termination (47 days).
---**2013 and 2014**: Dates of sampling generally indicate at commodity crop planting (barley), at cover crop planting, and cover crop termination.

Soils Parameter	Date of Sample	Method	Depth (Inches)	Samples	Data Table
---classification	7/30/2012	Order 1 Soil Survey, descriptions made, sent to soil survey lab to cross check soil particle size			**Figure CC-1**
---bulk density	7/30/2012 8/20/2013 8/05/2014	3" ring (soil quality test kit)	0-3 0-3 0-2 & 2-4	5 samples/plot	**Table CC-2**
---temperature	7/30/2012 9/25/2012 5/13/2013 8/20/2013 10/31/2013 05/12/2014 08/05/2014 10/24/2014	soil thermometer	0-3 0-3 0-3 0-3 0-3 0-3 0-3 0-3	5samples/plot	**Table CC-3**
---moisture	7/30/2012 9/25/2012 5/13/2013 8/20/2013 10/31/2013 05/12/2014 08/05/2014 10/24/2014	Hydrosense moisture meter	0-3 0-3 0-3 0-3 0-3 0-3 0-3 0-3	5 samples/plot	**Table CC-3**

---resistance	7/30/2012 8/20/2013 8/5/2014	Penetrometer	6 6 6	5 samples/plot	**Table CC-3**
---biological	7/30/2012 9/25/2012 5/13/2013 8/20/2013 10/31/2013 05/12/2014 08/05/2014 10/24/2014	Hand trowel, samples dried at Mandan ARS, sent to Dr. Haney (TX) for analysis , kept in cold and dry storage prior to sending	0-6 0-6 0-6 0-6 0-6 0-6 0-6 0-6	2/3 quart/plot	**Table CC-4**
---soil indicators	8/30/2012 8/20/2013 8/05/2014	Hand trowel samples dried at Mandan ARS, sent to Larry Arnold, Lincoln, NE for analysis	0-2 & 2-4 0-2 & 2-6 0-2 & 2-6	2/3 quart/plot for each depth	Results are not recorded in this report. See Project File folder. Results will be included in final report

---Soil Notes: Personnel from soils staffs within ND NRCS were leaders in collecting the soils data. Personnel from NRCS Soils staffs included: Susan Liebig, Perry Sullivan, Hal Weiser, Kyle Thomson and Beth Burdolski. PMC staff assisted the soils staff. Along with listed measured soil parameters, some infiltration rates were also measured in a few random plots. A soil survey pit was also dug in the late fall 2012 and samples taken down to 100 cm. These samples will get a complete soil characterization by the Soil Survey Laboratory in Lincoln, NE. The pit was dug in the vicinity where the HOBO weather station was placed in early 2013. It should also be noted that samples for soil indicator measurements were originally taken at 0-6 inches. These were not sent in for analysis, but were archived to use as baseline data, if needed.

Plant Parameter Cover Crop	**Date of Sample**	**Method**	**Number of Samples**	**Data Table**
---canopy cover	8/31/2012 9/25/2012 2013(none) 9/16/2014 10/9/2014	Line transect-entire plot (30'X 50' plot size), recorded type of cover every 1 foot of diagonal transect Canopy cover was not measured in 2013 as almost all of the cover was volunteer barley.	50 points/plot	**Table CC-5**
---plant height	8/31/2012 9/25/2012 2013-none 9/16/2014 10/09/2014	5 random plant areas (17'X 30'portion of plot)	5 heights/plot	**Table CC-5**
---yield	9/25/2012 10/31/2013 10/24/2014	Clipped 50cm x 100cm frame within each plot, 1/4" stubble height, separated components, dried samples at 55° C, weighed parts separately, combined all parts except radish bottom.	1 frame/plot	**Table CC-6**
---%N	9/25/2012 10/31/2013 10/24/2014	Combined dry sample of all parts but radish bottom, hammer milled prior to sending for analysis by Dairy One Lab, Ithaca, NY (sent to NPMC to handle).	1 sample/plot (2 if radish present)	**Table CC-6**
---quality	9/25/2012	Clipped random plots from entire planting and bulked within each species. Oven dried at 50^{0} C. Sent one sample of each specie to Stearns DHIA (MN) for separate species analysis.	1 sample/species	

Plant Parameter Commodity Crop Barley				
---yield	8/6/2013 7/14/2014	2013: 17-foot of one drill row was hand clipped and seed heads thrashed with head thrasher at Mandan ARS. Seed was dried down in oven. Moisture meter used at ARS. 2014: 3 feet of one drill row in each plot was clipped. The number of seed heads and the number of kernels were counted to estimate yield.	1 sample/plot	**Table CC-7**

---Plant Notes: 2012: Sample drying was done in batches. Radish roots were difficult to dry, so were cut in smaller pieces. All vegetation was left standing on the plots over the winter. Height of plots was taken in inches and converted to cm. The initial hard frost was considered cover crop termination. Plants continued to grow after the initial hard frost. The ND NRCS State agronomist Ted Alme and Dwight Tober (retired PMS) assisted in clipping forage production in 2012. Dwight Tober also assisted in canopy cover measurements.
2014: Radish roots were chopped into small pieces to better aid drying. The forage samples and the radish root samples were hammer milled prior to sending for analysis.

Results and Discussion:
2012: Cover crop growth was good even though planting date was late in the season and precipitation was 20% below normal for the growing season. Hard frosts came late in the fall, which may have allowed for extended growth. The legume component growth was not abundant, as is shown in the yield data. This may be due to the short window of time it had to grow before a frost. Baseline soils data indicated soils in all plots were high in N. This may be due to previous history of composting on the field. Growth of the cover crop in Replication 2 and Replication 4 was stunted as a result of a tree row (green ash) to the east of the field.

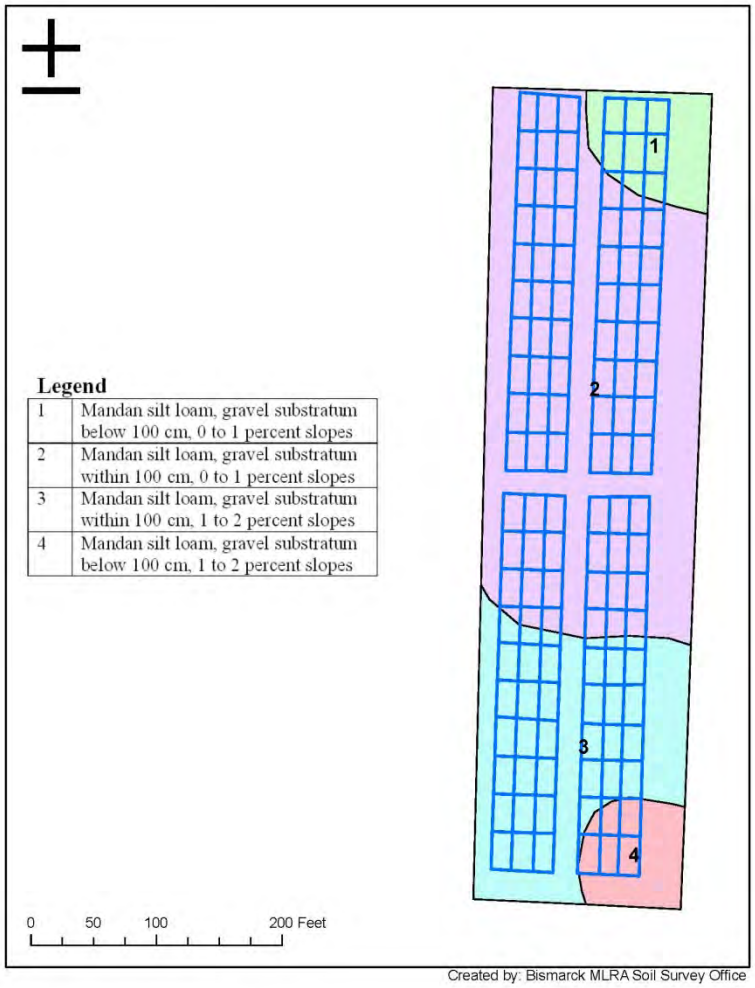
2012: Summary of the Cover Crop Measurements (Joel Douglas, Regional Plant Materials Specialist) See Technical Report (2013) for statistical analysis of data collected in 2012.

2013: The barley commodity crop yields were good (see **Table CC-7**). Nitrogen levels were high in 2013 and were slightly reduced after the barley crop. The cover crop was planted almost a month later than in 2012. Barley seed shattered before harvest. Though the cover crops appeared to germinate, they were overtaken by volunteer barley. Most of the forage yield in 2013 was barley.

2014: Cover crop growth was considerably less than in 2012. There was a much smaller amount of the grass type cover crops and more growth of the radishes. Some plots had poor stands of both. Red clover was very sparse and small in the plots.

Some trends are beginning to emerge in the soils data. All statistical analysis will be run and documented in upcoming reports.

Figure CC-1. Cover crop study soil survey (soils mapping unit descriptions follow)



Soils mapping units

Map unit 1 - Mandan silt loam, gravelly substratum below 100 cm, 0 to 1 percent slopes

Taxonomic Class: Coarse-silty, mixed, superactive, calcareous, frigid Pachic Haplustolls

The Mandan series consists of very deep, well drained soils on terraces in alluvial plains. Permeability is moderately high in the surface layer and moderately low to moderately high in the substratum. These soils formed in loess over gravel.

Landform: Terrace
Landscape: Alluvial Plain
Parent Material: Loess over Gravel
Slope Range: 0 to 1%
Depth to Gravel: > 100 cm
Salt or Sodium Affected: Not Affected
Drainage Class: Well
Water Table: > 6 feet
Ponding: None

Typical Profile
Ap ---0 to 28 cm; silt loam
Bw ---28 to 57 cm; silt loam
Bk ---57 to 86 cm; silt loam
BCk ---86 to 110 cm; very fine sandy loam
2C --- 110 to 120 cm; very gravelly sand

Typical Range
Mollic, Ap: 46-65 cm
Depth to Carbonates: 24-30 cm
Depth to Gravel: 102-132 cm

Major uses: Cropland

Map unit 2 - Mandan silt loam, gravelly substratum within 100 cm, 0 to 1 percent slopes

Taxonomic Class: Coarse-silty, mixed, superactive, calcareous, frigid Pachic Haplustolls

The Mandan series consists of very deep, well drained soils on terraces in alluvial plains. Permeability is moderately high in the surface layer and moderately low to moderately high in the substratum. These soils formed in loess over gravel.

Landform: Terrace
Landscape: Alluvial Plain
Parent Material: Loess over Gravel
Slope Range: 0 to 1%
Depth to Gravel: 85-100 cm
Salt or Sodium Affected: Not Affected
Drainage Class: Well
Water Table: > 6 feet
Ponding: None

Typical Profile
Ap ---0 to 25 cm; silt loam
Bw ---25 to 59 cm; silt loam
Bk ---59 to 91 cm; very fine sandy loam
2C ---91-120 cm; very gravelly sand

Typical Range
Mollic, Ap: 25-59 cm
Depth to Carbonates: 25-91 cm
Depth to Gravel: 91-120 cm

Major uses: Cropland

Map unit 3 - Mandan silt loam, gravelly substratum within 100 cm, 1 to 2 percent slopes

Taxonomic Class: Coarse-silty, mixed, superactive, calcareous, frigid Pachic Haplustolls

The Mandan series consists of very deep, well drained soils on terraces in alluvial plains. Permeability is moderately high in the surface layer and moderately low to moderately high in the substratum. These soils formed in loess over gravel.

Landform: Terrace
Landscape: Alluvial Plain
Parent Material: Loess over Gravel
Slope Range: 1 to 2%
Depth to Gravel: 85 cm
Salt or Sodium Affected: Not Affected
Drainage Class: Well
Water Table: > 6 feet
Ponding: None

Typical Profile
Ap ---0 to 33 cm; silt loam
Bw ---33 to 63 cm; silt loam
Bk ---63 to 85 cm; silt loam
2C ---85-120 cm; very gravelly sand

Typical Range
Mollic, Ap: 53-63 cm
Depth to Carbonates: 20-33 cm
Depth to Gravel: 85-87 cm

Major uses: Cropland

Map unit 4 - Mandan silt loam, gravelly substratum below 100 cm, 1 to 2 percent slopes

Taxonomic Class: Coarse-silty, mixed, superactive, calcareous, frigid Pachic Haplustolls

The Mandan series consists of very deep, well drained soils on terraces in alluvial plains. Permeability is moderately high in the surface layer and moderately low to moderately high in the substratum. These soils formed in loess over gravel.

Landform: Terrace
Landscape: Alluvial Plain
Parent Material: Loess over Gravel
Slope Range: 1 to 2%
Depth to Gravel: 122cm +
Salt or Sodium Affected: Not Affected
Drainage Class: Well
Water Table: > 6 feet
Ponding: None

Typical Profile
Ap ---0 to 24 cm; silt loam
Bw ---24 to 62 cm; silt loam
Bk ---62 to 122 cm; silt loam
2C ---122cm; very gravelly loamy sand

Typical Range
Mollic, Ap: 9-15”
Depth to Carbonates: 24-62 cm
Depth to Gravel: 122 cm

Major uses: Cropland

Figure CC-2. Plot map

A	101	01
YR3	YR2	YR1
B	102	02
YR2	YR1	YR3
C	103	03
YR1	YR3	YR2
D	104	04
YR1	YR2	YR3
E	105	05
YR1	YR3	YR2
F	106	06
YR1	YR2	YR3
G	107	07
YR2	YR3	YR1
H	108	08
YR1	YR3	YR2
I	109	09
YR2	YR3	YR1
J	110	10
YR3	YR1	YR2

F	201	11
YR1	YR2	YR3
G	202	12
YR1	YR2	YR3
C	203	13
YR3	YR1	YR2
D	204	14
YR3	YR2	YR1
A	205	15
YR2	YR3	YR1
I	206	16
YR3	YR1	YR2
J	207	17
YR1	YR2	YR3
H	208	18
YR3	YR2	YR1
E	209	19
YR2	YR1	YR3
B	210	20
YR2	YR3	YR1

C	301	21
YR2	YR1	YR3
G	302	22
YR1	YR2	YR3
I	303	23
YR3	YR2	YR1
B	304	24
YR1	YR2	YR3
J	305	25
YR3	YR1	YR2
F	306	26
YR2	YR3	YR1
A	307	27
YR3	YR2	YR1
D	308	28
YR3	YR1	YR2
H	309	29
YR1	YR2	YR3
E	310	30
YR1	YR2	YR3

F	401	31
YR2	YR3	YR1
C	402	32
YR3	YR1	YR2
H	403	33
YR1	YR2	YR3
D	404	34
YR3	YR2	YR1
A	405	35
YR1	YR2	YR3
J	406	36
YR2	YR1	YR3
E	407	37
YR1	YR2	YR3
I	408	38
YR2	YR3	YR1
B	409	39
YR1	YR2	YR3
G	410	40
YR3	YR1	YR2

A	Triticale, Red clover/20 seed ft^2
B	Triticale, Red clover/40 seed ft^2
C	Triticale, Red clover/60 seed ft^2
D	Triticale, Red clover, Hairy Vetch, Radish/20 seed ft^2
E	Triticale, Red clover, Hairy Vetch, Radish/40 seed ft^2
F	Triticale, Red clover, Hairy Vetch, Radish/60 seed ft^2
G	Triticale, Red clover, Hairy Vetch, Radish, Oats, Rapeseed/20 seed ft^2
H	Triticale, Red clover, Hairy Vetch, Radish, Oats, Rapeseed/40 seed ft^2
I	Triticale, Red clover, Hairy Vetch, Radish, Oats, Rapeseed/60 seed ft^2
J	Control – No Cover Crop

Table CC-1. Seeding rates for cover crop species

Mixes	Species	Seeds/lb	Seeding Rate per Plot in seeds/ft2	% of the Mix	PLS Lbs. per Acre
2 Species Mix	triticale	12000	20	50	36.3
	red clover	260000		50	1.68
	triticale	12000	40	50	72.60
	red clover	260000		50	3.35
	triticale	12000	60	50	108.90
	red clover	260000		50	5.03
4 Species Mix	triticale	12000	20	45	32.67
	red clover	260000		22.5	0.75
	hairy vetch	21000		22.5	9.33
	radish	45000		10	1.94
	triticale	12000	40	45	65.34
	red clover	260000		22.5	1.51
	hairy vetch	21000		22.5	18.67
	radish	45000		10	3.87
	triticale	12000	60	45	98.01
	red clover	260000		22.5	2.26
	hairy vetch	21000		22.5	28.00
	radish	45000		10	5.81
6 Species Mix	triticale	12000	20	22.5	16.34
	red clover	260000		22.5	0.75
	hairy vetch	21000		22.5	9.33
	radish	45000		5	0.97
	oats	14000		22.5	14.00
	Rape	156960		5	0.28
	triticale	12000	40	22.5	32.67
	red clover	260000		22.5	1.51
	hairy vetch	21000		22.5	18.67
	radish	45000		5	1.94
	oats	14000		22.5	28.00
	Rape	156960		5	0.56
	triticale	12000	60	22.5	49.01
	red clover	260000		22.5	2.26
	hairy vetch	21000		22.5	28.00
	radish	45000		5	2.90
	oats	14000		22.5	42.00
	Rape	156960		5	0.83

Table CC-2. Bulk density (core method)

Date	Mix	Plot	Depth	Bulk Density g/cm3)
7/30/2012	220	101	0-3"	1.30
8/21/2013	220	101	0-2"	1.19
8/21/2013	220	101	2-4"	1.28
8/05/2014	220	101	0-2”	1.06
8/05/2014	220	101	2-4”	1.30
7/30/2012	220	205	0-3"	1.22
8/21/2013	220	205	0-2"	1.26
8/21/2013	220	205	2-4"	1.20
8/05/2014	220	205	0-2”	1.01
8/05/2014	220	205	2-4”	1.18
7/30/2012	220	307	0-3"	1.04
8/21/2013	220	307	0-2"	1.11
8/21/2013	220	307	2-4"	1.21
8/05/2014	220	307	0-2”	.85
8/05/2014	220	307	2-4”	1.15
7/30/2012	220	405	0-3"	1.18
8/21/2013	220	405	0-2"	1.06
8/21/2013	220	405	2-4"	1.20
8/05/2014	220	405	0-2”	.94
8/05/2014	220	405	2-4”	1.07
7/30/2012	240	102	0-3"	1.28
8/21/2013	240	102	0-2"	1.24
8/21/2013	240	102	2-4"	1.41
8/05/2014	240	102	0-2”	1.09
8/05/2014	240	102	2-4”	1.26
7/30/2012	240	210	0-3"	1.16
8/21/2013	240	210	0-2"	1.16
8/21/2013	240	210	2-4"	1.17
8/05/2014	240	210	0-2”	.94
8/05/2014	240	210	2-4”	1.25
7/30/2012	240	304	0-3"	1.10
8/21/2013	240	304	0-2"	1.13
8/21/2013	240	304	2-4"	1.06
8/05/2014	240	304	0-2”	.92
8/05/2014	240	304	2-4”	1.13
7/30/2012	240	409	0-3"	1.19
8/21/2013	240	409	0-2"	1.09
8/21/2013	240	409	2-4"	1.20

Date	Mix	Plot	Depth	Bulk Density g/cm3)
8/05/2014	240	409	0-2”	.94
8/05/2014	240	409	2-4”	1.02
7/30/2012	260	103	0-3"	1.23
8/21/2013	260	103	0-2"	1.23
8/21/2013	260	103	2-4"	1.29
8/05/2014	260	103	0-2”	.89
8/05/2014	260	103	2-4”	1.27
7/30/2012	260	203	0-3"	1.23
8/21/2013	260	203	0-2"	1.15
8/21/2013	260	203	2-4"	1.16
8/05/2014	260	203	0-2”	.85
8/05/2014	260	203	2-4”	1.25
7/30/2012	260	301	0-3"	0.97
8/21/2013	260	301	0-2"	1.15
8/21/2013	260	301	2-4"	1.14
8/05/2014	260	301	0-2”	.91
8/05/2014	260	301	2-4”	1.17
7/30/2012	260	402	0-3"	1.05
8/21/2013	260	402	0-2"	0.94
8/21/2013	260	402	2-4"	1.27
8/05/2014	260	402	0-2”	1.03
8/05/2014	260	402	2-4”	1.12
7/30/2012	420	104	0-3"	1.23
8/21/2013	420	104	0-2"	1.19
8/21/2013	420	104	2-4"	1.37
8/05/2014	420	104	0-2”	1.03
8/05/2014	420	104	2-4”	1.14
7/30/2012	420	204	0-3"	1.25
8/21/2013	420	204	0-2"	0.99
8/21/2013	420	204	2-4"	1.43
8/05/2014	420	204	0-2”	.94
8/05/2014	420	204	2-4”	1.19
7/30/2012	420	308	0-3"	1.01
8/21/2013	420	308	0-2"	1.06
8/21/2013	420	308	2-4"	1.13
8/05/2014	420	308	0-2”	0.93
8/05/2014	420	308	2-4”	1.03
7/30/2012	420	404	0-3"	1.09
8/21/2013	420	404	0-2"	1.12

Date	Mix	Plot	Depth	Bulk Density g/cm3)
8/21/2013	420	404	2-4"	1.15
8/05/2014	420	404	0-2”	1.00
8/05/2014	420	404	2-4”	1.10
7/30/2012	440	105	0-3"	1.28
8/21/2013	440	105	0-2"	1.21
8/21/2013	440	105	2-4"	1.28
8/05/2014	440	105	0-2”	1.22
8/05/2014	440	105	2-4”	1.18
7/30/2012	440	209	0-3"	1.17
8/21/2013	440	209	0-2"	1.05
8/21/2013	440	209	2-4"	1.25
8/05/2014	440	209	0-2”	.88
8/05/2014	440	209	2-4”	1.12
7/30/2012	440	310	0-3"	1.11
8/21/2013	440	310	0-2"	1.04
8/21/2013	440	310	2-4"	1.05
8/05/2014	440	310	0-2”	.86
8/05/2014	440	310	2-4”	1.12
7/30/2012	440	407	0-3"	1.19
8/21/2013	440	407	0-2"	1.14
8/21/2013	440	407	2-4"	1.23
8/05/2014	440	407	0-2”	1.04
8/05/2014	440	407	2-4”	1.02
7/30/2012	460	106	0-3"	1.24
8/21/2013	460	106	0-2"	1.08
8/21/2013	460	106	2-4"	1.40
8/05/2014	460	106	0-2”	1.02
8/05/2014	460	106	2-4”	1.14
7/30/2012	460	201	0-3"	1.23
8/21/2013	460	201	0-2"	1.08
8/21/2013	460	201	2-4"	1.43
8/05/2014	460	201	0-2”	1.10
8/05/2014	460	201	2-4”	1.08
7/30/2012	460	306	0-3"	1.06
8/21/2013	460	306	0-2"	1.12
8/21/2013	460	306	2-4"	1.24
8/05/2014	460	306	0-2”	.79
8/05/2014	460	306	2-4”	1.10
7/30/2012	460	401	0-3"	1.07

Date	Mix	Plot	Depth	Bulk Density g/cm3)
8/21/2013	460	401	0-2"	1.16
8/21/2013	460	401	2-4"	1.17
8/05/2014	460	401	0-2”	.85
8/05/2014	460	401	2-4”	1.14
7/30/2012	620	107	0-3"	1.23
8/21/2013	620	107	0-2"	1.26
8/21/2013	620	107	2-4"	1.40
8/05/2014	620	107	0-2”	1.02
8/05/2014	620	107	2-4”	1.12
7/30/2012	620	202	0-3"	1.19
8/21/2013	620	202	0-2"	1.13
8/21/2013	620	202	2-4"	1.50
8/05/2014	620	202	0-2”	.99
8/05/2014	620	202	2-4”	1.28
7/30/2012	620	302	0-3"	1.17
8/21/2013	620	302	0-2"	1.09
8/21/2013	620	302	2-4"	1.07
8/05/2014	620	302	0-2”	.91
8/05/2014	620	302	2-4”	1.06
7/30/2012	620	410	0-3"	1.04
8/21/2013	620	410	0-2"	0.99
8/21/2013	620	410	2-4"	1.11
8/05/2014	620	410	0-2”	.98
8/05/2014	620	410	2-4”	1.03
7/30/2012	640	108	0-3"	1.22
8/21/2013	640	108	0-2"	1.14
8/21/2013	640	108	2-4"	1.24
8/05/2014	640	108	0-2”	.99
8/05/2014	640	108	2-4”	1.20
7/30/2012	640	208	0-3"	1.09
8/21/2013	640	208	0-2"	1.11
8/21/2013	640	208	2-4"	1.25
8/05/2014	640	208	0-2”	.89
8/05/2014	640	208	2-4”	1.20
7/30/2012	640	309	0-3"	1.05
8/21/2013	640	309	0-2"	1.01
8/21/2013	640	309	2-4"	1.30
8/05/2014	640	309	0-2”	.89
8/05/2014	640	309	2-4”	1.13

Date	Mix	Plot	Depth	Bulk Density g/cm3)
7/30/2012	640	403	0-3"	1.16
8/21/2013	640	403	0-2"	1.17
8/21/2013	640	403	2-4"	1.25
8/05/2014	640	403	0-2”	1.18
8/05/2014	640	403	2-4”	1.00
7/30/2012	660	109	0-3"	1.24
8/21/2013	660	109	0-2"	1.14
8/21/2013	660	109	2-4"	1.21
8/05/2014	660	109	0-2”	.93
8/05/2014	660	109	2-4”	1.13
7/30/2012	660	206	0-3"	1.21
8/21/2013	660	206	0-2"	1.10
8/21/2013	660	206	2-4"	1.37
8/05/2014	660	206	0-2”	.82
8/05/2014	660	206	2-4”	1.22
7/30/2012	660	303	0-3"	1.02
8/21/2013	660	303	0-2"	0.94
8/21/2013	660	303	2-4"	1.19
8/05/2014	660	303	0-2”	.91
8/05/2014	660	303	2-4”	1.17
7/30/2012	660	408	0-3"	1.13
8/21/2013	660	408	0-2"	1.16
8/21/2013	660	408	2-4"	1.19
8/05/2014	660	408	0-2”	1.02
8/05/2014	660	408	2-4”	1.05
7/30/2012	1000	110	0-3"	1.14
8/21/2013	1000	110	0-2"	1.12
8/21/2013	1000	110	2-4"	1.22
8/05/2014	1000	110	0-2”	.89
8/05/2014	1000	110	2-4”	1.14
7/30/2012	1000	207	0-3"	1.20
8/21/2013	1000	207	0-2"	1.16
8/21/2013	1000	207	2-4"	1.29
8/05/2014	1000	207	0-2”	1.07
8/05/2014	1000	207	2-4”	1.19
7/30/2012	1000	305	0-3"	1.00
8/21/2013	1000	305	0-2"	1.08
8/21/2013	1000	305	2-4"	1.08
8/05/2014	1000	305	0-2”	.98

Date	Mix	Plot	Depth	Bulk Density g/cm3)
8/05/2014	1000	305	2-4”	1.10
7/30/2012	1000	406	0-3"	1.19
8/21/2013	1000	406	0-2"	1.16
8/21/2013	1000	406	2-4"	1.24
8/05/2014	1000	406	0-2”	.93
8/05/2014	1000	406	2-4”	1.03

Table CC-3. Soil moisture, temperature, and resistance

				Soil Moisture		Soil Temperature	Resistance (psi)	
Time	Date	Mix	Plot	VWC%	% or µs	ºF	0-6”	6-12”
Ccplanting	7/30/2012	220	101	13.40		90.54	288	
CCTerm	9/25/2012	220	101	12.40		52.64		
Barley plant	5/13/2013	220	101	18.24	1.40	58.20		
Ccplanting	8/20/2013	220	101	10.34	1.28	78.58	290	
CCterm	10/31/2013	220	101	23.54	1.48	39.60		
Barley plant	5/12/2014	220	101	28.92	1.556	39.2		
Ccplanting	8/05/2014	220	101	31.22	1.59	66.2	160	145
CCterm	10/24/2014	220	101	10.94	1.2862	47.18		
Ccplanting	7/30/2012	220	205	12.20		76.16	300	
CCTerm	9/25/2012	220	205	12.80		53.64		
Barley plant	5/13/2013	220	205	16.20	1.37	60.00		
Ccplanting	8/20/2013	220	205	6.50	1.22	73.00	300	
CCterm	10/31/2013	220	205	24.84	1.49	39.20		
Barley plant	5/12/2014	220	205	26.34	1.52	38.20		
Ccplanting	8/05/2014	220	205	30.62	1.58	65.80	205	270
CCterm	10/24/2014	220	205	9.86	1.27	49.42		
Ccplanting	7/30/2012	220	307	17.60		81.38	278	
CCTerm	9/25/2012	220	307	18.40		54.88		
Barley plant	5/13/2013	220	307	13.36	1.32	61.00		
Ccplanting	8/20/2013	220	307	6.32	1.21	74.80	260	
CCterm	10/31/2013	220	307	23.84	1.48	40.00		
Barley plant	5/12/2014	220	307	27.70	1.54	42.80		
Ccplanting	8/05/2014	220	307	29.80	1.57	67.40	220	300
CCterm	10/24/2014	220	307	13.80	1.33	49.30		
Ccplanting	7/30/2012	220	405	17.20		79.98	292	
CCTerm	9/25/2012	220	405	16.00		54.10		
Barley plant	5/13/2013	220	405	17.74	1.39	55.80		
Ccplanting	8/20/2013	220	405	6.98	1.22	73.80	280	

				Soil Moisture		Soil Temperature	Resistance (psi)	
Time	Date	Mix	Plot	VWC%	% or µs	ºF	0-6”	6-12”
CCterm	10/31/2013	220	405	24.88	1.50	38.80		
Barley plant	5/12/2014	220	405	24.94	1.50	39.40		
Ccplanting	8/05/2014	220	405	31.56	1.60	66.20	200	295
CCterm	10/24/2014	220	405	18.36	1.41	49.00		
Ccplanting	7/30/2012	240	102	15.00		91.04	284	
CCTerm	9/25/2012	240	102	13.20		52.92		
Barley plant	5/13/2013	240	102	17.82	1.39	57.40		
Ccplanting	8/20/2013	240	102	10.12	1.28	76.40	345	
CCterm	10/31/2013	240	102	25.54	1.50	39.60		
Barley plant	5/12/2014	240	102	27.16	1.53	40.20		
Ccplanting	8/05/2014	240	102	27.18	1.53	64.80	135	230
CCterm	10/24/2014	240	102	5.06	1.19	46.96		
Ccplanting	7/30/2012	240	210	15.60		77.30	286	
CCTerm	9/25/2012	240	210	15.60		52.92		
Barley plant	5/13/2013	240	210	17.70	1.39	57.40		
Ccplanting	8/20/2013	240	210	5.88	1.20	72.80	275	
CCterm	10/31/2013	240	210	26.94	1.53	38.00		
Barley plant	5/12/2014	240	210	31.24	1.59	38.60		
Ccplanting	8/05/2014	240	210	30.56	1.58	65.60	235	280
CCterm	10/24/2014	240	210	8.02	1.24	49.78		
Ccplanting	7/30/2012	240	304	16.00		80.34	260	
CCTerm	9/25/2012	240	304	16.20		52.82		
Barley plant	5/13/2013	240	304	13.60	1.33	60.20		
Ccplanting	8/20/2013	240	304	6.88	1.22	72.80	265	
CCterm	10/31/2013	240	304	25.74	1.51	39.60		
Barley plant	5/12/2014	240	304	25.02	1.50	41.20		
Ccplanting	8/05/2014	240	304	31.40	1.61	66.80	265	300
CCterm	10/24/2014	240	304	13.84	1.33	49.70		
Ccplanting	7/30/2012	240	409	15.00		79.34	255	
CCTerm	9/25/2012	240	409	15.60		53.30		
Barley plant	5/13/2013	240	409	15.90	1.36	54.40		
Ccplanting	8/20/2013	240	409	7.16	1.23	75.00	295	
CCterm	10/31/2013	240	409	23.16	1.47	39.60		
Barley plant	5/12/2014	240	409	27.78	1.54	41.20		
Ccplanting	8/05/2014	240	409	29.12	1.57	67.00	210	285
CCterm	10/24/2014	240	409	8.86	1.25	51.66		
Ccplanting	7/30/2012	260	103	14.00		92.52	300	
CCTerm	9/25/2012	260	103	15.60		50.98		
Barley plant	5/13/2013	260	103	17.38	1.39	57.60		

				Soil Moisture		Soil Temperature	Resistance (psi)	
Time	Date	Mix	Plot	VWC%	% or µs	ºF	0-6”	6-12”
Ccplanting	8/20/2013	260	103	7.30	1.23	73.80	310	
CCterm	10/31/2013	260	103	23.22	1.47	39.20		
Barley plant	5/12/2014	260	103	26.50	1.52	38.4		
Ccplanting	8/05/2014	260	103	26.14	1.52	65.20	175	285
CCterm	10/24/2014	260	103	6.48	1.21	47.76		
Ccplanting	7/30/2012	260	203	16.20		77.14	258	
CCTerm	9/25/2012	260	203	13.00		54.58		
Barley plant	5/13/2013	260	203	13.70	1.33	59.60		
Ccplanting	8/20/2013	260	203	5.40	1.20	72.80	285	
CCterm	10/31/2013	260	203	21.04	1.44	37.80		
Barley plant	5/12/2014	260	203	24.20	1.49	39.00		
Ccplanting	8/05/2014	260	203	29.42	1.57	66.20	210	280
CCterm	10/24/2014	260	203	7.24	1.23	48.94		
Ccplanting	7/30/2012	260	301	15.20		80.62	290	
CCTerm	9/25/2012	260	301	14.00		51.62		
Barley plant	5/13/2013	260	301	16.68	1.38	58.60		
Ccplanting	8/20/2013	260	301	7.58	1.23	72.20	240	
CCterm	10/31/2013	260	301	24.72	1.49	39.20		
Barley plant	5/12/2014	260	301	27.60	1.54	41.40		
Ccplanting	8/05/2014	260	301	30.82	1.59	67.40	205	295
CCterm	10/24/2014	260	301	11.02	1.29	48.06		
Ccplanting	7/30/2012	260	402	15.80		79.94	265	
CCTerm	9/25/2012	260	402	15.60		51.08		
Barley plant	5/13/2013	260	402	16.02	1.37	56.60		
Ccplanting	8/20/2013	260	402	6.70	1.22	73.20	240	
CCterm	10/31/2013	260	402	25.38	1.50	38.80		
Barley plant	5/12/2014	260	402	27.30	1.53	39.20		
Ccplanting	8/05/2014	260	402	31.18	1.59	66.20	230	210
CCterm	10/24/2014	260	402	9.18	1.26	50.04		
Ccplanting	7/30/2012	420	104	15.20		92.34	296	
CCTerm	9/25/2012	420	104	16.80		51.86		
Barley plant	5/13/2013	420	104	15.82	1.36	59.00		
Ccplanting	8/20/2013	420	104	7.06	1.22	73.60	300	
CCterm	10/31/2013	420	104	24.58	1.49	38.80		
Barley plant	5/12/2014	420	104	25.36	1.50	39.60		
Ccplanting	8/05/2014	420	104	28.82	1.56	64.40	190	275
CCterm	10/24/2014	420	104	5.98	1.20	46.68		
Ccplanting	7/30/2012	420	204	13.40		76.62	284	
CCTerm	9/25/2012	420	204	12.80		54.16		

