

# Grasses for the Northern Plains

Growth Patterns, Forage Characteristics  
and Wildlife Values

Volume I - Cool-season



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# Introduction

**G**rasses commonly are planted as a permanent forage for livestock production, cover type for wildlife habitat and conservation practices for soil protection, providing a major staple in the diets of domestic and wild herbivores, habitat structure for many wildlife species and ground cover to stabilize soils. Both cool- and warm-season grasses are utilized, depending on the resource needs and objectives of the land manager. Cool-season grasses are defined as plants that produce the major portion of their growth during late spring/early summer, with a second growth occurring in late summer or early fall, depending on moisture conditions. Warm-season grasses produce most or all of their growth during the late spring to early fall period. This publication will concentrate on selected cool-season grasses, listing the most pertinent releases adapted to the Northern Plains.

Selection of the proper species and variety is an important step when choosing a grass seeding mixture. Grass species and varieties differ in growth habitat, productivity, forage quality, drought resistance, tolerance to grazing, winter hardiness, seedling vigor, salinity tolerance and many other characteristics. Therefore, selection should be based on the climate, soils, intended use and planned management. Planting the proper selection also can provide long-term benefits and affect future productivity of the stand.

This publication is designed to summarize the growth patterns; forage characteristics, including nutritional value and herbage production; plant performance characteristics, including seedling and plant vigor, weed competition, stand density, stand rating, plant height, disease and seed production; salinity tolerance; fiber content; wildlife values; and the list of varieties suited to the Northern Plains region for a select group of cool-season grasses studied in a field experiment near Hettinger, N.D., and Fort Pierre, S.D. Perennial grasses were studied during a period of eight years beginning in 1990 under different environmental conditions. Recommended seeding rates and specific guidelines can be obtained by consulting your county conservation district, Natural Resources Conservation Service or Extension Service office.



### Grass Species and Varieties

The original study included 101 accessions/ varieties of 33 different species that were evaluated for emergence, weed competition, stand density, plant height, disease, seed production and vigor from 1992 to 1997 at Hettinger, N.D., and 1990 to 1995 at Fort Pierre, S.D. (USDA NRCS 1997). Twenty of these cool-season grasses were selected for further study based upon popularity and future potential at the Hettinger site to study growth patterns, forage characteristics and fiber content from 1995 through 1997 (Table 1). Fourteen were introduced exotic grasses, five native to North America and one introduced native grass-hybrid cross. This second study will be further referenced throughout the remainder of this document as the "Growth Pattern and Nutritional Study (GPNS)". The USDA PLANTS database was used for taxonomic nomenclature (USDA NRCS 2006a).

### Study Area

This research and demonstration project was conducted on private land (T129, R96, Sec 24, SE1/4) south of Hettinger, N.D., and public land (T5, R31, W1/2SW1/4SE1/4 Sec 5) northwest of Fort Pierre, S.D. All grass species and varieties were planted on a Vebar-Flasher soils series near Hettinger and Promise soil series near Fort Pierre. Vebar-Flasher soils are classified as fine sandy loam complex, slopes 3 percent to 9 percent, shallow, somewhat excessively drained and prone to erosion (Ulmer and Conta 1987). Promise soil is classified as clay with nearly level slope, somewhat poor drainage, moderate levels of organic matter and poor tilth (Borchers 1980).

One hundred one different varieties or experimental lines were seeded in 6-foot by 25-foot plots on April 6, 1992, near Hettinger and April 9, 1990, near Fort Pierre

**Table 1. List of grass species and variety of each cool-season grass tested near Hettinger, N.D., 1995-1997.**

Grass Species	Common Name	Release
<i>Elymus trachycaulus ssp. trachycaulus</i>	Slender wheatgrass	Revenue
<i>Pascopyrum smithii</i>	Western wheatgrass	Rodan
<i>Pseudoroegneria spicata ssp. spicata</i>	Bluebunch wheatgrass	Goldar
<i>Pseudoroegneria spicata ssp. spicata/ Elytrigia repens</i>	Bluebunch wheatgrass/quackgrass hybrid	NewHy
<i>Thinopyrum elongatum</i>	Tall wheatgrass	Alkar
<i>Thinopyrum intermedium</i>	Intermediate wheatgrass	Manska
<i>Thinopyrum intermedium</i>	Intermediate wheatgrass	MDN-759
<i>Thinopyrum intermedium</i>	Intermediate wheatgrass	Oahe
<i>Thinopyrum intermedium</i>	Intermediate wheatgrass	Reliant
<i>Agropyron cristatum</i>	Crested wheatgrass	Ephraim
<i>Agropyron desertorum</i>	Crested wheatgrass	Nordan
<i>Agropyron cristatum/desertorum</i>	Crested wheatgrass	HyCrest
<i>Leymus cinereus</i>	Basin wildrye	Magnar
<i>Leymus angustus</i>	Altai wildrye	Prairieland
<i>Psathyrostachys junceus</i>	Russian wildrye	Mankota
<i>Psathyrostachys junceus</i>	Russian wildrye	Bozoisky Select
<i>Bromus inermis</i>	Smooth brome grass	Rebound
<i>Bromus inermis</i>	Smooth brome grass	Cottonwood
<i>Bromus biebersteinii</i>	Meadow brome grass	Regar
<i>Nassella viridula</i>	Green needlegrass	Lodorm

## INTRODUCTION



**Plots near Fort Pierre,  
South Dakota.**



**Plots near Hettinger,  
North Dakota.**

on three replicates using a randomized complete block design. Seeding rate varied with species but followed recommended seeding rates as specified in the NRCS Technical Guide (USDA NRCS 2006b).

### Climate

North and South Dakota are at the geographic center of North America. This results in a continental climate characterized by continuous air movement and large annual, daily and day-to-day temperature changes. Relative humidity is low and precipitation tends to be irregular in time and distribution.

Approximately 70 percent to 75 percent of the annual precipitation falls during the summer months,

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with 50 percent falling during May, June and July in North and South Dakota. A drought is defined as a prolonged period of time receiving less than 75 percent of the average precipitation, causing the plants to suffer from lack of water (Vallentine 1990). Only 1997 was considered a drought year at Hettinger, with 1995 and

1996 above average and 1993 and 1994 slightly below average (Table 2). Drought conditions occurred at Fort Pierre in 1990 and 1994, with 1995 well above average (Table 3). The years 1991, 1992 and 1993 had nearly average rainfall at Fort Pierre.

**Table 2. Monthly precipitation at Hettinger Research Extension Center for 1992-1997.**

Month	1992	1993	1994	1995	1996	1997	Average
January	0.26	0.47	0.59	0.20	0.56	0.05	0.36
February	0.00	0.25	0.15	0.42	0.31	0.18	0.22
March	0.82	0.45	0.57	0.75	0.95	0.32	0.64
April	0.51	0.85	0.95	1.18	1.02	3.68	1.37
May	2.13	1.37	0.80	6.07	5.20	1.16	2.79
June	4.34	4.39	2.39	2.88	2.45	3.79	3.37
July	3.81	4.90	3.02	2.21	0.86	1.16	2.66
August	1.95	0.73	0.34	3.71	0.53	0.73	1.33
September	0.33	0.19	1.39	0.44	4.09	0.25	1.12
October	0.36	0.17	3.94	1.27	0.55	0.89	1.19
November	1.58	0.87	0.61	0.49	1.59	0.39	0.92
December	0.30	0.52	0.06	0.15	0.72	0.05	0.30
<b>Totals</b>	<b>16.39</b>	<b>15.16</b>	<b>14.80</b>	<b>19.77</b>	<b>18.83</b>	<b>12.65</b>	<b>16.27</b>

**Table 3. Monthly precipitation from the official weather station at Fort Pierre, S.D., for 1992-1997.**

Month	1992	1993	1994	1995	1996	1997	Average
January	0.02	0.28	0.72	0.28	0.40	0.40	0.46
February	0.33	1.33	0.62	0.76	0.62	0.33	0.68
March	0.74	0.63	1.23	1.81	0.18	0.98	0.89
April	2.33	2.74	0.27	2.62	1.73	3.37	1.94
May	1.73	6.26	0.65	1.57	1.82	3.74	2.71
June	2.13	3.36	3.69	3.38	2.03	4.42	3.76
July	2.25	0.55	6.04	3.78	3.40	2.28	2.15
August	1.03	1.07	2.42	0.64	1.12	1.74	2.00
September	0.89	0.81	1.41	1.35	0.31	0.92	1.32
October	0.54	1.41	0.29	0.44	3.21	4.82	1.11
November	0.09	0.40	1.33	1.20	0.03	0.56	0.47
December	0.26	0.11	0.20	0.37	0.29	0.16	0.59
<b>Totals</b>	<b>12.34</b>	<b>18.95</b>	<b>18.87</b>	<b>18.20</b>	<b>15.14</b>	<b>23.72</b>	<b>18.08</b>

**Herbage Production from the Growth Pattern and Nutritional Study (GPNS)**

Annual herbage production differed ( $P < 0.1$ ) between years for all entries except Russian wildrye, the Bozoisky Select variety. Differences occurred due to variability and timing of year-to-year precipitation. Tall wheatgrass and basin wildrye produced the greatest amount of herbage production in 1995 (Table 4). Total precipitation was 23 percent above the long-term average and growing season precipitation (April to September) was 29 percent above the long-term average in 1995.

The Manska and MDN-759 intermediate wheatgrass varieties were the highest producing grasses in 1996, followed by Altai and basin wildrye (Table 4). Annual and growing season precipitation was slightly above average, 17 percent and 11 percent, respectively, compared with the long-term averages in 1996. The 1996 precipitation

was closest to the long-term average among the three study years. Herbage production for tall and slender wheatgrass, basin wildrye, Russian wildrye (Mankota) and both smooth brome grass varieties was reduced by 50 percent or more in the nearly average precipitation year, 1996, compared with the wet year, 1995. Although no grass species produced more herbage in the normal moisture year, compared with the wet year, crested wheatgrass (Ephraim) was only 7 percent less productive in 1996, compared with 1995. Bluebunch wheatgrass and Russian wildrye (Bozoisky Select) were lower in herbage production in 1996, compared with 1995, by 14 percent and 17 percent, respectively. All other grass varieties were reduced by 30 percent to 50 percent in 1996, compared with 1995.

**Table 4. Cumulative herbage production pounds per acre (lb/ac) of selected cool-season grasses from the Growth Pattern and Nutritional Study near Hettinger, N.D., in 1995-1997.**

Species	Variety	1995	1996	1997	Mean
Basin wildrye	Magnar	7,332	3,480	4,932	5,248
Tall wheatgrass	Alkar	7,748	3,108	2,892	4,583
Pubescent wheatgrass	Manska	5,840	4,080	2,812	4,244
Altai wildrye	Prairieland	5,172	3,548	3,280	4,000
Intermediate wheatgrass	Reliant	6,132	3,000	2,652	3,928
Crested wheatgrass	Nordan	4,948	3,388	3,252	3,863
Pubescent wheatgrass	MDN-759	5,320	3,720	2,320	3,787
Intermediate wheatgrass	Oahe	5,452	2,840	2,548	3,613
Slender wheatgrass	Revenue	4,988	2,040	2,680	3,236
Bluebunch wheatgrass	Goldar	3,988	3,412	1,920	3,107
Western wheatgrass	Rodan	4,360	2,572	2,292	3,075
Crested wheatgrass	HyCrest	4,492	2,480	2,108	3,027
Meadow brome grass	Regar	4,428	3,028	1,572	3,009
Crested wheatgrass	Ephraim	3,268	3,028	2,108	2,801
Smooth brome grass	Cottonwood	4,188	1,988	1,600	2,592
Green needlegrass	Lodorm	3,932	2,080	1,680	2,564
Bluebunch/Quackgrass	NewHy	3,508	2,188	1,720	2,472
Russian wildrye	Bozoisky Select	2,680	2,228	2,228	2,379
Smooth brome grass	Rebound	3,628	1,680	1,748	2,352
Russian wildrye	Mankota	3,560	1,560	1,480	2,200
LSD ( $P < 0.1$ )		1,532	828	912	

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The driest year in the GPNS was 1997. Annual and growing season precipitation was 22 percent and 17 percent below the long-term average, respectively. Basin wildrye and slender wheatgrass were the only species unaffected by the drier conditions, compared with the 1996 cumulative production levels. Basin wildrye and slender wheatgrass cumulative production in 1997, compared with 1996, was 42 percent and 31 percent higher, respectively. The drier conditions had the greatest negative impact on bluebunch wheatgrass (56 percent reduction), meadow brome (48 percent reduction), and intermediate wheatgrass Manska and MDN-759 (31 percent and 38 percent reduction).

### Field Evaluation for Plant Characteristics of the Original Study

Each accession/variety was evaluated for stand emergence, weed competition, stand density, plant height, disease, seed production and vigor at Hettinger, N.D., and Fort Pierre, S.D. (Tables 5 and 6). Emergence and stand uniformity evaluations were conducted seven weeks after seeding and rated 1 for excellent, 5 for fair

and 9 when no emergence occurred. Weed competition was rated on July 21, 1992, and Aug. 17, 1993, at Hettinger and Aug. 5, 1990, and Aug. 4, 1991, at Fort Pierre and rated 1 for none, 5 for moderate and 9 for severe. Density estimates (percent of full rows in sample frames) were collected July 21, 1992, and Aug. 17, 1993, at Hettinger and Aug. 14, 1990, and May 21, 1991, at Fort Pierre, with 100 percent equaling a full frame. Stand rating within plot was conducted Aug. 16, 1994; Aug. 30, 1995; July 31, 1996; and July 30, 1997, at Hettinger and Aug. 11, 1994, at Fort Pierre, with rating of 1 excellent, 5 fair and 9 poor. Plant height average (in inches) was recorded Aug. 17, 1993; Aug. 30, 1995; and July 31, 1996, at Hettinger and Aug. 5, 1992; Aug. 4, 1993; and Aug. 1, 1995, at Fort Pierre. Disease problems (primarily stem and leaf rust) were recorded Aug. 17, 1993, at Hettinger and Aug. 5, 1992; Aug. 4, 1993; and Aug. 11, 1994, at Fort Pierre, with a rating of 1 for none, 5 for moderate and 9 for severe. Seed production potential (using number of culms as an indicator) was recorded Aug. 17, 1993; Aug. 16, 1994; and July 31, 1996, at Hettinger and Aug. 5, 1992, and Aug. 4, 1993, with a rating of 1 for excellent, 5 for fair and 9 for poor. Vigor (overall plant health) was recorded Aug. 30, 1995;



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**Visual differences between two intermediate wheatgrass varieties at the Hettinger plot.**

July 31, 1996; and July 30, 1997, at Hettinger and Aug. 1, 1995, at Fort Pierre, with a rating of 1 for excellent, 5 for fair and 9 for poor. Herbage production was clipped annually for five consecutive years with a forage harvester at each study site in July and August (USDA NRCS 1997). All samples were weighed with subsamples collected and oven dried at 140 F for 48 hours. Subsamples were weighed to the nearest 0.1 gram and converted to lb/ac.

### **Plant Description, Growth Patterns, Nutritional Quality and Use Potential for the Growth Patterns and Nutritional Study**

These selected cool-season grasses were analyzed for nutritional quality and plant growth pattern. Above-ground biomass yields were estimated for each variety by sampling April 26, May 15, June 1, June 15, July 1, July 20, Aug. 20, Sept. 15 and Oct. 1 in 1995, 1996 and 1997. Standing vegetation was clipped at 0.5 inch from ground level from each subplot of each variety using a 0.25 m<sup>2</sup> frame placed in its designated quadrat as randomly selected for each clipping period. Vegetation was placed into a paper bag with clipping date and

physiological growth stage recorded at each clipping period. All samples were oven dried at 140 F until weight was constant and weighed to the nearest 0.1 gram.

Nutritional quality and forage production were determined from ungrazed, nonmowed cool-season grass clippings at the nine periods throughout the growing season beginning in late April and ending in early October. Each of the grass varieties was tested for dry matter, ash, crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), phosphorus and calcium. All samples were ground through a 1 mm screen in a Wiley mill and analyzed at the North Dakota State University Animal and Range Sciences nutritional laboratory. Dry matter, ash and ADF were determined following standardized procedures (AOAC 1990), NDF using procedures described by Robertson and Van Soest (1982) and CP using the Kjeldahl Auto System II (AOAC 1990). Total digestible nutrients (TDN) were determined for each grass species using the net energy lactation (NEL) formula involving ADF in the model  $\{4.898 + (89.796 \times \text{NEL})\}$ , where  $\text{NEL} = 1.085 - (0.0124 \times \text{percent ADF})$ . Forage production was determined for each of the grass varieties for each clipping period to determine peak herbage production and time period.

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**Table 5. Field evaluation of cool-season grasses used for pasture, rangeland, wildlife habitat and protection of surface and groundwater at Hettinger, N.D., from 1992 to 1997.**

Species/variety	Emergence <sup>1</sup>		Weed Competition <sup>2</sup>		Stand Density <sup>3</sup>		Stand Rating <sup>4</sup>				Plant Height <sup>5</sup>			Disease <sup>6</sup>	Seed Production <sup>7</sup>			Vigor <sup>8</sup>		
	92		92	93	92	93	94	95	96	97	93	95	96	93	93	94	96	95	96	97
<b>Fairway Wheatgrass</b>																				
Parkway	2		2	2	53	75	3	3	2	3	28	21	22	2	2	6	8	4	3	4
Kirk	3		3	2	52	68	3	3	3	2	31	29	25	2	1	4	5	3	2	4
Ephraim	3		4	2	40	59	3	4	3	3	26	25	21	2	3	5	7	4	4	5
Ruff	4		3	2	48	69	3	3	2	2	29	25	17	2	2	5	8	2	3	4
NU-ARS AC2	4		2	2	48	66	3	2	3	2	29	25	19	2	2	5	7	2	4	4
<b>Crested Wheatgrass</b>																				
Summit	3		3	2	45	62	3	4	3	2	30	31	29	2	2	3	4	2	2	3
Nordan	4		4	3	41	66	3	3	3	2	31	33	21	2	2	3	6	3	3	3
<b>Fairway x Crested</b>																				
HyCrest	3		3	2	42	68	3	3	3	3	32	28	29	2	1	4	4	2	3	3
CD-II	3		3	1	40	61	3	4	3	2	28	27	29	2	2	3	5	3	2	4
<b>Intermediate Wheatgrass</b>																				
Chief	3		5	2	52	60	1	2	2	2	42	38	32	2	1	5	5	1	3	2
Clarke	3		3	2	60	75	2	2	3	2	42	33	38	2	2	5	6	2	4	2
Reliant	2		1	1	58	77	1	2	2	2	44	35	33	2	1	5	6	3	3	3
Oahe	2		2	1	56	61	2	2	3	2	42	35	28	2	2	6	7	3	3	3
Slate	1		2	1	64	70	2	1	2	2	43	38	29	2	2	4	7	3	3	3
Haymaker	2		2	2	58	60	1	1	2	2	44	41	28	2	1	3	6	1	3	3
<b>Pubescent Wheatgrass</b>																				
Greenleaf	3		3	2	56	67	2	1	3	2	44	37	27	2	2	7	8	2	3	4
MDN-759	3		2	1	55	64	2	3	4	2	42	35	26	2	2	5	7	3	5	4
Manska	2		2	1	44	63	1	2	3	2	41	33	30	2	2	4	8	2	4	4
<b>Tall Wheatgrass</b>																				
Orbit	3		5	2	49	61	2	2	3	3	48	52	32	2	2	4	5	2	3	4
Alkar	3		5	2	40	66	3	4	4	2	46	47	33	2	2	4	5	3	2	4
Platte	3		4	1	54	63	2	2	3	2	51	45	34	2	2	3	6	2	4	3
<b>Smooth Bromegrass</b>																				
Magna	3		3	1	40	77	1	1	3	2	35	37	24	2	2	5	6	2	4	3
Manchar	3		3	2	42	76	1	4	3	3	32	33	27	2	2	4	5	4	4	4
Rebound	4		3	1	44	80	1	3	2	2	31	35	32	2	3	8	7	3	3	4
Cottonwood	5		3	1	38	80	1	2	2	2	33	37	26	2	3	6	6	2	4	4
Lincoln	3		2	2	44	76	2	2	2	2	30	31	31	2	3	7	7	3	4	5
<b>Meadow Bromegrass</b>																				
Fleet	2		2	1	53	76	1	1	3	2	34	18	23	2	4	8	8	2	4	5
Paddock	3		2	1	54	73	2	2	2	2	32	15	17	2	6	8	8	3	3	5
Regar	3		4	1	33	74	2	2	3	2	29	19	14	2	7	9	8	2	4	6