				Soil Moisture		Soil Temperature	Resistance (psi)	
Time	Date	Mix	Plot	VWC%	% or µs	ºF	0-6”	6-12”
Barley plant	5/13/2013	420	204	16.82	1.38	59.60		
Ccplanting	8/20/2013	420	204	7.06	1.23	72.20	290	
CCterm	10/31/2013	420	204	24.20	1.49	38.00		
Barley plant	5/12/2014	420	204	25.14	1.50	38.20		
Ccplanting	8/05/2014	420	204	28.90	1.56	66.20	200	280
CCterm	10/24/2014	420	204	8.94	1.25	49.28		
Ccplanting	7/30/2012	420	308	15.80		81.70	266	
CCTerm	9/25/2012	420	308	15.40		53.76		
Barley plant	5/13/2013	420	308	15.30	1.39	61.20		
Ccplanting	8/20/2013	420	308	6.64	1.22	76.20	280	
CCterm	10/31/2013	420	308	23.08	1.47	39.20		
Barley plant	5/12/2014	420	308	27.02	1.53	43.20		
Ccplanting	8/05/2014	420	308	29.20	1.56	67.40	165	285
CCterm	10/24/2014	420	308	7.08	1.22	50.68		
Ccplanting	7/30/2012	420	404	15.40		79.48	277	
CCTerm	9/25/2012	420	404	16.20		53.12		
Barley plant	5/13/2013	420	404	16.80	1.38	57.20		
Ccplanting	8/20/2013	420	404	7.52	1.23	73.80	280	
CCterm	10/31/2013	420	404	26.22	1.52	39.20		
Barley plant	5/12/2014	420	404	29.24	1.56	39.20		
Ccplanting	8/05/2014	420	404	30.34	1.58	66.00	220	225
CCterm	10/24/2014	420	404	12.62	1.32	52.48		
Ccplanting	7/30/2012	440	105	15.60		90.78	290	
CCTerm	9/25/2012	440	105	14.80		51.22		
Barley plant	5/13/2013	440	105	16.32	1.37	60.20		
Ccplanting	8/20/2013	440	105	7.62	1.23	73.00	210	
CCterm	10/31/2013	440	105	22.78	1.46	38.80		
Barley plant	5/12/2014	440	105	28.18	1.55	40.20		
Ccplanting	8/05/2014	440	105	27.66	1.54	65.00	215	250
CCterm	10/24/2014	440	105	5.58	1.19	47.04		
Ccplanting	7/30/2012	440	209	17.40		76.88	246	
CCTerm	9/25/2012	440	209	16.00		51.92		
Barley plant	5/13/2013	440	209	17.66	1.39	57.80		
Ccplanting	8/20/2013	440	209	7.30	1.23	72.40	270	
CCterm	10/31/2013	440	209	27.38	1.53	38.40		
Barley plant	5/12/2014	440	209	26.08	1.51	38.00		
Ccplanting	8/05/2014	440	209	28.14	1.55	65.60	200	275
CCterm	10/24/2014	440	209	11.06	1.29	48.34		
Ccplanting	7/30/2012	440	310	15.80		82.52	254	

				Soil Moisture		Soil Temperature	Resistance (psi)	
Time	Date	Mix	Plot	VWC%	% or µs	ºF	0-6”	6-12”
CCTerm	9/25/2012	440	310	13.40		54.92		
Barley plant	5/13/2013	440	310	16.94	1.38	59.40		
Ccplanting	8/20/2013	440	310	5.92	1.20	75.00	275	
CCterm	10/31/2013	440	310	26.20	1.51	39.20		
Barley plant	5/12/2014	440	310	25.86	1.51	41.00		
Ccplanting	8/05/2014	440	310	30.40	1.59	66.60	250	300
CCterm	10/24/2014	440	310	6.46	1.21	51.90		
Ccplanting	7/30/2012	440	407	15.60		79.86	289	
CCTerm	9/25/2012	440	407	14.60		54.92		
Barley plant	5/13/2013	440	407	14.92	1.35	57.20		
Ccplanting	8/20/2013	440	407	6.54	1.22	75.80	290	
CCterm	10/31/2013	440	407	23.22	1.47	39.60		
Barley plant	5/12/2014	440	407	27.82	1.54	41.60		
Ccplanting	8/05/2014	440	407	29.04	1.56	67.00	230	300
CCterm	10/24/2014	440	407	8.06	1.24	49.74		
Ccplanting	7/30/2012	460	106	15.40		90.98	258	
CCTerm	9/25/2012	460	106	14.40		50.90		
Barley plant	5/13/2013	460	106	16.86	1.38	58.40		
Ccplanting	8/20/2013	460	106	9.12	1.26	73.00	265	
CCterm	10/31/2013	460	106	23.82	1.48	38.40		
Barley plant	5/12/2014	460	106	26.92	1.53	39.20		
Ccplanting	8/05/2014	460	106	29.24	1.56	64.40	220	250
CCterm	10/24/2014	460	106	5.94	1.20	47.62		
Ccplanting	7/30/2012	460	201	16.00		76.78	224	
CCTerm	9/25/2012	460	201	14.00		53.70		
Barley plant	5/13/2013	460	201	17.00	1.38	60.00		
Ccplanting	8/20/2013	460	201	6.00	1.21	72.20	290	
CCterm	10/31/2013	460	201	24.38	1.49	37.20		
Barley plant	5/12/2014	460	201	25.48	1.50	39.60		
Ccplanting	8/05/2014	460	201	28.60	1.55	66.60	190	295
CCterm	10/24/2014	460	201	6.08	1.20	49.90		
Ccplanting	7/30/2012	460	306	15.80		80.80	270	
CCTerm	9/25/2012	460	306	15.20		53.48		
Barley plant	5/13/2013	460	306	14.08	1.34	60.60		
Ccplanting	8/20/2013	460	306	6.68	1.22	75.20	290	
CCterm	10/31/2013	460	306	23.64	1.48	39.20		
Barley plant	5/12/2014	460	306	23.98	1.48	42.60		
Ccplanting	8/05/2014	460	306	30.06	1.47	66.40	265	300
CCterm	10/24/2014	460	306	4.20	1.17	51.64		

				Soil Moisture		Soil Temperature	Resistance (psi)	
Time	Date	Mix	Plot	VWC%	% or µs	ºF	0-6”	6-12”
Ccplanting	7/30/2012	460	401	14.20		79.86	268	
CCTerm	9/25/2012	460	401	16.00		52.32		
Barley plant	5/13/2013	460	401	14.98	1.35	58.80		
Ccplanting	8/20/2013	460	401	7.42	1.23	75.80	285	
CCterm	10/31/2013	460	401	26.50	1.52	38.00		
Barley plant	5/12/2014	460	401	24.62	1.50	39.40		
Ccplanting	8/05/2014	460	401	28.34	1.55	66.00	230	295
CCterm	10/24/2014	460	401	5.64	1.20	49.70		
Ccplanting	7/30/2012	620	107	14.80		91.58	260	
CCTerm	9/25/2012	620	107	16.20		52.46		
Barley plant	5/13/2013	620	107	18.10	1.40	59.20		
Ccplanting	8/20/2013	620	107	9.68	1.27	72.60	270	
CCterm	10/31/2013	620	107	23.98	1.48	38.40		
Barley plant	5/12/2014	620	107	27.84	1.54	39.80		
Ccplanting	8/05/2014	620	107	27.92	1.54	64.40	170	275
CCterm	10/24/2014	620	107	5.96	1.20	47.66		
Ccplanting	7/30/2012	620	202	17.80		76.78	260	
CCTerm	9/25/2012	620	202	12.40		53.90		
Barley plant	5/13/2013	620	202	17.04	1.38	60.80		
Ccplanting	8/20/2013	620	202	5.82	1.20	72.00	270	
CCterm	10/31/2013	620	202	23.32	1.47	38.00		
Barley plant	5/12/2014	620	202	25.60	1.51	39.80		
Ccplanting	8/05/2014	620	202	28.84	1.56	66.40	220	290
CCterm	10/24/2014	620	202	7.46	1.23	49.48		
Ccplanting	7/30/2012	620	302	19.20		80.50	270	
CCTerm	9/25/2012	620	302	17.40		52.52		
Barley plant	5/13/2013	620	302	15.36	1.36	59.60		
Ccplanting	8/20/2013	620	302	7.72	1.24	72.80	260	
CCterm	10/31/2013	620	302	25.60	1.51	38.80		
Barley plant	5/12/2014	620	302	28.52	1.55	41.2		
Ccplanting	8/05/2014	620	302	32.94	1.63	66.6	165	300
CCterm	10/24/2014	620	302	6.44	1.21	49.22		
Ccplanting	7/30/2012	620	410	17.20		79.28	252	
CCTerm	9/25/2012	620	410	16.80		52.58		
Barley plant	5/13/2013	620	410	16.28	1.37	54.00		
Ccplanting	8/20/2013	620	410	6.70	1.22	74.80	275	
CCterm	10/31/2013	620	410	23.46	1.47	40.00		
Barley plant	5/12/2014	620	410	28.94	1.56	41.2		
Ccplanting	8/05/2014	620	410	31.86	1.60	66.6	235	300

				Soil Moisture		Soil Temperature	Resistance (psi)	
Time	Date	Mix	Plot	VWC%	% or µs	ºF	0-6”	6-12”
CCterm	10/24/2014	620	410	7.88	1.24	50.98		
Ccplanting	7/30/2012	640	108	12.40		92.04	280	
CCTerm	9/25/2012	640	108	14.20		52.76		
Barley plant	5/13/2013	640	108	16.14	1.37	58.20		
Ccplanting	8/20/2013	640	108	7.38	1.23	73.60	235	
CCterm	10/31/2013	640	108	24.06	1.48	39.60		
Barley plant	5/12/2014	640	108	27.08	1.53	39.80		
Ccplanting	8/05/2014	640	108	27.64	1.54	65.00	215	275
CCterm	10/24/2014	640	108	5.92	1.20	48.82		
Ccplanting	7/30/2012	640	208	14.80		76.82	300	
CCTerm	9/25/2012	640	208	15.40		52.12		
Barley plant	5/13/2013	640	208	17.58	1.39	57.40		
Ccplanting	8/20/2013	640	208	7.12	1.23	72.20	250	
CCterm	10/31/2013	640	208	24.96	1.50	38.40		
Barley plant	5/12/2014	640	208	26.04	1.51	38.40		
Ccplanting	8/05/2014	640	208	27.44	1.54	66.40	195	300
CCterm	10/24/2014	640	208	8.20	1.24	49.30		
Ccplanting	7/30/2012	640	309	16.60		83.16	258	
CCTerm	9/25/2012	640	309	12.80		54.24		
Barley plant	5/13/2013	640	309	14.04	1.34	61.40		
Ccplanting	8/20/2013	640	309	6.26	1.21	75.00	260	
CCterm	10/31/2013	640	309	24.62	1.49	39.20		
Barley plant	5/12/2014	640	309	29.40	1.56	42.40		
Ccplanting	8/05/2014	640	309	29.12	1.56	66.80	235	295
CCterm	10/24/2014	640	309	4.46	1.17	52.74		
Ccplanting	7/30/2012	640	403	18.60		90.08	292	
CCTerm	9/25/2012	640	403	14.80		51.72		
Barley plant	5/13/2013	640	403	15.98	1.37	57.40		
Ccplanting	8/20/2013	640	403	9.66	1.27	74.40	290	
CCterm	10/31/2013	640	403	27.10	1.53	38.40		
Barley plant	5/12/2014	640	403	29.12	1.56	39.00		
Ccplanting	8/05/2014	640	403	29.60	1.58	66.40	190	300
CCterm	10/24/2014	640	403	7.70	1.23	50.66		
Ccplanting	7/30/2012	660	109	14.60		91.58	280	
CCTerm	9/25/2012	660	109	14.00		52.74		
Barley plant	5/13/2013	660	109	16.08	1.37	59.20		
Ccplanting	8/20/2013	660	109	6.64	1.22	73.40	280	
CCterm	10/31/2013	660	109	25.36	1.50	39.20		
Barley plant	5/12/2014	660	109	25.82	1.51	40.00		

				Soil Moisture		Soil Temperature	Resistance (psi)	
Time	Date	Mix	Plot	VWC%	% or µs	ºF	0-6”	6-12”
Ccplanting	8/05/2014	660	109	28.00	1.55	65.40	195	295
CCterm	10/24/2014	660	109	3.88	1.16	48.94		
Ccplanting	7/30/2012	660	206	13.20		76.52	252	
CCTerm	9/25/2012	660	206	15.20		52.40		
Barley plant	5/13/2013	660	206	14.96	1.35	58.40		
Ccplanting	8/20/2013	660	206	7.10	1.23	73.00	270	
CCterm	10/31/2013	660	206	23.30	1.47	38.40		
Barley plant	5/12/2014	660	206	26.70	1.52	38.60		
Ccplanting	8/05/2014	660	206	27.66	1.54	66.00	190	285
CCterm	10/24/2014	660	206	6.78	1.22	49.45		
Ccplanting	7/30/2012	660	303	16.80		81.32	290	
CCTerm	9/25/2012	660	303	16.60		51.04		
Barley plant	5/13/2013	660	303	15.78	1.36	60.20		
Ccplanting	8/20/2013	660	303	8.08	1.24	73.20	260	
CCterm	10/31/2013	660	303	25.66	1.51	38.80		
Barley plant	5/12/2014	660	303	26.30	1.52	42.20		
Ccplanting	8/05/2014	660	303	31.66	1.60	66.80	225	300
CCterm	10/24/2014	660	303	5.10	1.19	50.00		
Ccplanting	7/30/2012	660	408	14.60		79.52	283	
CCTerm	9/25/2012	660	408	13.80		54.22		
Barley plant	5/13/2013	660	408	14.62	1.35	55.60		
Ccplanting	8/20/2013	660	408	6.20	1.21	76.00	295	
CCterm	10/31/2013	660	408	22.92	1.47	39.20		
Barley plant	5/12/2014	660	408	25.44	1.51	41.40		
Ccplanting	8/05/2014	660	408	29.30	1.56	66.80	185	285
CCterm	10/24/2014	660	408	4.18	1.17	51.22		
Ccplanting	7/30/2012	1000	110	13.20		92.26	273	
CCTerm	9/25/2012	1000	110	18.80		53.92		
Barley plant	5/13/2013	1000	110	18.28	1.40	62.40		
Ccplanting	8/20/2013	1000	110	6.78	1.22	75.60	280	
CCterm	10/31/2013	1000	110	22.66	1.46	38.40		
Barley plant	5/12/2014	1000	110	24.96	1.50	40.0		
Ccplanting	8/05/2014	1000	110	27.48	1.54	65.0	210	290
CCterm	10/24/2014	1000	110	17.66	1.40	47.46		
Ccplanting	7/30/2012	1000	207	16.60		77.56	260	
CCTerm	9/25/2012	1000	207	24.00		54.88		
Barley plant	5/13/2013	1000	207	18.46	1.40	59.20		
Ccplanting	8/20/2013	1000	207	7.28	1.23	72.80	295	
CCterm	10/31/2013	1000	207	25.08	1.50	38.00		

				Soil Moisture		Soil Temperature	Resistance (psi)	
Time	Date	Mix	Plot	VWC%	% or µs	ºF	0-6”	6-12”
Barley plant	5/12/2014	1000	207	21.30	1.44	39.20		
Ccplanting	8/05/2014	1000	207	27.22	1.53	66.20	185	295
CCterm	10/24/2014	1000	207	17.78	1.70	50.10		
Ccplanting	7/30/2012	1000	305	15.20		80.48	258	
CCTerm	9/25/2012	1000	305	22.20		54.52		
Barley plant	5/13/2013	1000	305	15.68	1.36	61.60		
Ccplanting	8/20/2013	1000	305	6.46	1.21	74.40	275	
CCterm	10/31/2013	1000	305	23.64	1.48	39.20		
Barley plant	5/12/2014	1000	305	23.90	1.48	41.80		
Ccplanting	8/05/2014	1000	305	30.78	1.59	67.20	205	250
CCterm	10/24/2014	1000	305	15.30	1.36	49.74		
Ccplanting	7/30/2012	1000	406	16.60		79.94	273	
CCTerm	9/25/2012	1000	406	17.80		54.94		
Barley plant	5/13/2013	1000	406	17.02	1.38	57.40		
Ccplanting	8/20/2013	1000	406	6.48	1.22	75.40	280	
CCterm	10/31/2013	1000	406	23.10	1.47	38.80		
Barley plant	5/12/2014	1000	406	27.40	1.53	39.00		
Ccplanting	8/05/2014	1000	406	29.86	1.57	66.20	220	300
CCterm	10/24/2014	1000	406	18.00	1.40	48.66		

CC-4. Biological analysis

Mix	Plot	Date	N lbs per acre	P2O5 lbs per acre	K2O lbs per acre	NO3-N Only (traditional testing) lbs per acre	Additional N (SHT) lbs per acre	Solvita 1-day CO2-C	Organic C	Organic N	Organic C:N	Soil Health Calculation	Total Nitrogen lbslacre	Inorganic N	Organic N	Total Phosphate lbs/acre	Inorganic P	Organic P
220	101	7/30/12	186.92	399.75	631.80			24.2	284	30.9	9.2	8.6	247.44	185.62	61.81	549.70	395.73	154
220	101	9/25/12	144.93	460.07	673.40			21.65	312.21	35.1	8.9	9.1	216.90	146.66	70.24	623.30	456.34	167
220	101	5/13/13	73.30	456.32	642.39	44.07	29.23	36.56	376.49	37.82	9.96	11.22	122.82	47.18	75.63	521.79	449.34	72.45
220	101	8/20/13	48.31	398.37	559.22	23.16	25.15	34.16	306.58	32.35	9.48	9.91	87.99	23.29	64.71	446.60	391.52	55.08
220	101	10/31/13	30.01	336.21	462.77	6.35	23.65	25.66	317.96	30.56	10.40	8.70	67.87	6.75	61.12	393.95	331.54	62.40
220	101	5/12/2014	41.8	367.8	444.3			29.5	313.9	34.2	9.2	9.8	90.5	22.1	68.4	415.5	353.8	61.7
220	101	8/05/2014	72.3	385.9	350.1			36.7	341.0	53.5	6.4	12.4	144.4	37.3	107.1	385.9	365.8	20.1
220	101	10/24/2014	24.3	324.0	450.4			17.5	286.2	30.3	9.4	7.6	73.7	13.0	60.6	345.3	316.0	29.3
220	205	7/30/12	244.37	385.41	787.80			27.74	338.67	32.7	10.4	9.3	299.67	234.24	65.43	547.40	381.44	166
220	205	9/25/12	145.50	472.54	759.20			32.76	374.85	52.4	7.2	13.6	230.12	125.42	104.70	593.40	465.76	127.6
220	205	5/13/13	83.55	524.82	799.19	33.91	49.64	70.48	478.73	46.93	10.20	16.39	134.82	40.97	93.85	516.04	511.71	4.33
220	205	8/20/13	59.52	505.84	792.29	37.87	21.65	31.85	382.53	40.92	9.35	11.33	120.41	38.56	81.85	503.23	499.37	3.86
220	205	10/31/13	52.24	458.78	588.20	14.45	37.79	32.90	389.71	40.50	9.62	11.37	97.91	16.91	81.00	456.08	452.28	3.80
220	205	5/12/2014	61.3	515.3	606.8			40.4	343.3	39.5	8.7	12.0	112.9	33.9	78.9	528.4	495.2	33.2
220	205	8/05/2014	65.6	420.4	357.9			28.2	408.8	65.6	6.2	13.5	173.1	41.9	131.2	446.5	403.2	43.3
220	205	10/24/2014	61.8	421.8	491.9			22.8	309.7	33.0	9.4	8.7	126.3	60.3	66.0	442.9	411.2	31.7
220	307	7/30/12	428.27	606.12	1051.70			49.57	387.08	37.2	10.4	12.3	482.12	407.82	74.30	821.10	599.10	222
220	307	9/25/12	334.58	554.80	913.90			29.2	390.79	72.1	5.4	16.5	468.20	323.92	144.28	660.10	547.75	112.4
220	307	5/13/13	76.83	620.46	917.00	35.94	40.89	56.30	563.74	53.53	10.53	16.34	148.75	41.69	107.06	618.00	610.36	7.63
220	307	8/20/13	84.94	633.30	896.31	61.99	22.95	33.26	449.44	44.66	10.06	12.26	152.32	63.00	89.32	709.78	627.02	82.76
220	307	10/31/13	55.80	597.65	611.01	15.96	39.84	56.52	349.22	35.68	9.79	12.84	89.18	17.81	71.37	615.91	586.67	29.24
220	307	5/12/2014	96.5	529.2	697.8			73.6	382.1	44.7	8.6	16.9	128.6	39.3	89.3	529.2	525.1	4.1
220	307	8/05/2014	127.7	495.2	319.0			65.3	397.5	65.0	6.1	17.0	190.3	60.4	129.9	495.4	455.0	40.4
220	307	10/24/2014	96.2	490.2	619.5			49.4	395.5	39.6	9.2	12.5	154.8	75.7	79.1	505.0	466.9	38.1
220	405	7/30/12	298.68	500.65	884.00			30.73	394.67	46.3	8.5	12.2	399.18	306.55	92.63	671.60	495.14	176.5
220	405	9/25/12	292.78	519.31	828.10			27.74	387.58	67.1	5.8	15.4	410.38	276.14	134.24	607.20	512.80	94.4

Mix	Plot	Date	N lbs per acre	P2O5 lbs per acre	K2O lbs per acre	NO3-N Only (traditional testing) lbs per acre	Additional N (SHT) lbs per acre	Solvita 1-day CO2-C	Organic C	Organic N	Organic C:N	Soil Health Calculation	Total Nitrogen lbslacre	Inorganic N	Organic N	Total Phosphate lbs/acre	Inorganic P	Organic P
220	405	5/13/13	83.79	601.11	903.67	29.91	53.88	81.52	514.30	48.15	10.68	17.59	131.49	35.18	96.31	591.78	586.73	5.04
220	405	8/20/13	88.58	594.22	800.41	60.68	27.90	43.03	357.05	36.48	9.79	11.61	134.77	61.82	72.95	602.27	585.86	16.40
220	405	10/31/13	61.93	551.90	602.71	21.66	40.27	52.30	370.40	37.42	9.90	12.73	100.26	25.41	74.85	563.93	541.85	22.08
220	405	5/12/2014	119.2	549.5	616.8			211.3	373.7	41.9	8.9	31.6	134.0	50.2	83.8	549.5	538.4	11.0
220	405	8/05/2014	86.6	511.4	243.9			34.9	400.4	64.5	6.2	13.9	188.3	59.3	129.0	511.4	505.5	5.8
220	405	10/24/2014	154.6	539.7	562.4			79.2	331.5	37.5	8.8	15.0	192.5	117.5	75.0	543.6	500.8	42.8
240	102	7/30/12	242.83	374.55	757.90			21.56	312.92	29.4	10.6	8.1	316.18	257.32	58.86	515.20	371.58	143.6
240	102	5/13/13	77.82	457.09	595.29	56.30	21.52	24.08	414.47	42.47	9.76	10.86	146.78	61.83	84.95	502.84	452.40	50.45
240	102	8/20/13	60.03	451.02	697.63	37.10	22.93	35.11	360.12	36.47	9.87	10.80	109.66	36.73	72.94	484.33	444.26	40.07
240	102	10/31/13	54.83	388.05	521.54	11.73	43.10	41.97	410.43	42.06	9.76	12.61	96.68	12.56	84.12	442.31	379.87	62.44
240	102	5/12/2014	63.3	555.2	599.4			39.2	347.1	39.3	8.8	11.8	117.2	38.6	78.6	576.8	536.0	40.8
240	102	8/05/2014	62.8	474.2	398.4			26.8	348.6	53.3	6.5	11.5	149.3	42.8	106.5	474.2	468.3	5.9
240	102	10/24/2014	34.6	436.8	515.6			22.3	300.2	32.1	9.4	8.4	86.2	22.1	64.1	456.5	426.4	30.1
240	210	7/30/12	390.33	474.41	902.20			41.79	372.66	39.4	9.5	12.1	440.95	362.22	78.72	660.10	467.69	192.4
240	210	9/25/12	205.28	552.08	828.10			37.4	415.29	61.5	6.8	15.9	293.10	170.04	123.06	676.20	544.04	132.2
240	210	5/13/13	85.86	588.32	898.70	38.11	47.75	61.92	524.65	55.22	9.50	17.29	155.93	45.49	110.44	585.25	575.93	9.32
240	210	8/20/13	71.85	572.69	828.66	50.00	21.85	33.06	365.70	37.55	9.74	10.81	125.42	50.31	75.11	574.43	566.24	8.19
240	210	10/31/13	62.30	550.54	644.92	19.10	43.20	39.86	390.14	41.07	9.50	12.21	103.19	21.05	82.15	554.20	542.56	11.64
240	210	5/12/2014	137.1	585.4	683.0			181.2	428.9	48.1	8.9	29.4	153.6	57.4	96.2	585.4	556.1	29.2
240	210	8/05/2014	91.3	487.0	330.8			47.2	412.5	64.9	6.4	15.3	175.2	45.4	129.8	519.3	458.4	60.9
240	210	10/24/2014	118.1	499.8	580.7			78.9	357.3	37.2	9.6	15.2	148.9	74.5	74.4	499.8	465.4	34.4
240	304	7/30/12	437.75	534.97	1077.70			38.7	431	40.9	10.5	12.1	514.77	432.96	81.80	742.90	529.59	213.3
240	304	9/25/12	347.61	545.80	956.80			37.4	455.98	79.3	5.8	19.0	468.96	310.44	158.52	660.10	537.01	123.1
240	304	5/13/13	86.06	638.82	968.20	36.22	49.84	68.34	606.72	59.75	10.15	18.77	163.79	44.30	119.49	645.71	626.05	19.67
240	304	8/20/13	93.99	604.61	821.65	53.06	40.92	63.04	386.66	40.19	9.62	14.44	134.05	53.67	80.38	601.80	592.15	9.65
240	304	10/31/13	60.92	561.72	636.86	20.53	40.39	40.19	382.54	39.59	9.66	11.94	101.54	22.36	79.18	573.05	553.81	19.24
240	304	5/12/2014	126.1	623.3	691.9			366.1	400.6	46.9	8.5	51.6	139.3	45.5	93.8	623.3	599.4	23.8

Mix	Plot	Date	N lbs per acre	P2O5 lbs per acre	K2O lbs per acre	NO3-N Only (traditional testing) lbs per acre	Additional N (SHT) lbs per acre	Solvita 1-day CO2-C	Organic C	Organic N	Organic C:N	Soil Health Calculation	Total Nitrogen lbslacre	Inorganic N	Organic N	Total Phosphate lbs/acre	Inorganic P	Organic P
240	304	8/05/2014	120.8	524.7	340.7			46.1	421.5	70.4	6.0	15.9	225.4	84.6	140.7	562.8	496	66.8
240	304	10/24/2014	136.2	656.8	624.4			90.7	348.5	37.0	9.4	16.3	162.4	88.3	74.1	656.8	615.4	41.4
240	409	7/30/12	329.49	557.97	949.00			38.7	393.78	47.0	8.4	13.3	394.77	300.81	93.96	736.00	550.91	185.1
240	409	9/25/12	293.64	494.01	894.40			32.76	378.2	65.9	5.7	16.1	377.40	245.56	131.84	607.20	486.30	120.9
240	409	5/13/13	93.54	603.24	939.75	40.03	53.50	77.90	559.74	54.08	10.35	18.53	153.06	44.90	108.16	598.40	588.98	9.41
240	409	8/20/13	67.18	534.55	767.76	46.12	21.06	33.55	388.90	38.71	10.05	11.10	123.23	45.80	77.43	535.10	528.20	6.90
240	409	10/31/13	43.46	429.70	587.57	11.66	31.80	34.31	368.79	35.61	10.36	10.56	85.78	14.56	71.22	440.64	423.42	17.22
240	409	5/12/2014	98.1	567.8	662.6			73.6	391.1	42.9	9.1	16.3	132.4	46.7	85.7	567.8	563.8	4.0
240	409	8/05/2014	89.2	515.3	263.8			38.2	451.2	69.8	6.5	15.3	199.4	59.8	139.6	533.6	492.4	41.2
240	409	10/24/2014	94.6	470.6	505.8			72.4	381.1	41.1	9.3	15.2	127.1	45.0	82.1	479.1	436.5	42.6
260	103	7/30/12	316.19	393.26	895.70			36.92	355.25	37.0	9.6	11.1	379.29	305.30	74.00	545.10	387.43	157.7
260	103	9/25/12	156.41	435.03	925.60			30.99	409.56	46.3	8.9	12.2	236.08	143.52	92.56	586.50	429.67	156.8
260	103	5/13/13	93.59	528.08	706.09	40.24	53.35	79.08	458.64	45.17	10.15	16.89	135.67	45.34	90.33	562.22	513.30	48.92
260	103	8/20/13	72.11	563.43	629.17	36.24	35.87	52.78	376.85	39.93	9.44	13.35	117.55	37.69	79.86	601.80	552.81	49.00
260	103	10/31/13	44.81	489.81	464.78	15.96	28.85	31.35	331.95	33.56	9.89	9.85	85.41	18.29	67.12	547.51	483.79	63.72
260	103	5/12/2014	73.9	524.6	573.4			51.3	370.5	41.9	8.8	13.7	122.3	38.4	83.9	530.2	499.4	30.8
260	103	8/05/2014	71.25	411.36	437.92			32.6	366.08	54.57	6.71	12.38	154.84	45.7	109.15	411.36	405.54	5.82
260	103	10/24/2014	50.57	428.67	541.48			39.06	323.57	33.56	9.64	10.5	93.05	25.93	67.12	439.61	410.96	28.65
260	203	7/30/12	322.60	387.10	821.60			33.04	347.9	26.7	13.1	8.7	382.94	329.62	53.32	552.00	384.16	167.8
260	203	5/13/13	70.12	544.76	810.29	27.76	42.36	59.67	485.19	47.76	10.16	15.50	128.61	33.08	95.53	536.67	533.61	3.06
260	203	8/20/13	71.35	450.72	618.18	41.99	29.36	46.67	329.27	33.48	9.83	11.39	108.16	41.20	66.96	448.38	441.70	6.68
260	203	10/31/13	46.76	345.38	455.89	11.77	34.99	45.09	337.45	34.52	9.78	11.44	82.14	13.10	69.04	345.55	336.61	8.94
260	203	5/12/2014	80.4	518.8	578.9			50.4	314.5	34.8	9.0	12.2	119.7	50.0	69.6	520.5	494.6	25.9
260	203	8/05/2014	80.1	465.3	350.8			32.9	379.2	59.1	6.4	13.0	173.9	55.6	118.3	482.9	445.5	37.4
260	203	10/24/2014	36.5	434.1	513.7			19.5	399.9	32.6	9.2	8.2	92.9	27.7	65.3	458.9	424.8	34.1
260	301	7/30/12	344.97	554.20	980.20			39.7	393.68	42.9	9.2	12.6	400.73	314.85	85.88	763.60	547.58	216
260	301	9/25/12	205.55	481.42	876.20			32.76	433.59	66.5	6.5	16.0	314.34	181.38	132.96	595.70	474.23	121.5

Mix	Plot	Date	N lbs per acre	P2O5 lbs per acre	K2O lbs per acre	NO3-N Only (traditional testing) lbs per acre	Additional N (SHT) lbs per acre	Solvita 1-day CO2-C	Organic C	Organic N	Organic C:N	Soil Health Calculation	Total Nitrogen lbslacre	Inorganic N	Organic N	Total Phosphate lbs/acre	Inorganic P	Organic P
260	301	5/13/13	84.10	659.89	961.19	38.74	45.36	61.75	565.16	55.72	10.14	17.31	157.40	45.97	111.43	667.56	648.34	19.22
260	301	8/20/13	88.44	587.16	902.49	55.77	32.68	48.37	415.95	44.13	9.43	13.70	145.04	56.78	88.26	596.09	577.41	18.67
*	301	10/31/13	57.98	478.45	656.54	21.25	36.73	39.46	376.29	37.49	10.04	11.44	98.16	23.19	74.97	475.48	470.98	4.50
260	301	5/12/2014	133.7	613.7	710.2			102.4	381.6	43.1	8.9	19.7	153.5	67.3	86.2	613.7	582.4	31.3
260	301	8/05/2014	103.5	537.8	353.4			35.3	393.4	66.0	6.0	14.1	212.0	80.0	132.0	593.6	515.8	77.8
260	301	10/24/2014	138.7	598.6	629.7			69.1	338.8	36.4	9.3	13.9	186.0	113.2	72.8	607.0	566.2	40.8
260	402	7/30/12	406.75	555.18	923.00			35.08	392.1	50.5	7.8	13.5	499.09	398.11	100.98	644.00	548.35	95.65
260	402	9/25/12	216.10	523.67	846.30			30.73	369.08	58.7	6.3	14.5	310.52	193.14	117.38	637.10	516.78	120.3
260	402	5/13/13	67.53	572.20	888.59	35.09	32.44	41.41	491.94	47.49	10.36	13.67	135.37	40.39	94.98	565.46	564.63	0.83
260	402	8/20/13	102.36	568.24	753.61	72.18	30.18	48.24	373.02	36.80	10.14	12.17	146.21	72.62	73.59	583.19	559.21	23.98
260	402	10/31/13	57.16	533.29	581.82	18.46	38.70	54.98	349.45	35.32	9.89	12.58	91.99	21.34	70.65	541.29	522.73	18.57
260	402	5/12/2014	69.7	539.4	606.4			48.4	388.4	43.5	8.9	13.6	124.3	37.4	87	529.4	511.1	18.3
260	402	8/05/2014	136.8	545.9	296.1			63.5	421.6	70.6	6.0	17.6	215.1	74.0	141.1	545.9	506.9	39.0
260	402	10/24/2014	97.1	567.6	518.2			88.1	49.1	45.6	9.2	17.6	119.5	28.2	91.3	567.6	526.5	41.1
420	104	7/30/12	286.42	354.64	811.20			39.36	347.19	39.5	8.8	11.9	400.45	321.51	78.94	480.70	347.79	132.9
420	104	9/25/12	241.41	416.25	917.80			32.76	395.21	47.5	8.3	12.6	335.70	240.70	95.00	565.80	410.24	155.6
420	104	5/13/13	88.91	528.01	725.50	40.27	48.64	69.06	520.74	50.78	10.25	17.02	146.89	45.33	101.56	566.51	515.24	51.27
420	104	8/20/13	83.68	503.12	646.20	53.50	30.17	42.08	344.77	36.47	9.45	11.55	129.98	57.04	72.94	537.26	494.66	42.60
420	104	10/31/13	51.09	436.34	598.85	13.61	37.49	40.98	381.46	38.42	9.93	11.78	91.49	14.66	76.83	482.12	428.50	53.61
420	104	5/12/2014	104.5	486.7	582.0			283.4	350.6	36.8	9.5	36.9	117.2	43.6	73.6	486.7	455.1	31.6
420	104	8/05/2014	135.02	479.32	421.45			84.34	393.26	58.34	6.74	18.20	166.46	49.79	116.67	479.32	472.49	6.82
420	104	10/24/2014	69.71	480.72	517.10			49.27	335.83	35.60	9.43	11.84	111.04	39.85	71.19	482.22	457.91	24.31
420	204	7/30/12	273.03	370.18	772.20			38.7	339.72	33.5	10.1	10.6	316.22	249.20	67.02	512.90	364.49	148.4
420	204	9/25/12	120.48	400.55	700.70			27.15	383.59	50.1	7.7	12.4	209.80	109.58	100.22	503.70	395.21	108.5
420	204	5/13/13	78.05	507.92	809.32	33.78	44.27	62.49	489.91	47.44	10.33	15.69	134.53	39.65	94.88	503.09	496.46	6.63
420	204	8/20/13	73.95	468.63	708.85	50.32	23.63	34.98	326.32	34.78	9.38	10.47	118.60	49.03	69.57	463.37	461.55	1.82
420	204	10/31/13	49.30	425.68	550.10	14.42	34.88	38.27	334.15	35.82	9.33	11.03	86.21	14.58	71.64	419.01	417.90	1.11

Mix	Plot	Date	N lbs per acre	P2O5 lbs per acre	K2O lbs per acre	NO3-N Only (traditional testing) lbs per acre	Additional N (SHT) lbs per acre	Solvita 1-day CO2-C	Organic C	Organic N	Organic C:N	Soil Health Calculation	Total Nitrogen lbslacre	Inorganic N	Organic N	Total Phosphate lbs/acre	Inorganic P	Organic P
420	204	5/12/2014	70.1	523	551.6			51.8	374.9	42.2	8.9	13.8	117.4	33.0	84.3	526.4	497.7	28.7
420	204	8/05/2014	165.2	475.9	359.3			107.4	393.6	61.5	6.4	20.8	183.3	60.3	122.9	475.9	441.9	34.1
420	204	10/24/2014	48.7	487.4	542.7			43.2	360.2	39.2	9.2	11.8	93.9	15.6	78.3	501.6	466.9	34.7
420	308	7/30/12	477.52	591.88	1094.60			44.55	424.26	73.7	5.8	19.4	512.39	365.00	147.39	828.00	581.42	246.6
420	308	9/25/12	351.75	570.37	1040.00			29.2	450.55	74.7	6.0	16.8	469.22	319.76	149.46	685.40	563.67	121.7
420	308	5/13/13	87.55	635.36	976.47	36.89	50.66	73.08	594.55	56.07	10.60	18.44	156.77	44.64	112.13	635.80	622.35	13.45
420	308	8/20/13	127.81	665.12	893.54	89.71	38.10	56.90	420.20	42.35	9.92	14.17	174.80	90.10	84.71	736.00	654.22	81.78
420	308	10/31/13	71.58	674.97	718.78	16.54	55.05	48.02	462.51	48.08	9.62	14.43	115.35	19.19	96.16	711.75	665.48	46.27
420	308	5/12/2014	70.7	569.8	692.3			47.2	399.7	46.7	8.5	14.2	130.8	37.3	93.5	569.8	560.6	9.2
420	308	8/05/2014	99.8	483.5	278.9			33.5	409.8	68.0	6.0	14.2	215.0	79.1	135.9	499.6	462.8	38.8
420	308	10/24/2014	79.7	482.8	598.8			62.4	358.2	39.5	9.1	13.8	113.5	34.5	79.0	489.3	452.8	36.5
420	404	7/30/12	343.46	505.67	920.40			44.55	391.85	46.3	8.5	13.8	425.25	332.72	92.53	673.90	497.62	176.3
420	404	9/25/12	328.25	609.15	930.80			38.7	392.36	67.7	5.8	17.4	413.60	278.12	135.48	724.50	600.09	124.4
420	404	5/13/13	103.67	453.85	836.13	68.16	35.51	70.75	608.41	45.06	13.50	15.83	224.43	134.32	90.12	449.73	445.36	4.36
420	404	8/20/13	95.79	594.50	813.13	71.59	24.20	35.86	371.31	38.55	9.63	11.29	147.74	70.65	77.09	631.64	587.42	44.22
420	404	10/31/13	64.67	524.52	603.50	20.97	43.70	55.06	384.30	40.12	9.58	13.60	103.88	23.65	80.23	532.96	513.59	19.37
420	404	5/12/2014	96.1	489.1	584.7			55.5	353.1	37.5	9.4	13.2	144.5	69.6	74.9	489.1	471.3	17.8
420	404	8/05/2014	89.6	486.3	260.6			33.6	404.1	67.0	6.0	14.1	198.1	64.2	133.9	486.3	474.0	12.4
420	404	10/24/2014	105.3	489.8	511.1			61.8	323.2	35.6	9.1	13.0	143.0	71.8	71.2	498.1	460.1	38.0
440	105	7/30/12	319.23	463.49	917.80			29.2	387.29	46.2	8.4	12.0	412.83	320.53	92.31	637.10	458.18	178.9
440	105	9/25/12	232.31	425.86	930.80			27.62	392.17	44.2	8.9	11.5	316.50	228.14	88.36	588.80	421.09	167.7
440	105	5/13/13	83.19	591.92	721.18	30.34	52.86	77.65	490.92	48.66	10.09	17.47	131.23	33.91	97.32	629.12	577.30	51.82
440	105	8/20/13	57.03	563.72	602.96	36.21	20.82	29.67	368.84	39.78	9.27	10.87	117.97	38.40	79.57	607.29	557.65	49.64
440	105	10/31/13	54.44	463.56	573.69	11.57	42.87	39.62	403.26	42.55	9.48	12.47	98.74	13.64	85.10	472.19	455.62	16.58
440	105	5/12/2014	93.6	498.8	548.7			255.0	333.5	37.7	8.8	35.9	100.8	25.4	75.4	498.8	455.6	43.2
440	105	8/05/2014	114.1	422.2	425.8			60.7	338.6	53.5	6.3	14.8	160.4	53.4	106.9	422.2	418.8	3.4
440	105	10/24/2014	50.1	402.4	513.0			44.1	343.7	38.0	9.0	11.6	91.4	15.3	76.0	404.6	381.2	23.4

Mix	Plot	Date	N lbs per acre	P2O5 lbs per acre	K2O lbs per acre	NO3-N Only (traditional testing) lbs per acre	Additional N (SHT) lbs per acre	Solvita 1-day CO2-C	Organic C	Organic N	Organic C:N	Soil Health Calculation	Total Nitrogen lbslacre	Inorganic N	Organic N	Total Phosphate lbs/acre	Inorganic P	Organic P
440	209	7/30/12	373.92	502.86	963.30			16.13	380.35	37.1	10.3	9.1	456.54	382.32	74.22	694.60	500.52	194.1
440	209	9/25/12	245.22	501.60	846.30			33.04	405.99	64.1	6.3	15.7	354.56	226.44	128.12	627.90	494.22	133.7
440	209	5/13/13	141.95	608.02	934.37	77.51	64.44	102.25	557.63	51.19	10.89	20.08	190.60	88.22	102.38	600.68	590.42	10.26
440	209	8/20/13	89.04	567.64	813.11	50.06	38.98	57.72	404.47	43.17	9.37	14.52	136.67	50.32	86.35	576.39	555.95	20.44
440	209	10/31/13	72.66	533.31	596.22	21.48	51.18	48.62	399.26	42.49	9.40	13.41	110.43	25.46	84.97	550.17	523.49	26.69
440	209	5/12/2014	117.0	549.1	649.3			412.9	363.4	37.6	9.7	50.2	134.1	58.9	75.3	549.1	537.1	12.1
440	209	8/05/2014	128.0	506.8	342.7			59.3	431.7	69.4	6.2	17.2	212.6	73.8	138.8	529.6	470.5	59.0
440	209	10/24/2014	49.3	490.7	517.0			43.5	399.4	45.3	8.8	12.9	104.4	13.9	90.6	509.9	469.4	40.5
440	310	7/30/12	438.62	537.10	1132.30			36.92	418.67	44.3	9.5	12.5	507.77	419.22	88.55	729.10	531.16	197.9
440	310	9/25/12	321.70	518.78	972.40			30.73	404.65	72.6	5.6	16.8	433.96	288.70	145.26	616.40	511.45	105
440	310	5/13/13	89.82	765.79	1034.88	39.38	50.44	71.49	560.74	53.34	10.51	17.74	151.92	45.24	106.68	773.56	752.94	20.61
440	310	8/20/13	121.65	691.24	974.40	89.32	32.33	51.10	477.25	46.18	10.33	14.34	185.03	92.67	92.36	814.20	681.88	132.32
440	310	10/31/13	80.42	656.36	732.57	31.30	49.12	72.76	438.43	44.26	9.91	16.16	123.40	34.88	88.52	678.42	642.39	36.03
440	310	5/12/2014	161.2	735.8	775.4			211.1	446.4	50.3	8.9	33.3	186.3	85.7	100.6	735.8	707.7	28.1
440	310	8/05/2014	153.2	652.1	334.3			69.0	460.2	76.3	6.0	19.1	240.7	88.2	152.5	662.8	609.4	53.4
440	310	10/24/2014	97.6	695.6	645.0			91.4	443.1	48.9	9.1	18.5	121.1	23.3	97.8	699.5	651.6	47.8
440	407	7/30/12	351.53	489.07	945.10			27.74	366.18	43.2	8.5	11.3	431.33	344.95	86.37	660.10	484.07	176
440	407	9/25/12	209.69	453.25	846.30			25.8	376.89	60.0	6.3	13.9	323.08	203.12	119.96	565.80	447.47	118.3
440	407	5/13/13	81.42	577.96	907.46	40.71	40.71	58.04	513.01	48.64	10.55	15.50	143.79	46.50	97.28	576.17	567.56	8.61
440	407	8/20/13	78.86	541.21	776.37	56.12	22.74	32.51	356.03	38.90	9.15	11.00	134.00	56.20	77.81	556.90	534.48	22.42
440	407	10/31/13	48.62	453.06	568.85	16.95	31.68	33.33	345.96	34.55	10.01	10.24	89.66	20.56	69.10	474.60	446.73	27.87
440	407	5/12/2014	64.4	534.0	640.0			43.2	368.4	39.7	9.3	12.3	118.0	38.6	79.4	551.5	513.7	37.8
440	407	8/05/2014	98.3	494.7	252.3			42.5	408.0	65.0	6.3	14.8	193.0	63.0	130.0	494.7	474.2	20.5
440	407	10/24/2014	84.7	480.1	544.4			53.2	342.4	39.0	8.8	12.6	128.7	50.7	78.1	493.8	453.9	39.9
460	106	9/25/12	187.36	446.34	882.70			35.08	396.92	51.0	7.8	13.6	264.14	162.08	102.06	600.30	439.52	160.8
460	106	5/13/13	105.49	594.93	889.34	57.60	47.89	71.22	516.20	49.04	10.53	16.83	162.68	64.60	98.09	644.47	582.15	62.32
460	106	8/20/13	89.63	534.97	672.95	54.14	35.49	51.80	334.09	36.87	9.06	12.75	128.62	54.88	73.74	570.72	524.15	46.57

Mix	Plot	Date	N lbs per acre	P2O5 lbs per acre	K2O lbs per acre	NO3-N Only (traditional testing) lbs per acre	Additional N (SHT) lbs per acre	Solvita 1-day CO2-C	Organic C	Organic N	Organic C:N	Soil Health Calculation	Total Nitrogen lbslacre	Inorganic N	Organic N	Total Phosphate lbs/acre	Inorganic P	Organic P
460	106	10/31/13	56.89	486.52	613.93	18.34	38.54	42.90	370.99	38.18	9.72	11.94	96.54	20.17	76.37	502.02	478.13	23.90
460	106	5/12/2014	69.1	583.0	651.3			43.1	385.0	44.7	8.6	13.3	130.2	40.8	89.3	586.9	561.5	25.5
460	106	8/05/2014	66.6	522.0	513.4			28.6	392.2	58.8	6.7	12.7	163.7	46.1	117.6	522.0	511.0	11.0
460	106	10/24/2014	49.7	477.4	568.0			45.7	337.3	36.6	9.2	11.6	87.5	14.4	73.1	479.1	455.8	23.3
460	201	7/30/12	378.54	456.16	968.50			38.7	346.75	30.0	11.6	9.8	417.90	357.94	59.97	660.10	451.56	208.5
460	201	9/25/12	262.10	601.57	920.40			34.78	399.11	63.3	6.3	15.8	371.90	245.32	126.58	756.70	593.78	162.9
460	201	5/13/13	87.47	507.31	790.94	51.02	36.45	47.41	445.05	44.11	10.09	13.56	146.91	58.69	88.23	505.32	498.39	6.93
460	201	8/20/13	86.03	500.31	749.27	58.49	27.55	39.26	338.82	37.75	8.98	11.54	131.18	55.69	75.49	493.66	492.04	1.62
460	201	10/31/13	52.73	431.25	536.27	16.15	36.58	38.43	341.17	37.15	9.18	11.31	91.63	17.34	74.29	435.79	423.32	12.47
460	201	5/12/2014	69.9	450.4	535.7			46.5	328.0	37.3	8.8	12.3	113.7	39.0	74.7	456.6	427.5	29.1
460	201	8/05/2014	64.1	356.7	302.4			29.6	350.9	53.2	6.6	11.8	146.7	40.3	106.4	356.7	342.3	14.3
460	201	10/24/2014	22.1	361.1	418.4			19.0	320.1	37.2	8.6	8.8	80.6	6.1	74.5	379.4	351.5	27.9
460	306	7/30/12	399.02	590.15	1019.20			43.8	392.33	39.8	9.9	12.3	455.33	375.77	79.56	786.60	583.46	203.1
460	306	9/25/12	363.90	587.41	959.40			34.78	427.46	81.1	5.3	19.0	490.32	328.10	162.22	722.20	578.90	143.3
460	306	5/13/13	120.78	680.37	1007.41	57.07	63.70	89.70	596.78	59.75	9.99	20.92	185.97	66.47	119.50	685.11	663.31	21.80
460	306	8/20/13	118.25	603.32	893.75	74.11	44.15	64.64	431.78	46.27	9.33	15.87	166.23	73.68	92.55	634.87	590.17	44.70
460	306	10/31/13	60.22	509.13	643.96	18.50	41.72	42.15	397.53	40.39	9.84	12.30	102.70	21.91	80.79	516.33	500.99	15.34
460	306	5/12/2014	129.9	626.5	655.2			186.0	434.9	49.7	8.7	30.6	142.3	42.8	99.5	629.5	602.1	24.4
460	306	8/05/2014	134.0	545.9	328.3			52.8	414.3	70.9	5.8	16.5	229.8	88.0	141.8	565.5	512.7	52.8
460	306	10/24/2014	78.8	594.0	574.1			72.6	398.7	46.7	8.5	15.9	108.2	14.7	93.5	605.9	557.4	48.5
460	401	7/30/12	334.01	513.69	924.30			42.33	402.08	26.7	15.0	9.5	443.28	389.80	53.48	692.30	511.60	180.7
460	401	9/25/12	271.17	572.33	913.90			47.3	422.57	67.1	6.3	18.4	350.82	216.72	134.10	680.80	561.74	119.1
460	401	5/13/13	66.43	448.73	754.29	22.09	44.34	65.46	508.20	48.67	10.44	16.22	132.28	34.94	97.34	464.53	436.87	27.67
460	401	8/20/13	74.21	569.46	860.05	51.35	22.86	37.91	393.34	37.62	10.46	11.32	125.47	50.24	75.23	619.27	562.61	56.67
460	401	10/31/13	58.26	533.17	709.83	19.96	38.30	48.29	345.36	35.70	9.67	12.02	92.52	21.12	71.41	541.45	523.68	17.77
460	401	5/12/2014	101.7	533.7	571.7			291.1	308.4	34.2	9.0	38.8	115.0	46.6	68.4	533.7	517.8	15.9
460	401	8/05/2014	147.9	574.5	276.5			72.5	453.7	74.2	6.1	19.2	224.0	75.6	148.5	577.8	529.9	47.9

Mix	Plot	Date	N lbs per acre	P2O5 lbs per acre	K2O lbs per acre	NO3-N Only (traditional testing) lbs per acre	Additional N (SHT) lbs per acre	Solvita 1-day CO2-C	Organic C	Organic N	Organic C:N	Soil Health Calculation	Total Nitrogen lbslacre	Inorganic N	Organic N	Total Phosphate lbs/acre	Inorganic P	Organic P
460	401	10/24/2014	43.5	538.0	524.8			35.7	412.7	47.3	8.7	12.4	109.1	14.4	94.7	558.3	520.3	38.0
620	107	7/30/12	389.15	549.34	967.20			39.36	374.17	45.4	8.2	13.1	459.17	368.31	90.86	736.00	542.05	194
620	107	9/25/12	324.84	563.24	942.50			33.04	403.43	54.8	7.4	14.0	412.32	302.78	109.54	736.00	556.55	179.5
620	107	5/13/13	81.57	608.82	881.41	49.17	32.40	40.52	596.04	57.14	10.43	15.56	170.26	55.98	114.28	604.84	601.47	3.36
620	107	8/20/13	85.55	500.71	782.40	50.51	35.04	55.50	364.63	37.11	9.83	13.01	126.88	52.66	74.22	492.20	489.97	2.23
620	107	10/31/13	60.07	476.46	630.07	20.75	39.32	43.38	371.08	38.35	9.67	12.03	99.98	23.27	76.71	470.27	467.93	2.34
620	107	5/12/2014	129.6	547.4	662.4			423.3	385.7	41.8	9.2	53.9	148.3	64.7	83.5	547.4	523.3	24.1
620	107	8/12/2014	89.9	473.8	435.1			31.5	377.0	59.8	6.3	12.9	190.9	71.2	119.7	473.8	461.2	12.6
620	107	10/24/2014	44.5	439.0	538.8			34.3	335.5	36.8	9.1	10.5	94.1	20.5	73.6	451.2	422.6	28.5
620	202	7/30/12	347.11	439.38	924.30			43.8	331.37	25.5	13.0	9.2	402.26	351.17	51.08	616.40	435.41	181
620	202	9/25/12	241.92	574.59	848.90			34.78	402.24	57.1	7.1	14.7	331.92	217.74	114.18	680.80	567.32	113.5
620	202	5/13/13	80.88	517.62	782.35	32.90	47.98	67.78	457.86	44.63	10.26	15.65	125.47	36.22	89.26	505.31	505.10	0.22
620	202	8/20/13	64.96	430.38	688.75	46.31	18.65	26.61	308.49	33.07	9.33	9.24	112.77	46.63	66.14	427.72	424.96	2.76
620	202	10/31/13	46.55	405.17	526.72	11.87	34.68	41.51	339.54	34.98	9.71	11.17	83.22	13.27	69.95	405.16	397.04	8.11
620	202	5/12/2014	46.9	422.1	462.2			37.2	342.0	37.0	9.2	11.2	94.7	20.6	74.1	429.3	404.5	24.8
620	202	8/05/2014	64.1	325.1	314.0			28.5	346.5	51.9	6.7	11.5	146.6	42.8	103.8	325.1	316.0	9.1
620	202	10/24/2014	25.2	354.1	405.3			22.8	336.3	33.8	9.9	9.0	77.3	9.6	67.7	370.3	344.1	26.2
620	302	7/30/12	404.25	490.37	1016.60			43.8	401.75	34.2	11.7	11.2	469.14	400.67	68.47	678.50	485.32	193.2
620	302	9/25/12	284.07	474.29	884.00			34.78	387.42	65.4	5.9	16.3	382.06	251.28	130.78	572.70	466.24	106.5
620	302	5/13/13	110.53	639.75	947.12	51.10	59.43	84.83	592.56	58.67	10.10	20.19	175.73	58.39	117.34	648.53	623.80	24.73
620	302	8/20/13	87.59	595.24	848.77	60.49	27.09	37.95	404.52	44.62	9.07	12.69	148.25	59.01	89.25	602.52	587.32	15.20
620	302	10/31/13	72.92	567.19	651.34	26.41	46.51	39.97	403.51	43.68	9.24	12.73	117.09	29.74	87.35	562.96	558.99	3.97
620	302	5/12/2014	77.6	598.9	689.5			57.0	440.6	50.2	8.8	15.9	136.6	36.2	100.4	598.9	586.9	12.1
620	302	8/05/2014	121.7	512.8	368.5			39.3	401.5	70.7	5.7	15.0	236.1	94.8	141.3	554.7	487.8	66.9
620	302	10/24/2014	119.5	626.0	643.9			82.3	370.3	41.6	8.9	16.1	147.7	64.5	83.2	626.0	586.1	39.9
620	410	7/30/12	405.35	640.96	1064.70			27.39	421.82	54.4	7.8	13.2	498.87	390.05	108.82	853.30	635.62	217.7
620	410	9/25/12	417.60	662.28	945.10			79.96	460.22	85.8	5.4	28.1	511.96	340.34	171.62	717.60	642.87	74.73

Mix	Plot	Date	N lbs per acre	P2O5 lbs per acre	K2O lbs per acre	NO3-N Only (traditional testing) lbs per acre	Additional N (SHT) lbs per acre	Solvita 1-day CO2-C	Organic C	Organic N	Organic C:N	Soil Health Calculation	Total Nitrogen lbslacre	Inorganic N	Organic N	Total Phosphate lbs/acre	Inorganic P	Organic P
620	410	5/13/13	84.33	731.16	1012.67	33.15	51.17	70.90	628.52	61.05	10.29	19.28	163.10	40.99	122.11	732.58	718.10	14.47
620	410	8/20/13	91.60	637.01	884.71	61.65	29.95	46.09	426.02	43.02	9.90	13.22	149.36	63.32	86.04	719.31	628.16	91.15
620	410	10/31/13	59.06	553.77	610.80	19.41	39.65	38.90	383.07	39.33	9.74	11.76	100.17	21.51	78.66	569.01	546.18	22.83
620	410	5/12/2014	143.8	702.9	692.0			567.5	486.6	52.0	9.4	70.7	159.2	55.3	103.9	702.9	694.5	8.40
620	410	8/05/2014	210.6	707.5	284.9			147.5	510.7	78.5	6.5	27.7	233.5	76.6	157.0	707.5	649.8	57.7
620	410	10/24/2014	124.6	633.4	593.1			108.7	407.4	47.1	8.7	19.6	136.7	42.5	94.1	636.4	579.2	57.2
640	108	7/30/12	319.84	435.62	895.70			35.08	386.79	43.7	8.9	12.2	407.21	319.79	87.43	586.50	429.55	157
640	108	9/25/12	223.63	519.75	924.30			39.7	406.08	51.2	7.9	14.2	307.14	204.70	102.44	680.80	512.15	168.7
640	108	5/13/13	97.24	560.34	867.69	38.54	58.69	91.56	533.70	50.36	10.60	19.01	144.67	43.95	100.72	545.79	544.04	1.76
640	108	8/20/13	76.11	597.01	828.21	45.95	30.16	45.52	360.15	38.28	9.41	12.27	121.60	45.03	76.57	602.52	587.82	14.69
640	108	10/31/13	55.54	543.64	645.11	17.78	37.76	38.64	365.35	38.23	9.56	11.52	96.98	20.52	76.46	551.55	535.96	15.59
640	108	5/12/2014	119.9	547.2	633.6			535.6	359.7	40.1	9.0	67.3	135.8	55.6	80.2	547.2	525.3	21.9
640	108	8/05/2014	85.2	469.4	471.3			38.1	442.2	59.6	7.4	14.2	182.1	63.0	119.1	472.2	448.3	23.9
640	108	10/24/2014	68.9	504.6	557.1			64.5	351.3	39.1	9.0	13.9	94.5	16.2	78.3	504.6	475.8	28.8
640	208	7/30/12	367.58	483.91	878.80			34.78	349.84	41.5	8.4	11.8	384.43	301.51	82.92	657.80	477.61	180.2
640	208	9/25/12	221.83	515.70	843.70			33.04	396.24	58.1	6.8	14.6	311.52	195.26	116.26	630.20	508.64	121.6
640	208	5/13/13	82.80	585.34	868.01	34.94	47.86	68.32	493.05	48.43	10.18	16.48	136.23	39.37	96.86	578.67	572.61	6.06
640	208	8/20/13	96.75	561.91	797.98	69.29	27.45	39.37	358.44	38.66	9.27	11.70	146.66	69.34	77.32	554.01	553.85	0.16
640	208	10/31/13	56.08	522.61	615.92	16.60	39.49	44.13	369.47	37.99	9.73	12.03	94.00	18.03	75.98	519.57	513.98	5.60
640	208	5/12/2014	157.6	597.0	713.4			503.1	430.0	45.0	9.5	61.5	181.5	91.5	90.1	597.0	589.0	8.0
640	208	8/05/2014	80.4	468.5	364.7			28.5	381.8	61.4	6.2	12.8	185.1	62.2	122.8	506.9	451.0	55.9
640	208	10/24/2014	41.4	507.4	576.2			28.6	360.8	41.1	8.8	10.6	103.8	21.5	82.2	532.4	493.3	39.1
640	309	7/30/12	442.72	526.85	1101.10			43.8	389.41	42.2	9.2	12.9	483.60	399.27	84.33	740.60	519.61	221
640	309	9/25/12	255.40	448.71	897.00			25.8	411.38	67.9	6.1	15.2	381.38	245.62	135.76	552.00	442.81	109.2
640	309	5/13/13	92.31	652.04	991.30	44.61	47.70	65.67	582.62	56.37	10.34	17.82	169.04	56.29	112.75	655.98	640.00	15.98
640	309	8/20/13	127.90	673.13	891.26	88.98	38.92	64.96	419.96	38.98	10.77	14.13	164.68	86.72	77.96	779.32	661.79	117.53
640	309	10/31/13	66.32	623.90	668.79	19.08	47.24	20.86	460.12	49.50	9.30	11.80	121.59	22.59	99.00	643.62	619.64	23.98

Mix	Plot	Date	N lbs per acre	P2O5 lbs per acre	K2O lbs per acre	NO3-N Only (traditional testing) lbs per acre	Additional N (SHT) lbs per acre	Solvita 1-day CO2-C	Organic C	Organic N	Organic C:N	Soil Health Calculation	Total Nitrogen lbslacre	Inorganic N	Organic N	Total Phosphate lbs/acre	Inorganic P	Organic P
640	309	5/12/2014	128.5	667.4	670.8			134.1	403.3	45.7	8.8	23.8	143.7	52.2	91.5	667.4	637.1	30.3
640	309	8/05/2014	211.2	622.9	285.0			107.4	387.1	69.7	5.6	21.6	241.9	102.5	139.3	622.9	557.8	65.2
640	309	10/24/2014	81.1	665.2	623.1			78.1	422.7	47.2	9.0	16.8	109.8	15.4	94.3	678.8	627.3	51.4
640	403	7/30/12	358.55	472.58	929.50			39.36	365.52	42.1	8.7	12.4	433.35	349.22	84.13	639.40	465.64	173.8
640	403	9/25/12	195.77	437.57	738.40			22.99	357.42	53.4	6.7	12.4	297.24	190.38	106.86	547.40	432.59	114.8
640	403	5/13/13	90.34	609.44	892.29	52.64	37.70	56.42	485.68	42.94	11.31	14.14	145.38	59.50	85.88	602.12	600.20	1.91
640	403	8/20/13	97.90	589.67	833.62	74.18	23.72	39.71	388.25	36.04	10.77	11.17	147.00	74.91	72.09	607.90	582.73	25.16
640	403	10/31/13	59.93	507.76	574.58	19.10	40.83	46.54	367.51	38.36	9.58	12.37	98.12	21.40	76.72	515.24	498.52	16.71
640	403	5/12/2014	77.8	567.3	640.8			51.8	370.2	43.7	8.5	14.2	128.3	40.8	87.5	567.3	550.6	16.7
640	403	8/05/2014	93.6	536.6	271.8			41.8	426.1	67.6	6.3	15.2	193.1	57.8	135.3	547.6	511.2	36.3
640	403	10/24/2014	62.5	539.4	505.3			51.2	363.1	40.9	8.9	12.8	104.4	22.7	81.7	556.0	514.5	41.5
660	109	7/30/12	366.40	584.69	945.10			36.92	387.42	43.5	8.9	12.4	447.41	360.51	86.90	782.00	578.35	203.7
660	109	9/25/12	241.57	626.06	926.90			33.04	415.95	49.4	8.4	13.0	335.58	236.84	98.74	816.50	620.06	196.4
660	109	5/13/13	111.03	636.30	993.38	57.62	53.41	80.93	512.03	48.73	10.51	17.70	152.94	55.48	97.46	630.98	621.75	9.24
660	109	8/20/13	100.36	566.43	836.09	65.40	34.96	54.56	378.48	38.73	9.77	13.24	143.24	65.78	77.46	564.91	555.81	9.10
660	109	10/31/13	57.10	419.88	631.09	18.70	38.40	47.72	344.05	36.29	9.48	12.10	93.25	20.68	72.57	429.93	410.32	19.61
660	109	5/12/2014	128.1	568.9	597.1			347.7	369.3	41.5	8.9	46.9	145.3	62.4	83.0	568.9	536.6	32.3
660	109	8/05/2014	102.4	514.0	434.5			35.9	400.1	65.0	6.2	14.1	209.6	79.6	130.0	533.3	492.0	41.2
660	109	10/24/2014	50.3	560.6	588.3			38.6	372.6	41.6	9.0	11.7	105.9	22.6	83.2	580.3	541.9	38.4
660	206	7/30/12	342.15	433.85	890.50			39.7	362.34	35.6	10.2	11.1	389.56	318.38	71.18	602.60	428.04	174.6
660	206	9/25/12	149.75	481.66	808.60			29.2	380.75	55.6	6.9	13.6	248.66	137.56	111.10	602.60	475.45	127.2
660	206	5/13/13	67.61	533.07	834.37	33.34	34.28	45.06	500.69	48.83	10.25	14.28	137.11	39.44	97.67	525.07	524.74	0.33
660	206	8/20/13	70.59	488.65	652.34	44.97	25.62	36.68	333.12	36.39	9.16	10.98	116.70	43.93	72.77	481.80	481.06	0.74

Mix	Plot	Date	N lbs per acre	P2O5 lbs per acre	K2O lbs per acre	NO3-N Only (traditional testing) lbs per acre	Additional N (SHT) lbs per acre	Solvita 1-day CO2-C	Organic C	Organic N	Organic C:N	Soil Health Calculation	Total Nitrogen lbslacre	Inorganic N	Organic N	Total Phosphate lbs/acre	Inorganic P	Organic P
660	206	10/31/13	53.92	457.61	505.63	21.08	32.85	41.93	315.72	32.36	9.76	10.69	87.35	22.63	64.73	457.77	449.44	8.33
660	206	5/12/2014	71.5	554.4	589.5			43.7	398.6	41.3	8.9	12.7	128.2	45.7	82.6	575.6	533.1	42.5
660	206	8/05/2014	100.6	474.0	385.2			28.5	386.1	65.3	5.9	13.2	219.1	88.5	130.6	504.5	456.2	48.3
660	206	10/24/2014	38.7	478.9	537.8			33.9	386.1	42.0	9.2	11.5	97.0	12.9	84.1	498.8	462.9	35.9
660	303	7/30/12	419.45	573.37	1021.80			47.3	386.05	50.1	7.7	15.0	467.36	367.26	100.10	782.00	564.11	217.9
660	303	9/25/12	310.86	584.96	911.30			46.89	403.95	64.2	6.3	17.9	406.88	278.52	128.36	692.30	574.45	117.9
660	303	5/13/13	103.19	634.81	994.20	52.73	50.45	72.30	590.75	56.90	10.38	18.56	172.09	58.29	113.80	640.49	621.62	18.87
660	303	8/20/13	109.42	633.41	867.93	75.63	33.79	50.73	388.39	40.45	9.60	13.21	158.25	77.36	80.90	656.47	623.37	33.10
660	303	10/31/13	67.55	562.95	702.98	21.24	46.31	44.69	407.90	42.95	9.50	13.08	110.27	24.36	85.91	555.60	554.01	1.59
660	303	5/12/2014	125.9	583.5	758.0			152.1	409.6	45.4	9.0	25.5	140.4	49.6	90.8	583.5	567.0	16.5
660	303	8/05/2014	146.9	466.5	349.8			59.8	424.3	71.1	6.0	17.3	237.5	95.2	142.2	489.9	429.3	60.6
660	303	10/24/2014	53.2	520.2	587.4			38.5	397.4	44.8	8.9	12.3	115.6	26.0	89.7	541.7	501.4	40.3
660	408	7/30/12	336.99	442.23	911.30			33.04	377.95	42.6	8.9	11.8	424.44	339.28	85.16	598.00	436.53	161.5
660	408	9/25/12	215.43	427.46	786.50			32.76	378.64	55.9	6.8	14.2	301.86	190.18	111.68	519.80	420.44	99.36
660	408	5/13/13	100.04	620.20	972.28	50.64	49.40	75.24	540.56	50.21	10.77	17.41	155.09	54.67	100.42	609.94	607.06	2.88
660	408	8/20/13	103.08	573.36	835.04	76.22	26.86	40.95	354.65	36.57	9.70	11.43	147.89	74.75	73.14	590.95	565.33	25.61
660	408	10/31/13	49.14	437.84	616.14	18.49	30.64	30.83	342.75	34.84	9.84	10.05	90.42	20.74	69.68	443.29	431.88	11.41
660	408	5/12/2014	63.8	429.2	598.3			43.0	330.6	37.8	8.7	12.0	110.2	34.6	75.6	433.3	407.9	25.4
660	408	8/05/2014	29.6	401.6	248.4			3.1	395.1	60.6	6.5	10.3	158.0	36.8	121.2	440.9	399.7	41.2
660	408	10/24/2014	34.9	332.9	490.4			31.3	335.9	36.9	9.1	10.2	83.4	9.7	73.8	348.9	318.0	30.9
1000	110	7/30/12	334.43	579.72	954.20			36.92	403.68	44.9	9.0	12.6	427.21	337.35	89.87	765.90	573.43	192.5
1000	110	9/25/12	388.87	617.28	1001.00			38.7	388.62	54.3	7.2	14.7	484.70	376.10	108.60	807.30	609.27	198
1000	110	5/13/13	104.53	687.75	982.04	41.47	63.07	93.59	574.18	56.42	10.18	20.58	160.95	48.10	112.84	675.92	670.30	5.62
1000	110	8/20/13	107.03	644.43	861.82	72.07	34.96	51.16	399.26	43.38	9.20	13.89	158.87	72.11	86.76	692.32	633.90	58.43
1000	110	10/31/13	65.12	613.58	654.44	20.74	44.38	43.98	386.88	41.89	9.23	12.82	106.50	22.71	83.79	617.94	604.55	13.39
1000	110	5/12/2014	108.0	488.3	644.9			553.1	412.4	39.3	10.5	60.7	119.6	41.1	78.5	488.3	461.9	26.5
1000	110	8/05/2014	76.6	595.3	451.5			30.8	433.3	66.7	6.5	14.1	188.5	55.2	133.4	612.2	576.9	35.4

Mix	Plot	Date	N lbs per acre	P2O5 lbs per acre	K2O lbs per acre	NO3-N Only (traditional testing) lbs per acre	Additional N (SHT) lbs per acre	Solvita 1-day CO2-C	Organic C	Organic N	Organic C:N	Soil Health Calculation	Total Nitrogen lbslacre	Inorganic N	Organic N	Total Phosphate lbs/acre	Inorganic P	Organic P
1000	110	10/24/2014	168.1	597.7	646.3			71.9	318.4	26.5	12.0	13.0	224.7	171.6	53.1	610.3	572.9	37.4
1000	207	7/30/12	359.09	454.14	902.20			25.8	345.43	24.0	14.4	7.6	413.87	365.92	47.95	632.50	452.55	180
1000	207	9/25/12	311.32	539.00	861.90			27.74	368.52	67.7	5.5	15.5	429.80	294.50	135.30	641.70	532.31	109.4
1000	207	5/13/13	76.85	677.66	957.51	28.23	48.61	68.27	539.17	52.81	10.21	17.36	138.37	32.75	105.62	668.19	664.97	3.22
1000	207	8/20/13	75.99	551.63	794.40	49.75	26.24	38.00	366.50	39.73	9.22	11.76	129.61	50.15	79.46	549.70	543.82	5.88
1000	207	10/31/13	58.96	486.47	630.07	16.79	42.17	40.14	405.92	41.51	9.78	12.32	101.29	18.27	83.03	485.89	478.66	7.22
1000	207	5/12/2014	103.3	558.7	557.5			241.5	325.1	35.1	9.3	32.8	116.7	46.5	70.2	558.7	512.9	45.8
1000	207	8/05/2014	75.6	450.1	288.7			26.9	370.7	60.2	6.2	12.4	178.3	57.9	120.3	482.3	433.6	48.8
1000	207	10/24/2014	113.6	473.7	536.0			57.7	306.7	32.4	9.5	12.1	157.0	92.3	64.7	481.5	447.1	34.3
1000	305	7/30/12	439.92	598.66	1098.50			49.57	405.76	48.2	8.4	14.8	494.63	398.32	96.32	832.60	589.66	242.9
1000	305	9/25/12	421.38	604.70	1032.20			33.04	439.45	93.3	4.7	20.7	572.34	385.84	186.50	724.50	596.25	128.3
1000	305	5/13/13	64.01	555.96	833.68	17.29	46.73	63.55	609.37	62.17	9.80	18.79	155.91	31.57	124.34	553.23	543.64	9.59
1000	305	8/20/13	106.66	655.92	894.60	74.52	32.14	46.68	400.38	40.34	9.92	12.74	157.58	76.89	80.69	747.64	646.98	100.66
1000	305	10/31/13	59.69	550.16	601.77	19.91	39.77	42.79	359.43	37.95	9.47	11.91	99.39	23.49	75.90	572.13	541.58	30.55
1000	305	5/12/2014	114.0	570.9	737.6			93.8	373.3	42.6	8.8	18.7	126.0	40.8	85.2	570.9	558.7	12.1
1000	305	8/05/2014	158.3	505.5	308.5			60.2	377.2	68.3	5.5	16.6	238.1	101.4	136.7	528.8	466.8	62.0
1000	305	10/24/2014	118.5	576.2	636.4			68.3	357.1	39.7	9.0	14.4	161.4	82.0	79.4	585.9	543.2	42.7
1000	406	7/30/12	367.09	493.22	954.20			33.04	373.46	51.5	7.3	13.4	462.86	359.96	102.90	685.40	486.45	199
1000	406	9/25/12	357.34	480.61	872.30			32.9	352.83	68.9	5.1	16.8	460.68	322.90	137.78	595.70	472.46	123.2
1000	406	5/13/13	71.90	593.17	896.08	27.86	44.04	61.69	511.85	49.62	10.32	16.06	133.51	34.28	99.24	582.51	581.84	0.68
1000	406	8/20/13	89.95	563.33	825.07	67.09	22.87	34.72	357.57	36.82	9.71	10.83	140.78	67.14	73.64	579.00	556.53	22.47
1000	406	10/31/13	48.25	477.28	569.85	18.22	30.03	31.20	339.49	34.06	9.97	9.93	89.23	21.11	68.11	490.55	471.33	19.22
1000	406	5/12/2014	122.5	620.1	597.7			55.7	319.6	64.6	4.9	15.2	175.0	45.8	129.2	625.9	582.8	43.1
1000	406	8/05/2014	86.9	524.3	270.9			39.8	435.3	67.0	6.5	15.0	188.1	54.1	134.0	524.3	521.2	3.2
1000	406	10/24/2014	129.2	547.3	585.0			64.4	360.5	40.9	8.8	14.1	181.9	100.2	81.7	560.6	515.7	44.9