Table 5. Continued

Species/variety	Emergence <sup>1</sup>		Weed Competition <sup>2</sup>		Stand Density <sup>3</sup>		Stand Rating <sup>4</sup>				Plant Height <sup>5</sup>			Disease <sup>6</sup>	Seed Production <sup>7</sup>			Vigor <sup>8</sup>		
	92	92	93	92	93	94	95	96	97	93	95	96	93	93	94	96	95	96	97	
<b>Smooth x Meadow hybrid</b>																				
AC Knowles	4	3	2	8	64	4	3	3	3	34	32	29	2	3	6	6	3	3	5	
<b>Russian Wildrye</b>																				
Mayak	5	4	3	40	57	3	3	3	4	40	19	17	2	4	9	8	4	5	5	
Swift	5	5	2	26	53	3	3	3	3	40	23	14	2	5	9	7	3	4	5	
Cabree	4	3	2	36	63	4	5	4	4	37	13	13	2	3	9	8	4	4	5	
Mankota	6	5	3	41	56	4	4	3	3	42	25	24	2	3	8	7	4	4	5	
Bozoisky Select	5	4	2	40	56			4	4	46	25	22	2	2	8	8	3	5	5	
<b>Altai Wildrye</b>																				
Prairieland	3	3	2	40	66	1	3	4	4	38	23	29	2	8	8	6	3	3	4	
Pearl	3	4	2	33	66	3	4	3	6	38	20	29	2	7	7	7	4	2	5	
Eejay	3	5	3	31	62	2	2	4	3	38	27	31	2	8	8	8	2	3	4	
<b>Basin Wildrye</b>																				
Trailhead	3	2	2	32	72	4	3	3	4	40	33	41	7	7	7	6	3	3	5	
Magnar	4	6	2	26	57	3	5	4	4	44	36	43	4	6	6	6	3	2	3	
<b>Bluebunch Wheatgrass</b>																				
Goldar	1	4	2	57	79	2	2	2	2	27	14	18	2	7	8	7	3	3	5	
Secar	1	3	2	61	80	3	3	2	2	28	28	23	3	6	8	7	4	3	4	
NewHy hybrid	3	3	2	53	64	2	2	4	2	38	26	26	2	3	7	5	4	3	3	
<b>Green Needlegrass</b>																				
Lodorm	4	6	2	45	67	2	4	3	3	36	35	28	2	2	3	4	2	3	4	
SD-93	3	4	2	23	56	4	4	3	3	35	33	28	2	3	3	3	2	2	3	
<b>Western Wheatgrass</b>																				
Walsh	4	4	2	50	74	1	1	2	2	24	25	17	2	7	8	8	3	4	5	
Rodan	3	4	1	53	79	1	1	3	2	26	22	24	2	6	8	7	2	3	3	
Flintlock	3	4	2	36	54	1	1	2	2	31	29	25	2	6	8	7	1	3	3	
<b>Slender Wheatgrass</b>																				
Revenue	3	2	2	71	64	2	3	4	5	39	35	31	2	1	1	3	2	3	3	
Adanac	2	2	2	69	62	2	2	3	5	37	33	26	3	1	1	3	2	3	5	
Pryor	4	3	2	35	50	4	4	4	4	33	33	22	3	2	2	4	3	3	4	
Primar	2	2	2	40	62	3	2	4	5	36	33	22	2	2	2	4	2	3	4	

<sup>1</sup>Emergence and stand uniformity seven weeks after seeding (May 21, 1992). Rating: 1=excellent, 5=fair, 9=no emergence.

<sup>2</sup>Weed competition (July 21, 1992, and Aug. 17, 1993). Rating: 1=none, 5=moderate, 9=severe.

<sup>3</sup>Density estimate (percent of full rows in sample frames). 100 percent equals full frame (July 21, 1992, and Aug. 17, 1993).

<sup>4</sup>Stand within plot (Aug. 16, 1994; Aug. 30, 1995; July 31, 1996; and July 30, 1997). Rating: 1=excellent, 5=fair, 9=poor.

<sup>5</sup>Plant height average in inches (Aug. 17, 1993; Aug. 30, 1995; and July 31, 1996).

<sup>6</sup>Disease (primarily stem and leaf rust) problems (Aug. 17, 1993). Rating: 1=none, 5=moderate, 9=severe.

<sup>7</sup>Seed production potential, using number of culms as an indicator (Aug. 17, 1993; Aug. 16, 1994; and July 31, 1996). Rating: 1=excellent, 5=fair, 9=poor.

<sup>8</sup>Vigor (overall plant health), (Aug. 30, 1995; July 31, 1996; and July 30, 1997). Rating: 1=excellent, 5=fair, 9=poor.

## Volume I - COOL-SEASON GRASSES

**Table 6. Field evaluation of cool-season grasses used for pasture, rangeland, wildlife habitat and protection of surface and groundwater at Pierre, S.D., from 1990 to 1995.**

Species/variety	Emergence <sup>1</sup>	Weed Competition <sup>2</sup>		Stand Density <sup>3</sup>		Stand Rating <sup>4</sup>		Plant Height <sup>5</sup>			Disease <sup>6</sup>			Seed Production <sup>7</sup>		Vigor <sup>8</sup>
	90	92	93	90	91	94	95	92	93	95	92	93	94	92	93	95
<b>Fairway Wheatgrass</b>																
Parkway	3	2	1	46	59	3	2	16	28	27	2	2	4	5	2	2
Kirk	2	2	2	46	62	3	3	17	31	28	3	2	4	6	3	2
Ephraim	3	2	2	34	50	4	3	14	27	27	3	2	3	7	4	3
<b>Crested Wheatgrass</b>																
Summit	3	2	1	35	48	4	3	16	30	28	4	2	4	7	2	3
Nordan	3	2	1	35	56	3	3	19	31	30	3	2	3	4	3	2
<b>Fairway x Crested</b>																
HyCrest	3	2	1	34	53	3	3	19	31	34	3	2	3	5	2	2
CD-II	3	1	1	32	56	3	3	21	33	32	2	2	4	5	2	2
<b>Intermediate Wheatgrass</b>																
Chief	3	2	2	37	39	3	2	32	39	39	2	2	4	3	3	2
Clarke	4	3	1	28	31	3	2	30	37	36	2	2	4	3	3	2
Reliant	3	1	2	49	56	3	2	32	39	41	2	2	4	3	3	3
Oahe	3	2	1	46	57	3	1	34	43	41	3	2	4	2	3	2
Slate	4	1	1	44	51	3	2	32	41	41	2	2	5	3	3	2
Haymaker	2	1	1	61	61	3	2	34	43	43	2	2	4	2	3	1
<b>Pubescent Wheatgrass</b>																
Greenleaf	3	2	2	19	35	4	2	32	39	37	2	2	5	3	3	2
MDN-759	3	1	1	39	54	2	2	33	38	41	2	2	4	2	3	2
Manska	2	1	1	45	53	2	2	31	39	39	2	2	4	2	3	2
<b>Tall Wheatgrass</b>																
Orbit	4	3	2	31	33	4	4	30	48	48	1	2	3	5	3	2
Alkar	4	3	1	35	33	3	3	30	43	48	2	2	3	5	3	1
Platte	3	3	1	35	43	4	3	31	43	45	2	2	3	4	3	1
<b>Smooth Bromegrass</b>																
Magna	3	3	1	46	50	3	2	21	33	33	1	2	3	6	3	3
Manchar	3	1	1	46	42	3	3	25	33	27	2	2	3	6	3	5
Rebound	3	2	1	32	41	3	2	25	35	33	1	2	3	8	3	2
Cottonwood	3	1	1	23	50	2	2	17	35	33	1	2	3	8	3	2
Lincoln	3	1	2	42	52	2	2	18	37	33	1	2	3	7	3	3
<b>Meadow Bromegrass</b>																
Fleet	2	2	1	35	53	3	3	24	38	33	2	2	3	7	3	2
Paddock	2	1	1	32	58	4	2	20	36	33	2	2	3	7	5	3
Regar	4	1	2	25	40	5	3	27	39	35	2	2	3	8	3	2
<b>Smooth x Meadow hybrid</b>																
AC Knowles	3	2	2	41	49	4	4	23	35	31	2	2	3	5	3	4

Table 6. Continued

Species/variety	Emergence <sup>1</sup>		Weed Competition <sup>2</sup>		Stand Density <sup>3</sup>		Stand Rating <sup>4</sup>		Plant Height <sup>5</sup>			Disease <sup>6</sup>			Seed Production <sup>7</sup>		Vigor <sup>8</sup>
	90		92	93	90	91	94	95	92	93	95	92	93	94	92	93	95
<b>Russian Wildrye</b>																	
Mayak	3		2	1	30	57	3	3	10	39	36	3	2	3	9	6	3
Swift	3		1	1	29	40	3	3	12	43	33	2	2	3	9	5	3
Cabree	3		2	1	35	49	3	3	11	42	38	2	2	3	9	6	3
Mankota	3		2	1	32	51	3	3	13	45	40	2	2	3	9	4	3
Bozoisky Select	3		1	1	24	45	3	3	13	48	38	2	2	3	9	3	2
<b>Altai Wildrye</b>																	
Prairieland	1		4	4	38	47	5	6	19	42	43	2	2	3	9	3	4
Pearl	2		5	4	38	46	6	6	16	38	41	1	2	3	9	3	4
Eejay	2		7	7	24	20	7	6	18	40	32	2		4	9	3	3
<b>Basin Wildrye</b>																	
Trailhead	7		6	5	3	11	6	6	21	42	43	6	7	6	9	5	5
Magnar	4		4	6	6	19	6	7	21	49	44	3	4	7	9	3	4
<b>Bluebunch Wheatgrass</b>																	
Goldar	3		8	8	24	25	8	9	15	24	20	3	2	5	9	5	2
Secar	6		9	8	0	5	7	7	20	33	33	3	4	3	4	3	2
<b>Green Needlegrass</b>																	
Lodorm	6		5	5	22	38	3	4	27	43	38	1	2	3	4	3	2
SD-93	4		6	6	27	33	4	5	29	36	39	1	2	3	4	3	3
<b>Western Wheatgrass</b>																	
Walsh	4		1	1	50	32	6	5	16	29	23	2	3	6	9	8	4
Rodan	4		2	1	53	32	6	5	16	29	23	2	3	6	9	8	4
Flintlock	4		1	1	36	32	6	5	16	29	23	2	3	6	9	8	4
<b>Slender Wheatgrass</b>																	
Revenue	--		9	--	--	--	8	8	--	0	30	--	0	6	--	0	3
Adanac	3		2	2	45	55	4	4	22	27	34	2	2	4	6	3	2
Pryor	3		2	2	28	56	5	4	26	35	31	2	3	4	6	2	3
Primar	3		1	3	52	49	5	5	26	--	--	2	3	3	3	3	3

<sup>1</sup>Emergence and stand uniformity seven weeks after seeding (May 22, 1990). Rating: 1=excellent, 5=fair, 9=no emergence.

<sup>2</sup>Weed competition (Aug. 5, 1990, and Aug. 4, 1991). Rating: 1=none, 5=moderate, 9=severe.

<sup>3</sup>Density estimate (percent of full rows in sample frames). 100 percent equals full frame (Aug. 14, 1990, and May 21, 1991).

<sup>4</sup>Stand within plot (Aug. 11, 1994). Rating: 1=excellent, 5=fair, 9=poor.

<sup>5</sup>Plant height average in inches (Aug. 5, 1992; Aug. 4, 1993; and Aug. 1, 1995).

<sup>6</sup>Disease (primarily stem and leaf rust) problems (Aug. 5, 1992; Aug. 4, 1993; and Aug. 11, 1994). Rating: 1=none, 5=moderate, 9=severe.

<sup>7</sup>Seed production potential, using number of culms as an indicator (Aug. 5, 1992, and Aug. 4, 1993). Rating: 1=excellent, 5=fair, 9=poor.

<sup>8</sup>Vigor (overall plant health), (Aug. 1, 1995). Rating: 1=excellent, 5=fair, 9=poor.

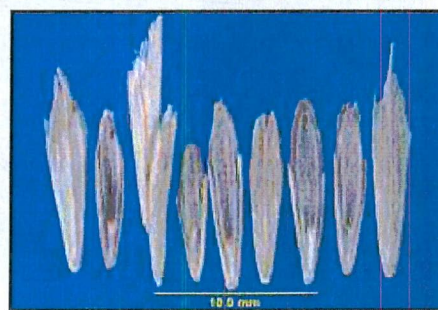
**Volume I - COOL-SEASON GRASSES**

# Meadow Bromegrass

**M**eadow bromegrass was collected in Turkey and introduced into the United States in 1949. It is less rhizomatous than smooth bromegrass, with leaves and stems pubescent. Meadow bromegrass is a long-lived bunch grass used extensively for pasture and hay land. Unlike smooth bromegrass, it is deep rooted with basal tillers, making it capable of strong summer growth and regrowth following grazing or haying events. It is less aggressive than smooth bromegrass and retains a better balance with alfalfa in grass-alfalfa mixtures. Seeds of meadow bromegrass are similar in appearance to smooth bromegrass seeds but are almost twice the size and have much larger awns.

Seeds germinate readily, with seedling vigor good, and seedlings establish well. Meadow bromegrass can be grown under dryland conditions in areas receiving greater than 14 inches of annual precipitation, but performs best

with 16 inches or more of precipitation or with irrigation. With drier conditions, field selection is critical and should be limited to soils with higher water-holding capacity (e.g., loams and clay loams).



## Volume I - COOL-SEASON GRASSES

### Herbage Production

Similar yields from the original study were recorded among Regar, Fleet and Paddock meadow brome grass on field trials from Hettinger, N.D., and Fort Pierre, S.D. No differences were found among varieties in any year, with a five-year mean production of 1,231, 1,204 and 1,328 lb/ac for Fleet, Paddock and Regar, respectively, near Hettinger. No differences were found among varieties in any year, with a five-year mean production of 1,182, 1,398 and 1,743 lb/ac for Fleet, Paddock and Regar, respectively, near Fort Pierre. AC Knowles (smooth x meadow brome grass hybrid) was similar or lower yielding than all meadow brome grass releases in these studies.

Cumulative herbage production from the GPNS for Regar was 4,428 lb/ac when growing season precipitation was greater than 16 inches (Table 4). During a dry year when growing season moisture was less than 11 inches, cumulative herbage production was 1,572 lb/ac. Meadow brome grass was not very drought

tolerant or water use efficient, providing good growth when moisture was good to high. In a drier climate receiving an average of 16 inches of annual precipitation or less, meadow brome grass was less productive than smooth brome grass.

### Growth Patterns

Regar was an early maturing grass, reaching peak standing crop in early July in 1996 and 1997, and mid to late July in 1995. Regar has no yearly differences in percent of total growth produced per clipping for any clipping date. On average, about 10 percent of the plant growth occurs in April and 47 percent by late May or early June. On average, Regar achieves the highest level of standing crop by early July. Although this grass will continue to grow throughout the remainder of the growing season, the loss of the current year's growth is greater than any gain of new growth at this study area.

## Meadow brome grass

Releases	Date Released	Released By	Statement of Use
<b>Cache</b>	2004	ARS, Logan, Utah	Improved forage yields compared with Regar and Fleet and better persistence than Fleet.
<b>MacBeth</b>	2001	MSU, Bozeman, Mont.	Excellent seed yield, similar forage yield to other releases.
<b>Montana</b>	2000	MSU, Bozeman, Mont.	Improved seed yields compared with Regar and Paddock, with fast recovery following defoliation or cutting.
<b>AC Knowles</b>	2000	AAF, Canada	Interspecific hybrid between smooth brome grass and meadow brome grass. Higher yields than Paddock, but less than smooth brome grass.
<b>Fleet</b>	1987	Canada Dept. of Ag.	Similar to Regar in forage yield and Saskatoon, Saskatchewan regrowth characteristics. Higher seed yields compared with Regar.
<b>Paddock</b>	1987	Canada Dept. of Ag.	Similar habitat of growth and forage Saskatoon, Saskatchewan yields to Regar and Fleet. Leaves slightly wider and seed yields greater than Regar.
<b>Regar</b>	1966	SCS, Aberdeen, Idaho	Rapid seed germination. Lacks basal leaves with good regrowth. The first variety released and provides the standard from which all new varieties were compared.

This created a continuing decline of standing biomass below the peak level when not mowed or grazed. In mid-September, meadow brome grass had a 1.5 percent increase in standing biomass compared with late August; then it declined in October.

### Nutritional Quality

Meadow brome grass is highly nutritional and a palatable forage for all classes of livestock. Individual plants of Regar that were in the vegetative to pre-boot growth stage had a crude protein (CP) content of 10 percent or greater. Once the plant reaches the seed-set stage, CP content drops to 7 percent and continues to decline as it matures. Regar, in terms of all standing material combined, was at 4 percent CP in October when cured on the stem.

Total digestible nutrients (TDN) of Regar were above 56 percent when the plant was in the vegetative through seed-hardening growth stage. TDN dropped below 50 percent in late August when mature. The TDN content was at 46 percent in October and November.

### Fiber Content

Fiber content of Regar was lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) increased quickly until the pre-boot stage (28.7 percent to 38 percent), then remained at a similar level until mid-August, peaking at 49.2 percent by early October.

Regar ranked 14th out of the 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. Harvesting maximum levels of fiber occurs from early to late July, with 1,003 pounds of ADF produced per acre. Meadow brome grass would be considered one of the most efficient cool-season grasses, reaching peak herbage and fiber production in early July, when CP and TDN are at or above the minimum levels of a lactating cow.

### Performance Characteristics

Meadow brome grass varieties were studied for emergence and stand uniformity seven weeks after seeding, weed competition, stand density, stand rating, plant height, disease, seed production and vigor (Tables 5 and 6). Fleet established more readily than Regar or Paddock and had a higher stand density the first year. After the establishment year, performance characteristics were similar among varieties. Although Fleet showed improved seed production in the first year following establishment at Hettinger, overall seed production was poor for all varieties.

### Salinity Tolerance

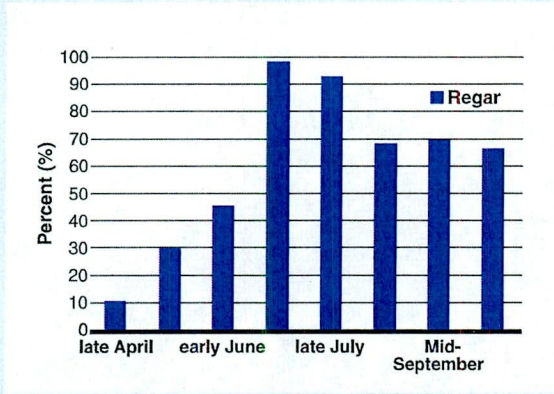
The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated meadow brome grass as moderate for salt tolerance. When comparing meadow brome grass with salt-tolerant grass species, electroconductivity (EC) was 4 to 10 millimhos per centimeter (mmhos/cm). In comparison, beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass have an EC rating of 13 to 26 mhos/cm. Alfalfa has an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (2003) rates meadow brome grass as having a poor salt tolerance, based on the sodium adsorption ratio (SAR) values.