*Plot 301 accidentally seeded with 460 Mix in 2013

Table CC-5. Canopy cover and plant height

MIX	Plot ID	Days post planting	Date*	Total Cover	Canopy Cover (decimal %)													Height (inches)
					Dead Organic Cover	Bare Ground	Weed	Planted Grass	Planted Legume	Planted Forb	Total Planted Cover	Rye/ Tritcale	Oat	Clover	Vetch	Rape	Radish	
220	101	30	08/31/12	0.64		0.36	0.06	0.56	0.02	0.00	0.58	0.56	0.00	0.02	0.00	0.00	0.00	11.20
220	101	47	09/18/12	0.92		0.08	0.16	0.74	0.00	0.02	0.76	0.74	0.00	0.00	0.00	0.00	0.02	22.90
220	101	30	09/16/14	0.98	0.70	0.02	0.00	0.24	0.00	0.00	0.28	0.24	0.00	0.00	0.00	0.00	0.00	9.20
220	101	60	10/09/14	0.96	0.14	0.04	0.00	0.60	0.00	0.00	0.82	0.60	0.00	0.00	0.00	0.00	0.00	16.20
220	205	30	08/31/12	0.60		0.40	0.34	0.26	0.00	0.00	0.26	0.26	0.00	0.00	0.00	0.00	0.00	14.00
220	205	47	09/18/12	0.88		0.12	0.22	0.66	0.00	0.00	0.66	0.66	0.00	0.00	0.00	0.00	0.00	35.10
220	205	30	09/16/14	1.00	0.78	0.00	0.00	0.22	0.00	0.00	0.22	0.22	0.00	0.00	0.00	0.00	0.00	9.60
220	205	60	10/09/14	0.88	0.34	0.12	0.00	0.54	0.00	0.00	0.54	0.54	0.00	0.00	0.00	0.00	0.00	13.20
220	307	30	08/31/12	0.68		0.32	0.16	0.50	0.00	0.02	0.52	0.50	0.00	0.00	0.00	0.00	0.02	8.10
220	307	47	09/18/12	0.96		0.04	0.22	0.72	0.00	0.02	0.74	0.72	0.00	0.00	0.00	0.00	0.02	22.90
220	307	30	09/16/14	1.00	0.86	0.00	0.00	0.14	0.00	0.00	0.14	0.14	0.00	0.00	0.00	0.00	0.00	10.20
220	307	60	10/09/14	0.92	0.68	0.08	0.00	0.24	0.00	0.00	0.24	0.24	0.00	0.00	0.00	0.00	0.00	12.40
220	405	30	08/31/12	0.66		0.34	0.34	0.30	0.02	0.00	0.32	0.30	0.00	0.00	0.02	0.00	0.00	15.00
220	405	47	09/18/12	0.94		0.06	0.14	0.80	0.00	0.00	0.80	0.80	0.00	0.00	0.00	0.00	0.00	33.00
220	405	30	09/16/14	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
220	405	60	10/09/14	0.86	0.86	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
240	102	30	08/31/12	0.72		0.28	0.14	0.58	0.00	0.00	0.58	0.58	0.00	0.00	0.00	0.00	0.00	14.00
240	102	47	09/18/12	0.98		0.02	0.04	0.92	0.00	0.02	0.94	0.92	0.00	0.00	0.00	0.00	0.02	28.40
240	102	30	09/16/14	1.00	0.62	0.00	0.00	0.34	0.00	0.00	0.38	0.34	0.00	0.00	0.00	0.00	0.00	8.40
240	102	60	10/09/14	1.00	0.20	0.00	0.00	0.78	0.02	0.00	0.80	0.78	0.00	0.02	0.00	0.00	0.00	15.80
240	210	30	08/31/12	0.66		0.34	0.18	0.48	0.00	0.00	0.48	0.48	0.00	0.00	0.00	0.00	0.00	17.50
240	210	47	09/18/12	0.92		0.08	0.10	0.82	0.00	0.00	0.82	0.82	0.00	0.00	0.00	0.00	0.00	34.50
240	210	30	09/16/14	1.00	0.88	0.00	0.00	0.12	0.00	0.00	0.12	0.12	0.00	0.00	0.00	0.00	0.00	7.20
240	210	60	10/09/14	0.90	0.40	0.10	0.00	0.50	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	10.80

MIX	Plot ID	Days post planting	Date*	Total Cover	Canopy Cover (decimal %)													Height (inches)
					Dead Organic Cover	Bare Ground	Weed	Planted Grass	Planted Legume	Planted Forb	Total Planted Cover	Rye/ Tritcale	Oat	Clover	Vetch	Rape	Radish	
240	304	30	08/31/12	0.54		0.46	0.14	0.40	0.00	0.00	0.40	0.40	0.00	0.00	0.00	0.00	0.00	13.20
240	304	47	09/18/12	1.00		0.00	0.10	0.90	0.00	0.00	0.90	0.90	0.00	0.00	0.00	0.00	0.00	27.40
240	304	30	09/16/14	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
240	304	60	10/09/14	0.88	0.82	0.12	0.00	0.06	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.00	0.00	8.00
240	409	30	08/31/12	0.78		0.22	0.08	0.70	0.00	0.00	0.70	0.70	0.00	0.00	0.00	0.00	0.00	17.80
240	409	47	09/18/12	0.96		0.04	0.04	0.92	0.00	0.00	0.92	0.92	0.00	0.00	0.00	0.00	0.00	33.50
240	409	30	09/16/14	1.00	0.80	0.00	0.00	0.20	0.00	0.00	0.20	0.20	0.00	0.00	0.00	0.00	0.00	11.20
240	409	60	10/09/14	0.92	0.40	0.08	0.00	0.52	0.00	0.00	0.52	0.52	0.00	0.00	0.00	0.00	0.00	11.60
260	103	30	08/31/12	0.74		0.26	0.08	0.64	0.02	0.00	0.66	0.64	0.00	0.02	0.00	0.00	0.00	17.30
260	103	47	09/18/12	0.98		0.02	0.06	0.92	0.00	0.00	0.92	0.92	0.00	0.00	0.00	0.00	0.00	29.50
260	103	30	09/16/14	1.00	0.42	0.00	0.00	0.58	0.00	0.00	0.58	0.58	0.00	0.00	0.00	0.00	0.00	11.20
260	103	60	10/09/14	0.98	0.18	0.02	0.00	0.80	0.00	0.00	0.80	0.80	0.00	0.00	0.00	0.00	0.00	15.40
260	203	30	08/31/12	0.76		0.24	0.08	0.68	0.00	0.00	0.68	0.68	0.00	0.00	0.00	0.00	0.00	19.10
260	203	47	09/18/12	0.94		0.06	0.02	0.92	0.00	0.00	0.92	0.92	0.00	0.00	0.00	0.00	0.00	34.30
260	203	30	09/16/14	1.00	0.50	0.00	0.00	0.50	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	10.80
260	203	60	10/09/14	1.00	0.18	0.00	0.00	0.82	0.00	0.00	0.82	0.82	0.00	0.00	0.00	0.00	0.00	15.20
260	301	30	08/31/12	0.70		0.30	0.12	0.58	0.00	0.00	0.58	0.58	0.00	0.00	0.00	0.00	0.00	17.80
260	301	47	09/18/12	1.00		0.00	0.02	0.98	0.00	0.00	0.98	0.98	0.00	0.00	0.00	0.00	0.00	31.50
260	301	30	09/16/14	1.00	0.84	0.00	0.00	0.12	0.04	0.00	0.16	0.12	0.00	0.00	0.04	0.00	0.00	8.80
260	301	60	10/09/14	0.96	0.56	0.04	0.00	0.38	0.02	0.00	0.40	0.38	0.00	0.00	0.02	0.00	0.00	15.60
260	402	30	08/31/12	0.74		0.26	0.02	0.72	0.00	0.00	0.72	0.72	0.00	0.00	0.00	0.00	0.00	17.30
260	402	47	09/18/12	0.88		0.12	0.00	0.88	0.00	0.00	0.88	0.88	0.00	0.00	0.00	0.00	0.00	33.50
260	402	30	09/16/14	1.00	0.60	0.00	0.00	0.40	0.00	0.00	0.40	0.40	0.00	0.00	0.00	0.00	0.00	9.40
260	402	60	10/09/14	0.98	0.16	0.02	0.00	0.82	0.00	0.00	0.82	0.82	0.00	0.00	0.00	0.00	0.00	12.20

MIX	Plot ID	Days post planting	Date*	Total Cover	Canopy Cover (decimal %)													Height (inches)
					Dead Organic Cover	Bare Ground	Weed	Planted Grass	Planted Legume	Planted Forb	Total Planted Cover	Rye/ Tritcale	Oat	Clover	Vetch	Rape	Radish	
420	104	30	08/31/12	0.72		0.28	0.16	0.22	0.08	0.26	0.56	0.22	0.00	0.00	0.08	0.00	0.26	9.70
420	104	47	09/18/12	1.00		0.00	0.02	0.54	0.02	0.42	0.98	0.54	0.00	0.00	0.02	0.00	0.42	26.90
420	104	30	09/16/14	1.00	0.44	0.00	0.00	0.16	0.10	0.30	0.56	0.16	0.00	0.00	0.10	0.00	0.30	7.40
420	104	60	10/09/14	1.00	0.14	0.00	0.00	0.36	0.04	0.46	0.86	0.36	0.00	0.00	0.04	0.00	0.46	13.40
420	204	30	08/31/12	0.78		0.22	0.30	0.26	0.02	0.20	0.48	0.26	0.00	0.00	0.02	0.00	0.20	13.70
420	204	47	09/18/12	0.96		0.04	0.06	0.50	0.02	0.38	0.90	0.50	0.00	0.00	0.02	0.00	0.38	34.50
420	204	30	09/16/14	1.00	0.64	0.00	0.00	0.08	0.08	0.20	0.36	0.08	0.00	0.00	0.08	0.02	0.18	8.40
420	204	60	10/09/14	1.00	0.18	0.00	0.00	0.28	0.12	0.42	0.82	0.28	0.00	0.00	0.12	0.00	0.42	15.00
420	308	30	08/31/12	0.72		0.28	0.14	0.36	0.10	0.12	0.58	0.36	0.00	0.00	0.10	0.00	0.12	10.20
420	308	47	09/18/12	0.98		0.02	0.12	0.48	0.02	0.36	0.86	0.48	0.00	0.00	0.02	0.00	0.36	25.90
420	308	30	09/16/14	1.00	0.64	0.00	0.00	0.12	0.04	0.20	0.36	0.12	0.00	0.00	0.04	0.00	0.20	8.80
420	308	60	10/09/14	1.00	0.26	0.00	0.00	0.26	0.08	0.40	0.74	0.26	0.00	0.00	0.08	0.00	0.40	14.40
420	404	30	08/31/12	0.78		0.22	0.12	0.36	0.06	0.24	0.66	0.36	0.00	0.00	0.06	0.02	0.22	16.50
420	404	47	09/18/12	0.96		0.04	0.04	0.36	0.02	0.54	0.92	0.36	0.00	0.00	0.02	0.00	0.54	36.10
420	404	30	09/16/14	1.00	0.74	0.00	0.00	0.02	0.02	0.22	0.26	0.02	0.00	0.00	0.02	0.12	0.10	7.60
420	404	60	10/09/14	1.00	0.40	0.00	0.00	0.14	0.10	0.36	0.60	0.14	0.00	0.00	0.10	0.00	0.36	12.60
440	105	30	08/31/12	0.86		0.14	0.06	0.34	0.08	0.38	0.80	0.34	0.00	0.00	0.08	0.00	0.38	15.50
440	105	47	09/18/12	0.96		0.04	0.00	0.54	0.00	0.42	0.96	0.54	0.00	0.00	0.00	0.02	0.40	29.50
440	105	30	09/16/14	1.00	0.32	0.00	0.00	0.16	0.14	0.38	0.68	0.16	0.00	0.00	0.14	0.00	0.38	8.80
440	105	60	10/09/14	0.98	0.12	0.02	0.00	0.36	0.04	0.46	0.86	0.36	0.00	0.00	0.04	0.00	0.46	17.80
440	209	30	08/31/12	0.78		0.22	0.08	0.24	0.08	0.38	0.70	0.24	0.00	0.00	0.08	0.00	0.38	17.80
440	209	47	09/18/12	0.98		0.02	0.02	0.40	0.00	0.56	0.96	0.40	0.00	0.00	0.00	0.00	0.56	40.60
440	209	30	09/16/14	1.00	0.40	0.00	0.00	0.18	0.00	0.42	0.60	0.18	0.00	0.00	0.00	0.02	0.40	9.60
440	209	60	10/09/14	1.00	0.06	0.00	0.00	0.14	0.00	0.80	0.94	0.14	0.00	0.00	0.00	0.00	0.80	16.80

MIX	Plot ID	Days post planting	Date*	Total Cover	Canopy Cover (decimal %)													Height (inches)
					Dead Organic Cover	Bare Ground	Weed	Planted Grass	Planted Legume	Planted Forb	Total Planted Cover	Rye/ Tritcale	Oat	Clover	Vetch	Rape	Radish	
440	310	30	08/31/12	0.78		0.22	0.10	0.36	0.08	0.24	0.68	0.36	0.00	0.00	0.08	0.00	0.24	14.00
440	310	47	09/18/12	0.94		0.06	0.08	0.42	0.00	0.44	0.86	0.42	0.00	0.00	0.00	0.00	0.44	24.40
440	310	30	09/16/14	1.00	0.42	0.00	0.00	0.24	0.06	0.28	0.58	0.24	0.00	0.00	0.06	0.00	0.28	10.60
440	310	60	10/09/14	1.00	0.14	0.00	0.00	0.40	0.08	0.38	0.86	0.40	0.00	0.00	0.08	0.00	0.38	13.60
440	407	30	08/31/12	0.88		0.12	0.10	0.32	0.04	0.42	0.78	0.32	0.00	0.00	0.04	0.00	0.42	18.30
440	407	47	09/18/12	0.98		0.02	0.00	0.40	0.00	0.58	0.98	0.40	0.00	0.00	0.00	0.00	0.58	33.00
440	407	30	09/16/14	1.00	0.68	0.00	0.00	0.00	0.06	0.26	0.32	0.00	0.00	0.00	0.06	0.00	0.26	7.80
440	407	60	10/09/14	1.00	0.36	0.00	0.00	0.06	0.06	0.52	0.64	0.06	0.00	0.00	0.06	0.00	0.52	12.00
460	106	30	08/31/12	0.92		0.08	0.04	0.44	0.08	0.36	0.88	0.44	0.00	0.00	0.08	0.00	0.36	17.80
460	106	47	09/18/12	1.00		0.00	0.00	0.46	0.00	0.54	1.00	0.46	0.00	0.00	0.00	0.00	0.54	33.00
460	106	30	09/16/14	1.00	0.28	0.00	0.00	0.18	0.06	0.48	0.72	0.18	0.00	0.00	0.06	0.00	0.48	9.20
460	106	60	10/09/14	1.00	0.02	0.00	0.00	0.18	0.04	0.76	0.98	0.18	0.00	0.00	0.04	0.00	0.76	16.00
460	201	30	08/31/12	0.86		0.14	0.06	0.42	0.02	0.36	0.80	0.42	0.00	0.00	0.02	0.00	0.36	15.20
460	201	47	09/18/12	0.90		0.10	0.00	0.32	0.00	0.58	0.90	0.32	0.00	0.00	0.00	0.00	0.58	33.50
460	201	30	09/16/14	1.00	0.12	0.00	0.00	0.28	0.04	0.56	0.88	0.28	0.00	0.00	0.04	0.00	0.56	11.00
460	201	60	10/09/14	1.00	0.04	0.00	0.00	0.24	0.06	0.66	0.96	0.24	0.00	0.00	0.06	0.00	0.66	15.60
460	306	30	08/31/12	0.94		0.06	0.04	0.38	0.02	0.50	0.90	0.38	0.00	0.00	0.02	0.00	0.50	16.80
460	306	47	09/18/12	1.00		0.00	0.00	0.44	0.00	0.56	1.00	0.44	0.00	0.00	0.00	0.00	0.56	29.00
460	306	30	09/16/14	1.00	0.28	0.00	0.00	0.32	0.02	0.38	0.72	0.32	0.00	0.00	0.02	0.00	0.38	11.00
460	306	60	10/09/14	1.00	0.12	0.00	0.00	0.24	0.08	0.56	0.88	0.24	0.00	0.00	0.08	0.00	0.56	14.00
460	401	30	08/31/12	0.76		0.24	0.02	0.42	0.02	0.30	0.74	0.42	0.00	0.00	0.02	0.00	0.30	15.50
460	401	47	09/18/12	0.84		0.16	0.00	0.46	0.00	0.38	0.84	0.46	0.00	0.00	0.00	0.00	0.38	39.60
460	401	30	09/16/14	1.00	0.34	0.00	0.00	0.16	0.06	0.44	0.66	0.16	0.00	0.00	0.06	0.04	0.40	9.40
460	401	60	10/09/14	1.00	0.06	0.00	0.00	0.28	0.00	0.66	0.94	0.28	0.00	0.00	0.00	0.00	0.66	13.60

MIX	Plot ID	Days post planting	Date*	Total Cover	Canopy Cover (decimal %)													Height (inches)
					Dead Organic Cover	Bare Ground	Weed	Planted Grass	Planted Legume	Planted Forb	Total Planted Cover	Rye/ Tritcale	Oat	Clover	Vetch	Rape	Radish	
620	107	30	08/31/12	0.72		0.28	0.16	0.34	0.02	0.20	0.56	0.34	0.00	0.00	0.02	0.06	0.14	11.70
620	107	47	09/18/12	1.00		0.00	0.10	0.48	0.04	0.38	0.90	0.48	0.00	0.00	0.04	0.08	0.30	26.40
620	107	30	09/16/14	1.00	0.66	0.00	0.00	0.30	0.00	0.04	0.34	0.30	0.00	0.00	0.00	0.00	0.04	6.60
620	107	60	10/09/14	1.00	0.10	0.00	0.00	0.66	0.04	0.20	0.90	0.66	0.00	0.00	0.04	0.00	0.20	16.00
620	202	30	08/31/12	0.78		0.22	0.28	0.32	0.04	0.14	0.50	0.32	0.00	0.00	0.04	0.00	0.14	15.70
620	202	47	09/18/12	0.88		0.12	0.14	0.42	0.04	0.28	0.74	0.42	0.00	0.00	0.04	0.08	0.20	30.00
620	202	30	09/16/14	1.00	0.44	0.00	0.00	0.26	0.06	0.24	0.56	0.26	0.00	0.00	0.06	0.02	0.22	9.60
620	202	60	10/09/14	0.98	0.06	0.02	0.00	0.66	0.04	0.22	0.92	0.66	0.00	0.00	0.04	0.06	0.16	15.40
620	302	30	08/31/12	0.70		0.30	0.14	0.40	0.04	0.12	0.56	0.40	0.00	0.00	0.04	0.04	0.08	10.70
620	302	47	09/18/12	1.00		0.00	0.04	0.58	0.00	0.38	0.96	0.58	0.00	0.00	0.00	0.16	0.22	31.00
620	302	30	09/16/14	1.00	0.54	0.00	0.00	0.38	0.00	0.08	0.46	0.38	0.00	0.00	0.00	0.00	0.08	9.20
620	302	60	10/09/14	0.98	0.26	0.02	0.00	0.60	0.02	0.10	0.72	0.60	0.00	0.00	0.02	0.00	0.10	14.40
620	410	30	08/31/12	0.64		0.36	0.18	0.32	0.04	0.10	0.46	0.32	0.00	0.00	0.04	0.00	0.10	15.70
620	410	47	09/18/12	0.96		0.04	0.08	0.48	0.00	0.40	0.88	0.48	0.00	0.00	0.00	0.16	0.24	38.10
620	410	30	09/16/14	1.00	0.50	0.00	0.00	0.36	0.04	0.10	0.50	0.36	0.00	0.00	0.04	0.02	0.08	9.40
620	410	60	10/09/14	1.00	0.24	0.00	0.00	0.58	0.02	0.16	0.76	0.58	0.00	0.00	0.02	0.00	0.16	12.80
640	108	30	08/31/12	0.74		0.26	0.08	0.38	0.06	0.22	0.66	0.38	0.00	0.00	0.06	0.04	0.18	13.20
640	108	47	09/18/12	1.00		0.00	0.00	0.52	0.02	0.46	1.00	0.52	0.00	0.00	0.02	0.18	0.28	33.50
640	108	30	09/16/14	1.00	0.20	0.00	0.00	0.60	0.06	0.14	0.80	0.60	0.00	0.00	0.06	0.00	0.14	10.40
640	108	60	10/09/14	1.00	0.02	0.00	0.00	0.62	0.00	0.36	0.98	0.62	0.00	0.00	0.00	0.06	0.30	17.40
640	208	30	08/31/12	0.88		0.12	0.10	0.44	0.04	0.30	0.78	0.44	0.00	0.00	0.04	0.02	0.28	17.50
640	208	47	09/18/12	0.98		0.02	0.00	0.56	0.02	0.40	0.98	0.56	0.00	0.00	0.02	0.04	0.36	43.20
640	208	30	09/16/14	1.00	0.46	0.00	0.00	0.32	0.06	0.16	0.54	0.32	0.00	0.00	0.06	0.08	0.08	11.00
640	208	60	10/09/14	1.00	0.08	0.00	0.00	0.52	0.04	0.36	0.92	0.52	0.00	0.00	0.04	0.00	0.36	17.20

MIX	Plot ID	Days post planting	Date*	Total Cover	Canopy Cover (decimal %)													Height (inches)
					Dead Organic Cover	Bare Ground	Weed	Planted Grass	Planted Legume	Planted Forb	Total Planted Cover	Rye/ Tritcale	Oat	Clover	Vetch	Rape	Radish	
640	309	30	08/31/12	0.76		0.24	0.04	0.42	0.00	0.30	0.72	0.42	0.00	0.00	0.00	0.08	0.22	13.20
640	309	47	09/18/12	1.00		0.00	0.04	0.54	0.00	0.42	0.96	0.54	0.00	0.00	0.00	0.10	0.32	27.40
640	309	30	09/16/14	1.00	0.28	0.00	0.00	0.54	0.00	0.18	0.72	0.54	0.00	0.00	0.00	0.00	0.18	11.20
640	309	60	10/09/14	1.00	0.18	0.00	0.00	0.54	0.02	0.26	0.82	0.54	0.00	0.00	0.02	0.00	0.26	15.60
640	403	30	08/31/12	0.82		0.18	0.16	0.42	0.06	0.14	0.66	0.42	0.00	0.00	0.06	0.04	0.10	16.50
640	403	47	09/18/12	0.92		0.08	0.02	0.38	0.06	0.46	0.90	0.38	0.00	0.00	0.06	0.02	0.44	43.20
640	403	30	09/16/14	1.00	0.26	0.00	0.00	0.54	0.06	0.14	0.74	0.54	0.00	0.00	0.06	0.06	0.08	12.40
640	403	60	10/09/14	1.00	0.02	0.00	0.00	0.74	0.02	0.22	0.98	0.74	0.00	0.00	0.02	0.02	0.20	18.40
660	109	30	08/31/12	0.84		0.16	0.04	0.44	0.02	0.34	0.80	0.44	0.00	0.00	0.02	0.10	0.24	15.20
660	109	47	09/18/12	0.98		0.02	0.00	0.40	0.00	0.58	0.98	0.40	0.00	0.00	0.00	0.10	0.48	35.10
660	109	30	09/16/14	1.00	0.20	0.00	0.00	0.52	0.04	0.24	0.80	0.52	0.00	0.00	0.04	0.02	0.22	10.20
660	109	60	10/09/14	1.00	0.04	0.00	0.00	0.66	0.02	0.28	0.96	0.66	0.00	0.00	0.02	0.02	0.26	15.00
660	206	30	08/31/12	0.66		0.34	0.08	0.38	0.04	0.16	0.58	0.38	0.00	0.00	0.04	0.04	0.12	13.50
660	206	47	09/18/12	0.82		0.18	0.00	0.50	0.04	0.28	0.82	0.50	0.00	0.00	0.04	0.02	0.26	39.10
660	206	30	09/16/14	1.00	0.12	0.00	0.00	0.56	0.06	0.26	0.88	0.56	0.00	0.00	0.06	0.04	0.22	10.00
660	206	60	10/09/14	1.00	0.00	0.00	0.00	0.64	0.02	0.34	1.00	0.64	0.00	0.00	0.02	0.06	0.28	17.80
660	303	30	08/31/12	0.80		0.20	0.04	0.42	0.02	0.32	0.76	0.42	0.00	0.00	0.02	0.04	0.28	17.30
660	303	47	09/18/12	1.00		0.00	0.02	0.40	0.00	0.58	0.98	0.40	0.00	0.00	0.00	0.10	0.48	38.10
660	303	30	09/16/14	1.00	0.20	0.00	0.00	0.60	0.04	0.16	0.80	0.60	0.00	0.00	0.04	0.00	0.16	11.80
660	303	60	10/09/14	1.00	0.04	0.00	0.00	0.62	0.04	0.30	0.96	0.62	0.00	0.00	0.04	0.02	0.28	16.60
660	408	30	08/31/12	0.92		0.08	0.02	0.54	0.06	0.30	0.90	0.54	0.00	0.00	0.06	0.08	0.22	19.80
660	408	47	09/18/12	0.98		0.02	0.00	0.48	0.04	0.46	0.98	0.48	0.00	0.00	0.04	0.10	0.36	38.60
660	408	30	09/16/14	1.00	0.14	0.00	0.00	0.52	0.02	0.32	0.86	0.52	0.00	0.00	0.02	0.04	0.28	12.80
660	408	60	10/09/14	1.00	0.10	0.00	0.00	0.64	0.02	0.24	0.90	0.64	0.00	0.00	0.02	0.02	0.22	15.80

MIX	Plot ID	Days post planting	Date*	Total Cover	Canopy Cover (decimal %)													Height (inches)
					Dead Organic Cover	Bare Ground	Weed	Planted Grass	Planted Legume	Planted Forb	Total Planted Cover	Rye/ Tritcale	Oat	Clover	Vetch	Rape	Radish	
1000	110	30	08/31/12	0.50		0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.50
1000	110	47	09/18/12	0.94		0.06	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.10
1000	110	30	09/16/14	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1000	110	60	10/09/14	0.90	0.90	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1000	207	30	08/31/12	0.46		0.54	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.50
1000	207	47	09/18/12	0.84		0.16	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.70
1000	207	30	09/16/14	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1000	207	60	10/09/14	0.86	0.86	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1000	305	30	08/31/12	0.42		0.58	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.50
1000	305	47	09/18/12	0.86		0.14	0.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.60
1000	305	30	09/16/14	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1000	305	60	10/09/14	0.90	0.90	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1000	406	30	08/31/12	0.42		0.58	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.50
1000	406	47	09/18/12	0.94		0.06	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.90
1000	406	30	09/16/14	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1000	406	60	10/09/14	0.90	0.90	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*No canopy cover data measured in 2014 as plots were primarily volunteer barley

Table CC-6. Crop biomass and botanical composition

Sample Date	Mix	Plot	Above ground Dry Matter %	Total Above ground DM lb/acre	Botanical Composition of Aboveground Biomass						Radish Root Dry Matter %	Radish Root DM lb/acre	Radish Root % N
					% Weed	% Grass	% Legume	% Rape	% Radish (top)	Above Ground N %			
09/21/12	220	101	14.2	3404	2.7	97.3	0.0	.	.	5.0	.	.	.
10/31/13	220	101	21.6	1437	.	100.0	0.0	.	.	2.6	.	.	.
10/21/2014	220	101	22.5	1387	21.6	78.4	0			3.8			
09/21/12	220	205	15.0	3189	26.3	73.7	0.0	.	.	5.2	.	.	
10/31/13	220	205	14.9	2831	.	100.0	0.0	.	.	4.4	.	.	
10/21/2014	220	205	19.3	867		100.0	0			4.9			
09/21/12	220	307	19.2	3534	13.6	86.4	0.0	.	.	5.0	.	.	
10/31/13	220	307	15.3	3309	.	100.0	0.0	.	.	3.3	.	.	
10/21/2014	220	307	15.5	96		100.0	0			5.3			
09/21/12	220	405	17.9	3826	20.0	80.0	0.0	.	.	4.9	.	.	
10/31/13	220	405	12.0	3398	.	100.0	0.0	.	.	4.3	.	.	
10/21/2014	220	405	0	0			0			0			
09/21/12	240	102	15.4	2753	8.1	91.8	0.0	.	.	5.0	.	.	.
10/31/13	240	102	16.1	2845	.	100.0	0.0	.	.	4.3	.	.	.
10/21/2014	240	102	18.1	2313		100.0	0			5.0			
09/21/12	240	210	13.5	3435	1.9	98.1	0.0	.	.	5.0	.	.	
10/31/13	240	210	12.3	2716	.	100.0	0.0	.	.	4.4	.	.	
10/21/2014	240	210	20.3	625		100.0	0			5.1			
09/21/12	240	304	12.1	3503	8.9	91.1	0.0	.	.	4.8	.	.	
10/31/13	240	304	13.6	1891	.	100.0	0.0	.	.	4.2	.	.	
10/21/2014	240	304	21.4	510		100.0	0			5.3			
09/21/12	240	409	16.5	4137	0.1	99.8	0.0	.	.	5.0	.	.	
10/31/13	240	409	16.1	3735	.	100.0	0.0	.	.	3.4	.	.	
10/21/2014	240	409	19.6	1430		100.0	0			5.0			
09/21/12	260	103	14.7	4877	2.0	97.9	0.0	.	.	4.8	.	.	.
10/31/13	260	103	14.7	3298	0.0	100.0	0.0	.	.	4.2	.	.	.
10/21/2014	260	103	22.1	2943		100.0	0			3.5			

Sample Date	Mix	Plot	Above ground Dry Matter %	Total Above ground DM lb/acre	Botanical Composition of Aboveground Biomass						Radish Root Dry Matter %	Radish Root DM lb/acre	Radish Root % N
					% Weed	% Grass	% Legume	% Rape	% Radish (top)	Above Ground N %			
09/21/12	260	203	14.7	3676	1.4	98.5	0.0	.	.	4.8	.	.	
10/31/13	260	203	17.8	2325	.	100.0	0.0	.	.	3.3	.	.	
10/21/2014	260	203	20.4	2894		100.0	0			4.5			
09/21/12	260	301	17.3	3529	1.9	98.1	0.0	.	.	5.4	.	.	
10/31/13	*	301	13.3	2818	.	96.9	0.0	.	3.1	4.4	.	0	2.9
10/21/2014	260	301	19.8	1105		100.0	0			4.7			
09/21/12	260	402	17.0	3411	2.8	97.1	0.0	.	.	4.9	.	.	
10/31/13	260	402	12.6	2584	.	100.0	0.0	.	.	4.7	.	.	
10/21/2014	260	402	17.0	3959		100.0	0			4.5			
09/21/12	420	104	14.6	4877	21.0	31.8	0.7	.	46.5	4.8	8.5	556	4.1
10/31/13	420	104	14.8	2312	.	74.3	0.0	.	25.7	4.3	9.3	106	2.3
10/21/2014	420	104	15.0	4056		0	1.5		98.5	4.9	10.6	774	4.9
09/21/12	420	204	11.9	3386	9.8	51.4	0.0	.	38.7	5.3	8.3	298	3.7
10/31/13	420	204	14.7	2294	.	89.9	0.0	.	10.1	4.4	4.9	24	2.8
10/21/2014	420	204	11.5	4576		1.3	2.5		96.2	5.2	6.0	986	4.3
09/21/12	420	308	17.8	4051	15.0	45.6	2.3	.	37.1	5.5	13.6	323	4.2
10/31/13	420	308	11.7	2633	.	89.4	0.0	.	10.6	4.8	5.6	22	2.5
10/21/2014	420	308	16.3	3239		21.6	13.3		65.2	4.9	4.4	432	4.9
09/21/12	420	404	16.6	2637	14.4	68.4	1.7	.	15.5	5.3	7.7	135	3.8
10/31/13	420	404	12.0	2475	.	91.9	0.0	.	8.1	4.9	4.3	17	2.4
10/21/2014	420	404	10.8	4266		0	0		100.0	5.3	4.9	826	4.3
09/21/12	440	105	9.1	4352	2.7	33.7	0.1	.	63.5	5.0	10.5	403	4.2
10/31/13	440	105	14.8	3017	.	82.1	0.0	.	17.9	4.3	10.4	120	2.8
10/21/2014	440	105	19.8	3070		48.5	4.0		47.5	3.9	11.8	259	4.6
09/21/12	440	209	9.9	4055	1.5	51.3	1.2	.	46.0	5.9	9.3	187	4.3
10/31/13	440	209	12.7	3308	.	94.5	0.0	.	5.5	4.5	4.3	17	2.2
10/21/2014	440	209	12.2	4304		26.1	8.0		65.9	4.9	5.7	600	3.7
09/21/12	440	310	15.4	3579	3.5	49.1	2.1	.	45.2	5.4	13.3	336	4.1
10/31/13	440	310	11.8	3035	.	96.3	0.0	.	3.7	4.5	.	0	2.9

Sample Date	Mix	Plot	Above ground Dry Matter %	Total Above ground DM lb/acre	Botanical Composition of Aboveground Biomass						Radish Root Dry Matter %	Radish Root DM lb/acre	Radish Root % N
					% Weed	% Grass	% Legume	% Rape	%Radish (top)	Above Ground N %			
10/21/2014	440	310	16.0	2162		51.1	1.8		47.1	5.1	9.4	268	5.5
09/21/12	440	407	16.8	3872	5.2	61.4	1.7	.	31.8	5.3	12.3	357	4.1
10/31/13	440	407	14.7	3626	.	97.3	0.0	.	2.7	3.9	.	0	1.8
10/21/2014	440	407	13.1	3941		0	.5		99.5	5.4	5.6	565	3.9
09/21/12	460	106	11.2	4653	2.0	54.6	0.8	.	42.6	5.3	5.6	188	4
10/31/13	460	106	12.5	2710	.	76.4	0.0	.	23.6	4.8	6.3	22	2.8
10/21/2014	460	106	16.0	5983		7.0	3.1		89.9	4.7	10.5	1078	4.9
09/21/12	460	201	11.7	4274	7.4	42.4	0.6	.	49.6	5.1	8.9	362	4.3
10/31/13	460	201	14.4	2999	.	92.3	0.0	.	7.7	4.1	.	0	2.6
10/21/2014	460	201	17.3	1515		33.4	1.3		65.3	4.7	9.3	137	3.2
09/21/12	460	306	15.0	4877	0.0	48.4	0.9	.	50.7	5.5	15.2	309	4.6
10/31/13	460	306	12.2	2940	.	97.1	0.1	.	2.8	4.5	.	0	3.1
10/21/2014	460	306	20.0	3701		39.1	2.1		58.8	4.5	14.1	437	4.9
09/21/12	460	401	12.5	4288	0.9	54.4	0.9	.	43.8	5.6	11.1	226	4.4
10/31/13	460	401	11.0	3041	.	68.7	0.5	.	30.8	4.9	10.1	202	3.4
10/21/2014	460	401	16.1	4573		28.2	3.7		68.1	5.0	12.6	657	5.2
09/21/12	620	107	12.2	2813	6.8	64.7	3.0	9.4	16.0	5.3	8.9	242	3.6
10/31/13	620	107	13.0	3244	.	91.3	0.0	0.0	8.7	5	6.9	19	2.9
10/21/2014	620	107	15.1	2372		67.1	1.9	0.0	31.0	4.8	7.4	78	4.8
09/21/12	620	202	13.5	4088	7.0	65.5	4.2	4.7	18.7	5.2	7.9	282	4.5
10/31/13	620	202	15.2	2557	.	89.7	0.0	0.0	10.3	4.3	4.3	12	2
10/21/2014	620	202	20.6	4636		57.8	1.1	0.0	41.0	37.7	9.0	673	5.4
09/21/12	620	302	14.5	3435	30.6	68.1	1.3	0.1	0.0	5.5	0.0	0	
10/31/13	620	302	12.5	2676	.	96.3	0.0	0.0	3.7	4.5	1.5	3	1.9
10/21/2014	620	302	15.6	2279		100.0	0	0	0	4.8			
09/21/12	620	410	12.4	4058	9.7	57.5	2.4	0.8	29.7	5.4	9.1	140	3.7
10/31/13	620	410	11.5	2610	.	90.7	0.0	0.0	9.3	4.9	9.8	49	2.3
10/21/2014	620	410	14.2	1302		93.9	.8	1.1	4.2	5.0			

Sample Date	Mix	Plot	Above ground Dry Matter %	Total Above ground DM lb/acre	Botanical Composition of Aboveground Biomass						Radish Root Dry Matter %	Radish Root DM lb/acre	Radish Root % N
					% Weed	% Grass	% Legume	% Rape	% Radish (top)	Above Ground N %			
09/21/12	640	108	11.8	3604	3.4	65.2	1.7	0.0	29.7	5.2	7.6	204	3.9
10/31/13	640	108	13.7	2287	.	85.4	0.0	0.0	14.6	4.7	5.2	22	3
10/21/2014	640	108	16.4	3537		79.3	0	0.0	20.7	4.6	9.5	139	5.9
09/21/12	640	208	11.1	3920	5.1	51.0	0.7	0.0	43.2	5.3	8.5	476	4.2
10/31/13	640	208	12.7	2168	.	86.8	0.0	0.0	13.2	4.9	.	0	2.7
10/21/2014	640	208	16.6	2804		94.7	.3	0.0	5.0	4.6	1.4	2.0	3.3
09/21/12	640	309	20.6	4406	5.9	71.2	1.0	4.6	17.2	5.0	16.6	76	4.7
10/31/13	640	309	13.4	2978	.	97.9	0.0	0.0	2.1	4.1	.	0	2.2
10/21/2014	640	309	21.5	3304		50.4	2.6	0.0	47.0	4.6	11.7	425	6.1
09/21/12	640	403	14.2	4317	0.8	73.1	1.6	0.0	24.5	5.4	10.4	227	4.4
10/31/13	640	403	11.6	3095	.	93.2	0.0	0.0	6.8	4.7	.	0	3
10/21/2014	640	403	15.7	5355		56.1	1.7	7.0	35.2	4.8	8.9	316	4.8
09/21/12	660	109	12.0	3558	0.0	62.4	1.1	10.4	26.2	5.4	7.3	107	4.2
10/31/13	660	109	13.8	3598	.	94.6	0.0	0.0	5.4	4.2	1.2	3	2.7
10/21//2014	660	109	21.7	2966		59.0	2.5	10.9	27.6	4.2	12.2	169	4.8
09/21/12	660	206	12.0	4498	1.6	45.5	2.1	10.3	40.4	5.4	11.1	266	4.2
10/31/13	660	206	13.5	2553	.	84.3	1.0	0.5	14.2	4.4	9.0	47	2.4
10/21/2014	660	206	14.2	4836		57.1	1.9	0.0	41.0	4.2	6.1	403	4.1
09/21/12	660	303	15.0	4628	0.1	62.3	2.0	9.1	26.6	5.4	12.5	144	4.3
10/31/13	660	303	11.8	3318	.	100.0	0.0	0.0	0.0	4.4	.	0	
10/21/2014	660	303	16.8	5242		52.2	.5	0.0	47.3	4.8	9.6	423	4.4
09/21/12	660	408	16.5	3848	1.7	59.0	0.5	8.4	30.4	5.1	14.5	211	4.3
10/31/13	660	408	13.2	3159	.	97.8	0.0	0.0	2.2	4.2	.	0	2
10/21/2014	660	408	18.3	4695		65.2	.3	0.0	34.4	3.9	12.2	419	
09/21/12	1000	110	15.9	1824	100.0	.	.	.	.	4.5	.	.	
10/31/13	1000	110	14.5	1854	.	100.0	.	.	.	5.1	.	.	
10/21/2014	1000	110	0	0									
09/21/12	1000	207	13.0	3441	100.0	.	.	.	.	5.0	.	.	

Sample Date	Mix	Plot	Above ground Dry Matter %	Total Above ground DM lb/acre	Botanical Composition of Aboveground Biomass						Radish Root Dry Matter %	Radish Root DM lb/acre	Radish Root % N
					% Weed	% Grass	% Legume	% Rape	% Radish (top)	Above Ground N %			
10/31/13	1000	207	14.0	2458	.	100.0	.	.	.	5	.	.	
10/21/2014	1000	207	0	0									
09/21/12	1000	305	15.0	2984	100.0	.	.	.	.	4.6	.	.	
10/31/13	1000	305	13.1	3510	.	100.0	.	.	.	4	.	.	
10/21/2014	1000	305	0	0									
09/21/12	1000	406	10.6	2322	100.0	.	.	.	.	4.7	.	.	
10/31/13	1000	406	12.7	1861	.	100.0	.	.	.	5	.	.	
10/21/2014	1000	406	0	0									

Table CC-7. 2013-2014 barley yield

Mix	Plot	HV Date	Barley yield bu/ac
220	101	08/06/13	67
220	101	07/14/14	75
220	205	08/06/13	104
220	205	07/14/14	92
220	307	08/06/13	87
220	307	07/14/14	103
220	405	08/06/13	96
220	405	07/14/14	missing
240	102	08/06/13	94
240	102	07/14/14	132
240	210	08/06/13	89
240	210	07/14/14	98
240	304	08/06/13	139
240	304	07/14/14	150
240	409	08/06/13	97
240	409	07/14/14	100
260	103	08/06/13	90
260	103	07/14/14	115
260	203	08/06/13	107
260	203	07/14/14	102
260	301	08/06/13	114
260	301	07/14/14	109
260	402	08/06/13	83
260	402	07/14/14	89
420	104	08/06/13	153
420	104	07/14/14	123
420	204	08/06/13	97
420	204	07/14/14	103
420	308	08/06/13	77
420	308	07/14/14	109
420	404	08/06/13	66
420	404	07/14/14	73
440	105	08/06/13	107
440	105	07/14/14	124
440	209	08/06/13	83
440	209	07/14/14	99
440	310	08/06/13	77
440	310	07/14/14	174
440	407	08/06/13	79
440	407	07/14/14	95

Mix	Plot	HV Date	Barley yield bu/ac
460	106	08/06/13	106
460	106	07/14/14	missing
460	201	08/06/13	89
460	201	07/14/14	102
460	306	08/06/13	81
460	306	07/14/14	166
460	401	08/06/13	101
460	401	07/14/14	98
620	107	08/06/13	101
620	107	07/14/14	112
620	202	08/06/13	100
620	202	07/14/14	93
620	302	08/06/13	89
620	302	07/14/14	134
620	410	08/06/13	98
620	410	07/14/14	85
640	108	08/06/13	101
640	108	07/14/14	115
640	208	08/06/13	109
640	208	07/14/14	70
640	309	08/06/13	94
640	309	07/14/14	122
640	403	08/06/13	97
640	403	07/14/14	113
660	109	08/06/13	81
660	109	07/14/14	116
660	206	08/06/13	82
660	206	07/14/14	117
660	303	08/06/13	missing
660	303	07/14/14	120
660	408	08/06/13	96
660	408	07/14/14	96
1000	110	08/06/13	70
1000	110	07/14/14	125
1000	207	08/06/13	90
1000	207	07/14/14	86
1000	305	08/06/13	99
1000	305	07/14/14	118
1000	406	08/06/13	90
1000	406	07/14/14	104

ACTIVE STUDIES: TECHNICAL REPORT 2014

Study Number	**NDPMC-T-1301**
Title	**Warm-Season Grass Dormant Seeding Trial**
Objective	Compare
Duration	2013-2016
Cooperators	USDA, NRCS Plant Materials Center
Location	Bismarck, ND Plant Materials Center
-----Soils	Mandan silt loam
-----MLRA	53B
-----Precip.	**2013**: 26.75 inches **2014**: 13.92 inches

Background information: The influence of seeding date and seedbed cover on warm-season grass establishment in the Northern Great Plains will be evaluated. Warm-season grass establishment has been successful with spring seeding. Dormant and late summer seeding dates have been successful at times, but not consistent.

Methods and Materials: Five warm-season and one cool-season grass species were planted at three seeding dates into three different seedbed covers. The cool-season grass, Canada wildrye (*Elymus canadensis)* was used as a check, as it is known to successfully establish as a dormant seeding. The plots were replicated 3 times. There are two locations at the Plant Center where the seeding occurred. Trial 1, began in 2013 and is planted in Panel E-9. Trial 2 began in 2014 and is planted in Panel A-2. Both trials had identical entries and seed bed covers.

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Seed Source	
-----Species	5 warm-season species and 1 cool-season species. *Andropogon gerardii* (big bluestem), *Bouteloua curtipendula* (sideoats grama), *Panicum virgatum* (switchgrass), *Sorghastrum nutans* (Indiangrass), *Bouteloua gracilis* (blue grama), *Elymus canadensis* (Canada wildrye)
----Seed Lots	See **Table WSG-1**
----Seeding Rate	ND Technical Guide Standards X 1.5; See **Table WSG-1**
----Seeding Dates (Grasses)	**Trial 1=Late Summer:** 8/20/2013 **Dormant:** 11/5/2013 **Spring:** 5/9/2014 **Trial 2**= **Late Summer**: 8/13/2014 **Dormant:** 11/20/2014 Spring: 5/28/2015
----Seeding Method	No Till Great Plains Drill, through cone, seeding depth was shallow: ¼ - ½ inch.
-----Order of seeding	Trial 1. See **Figure WSG-1** Plot Map 2013. Trial 2. See **Figure WSG-2** Plot Map 2014.
Seedbeds	See **Figure WSG-1** for Plot Map
----Barley stubble	**Trial 1** (Panel E-9): Seeded 2-row barley (Rawson) on 5/9/2013 at a seeding rate of 80 lb/ac into cover crop residue from previous year. Seeded with Great Plains drill (through boxes). Harvested barley on 8/6/2013 with M17 combine, stubble height of 8-10" remaining. Glyphosate applied 8/7/2013 to barley stubble. **Trial 2** (Panel A-2): Seeded 2-row barley on 5/10/2014 at 80 lb/ac into fairly heavy stubble. Seeded approximately 1 inch deep into good moisture. Swathed barley on 7/25/2014 and combined the barley on 8/1/2015. Glyphosate (Cornerstone) was sprayed at 2 pts/acre on 8/8/2014 after barley harvest.
----Barley stubble + foxtail millet	**Trial 1 (E-9)**: Foxtail millet seeded 8/8/2013 into a section of the barley stubble at a seeding rate of 20 lb PLS/acre. Seeded with Great Plains Drill (through boxes). **Trial 2 (A-2):** Foxtail millet seeded 7/30/2014 into a section of the barley stubble at a seeding rate of 20 pounds PLS/acre. Seeded with Great Plains Drill (cone seeder) at a ¾-inch depth.
----Black	**Trial 1 (E-9):-**Site was disked August 1, 2013 and was cultivated and harrowed 4 times on August 7, 2013 and sprayed. **Trial 2 (A-2):** Site was disked and harrowed prior to grass planting.

Maintenance	
----Weed Control	**Trial 1 (E-9):** On 6/19/2014 swathed weeds and removed windrows on all plots. Sprayed with Cornerstone 5 plus Class Act at 2 pt plus 19 oz/ac on the north end where 2014 spring planting occurred. Sprayed plots with Sterling Blue at 1 pt/ac for broadleaf control on 7/28/2014. North and south fallow borders were sprayed with Cornerstone 5 plus at 2 pt/ac. **Trial 2 (A-2):** Sprayed fallow portion with Glyphosate on 7/23/2014.
Data Parameters	
----Moisture & Temperature	See **Tables WSG-2 and WSG-3.**
----Stand	**Trial 1 (E-9):** 2013**:** no count 2014: no count **Trial 2 (A-2):** 2014 late summer seeding. On 8/17/2014 a 1-yard (3 ft) alley was marked across plots in each seedbed type. The alley ran north /south. Within this alley, one row from each plot was selected and emergence was counted. See **Table WSG-4** for counts.

Results and Discussion

Trial 1:
2013: There was little or no stand establishment by freeze up. A few very small seedlings of Canada wildrye were found in the cultivated (black) seedbed of the late summer seeding at frost. Very few seedlings were growing for the other seedbed types or species. Conditions turned dry and cooler after the summer seeding, which may have influenced establishment. There were also very few weeds in any of the seedbeds by freeze up. It was extremely difficult to seed into tilled soil using the same drill depth setting as was used for seeding into no-till soils. The drill was set so seed was not planted too deeply into tilled soil. However, this depth was so shallow that the coulters were not deep enough to penetrate the surface soils in portions of the no-till plots. As plots were seeded across all seedbed types with the same pass of the drill, this became a problem.

2014: Weeds, particularly foxtail barley, became progressively more severe in all plots. No stand counts were taken because of the weeds. As plants get older, stand should be easier to measure. Seedlings could be seen in some of the plots. The weeds were definitely competing with any young grass seedlings. Counts will be made in 2015 for all grass entries in all seedbed types.

Trial 2:
2014: The millet was seeded into dry soil. Growth was somewhat slow and plants did not grow very tall. By the time of frost, few weeds had grown in any of the plots. Seedlings of the planted grass emerged before freeze-up in the late summer seeded plots. Seedlings were growing in all three of the seedbed types. Moisture and temperature conditions were conducive to germination in the late summer seeding. Moisture would commonly be limited at this time in most years. The most seedlings were visible in the black seedbed. Seedlings were still small at freeze-up. Counts will be made in 2015 to determine if the seedlings had a large enough root system to survive winter and become established. The dormant seeding was seeded into 1 inch snow cover at ½ inch depth. Difficulty was encountered seeding the sideoats grama in the second and third replication of the dormant seeding. A mistake was made in the grass seeding order for the dormant seeding (see **Figure WSG-2**). All replications were seeded in the same order and not randomized. Counts of the 2014 dormant seeding will also be made in 2015.

Figure WSG-1. Plot layout of warm-season grass dormant seeding study, trial 1 (panel E-9).

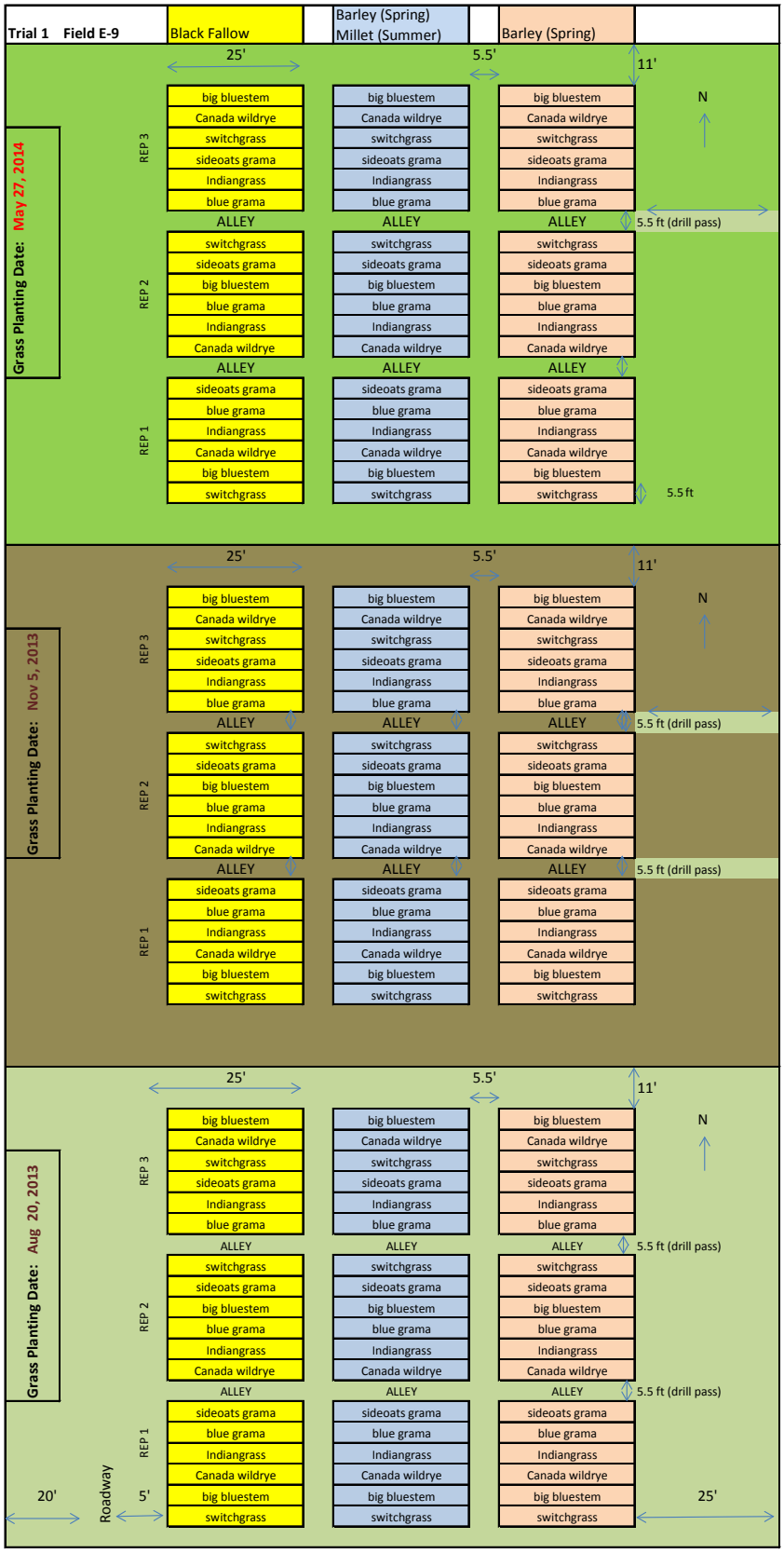


Figure WSG-2. Plot layout of warm-season grass dormant seeding study, trial 2 (panel A-2).

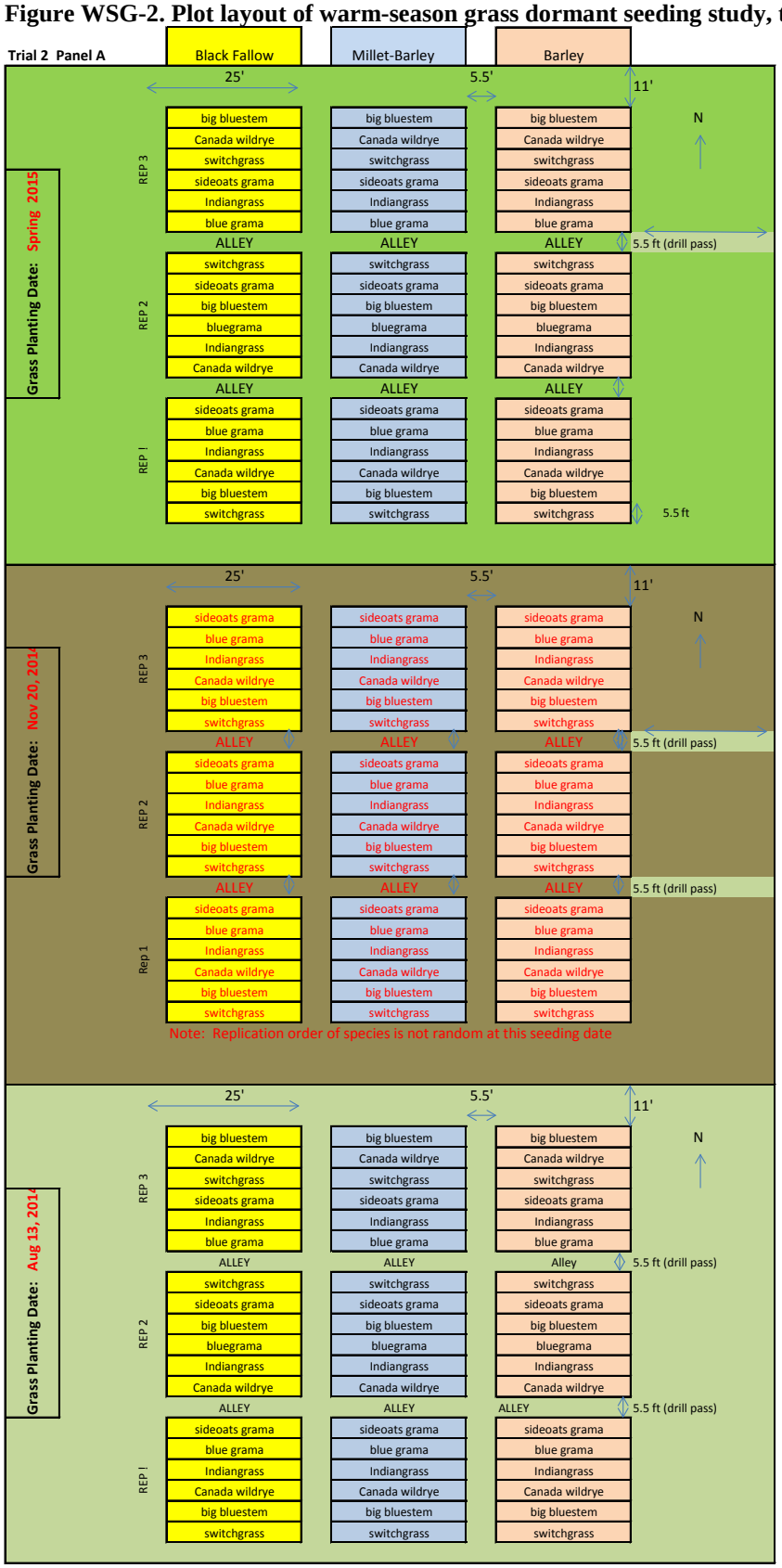


Table WSG-1. Seed lots

Year	Species	Variety	Lot	Tech Guide Seeding Rate PLS lb/ac	Seeding Rate Planted (1.5X Tech Guide) PLS lb/ac
Trial 1	big bluestem	Bonilla	SFD-09-D10	6.0	9.00
Trial 2	big bluestem	Bonilla	SFD-10-D10	6.0	9.00
Trial 1	switchgrass	Forestburg	SFD-07-D11	3.5	5.25
Trial 2	switchgrass	Forestburg	SFD-10-D10	3.5	5.25
Trial 1	Indiangrass	Tomahawk	SFD-05-E10	5.5	8.25
Trial 2	Indiangrass	Tomahawk	SFD-08-E10	5.5	8.25
Trial 1	blue grama	Bad River ecotype	SG2-12-E12	2.0	3.00
Trial 2	blue grama	Bad River ecotype	SCO-13-kaste55	2.0	3.00
Trial 1	sideoats grama	Pierre	SFD-12-E11	6.0	9.00
Trial 2	sideoats grama	Pierre	SFD-12-E9	6.0	9.00
Trial 1	Canada wildrye	Mandan	SFD-12-D9	6.5	9.75
Trial 2	Canada wildrye	Mandan	SFD-13-D9	6.5	9.75

Table WSG-2. Soil moisture and soil temperature 8/22/2013

			Bare Ground			Millet/Barley			Barley		
Sample	Planting Date	Data Collection Date	% mois-ture	mois-ture	^{0}F temp	% mois-ture	mois-ture	^{0}F temp	% mois-ture	mois-ture	^{0}F temp
1	8/21/13	8/22/13	18.1	1.414	70	12.6	1.320	67	6.1	1.209	68
2	8/21/13	8/22/13	10.9	1.292	70	14.8	1.352	68	8.4	1.251	66
3	8/21/13	8/22/13	9.1	1.264	70	9.1	1.261	67	7.8	1.239	68
4	8/21/13	8/22/13	8.5	1.253	70	9.9	1.277	68	9.5	1.270	67
5	8/21/13	8/22/13	7.8	1.241	70	9.5	1.269	67	12.1	1.312	68
6	8/21/13	8/22/13	8.8	1.258	70	8.9	1.261	67	8.5	1.251	68
7	8/21/13	8/22/13	7.4	1.234	70	7.7	1.238	66	13.3	1.327	64
8	8/21/13	8/22/13	9.8	1.275	70	10.5	1.287	69	14.2	1.343	69
9	8/21/13	8/22/13	13.3	1.33	70	9.8	1.276	69	17.1	1.386	68
10	8/21/13	8/22/13	7.8	1.239	70	8.8	1.258	68	14.5	1.346	68
		AVERAGE	10.15	1.28	70	10.16	1.2799	67.6	11.15	1.2934	67.4

Table WSG-3. Soil moisture and soil temperature 11/5/2013

			Bare Ground		Millet/Barley		Barley	
Sample	**Planting Date**	**Data Collection Date**	**% moisture**	**^{0}F temp**	**% moisture**	**^{0}F temp**	**% moisture**	**^{0}F temp**
1r1	8/21/13	11/5/13	21.8	31	24.8	30	28.700	30
2r1	8/21/13	11/5/13	21.3	30	24.7	30	27.800	30
3r1	8/21/13	11/5/13	21.2	30	22.9	30	26.800	30
1r2	8/21/13	11/5/13	17.9	30	21.5	30	27.000	30
2r2	8/21/13	11/5/13	15.9	30	21.8	30	26.900	30
3r3	8/21/13	11/5/13	17.4	30	23	30	27.000	32
1r3	8/21/13	11/5/13	17.5	30	21.8	30	22.700	30
2r3	8/21/13	11/5/13	20.4	30	22.7	30	22.200	30
3r3	8/21/13	11/5/13	17.9	30	21	30	22.900	30
newr1	11/5/13	11/5/13	17.6	30	20.1	30	21.900	30
newr2	11/5/13	11/5/13	20.7	30	26.6	30	22.300	30
newr3	11/5/13	11/5/13	23.1	30	24.3	30	24.200	32
		AVERAGE	19.39	30.08	22.93	30.00	25.03	30.33

Table WSG-4. Seedling counts

Rep*	Species	Seedbed	Seeding Date	Count Date	Count (1 ft of row)
1	switchgrass	tilled (black)	08/13/14	9/17/2014	41
1	big bluestem	tilled (black)	08/13/14	9/17/2014	34
1	Canada wildrye	tilled (black)	08/13/14	9/17/2014	20
1	Indiangrass	tilled (black)	08/13/14	9/17/2014	15
1	blue grama	tilled (black)	08/13/14	9/17/2014	22
1	sideoats grama	tilled (black)	08/13/14	9/17/2014	26
2	Canada wildrye	tilled (black)	08/13/14	9/17/2014	33
2	Indiangrass	tilled (black)	08/13/14	9/17/2014	13
2	blue grama	tilled (black)	08/13/14	9/17/2014	27
2	big bluestem	tilled (black)	08/13/14	9/17/2014	29
2	sideoats grama	tilled (black)	08/13/14	9/17/2014	25
2	switchgrass	tilled (black)	08/13/14	9/17/2014	28
3	blue grama	tilled (black)	08/13/14	9/17/2014	14
3	Indiangrass	tilled (black)	08/13/14	9/17/2014	17
3	sideoats grama	tilled (black)	08/13/14	9/17/2014	9
3	switchgrass	tilled (black)	08/13/14	9/17/2014	35
3	Canada wildrye	tilled (black)	08/13/14	9/17/2014	31
3	big bluestem	tilled (black)	08/13/14	9/17/2014	25
1	switchgrass	millet/barley	08/13/14	9/17/2014	19
1	big bluestem	millet/barley	08/13/14	9/17/2014	8

Rep*	Species	Seedbed	Seeding Date	Count Date	Count (1 ft of row)
1	Canada wildrye	millet/barley	08/13/14	9/17/2014	21
1	Indiangrass	millet/barley	08/13/14	9/17/2014	7
1	blue grama	millet/barley	08/13/14	9/17/2014	3
1	sideoats grama	millet/barley	08/13/14	9/17/2014	1
2	Canada wildrye	millet/barley	08/13/14	9/17/2014	6
2	Indiangrass	millet/barley	08/13/14	9/17/2014	5
2	blue grama	millet/barley	08/13/14	9/17/2014	2
2	big bluestem	millet/barley	08/13/14	9/17/2014	10
2	sideoats grama	millet/barley	08/13/14	9/17/2014	3
2	switchgrass	millet/barley	08/13/14	9/17/2014	13
3	blue grama	millet/barley	08/13/14	9/17/2014	2
3	Indiangrass	millet/barley	08/13/14	9/17/2014	7
3	sideoats grama	millet/barley	08/13/14	9/17/2014	6
3	switchgrass	millet/barley	08/13/14	9/17/2014	11
3	Canada wildrye	millet/barley	08/13/14	9/17/2014	17
3	big bluestem	millet/barley	08/13/14	9/17/2014	13
1	switchgrass	barley	08/13/14	9/17/2014	26
1	big bluestem	barley	08/13/14	9/17/2014	12
1	Canada wildrye	barley	08/13/14	9/17/2014	24
1	Indiangrass	barley	08/13/14	9/17/2014	10
1	blue grama	barley	08/13/14	9/17/2014	5
1	sideoats grama	barley	08/13/14	9/17/2014	6
2	Canada wildrye	barley	08/13/14	9/17/2014	21
2	Indiangrass	barley	08/13/14	9/17/2014	5
2	blue grama	barley	08/13/14	9/17/2014	4
2	big bluestem	barley	08/13/14	9/17/2014	12
2	sideoats grama	barley	08/13/14	9/17/2014	21
2	switchgrass	barley	08/13/14	9/17/2014	10
3	blue grama	barley	08/13/14	9/17/2014	5
3	Indiangrass	barley	08/13/14	9/17/2014	9
3	sideoats grama	barley	08/13/14	9/17/2014	10
3	switchgrass	barley	08/13/14	9/17/2014	19
3	Canada wildrye	barley	08/13/14	9/17/2014	16
3	big bluestem	barley	08/13/14	9/17/2014	13

*reps numbered from south to north

CONSERVATION FIELD TRIALS

CONSERVATION FIELD TRIALS: TECHNICAL REPORT 2014

Number and Title: NDPMC-F-0703-PA Grass/Legume/Forb Demonstration, Wessington Springs, South Dakota

Objective: Compare performance differences among species and varieties of various grasses, forbs, and legumes. The site will be used for education and demonstration and is open for public viewing.

Date Seeded: May 15, 2007

Cooperators: Jerauld County Conservation District and the USDA-NRCS, Wessington Springs, South Dakota

Figure WS-1. Plot layout of grass/forb demonstration at Wessington Springs, South Dakota, planted 5/15/2007.

48 ft. | 20 ft. | 48 ft. | 20 ft. | 28 ft.

12 ft.

1	AC2	crested wheatgrass	18	Rodan	western wheatgrass	1	Lutana	cicer milkvetch
2	NewHy	wheatgrass X	19	Icy Blue	Canada wildrye	2	VNS	alsike clover
3	Climax	timothy	20	Mandan	Canada wildrye	3	VNS	ladino white clover
4	Latar	orchardgrass	21	Lodorm	green needlegrass	4	Kenland	red clover
5	Mankota	Russian wildrye	22	VNS	porcupinegrass	5	Travois	alfalfa
6	VNS	altai wildrye	23	VNS	needle-and-thread	6	SDSUlonetree	yellow alfalfa
7	Arthur	Dahurian wildrye	24	Bowie	buffalograss	7	Dawn	birdsfoot trefoil
8	Rebound	smooth bromegrass	25	Bad River Ecotype	blue grama	8	Eski	sainfoin
9	Fleet	meadow bromegrass	26	Badlands	little bluestem	9	Bismarck+Pierre	ppc+sog
10	Reliant	intermediate wheatgrass	27	Pierre	sideoats grama	10	Antelope+Pierre	wpc+sog
11	Manifest	intermediate wheatgrass	28	Bonilla	big bluestem	11	9069117+Pierre	canmv+sog
12	Haymaker	intermediate wheatgrass	29	Forestburg	switchgrass	12	MN+Pierre	Illinois bundlflwr+sog
13	Beefmaker	intermediate wheatgrass	30	Tomahawk	Indiangrass	13	Appar+Pierre	blue flax+sog
14	Manska	pubescent wheatgrass	31	Fleet+Travois	meadow brome+alfalfa	14	Stillwater+Pierre	yellowconeflw+sog
15	Alkar	tall wheatgrass	32	Reliant+Lutana	intermediate wheatg+cicer milkvetch	15	VNS+Pierre	blanketflower+sog
16	VNS	prairie junegrass	33	Rodan+Lodorm+Bis	wwg+gng+ppc	16	Med. Creek+Pierre	maxsnflwr+sog
17	Pryor	slender wheatgrass	34	Pierre+Badland+Bis	sog+lbs+ppc	17	Bismarck+Pierre	stiffsunflower+sog

blue grama border

Methods and Materials: There are 51 plots of various grasses, legumes, forbs, and mixtures of each. They were seeded with a 6-foot plot drill. The drill consisted of a cone-seeder attachment for each opener so individual rows

were metered separately. Plot size is 12 feet by 48 feet with 16 rows per plot for the grass plots. The forb and selected legumes plots were 28 feet in length and the same width. There are 6-foot borders separating each plot and larger borders on the ends. These areas were seeded to Bad River ecotype blue grama. Two larger plots about ½-acre each along the sides of the demonstration area were seeded to an introduced and a native mixture. The south side plot was seeded to an introduced mixture of 35% 'Reliant' intermediate wheatgrass, 35% 'Fleet' meadow bromegrass, and 30% 'Travois' alfalfa. The north side plot was seeded to a native mixture of 10 species at 10% each. These included 'Bonilla' big bluestem, Bad River ecotype blue grama, 'Lodorm' green needlegrass, 'Tomahawk' Indiangrass, Badlands ecotype little bluestem, needle-and-thread, 'Goshen' prairie sandreed, 'Pierre' sideoats grama, 'Forestburg' switchgrass, and 'Rodan' western wheatgrass. See Figure WS-1 for plot layout.

Site Information: The site was previously planted to alfalfa. The soils are a Lane silty clay loam and the Ecological Site Description is clayey. The site is level. The property is owned by the Jerauld Conservation District and is located on the north edge of Wessington Springs, South Dakota, adjacent to a county highway. The land was sprayed and tilled in 2006. A seedbed was prepared in the spring of 2007 by cultivating, harrowing, and roller packing. Above average rainfall was received in April and May. The plots and borders were mowed twice for weed control during the growing season.