### Grazing Value

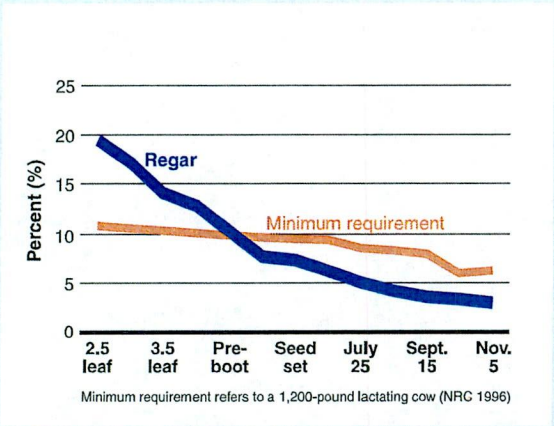
Meadow brome grass will provide excellent grazing in May, June and early July. When comparing growth patterns and nutritional value, livestock grazing from early May through early July will optimize forage use and nutrient content. Total digestible nutrients will be adequate only through July, with crude protein becoming deficient by early July. A rotational grazing system can extend immature plant growth through late September or early October, increasing nutritional quality and palatability.

**Recommended Grazing Season:  
early May to early July.**

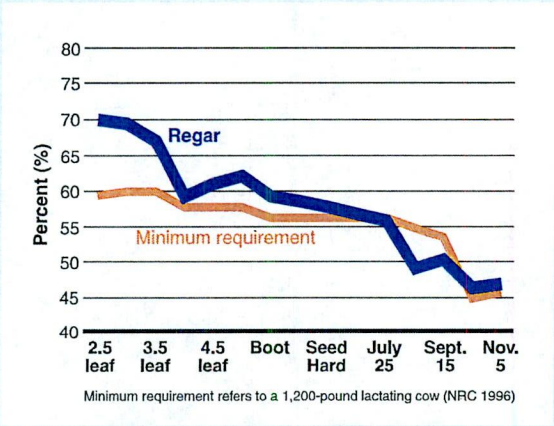
# Meadow bromegrass



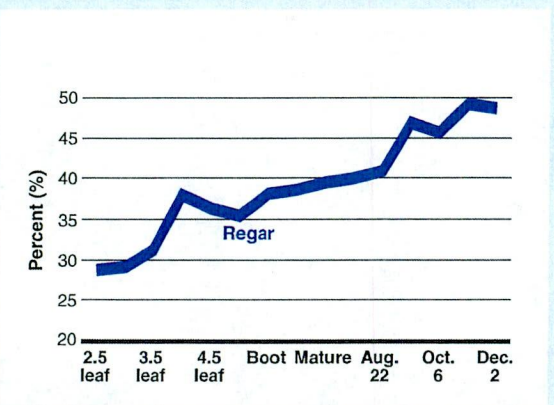
Percent of average peak standing biomass (3,009 lb/ac) for meadow bromegrass



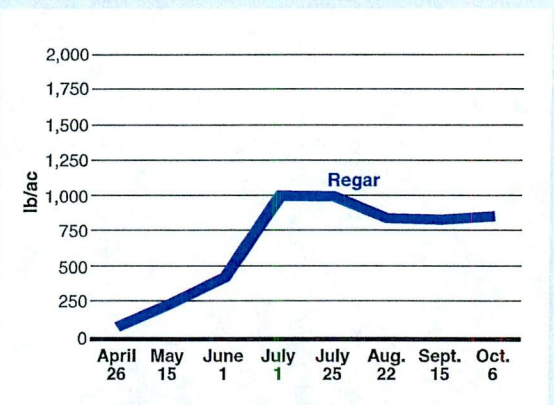
Crude protein content of meadow bromegrass



Total digestible nutrient content for meadow bromegrass



Acid detergent fiber content of meadow bromegrass



Pounds of acid detergent fiber produced per acre for each period of meadow bromegrass

**Hay Value**

Meadow brome grass will make good hay because of its high palatability; however, since most leaf tissue is basal, capturing a high proportion of plant tissue will be lower than upright grasses. Meadow brome grass would be recommended as the first choice for pasture use and hay land a second option, especially in dry climates and years. Meadow brome grass will make a better hay-type grass in higher moisture areas and a poorer one in dry areas. Meadow brome grass should be cut by the third week in June to maintain good CP (9 percent to 10 percent) and TDN (> 56 percent) for winter feed and early July to maintain CP and TDN levels for nonlactating animals. When optimizing quality with production (lb + CP), meadow brome grass should be harvested by late June for optimal harvest efficiency.

Meadow brome grass makes excellent hay when planted with alfalfa. Alfalfa supports the drooping leaves of the meadow brome grass, creating a grass/alfalfa mixture that is maintained in the second and third cuttings.

**Recommended Haying Time: late June for a nonlactating ration, and optimum quality and production; mid-June for a lactating ration, optimum quality and lower production.**

**Wildlife Value**

Meadow brome grass was moderately to highly productive in normal to wet years, compared with other cool-season grasses, and low producing in dry years. This grass will provide good cover in the spring due to its aggressive spring growth; however, cover in the fall will be fair due to a 35 percent to 40 percent loss of standing crop. However, since meadow brome grass is a bunch grass, it will provide higher structure when dormant, compared with smooth brome grass. When used in conjunction with forbs and legumes (e.g., alfalfa) it can provide adequate grassland nesting bird habitat.

Meadow brome grass is a very palatable grass that provides good growth in the spring and lush regrowth throughout the summer, depending on moisture availability. This growth provides a high feed value for foraging animals in the spring and fall, and summer months when moisture is sufficient. Regrowth is very palatable to Canada geese. Birds and rodents eat its large seeds. Use by native pollinators is limited.

**Cover Value**

Spring: Good  
 Summer: Good  
 Fall: Fair  
 Winter: Fair

**Forage Value**

Spring: Excellent  
 Summer: Fair  
 Fall: Good  
 Winter: Fair  
 Regrowth: Excellent

## Smooth Bromegrass

Smooth bromegrass was introduced into the United States in the 1880s from Europe. It is a long-lived, sod-forming rhizomatous grass used extensively for pastures, hay land and soil conservation. It has a slight constriction on the leaf blade about midway from tip to collar, forming a W or M shape. It is considered an aggressive grass that often is planted with alfalfa for hay production. It tends to increase or invade adjacent undisturbed areas, especially idle lands.

Seeds of smooth bromegrass are similar in appearance to meadow bromegrass seeds but are half the size and have shorter awns. Seeds germinate readily, seedling vigor is good and

seedlings establish well. Smooth bromegrass can be grown under dryland conditions in areas receiving greater than 14 inches of annual precipitation, but performs best with 16 inches or more of precipitation or with irrigation. With drier conditions, field selection is critical and should be limited to soils with higher water-holding capacity (e.g., loams and clay loams).

The southern types mature earlier than northern types and have an aggressive root system. It has good seedling vigor and is easy to establish. Cottonwood is a vigorously spreading, drought-tolerant variety. Rebound is a selected variety for greater recovery from haying or grazing.



## Smooth bromegrass

Type	Release	Date Released	Released By	Statement of Use
Southern	<b>AC Rocket</b>	2001	Agricor United	Drought tolerant, vigorous growth, very leafy for higher forage quality, high forage yields.
Southern	<b>AC Knowles hybrid</b> (smooth bromegrass X meadow bromegrass)	2000	AAF, Canada	Interspecific hybrid between smooth bromegrass and meadow bromegrass. Higher yields than Paddock meadow bromegrass but less than smooth bromegrass.
Southern/intermediate	<b>Badger</b>	1990	University of Wisconsin	Excellent seed production, high forage yields, excellent resistance to seedling and foliar disease.
Southern	<b>Radisson</b>	1989	Ag. Canada, Saskatoon, Saskatchewan	Testing in Saskatchewan, Canada, showed forage yields similar to Carlton and Magna and seed yields lower than Carlton and Magna and similar to Baylor and Rebound.
Northern	<b>Bravo</b>	1983	Maple Leaf Mills Forage Division	Average forage yields. Maturity date similar to Saratoga and Baylor.
Intermediate	<b>Signal</b>	1983	Ag. Canada, Saskatoon, Saskatchewan	Similar to Magna in growth habit, taller than Carlton. Forage production similar to other varieties. Roots are slightly less strongly creeping. High seed yields and seed quality.
Northern	<b>Jubilee</b>	1979	Maple Leaf Mills Forage Division	Hardiness similar to Lincoln and Carlton, excellent seedling vigor and rate of establishment. Recovers rapidly after cutting. Very good seed yields. Slightly lower invitro-digestibility than other varieties.
Southern	<b>Rebound</b>	1978	South Dakota, AES	Less spreading and growth habit than Saratoga. Fewer reproductive tillers than Saratoga. Good regrowth recovery after cutting. Winter hardiness similar to Carlton. Good forage yields but lower seed yields than other varieties in western Canada trials.
Southern	<b>Barton</b>	1975	Land O' Lakes	Improved forage yield, rate of recovery, seed size, seedling vigor and leaf disease resistance compared with Lincoln.
Southern/intermediate	<b>Magna</b>	1968	Ag. Canada, Saskatoon, Saskatchewan	High seed quality and higher seed yields than southern types. Yields in western Canada are similar to or above those of southern types, but regrowth yields are somewhat lower.
Southern	<b>Cottonwood</b>	1979		Drought-tolerant, rapidly spreading variety.
Northern	<b>Polar</b>	1965	Alaska, AES	Superior in winter hardiness and yield compared with other northern types. Superior lodging resistance, less aggressive spreading habit of growth. Early maturity.
Southern	<b>Baylor</b>	1962	Rudy-Patrick Co.	Leafy and high forage production, disease resistant, good stand establishment, good recovery after cutting. Improved production of high quality seed. Same maturity as Lincoln.

Type	Release	Date Released	Released By	Statement of Use
Southern	<b>Saratoga</b>	1955	Cornell University, AES	High seedling vigor, early spring growth, higher yielding than Lincoln. Similar to Lincoln in seed yield and quality. Similar to Lincoln in resistance to brown spot and leaf scald.
Southern	<b>Elsberry</b>	1954	USDA-SCS, Elsberry, Mo.	High forage and seed yields, disease resistant, early maturity and excellent recovery after cutting.
Intermediate	<b>Manchar</b>	1943	USDA- SCS, Pullman, Wash.	Good seedling vigor, good forage production and seed yields. Recovers rapidly after cutting.
Southern	<b>Lincoln</b>	1942	Nebraska, AES	Good seedling vigor and ease of establishment. Rhizomatous sod forming. More aggressive than northern types of smooth brome grass.
Northern	<b>Carlton</b>	1961	Canada Department of Agriculture	Typical of northern type of smooth brome grass.

## Herbage Production

Similar yields from the original study were recorded among Rebound, Cottonwood and Lincoln smooth brome grass on field trials from Hettinger, N.D. On average, all three varieties produced greater yields than Magna and Manchar in all years. A five-year mean production was 1,740, 1,661, 1,568, 1,293 and 1,160 lb/ac for Lincoln, Rebound, Cottonwood, Magna and Manchar, respectively, near Hettinger. No differences were found among the Lincoln, Magna, Cottonwood and Rebound varieties in any year near Fort Pierre, S.D., with a five-year mean production of 1,863, 1,855, 1,823 and 1,514 lb/ac, respectively. The Manchar variety was lower than Lincoln in 1995, with a five-year mean production of 1,360 lb/ac. AC Knowles (smooth x meadow brome grass hybrid) was similar or lower yielding than all smooth brome grass releases in these studies.

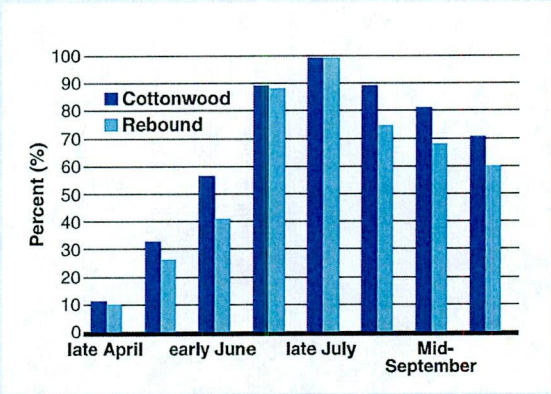
Cumulative herbage production from the GPNS ranged from 3,628 to 4,188 lb/ac for Rebound and Cottonwood, respectively, when growing season precipitation was greater than 16 inches (Table 4). In a dry year when growing season moisture was less than 11 inches, cumulative herbage production ranged from

1,600 to 1,748 lb/ac for Cottonwood and Rebound, respectively. Neither variety appears to be very drought tolerant or water efficient and provided good growth when moisture was high. Development of pasture or hay land with smooth brome grass would be recommended in areas with good moisture, a minimum of a 16-inch annual precipitation zone or water collection area.

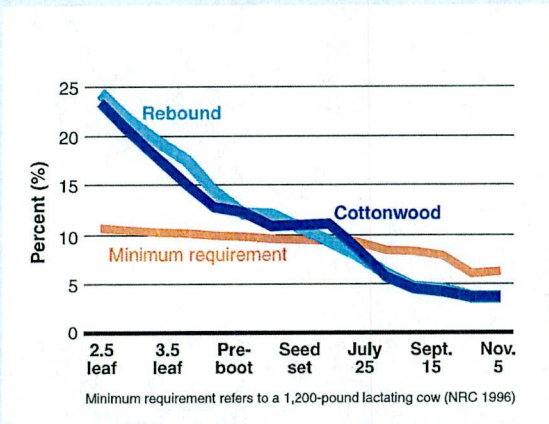
## Growth Patterns

Both Cottonwood and Rebound possess vigorous growth in the spring, reaching peak standing crop in late July during all three years. On average, about 10 percent of the plant growth occurs in April, with more than 41 percent of Rebound's and 57 percent of Cottonwood's growth occurring by late May or early June. Cottonwood is a more aggressively growing smooth brome grass variety in May. Both smooth brome grass varieties achieved the highest level of standing crop by late July. They had no yearly differences in percent of total growth produced per clipping period for any clipping date. Although this grass will continue to grow throughout the

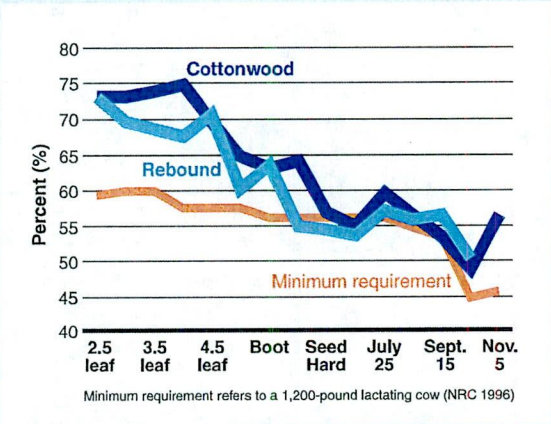
# Smooth bromegrass



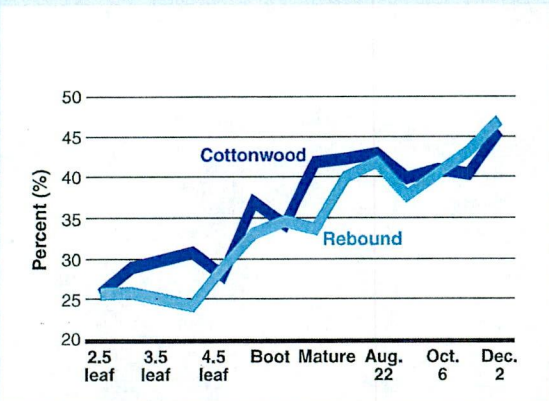
Percent of average peak standing biomass for smooth bromegrass Cottonwood (2,592 lb/ac) and Rebound (2,352 lb/ac)



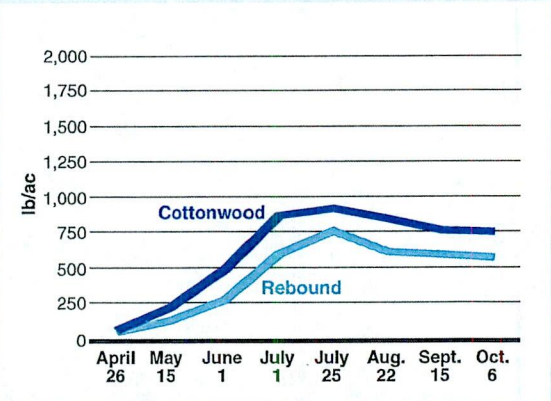
Crude protein content of smooth bromegrass



Total digestible nutrient content for smooth bromegrass



Acid detergent fiber content of smooth bromegrass



Pounds of acid detergent fiber produced per acre for each period of smooth bromegrass

remainder of the growing season, the loss of the current year's growth is greater than any gain of new growth at this study area. This loss creates a continuing decline of standing crop below the peak level. Neither Cottonwood nor Rebound had an increase in biomass production in mid-September, as recorded with Regar meadow brome grass in this trial.

### Nutritional Quality

Both Cottonwood and Rebound were similar in crude protein content (CP) with little to no differences in CP at any time throughout the clipping periods. Both varieties remained at or above the 10 percent CP from the vegetative through seed-set growth stages, dropping below 10 percent at the seed-hardening stage. Smooth brome grass was one of the few cool-season grasses to maintain a CP at 5 percent or greater when fully matured and cured.

Total digestible nutrients (TDN) were similar between the two varieties throughout the first half of the growing season. TDN for Rebound remained at 64 percent at the seed-set stage, while Cottonwood was at 55 percent at this growth stage. The TDN for both varieties was at or above 53 percent throughout the growing season, only dropping below 50 percent after early October.

### Fiber Content

Smooth brome grass was similar to all other cool-season grasses, with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) in Rebound was lower than Cottonwood in the vegetative growth stage, but similar from the pre-boot stage through maturation and senescence. ADF increased rapidly after the 4.5-leaf stage (28 percent to 29 percent), peaking at 46 percent and 47 percent in Rebound and Cottonwood, respectively, by early October.

Cottonwood ranked 16th and Rebound 20th out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum

levels of fiber per acre, smooth brome grass would not be recommended. Harvesting maximum levels of fiber occurs in late July for both varieties, with an average of 916 and 757 pounds of ADF produced per acre for Cottonwood and Rebound, respectively. Smooth brome grass would be considered a moderately efficient cool-season grass, reaching peak herbage and fiber production in late July, when TDN is at or above and CP slightly below the minimum levels of a lactating cow.

### Performance Characteristics

Magna, Manchar, Rebound, Cottonwood and Lincoln smooth brome grass varieties and the AC Knowles hybrid were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor (Tables 5 and 6). Emergence, stand density and stand rating were similar for all varieties. No disease problems were found and plant height and seed production were comparable for all entries. The AC Knowles hybrid generally was rated lower in stand ratings, compared with the other smooth brome grass entries.

### Salinity Tolerance

The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated smooth brome grass as moderate for salt tolerance. The electroconductivity (EC) was 5 to 10 millimhos per centimeter (mmhos/cm). In comparison, beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass are rated very high and have an EC rating of 13 to 26 mmhos/cm. Alfalfa is rated low and has an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates smooth brome grass as having a poor salt tolerance, based on the sodium adsorption ratio (SAR) values.

### Grazing Value

Smooth brome grass, irrelevant of variety, will provide excellent grazing in May, June and early July. When comparing growth patterns and nutritional value, livestock grazing from early May through early July will optimize forage use and nutrient content. Although TDN will be adequate throughout much of the growing season, crude protein will become deficient by mid-July unless sufficient plants are present in the vegetative stage.

**Recommended Grazing Season: early May to early July.**

### Hay Value

Smooth brome grass will make excellent hay because of its high palatability. Irrelevant of variety, smooth brome grass will make a good hay-type grass in good to high moisture areas. Smooth brome grass should be cut by late June to maintain good CP (9.5 percent to 11 percent) and TDN (> 56 percent) for winter feed and early to mid-July to maintain minimum CP and TDN levels for nonlactating animals. Harvest efficiency was different between the two varieties studied. When optimizing quality with production (lb + CP), both varieties can be harvested in late June or early July to optimize harvest efficiency. Cottonwood was 13 percent more efficient than Rebound in capturing CP and production (lb of CP/acre) in this study.

**Recommended Haying Time: late June or early July for a nonlactating ration and optimum quality and production; third week in June for a lactating ration and optimum quality, with slightly lower production.**

### Wildlife Value

Smooth brome grass was moderately productive in normal to wet years, compared with other cool-season grasses, and low producing in dry years. This grass will provide good cover in the spring due to its vigorous early growth; however, cover in the fall will be fair due to the 35 percent to 40 percent loss of herbage production and loss of rigidity, providing limited winter cover. When used in conjunction with legumes (e.g., alfalfa), it can provide good nesting bird habitat. To maintain vigor, it will need management on a routine basis. Prescribed burning or light disking once every three to five years will improve plant vigor, resulting in improved cover for grassland nesting birds.

Smooth brome grass is a very palatable grass that provides good growth in the spring and lush regrowth in the fall, depending on moisture availability. This growth provides a high feed value for foraging animals in the spring and fall, and summer months when moisture is sufficient. Early spring growth and regrowth is very palatable to Canada geese. Birds and rodents eat its seeds. Use by native pollinators is limited.

The invasive tendencies of smooth brome grass into native habitats may impact wildlife habitat negatively. Smooth brome grass does not have the rigidity of most native species, lessening its winter cover value. This trait reduces its value for spring nesting sites for grassland nesting birds, especially in heavy snow winters.

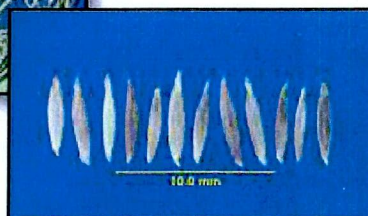
Cover Value		Forage Value	
Spring:	Good	Spring:	Excellent
Summer:	Good	Summer:	Fair
Fall:	Fair	Fall:	Good
Winter:	Poor	Winter:	Fair
		Regrowth:	Good

# Green Needlegrass

**G**reen needlegrass is native to North America and abundant on loamy ecological sites in mid- to high-seral plant community conditions. It is adapted to grow on most loam, sandy loam and clay loam ecological sites. It is a cool-season grass that grows 16 to 24 inches tall, depending

on soil type and region, with good yields when sufficient moisture is available. It is considered a very palatable grass, used primarily for pasture and rangeland.

Green needlegrass is a perennial bunch-type grass used for revegetating loamy soils, conservation plantings and, to a limited degree, hay land. It has good seedling vigor and is easy to establish with proper seedbed preparation. The plant remains palatable to livestock as it matures. Palatability for hay is good to excellent, depending on stage of maturity when harvested. Green needlegrass often is seeded with western wheatgrass, slender wheatgrass, switchgrass and big bluestem in a mixture for native grass reclamation.



### Herbage Production

Green needlegrass makes fair to good hay and good to excellent pasture in areas where moisture is fair to excellent. Similar yields were recorded in the original study between both green needlegrass varieties (Lodorm and SD-93) on field trials from Fort Pierre, S.D., in all five years. No differences were found between both varieties at the Hettinger, N.D., site in all five years. The five-year mean production was 1,495 and 1,231 lb/ac for Lodorm and SD-93, respectively, near Hettinger. The five-year mean production was 1,141 and 1,003 lb/ac for Lodorm and SD-93, respectively, near Fort Pierre.

When growing season precipitation was greater than 16 inches, cumulative herbage production in the GPNS for Lodorm was 3,932 lb/ac and it ranked as the 15th most productive grass in this study. In a dry year when growing season moisture was less than 11 inches, cumulative production was 1,680 lb/ac, and it was 2,080 lb/ac when growing season moisture was about 14 inches. Lodorm ranked 15th, 16th and 17th among the 20 cool-season grass varieties studied in 1995 through 1997. Lodorm was considered below average for productivity among all grasses studied, irrelevant of moisture conditions. Green needlegrass is an excellent grass for native plant reclamation areas and re-established pasture and rangeland with annual precipitation of 14 to 24 inches.

### Growth Patterns

Lodorm is a slow-growing cool-season grass in the spring, producing 33 percent of its total growth by June 1. Much of the plant's growth occurs in June, with more than 47 percent of its growth occurring in this month. Peak production occurs from late July to late August, with much of the standing biomass maintained through early October. Green needlegrass would make good pasture for late spring and summer grazing (early June to early October), based on plant growth, nutritional quality and palatability. Green needlegrass would make fair to good hay if harvested by early July; however, production was low, compared with other exotic grasses.

### Nutritional Quality

Lodorm was high in crude protein content (CP) during the vegetative growth stages in May and early June. However, by the seed-set stage of development, CP was below 10 percent and it was below 7 percent by late July in the maturing plant. The CP of the mature plant dropped below 5 percent by mid-August and about 3 percent when fully mature.

Total digestible nutrients (TDN) were above 55 percent until late July during seed development. TDN never dropped below 50 percent until early October, when TDN content was 48.9 percent. Both CP and TDN were low in the mature plants in mid-July, dropping below the requirement of a lactating 1,200-pound cow at this time in the mature growth phase.

## Green needlegrass

Releases	Date Released	Origin	Statement of Use
<b>AC Mallard Ecovar</b>	2002	Alberta, Saskatchewan, Canada	No major differences compared with other varieties.
<b>Lodorm</b>	1970	North Dakota	Selected for low seed dormancy. No other distinguishing traits from other varieties. Comparable in forage and seed yields.
<b>SD-93</b>	Experimental	South Dakota	Similar to Lodorm.

## Fiber

Green needlegrass was similar to all other cool-season grasses, with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) of Lodorm increased linearly throughout the growing season, ranging from 29 percent in the 2.5-leaf stage to 47 percent by early October.

Lodorm ranked 15th out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, green needlegrass would rank as a below-average fiber producer when compared with other cool-season grasses. Harvesting maximum levels of fiber from Lodorm will occur from late July to early October, averaging peak production of 988 pounds of ADF per acre in late August. Green needlegrass was one of the few grasses to maintain a peak from late July through October. Green needlegrass would be considered a moderately efficient cool-season grass, reaching peak herbage and fiber production in late July and maintaining TDN content at or above the minimum levels of a lactating cow through late July.

## Performance Characteristics

Lodorm and SD-93 were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. Emergence was rated good and stand density counts were comparable with other high-rated species. Weed competition was rated moderately high at both locations. Stand ratings were good. They had no disease problems. Seed production and vigor were rated good at both sites.

## Salinity Tolerance

The PLANTS database (USDA NRCS 2003) rated green needlegrass as medium for salinity tolerance. For comparison, tall wheatgrass and slender wheatgrass are rated as high and alfalfa is rated as low. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates green needlegrass as having a fair salt tolerance, based on the sodium adsorption ratio (SAR) values.

## Grazing Value

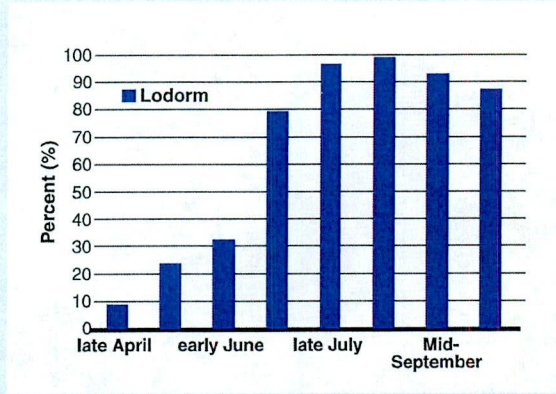
Green needlegrass would provide good grazing from early June through early October without damaging the vigor or stand quality under proper grazing management strategies. Only 33 percent of the potential plant growth occurs by early June, with peak herbage production occurring from late July through mid-September. Lodorm grows most vigorously in June, with more than 47 percent of its growth occurring in this month. Lodorm retains more than 88 percent of the standing crop into early October. When comparing growth patterns and nutritional value, livestock grazing from early June through mid-August will optimize quality and production if plants are allowed to mature. If immature tillers are maintained throughout the growing season, crude protein and total digestible nutrients will be adequate until early October for a lactating 1,200-pound cow, depending on regrowth.

**Recommended Grazing Season:  
early June through early October.**

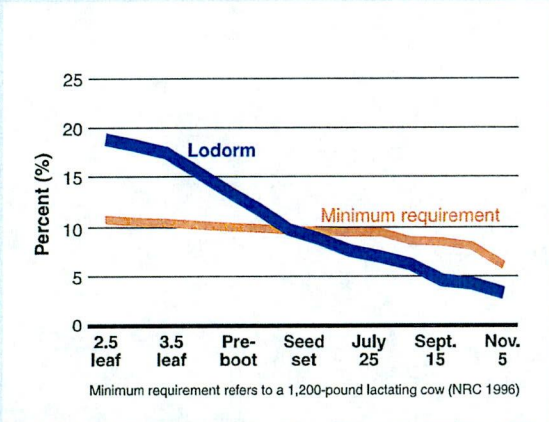
## Hay Value

Green needlegrass will make fair to good hay if harvested before the seed-set stage; however, only 65 percent to 75 percent of its growth will occur by this growth stage. Also, green needlegrass is classified as a midstature plant, with much of the foliage produced close to the ground surface, leaving a higher than desired level of unharvestable forage. Green needlegrass

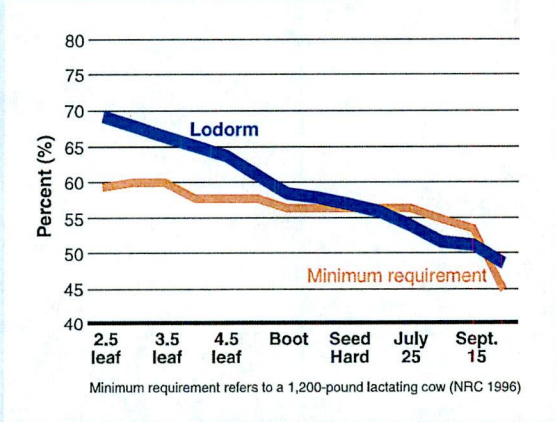
# Green needlegrass



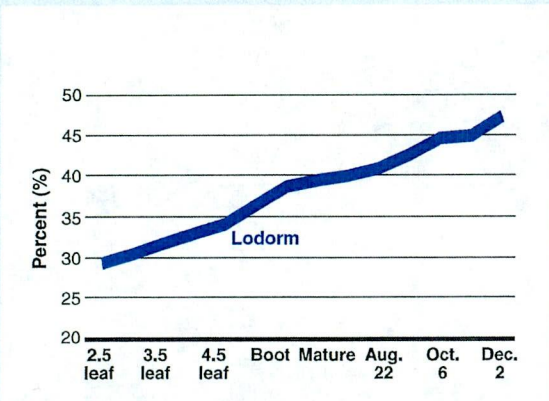
Percent of average peak standing biomass (2,564 lb/ac) for green needlegrass



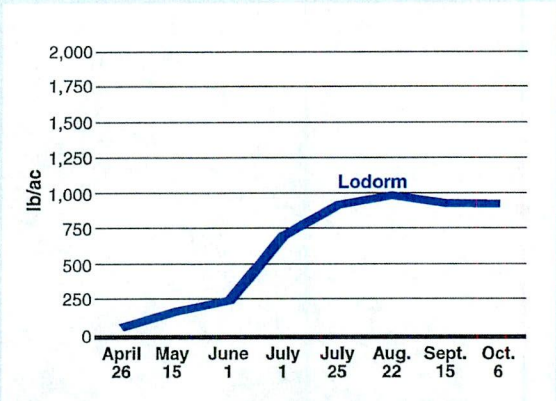
Crude protein content of green needlegrass



Total digestible nutrient content for green needlegrass



Acid detergent fiber content of green needlegrass



Pounds of acid detergent fiber produced per acre for each period of green needlegrass

is generally not recommended for hay as a monoculture; however, it could be used in a seed mixture. Green needlegrass should be cut by the third week in June to maintain good CP (9 percent to 10 percent) and TDN (> 55 percent) for winter feed and early to mid-July to maintain minimum CP levels for nonlactating animals. When optimizing quality with production (lb + CP), green needlegrass should be harvested by late June to optimize harvest efficiency.

**Recommended Haying Time: not highly recommended; early to mid-July for a nonlactating ration and optimum quality and production; third week in June for a lactating ration, optimum quality and lower production.**

**Wildlife Value**

Green needlegrass is a below-average producing grass in dry and wet years, compared with other cool-season grasses. This grass will provide good cover all year due to its upright structure and standing residue. Green needlegrass provides medium-sized structure that is retained into the winter months, providing some winter cover for many birds, and small and midsized mammals. Used in combination with native forbs, it provides structural diversity and insect populations for brood habitat.

Green needlegrass is a palatable grass in the spring and summer, becoming less palatable as it matures. This grass will provide a high feed value for foraging animals in the spring and early summer, moderate in midsummer and fair into the dormant season, depending on plant maturation. It has limited use for native pollinators. Many birds and small mammals use the seeds.

Cover Value	
Spring:	Good
Summer:	Excellent
Fall:	Good
Winter:	Fair

Forage Value	
Spring:	Excellent
Summer:	Good
Fall:	Good
Winter:	Fair
Regrowth:	Good



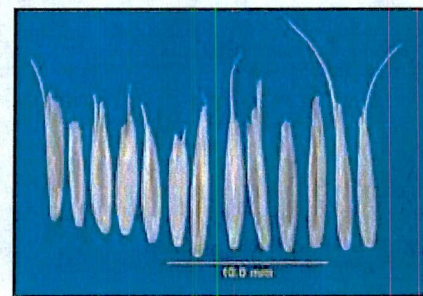
# Bluebunch Wheatgrass

**B**luebunch wheatgrass is native to North America and found on shallow and thin soils in xeric (dry) regions. It is adapted to grow on most dry soils. It is a cool-season grass that grows 12 to 24 inches tall, depending on soil type. It is considered a palatable wheatgrass, used primarily for pasture and rangeland.

Bluebunch wheatgrass is a perennial bunch grass used for revegetating native sites in drier climates. Bluebunch wheatgrass hybrid is used for revegetating alkaline and saline soils for grazing purposes. It has fair seedling vigor and needs one to two growing seasons to establish. The plant, especially the hybrid variety, becomes somewhat coarse and less palatable to livestock as it matures. Palatability for hay is good, depending

on stage of maturity when harvested. Bluebunch wheatgrass often is seeded with little bluestem, blue grama and green needlegrass in a mixture for native grass reclamation.

Bluebunch wheatgrass



### Herbage Production

Bluebunch wheatgrass makes fair hay and good to excellent pasture in areas where moisture is fair to good. The bluebunch and quackgrass (*Agropyron repens*) hybrid (NewHy) is more adapted to other ecological sites and moisture regimes. Similar yields were recorded in the original study among all bluebunch wheatgrass varieties, including the quackgrass hybrids (Goldar, Secar and NewHy) in field trials from Fort Pierre, S.D., in all years. All three varieties died by the third year of the study near Fort Pierre. No differences were found

among the three varieties at the Hettinger, N.D., site in all five years. The five-year mean production was 1,471, 1,431 and 1,395 lb/ac for Goldar, NewHy and Secar, respectively, near Hettinger. The two-year mean production was 166, 137, and 125 lb/ac for Secar, Goldar and NewHy, respectively, near Fort Pierre.

When growing season precipitation was greater than 16 inches, cumulative herbage production at the GPNS for bluebunch wheatgrass (Goldar) was 3,988 lb/ac and it ranked as the 15th most productive grass in this study. In a dry year when growing season moisture was less

### Bluebunch wheatgrass

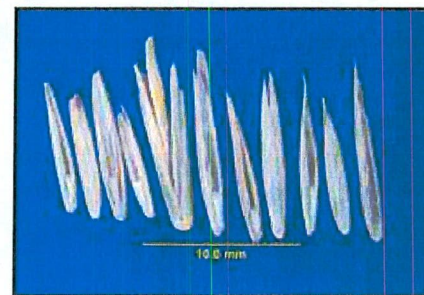
Species	Release	Date Released	Origin	Statement of Use
<i>Pseudoroegneria spicata ssp spicata</i>	<b>Anatone</b>	2003	Washington	Rapid establishment. High forage production. Ability to survive and thrive under dry conditions at or above 10 inches of rainfall.
<i>Pseudoroegneria spicata ssp spicata</i>	<b>P-7 Selected Germplasm</b>	2001	Idaho, Nevada, Oregon, Utah, Washington, and British Columbia, Canada	High genetic diversity.
<i>Elytrigia repens var repens x Pseudoroegneria spicata</i>	<b>NewHy hybrid</b>	1993	ARS, Logan, Utah	A hybrid-hybrid cross of bluebunch wheatgrass and quackgrass. More upright and significantly less rhizomatous than quackgrass. Tolerates heavier grazing pressure than bluebunch wheatgrass. Excellent palatability. Salinity tolerance similar to tall wheatgrass. Protein content and digestibility is equivalent or superior to other wheatgrasses.
<i>Pseudoroegneria spicata ssp spicata</i>	<b>Goldar</b>	1989	Washington	Rapid establishment. High forage production. Drought tolerant but grows best in areas receiving 12 inches or greater rainfall.
<i>Elymus wawawainsis</i>	<b>Secar</b>	1980	Idaho	Originally misidentified as bluebunch wheatgrass. It recently has been identified as a Snake River wheatgrass. Fair to good seedling vigor. One of the most drought-tolerant native perennial grasses available. Can survive with 8 inches of rainfall.
<i>Pseudoroegneria spicata ssp inermis</i>	<b>Whitmar</b>	1946	Washington	Good seedling vigor, long lived, drought tolerant. High forage and seed yields. Performs best in areas receiving 12 inches or greater rainfall.

than 11 inches, cumulative production was 1,920 lb/ac, and it was 3,412 lb/ac when growing season moisture was about 14 inches. Goldar ranked 15th, fifth and 14th among the 20 cool-season grass varieties studied in 1995 through 1997. Goldar was considered below average for productivity among all grasses studied in wet and dry years and above average during the 14-inch growing season moisture condition.

When growing season precipitation was greater than 16 inches, cumulative herbage production at the GPNS for NewHy was 3,508 lb/ac and it ranked as the 18th most productive grass in the trial. In a dry year when growing season moisture was less than 11 inches, cumulative production was 1,720 lb/ac, and it was 2,188 lb/ac when growing season moisture was about 14 inches. NewHy ranked 18th, 15th and 15th among the 20 cool-season grass varieties studied in 1995 through 1997. NewHy was considered below average for productivity among all grasses studied in this trial, irrelevant of moisture conditions.