Table WS-1. Plant performance at the Jerauld County Demonstration Site. In each column the first entry is for 2007, the second is for 2008, the third is for 2009, and the fourth is for 2010. The last column is forage production lbs/ac clipped from a 2' x 10' strip on September 9, 2010 with a forage harvester. Samples are oven-dried weights. Plots with NC were not clipped.

Common name/Variety (VNS=variety not stated)	(1) Weed Competition	(2) Stand Rating	(3) Vigor	Forage lbs/ac
Crested wheatgrass/AC2	3-2-2-4	4-1-1-3	2-1-1-1	3204
Wheatgrass hybrid/NewHy	2-1-1-2	2-1-1-1	1-1-1-1	3735
Timothy/Climax	6-5-4-5	7-5-4-4	3-2-2-2	2651
Orchardgrass/Latar	5-6-4-5	5-6-4-3	3-3-2-3	1922
Russian wildrye/Mankota	4-3-2-2	4-3-2-2	2-2-2-2	2241
Altai wildrye/VNS	5-6-3-2	3-3-2-1	2-3-2-2	6048
Dahurian wildrye/Arthur	1-1-3-4	2-1-3-4	1-1-3-5	1711
Smooth bromegrass/Rebound	2-1-1-1	2-1-1-1	1-1-1-1	5115
Meadow bromegrass/Fleet	2-1-1-2	2-1-1-2	1-1-1-1	3721
Intermediate wheatgrass/Reliant	2-1-1-1	2-1-1-1	1-1-1-1	8308
Intermediate wheatgrass/Manifest	3-2-1-1	3-2-1-1	3-1-1-1	7330
Intermediate wheatgrass/Haymaker	2-1-1-1	2-1-1-1	1-1-1-1	6849
Intermediate wheatgrass/Beefmaker	2-1-1-1	2-1-1-1	1-1-1-1	7509
Pubescent wheatgrass/Manska	3-1-1-1	3-1-1-1	2-1-1-1	7741
Tall wheatgrass/Alkar	2-1-1-1	2-1-1-1	3-1-1-1	9113
Prairie junegrass/VNS	8-8-8-8	8-8-8-8	NA	NC
Slender wheatgrass/Pryor	4-4-5-3	4-3-4-3	4-1-3-2	6379
Western wheatgrass/Rodan	3-4-5-5	4-4-4-4	2-2-2-3	2785
Canada wildrye/Icy Blue	3-3-3-3	4-3-3-3	4-2-2-2	4193
Canada wildrye/Mandan	3-2-2-2	2-2-1-2	2-1-1-2	2828
Green needlegrass/Lodorm	3-3-3-2	3-2-2-2	3-1-2-1	4254
Porcupinegrass/VNS	5-8-6-5	6-6-3-4	5-5-3-3	3279
Needle-and-thread/VNS	4-4-6-8	4-3-4-8	4-2-4-NA	NC
Buffalograss/Bowie	2-3-6-7	2-2-2-6	1-1-3-3	2416
Blue grama/Bad River	3-3-6-6	3-2-4-5	3-1-3-4	1882
Little bluestem/Badlands	5-6-4-5	5-6-4-3	4-4-2-4	5328
Sideoats grama/Pierre	3-5-3-3	3-4-3-3	3-2-2-4	2050
Big bluestem/Bonilla	4-4-3-2	4-3-3-2	4-3-2-1	5969
Switchgrass/Forestburg	5-6-3-3	4-5-3-1	5-4-2-1	4801
Indiangrass/Tomahawk	5-6-4-2	5-6-3-2	4-4-3-2	3959

Meadow brome (Fleet)+ alfalfa (Travois)	2-1-2-2	2-1-2-2	2-1-2-2	3923
Intermediate (Reliant) + cicer (Lutana)	2-2-2-2	2-2-2-2	2-2-2-2	5975
Western (Rodan) + green needle (Lodorm) + purple prairieclover (Bismarck)	4-3-2-2	4-2-2-2	4-2-2-2	3959
Sideoats (Pierre) + little blue (Badlands) + purple prairieclover (Bismarck)	4-6-3-3	4-5-3-3	4-4-3-3	NC
Cicer milkvetch/Lutana	4-4-2-2	4-2-1-1	3-3-2-2	5321
Alsike clover/VNS	2-2-8-8	2-2-8-8	2-2-NA-NA	NC
Ladino white clover/VNS	4-3-8-8	4-3-8-8	3-3-NA-NA	NC
Red clover/Kenland	3-2-6-3	2-2-3-2	2-3-3-2	5053
Alfalfa/Travois	2-1-2-4	2-1-1-3	2-1-3-5	4514
Yellow alfalfa/SDSU	3-2-2-2	3-1-1-1	3-1-2-1	5201
Birdsfoot trefoil/Dawn	2-2-2-3	2-1-1-2	2-1-3-3	5391
Sainfoin/Eski	2-2-5-6	3-1-4-6	3-1-6-6	NC
Sideoats (Pierre) + Purple prairieclover (Bismarck)	4-4-4	4-4-3	4-4-3-5*	NC
Sideoats (Pierre) + White prairieclover (Antelope)	4-4-5	4-3-4	4-4-3-5*	NC
Sideoats (Pierre) + Canada milkvetch (9069117)	4-5-6	6-6-5	4-5-3-5*	NC
Sideoats (Pierre) + Illinois bundleflower (MN)	4-5-5	4-5-4	4-5-3-7*	NC
Sideoats (Pierre) + Blue flax (Appar)	4-3-4	4-2-3	4-3-3-7*	NC
Sideoats (Pierre) + Yellow coneflower (Stillwater)	5-3-6	5-3-5	5-3-3-8*	NC
Sideoats (Pierre) + Blanketflower (VNS)	4-3-7	4-4-6	4-3-3-7*	NC
Sideoats (Pierre) + Maximillian sunflower (Medicine Creek)	5-5-4	5-5-4	5-5-3-3*	NC
Sideoats (Pierre) + Stiff sunflower (Bismarck)	4-4-3	4-4-2	4-4-2-4*	NC

(1) 1 = no weeds, 9 = all weeds
(2) 1 = highest, 9 = lowest
(3) 1 = highest, 9 = lowest
*Forb only rated

Results and Discussion:
2007: The plots were off to a good start after seeding. Evaluation ratings were taken on August 24, 2007, on stand, vigor, and weed competition (see Table WS-1 for performance information). 'NewHy' hybrid wheatgrass, 'Arthur' Dahurian wildrye, 'Rebound' smooth bromegrass, Fleet meadow bromegrass, 'Alkar' tall wheatgrass, 'Mandan' Canada wildrye, and all of the intermediate wheatgrass varieties established well and had stand ratings of 2. 'Bowie' buffalograss also looked very good and was the only warm-season entry to have an initial stand rating of 2. 'Climax' timothy and prairie junegrass did not establish well. Comparing the legumes, alsike clover, 'Kenland' red clover, Travois alfalfa, and 'Dawn' birdsfoot trefoil were off to a good start and had stand ratings of 2. The forb plantings (with sideoats grama) and the grass/legume mixtures generally had stand ratings of 4 to 6 and were slower to establish. Weed competition and vigor ratings varied considerably across all plots. The larger sized native and introduced mixture plots seeded on the north and south ends, established well.

2008: Notes were taken on July 21, 2008. Generally, there was less weed competition and most cool-season entries had higher stand ratings in 2008. The bromegrass entries (both smooth and meadow), tall wheatgrass, and pubescent/intermediate wheatgrass varieties had excellent stands and heavy biomass. NewHy hybrid wheatgrass and Arthur Dahurian wildrye performed very well. Canada wildrye had good stands with Mandan rated slightly better in stand and vigor compared to 'Icy Blue'. The stand of green needlegrass had improved from 2007 to 2008. The plot of Bowie buffalograss was again rated very good. Other warm-season grass species were rated somewhat lower than expected. Bonilla big bluestem had the best stand and Pierre sideoats grama the highest vigor rating.

Travois alfalfa, SDSU yellow alfalfa, 'Eski' sainfoin, and Dawn alfalfa performed the best of the legumes. The blanketflower, yellow coneflower, and blue flax were very showy in the spring and were rated good for stands. The sunflowers had the poorest stands of the forbs. Both the larger plot native and introduced mixture seedings performed well and had been mowed.

2009: Notes were taken on September 18, 2009. Generally, the cool-season grasses established most rapidly and had the least weed contamination. Warm-season grass species were slower, but many entries had good stands in 2009. Forb and legume species had the most variability in performance. Some of the species with outstanding performance in 2009 included Fleet meadow bromegrass, NewHy hybrid wheatgrass, Alkar tall wheatgrass, NU-ARS-AC2 crested wheatgrass, Rebound smooth bromegrass, all five varieties of pubescent/intermediate wheatgrass, Mandan Canada wildrye, Lodorm green needlegrass, Pierre sideoats grama, Bowie buffalograss, Lutana cicer milkvetch, Travois alfalfa, SDSU yellow-blossom alfalfa, and Dawn birdsfoot trefoil. A few of the poorer performing entries included prairie junegrass, alsike clover, and Ladino white clover. Patches of wild lettuce were scattered throughout the planting. The mixtures were harder to evaluate. Sideoats grama performed fairly well in the mixes and was not so aggressive that it took over the plot. Bad River blue grama worked well seeded as a border between entries. It allowed the observers to walk down the length of every plot without walking into the plot. Consideration will be given next year to sampling forage production in selected plots.

2010: A tour in conjunction with a plant materials training session was held on July 21, 2010. The plots were clipped and rated on September 10, 2010. Contaminated or poor performing plots were not harvested. A flail-knife forage harvester was used to clip a 2' x 10' strip in each plot. Contaminant weeds and other grasses were removed before clipping. NRCS and Conservation District employees helped with the clipping. Grab samples were collected and brought back to the PMC for oven drying. After drying the samples were weighed again to determine dry matter. The samples averaged 30%-40% moisture. Tall wheatgrass had the highest forage production at over 9,000 lbs/ac. The intermediate/pubescent wheatgrass entries were in the 7000-8000 lbs/ac range. Big bluestem had the highest production of the warm-season entries at almost 6,000 lbs/ac. Cicer milkvetch, yellow-blossom alfalfa, and red clover all produced more than 5,000 lbs/ac compared to 4,500 lbs/ac for the alfalfa entry. Some of the shorter life span species were gone. The larger mixture plots on the ends were also clipped. The meadow brome, intermediate wheatgrass, and alfalfa mix produced 5,421 lbs/ac compared to the ten species silty range site mix which produced 7,723 lbs/ac.

2011: Plots were evaluated to determine which of the plots would be terminated due to contamination from other species and weeds, and poor stands. Plots selected for termination were Plots 3 and 4, and plots 7-15. They are to be replanted to the same species in the spring of 2012.

2012: Several plots were clipped on 2/15/12 and tested for forage quality for winter grazing potential. Table WS-2 lists the species that were clipped and analyzed for forage quality. Cicer milkvetch, Russian wildrye, blue grama, Dahurian wildrye, and Fleet meadow brome were highest in crude protein and relative feed value as compared to the other species in the quality sampling. The plots indicated for termination in 2011 were tilled for re-seeding in May 2012. Soil conditions were not very conducive for seeding when the plots were seeded on May 16th. The seedbed was extremely chunky and dry due to soil and climatic conditions at the time. The following species (mostly forbs) were planted in the same original plot sites: blanketflower, yellow coneflower, blue flax, Illinois bundleflower, Canada milkvetch, white prairieclover, purple prairieclover, sainfoin, birdsfoot trefoil, timothy, and orchardgrass. Observations in July indicated poor emergence and grasshopper infestations, all due to seedbed conditions and drought across a large area in the southern portion of the Northern Great Plains.

2013: Annual evaluation and data collection by the PMC was finalized in 2012. However, the Conservation District continues to maintain and utilize the herbaceous and woody species plots for their education, demonstration, and evaluation purposes indefinitely. This planting will continue to be an asset and beneficial plant materials resource for all partners and the local community, for as long as these plots are maintained.

2014: No site visit or evaluation this year. A final report for this planting will be completed in 2015.

CONSERVATION FIELD TRIALS: TECHNICAL REPORT 2014

Number and Title: SDPMC-F-1202-PA Aurora County, South Dakota Conservation District Grass/Legume/Forb Demonstration

Objective: Establish a multi-species planting that will be utilized for community educational purposes training to demonstrate performance and utilization potential for conservation needs in the area.

Date Seeded: May 15, 2012

Cooperators: Plankinton, SD NRCS, Aurora County Conservation District, SDSU Extension Service, and Millborn Seeds.

Site Information: Along the south side of old Hwy 16 on the west edge of Plankinton, SD, just west of the Aurora County shop and Conservation District Building. The soils are Houdek-Dudley complex loam/silt loam, moderately drained, mostly level with clay-loam sub-layers. There is evidence of a pre-existing narrow driveway that was covered by a shallow layer of gravel, running east-west across the site. The seeding was done with the plot drill into soils that were left untilled (they were tilled early the previous year followed by chemical weed control the rest of the 2011 growing season). Some spots in the site had soils that were hard for the drill to penetrate, and those areas were hand raked to get adequate seed to soil contact. Figure PL-1 indicates the plot layout of warm and cool-season, native and introduced grasses, legumes and forbs that were established in 2012. Forty separate plots were established, with some species seeded as monocultures and others included in mixes. Species included in the mixes are shown in Table PL-1.

Methods and Materials: There are forty 11-ft x 38-ft plots of individual grasses, and grass/legume mixes with a 16-ft blue grama border in this planting (see Figure PL-1). There is an additional acreage for woody species to be planted on the south side of these plots. Total area of all herbaceous plantings is approximately three acres. The plots for this planting were tilled and chemical fallowed in 2011. They were again treated with glyphosate in the spring of 2012, prior to seeding with the PMC plot drill. There was no tillage done before seeding the plots. The blue grama border was seeded at a later date and that ground was tilled prior to seeding.

Figure PL-1. Plot layout of grass/legume/forb demonstration at Plankinton, South Dakota (11-ft x 38-ft plots)

16' Bad River blue grama border

1	Kootenai timothy	21	Forb Mix #3				
2	Latar orchardgrass	22	Forb Mix #1				
3	Fawn tall fescue	23	SD common alfalfa (purple)				
4	AC Saltlander quack X bluebunch	24	MN Native Canada milkvetch				
5	Fleet meadow brome	25	VNS (medium) red clover				
6	Omaha Virginia wildrye	26	Warm Season Mix				
7	Mankota Russian wildrye	27	Tomahawk Indiangrass				
8	Oahe intermediate wheatgrass	28	Bounty big bluestem				
9	Revenue slender wheatgrass	29	Sunnyview big bluestem				
10	Alkar tall wheatgrass	30	Sunburst switchgrass				
11	Lodorm green needlegrass	31	Rodan western wheatgrass				
12	Bonilla big bluestem	32	Manska pubescent wheatgrass				
13	Itasca little bluestem	33	Manifest intermediate wheatgrass				
14	Forestburg switchgrass	34	Mandan Canada wildrye				
15	Pierre sideoats grama	35	PMC Virginia wildrye				
16	VNS white clover	36	Prairieland Altai wildrye				
17	Lutana cicer milkvetch	37	NewHy quack X bluebunch				
18	Don yellow alfalfa	38	Garrison creeping foxtail				
19	Forb Mix #2	39	Pennlate orchardgrass				
20	Cool Season Mix	40	Palaton reed canarygrass				

16' Bad River blue grama border

16' Bad River blue grama border

16' Bad River blue grama border

16' Bad River blue grama border

Tree Plots

16' Bad River blue grama border

Table PL-1. Mixture components

Mixes			
Warm-Season Mix		**Forb Mix-1**	
big bluestem	Bonilla	purple prairieclover	Bismarck
Indiangrass	Holt	white prairieclover	Antelope
switchgrass	Forestburg	yellow coneflower	
little bluestem	Itasca	purple coneflower	
sideoats grama	Pierre	black-eyed susan	
Cool-Season Mix		**Forb Mix-2**	
meadow brome	Fleet	Illinois bundleflower	
pubescent wheatgrass	Manska	partridge pea	
cicer milkvetch	Lutana	blanketflower	
Forb Mix-3		bergamot	
Maximilian sunflower		blue flax	
stiff sunflower		western yarrow	

Results and Discussion

2012: Plots were evaluated for stand on 7/23/12. Stand ratings and comments are included in Table PL-2. This area experienced a severe drought in 2012, and rainfall was extremely limited from late spring throughout the entire growing season. There was adequate stored soil moisture for most species to germinate and establish well. The timothy, big bluestem, green needlegrass, and several forbs displayed the poorest emergence at this evaluation date. Weeds (pigweed and foxtail) were becoming an issue in several plots, especially the forb mixes on the western side of the site. Weeds were clipped prior to this evaluation, and it was recommended that (other than the forbs plots) they be clipped shorter to keep them from going to seed. There was no evidence of blue grama germination in the borders. The borders were seeded at a later date than the individual plots, and were planted into cultivated soil. For those reasons, it was apparent there was no longer sufficient soil moisture available for good germination, and/or seed may have been planted too deeply in the looser soil.

2013: Plots were evaluated on 6/24/13 for stand and overall appearance. It was seasonally early for evaluating some of the warm-season species that were just getting established. Weed pressure was especially heavy in plots that had poor or slow emergence. The timothy, orchardgrass, Indiangrass, tall fescue, big bluestem, switchgrass, and 'Omaha' Virginia wildrye plots were thin and very weedy as compared to the plots of other grass species and varieties. The PMC Virginia wildrye (under evaluation for future release) looked considerably better than the 'Omaha' variety at this juncture. The wheatgrasses and wheatgrass crosses were well established and competing well with the heavy weed pressure in these plots. Most legumes including the yellow and common alfalfas, and the Canada and cicer milkvetch were establishing well, while the red and white clovers were not. Some forbs in the forb mixes were establishing quite well in spite of the heavy weed pressure. Other forb species were not observed at all in the mixed plots. The cool-season mix was well established. The warm-season mix was fairly well established as compared to the individual plots of those species that are also included in the mix. Table PL-2 provides detailed evaluation information and also indicates plots that are located over an old driveway. Performance of plants is poorer in those portions of the plots that were seeded over that driveway. A general walk-through evaluation was also completed on 9/19/13. It appeared that the plots had not been clipped for weed control during the summer, and there was extremely heavy weed pressure with tall weeds crowding out several of the mixes and warm-season species, especially where stands were thin. It appeared that some of the forbs stands were still improving. Warm-season species plots that were thin in June were still very poorly established in September. It was apparent that some species would need to be reseeded. The Field Office and District will evaluate the site in May 2014 to determine which plots need to be reseeded.

2014: Plots were evaluated on June 11, 2014, for stand, weed pressure, and overall vigor and appearance. Evaluation results are shown in Table PL-2. Most warm-season species did not establish well the seeding year, and have not improved since, due to a combination of extreme drought, severe weed pressure, and no weed control. The tall fescue and orchardgrass experienced considerable winterkill last winter, and stand loss as a result. The timothy did not establish at all, and the slender wheatgrass stand continues to thin over time. The rest of the cool-season grasses and the cicer milkvetch continue to do well. The alfalfas and Canada milkvetch stands are declining. In October, a volunteer accidentally disked and destroyed most of the forb mix plots and the warm-season grass plots in an attempt clean up/maintain the plots. The Conservation District will seed all of those disked areas with oats in 2015, and will utilize a combination of herbicides and mowing to control weeds during the year. The PMC will provide a no-till drill and seed to re-seed those plots in 2016. Some of the grass plots will be clipped for production and forage quality in late June or early July 2015.

Table PL-2.
Evaluation results for grass/legume/forb demonstration at Plankinton, South Dakota. (Rated 1-10; 1=Best)

Table PL-2	Plankinton, SD Grasses and Forbs Plot Ongoing Evaluation							*(seeded May 15, 2012)*	
Plot #	Common Name	Variety	Stand			Weeds	Comments		
			7/23/12	6/24/13	6/11/14	6/11/14	2012	2013	2014
1	timothy	Fleet	9	9	9	9	Plots were very dry and very weedy w/pigweed and some Y/G foxtail.	No plants visible!	Few plants visible!
2	orchardgrass	Latar	4	8	8	9		Poor stand; very weedy	Poor stand; very weedy
3	tall fescue	Fawn	3	7	8	9		Poor stand; very weedy	Poor stand; very weedy
4	quack x bluebunch	Ac saltlander	2	1	1	1		Vigorous; few weeds	Vigorous; good stand; few weeds
5	meadow brome	Fleet	2	1	1	1	Some Diseased Leaves	Vigorous; few weeds	Vigorous; good stand; few weeds
6	Virginia wildrye	Omaha	4	8	5	5		Poor stand; very weedy	Poor stand; very weedy
7	Russian wildrye	Mankota	2	2	2	1	Recommended clipping weeds shorter and coming back with an application of Banvel in late May-2013, to control weeds in the grass plots	Good	Good
8	intermediate whtgrass	Oahe	2	2	1	1		Good	Good
9	slender wheatgrass	Revenue	3	5	6	5		Mediocre stand & weedy	Mediocre stand & weedy
10	tall wheatgrass	Alkar	2	1	1	1		Vigorous; few weeds	Vigorous; good stand; few weeds
11	green needlegrass	Lodorm	5	3	3	4		good stand; weedy	good stand; weedy
12	big bluestem	Bonilla	4	8	8	8		Poor stand; weedy	Poor stand; weedy
13	little bluestem	Itasca	5	9	8	8		no stand; weedy	no stand; weedy
14	switchgrass	Forestburg	5	7	7	7		Poor stand; weedy	Poor stand; weedy
15	sideoats grama	Pierre	3	1	5	7		good stand; weedy	good stand; weedy
16	white clover	VNS	4	7	9	9		Poor stand; weedy	Poor stand; weedy
17	cicer milkvetch	Lutana	5	3	2	2		Fairly good stand; weedy	Good stand; weedy
18	yellow alfalfa	Don	5	2	3	4		good stand; somewhat weedy	good stand; somewhat weedy
19	Forb Mix #2		3	2	5	7		Good stand of most species; weedy	Good stand of most species; weedy
20	Cool Season Mix		3	1	1	1		Vigorous; few weeds	Vigorous; good stand; few weeds
21	Forb Mix #3		9	6	2	7		Both species visible; weedy	good stand; mostly max. sunflower
22	Forb Mix #1		3	7	8	8	Some seedlings dried out!	3 species observed; weedy	Poor stand; 3 species observed; weedy
23	alfalfa (purple)	SD Common	3	2	7	7		somewhat weedy	Declining stand; weedy
24	Canada milkvetch	MN Native	6	*2-9	7	7		Fair stand; weedy	Variable stand; weedy
25	red clover	VNS(medium)	4	*2-9	5	8		Fair stand; weedy	Variable stand; weedy
26	Warm Season Mix		4	4	7	8		Fair stand; weedy	Declining stand; weedy
27	Indiangrass	Tomahawk	4	8	8	8		Poor stand; weedy	Poor stand; weedy
28	big bluestem	Bounty	5	*6-9	8	8		Fair-poor stand; weedy	Poor stand; weedy
29	big bluestem	Sunnyview	8	7	8	8		Mediocre stand & weedy	Poor stand; weedy
30	switchgrass	Sunburst	5	7	7	8		Mediocre stand & weedy	Poor stand; weedy
31	western wheatgrass	Rodan	4	1	2	2	Some seedlings dried out!	Good stand; somewhat weedy	Good stand; few weeds
32	pubescent whtgr	Manska	3	1	2	2		Awesome	Vigorous; good stand; few weeds
33	intermed whtgrass	Manifest	3	2	2	2		Awesome	Vigorous; good stand; few weeds
34	Canada wildrye	Mandan	3	3	2	2		Mostly good stand; somewhat weedy	Good stand; few weeds
35	Virginia wildrye	PMC	3	2	2	2		Vigorous; some weeds	Vigorous; good stand; few weeds
36	altai wildrye	Prairieland	3	2	3	3		good stand; some weeds	good stand; some weeds
37	quackXbluebunch	NewHy	2	1	2	1		Vigorous; few weeds	Vigorous; good stand; few weeds
38	creeping foxtail	Garrison	5	1	1	1	Some seedlings dried out!	Vigorous; few weeds	good stand; few weeds
39	orchardgrass	Pennlate	2	2	8	9		Vigorous; few weeds	Substantial winterkill 2013-14
40	reed canarygrass	Palaton	4	1	1	1		Vigorous; few weeds	good stand; few weeds
Borders- blue grama		Bad River	9	9	9	Clipped	Planted late-poor	Will be reseeded	Needs to be re-seeded

Portions of these plots apppear to be negatively impacted by what appears to be an old driveway

CONSERVATION FIELD TRIALS: TECHNICAL REPORT 2014

Number and Title: NDPMC-F-1103-PA Sully County, South Dakota Conservation District Grasses and Forbs Demonstration

Objective: Provide a living demonstration site to evaluate the forage potential of different grass and forb species

Date Seeded: June 7, 2011

Cooperators: Sully County Conservation District and Fair Board

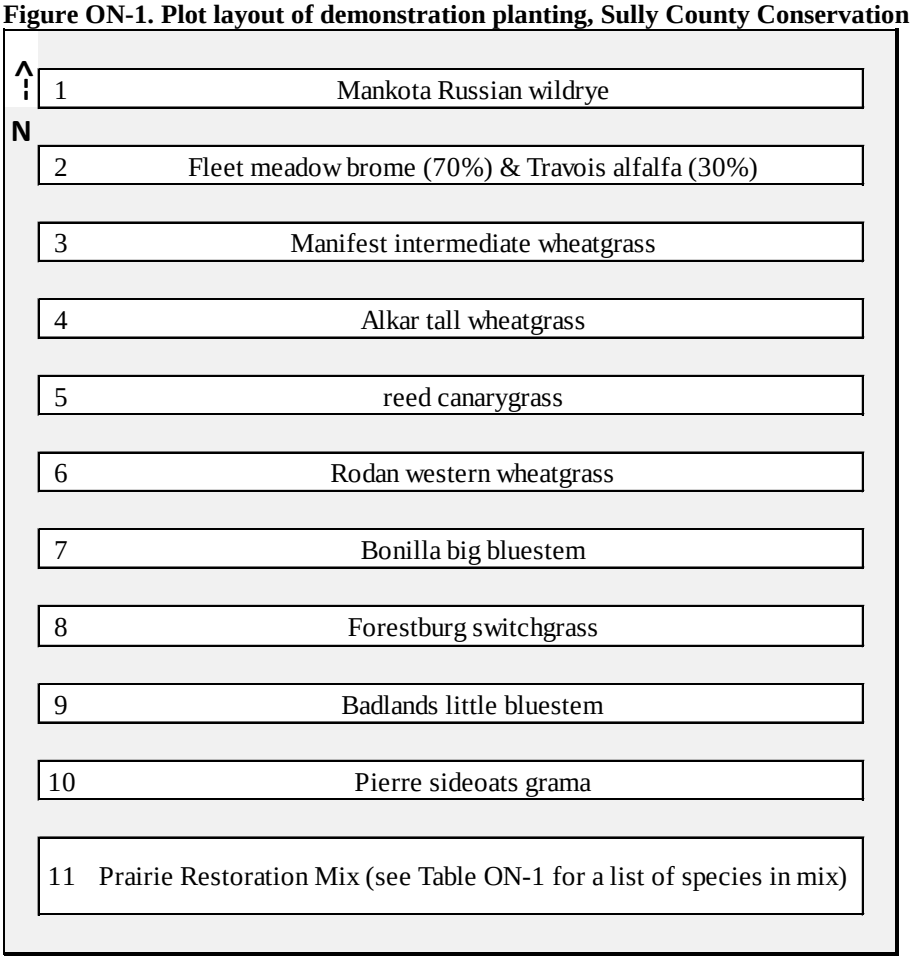
Methods and Materials: This planting includes 9 single species grass plots, one grass-legume plot, and one prairie restoration plot (see Figure ON-1). The plots were tilled and roller-packed prior to seeding with the PMC 5.5-foot plot drill. The drill consisted of a cone-seeder attachment for each opener, so individual rows were metered separately. Individual plots are 11 feet wide and 20 feet long with 16 rows per plot. The prairie restoration plot is 20 feet wide and 20 feet long with 32 rows seeded. There is a 5.5-foot blue grama border between each plot and a minimum 10-foot border around the entire planting. The border areas were seeded to Bad River blue grama. All species were seeded at 1½ times the recommended seeding rates.

Site Information: The planting is located on the eastern end of the Sully County Conservation District property at the eastern edge of the city of Onida, South Dakota. It is bordered by tree windbreaks on the east and south. It is adjacent to the county fairgrounds which borders this site on the north. The site was previously in grass until the spring /summer of 2010, when it was chemically fallowed with glyphosate to kill existing vegetation. In the fall of 2010 the chemical fallowed area was tilled in preparation for seeding in the spring of 2011. The soils are Onida silt loam complex and the site is level.

Table ON-1. List of species included in the prairie restoration mix in the demonstration planting, Sully County SCD, South Dakota

Grasses Included in the Prairie Restoration Mix	Forbs/Wildflowers Included in the Prairie Restoration Mix
Bad River Ecotype blue grama	Echinacea
‘Bonilla’ big bluestem	purple prairieclover
‘Lodorm’ green needlegrass	blanketflower
‘Tomahawk’ Indiangrass	yellow coneflower
Badlands Ecotype little bluestem	leadplant
needleandthread	shell-leaved penstemon
prairie junegrass	stiff sunflower
prairie sandreed	yarrow
‘Pierre’ sideoats grama	dotted gayfeather
‘Mandan’ Canada wildrye	Canada milkvetch
‘Rodan’ western wheatgrass	black-eyed susan
	false sunflower
	Maximilian sunflower

Figure ON-1. Plot layout of demonstration planting, Sully County Conservation District, South Dakota



Results and Discussion:

2011: Above average rainfall and a cool spring delayed planting until June 7. The soils were still saturated at planting and a few plots were almost too wet to plant. Heavy rainfall events during the summer of 2011 resulted in flooding on portions of the plots on the northern end of the site. Much of the flooding was a result of some minor diking on the driveway on the north side of the site. This concern was later remediated by the District and is no longer an issue. No further evaluation was done in 2011. A spring, 2012 evaluation will be completed to determine which species might need to be replanted as a result of the flooding.

2012: The site was evaluated by the District Conservationist on 4/1/12. Portions of plots 1, 2, and 3 were dead and bare as a result of 2011 flooding. Some of the blue grama border on the northern part of the site was also dead as a result of flooding. The bare areas of plots 1, 2, and 3 were tilled, packed and reseeded to original species and rates on May 16. The plots were evaluated again on July 23 (see Table ON-2). Most species that were not impacted by flooding appeared to be establishing well. The big and little bluestem plots were very thin and weedy, and the brome/alfalfa plot that was reseeded had very poor emergence and was very weedy. The prairie restoration plot was well-established and relatively weed-free. Some weeding was done during this evaluation, and District personnel will spray the grass plots that have the most serious broadleaf weed issues.

2013: The plots were evaluated on June 28, 2013 after the area received above-normal rainfall in May and June. All of the grasses and forbs appeared to be vigorous and exhibited very good growth (see Table ON-2). Most species were well established with good plant population. The little and big bluestem plots had thinner stands, but they were still adequate to provide ample forage and compete with the few weeds that were present. Foxtail barley, pigeongrass, and kochia were the most prevalent weeds, but infestations were light and scattered with no impact on performance. Portions of plots 1, 2, and 3 that were reseeded in 2012 due to flood damage were establishing well. Most of the forb species were visible and many were flowering in the prairie restoration plot. Portions of the blue grama border that flooded in 2011 were not reseeded as of this date. Those areas had the most significant weed

pressure. A few plants of smooth brome were also evident in some of the plots. District employees were planning to mow the border in the near future, and repair or replace some of the ID markers that were missing or destroyed. This planting is well established and in prime condition for demonstration/education purposes in the community.

Table ON-2. Evaluation of demonstration plots on 7/23/2012 at Sully County SCD, South Dakota

^	Onida, SD Grass Plots	7/23/2012			6/28/2013	
N	Evaluation (1=best; 9=poorest)	Stand	Weeds	comments	Stand	Weeds
1	Mankota Russian wildrye	2	3	Flood damage	1	2
2	Fleet meadow brome-70% & Travois Alfalfa-30%	7	8	Flood damage	3	4
3	Manifest intermediate wheatgrass	2	1	Flood damage	1	1
4	Alkar tall wheatgrass	1	1	considerable lodging	1	1
5	Reed canarygrass	1	1		1	1
6	Rodan western wheatgrass	1	1		1	1
7	Bonilla big bluestem	4	4		3	2
8	Forestburg switchgrass	3	3		2	2
9	Badlands little bluestem	5	5		3	3
10	Pierre sideoats grama	2	1		2	1
11	Prairie Restoration Mix	1	1		1	1

*Stand: 1=best, 9=poorest
**Weeds: 1=low weed population, 9=high weed population

2014: This site was not evaluated in 2014. The District has not expressed an interest in clipping the plots for production and quality. It will be evaluated in 2015 for stand persistence in all plots, and for forb presence in the prairie restoration seeding. A production clipping will also be included in that site visit.

CONSERVATION FIELD TRIALS: TECHNICAL REPORT 2014

Number and Title: NDPMC-F-1309-DE Marshall County, Minnesota Grasses and Forbs Demonstration

Objective: Provide a living demonstration site to evaluate the conservation potential of different grass and forb species, and conservation program mixes.

Date Seeded: June 18-19, 2013

Cooperators: Marshall County Conservation District and Marshall County Fair Board

Methods and Materials: This planting includes 19 single species grass plots, one single forb plot, 5 plots of different NRCS program conservation mixes, and two forb pollinator mixes. **Table WA-1** lists the species of grasses and/or forbs for the single species plots and the plots with different program mixes. Seed was provided by Carlson Seed Farm, Marshall County Conservation District, and the Bismarck PMC. The plots were seeded with a 5.5-ft double disc plot drill with depth bands on the openers. All species were seeded at 1½ times the recommended seeding rates. Individual plots are 11 feet wide and 50 feet long or 22 feet wide and 50 feet long. The borders were seeded to blue grama as indicated in **Figure WA-1**.

Site Information: Warren is located in the northwestern corner of Minnesota and on the eastern edge of the Red River Valley. The plots are located on the south side of the Marshall County Fairgrounds property which is located in the northeastern edge of the city, north of Highway 1. The plots are separated from the rest of the fairgrounds by a field windbreak, and the conservation district has a new planting of several rows of trees on the west side of this demonstration site. The soils are mostly Fargo clay with very little slope. The plots area was cropped with soybeans in 2012. It was cultivated after harvest with a field cultivator and received heavy snow cover during the winter months. The area received substantial rainfall moisture in the spring of 2013, and planting was delayed until rains subsided long enough to allow for dry seeding conditions. There was very little herbaceous growth prior to seeding, and the ground was packed with a field rolled prior to seeding. No herbicides were applied in 2013.