Bluebunch wheatgrass will provide an excellent grass for native plant reclamation areas and re-establishment of pasture and rangeland with annual precipitation of 8 to 16 inches. NewHy will provide an excellent grass for reclamation areas and pasture development in saline and alkaline sites with annual precipitation of 14 to 22 inches.

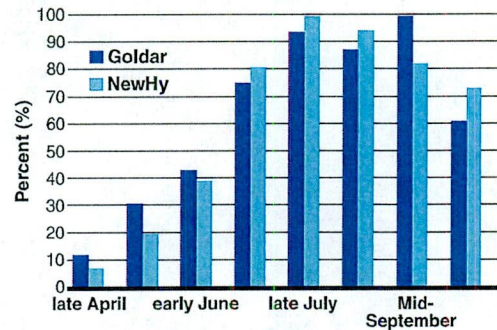
**Bluebunch wheatgrass  
hybrid (NewHy)**



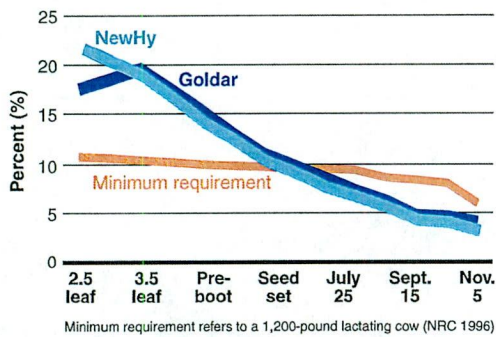
### Growth Patterns

Goldar is a moderately aggressive spring growing cool-season grass, producing slightly more than 30 percent of its total growth by mid-May and more than 43 percent of its total growth by early June. NewHy is slower to grow in early May, reaching similar growth potential by early June. Both Goldar and NewHy reach about 80 percent of their growth potential by early July, peaking in late July through mid-September. Bluebunch wheatgrass would make good pasturage for late spring and summer grazing (early June to early October), based on plant growth, nutritional quality and palatability.

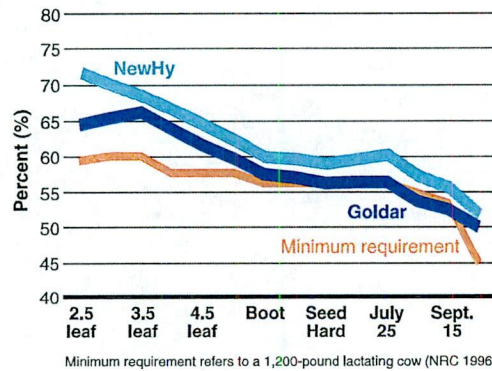
# Bluebunch Wheatgrass



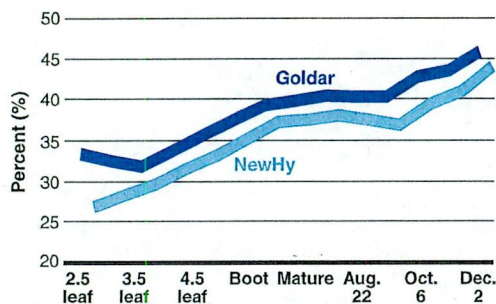
Percent of average peak standing biomass for bluebunch wheatgrass Goldar (3,107 lb/ac) and bluebunch wheatgrass/quackgrass hybrid NewHy (2,472 lb/ac)



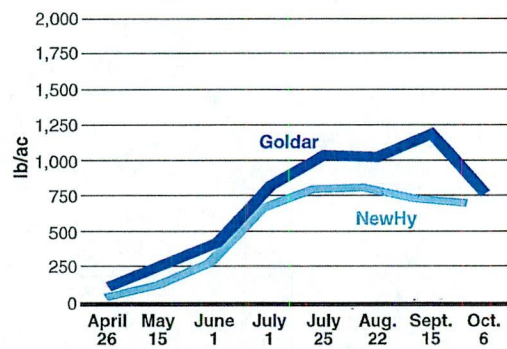
Crude protein content of bluebunch wheatgrass and bluebunch wheatgrass/quackgrass hybrid



Total digestible nutrient content for bluebunch wheatgrass and bluebunch wheatgrass/quackgrass hybrid



Acid detergent fiber content of bluebunch wheatgrass and bluebunch wheatgrass/quackgrass hybrid



Pounds of acid detergent fiber produced per acre for each period of bluebunch wheatgrass and bluebunch wheatgrass/quackgrass hybrid

Bluebunch wheatgrass would make fair to good hay if harvested by late June or early July; however, production was low, compared with exotic grasses.

### Nutritional Quality

Goldar and NewHy were very similar in nutritional quality - high in crude protein content (CP) - during the vegetative growth stages in May and early June. However, by the seed-set stage, CP was below 10 percent, and it was below 7 percent by late July when mature. The CP of the mature plant dropped below 5 percent by mid-August and below 4 percent when fully mature.

Both Goldar and NewHy maintained total digestible nutrients (TDN) above 55 percent until late August or mid-September. Total digestible nutrients never dropped below 50 percent through early October. Although CP was low by mid-July in mature plants, TDN remained high through early October or later.

### Fiber

Goldar and NewHy were similar to all other cool-season grasses, with fiber content lowest at the 2.5- to 3.5-leaf stages, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) increased linearly throughout the growing season after the four-leaf stage, ranging from 29.5 percent in the vegetative stage to 49.5 percent by early October.

Goldar ranked ninth and NewHy 18th out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, bluebunch wheatgrass would rank as an average fiber producer and NewHy a poor fiber producer when compared with other cool-season grasses. Harvesting maximum levels of fiber from bluebunch wheatgrass will occur in mid-September, averaging peak production of 1,184 pounds of ADF per acre, respectively. Harvesting maximum levels of fiber from NewHy will occur from late July to late August, averaging peak production of 795 to 806 pounds of ADF per acre, respectively. Goldar and NewHy would be considered moderately efficient cool-season grasses,

reaching peak herbage and fiber production in late July through mid-September, maintaining TDN content at or slightly below the minimum levels of a lactating cow through early October and CP above the minimum levels of a lactating cow through mid-August, depending on maturation.

### Performance Characteristics

Goldar, Secar and NewHy were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. NewHy is a hybrid between bluebunch wheatgrass and quackgrass. All three varieties established fairly well and were very similar in most performance characteristics, with good stand density counts and stand ratings at the Hettinger location. They had no disease problems. Goldar and Secar established more quickly on the lighter soils at the Hettinger site, compared with the heavy clay soil at the Fort Pierre site, where stand densities and ratings were low and weed competition rated high. The hybrid NewHy performed much better at the Fort Pierre site, compared with Goldar and Secar. Seed production was better for NewHy.

### Salinity Tolerance

Salinity tolerance for bluebunch wheatgrass is rated as low by the PLANTS database (USDA NRCS 2003). For comparison, tall wheatgrass and slender wheatgrass are rated as high and alfalfa is rated as low. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates bluebunch wheatgrass as having a poor salt tolerance, based on the sodium adsorption ratio (SAR) values. However, the NewHy hybrid has half the parentage of quackgrass, and the Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated NewHy as very high for salt tolerance, with an electroconductivity (EC) measurement of 13 to 26 millimhos per centimeter (mmhos/cm), which was the same as for beardless wildrye and tall wheatgrass. Section IV of the North Dakota NRCS Field Office Technical Guide rates NewHy as having good salt tolerance, based on the SAR values.

### Grazing Value

Bluebunch wheatgrass and NewHy would provide good grazing from early June through early October without damaging the vigor or stand quality under proper grazing management strategies. About 40 percent of the potential plant growth occurs by early June, with peak herbage production occurring from late July through mid-September. Bluebunch wheatgrass and NewHy grow most vigorously in May and June, with 60 percent to 70 percent of the growth occurring in these months. Bluebunch wheatgrass retains 60 percent to 70 percent of the peak standing crop into early October. When comparing growth pattern and nutritional value, livestock grazing from early June through mid-August will optimize quality and production if plants are allowed to mature. If immature tillers are maintained throughout the growing season, CP and TDN will be adequate until early October for a lactating 1,200-pound cow, depending on regrowth.

**Recommended Grazing Season:**  
early June through early October.

### Hay Value

Bluebunch wheatgrass will make fair to good hay and NewHy good hay if harvested before the seed-set stage, with 60 percent to 80 percent of plant growth occurring by this growth stage. Bluebunch wheatgrass is classified as a midstature plant, with much of the foliage close to the ground surface, leaving a higher than desired level of unharvestable forage. Bluebunch wheatgrass is generally not recommended for hay as a monoculture; however, it could be used in a seed mixture. NewHy could be used as a monoculture for hay in site-specific situations. Bluebunch wheatgrass and NewHy should be cut by the third week in June to maintain good CP (9 percent to 10 percent) and TDN (> 55 percent) for winter feed and early to mid-July to maintain minimum CP levels for nonlactating animals. When optimizing quality with production (lb + CP), bluebunch wheatgrass and NewHy should be harvested by late June to optimize harvest efficiency.

**Recommended Haying Time:** bluebunch wheatgrass is not highly recommended; however, NewHy would be recommended in high-saline areas. Harvest by early to mid-July for a nonlactating ration and optimum quality and production; third week in June for a lactating ration, optimum quality and lower production.

### Wildlife Value

Bluebunch wheatgrass and NewHy were average-producing grasses in dry and wet years, compared with other cool-season grasses. Bluebunch wheatgrass provides good cover on upland ecological sites all year due to its upright structure and standing residue. Bluebunch wheatgrass provides medium-sized structure that is somewhat retained into the winter months, providing some winter cover for many birds, and small and midsized mammals. Used in combination with forbs and legumes, Bluebunch wheatgrass and NewHy will provide structural diversity and insect populations for brood habitat.

Bluebunch wheatgrass and NewHy are palatable grasses in the spring and summer, becoming less palatable as they mature. These grasses will provide a high feed value for foraging animals in the spring and early summer, moderate in midsummer and fair into the dormant season. They have limited use for native pollinators. Many birds and small mammals use the seeds.

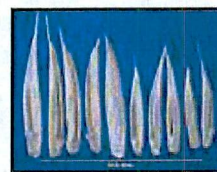
Cover Value		Forage Value	
Spring:	Good	Spring:	Excellent
Summer:	Excellent	Summer:	Good
Fall:	Good	Fall:	Good
Winter:	Fair	Winter:	Fair
		Regrowth:	Fair

# Crested Wheatgrass

Crested wheatgrass was introduced into the United States in 1906 from Russia and Siberian steppe habitats. The scientific name of crested wheatgrass is *Agropyron cristatum* (L.) Gaertn. (Poaceae). Wheatgrasses (Triticeae), including crested wheatgrass, frequently hybridize and often produce fertile crosses. Crested wheatgrass readily crosses with desert wheatgrass (*A. desertorum*) to produce fertile hybrids such as the variety HyCrest. Some taxonomists do not consider crested and desert wheatgrass to be distinct species.

Crested wheatgrass is a long-lived bunch grass used extensively for hay, pastureland and soil conservation. It has excellent seedling vigor and ease of establishment. The fairway types (e.g., Ephraim) are shorter, leafier and have fewer tendencies to form large clumps with age. Fairway types frequently are recommended for dryland lawns in areas receiving less than 13

inches of precipitation. Standard types (e.g., Nordan) tend be more productive than fairway types; however, they become clumpy under a haying program. HyCrest is a type of hybrid crested wheatgrass obtained by crossing standard and fairway types.



**Standard**  
(5 on left)  
and **Fairway**  
(5 on right)

## Crested wheatgrass

Type	Species	Release	Date Released	Released by	Statement of Use
Fairway	<i>Agropyron cristatum</i>	<b>NU-ARS-AC2</b>	2002	ARS, Lincoln, Neb.	Greater average forage yields than other fairway types of crested wheatgrass. Yields equaled that of standard types of crested wheatgrass varieties. Averages 6 inches shorter in height than standard types of crested wheatgrass. Recommended for pasture and hay land.
Fairway	<i>Agropyron cristatum</i>	<b>RoadCrest</b>	1998	ARS, Logan, Utah	Significantly more rhizomatous than Ephraim. Recommended for use in low-maintenance turf applications.
Hybrid	<i>Agropyron cristatum x desertorum</i>	<b>HyCrest II</b>	1996	ARS, Logan, Utah	Increased growth characteristics under cold temperatures. Replaces the variety HyCrest.
Fairway	<i>Agropyron cristatum</i>	<b>Douglas</b>	1994	ARS, Logan, Utah	Larger seed sizes than other varieties. Excellent seedling vigor. Produces less forage than other varieties but is leafier and remains green longer into the growing season. Requires 13 to 14 inches or more of annual precipitation. Not recommended for turfgrass applications.
Hybrid	<i>Agropyron cristatum x desertorum</i>	<b>HyCrest</b>	1984	ARS, Logan, Utah	Easier to establish than standard or fairway types. Long-term production exceeds fairway types and equal to standard types of crested wheatgrass. Leaves and stems are coarser and more abundant than fairway types.
Fairway	<i>Agropyron cristatum</i>	<b>Ephraim</b>	1983	FS, Provo, Utah	Recommended for low-maintenance turf. Rhizomatous spreading roots form dense sod.
Fairway	<i>Agropyron cristatum</i>	<b>Ruff</b>	1974	ARS, Lincoln, Neb.	Rapid seed germination and easily established. Forage yields similar to Nordan. Superior resistance to root rot.
Fairway	<i>Agropyron cristatum</i>	<b>Parkway</b>	1969	Canada Dept. of Ag., Saskatoon, Saskatchewan	Good seed production and lodging resistance. Not recommended for turf applications. Recommended for hay and pasture seedings.
Standard	<i>Agropyron desertorum</i>	<b>Nordan</b>	1953	ARS, Mandan, N.D.	Very good forage yields. Good seedling vigor and very good drought tolerance.
Standard	<i>Agropyron desertorum</i>	<b>Summit</b>	1953	Canada Dept. of Ag., Saskatoon, Saskatchewan	Good seed yield and seed quality. Similar to other standard types.

## Herbage Production

Crested wheatgrass makes excellent hay and pasture in areas where moisture is low to good and on many types of soils. Similar yields in the original study were recorded between the standard varieties (Nordan and Summit) of crested wheatgrass on field trials from Hettinger, N.D., and Fort Pierre, S.D. Similar yields were recorded among the fairway varieties (Parkway, Ephraim and Ruff) on field trials from Hettinger; however, Parkway was superior at Fort Pierre. The standard varieties were the superior-producing crested wheatgrasses, followed by the fairway/standard cross (HyCrest). The fairway varieties were lower producing among the crested wheatgrass varieties at both Hettinger and Fort Pierre, with the exception of Parkway at Fort Pierre. A five-year mean production was 2,012 and 1,919 lb/ac for Summit and Nordan at Hettinger, respectively, and 1,380 and 1,548 lb/ac at Fort Pierre, respectively. A five-year mean production was 1,391, 1,271 and 1,057 lb/ac for Ruff, Ephraim and Parkway at Hettinger, respectively, and 1,137, 1,107 and 1,614 lb/ac at Fort Pierre, respectively. The five-year mean production was 1,521 and 1,580 lb/ac for HyCrest at Hettinger and Fort Pierre, respectively. NU-ARS AC2 had the highest five-year mean production of the fairway wheatgrasses at Fort Pierre (1,647 lb/ac) and Hettinger (1,803 lb/ac).

In the GPNS, cumulative production was 3,268 lb/ac for Ephraim, 4,492 lb/ac for HyCrest and 4,948 lb/ac for Nordan when growing season precipitation was greater than 16 inches. In a dry year when growing season moisture was less than 11 inches, cumulative herbage production was reduced by 4 percent for Nordan, 15 percent for HyCrest and 30 percent for Ephraim, compared with a normal year of precipitation. During this normal year of precipitation, cumulative production ranged from 3,388 lb/ac for Nordan and 3,028 lb/ac for Ephraim to 2,480 lb/ac for HyCrest. All three varieties appear to be drought tolerant or water efficient; however, Nordan and HyCrest were more productive when moisture conditions were above average. Development of pasture or hay land with crested wheatgrass would be recommended in areas with fair to good moisture conditions and growing season precipitation ranging from 8 to 14 inches. When growing season precipitation is greater than 14 inches, other cool-season grasses will provide greater production with similar or higher quality.

## Growth Patterns

All three varieties have vigorous growth in the spring, with 9 percent to 16 percent of total growth occurring in April and 40 percent to 46 percent of growth by late May or early June. Peak biomass production occurred for all three varieties in early July to late August, depending on moisture. Nordan and Ephraim maintained peaked standing crop levels until early October. HyCrest did not reach peak standing crop until late July, losing standing crop by mid-August, with only 50 percent of total weight remaining by early October. In comparison, both Nordan and Ephraim maintained 70 percent to 75 percent of peak standing crop in early October. All three varieties would make excellent pasture for spring and early summer grazing (early May to late June), based on growth patterns.

## Nutritional Quality

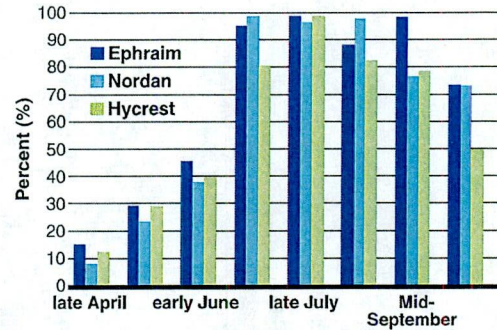
Ephraim and Nordan were 2 percent to 3 percent higher in crude protein content (CP) than HyCrest during the vegetative growth stage; however, all three varieties were similar in CP from July through November. All three varieties were at or above the 10 percent CP until the seed-set stage, dropping below 7 percent CP by the third week in July when plants were mature and cured. All three varieties had a CP of 5 percent or less by mid to late August when fully mature.

Total digestible nutrients (TDN) varied among varieties throughout the growing season; however, all three varieties were greater than 60 percent TDN through the boot stage of development. Nordan and HyCrest maintained a 55 percent TDN throughout the growing season, with all three less than 50 percent by early October.

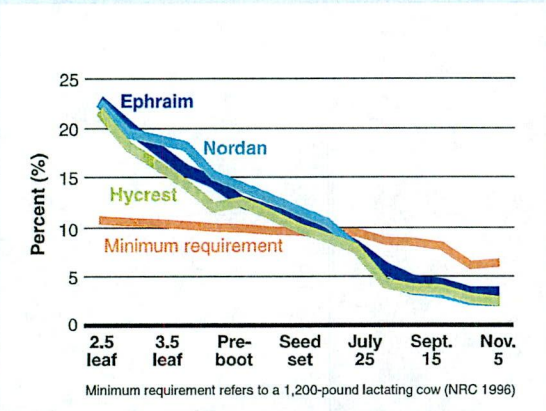
## Fiber Content

Crested wheatgrass was similar to all other cool-season grasses, with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) was similar for all three varieties (Ephraim, Nordan and HyCrest) tested during all growth stages, with the exception of the three- to four-leaf stage. ADF increased gradually throughout the growing season, with no upward or

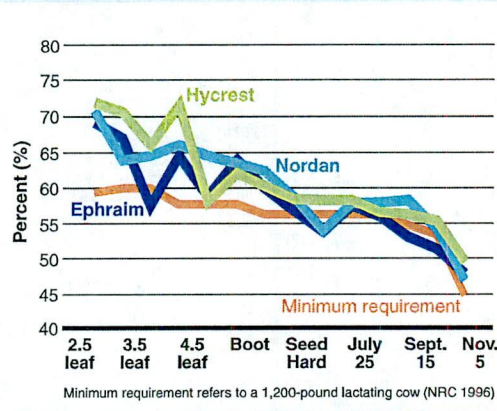
# Crested wheatgrass



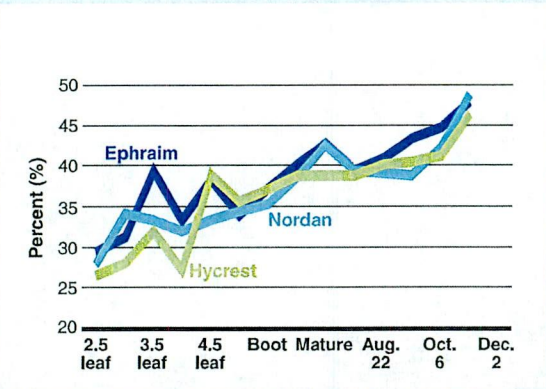
Percent of average peak standing biomass for crested wheatgrass Ephraim (2,801 lb/ac), Nordan (3,863 lb/ac) and Hycrest (3,027 lb/ac)



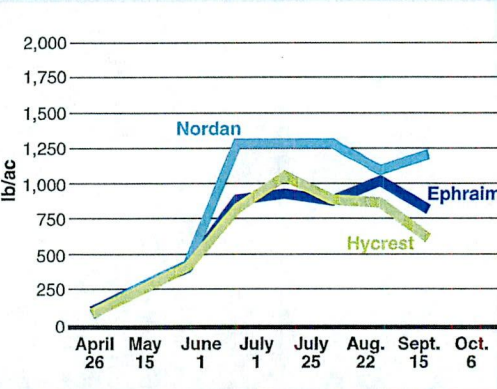
Crude protein content of crested wheatgrass



Total digestible nutrient content for crested wheatgrass



Acid detergent fiber content of crested wheatgrass



Pounds of acid detergent fiber produced per acre for each period of crested wheatgrass

downward spikes, and ranged from 26 percent to 29 percent in the 2.5-leaf stage to 46 percent to 49 percent by early October.

Nordan ranked sixth, HyCrest 11th and Ephraim 13th out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, crested wheatgrass ranks average when compared with other cool-season grasses, with the Nordan variety above average. Harvesting maximum levels of fiber occurs throughout July and into August for Nordan, averaging 1,289 and 1,287 pounds of ADF produced per acre in early July and mid-August, respectively. HyCrest peaked in late July at 1,057 pounds of ADF produced per acre, while Ephraim peaked in early July, maintaining this peak ADF production through mid-September at 1,017 lb/ac. Crested wheatgrass would be considered a moderately efficient cool-season grass, reaching peak herbage and fiber production in early July to mid-September when TDN is at or above and CP slightly to well below the minimum levels of a lactating cow.

### Performance Characteristics

Parkway, Ephraim, Ruff, Summit, Nordan, HyCrest and CD-II crested wheatgrass varieties were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. Parkway had the best emergence and stand density at Hettinger. Stand ratings and plant height all were comparable at both sites. Nordan and HyCrest were generally the tallest entries. They had no disease problems. Seed production was slightly better for Nordan, HyCrest and NU-ARS AC2. Ephraim was rated lower than the other entries for vigor and seed production.

### Salinity Tolerance

The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated crested wheatgrass as high for salt tolerance. The electroconductivity (EC) was 6 to 16 millimhos per centimeter (mmhos/cm). In comparison, beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass are rated very high and have an EC rating of 13 to 26 mmhos/cm. Alfalfa is rated low and has an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates crested wheatgrass as having a fair salt tolerance, based on the sodium adsorption ratio (SAR) values.

### Grazing Value

Crested wheatgrass, irrelevant of variety, will provide excellent grazing in May and June. When comparing growth patterns and nutritional value, livestock grazing from early May through late June will optimize forage use and nutrient content. Nordan and HyCrest provided 27 percent to 34 percent more forage than Ephraim during the high-moisture year, while Nordan provided 35 percent more forage than either Ephraim or HyCrest during the dry year. During the average-moisture year, Nordan produced greater forage, with Ephraim ranked second and HyCrest third.

Although TDN for crested wheatgrass will be adequate throughout much of the growing season (Ephraim will become deficient by mid-August if vegetative plants are limited), crude protein will become deficient by mid-July. To optimize forage quality with growth, terminate livestock grazing by late June or early July.

**Recommended Grazing Season:  
early May to mid-June.**

### Hay Value

Crested wheatgrass will make good hay because of its high palatability and quality when harvested at the proper time. Nordan and HyCrest, based on the findings from this study, would be recommended over Ephraim because of the more productive, taller plants. Crested wheatgrass should be cut by the third week in June to maintain good CP (9.5 percent to 11 percent) and TDN (> 59 percent) for winter feed and early July to maintain highest quantity and provide the minimum CP levels for nonlactating animals.

Harvest efficiency was different among the three varieties studies. When optimizing quality with production (lb + CP), all varieties should be harvested by late June to optimize harvest efficiency. Nordan was 8 percent and 16 percent more efficient than Ephraim and HyCrest, respectively, in capturing CP and production (lb of CP/acre) in this study.

**Recommended Haying Time: late June or early July for a nonlactating ration and optimum quality and production; mid to third week in June for a lactating ration, optimum quality and lower production.**

### Wildlife Value

Crested wheatgrass was moderately to highly productive in normal to wet years, depending on variety, compared with other cool-season grasses, and good producing in dry years. All three varieties will provide good cover in the spring due to its vigorous spring growth; however, Nordan and Ephraim will provide better cover in the fall, with only a 25 percent loss from peak standing crop, compared with 50 percent for HyCrest. Nordan and HyCrest produce taller, dense clumps that will maintain height and structure during the winter months. Its use for grassland nesting birds is relatively limited since it often exists in a monoculture, thus lacking structural diversity. The inability to maintain forbs and legumes in a mix with crested wheatgrass limits the production of insects important for brooding habitat.

Crested wheatgrass does remain rigid into winter; however, its short stature and monoculture tendencies limit its winter cover use for many wildlife species. Crested wheatgrass is a very palatable grass that provides good growth in the spring and lush regrowth in the fall. This growth provides a high feed value for some foraging animals, especially deer in the spring and fall, and occasionally in summer months when moisture is sufficient for regrowth. It has limited use for native pollinators. Seeds are of limited use.

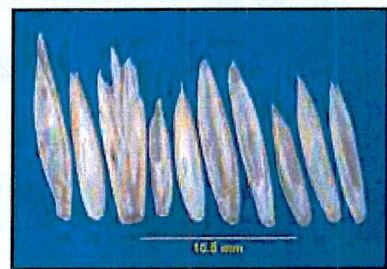
Cover Value		Forage Value	
Spring:	Fair	Spring:	Excellent
Summer:	Fair	Summer:	Fair
Fall:	Fair	Fall:	Good
Winter:	Poor	Winter:	Poor
		Regrowth:	Fair

# Intermediate Wheatgrass

Intermediate wheatgrass was introduced into the United States in the mid-1900s from Russia. It has proven to be well-adapted to the Central Great Plains and Pacific Northwest regions. It is less hardy and drought resistant than crested wheatgrass; however, it is more productive when moisture is average to high. It is slower to grow in the spring, producing most of its growth in June and July.

Intermediate wheatgrass is a vigorous, fast-growing, moderately long-lived, sod-forming grass used extensively for hay, pastureland and soil conservation. The pubescent wheatgrass varieties are reported to be more drought tolerant and form a sod more rapidly than the intermediate varieties. Intermediate and pubescent wheatgrass are considered the same species. They have excellent seedling vigor and ease of

establishment, and are fast growing. Intermediate wheatgrass was and continues to be common grass used in Conservation Reserve Program plantings in the Northern Great Plains region.



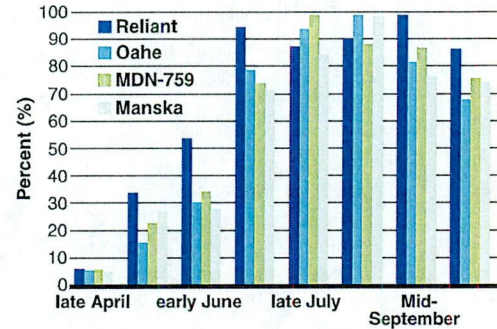
## Intermediate wheatgrass

Type	Species	Release	Date Released	Released by	Statement of Use
Intermediate	<i>Thinopyrum intermedium</i>	<b>Manifest</b>	2007	ARS, Mandan, N.D.	Excellent stand establishment with improved forage yields and improved persistence because of higher tiller densities.
Intermediate	<i>Thinopyrum intermedium</i>	<b>Haymaker</b>	2003	ARS, Lincoln, Neb.	High forage yields. Forage quality less than Beefmaker but similar to that of other varieties. Taller than most other intermediate wheatgrass varieties.
Intermediate	<i>Thinopyrum intermedium</i>	<b>Beefmaker</b>	2003	ARS, Lincoln, Neb.	Forage yields less than Haymaker but similar to yields of other released varieties. Good forage quality.
Intermediate	<i>Thinopyrum intermedium</i>	<b>Rush</b>	1994	Idaho AES and USDA-SCS, Aberdeen, Idaho	Superior seedling emergence and vigor. Good rate of spread by rhizomes. High forage and seed production. Largest seed of the intermediate wheatgrasses. Not adapted to hay land mixes with alfalfa. Did not perform well in trials at Bismarck, N.D.
Intermediate	<i>Thinopyrum intermedium</i>	<b>Reliant</b>	1991	ARS, Mandan, N.D.	Improved forage production, seed production, forage quality and winter survival. Improved seedling vigor and resistant to leaf spot. Late maturing. Recommended for hay land containing alfalfa as part of the mix.
Intermediate	<i>Thinopyrum intermedium</i>	<b>Clarke</b>	1980	Ag. Canada, Swift Current, Saskatchewan	Drought-tolerant, winter-hardy variety. High seed yields.
Intermediate	<i>Thinopyrum intermedium</i>	<b>Slate</b>	1969	Nebraska AES	Strong rhizomatous spread, broad flat leaves, erect form, slate green.
Intermediate	<i>Thinopyrum intermedium</i>	<b>Chief</b>	1961	Ag. Canada, Saskatoon, Saskatchewan	High seed yields. High forage quality recommended for hay land in mixes with alfalfa. Short-term pasture. Remains productive for 5 years under heavy grazing pressure.
Intermediate	<i>Thinopyrum intermedium</i>	<b>Oahe</b>	1961	South Dakota AES	Bluish green. Good seedling vigor. Drought tolerant. High seed yields. Rhizomatous traits.
Intermediate	<i>Thinopyrum intermedium</i>	<b>Tegmar</b>	1968	USDA-SCS, Aberdeen, Idaho	Dwarf growth form (half the height of other varieties). Long lived, late maturing, vigorous seedlings. Rapidly developing rhizomes. Drought tolerant.

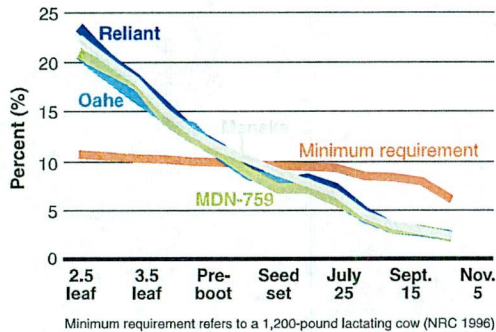
## INTERMEDIATE WHEATGRASS

Type	Species	Release	Date Released	Released by	Statement of Use
Intermediate	<i>Thinopyrum intermedium</i>	<b>Amur</b>	1952	New Mexico AES	Leafy, vigorous growth, strong seedling vigor. Good seed production. Slow sod former. Replaced by other varieties that are more widely adapted and have better forage production.
Intermediate	<i>Thinopyrum intermedium</i>	<b>Greenar</b>	1945	Washington, Idaho, Oregon, AESs	Leafy, broadleafed variety. Late maturing and high forage production. Moderate sod yields.
Pubescent	<i>Thinopyrum intermedium</i> spp. <i>trichophorum</i>	<b>Manska</b>	1992	ARS, Mandan, N.D.	Improved vigor, high forage and seed production. High nutritional quality is the primary advantage over other varieties. Resistant to leaf spot. Recommended for hay land containing alfalfa in mix and pasture.
Pubescent	<i>Thinopyrum intermedium</i> spp. <i>trichophorum</i>	<b>Greenleaf</b>	1966	Canada Dept. of Ag., Lethbridge, Alberta	Higher forage yields than Topar. Improved seedling vigor over Mandan 759. Winter hardy. Stands will not maintain high productivity under continuous heavy grazing.
Pubescent	<i>Thinopyrum intermedium</i> spp. <i>trichophorum</i>	<b>Luna</b>	1963	USDA-SCS, Los Lunas, N.M.	Excellent seedling vigor, fast establishment. Good forage production. One of the most broadly adapted pubescent wheatgrasses available and performs well from the central to northern Great Plains to the northern Rockies and Sierra Nevada region.
Pubescent	<i>Thinopyrum intermedium</i> spp. <i>trichophorum</i>	<b>Topar</b>	1953	USDA-SCS, Aberdeen, Idaho	Very good seedling vigor, very rhizomatous. Seed production is moderate and seed does not shatter easily.
Pubescent	<i>Thinopyrum intermedium</i> spp. <i>trichophorum</i>	<b>Mandan 759</b>	Never officially released	ARS, Mandan, N.D.	Replaced with the variety Manska.

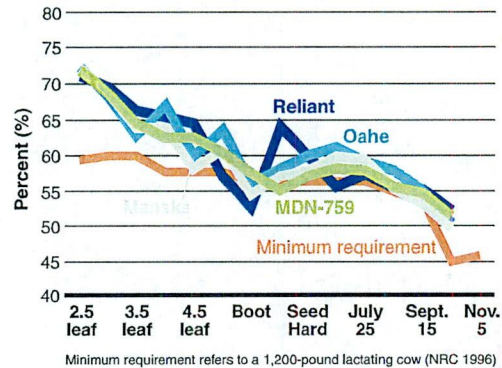
# Intermediate wheatgrass



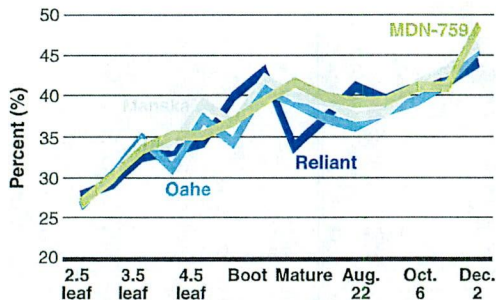
Percent of average peak standing biomass for intermediate wheatgrass Reliant (3,928 lb/ac) and Oahe (3,613 lb/ac) and pubescent wheatgrass Manska (4,244 lb/ac) and MDN-759 (3,787 lb/ac)



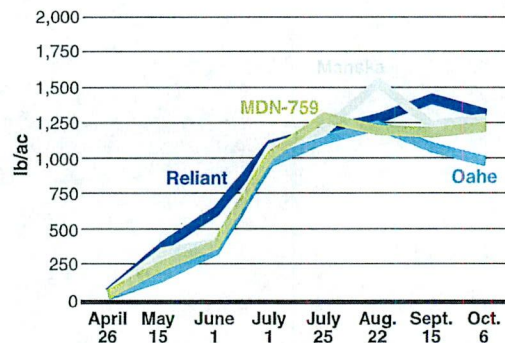
Crude protein content of intermediate (Reliant and Oahe) and pubescent wheatgrass (Manska and MDN-759)



Total digestible nutrient content for intermediate (Reliant and Oahe) and pubescent wheatgrass (Manska and MDN-759)



Acid detergent fiber content of intermediate (Reliant and Oahe) and pubescent wheatgrass (Manska and MDN-759)



Pounds of acid detergent fiber produced per acre for each period of intermediate (Reliant and Oahe) and pubescent wheatgrass (Manska and MDN-759)

## Herbage Production

Intermediate wheatgrass is a widely adapted grass that makes good hay and fair to good pasture in areas where moisture is fair to high and on many soils types. Similar yields were recorded in the original study among the intermediate (Chief, Clarke, Reliant, Oahe, Slate, Haymaker) and pubescent (Greenleaf, MDN-759, Manska) varieties on field trials from Hettinger, N.D., and Fort Pierre, S.D., except 1994 at Fort Pierre. Oahe produced more herbage than Chief and Greenleaf in 1994. A five-year mean production was 2,764, 2,715, 2,629, 2,530, 2,527, 2,337, 2,276, 2,276 and 2,103 lb/ac for Haymaker, Manska, Clarke, Chief, Reliant, Greenleaf, Oahe, MDN-759 and Slate, respectively, at Hettinger. A five-year mean production was 2,424, 2,201, 2,049, 1,950, 1,916, 1,816, 1,747, 1,679 and 1,576 lb/ac for Oahe, Haymaker, Slate, MDN-759, Manska, Reliant, Clarke, Chief and Greenleaf, respectively, at Fort Pierre.

In the GPNS, no differences were noted among all four varieties when comparing herbage production during the wet or dry year. During a nearly normal precipitation year, both pubescent wheatgrass varieties MND-759 and Manska produced greater production than the intermediate wheatgrass varieties Oahe and Reliant. When growing season precipitation was greater than 16 inches, cumulative production was 6,132 lb/ac for Reliant, 5,840 lb/ac for Manska, 5,452 lb/ac for Oahe and 5,320 lb/ac for MDN-759. In a dry year when growing season moisture was less than 11 inches, cumulative herbage production was very similar among the varieties (2,320 to 2,812 lb/ac). During the nearly normal precipitation year and with growing season moisture of about 14 inches, cumulative production was greatest with Manska at 9 percent, 26 percent and 30 percent greater than MDN-759, Reliant and Oahe, respectively.

All four varieties appear to be somewhat drought tolerant or water efficient. Development of pasture or hay land with intermediate wheatgrass would be recommended in areas with fair to good moisture conditions, with growing season precipitation 12 inches or more. When growing season precipitation is less than 12 inches, other cool-season grasses will provide greater production with similar or higher quality.

## Growth Patterns

Intermediate wheatgrass is not a vigorously growing grass in the spring; however, varietal differences did occur. Reliant was the most aggressive spring growing grass, with 35 percent of total growth occurring by mid-May and 54 percent of growth by early June. Oahe was the slowest spring growing grass, with only 16 percent of total growth occurring by mid-May and 30 percent of growth by early June. The pubescent wheatgrass varieties were moderate in spring growth vigor and very similar among varieties, with 25 percent of total growth occurring by mid-May and about 30 percent to 35 percent of growth by early June. All four varieties reached peak standing crop by late July to mid-August. Reliant and Manska retained much of their production through mid-September, with Reliant maintaining 88 percent of the peak production through early October. Oahe and MDN-759 were least effective in retaining their growth into October, with a 32 percent loss from peak standing crop by early October. Oahe appears to be less vigorous and Reliant more vigorous in May and June. Oahe would be least desirable, compared with the other varieties, for late spring or early summer pastures or hay, based on the findings from this study.

## Nutritional Quality

All four varieties were very similar in crude protein content (CP) in early vegetative growth through maturation. Reliant and MDN-759 were 1.5 percent to 2 percent higher in CP than Manska or Oahe in the boot stage through seed hardening (mid-June to mid-July). All four varieties were at or above the 10 percent CP through the boot stage, dropping below 5 percent CP by the third week in July in maturing plants. All four varieties had a CP of 4 percent or less from late August through early October.

Total digestible nutrients (TDN) were variable among all varieties throughout the growing season. All four varieties were at or above 55 percent TDN until mid-September, remaining at or near 50 percent in early October. All varieties met the minimum requirements of a lactating cow until mid-September and a dry cow until early October.