Figure WA-1. Plot layout of demonstration planting, Marshall County Conservation District, Minnesota

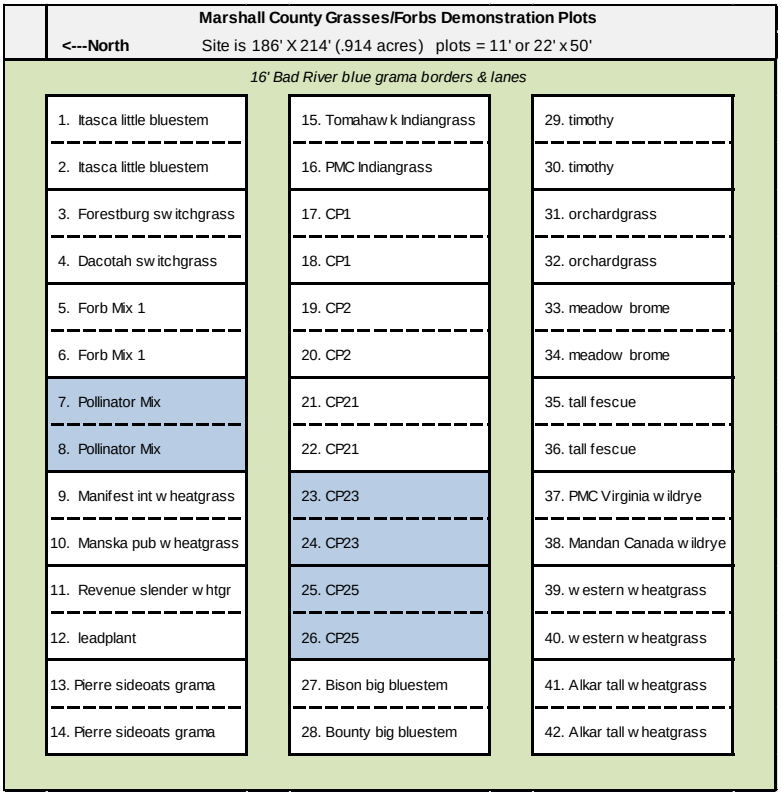


Table WA-1. List of species by mixture planted at demonstration planting, Marshall County Conservation District, Minnesota

Single varieties/species plots		Pollinator Mix		CP 25 Mix	
Bad River	blue grama border	VNS	big bluestem	VNS	Indiangrass
Itasca	little bluestem	VNS	little bluestem	VNS	big bluestem
Forestburg	switchgrass	VNS	Indiangrass	VNS	switchgrass
Dacotah	switchgrass	VNS	Canada wildrye	VNS	sideoats grama
Manifest	intermed whtgrass	VNS	sideoats grama	VNS	slender wheatgrass
Manska	pubescent whtgrass	VNS	wild bergamot	VNS	western wheatgrass
Revenue	slender wheatgrass	VNS	golden alexanders	VNS	little bluestem
PMC	leadplant	VNS	stiff goldenrod	VNS	purple prairieclover
Pierre	sideoats grama	VNS	purple prairieclover	VNS	black-eyed susan
Pierre	sideoats grama	VNS	black-eyed susan	VNS	common oxeye
Tomahawk	Indiangrass	VNS	evening primrose	VNS	Maximilian sunflower
PMC	Indiangrass	VNS	Maximilian sunflower	VNS	white prairieclover
Bison	big bluestem	VNS	white prairieclover	VNS	yellow coneflower
Bounty	big bluestem	VNS	yellow coneflower	VNS	hoary vervain
Climax	timothy	VNS	showy goldenrod	VNS	Canada milkvetch
Potomac or Orion	orchardgrass	VNS	Canada milkvetch	VNS	yarrow
Fleet	meadow brome	VNS	smooth aster	VNS	prairie cinquefoil
Courtenay/select	tall fescue		**CP 21 Mix**	VNS	wild bergamont
PMC	Virginia wildrye	Mandan	Canada wildrye		**CP 23A Mix**
Mandan	Canada wildrye	Rodan	western wheatgrass	Tomahawk	Indiangrass
Rodan	western wheatgrass	Dacotah	switchgrass	Bison	big bluestem
Alkar	tall wheatgrass	Pierre	sideoats grama	Dacotah	switchgrass
CP 2 Mix		**CP Mix 1**		Red River	prairie cordgrass
Tomahawk	Indiangrass	VNS	orchardgrass	Mandan	Canada wildrye
Bison	big bluestem	VNS	timothy	Rodan	western wheatgrass
Dacotah	switchgrass	Manifest	intermed wheatgrass	Bismarck Germ	purple coneflower
Mandan	Canada wildrye	Travois	alfalfa	VNS	blackeyed susan
Bismarck Germ	purple prairieclover	VNS	red clover	VNS	yarrow
VNS	black-eyed susan	VNS	white clover	VNS	yellow coneflower
VNS	white prairieclover	VNS	alsike clover		
VNS	yarrow				

Results and Discussion:

2013: Above average rainfall and a cool, wet spring delayed planting until June 18-19. The soils were still saturated at planting and a few plots were almost too wet to plant. Cool-season species were emerging 2-3 weeks after seeding and looked good. Other vegetative cover included pigweed and volunteer soybeans. These were mowed off in mid-July. There was no further evaluation on this planting for 2013. A spring/summer 2014 evaluation will be completed to determine establishment success of warm-season species.

2014: An evaluation of this site was conducted on June 18, 2014. Stand and weed ratings and comments are shown in **Table WA-2**. There had been no apparent maintenance since the plots were seeded the previous spring. The boundaries were all flagged on this date, so that they could be mowed off to make the individual plots more accessible. The District Conservationist who was initially responsible for oversight of these plots was no longer working in this field office. District employees did not appear to take much ownership in this planting, so one of the NRCS staff agreed to pass on to the new (as yet un-named) District Conservationist some ideas for ongoing

maintenance needs of this planting. The following suggestions were offered for consideration: Mow the blue grama borders to keep weeds down and from going to seed; Plan to mow or clip all plots as soon as possible to reduce weed competition; build and place variety/species markers on each plot by spring, 2015. By late fall of 2014, the new District Conservationist indicated that all of the plots had been mowed at some time during late summer or early fall. An evaluation will be conducted in 2015 and the Specialist will work the Field Office and District personnel to assume more ownership in this planting, as it has great potential as a training site for area field office and district staff.

Table WA-2. Stand and Weed Ratings on June 18, 2014. Marshall County Conservation District, Minnesota
(Rating scale: 1-10; 1=best)

Variety/Species	Stand	Weeds	Comments
1. Itasca little bluestem	7	8	Foxtail barley, sweetclover and bluegrass weeds
3. Forestburg switchgrass	7	9	Heavy sweetclover and bluegrass
4. Dacotah switchgrass	7	9	Spotty stand: from very good to very poor
5. Forb Mix 1	2	7	Good stand with most species present
7. Pollinator Mix	1	5	Excellent
9. Manifest intermediate wheatgrass	1	1	Excellent
10. Manska pubescent wheatgrass	1	1	Excellent
11. Revenue slender wheatgrass	7	7	Scattered thin stand
12. Leadplant	9	9	Canada thistle, downy brome, few visible leadplant plants
13. Pierre sideoats grama	1	5	Good stand and vigor
15. Tomahawk Indiangrass	6	7	Spotty stand from good to poor
16. PMC Indiangrass	7	8	Stand is poorer than Tomahawk
17. CP1	1	1	Excellent, alfalfa is quite dominant
19. CP2	2	7	Good stand, most species present
21. CP21	2	4	Good stand, with all species present
23. CP23	3	5	Good stand, most species present
25. CP25	2	4	Good stand, most species present; bluegrass infestation
27. Bison big bluestem	3	7	Taller and more vigorous than Bounty
28. Bounty big bluestem	5	8	Thinner stand, shorter and less vigorous than Bison
29. Timothy	4	8	Spotty stand from good to poor
31. Orchardgrass	1	2	Excellent
33. Meadow brome	2	3	Looks very good except for a wet area in the plot
35. Tall fescue	5	8	Thin, less vigor, heavy weed pressure
37. PMC Virginia wildrye	3	6	Good stand, 8 " taller than the Canada wildrye
38. Mandan Canada wildrye	3	7	Good stand but much less biomass than Virginia wildrye
39. Western wheatgrass	2	6	Good stand, heavy weed pressure in one area
41. Alkar tall wheatgrass	1	3	Good stand and few weeds

CONSERVATION FIELD TRIALS: TECHNICAL REPORT 2014

Number and Title: MNPMC-F-1409 Pollinator Demonstration Plots, U of M; WCROC, Morris, Minnesota

Objective: Compare performance and compatibility of different NRCS grass-forb mixes, and demonstrate their potential as habitat for pollinating insects. Four different mixes and one annual oilseed crop are included in this education and demonstration planting that will be available for public viewing and used for training by the university, NRCS, and other entities.

Date Initiated: April 19, 2012

Date Seeded: May 28-29, 2014

Cooperators: University of Minnesota West Central Research and Outreach Center, USDA Natural Resources Conservation Service, USDA Agricultural Research Center, and Bismarck Plant Materials Center.

Methods and Materials: Four native perennial grass and/or forb seed mixes and one annual oilseed crop were seeded in these plots, and each was duplicated once, for a total of ten plots in this demonstration. The program mixes consisted of 25, 50, 75, and 100 % forbs to grasses. The forb species in the mixes were selected for environmental adaptability and for different flowering periods to extend pollination over a broader window throughout the growing season. Table MO-1 provides a listing of all species and seeding rates for all of the seed mixes in the plots.

Site Information: Plots are located in the southwest corner of the Horticultural Display Garden area at the West Central Research and Outreach Center location **(Figures MO-1 and MO-2)**. Soils consist of Doland silt loam with 0-4% slope and Buse-Barnes loams, 12-18% slope. Average precipitation is 26.5 per year. An April 19, 2012 analysis of existing vegetation on this site revealed approximately 60% Kentucky blue grass, 10% crown vetch, 5% smooth brome, and 5% Canada thistle. Another concern was the Siberian elm, green ash, and buckthorn growing along the eastern edge of the plots, adding to the invasive issues for this planting. During the initial cooperator meeting, it was consensus that a one or two year effort on weed control was needed before any seeding of pollinator plant species should be done. There would not be an option for weed control with herbicides once the plots were seeded. There was no tillage involved with this planting. Herbicides were used for burn down and control of existing vegetation, and a fire burn was also completed to remove a significant amount of the bluegrass thatch layer that was present.

Results and Discussion

2012: During the growing season the following weed control efforts were completed:
June 18 – applied 1 quart glyphosate and 1 quart Milestone;
July 9 - applied 1 quart of Glyphosate;
July 31- Burned the plots. Because there was no rain between the herbicide application and the burn, it was assumed that the Milestone application may not have been effective;
August 31- applied 3 quarts of Roundup. On Sept. 24th, the plots were still weed-free after the August application.

2013: Cooperators met again on May 7 and determined to hold off seeding for another year to allow more time to control problem weeds and other vegetation. Glyphosate and Milestone were applied in May, followed by a second application of Glyphosate during the summer.

2014: The plots were seeded on May 28 with the PMC no-till plot drill. A glyphosate application was completed a week prior to the seeding, so there were very few weeds present. Seeding depth was ¼ inch into a firm seedbed. Seeding rates and mixes are shown in **Table MO-1**. There was good soil moisture at the time of seeding. Blue grama was seeded in the borders between/around each of the plots at a 5.7 PLS lbs/acre rate. The annual oilseed pollinator plots were seeded the first week of June with a mix of canola, echium, cuphea, and calendula. A heavy and hard rain fell on the plots within a couple weeks of seeding, causing some erosion on the steeper slopes. It also brought on a flush of tree seedlings that were hand weeded out of the plots by volunteers during the 2nd and 3rd week of July. A field day was conducted at the site on September 4th. The grass/forb perennial plots appeared to be well established with all grasses visible and at least 10 forb species present. The oilseed plots attracted a sizeable population of pollinating insects, and the different species in the mix provided pollen throughout the growing season.

Figure MO-1. Layout of the Horticultural Display Garden area at the West Central Research and Outreach Center, Morris, Minnesota (plots are located in the southwest corner)

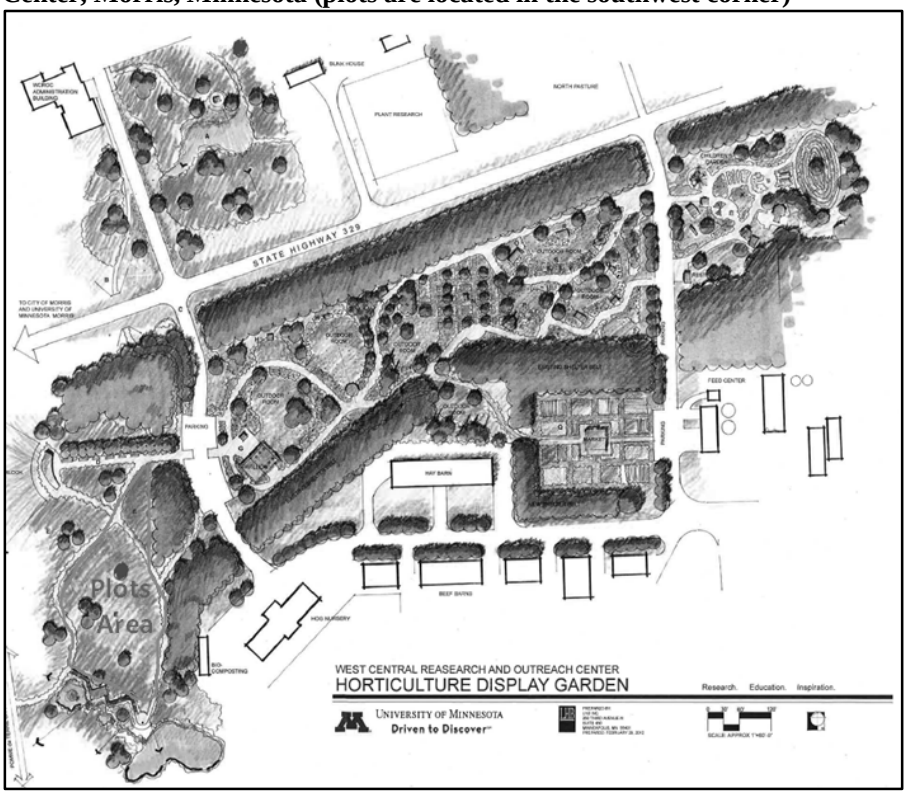


Figure MO-2. Plot layout of the Pollinator Demonstration Plots, West Central Research and Outreach Center, Morris, Minnesota

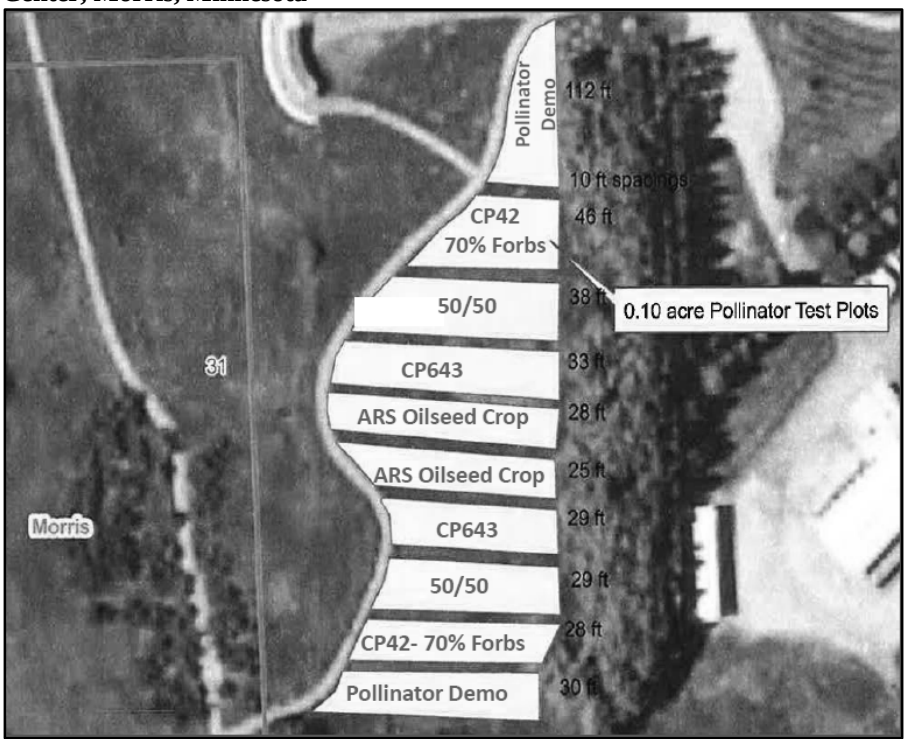


Table MO-1. Seeding rates and mixture composition of pollinator plots, Morris, Minnesota

Components	Species	25 % Forbs		50 % Forbs		75 % Forbs		100 % Forbs	
		PLS Seeds /ft²	PLS Seeding Rate (lbs/ac)	PLS Seeds /ft²	PLS Seeding Rate (lbs/ac)	PLS Seeds /ft²	PLS Seeding Rate (lbs/ac)	PLS Seeds /ft²	PLS Seeding Rate (lbs/ac)
Grasses	Blue grama	5.81	0.33	1.92	0.11	0.00	0	None	
	Sideoats grama	9.74	2.2	6.43	1.46	6.45	1.46		
	Little bluestem	6.92	1.15	5.27	0.88	5.16	0.86		
	Prairie dropseed	6.64	1.1	5.27	0.88	3.31	0.55		
	Green needlegrass	6.86	2.2	5.11	1.65	6.56	2.11		
Forbs Dry to Mesic	Illinois bundleflower	0.00	0	0.20	0.13	0.03	0.02	0.10	0.07
	Stiff sunflower	0.00	0	0.26	0.13	0.04	0.02	0.13	0.07
	Culvers root	0.00	0	3.88	0.01	12.94	0.04	11.00	0.04
	Shell-leaf penstemon	0.00	0	1.79	0.14	2.75	0.22	6.93	0.55
	Blue flax	0.00	0	1.00	0.13	0.83	0.11	4.16	0.55
	Purple coneflower	0.00	0	0.34	0.13	0.06	0.02	0.39	0.13
	Rough blazingstar	1.04	0.18	0.78	0.13	0.26	0.04	0.62	0.11
	Smooth aster	2.46	0.12	1.78	0.09	5.78	0.29	8.93	0.44
	Wild lupine*	0.08	0.2	0.04	0.09	0.01	0.02	0.15	0.31
Forbs Mesic to Wet Mesic	Common ox-eye	0.36	0.15	0.25	0.11	0.05	0.02	0.23	0.11
	Golden alexanders	0.36	0.09	0.44	0.11	0.09	0.02	1.39	0.33
	Partridge pea*	0.00	0	0.11	0.11	0.02	0.02	0.15	0.18
	Wild bergamot	2.36	0.01	4.71	0.01	13.34	0.04	14.09	0.04
	Yellow coneflower	0.00	0	0.97	0.09	1.21	0.11	2.43	0.22
Forbs Dry to Wet Mesic	Black-eyed susan	0.00	0	1.49	0.04	10.79	0.32	8.93	0.26
	Anise hyssop	2.59	0.08	2.21	0.07	10.67	0.32	10.67	0.32
	Leadplant*	0.00	0	0.78	0.13	0.26	0.04	1.31	0.22
	Purple prairieclover*	0.22	0.03	0.87	0.13	0.29	0.04	1.46	0.22
	Stiff goldenrod	2.33	0.15	1.33	0.09	3.32	0.22	3.31	0.22
	White prairieclover*	0.23	0.03	0.77	0.11	0.77	0.11	0.77	0.11
Totals		**48**	**8.02**	**48**	**6.96**	**85**	**7.02**	**77**	**4.5**

CONSERVATION FIELD TRIALS: TECHNICAL REPORT 2014

Number and Title: NDPMC-F-1206-PA Winter Forage Trial, Curt Knight, Gann Valley, South Dakota

Objective: Evaluate grass and forb species and combinations of species to determine potential value for livestock and wildlife in a winter grazing system.

Date Seeded: May, 2011

Cooperators: Curt Knight, Gann Valley, South Dakota, NDSU Extension, and NRCS, Miller, South Dakota.

Methods and Materials: The plots in this trial include:

- Site 1 Plots (See **Figures CK-1** and **CK-2**) with:
  - 11 plots each seeded to 11 different grass species
  - 11 plots each seeded with a different single species grass mixed with *falcata* alfalfa.
  - Each plot is approximately 20 feet by 1,340 feet
- Site 2 Plots (See **Figures CK-3** and **CK-4**) with:
  - 4 different plots of mixed grasses and forbs
  - Plots vary from 12 to 20 acres in size
  - **Figure CK-4** provides details on species and seeding.

Varieties and species to be planted were determined by the Cooperator based on his own extensive research and experience with all of the plant species and varieties in this trial. He seeded all of the plots with a 10-foot by 7.5-inch Great Plains no-till drill. Grass species were seeded at recommended NRCS Technical Guide rates, while forbs and mixes were seeded according to producer preference. Seeding rates per acre are listed in **Figures CK-2 and CK-3.**

Site 1 plots clipped and sampled for forage quality as follows:

1. A June 2013 benchmark sample collected from each individual species plot.
2. Thereafter, one-half of each plot will be cut for hay in late June or early July on an annual basis.
3. All plots will be sampled (at a minimum) in June, September, December, February and April of each year.
4. For each sampling event from number three above, two samples will be collected from each plot that was cut for hay, and two samples will be collected from each plot that was not cut for hay.

Site 2 plots will be visually evaluated on an ongoing basis for:

1. Species vigor, number and percent of individual species in each plot, weed pressure, symbiosis between species, and other characteristics that would enhance a winter grazing system.

Site Information: The plots are located near one of the farmsteads owned by Curt Knight (**Figure CK-1**). The farmstead is located northwest of Gann Valley, South Dakota; 2 miles south, 2 miles west, and 1/3 mile south of the junction of SD Highways 34 and 45.

Figure CK-1. Location of Winter Forage Trial, Curt Knight, Gann Valley, South Dakota

Figure CK-2. Winter Forage Trial, Curt Knight Site 1 plots (1340' x 40'; seeding rates are PLS lbs/acre)

blue grama and sideoats grama border

7.5# Pierre sideoats grama + 1# Don falcata alfalfa seeded 5/20/12
10.3# Pierre sideoats grama seeded 5/20/12
3.2# Bad River blue grama seeded 5/20/12
2.3# Bad River blue grama + 1# Don falcata alfalfa seeded 5/20/12
5.4# Goshen prairie sandreed + 1# Don falcata alfalfa seeded 5/12/12
7.4# Goshen prairie sandreed seeded 5/12/12
4.4# Piaute orchardgrass seeded 5/3/12
3.2# Piaute orchardgrass +1# Don falcata alfalfa seeded 5/3/12
6.1# Teton tall + 1# Don falcata alfalfa seeded 5/3/12
8.3# Teton tall fescue seeded 5/3/12
18.7# Fleet Meadow Brome seeded 5/3/12
13.7# Fleet Meadow Brome + 1# Don falcata alfalfa seeded 5/3/12
8.9# Shoshone Beardless wildrye + 1# Don falcata alfalfa seeded 5/1/12
12.1# Shoshone Beardless wildrye seeded 5/1/12
14.7# AC Saltlander seeded 5/1/12
10.7# AC Saltlander + 1# Don falcata alfalfa seeded 5/1/12
10.4# Rosana western wheatgrass + 1# Don falcata alfalfa seeded 5/1/12
14.3# Rosanna western wheatgrass seeded 5/1/12
26.2# Altai wildrye seeded 4/26/12
19.2# Altai wildrye + 1# Don falcata alfalfa seeded 4/26/12
11.7# Bozoisky Russian wildrye + 1# Don falcata alfalfa seeded 4/26/12
15.9# Bozoisky Russian wildrye seeded 4/26/12

blue grama and sideoats grama border

Figure CK-3. Winter Forage Trial, Curt Knight Site 2 Plot

Existing plot: 20 acres seeded in 2009 to:

- Rosana western wheatgrass, Bad River blue grama, Pierre sideoats grama, Bozoisky Russian wildrye.

Interseeded in the spring of 2011 to:

- western wheatgrass, falcata alfalfa, Travois alfalfa, cicer milkvetch, Canada milkvetch, and small burnet.

Plot 1 seeded 5/24/12 to: -50# AC Saltlander - 25# Pierre sideoats grama - 25# Bad River blue grama - 15# Goshen prairie sandreed - 38# Rosana western wheatgrass - 84# Altai wildrye - 28# Bozoisky Russian wildrye	**Plus 2#/acre mix of:** - Illinois bundleflower - cicer milkvetch - Don falcata alfalfa - Native leadplant - 4-wing saltbush - small burnet	* Forb species in this plot were seeded separately down in certain drill rows; Grass mix was seeded through all openers. **(See Figure CK-4)**
Plot 2 - 18.8 acres seeded 5/18/12 to: - 19# Altai wildrye - 22.7# Bozoisky Russian wildrye - 33.4# AC Saltlander - 65# Fleet meadow brome - 50# Manska pubescent wheatgrass - 17# Fawn tall fescue	- 1.2#/acre Travois alfalfa - 1#/acre cicer milkvetch - 2#/acre small burnet	* Forb species in this plot were seeded separately in certain drill rows between rows that contained only the grass mix. **(See Figure CK-4)**
Plot 3 - 12.8 acres seeded 5/18/12 to: - 39.6# AC Saltlander - 14.3# Teton tall fescue - 45.5# Fleet meadow brome - 11.5# Platte orchardgrass	- 1.2#/acre Travois alfalfa - 1#/acre cicer milkvetch - 2# small burnet	* Forb species in this plot were seeded separately in certain drill rows between rows that contained only the grass mix. **(See Figure CK- 4)**

Figure CK-4. Winter Forage Trial, Curt Knight Site 2 Plot, species in each row per drill pass (15 rows/pass)

Plot 1 species

Mixed Grass	*Cicer milkvetch & Grass Mix*	*Illinois bundleflower & Grass Mix*	*Mixed Grass*	*Mixed Grass*	*Don falcata alfalfa & Grass Mix*	*Blue flax & Grass Mix*	*Mixed Grass*	*Cicer milkvetch & Grass Mix*	*Mixed Grass*	*Mixed Grass*	*Don falcata alfalfa & Grass Mix*	*Mixed Grass*	*Cicer milkvetch & Grass Mix*	*Mixed Grass*
Also Travois alfalfa and Native leadplant in these 3 rows												Also 4-wing saltbush in these 3 rows		

Plot 2 species

Mixed Grass	*Don falcata alfalfa*	*Mixed Grass*	*Don falcata alfalfa*	*Mixed Grass*	*Mixed Grass*	*Don falcata alfalfa*	*Mixed Grass*	*Mixed Grass*	*Cicer milkvetch*	*Mixed Grass*	*Mixed Grass*	*Cicer milkvetch*	*Mixed Grass*	*Mixed Grass*

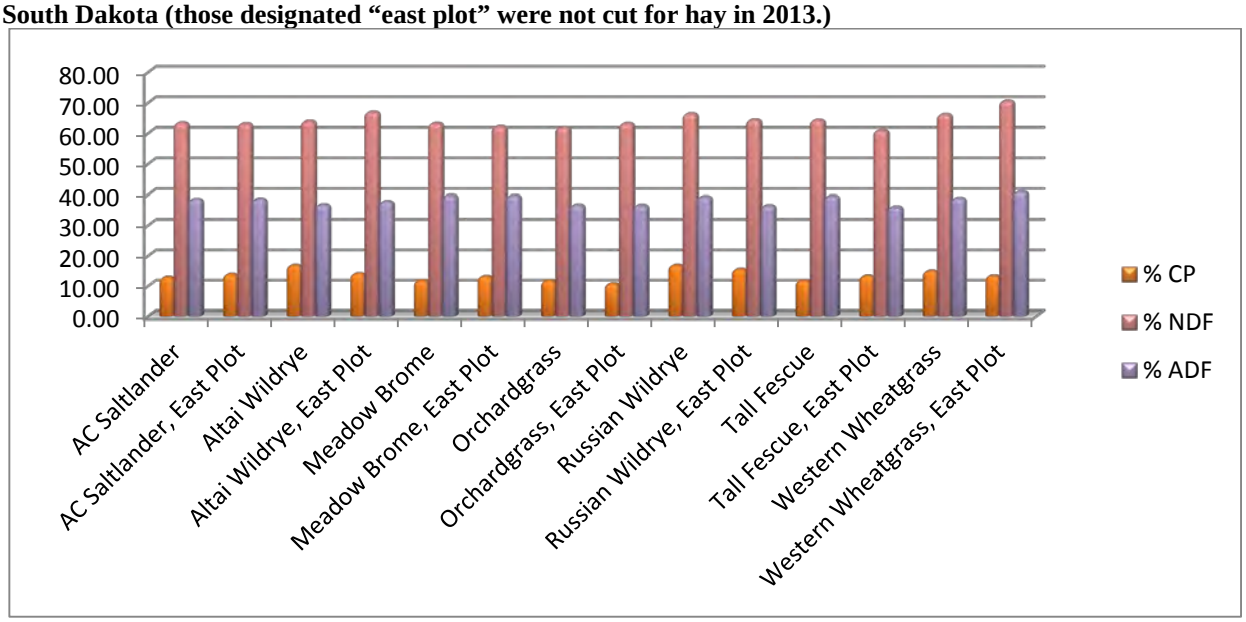
Plot 3 species

Mixed Grass	*Travois alfalfa*	*Mixed Grass*	*Travois alfalfa*	*Mixed Grass*	*Mixed Grass*	*Travois alfalfa*	*Mixed Grass*	*Mixed Grass*	*Mixed Grass*	*Cicer milkvetch*	*Mixed Grass*	*Mixed Grass*	*Cicer milkvetch*	*Mixed Grass*

Results and Discussion:

2013: Rainfall averaged above-normal in May and June and was especially beneficial to the cool season species in the plots. July and August were much drier than normal, while rainfall amounts returned to normal in the fall. The benchmark samples were clipped on June 26, 2013. Data from those samples is shown in **Figure CK-5**. One half of each plot was cut and harvested for hay in early July. Sampling events were completed on September 1 and December 2, 2013. Data collection for those samples will be available in 2014.

Figure CK-5. Crude protein (CP), nutrient detergent fiber (NDF), and acid detergent fiber (ADF) percentages in benchmark forage samples from 6/26/13Winter Forage Trial, Curt Knight, Gann Valley, South Dakota (those designated "east plot" were not cut for hay in 2013.)



2014: Growing season precipitation was slightly below normal while the month of July was well below normal. The individual species plots at site 1 were clipped for production and quality on June 12, 2014. Plots selected for future clipping (harvested plots) in 2014 were swathed and baled for hay within a few days after this initial clipping. The following observations were noted on this date:

Meadow Brome: Dark green, leafy; un-hayed thicker than hayed; very clean, one of the nicer stands.
Tall Fescue: Very poor stand; hayed portion has lots of alfalfa
Orchardgrass: Stand reduced from 2013, now 30-40%; hayed is better than un-hayed
Prairie sandreed: Sprayed and seeded to Profile orchardgrass; 10% stand of prairie sandreed remaining
Blue grama: Poor stand: 20-30%
Sideoats grama: Unsprayed portion has a 50-60% stand; 2-4 D sprayed portion has 80% stand
Shoshone wildrye: Killed w/ Plateau the previous fall; interseeded Quickdraw orchardgrass on 5/15/14
AC Saltlander: Un-hayed is taller, darker green, and leafier; excellent stand and few weeds
Western wheatgrass: Better stand on un-hayed, and leafier; few weeds
Altai wildrye: 3-4 times more seed heads in the hayed portion; excellent stand, but 20-30% less than 2013
Russian wildrye: Excellent stand; clean plot; strongly competes with alfalfa; slight moisture stress

Harvested plots and non-harvested plots were again clipped on 9/10/14 and 11/8/14 for quality. Quality data for 2014 is shown in **Table CK-2.**

Table CK-2. Forage Quality, Winter Forage Trial, Curt Knight, Gann Valley, South Dakota

Species	clip date	hayed/ not hayed	CP	Sugar	ADF	NDF	CF	TDN	DOM/CP	Ca	P	K	Mg	RFQ	RFV
AC Saltlander green wheatgrass	6/12/2014	hayed	9.98	6.41	36.76	64.55	29.4	60.64	5.7	0.32	0.26	1.92	0.13	114.1	86.9
AC Saltlander green wheatgrass	9/10/2014	hayed	14.61	4.69	36.20	62.99	28.96	61.28	4.0	0.31	0.36	2.41	0.16	125.9	89.7
AC Saltlander green wheatgrass	11/8/2014	hayed	5.61		53.79	73.97	43.03	41.22	6.9	0.36	0.09	0.52	0.10		59.1
AC Saltlander green wheatgrass	6/12/2014	no	12.9	5.64	37.92	64.67	30.34	59.31	4.3	0.38	0.32	2.3	0.15	109.0	85.4
AC Saltlander green wheatgrass	9/10/2014	no	8.82	1.91	46.07	75.15	36.85	50.02	5.4	0.24	0.21	1.44	0.09	70.8	65.6
AC Saltlander green wheatgrass	11/8/2014	no	4.39		52.34	76.91	41.87	42.87	9.2	0.33	0.04	0.30	0.09		58.2
Altai wildrye	6/12/2014	hayed	11.24	5.37	37.87	65.24	30.3	59.37	5.0	0.24	0.26	1.96	0.17	119.1	84.7
Altai wildrye	9/10/2014	hayed	12.97	3.31	39.51	67.08	31.61	57.50	4.2	0.27	0.27	1.71	0.20	110.8	80.6
Altai wildrye	11/8/2014	hayed	7.52		47.45	69.13	37.96	48.45	6.1	0.70	0.12	1.21	0.17		69.9
Altai wildrye	6/12/2014	no	12.84	4.41	36.09	61.02	28.87	61.4	4.5	0.32	0.3	2.17	0.18	121.5	92.7
Altai wildrye	9/10/2014	no	11.34	3.50	42.04	70.11	33.63	54.62	4.5	0.23	0.23	1.45	0.17	96.5	74.5
Altai wildrye	11/8/2014	no	7.63		50.34	72.45	40.27	45.16	5.6	0.58	0.11	0.88	0.17		63.8
blue grama	6/12/2014	hayed	13.19	4.58	39.12	62.64	31.29	57.95	4.1	0.34	0.27	1.91	0.17	115.6	86.8
blue grama	9/10/2014	hayed	11.96	3.82	39.42	66.53	31.53	57.61	4.5	0.59	0.56	1.98	0.11	106.8	81.4
blue grama	11/8/2014	hayed	4.56		51.67	70.92	41.34	43.63	9.0	0.39	0.06	0.00	0.08		63.8
Blue grama	6/12/2014	no	13.1	5.29	36.82	60.7	29.45	60.58	4.4	0.14	0.28	2.14	0.17	135.7	92.3
Blue grama	9/10/2014	no	12.61	2.26	41.24	68.31	32.99	55.53	4.2	0.32	0.18	1.41	0.11	95.5	77.3
Blue grama	11/8/2014	no	4.31		54.35	71.28	43.48	40.58	8.9	0.43	0.04	0.00	0.10		60.8
Bozoisky Russian wildrye	6/12/2014	hayed	10.72	5.53	38.75	66.97	31	58.36	5.1	0.26	0.28	1.94	0.15	110.3	81.6
Bozoisky Russian wildrye	9/10/2014	hayed	15.90	4.71	35.03	61.18	28.03	62.61	3.7	0.28	0.32	1.88	0.22	138.6	93.7
Bozoisky Russian wildrye	11/8/2014	hayed	7.17		51.54	75.10	41.23	43.79	5.8	0.58	0.09	0.63	0.16		60.4
Bozoisky Russian wildrye	6/12/2014	no	10.92	4.09	40.3	66.46	32.24	56.6	4.9	0.25	0.27	2.14	0.15	108.5	80.5
Bozoisky Russian wildrye	9/10/2014	no	14.27	4.59	37.04	64.00	29.64	60.31	4.0	0.16	0.31	1.78	0.23	136.8	87.3
Bozoisky Russian wildrye	11/8/2014	no	7.46		49.40	73.56	39.52	46.22	5.8	0.55	0.10	0.72	0.16		63.8
Meadow brome	6/12/2014	hayed	10.44	6.50	37.19	59.95	29.75	60.15	5.4	0.41	0.29	2.19	0.19	131.3	93.0
Meadow brome	9/10/2014	hayed	12.12	2.99	40.71	63.55	32.57	56.13	4.4	0.32	0.24	2.00	0.23	113.7	83.7
Meadow brome	11/8/2014	hayed	6.05		53.65	73.29	42.92	41.37	6.5	0.51	0.06	0.41	0.17		59.8