### Fiber

Intermediate and pubescent wheatgrass were similar to all other cool-season grasses, with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) was similar for all varieties (Reliant, Oahe, Manska and MDN-759) during all growth stages. ADF increased dramatically from the 2.5-leaf stage through seed set, ranging from 26 percent to 28 percent in the 2.5-leaf stage to 39 percent to 43 percent by the seed-set stage. ADF did not change from seed set (~ mid-July) through mid-September, peaking at 44 percent to 49 percent in early October.

Manska ranked third, Reliant fifth, Oahe seventh and MDN-759 eighth out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period of this study. When selecting a grass to produce maximum levels of fiber per acre, intermediate and pubescent wheatgrass would rank high when compared with other cool-season grasses, particularly Manska and Reliant, with only basin wildrye (Magnar) and tall wheatgrass (Alkar) superior to Manska. Harvesting maximum levels of fiber occurs in mid-August for Manska and Oahe and into mid-September for Reliant. The average peak production was 1,527, 1,419, 1,288 and 1,230 pounds of ADF per acre for Manska, Reliant, Oahe and MDN-759, respectively. Intermediate wheatgrass (Oahe) and pubescent wheatgrass (Manska, MDN-759) would be considered low to moderately efficient cool-season grasses, reaching peak herbage and fiber production from late July through mid-September when TDN is at or above and CP well below the minimum levels of a lactating cow. Intermediate wheatgrass (Reliant) would be considered a highly efficient cool-season grass, with aggressive spring growth when nutritional quality was high, and retaining peak production through mid-September when fiber content was greatest.

### Performance Characteristics

Chief, Clarke, Reliant, Oahe, Slate, Greenleaf, MDN-759 and Manska were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. Emergence and stand densities were similar at both sites. Slate was rated the highest for stand emergence and had the highest stand density the year of establishment at Hettinger. Reliant had the highest stand density the second growing season at Hettinger. All entries had good stand ratings. Haymaker, Reliant and Chief were among the taller entries. They had no disease problems except in 1994 at Fort Pierre. Seed production was rated as excellent for all entries in 1993, and reduced to poor to fair yields in 1994 and 1996 at Hettinger.

### Salinity Tolerance

The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated intermediate wheatgrass as moderate for salt tolerance. The electroconductivity (EC) was 6 to 12 millimhos per centimeter (mmhos/cm). In comparison, beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass are rated very high and have an EC rating of 13 to 26 mmhos/cm. Alfalfa is rated low and has an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates intermediate wheatgrass as having a fair salt tolerance, based on the sodium adsorption ratio (SAR) values.

### Grazing Value

Intermediate and pubescent wheatgrass will provide good grazing from mid-May through early July for Reliant and late May through early July for Manska, Oahe and MDN-759. When comparing growth patterns and nutritional value, livestock grazing from mid to late May through late June will optimize forage use and nutrient content; however, with a rotational grazing system, the potential to extend the nutritional quality through late September may be achieved by maintaining immature plants.

Although TDN for intermediate wheatgrass, irrelevant of variety, will be adequate throughout much of the growing season, crude protein will become deficient by mid to late July, depending on the number of plants in the vegetative growth stage. To optimize forage quality with growth, begin grazing in mid to late May and terminate grazing by mid-July. Manska and Reliant appeared to be superior varieties over Oahe and MDN-759.

**Recommended Grazing Season:  
mid to late May to mid-July.**

### Hay Value

Intermediate and pubescent wheatgrass will make good hay because of their good palatability and quality when harvested at the proper time. The Manska and Reliant varieties would be recommended over Oahe due to higher productivity, with Reliant producing more of its potential growth in June and early July, when forage quality is highest. Intermediate wheatgrass should be cut by the third week in June to maintain good CP (9.5 percent to 11 percent) and TDN (> 55 percent) for winter feed; however, less than 70 percent of the total growth is achieved by this time period. Only Reliant had produced more than 90 percent of the total growth by the third week in June. Harvest Manska, MDN-759 and Oahe in mid-July to optimize quantity of growth and quality that maintains a minimum CP level for nonlactating animals. Reliant can be harvested in early July to optimize quantity of growth and quality that maintains a minimum CP level for nonlactating animals.

Harvest efficiency was different among the four varieties studies. When optimizing quality with production (lb + CP), all varieties should be harvested in late June or early July to optimize harvest efficiency. Reliant was 7 percent, 9 percent and 16 percent more efficient than Oahe, MDN-759 and Manska, respectively, in capturing CP and production (lb of CP/acre) in this study.

**Recommended Haying Time: Reliant: early July for a nonlactating ration and optimum quality and production; the third week in June for a lactating ration, optimum quality and good production; Manska, MDN-759, Oahe: mid-July for a nonlactating ration and optimum quality and production; third week in June for a lactating ration, optimum quality and lower production.**

### Wildlife Value

Intermediate wheatgrass is highly productive in normal to wet years, compared with other cool-season grasses, and good producing in dry years. All four varieties will provide good cover in late spring due to their moderate spring growth and high carry-over of standing residue. Reliant, Manska and MDN-759 will provide better cover in the fall due to only a 10 percent to 20 percent loss of herbage, compared with 30 percent loss with Oahe. All varieties will provide tall, dense clumps that will maintain height and structure during the winter months, providing good winter cover for many bird, and small and midsized mammals. When used in conjunction with forbs and legumes (e.g., alfalfa), it can provide excellent grassland nesting bird habitat. This combination also provides diversity in structure and insect population for brood habitat.

Intermediate wheatgrass is a palatable grass that provides good growth in the spring and regrowth in the fall. This growth provides a high feed value for foraging animals in the spring and fall, and summer months when moisture is good. Intermediate wheatgrass has poor quality and palatability during the winter months; however, it does provide winter cover for resident wildlife species due to its rigidity. This tendency to

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remain upright during the winter makes it very attractive in the spring for grassland nesting birds. It has limited use for native pollinators. Many birds and small mammals use the seeds.

### Cover Value

Spring: Good  
Summer: Excellent  
Fall: Excellent  
Winter: Excellent

### Forage Value

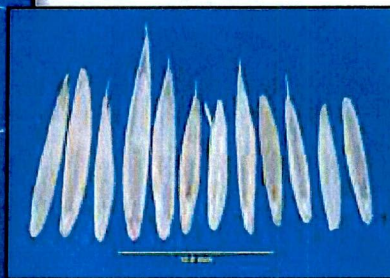
Spring: Excellent  
Summer: Fair  
Fall: Good  
Winter: Poor  
Regrowth: Good

## Slender Wheatgrass

**S**lender wheatgrass is native to North America and found on clay, loamy, wet meadow and saline lowland ecological sites. It is adapted to grow on wet, alkaline soils that experience spring flooding. It is a cool-season grass that grows to 12 to 24 inches tall, depending on soil type, with good yields when sufficient moisture is present. It is considered a

palatable wheatgrass, used primarily for pasture and rangeland. It often is used in seed mixtures for native and conservation program plantings to achieve quick establishment and cover.

Slender wheatgrass is a perennial, sod-forming grass used for revegetating clay to loamy soils, saline and alkali soils, and conservation plantings, and in a mixture for hay. It has good seedling vigor and is easy to establish. The plant becomes somewhat coarse and less palatable to livestock as it matures. Palatability for hay is good, depending on its stage of maturity when harvested. Slender wheatgrass often is seeded with green needlegrass, western wheatgrass, switchgrass and big bluestem in a mixture for native grass reclamation and with intermediate wheatgrass, tall wheatgrass, alfalfa and/or sweetclover in conservation plantings.



## Herbage Production

Slender wheatgrass makes fair to good hay and good pasture in areas where moisture is fair to excellent. Similar yields in the original study were recorded among all slender wheatgrass varieties (Adanac, Pryor and Primar) in field trials from Fort Pierre, S.D., in all five years. Revenue did not establish successfully near

Fort Pierre. No differences were found among the four varieties at the Hettinger, N.D., site in two of five years. Revenue had greater yields than the other three varieties in the other three years. The five-year mean production was 2,042, 1,383, 1,241 and 1,154 lb/ac for Revenue, Primar, Adanac and Pryor, respectively, near Hettinger. The five-year mean production was 1,777, 1,701 and

## Slender wheatgrass

Releases	Date Released	Origin	Statement of Use
<b>FirstStrike</b>	2007	Colorado, Wyoming	Improved seedling vigor equal to or greater than current cultivars. Taller than San Luis, but shorter than Pryor. Flag leaves wider and longer than San Luis. Germinates five days earlier than Pryor.
<b>AC Pintail Ecover</b> (awned wheatgrass)	2002	Manitoba, Saskatchewan, Alberta, Canada	Establishes quickly. Longer lived than slender wheatgrass.
<b>AC Sprig Ecover</b> (awned wheatgrass)	2002	Alberta, Saskatchewan, Canada	Establishes quickly. Longer lived than slender wheatgrass.
<b>AEC Hillcrest</b>	1994	Alberta, Canada	Similar forage production as Revenue at elevations of 6,000 feet. Seed ripens two weeks earlier than Revenue.
<b>Adanac</b>	1990	Saskatchewan, Canada	Taller with less leaf-to-stem ratio than Revenue. Superior in establishment, persistence and productivity under saline conditions compared with Revenue. Higher forage yields, but forage quality less than Revenue.
<b>Pryor</b>	1988	Montana	Superior to other slender wheatgrass varieties in drought tolerance, saline tolerance and seedling vigor. Earlier to mature and has a larger seed compared with other varieties.
<b>San Luis</b>	1984	Colorado	Rapid establishment and longevity. Performs best at elevations above 6,000 feet in areas receiving more than 14 inches of annual precipitation.
<b>Elbee</b>	1980	Alberta, Saskatchewan, Canada	High seedling vigor, excellent germination. Aggressive root system, good forage and seed yields.
<b>Revenue</b>	1970	Saskatchewan, Canada	Superior to Primar in establishment, salinity tolerance, forage and seed yield. Higher leaf to stem ratio, dry matter digestibility and greater smut resistance than Primar.
<b>Primar</b>	1946	Montana, Washington	Superior to other varieties in resistance to head smut. Resistant to leaf, stem and stripe rust. Good seed production. Usually 10 days earlier in seed maturity and 5 to 10 inches taller than other varieties. Alkali tolerant.

1,684 lb/ac for Pryor, Primar and Adanac, respectively, near Fort Pierre.

When growing season precipitation was greater than 16 inches, cumulative herbage production in the GPNS for Revenue was 4,988 lb/ac and ranked the as the eighth most productive grass in this study. In a dry year when growing season moisture was less than 11 inches, cumulative production was 2,680 lb/ac, and it was 2,040 lb/ac when growing season moisture was about 14 inches. Revenue ranked eighth, 17th and sixth among the 20 cool-season grass varieties studied in 1995 through 1997. Revenue was considered slightly above average for productivity among all grasses studied, irrelevant of moisture conditions. Slender wheatgrass will provide an excellent grass for native plant reclamation areas and re-established pasture and rangeland with annual precipitation of 10 to 24 inches.

### **Growth Patterns**

Revenue was a slow spring growing cool-season grass, producing slightly more than 20 percent of its total growth by late May or early June. Much of the plant's growth occurs in June and July, with almost 80 percent of its growth occurring during these two months. Peak production occurs by late July, declining with maturation to less than 68 percent of peak standing crop by early October. Slender wheatgrass would make good pasturage for late spring and summer grazing (early June to early October), based on plant growth, nutritional quality and palatability. Slender wheatgrass would make fair to good hay land if harvested by early July; however, production was low compared with other exotic grasses.

### **Nutritional Quality**

Revenue was high in crude protein content (CP) during the vegetative growth stages in May and early June. However, by the seed-set stage, CP was below 10 percent, and it dropped below 7 percent by late July when mature. The CP of the mature plant dropped below 5 percent by mid-August, and below 3 percent when fully mature.

Total digestible nutrients (TDN) were above 55 percent until late July when mature. Total digestible nutrients never dropped below 50 percent until early

October, when TDN content was 46.1 percent. Although CP was low by mid-July in mature plants, TDN remained adequate until late August.

### **Fiber**

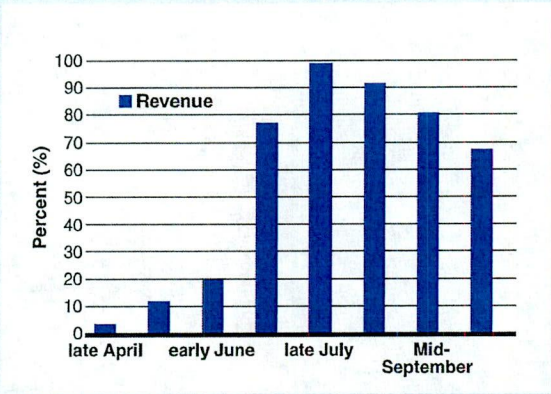
Slender wheatgrass was similar to all other cool-season grasses, with fiber content lowest at the 2.5- to four-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) increased linearly throughout the growing season after the fourth-leaf stage, ranging from 29.5 percent in the vegetative stage to 49.5 percent by early October.

Revenue ranked ninth out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, Revenue would rank as an average fiber producer when compared with other cool-season grasses. Harvesting maximum levels of fiber from Revenue will occur from late July to late August, averaging peak production of 1,185 to 1,139 pounds of ADF per acre, respectively. Slender wheatgrass would be considered a moderately efficient cool-season grass, reaching peak herbage and fiber production in late July, and maintaining TDN content at or slightly below the minimum levels of a lactating cow through early October and CP above the minimum levels of a lactating cow through mid-August, depending on maturation.

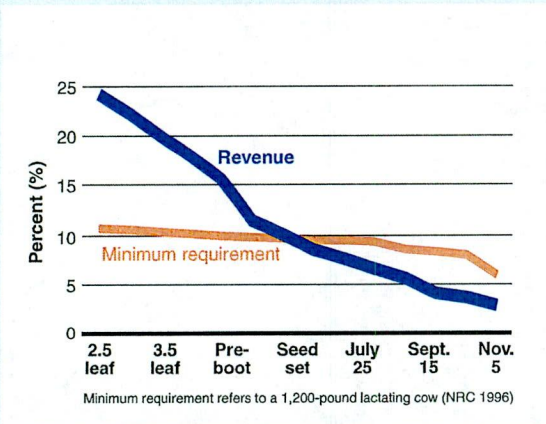
### **Performance Characteristics**

Revenue, Adanac, Pryor and Primar were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. Adanac and Primar had the best emergence at Hettinger. Revenue and Adanac had the highest rated stand density at Hettinger. Revenue failed to establish at Pierre due to low germination of the seed lot. Stand ratings were all comparable at both sites. Revenue was the tallest entry at Hettinger. Stem and leaf rust was rated moderate for all entries. Seed production was higher at Hettinger.

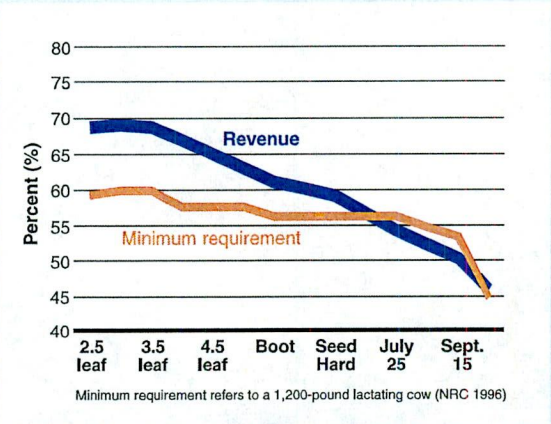
# Slender wheatgrass



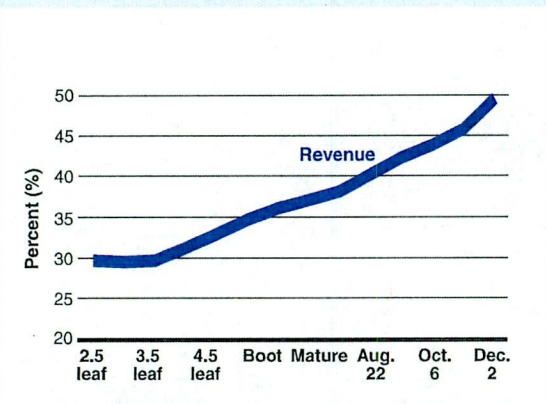
Percent of average peak standing biomass (3,236 lb/ac) for slender wheatgrass



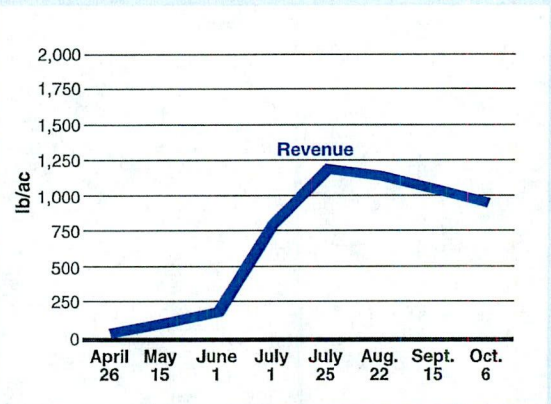
Crude protein content of slender wheatgrass



Total digestible nutrient content for slender wheatgrass



Acid detergent fiber content of slender wheatgrass



Pounds of acid detergent fiber produced per acre for each period of slender wheatgrass

## Salinity Tolerance

The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated slender wheatgrass as very high for salt tolerance. The electroconductivity (EC) was 10 to 22 millimhos per centimeter (mhos/cm). For comparison, beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass also were rated very high and measured at 13 to 26 mmhos/cm. Alfalfa is rated low and had an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates slender wheatgrass as having good salt tolerance, based on sodium adsorption ratio (SAR) values.

## Grazing Value

Slender wheatgrass would provide good grazing from early June through early October without damaging the vigor or stand quality under proper grazing management strategies. Only 20 percent of the potential plant growth of Revenue occurs by early June, with peak herbage production occurring in late July. Revenue grows most vigorously in June, with more than 58 percent of peak production occurring in this month. Revenue retains only 68 percent of peak biomass into early October. When comparing growth patterns and nutritional value, livestock grazing from early June through mid-August will optimize quality and production if plants are allowed to mature. If young tillers are maintained throughout the growing season, CP and TDN will be adequate until early October for a lactating 1,200-pound cow, depending on regrowth.

**Recommended Grazing Season:  
early June through early October.**

## Hay Value

Slender wheatgrass will make fair to good hay if harvested before the seed-set stage; however, only 60 percent to 80 percent of its growth will occur by this growth stage. Slender wheatgrass is classified as a midstature plant, with much of the foliage production occurring close to the ground surface, leaving a higher than desired level of unharvestable forage. Slender wheatgrass is generally not recommended for hay as a monoculture; however, it could be used in a seed mixture. Slender wheatgrass should be cut by the third week in June to maintain good CP (9 percent to 10 percent) and TDN (> 55 percent) for winter feed and early to mid-July to maintain minimum CP levels for nonlactating animals. When optimizing quality with production (lb + CP), slender wheatgrass should be harvested by late June to optimize harvest efficiency.

**Recommended Haying Time: early to mid-July for a nonlactating ration and optimum quality and production; third week in June for a lactating ration, optimum quality and lower production.**

## Wildlife Value

Slender wheatgrass was an average producing grass in dry and wet years, compared with other cool-season grasses. This grass will provide good cover all year due to its upright structure and standing residue. Slender wheatgrass provides medium-sized structure that is retained into the winter months, providing some winter cover for many birds, and small and midsized mammals. Used in combination with forbs and legumes, it provides structural diversity and insect populations for brood habitat.