Species	clip date	hayed/ not hayed	CP	Sugar	ADF	NDF	CF	TDN	DOM/CP	Ca	P	K	Mg	RFQ	RFV
Meadow brome	6/12/2014	no	11.38	6.66	35.69	60.2	28.55	61.86	5.1	0.18	0.3	2.89	0.14	125.3	94.4
Meadow brome	9/10/2014	no	13.20	2.33	40.85	66.72	32.68	55.97	4.0	0.34	0.27	1.89	0.21	98.1	79.6
Meadow brome	11/8/2014	no	6.64		50.65	73.06	40.52	44.80	6.4	0.46	0.05	0.92	0.12		63.0
Orchardgrass	6/12/2014	hayed	11.45	7.25	35.86	61.95	28.68	61.67	5.1	0.39	0.35	2.65	0.2	132.6	91.6
Orchardgrass	9/10/2014	hayed	13.68	3.05	37.59	65.03	30.07	59.70	4.1	0.27	0.36	2.72	0.22	119.5	85.3
Orchardgrass	11/8/2014	hayed	9.02		38.74	60.70	30.99	58.38	6.1	0.55	0.16	2.06	0.14		90.0
Orchardgrass	6/12/2014	no	13	6.52	34.79	57.69	27.84	62.88	4.6	0.53	0.38	2.68	0.23	133.3	99.6
Orchardgrass	9/10/2014	no	13.24	2.93	39.44	68.69	31.55	57.59	4.1	0.23	0.34	2.44	0.22	111.3	78.8
Orchardgrass	11/8/2014	no	7.17		44.59	66.13	35.67	51.71	6.8	0.48	0.12	1.55	0.13		76.2
Prairie sandreed	6/12/2014	hayed													
Prairie sandreed	11/8/2014	hayed	6.49		53.31	73.39	42.65	41.77	6.1	0.63	0.07	0.29	0.20		60.0
Prairie sandreed	9/10/2014	no	7.86	1.33	45.87	76.1	36.69	50.25	6.0	0.52	0.21	1.52	0.12	68.4	65.0
Prairie sandreed	11/8/2014	no	7.56		50.98	72.58	40.78	44.43	5.5	0.64	0.08	0.42	0.22		63.0
Rosana western wheatgrass	6/12/2014	hayed	12.04	5.23	34.31	62.78	27.45	63.43	5.0	0.22	0.31	2.29	0.1	127.5	92.1
Rosana western wheatgrass	9/10/2014	hayed	12.19	3.15	37.9	64.61	30.32	59.34	4.6	0.14	0.29	2.39	0.08	92.9	85.5
Rosana western wheatgrass	11/8/2014	hayed	10.45		47.98	68.07	38.38	47.84	4.3	0.45	0.13	0.75	0.14		70.4
Rosana western wheatgrass	6/12/2014	no	14.66	5.35	34.02	59.6	27.22	63.76	4.1	0.33	0.34	2.56	0.14	129.2	97.4
Rosana western wheatgrass	9/10/2014	no	9.68	2.67	43.28	70.07	34.63	53.20	5.2	0.20	0.21	1.35	0.11	88.1	73.3
Rosana western wheatgrass	11/8/2014	no	4.82		49.77	75.68	39.82	45.80	9.0	0.32	0.03	0.17	0.11		61.6
Shoshone manystem wildrye	6/12/2014	hayed													
Shoshone manystem wildrye	11/8/2014	hayed	10.42		46.48	69.43	37.18	49.55	4.5	0.67	0.08	0.78	0.19		70.6
Shoshone manystem wildrye	11/8/2014	no	7.52		46.09	69.34	36.87	50.00	6.3	0.57	0.10	0.60	0.13		71.1
Sideoats grama	6/12/2014	hayed	13.21	5.37	34.1	62.92	27.28	63.67	4.5	0.09	0.28	2.62	0.17	125.4	92.2
Sideoats grama	9/10/2014	hayed	11.75	4.14	39.23	67.52	31.38	57.82	4.6	0.26	0.20	2.01	0.09	102.3	80.4
Sideoats grama	11/8/2014	hayed	4.10		58.27	76.26	46.62	36.11	8.3	0.33	0.03	0.00	0.08		53.1
Sideoats grama	6/12/2014	no	12.06	4.69	35.02	61.56	28.02	62.62	4.9	0.14	0.22	2.24	0.24	130.4	93.1
Sideoats grama	9/10/2014	no	8.60	1.68	43.04	74.78	34.43	53.48	5.9	0.17	0.13	1.31	0.06	82.7	68.9
Sideoats grama	11/8/2014	no	3.21		56.02	73.80	44.82	38.67	11.4	0.31	0.09	0.22	0.07		57.1

Species	clip date	hayed/ not hayed	CP	Sugar	ADF	NDF	CF	TDN	DOM/CP	Ca	P	K	Mg	RFQ	RFV
Teton tall fescue	6/12/2014	hayed	12.97	7.47	33.93	55.9	27.14	63.87	4.6	0.6	0.31	2.31	0.2	125.1	104.0
Teton tall fescue	9/10/2014	hayed	15.91	5.21	31.24	50.97	24.99	66.94	4.0	0.60	0.34	2.54	0.22	138.5	117.8
Teton tall fescue	11/8/2014	hayed	12.21		38.91	55.91	31.13	58.19	4.5	0.61	0.22	1.94	0.17		97.5
Teton tall fescue	6/12/2014	no	13.7	8.23	33.67	54.45	26.93	64.17	4.4	0.65	0.32	2.59	0.18	124.6	107.1
Teton tall fescue	9/10/2014	no	17.52	5.21	33.55	55.05	26.84	64.30	3.5	0.54	0.31	2.43	0.19	118.6	106.1
Teton tall fescue	11/8/2014	no	13.27		39.70	59.36	31.76	57.29	4.1	0.58	0.19	1.43	0.17		90.9

SEED PRODUCTION

SEED PRODUCTION RECORD
Accession: 'Bison' (NDG-4, 9005667, PI-477994)
Name/Species: big bluestem, *Andropogon gerardii*
Location: Field E-8
Year of Establishment: 1997
Origin/Source: Oliver County, North Dakota; USDA, ARS, Mandan, North Dakota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date	Notes
1998	Foundation	980067-1	9808345	3.04	248.0	95.60	87	0	4.26	0.14	0.00	3/24/1999	
1999	Foundation	990863-1	9904487	1.76	279.5	90.13	90	0	9.86	0.01	0.00	1/26/2000	
1999	Foundation	990863-1	9903569	1.28	165.0	93.62	88	0	6.35	0.03	0.00	1/12/2000	Plateau
2000	Foundation	201150-1	2007607	3.04	294.0	95.89	90	1	3.95	0.16	0.00	3/13/2001	
2001	Foundation	S0113839	2107325	3.04	419.0	96.95	86	0	2.98	0.07	0.00	3/27/2002	
2002	Foundation	S0210299	L2210878	3.04	115.0	88.48	30	49	11.51	0.01	0.00	4/10/2003	
2003	Foundation	C54832	L2304932	3.04	328.0	93.90	28	57	6.10	0.00	0.00	2/3/2004	
2004	Foundation	S0412038	L2411492	3.00	446.0	96.61	55	37	3.38	0.01	0.00	4/15/2005	
2005	Foundation	S0513080	L2509594	3.00	462.0	96.40	47	42	3.60	0.00	0.00	3/20/2006	
2006	Foundation	S0611773	L2609510	3.00	26.0	69.03	47	38	30.95	0.01	0.01	3/28/2007	
2007	Foundation	C69301	L2703199	3.00	724.0	97.63	42	46	2.33	0.03	0.01	12/13/2007	
2008	Foundation	C81842	L2808793	3.00	270.0	95.71	62	26	4.29	0.00	0.00	4/16/2009	
2009	Foundation	C92149	L2910722	3.00	335.0	87.73	40	45	12.27	0.00	0.00	4/23/2010	
2010	Foundation	C12097	L1008984	2.80	50.0	94.22	61	22	5.62	0.15	0.01	4/21/2011	ergot 0.23%
2011	Foundation	C21794	L1104759	2.80	399.0	92.34	49	44	7.63	0.03	0.00	12/12/2012	ergot 0.1%
2012	Foundation	C26199	L1208309	2.80	269.0	98.06	55	43	1.90	0.04	0.00	4/23/2013	
2013	Foundation	C94128	L1308062	2.80	842.0	98.05	38	30	1.91	0.04	0.00	4/17/2014	milkweed
2014	Foundation	C15052	L1406040	2.80	703.0	99.67	62	16	0.33	0.00	0.00	2/17/2015	

SEED PRODUCTION RECORD
Accession: 'Bonilla' (SD-27, PI-315658)
Name/Species: big bluestem, *Andropogon gerardii*
Location: Field D-10
Year of Establishment: 1987
Origin/Source: Morton County; USDA, ARS, Mandan, North Dakota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date	Notes
1988	Foundation	1764	M35857	1.40	320.0	97.04	74	1	2.96	0.00	0.00	3/27/1989	
1989	Foundation	91992	N10095	1.40	159.0	95.33	76	0	4.66	0.00	0.01	12/15/1989	
1990	Foundation	1650	N2322	1.40	115.0	98.07	83	1	1.92	0.00	0.01	1/17/1991	
1991	Foundation	2135	N18291	1.40	118.0	93.76	77	0	6.24	0.00	0.00	1/27/1992	
1992	Foundation	1053-1	P08550	1.42	175.0	92.16	73	0	7.83	0.00	0.00	1/12/1993	
1993	Foundation	3067-1	9303772	1.42	165.0	95.07	72	0	4.93	0.00	0.00	2/28/1994	
1994	Foundation	940232-1	9406903	1.42	276.5	93.34	82	1	6.64	0.00	0.02	1/31/1995	
1995	Foundation	950194-1	9514495	1.42	124.5	97.35	89	0	2.64	0.01	0.00	4/22/1996	
1996	Foundation	960049-1	9609264	1.42	242.0	85.85	78	0	14.14	0.01	0.00	3/18/1997	
1997	Foundation	970037-1	9709197	1.42	180.5	92.18	83	1	7.82	0.00	0.00	3/13/1998	
1998	Foundation	980059-1	9803403	1.42	298.0	97.22	88	1	2.78	0.00	0.00	1/5/1999	
1999	Foundation	990858-1	9910452	1.42	237.5	94.58	87	0	5.42	0.00	0.00	4/27/2000	
2000	Foundation	201151-1	2011941	1.42	168.0	89.14	92	0	10.84	0.01	0.01	5/4/2001	
2001	Foundation	S0113838	2106047	1.42	49.0	92.78	88	0	6.75	0.46	0.01	2/26/2002	
2002	Foundation	S0210303	L2213179	1.42	71.0	95.5	70	16	4.48	0.01	0.01	5/7/2003	
2003	Foundation	C5660	L2311320	1.42	200.0	93.26	73	19	6.74	0.00	0.00	4/22/2004	
2004	Foundation	S0412037	L2413895	1.40	198.0	94.75	79	14	5.25	0.00	0.00	5/6/2005	
2005	Foundation	S0513081	L2513292	1.40	258.0	97.87	72	15	2.13	0.00	0.00	5/4/2006	
2006	minimal harvest	S0611774	no test	1.40	0.0								
2007	Foundation	C70557	L2708118	1.40	242.0	97.66	78	8	2.34	0.00	0.00	3/11/2008	
2008	Foundation	C81097	L2806016	1.40	274.0	98.23	84	9	1.76	0.00	0.00	2/1/2009	
2009	Foundation	C91516	L2907228	1.40	235.0	96.25	72	18	3.62	0.13	0.00	3/18/2010	
2010	Foundation	C10993	L1005406	1.40	150.0	96.6	78	9	3.37	0.01	0.01	2/8/2011	ergot 0.25%
2011	Foundation	C23752	L1111639	1.50	215.0	94.76	72	6	5.19	0.04	0.01	7/17/2012	
2012	Foundation	C25988	L1207474	1.40	175.0	96.13	69	15	3.86	0.01	0.00	4/9/2013	ergot 0.63%
2013	Foundation	C14488	L1403298	1.40	531.0	91.99	68	6	7.98	0.03	0.00	12/18/2014	brnyd, mlkwd
2014	Foundation	C14582	L1403748	1.40	335.0	95.97	36	43	4.03	0.00	0.00	12/26/2014	

SEED PRODUCTION RECORD
Accession: Bounty Germplasm
Name/Species: big bluestem; *Andropogon gerardii*
Location: D11
Year of Establishment: 2010
Origin/Source: composite; Minnesota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date	
2010	Breeder	no harvest											
2011	Breeder		L1110933	0.5	80	93.73	45	41	6.23	0.04	0.00	4/27/2012	
2012	Select	C25253	L1204953	0.5	27	96.52	26	31	3.48	0.00	0.00	2/11/2013	
2013	Select	C28583	L1302799	0.5	83	99.2	5	39	0.8	0.00	0.00	12/18/2013	low germ
2014	Select	C15826	L1408459	0.5	107	98.53	28	32	1.47	0.00	0.00	3/31/2015	

SEED PRODUCTION RECORD
Accession: 9082680
Name/Species: fourwing saltbush, *Atriplex canescens*
Location: Field D10 (deer fence)
Year of Establishment:
Origin/Source: Cottonwood, South Dakota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date
2002	breeder		no test		5.5		78(TZ)	0	1.4	0.00	0.00	11/13/2002
2003	breeder				3.5	98.6	46	9(hard)	1.4	0.00	0.00	3/3/2004
2004	breeder		no test		6.0							
2005	breeder		no test	100-ft row	0.5							
2006	breeder		no test		20.0							
2007	breeder	bulked with previous years' crop			5.0							
2008	breeder		no test		20.0							
2009	breeder		no test		32.0							
2010	breeder		no test		7.0							
2011	breeder		L1104382		16.0	96.88	4	67	3.12	0.00	0.00	12/28/2011
2012	breeder		no test		9.0							
2013	breeder		no test		21.0							

Field Removed

SEED PRODUCTION RECORD
Accession: Pierre (SD-251, PI-476980)
Name/Species: sideoats grama, *Bouteloua curtipendula*
Location: Field E-9
Year of Establishment: 1977
Origin/Source: Stanley County; Ft. Pierre, South Dakota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date
1978	Common		H20314	2.40	24.0	89.45	63		10.54		0.01	5/1/1979
1979	Common		I7089	2.40	899.0	88.58	76		11.41	0.01		4/18/1980
1980	Foundation	1020	J7932	1.00	125.0	96.36	69		3.63	0.01		5/11/1981
1981	Foundation	1177	J20193	1.00	346.0	96.74	80		3.24	0.01	0.01	3/25/1982
1982	Foundation	1160	J36814	1.00	344.0	97.43	56		2.55	0.01	0.01	3/24/1983
1983	Foundation	1498	K11299	1.00	520.0	97.85	82	1	2.13	0.01	0.01	4/12/1984
1984	Foundation	1643	K27724	1.00	248.0	98.78	88		1.20	0.01	0.01	4/15/1985
1985					No harvest							
1986	Common		L22863	1.00	123.0	98.77	87	1	1.23	0.00	0.00	3/24/1987
1987	Foundation	16797	M16481	1.00	192.0	93.11	64	1	6.89	0.00	0.00	4/20/1988
1988	Foundation	1777	M29887	1.00	218.0	97.8	77	1	2.18	0.02	0.00	1/3/1989
1989	Foundation	92011	N11668	0.90	129.0	99.34	61	0	0.66	0.00	0.00	1/17/1990
1990	Foundation	1666	N8366	1.10	572.0	98.06	92	0	1.93	0.01	0.00	4/16/1991
1991	Foundation	2143	N20087	1.10	273.5	97.85	80	0	2.13	0.02	0.00	2/28/1992
1992	Foundation	1049-1	P09603	1.10	229.0	93.28	83	0	6.70	0.00	0.02	2/4/1993
1993	Foundation	3062-1	9308492	1.10	113.0	94.19	71	0	5.81	0.00	0.00	4/27/1994
1994	Foundation	940238-1	9411461	1.09	100.0	96.57	68	0	3.43	0.00	0.00	3/21/1995
1995	Foundation	950191-1	9508544	1.09	234.5	97.69	75	0	2.29	0.02	0.00	2/21/1996
1996	Foundation	960044-1	9607307	1.09	186.0	98.43	81	0	1.57	0.00	0.00	2/20/1997
1997	Foundation	970044-1	9711274	1.09	92.5	90.16	88	0	9.84	0.00	0.00	3/19/1998
1998	Foundation	980056-1	9809152	1.09	174.5	96.45	85	0	3.55	0.00	0.00	3/30/1999
1999	Foundation	990860-1	990860-1	1.09	218.5	93.00	81	4	6.96	0.02	0.02	12/14/1999
2000	Foundation	201154-1	2002097	1.09	282.5	98.13	61	24	1.72	0.13	0.02	11/22/2000
2001	Foundation	S0113834	2103684	1.09	288.0	98.30	77	6	1.65	0.00	0.05	12/27/2001
2002	Foundation	S0210298	L2208214	1.09	200.0	95.51	82	0	4.47	0.02	0.00	2/28/2003
2003	Foundation	C56260	L2310165	1.09	157.0	93.95	75	11	6.03	0.02	0.00	4/7/2004
2004	Foundation	S0412041	L2410470	1.10	159.0	98.79	91	0	1.11	0.08	0.02	3/30/2005
2005	Foundation	S0513077	L2507111	1.10	170.0	98.95	87	1	1.03	0.02	0.00	2/14/2006
2006	Foundation	S0611782	L2602844	1.10	115.0	96.82	30	37	3.16	0.02	0.00	12/4/2006
2007	Foundation	C69026	L2702396	1.1	236.0	96.13	35	60	3.83	0.02	0.02	11/21/2007

2008	Foundation	C80610	L2803368	1.1	163.0	95.93	72	13	4.07	0.00	0.00	12/1/2008
2009	Foundation	C90499	L2902996	1.1	169.0	98.27	83	1	1.73	0.00	0.00	12/28/2009
2010	Foundation	C10797	L1004521	1.10	232.0	96.44	75	14	3.56	0.00	0.00	1/24/2011
2011	Foundation	C22115	L1105866	1.10	94.0	94.66	87	3	5.32	0.02	0.00	1/25/2012
2012	Foundation	C24915	L1203989	1.10	238.0	98.78	78	9	1.22	0.00	0.00	1/3/2012
2013	Foundation	C28485	L1302334	1.10	185.0	94.37	54	14	5.60	0.03	0.00	11/29/2013
2014	Foundation	C15825	L1408458	1.10	128.0	94.98	95	1	4.53	0.49	0.00	3/31/2015

SEED PRODUCTION RECORD
Accession: Pierre (SD-251, PI-476980)
Name/Species: sideoats grama, *Bouteloua curtipendula*
Location: Field E-11
Year of Establishment: 2009
Origin/Source: Stanley County; Ft. Pierre, South Dakota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date
2010	Foundation	C10992	L1005405	1.10	307.0	95.34	84	3	4.66	0.00	0.00	2/8/2011
2011	Foundation	C22247	L1106179	1.10	190.0	94.14	72	5	5.86	0.00	0.00	1/31/2012
2012	Foundation	C25071	L1204417	1.10	404.0	99.4	90	2	0.59	0.00	0.01	1/23/2013
2013	Foundation	C28474	L1302210	1.10	314.0	90.66	54	12	9.29	0.05	0.00	11/26/2013
2014	Foundation	C16035	L1409444	1.10	283.0	97.25	94	2	2.66	0.09	0.00	4/6/2015

SEED PRODUCTION RECORD
Accession: Bad River ecotype (9063064)
Name/Species: blue grama, *Bouteloua gracilis*
Location: Field E-12
Year of Establishment: 2010
Origin/Source: Haakon County; Philip, South Dakota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date	Notes
2010	no harvest-establishment year			1.02									
2011	Select	C22849	L1108133	1.00	100.0	95.96	96	0	3.92	0.08	0.04	3/7/2012	
2012	Select	C24477	L1202783	0.70	16.0	76.61	68	13	23.33	0.03	0.03	12/4/2012	
2013	Select	C29198	L1305263	1.00	114.0	96.69	86	2	3.18	0.13	0.00	2/21/2014	
2014	Select	C15978	L1409245	1.00	1.9	90.97	98	0	8.77	0.17	0.09	3/31/2015	ELVI, PAVI

SEED PRODUCTION RECORD
Accession: 9094357
Name/Species: Prairie sandreed, *Calamovilfa longifolia*
Location: Field E-9
Year of Establishment: 2009
Origin/Source: composite, Sherburne, Polk, Norman, Douglas, Chisago Counties, Minnesota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date
2010	breeder			0.25	85 gm							
2011	breeder		No test	0.25	1.2							
2012	breeder		L1202345	0.25	2.5	66.84	69	0	30.08	3.08	0.00	11/26/2012
2013	breeder		L1302415	0.25	7	74.62	76	0	24.72	0.34	0.32	11/20/2013
2014	breeder		L1404129	0.25	2.8	93.83	82	0	5.53	0.42	0.22	1/20/2015

SEED PRODUCTION RECORD
Accession: Bismarck germplasm (9006032)
Name/Species: purple prairieclover, *Dalea purpurea*
Location: E-12
Year of Establishment: 2009
Origin/Source: Lyman County; Presho, South Dakota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date
2010	no harvest	S1010037		0.5								
2011	Select	C23683	L1111282	0.5	44	99.01	29	0	0.99	0.00	0.00	5/16/2012
2012	Select	C25241	L1204921	0.5	12.5	98.57	31	48	1.4	0.03	0.00	2/6/2013
2013	No Harvest											
2014	Field Removed											

SEED PRODUCTION RECORD
Accession: Bismarck germplasm (9076759)
Name/Species: narrow-leaved purple coneflower, *Echinacea angustifolia*
Location: E-12
Year of Establishment: 2009
Origin/Source: composite; McKenzie, Slope, Sioux, Billings, Dunn, Burleigh, Sheridan, Morton, McHenry Counties in North Dakota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date	Notes
2010	no harvest	S1010036		0.32	0								
2011	Select	C22850	L1108134	0.1	73	84.96	15	49	15.04	0.00	0.00	3/5/2012	
2012	Select	C25542	L1205976	0.1	5	81.79	39	35	18.21	0.00	0.00	2/20/2013	
2013	Not tested-too dirty				8								

Field Removed

SEED PRODUCTION RECORD
Accession: 'Mandan' (9058908)
Name/Species: Canada wildrye, *Elymus canadensis*
Location: Field D-9
Year of Establishment: 2008
Origin/Source: central North Dakota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date	Notes
2009	Foundation	C91719	L2908364	1.0	467.0	96.57	76	0	3.43	0.00	0.00	4/14/2010	
2010	Common*	C11887	L1008287	0.87	86.0	92.93	67	0	7.06	0.00	0.01	4/19/2011	
2011	Foundation	C23742	L1111529	0.9	159.0	97.17	81	0	2.83	0.00	0.00	6/28/2012	ergot 0.04%
2012	Foundation	C25400	L1205502	0.9	179.0	94.63	70	0	5.36	0.01	0.00	3/4/2013	ergot 0.02%
2013	Foundation	C94254	L1308465	0.9	142.0	96.69	89	0	3.29	0.01	0.01	5/7/2014	ergot 1.75%
2014	Foundation	C15469	L140723	0.9	154.0	95.47	61	0	4.53	0.00	0.00	3/26/2015	Sustandard Germ

* failed certification due to low germination

SEED PRODUCTION RECORD
Accession: 9094359
Name/Species: Virginia wildrye *Elymus virginicus*
Location: Field E-12
Year of Establishment: 2013
Origin/Source: ND, SD, MN

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date	Notes
2014	Common*		L1407476	1.20	634.0	98.39	92	0	1.54	0.07	0.00	3/25/2015	not released*

SEED PRODUCTION RECORD
Accession: 9094359
Name/Species: Virginia wildrye *Elymus virginicus*
Location: Panel A
Year of Establishment:
Origin/Source: ND, SD, MN

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date	Notes
2014	Breeder		L1406833	0.10	12.0	94.76	94	0	2.92	2.26	0.06	3/11/2015	

SEED PRODUCTION RECORD
Accession: Bismarck germplasm (9047233)
Name/Species: stiff sunflower, *Helianthus pauciflorus* ssp. *pauciflorus*
Location: Field E-12
Year of Establishment: 2009
Origin/Source: composite

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date	Notes
2009	Select (G1)	C91409	L2906675	0.22	9	90.15	13	48	9.84	0.01	0.00	3/16/2010	
2010	Select (G1)	C10494	L1003258	0.09	10.0	96.08	20	72	3.92	0.00	0.00	12/16/2010	
2011	Common	Failed	L1107298	0.09	3.0	70.40	12	26	29.59	0.01	0.00	2/21/2012	
2012	Select-hold	C25508	L1205823	0.09	3.0	78.10	5	24	21.78	0.12	0.00	2/27/2013	excess weeds
2013	Common	Not tested-too dirty			6.0								

Field removed

SEED PRODUCTION RECORD
Accession: 'Rodan' (PI-477993)
Name/Species: western wheatgrass, *Pascopyrum smithii*
Location: Field E-7
Year of Establishment: 2007
Origin/Source: Field in Morton County; Mandan North Dakota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date	Notes
2009	Foundation	C90741	L2903919	1.0	137.0	91.45	92	1	8.42	0.08	0.05	2/8/2010	
2010	Foundation	C11362	L1006544	1.3	180.0	92.30	84	0	7.70	0.00	0.00	3/24/2011	ergot 0.93%
2011	Foundation	C21309	L1102287	1.3	125.0	85.41	61	1	14.57	0.02	0.00	3/20/2012	
2012	Foundation	C24478	L1202784	1.3	66.0	93.56	71		6.44	0.00	0.00	12/15/2012	
2013	Foundation	C28736	L1303203	1.3	68.0	86.46	70	5	13.54	0.00	0.00	1/9/2014	ergot 2.02%
2014	Failed FDN	C14732	L1404130	1.3	13.0	52.65	35	0	47.25	0.10	0.00	1/21/2015	low germ,high inert

SEED PRODUCTION RECORD
Accession: 'Rodan' (PI-477993)
Name/Species: western wheatgrass, *Pascopyrum smithii*
Location: Field D-8
Year of Establishment: 2013
Origin/Source: Field in Morton County; Mandan North Dakota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date	Notes
2014	Failed FDN	C14867	L1404947	1.8	48.0	78.72	48	2	21.15	0.10	0.03	2/6/2015	Lot 2
2014	Failed FDN	C14866	L1404946		18.0	73.21	43	1	26.73	0.02	0.04	2/6/2015	

SEED PRODUCTION RECORD
Accession: 'Rodan' (PI-477993)
Name/Species: western wheatgrass, *Pascopyrum smithii*
Location: Panel A
Year of Establishment: 2010
Origin/Source: Morton County, North Dakota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date	Notes
2007	Breeder		L2705642	0.1	13	94.31	87	1	5.68	0.01	0.00	2/20/2008	
2008	Breeder	No Test		0.1	1.6								
2009	Breeder	No Test		0.1	1								
2010	Breeder		L1003845	0.1	4.0	87.11	65	1	12.79	0.11	0.00	1/17/2011	
2011	Breeder	No Test		0.1	2.0								
2012	Breeder		L1203148	0.1	3.0	86.54	44		13.09	0.01	0.36	12/27/2012	
2013	Breeder		L1302243	0.1	2.0	75.93	37	5	24.07	0.00	0.00	12/10/2013	
2014	Breeder	No Harvest											

SEED PRODUCTION RECORD
Accession: 'Badlands' ecotype (ND-4115, 9036131)
Name/Species: little bluestem, *Schizachyrium scoparium*
Location: Field E-13 (adjacent to breeder's block)
Year of Establishment: 1989
Origin/Source: western North Dakota and western and central South Dakota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date
1990	Common		N8367	0.90	28.00	87.89	79	0	12.11	0.00	0.00	4/16/1991
1991	Common		P03212	0.90	78.50	64.08	59	0	35.92	0.00	0.00	5/28/1992
1992	Common		P16680	1.04	199.50	95.86	87	0	4.14	0.00	0.00	5/6/1993
1993	Common		9307613	1.04	83.00	93.94	78	0	6.06	0.00	0.00	4/13/1994
1994	Select (G2)	no tags	9415448	1.04	81.50	95.82	81	0	4.18	0.00	0.00	5/8/1995
1995	Select (G2)	9508543	9508543	1.04	60.00	87.14	67	0	12.84	0.02	0.00	2/21/1996
1996	Select (G2)	960047-1	9606987	2.17	113.00	86.11	75	0	13.85	0.02	0.02	2/18/1997
1997	Select (G2)	970040-1	9705283	2.17	221.50	93.87	80	0	6.13	0.00	0.00	1/23/1998
1998	Select (G2)	980064-1	9810818	2.17	53.00	66.21	72	0	33.75	0.02	0.02	4/19/1999
1999	Select (G2)	990861-1	9911692	2.17	210.00	74.00	70	0	25.98	0.00	0.02	5/1/2000
2000	Select (G2)	201157-1	2002928	2.17**	108.50	89.69	84	1	10.31	0.00	0.00	12/27/2000
2000	Select (G2)	201157-1	2003249	12 rows	52.00	93.70	84	0	6.26	0.02	0.02	1/3/2001
2001	Select (G2)	S0113840	2111940	2.17	247.00	92.60	88	0	7.38	0.02	0.00	5/2/2002
2002	Select (G2)	S0210304	L2209496	2.17	334.00	92.45	75	2	7.55	0.00	0.00	3/25/2003
2003	Select (G2)	C55305	L2306970	2.17	365.00	95.94	84	3	4.06	0.00	0.00	2/23/2004
2004	Select (G2)	S0412039	L2406861	2.20	89.00	95.98	71	16	3.85	0.15	0.02	2/22/2005
2004	Select (G2)	S0412039	L2406860	2.20	224.00	96.83	67	16	3.17	0.00	0.00	2/15/2005
2005	Select (G2)	S0513073	L2505889	2.20	390.00	93.79	79	7	6.19	0.02	0.00	1/31/2006
2006	Select (G2)	C66297	L2605801	2.20	241.00	94.17	65	24	5.81	0.00	0.02	1/25/2007
2007	Select (G2)	C71147	L2710754	2.20	227.00	92.66	66	20	7.19	0.13	0.02	4/14/2008
2008	Select (G2)	C82181	L2810250	2.20	90.00	95.14	86	0	4.69	0.17	0.00	4/30/2009
2009	Select (G2)	C10612	L1003847	2.20	217.00	97.15	84	2	2.77	0.09	0.00	1/3/2011
2010	Select (G2)	C10611	L1003846	2.20	78.00	92.58	82	9	7.29	0.13	0.00	1/3/2011
2011	No Harvest											
2012	Select (G2)	C25751	L1206679	2.20	131.00	97.42	67	9	2.56	0.02	0.00	3/26/2013
2013	Select (G2)	C94581	L1309764	2.20	225.00	92.48	76	5	7.50	0.00	0.02	5/27/2014
2014	no harvest due to excess in inventory											

*1992 and 1993 harvest is a composite of field and 340-plant breeder's block
**This acreage amount includes the 12 rows sprayed with Plateau herbicide

SEED PRODUCTION RECORD
Accession: 9094396
Name/Species: Cupplant, *Silphium perfoliatum*
Location: D-10 (deer fence)
Year of Establishment: 2012
Origin/Source: Ransom County, North Dakota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date
2013	Breeder		L1307294	0.10	45.0	89.75	26	37	10.25	0.00	0.00	4/10/2014
2014	Breeder		L1404010	0.10	43.0	93.05	7	70	6.95	0.00	0.00	1/7/2015

SEED PRODUCTION RECORD
Accession: 'Red River' germplasm (9069159)
Name/Species: prairie cordgrass, *Spartina pectinata*
Location: Field E-7
Year of Establishment: 2010
Origin/Source: North Dakota, South Dakota, and Minnesota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date
2010	No Harvest			1.25								
2011	Select	C24001	L1200003	1.25	45.0	90.96	53	37	9.01	0.03	0.00	7/24/2012
2012	Select	C25431	L1205621	1.25	50.0	97.76	6	74	2.06	0.17	0.01	3/26/2013
2013	Select	C29610	L1306521	1.25	95.0	54.91	15	66	45.06	0.00	0.03	3/25/2014
2014	Select	C14865	L1404944	1.25	30.0	92.39	2	85	7.59	0.01	0.01	1/30/2015

SEED PRODUCTION RECORD
Accession: 9094398
Name/Species: prairie dropseed, *Sporobolus heterolepis*
Location: Field D10 (north of deer fence)
Year of Establishment: 2010
Origin/Source: composite of large seed from ND, SD, MN

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date
2010	Breeder				58 gm	no test						
2011	Breeder				1062 gm	no test						
2012	Breeder	none	L1202344	0.1	5.00	97.59	35	6	2.18	0.23	0.00	12/3/2012
2013	Breeder	none	L1302041	0.1	12.50	96.75	71	0	3.25	0.00	0.00	12/11/2013
2014	Breeder		L1404128	0.1	7.00	97.59	44	0	2.29	0.12	0.00	1/27/2015

SEED PRODUCTION RECORD
Accession: 9094358
Name/Species: Indiangrass, *Sorghastrum nutans*
Location: Field D-11
Year of Establishment: 2010
Origin/Source: MN and SD

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date	Notes
2011	reselection within population												
2012	Breeder		L1208128	0.1	17.0	97.21	4	43	2.78	0.01	0.00	4/23/2013	
2013	Breeder		L1309369	0.1		88.15	1	70	11.81	0.03	0.01	5/12/2014	
2014	Breeder		L1410933	0.1	60.0	99.96	20	35	0.04	0.00	0.00	5/7/2015	

SEED PRODUCTION RECORD
Accession: 9094358
Name/Species: Indiangrass, *Sorghastrum nutans*
Location: Field D-11
Year of Establishment: 2012
Origin/Source: MN and SD

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date	Notes
2014	Increase Field		L1410933	1	14.0	99.96	20	35	0.04	0.00	0.00	5/7/2015	

SEED PRODUCTION RECORD
Accession: 'Manifest'
Name/Species: pubescent wheatgrass, *Thinopyrum intermedia*
Location: Field E-12
Year of Establishment: 2006
Origin/Source: USDA, ARS, Mandan, North Dakota

Prod. Year	Seed Class	App./Cert. No.	Seed Lab No.	Acres	Bulk (lbs) Quantity	Purity	Germ.	Dorm.	Inert	Weed	Other Crop	Test Date
2007	Foundation	C70776	L2709076	1.2	708.0	97.86	92	0	2.02	0.01	0.11	4/1/2008
2008	Foundation	C80609	L2803367	1.2	331.0	98.64	88	0	1.35	0.00	0.01	1/1/2009
2009	Foundation	C91062	L2905217	1.2	462.0	94.96	85	0	5.04	0.00	0.00	3/3/2010
2010	Foundation	C10796	L1004520	1.3	500.0	98.79	97	0	1.21	0.00	0.00	2/7/2011
2011	Foundation	C23684	L1111283	1.3	150.0	98.40	95	0	1.60	0.00	0.00	5/30/2012
2012	Foundation	C26156	L1208127	1.3	394.0	94.41	97	0	5.59	0.00	0.00	5/1/2013
2013	Foundation	C94382	L1309088	1.3	673.0	98.57	92	0	1.43	0.00	0.00	5/15/2014
2014	Foundation	C14581	L1403747	1.2	380.0	98.55	92	0	1.45	0.00	0.00	1/9/2015

STAFFING

STAFFING: TECHNICAL REPORT 2014

PERMANENT POSITIONS
Wayne L. Duckwitz, Manager
Craig M. Stange, Forester
Nancy K. Jensen, Agronomist
Earl G. Aune, Biological Science Technician (Foreman) (retired Aug 2014)
Michael D. Bellon, Biological Science Technician
Rachel H. Bergsagel, Biological Science Technician
Julius C. Sayler, Office Automation Clerk

SEASONAL POSITIONS:
Kevin M. Cortes, WAE, Seasonal Biological Science Aid
Sage A. Malingen, WAE, Seasonal Biological Science Aid
Mackenzie Markegard, Seasonal Biological Science Aid (Spherion Staffing)
Jenna Mehlhoff, Seasonal Biological Science Aid (Spherion Staffing)

INFORMATION

INFORMATION: TECHNICAL REPORT 2014

Publications - Fiscal Year 2014

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