Slender wheatgrass is a palatable grass in the spring and summer, becoming less palatable as it matures. This grass will provide a high feed value for foraging animals

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in the spring and early summer, moderate in midsummer and fair into the winter months. It has limited use for native pollinators. Many birds and small mammals use the seeds.

### Cover Value

Spring: Good  
Summer: Excellent  
Fall: Good  
Winter: Fair

### Forage Value

Spring: Good  
Summer: Good  
Fall: Good  
Winter: Fair  
Regrowth: Good

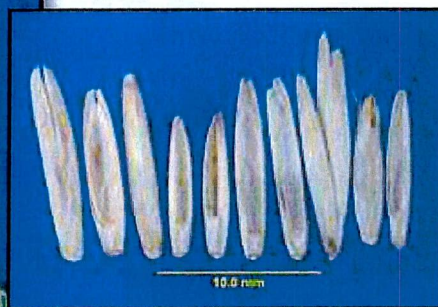
## Tall Wheatgrass

**T**all wheatgrass was introduced into the United States in 1932 from Russia. It is adapted to grow on wet, alkaline soils. Plants grow to 6 feet tall and yield heavily with sufficient available moisture. It is less palatable than most

all other wheatgrasses, but is useful for both hay and pasturage on soils not suitable for other wheatgrasses.

Tall wheatgrass is a perennial bunch grass used for revegetating saline-alkali soils, conservation plantings and, to a limited degree, hay land. It has good seedling vigor and is easy to establish. The plant becomes coarse and unpalatable to livestock as it matures.

Palatability for hay is fair to good, depending on the stage of maturity when harvested. Tall wheatgrass is used in narrow, uniformly spaced barriers for soil erosion and to manage snow for moisture conservation. It often is seeded in a mixture with intermediate wheatgrass, alfalfa and sweetclover for wildlife habitat.



### Herbage Production

Tall wheatgrass makes fair to good hay and fair to poor pasture in areas where moisture is good to excellent. Similar yields were recorded in the original study among Orbit, Alkar and Platte tall wheatgrass varieties on field trials from Fort Pierre, S.D., in three of five years. However, Platte produced greater yields than Orbit in the other years. No differences were found among the three varieties at the Hettinger, N.D., site in all five years. The five-year mean production was 2,382, 2,167 and 1,957 lb/ac for Alkar, Orbit and Platte, respectively, near Hettinger. The five-year mean production was 1,940, 1,756 and 1,404 lb/ac for Alkar, Platte and Orbit, respectively, near Fort Pierre.

When growing season precipitation was greater than 16 inches, cumulative herbage production in the GPNS for Alkar was 7,748 lb/ac, making it the most productive grass in this study. In a dry year when growing season moisture was less than 11 inches, the Alkar cumulative production was 2,892 lb/ac. When the growing season precipitation was about 14 inches, cumulative production was 3,108 lb/ac. Alkar was very productive when moisture was high and capable of producing high production levels. When growing season moisture was 14 inches or less, production was reduced by 60 percent to 63 percent, indicating tall wheatgrass is not a water

use-efficient plant. Although tall wheatgrass is not very water use efficient, Alkar still ranked seventh out of 20 in terms of overall cumulative herbage production in the normal precipitation year (14-inch growing season); however, it ranked only 13th out of 20 in the dry year. Tall wheatgrass will provide a good grass for conservation practices in areas with annual precipitation greater than 12 inches; however, growing season precipitation should be greater than 14 inches when planning hay land development.

### Growth Patterns

Alkar was the least vigorous spring growing cool-season grass in this trial, producing only 20 percent of its total growth by early June, with 78 percent of its production occurring in June and July. Once mature, tall wheatgrass retains standing crop biomass and maintains 85 percent of the standing crop through early October. Tall wheatgrass would make fair pasturage for spring and early summer grazing (early May to mid-July) based on lack of production, and fair summer grazing (July and August) if moisture is good to retain quality and palatability. However, tall wheatgrass is unpalatable and nutritional quality is poor when mature. Alkar would make fair to good hay if harvested in June; however, only 64 percent of its growth is achieved by late June.

## Tall wheatgrass

Releases	Date Released	Origin	Statement of Use
<b>Platte</b>	1972	ARS, Lincoln, Neb.	Winter hardy.
<b>Orbit</b>	1966	Canada Dept. of Ag., Swift Current, Saskatchewan	Superior to Alkar and other varieties for winter hardiness. Similar in seed and forage yield to other varieties.
<b>Jose</b>	1965	USDA- SCS, Los Lunas, N.M.	Not as coarse (finer leafed) as other tall wheatgrass varieties. Seed production is lower and forage production is similar to other varieties. Earlier maturing than other varieties.
<b>Largo</b>	1961	USDA- SCS, Los Lunas, N.M.	High forage and seed yields. Limited availability due to this variety being replaced with the variety Jose.
<b>Alkar</b>	1951	USDA-SCS, Pullman, Wash.	Good seedling vigor and later maturing.

## Nutritional Quality

Alkar was high in crude protein (CP) content during the vegetative growth stages in May and early June; however, by the pre-boot stage, CP dropped below 10 percent, and it dropped below 7 percent by late July during seed set. CP content of the primary growth dropped below 5 percent by mid-August. Tall wheatgrass does not cure well on the stem, losing 2 percent to 3 percent CP when fully mature.

Total digestible nutrients (TDN) were above 55 percent until late July when fully mature. TDN never dropped below 50 percent until early October, when TDN content was 49.6 percent. Although CP was low by mid-July, TDN remained adequate until mid-September.

## Fiber

Tall wheatgrass was similar to all other cool-season grasses, with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) in Alkar increased dramatically from the 2.5-leaf stage through the pre-boot stage, ranging from 23 percent in the 2.5-leaf stage to 44 percent by the pre-boot stage. ADF did not change from pre-boot (mid-June) through late July, peaking at 46 percent in early October.

Alkar ranked second out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, tall wheatgrass would rank superior when compared with other cool-season grasses, with only basin wildrye (Magnar) greater in fiber production. Harvesting maximum levels of fiber occurs in mid-August, averaging a peak production of 1,731 pounds of ADF per acre. Tall wheatgrass would be considered a low-efficient cool-season grass, reaching peak herbage and fiber production in mid-August, when TDN is at or below and CP well below the minimum levels of a lactating cow.

## Performance Characteristics

Orbit, Alkar and Platte were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. All three varieties established readily and were very similar in most performance characteristics. They had no disease problems. Seed production and plant height were quite variable each year at both sites.

## Salinity Tolerance

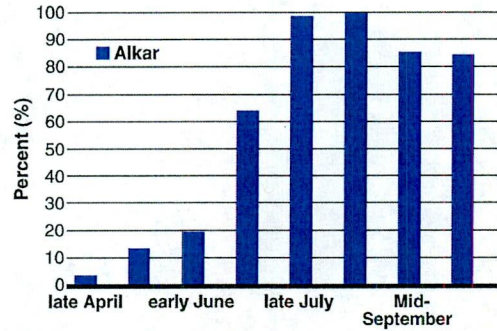
The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated tall wheatgrass as very high for salt tolerance. The electroconductivity (EC) was 13 to 26 millimhos per centimeter (mmhos/cm), which was the same rating as for beardless wildrye and NewHy hybrid wheatgrass. For comparison, alfalfa is rated low and has an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates tall wheatgrass as having a good salt tolerance, based on the sodium adsorption ratio (SAR) values.

## Grazing Value

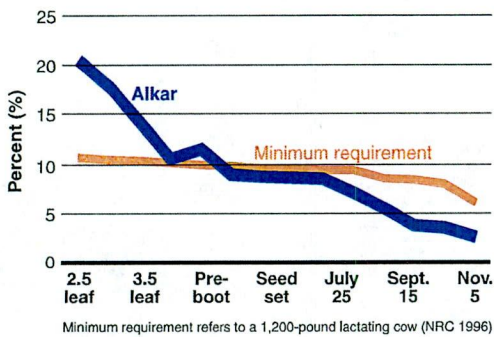
Tall wheatgrass would provide good grazing in May and June; however, plant growth did not achieve 60 percent until late June. Alkar appears to grow most vigorously in June and July, when quality is fair and palatability fair to poor. When comparing growth patterns and nutritional value, livestock grazing from late May through early July will optimize quality and production. Total digestible nutrients will be adequate until mid-September, depending on regrowth.

**Recommended Grazing Season: not recommended for pasturage, but if intent is to graze, utilize from early June through early July.**

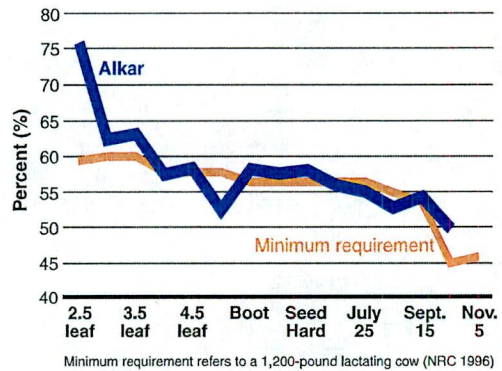
# Tall wheatgrass



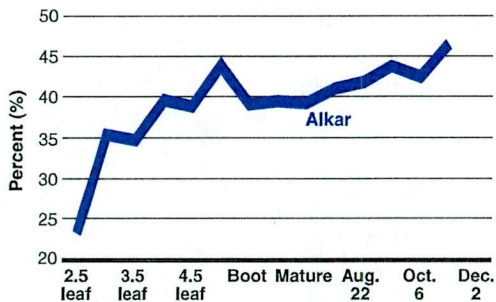
Percent of average peak standing biomass (4,583 lb/ac) for tall wheatgrass



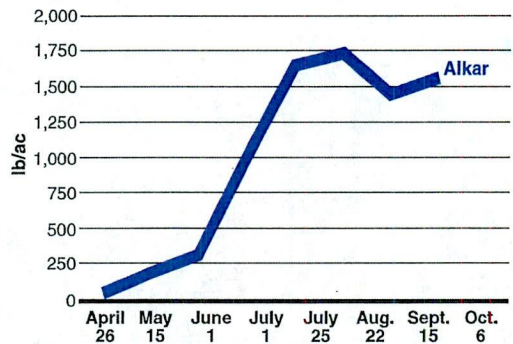
Crude protein content of tall wheatgrass



Total digestible nutrient content for tall wheatgrass



Acid detergent fiber content of tall wheatgrass



Pounds of acid detergent fiber produced per acre for each period of tall wheatgrass

**Hay Value**

Tall wheatgrass will make fair to good hay if harvested before the boot stage; however, only 40 percent to 60 percent of its growth will occur by this stage. Tall wheatgrass would not be recommended for hay as a monoculture; however, it could be used in a seed mixture, especially in good moisture areas. Tall wheatgrass should be cut by the third week in June to maintain good CP (9 percent to 10 percent) and TDN (>55 percent) for winter feed and early July to maintain minimum CP levels for nonlactating animals. When optimizing quality with production (lb + CP), tall wheatgrass should be harvested by early to mid-July to optimize harvest efficiency.

**Recommended Haying Time: early July for a nonlactating ration and optimum quality and production; mid-June for a lactating ration, optimum quality and and lower production.**

**Wildlife Value**

Tall wheatgrass was extremely productive in normal to wet years, compared with other cool-season grasses, and moderately productive in dry years. This grass will provide good to excellent cover all year due to its high growth and standing residue. When analyzing the level of herbage production and high maintenance of plant tissue late in the season, 2,892 to 4,623 lb/ac of Alkar herbage remained in mid-October, depending on yearly production. Tall wheatgrass provides tall, dense clumps that retain height and structure during winter months, providing good winter cover for many birds, and small and mid-sized mammals. When used in conjunction with forbs and legumes (e.g., alfalfa), it can provide excellent grassland nesting bird habitat since it maintains its structure during the winter. Used in combination with forbs and legumes, it provides structural diversity and insect populations for brood habitat.

Tall wheatgrass is a palatable grass in the spring, becoming unpalatable as it matures. This grass will provide good feed value for foraging animals in the spring, fair in early summer and poor from midsummer through the dormant season. It has limited use for native pollinators. Many birds and small mammals use the seeds.

**Cover Value**

Spring: Excellent  
 Summer: Excellent  
 Fall: Excellent  
 Winter: Excellent

**Forage Value**

Spring: Good  
 Summer: Fair  
 Fall: Poor  
 Winter: Poor  
 Regrowth: Fair

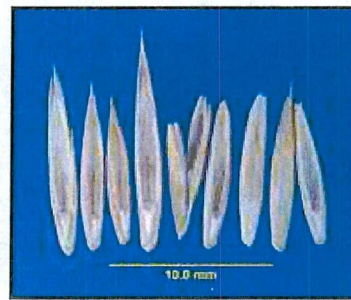
# Western Wheatgrass

**W**estern wheatgrass is native to North America and abundant on heavy clay, clay and loamy ecological sites. It is adapted to grow on most upland ecological sites, including wet, alkaline soils that experience spring flooding. It is a cool-season grass that grows 12 to 24 inches tall, depending on soil type, with good yields when sufficient moisture is available. Western wheatgrass spreads aggressively from rhizomes and tolerates salt-affected soils. It is considered a very palatable wheatgrass, used primarily for grazing as pasture and rangeland.

Western wheatgrass is a perennial, sod-forming grass used for revegetating clay to loamy soils, conservation plantings and, to a limited degree, hay land.

It becomes somewhat coarse and less palatable to livestock as it matures. Palatability for hay is good, depending on the stage of

maturity when it's harvested. Western wheatgrass often is seeded with green needlegrass, slender wheatgrass, switchgrass and big bluestem in a mixture for native grass reclamation.



### Herbage Production

Western wheatgrass makes fair to good hay and good to excellent pasture in areas where moisture is fair to excellent. Similar yields at the original study were recorded among Walsh, Rodan and Flintlock varieties on field trials from Fort Pierre, S.D., in two of five years. However, Flintlock had greater yields than Walsh and Rodan in the two years, and Walsh was the lowest producer in the fifth year. No differences were found among the three varieties at the Hettinger, N.D., site in three of five years. Flintlock had greater yields than Walsh and Rodan in one year, and Walsh was the lowest producer in the fifth year. The five-year mean production was 2,697, 2,267 and 1,323 lb/ac for Flintlock, Rodan and Walsh, respectively, near Hettinger. The five-year mean production was 1,954, 1,523 and 1,275 lb/ac for Flintlock, Rodan and Walsh, respectively, near Fort Pierre.

When growing season precipitation was greater than 16 inches, cumulative herbage production in the GPNS for Rodan was 4,360 lb/ac and it was ranked the 12th most productive grass in the study. In a dry year when growing season moisture was less than 11 inches, cumulative production was 2,292 lb/ac, and it was 2,572 lb/ac when growing season moisture was about 14 inches. Rodan ranked 12th, 12th and 10th among the 20 cool-season grass varieties studied in 1995 through 1997. Rodan was considered average for productivity among all grasses studied, irrelevant of moisture conditions. Western wheatgrass will provide an excellent grass for native plant reclamation areas and re-established pasture and rangeland with annual precipitation of 10 to 24 inches.

### Western wheatgrass

Releases	Date Released	Origin	Statement of Use
<b>Recovery</b>	2008	Colorado, Wyoming	Greater seed production compared to current cultivars. Improved seedling vigor equal to or greater than current cultivars. Less rhizomatous than Rosana and Rodan.
<b>Rodan</b>	1982	North Dakota	Leafy with good vigor. Leaves are thinner and less heavily veined than other varieties. Moderately rhizomatous. Rust resistant.
<b>Walsh</b>	1982	Alberta, Saskatchewan, Canada	Improved forage and seed yields. Noted for its tolerance to salinity. Aggressive rhizome spread.
<b>Flintlock</b>	1975	Nebraska, Kansas	Diverse collections from Kansas and Nebraska. Coarse culms and soft leaves compared with other varieties. Aggressive rhizome spread.
<b>Arriba</b>	1973	Colorado	Seed germinates rapidly with good seedling establishment. Superior seed production. Aggressive rhizome spread.
<b>Rosana</b>	1972	Montana	Good seedling vigor and ease of establishment. Good forage and seed production. Very aggressive rhizome spread, resulting in a very tight sod.
<b>Barton</b>	1970	Kansas	Leafy, high seed and forage producer. Strongly rhizomatous.

## Growth Patterns

Rodan is a slow, spring-growing cool-season grass, producing less than 36 percent of its total growth by late May or early June. Much of the plant's growth occurs in June, with more than 54 percent of growth occurring in this month. Peak production occurs by late July, with much of the standing biomass maintained through early October. Western wheatgrass would make good pasturage for late spring and summer grazing (early June to early October), based on plant growth, quality and palatability. Western wheatgrass would make fair to good hay land if harvested by early July; however, production was low, compared with other exotic grasses.

## Nutritional Quality

Rodan was high in crude protein content (CP) during the vegetative growth stages in May and early June. However, CP was below 10 percent at the seed-set stage, and below 7 percent by late July when the plant was mature. The CP of the mature plant dropped below 5 percent by mid-August, and below 3 percent when fully mature.

Total digestible nutrients (TDN) were above 55 percent until mid-August when fully mature. Total digestible nutrients never dropped below 50 percent until early October, when TDN content was 44.6 percent. Although CP was low by mid-July, TDN remained adequate until early October or later.

## Fiber

Western wheatgrass was similar to all other cool-season grasses, with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) increased linearly throughout the growing season, ranging from 28 percent at the 2.5-leaf stage to 46 percent by early October when mature.

Rodan ranked 10th out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, western

wheatgrass would rank as an average fiber producer when compared with other cool-season grasses. Harvesting maximum levels of fiber from western wheatgrass will occur from late July to early October, averaging peak production of 1,037 to 1,062 pounds of ADF per acre, respectively. Western wheatgrass was one of the few grasses to maintain a peak in fiber production from late July through October. Western wheatgrass would be considered a moderately efficient cool-season grass, reaching peak herbage and fiber production in late July, and maintaining TDN content at or above the minimum levels of a lactating cow through early October and CP above the minimum levels of a lactating cow through mid-August, depending on maturation.

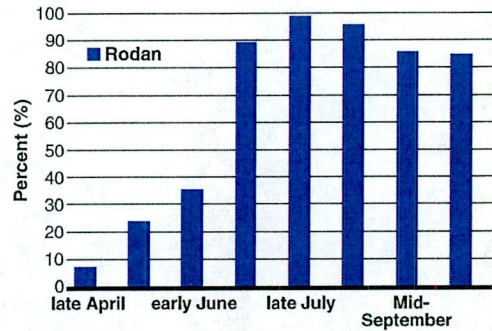
## Performance Characteristics

Walsh, Rodan and Flintlock were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. Emergence was similar for all varieties. Walsh and Rodan had higher stand densities the first year at both locations. Stand ratings were comparable. Flintlock was measured as being taller each of the three years height was documented at both sites. Seed production was comparatively low for all three varieties. Vigor was rated lowest for Walsh. No disease problems were found at either of the sites.

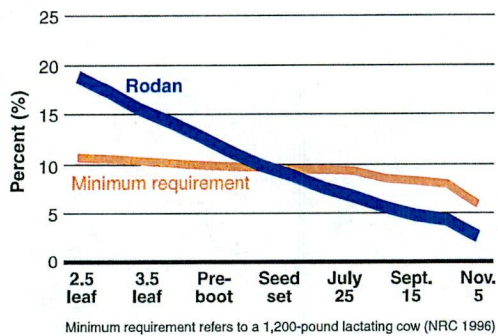
## Salinity Tolerance

The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated western wheatgrass as high for salt tolerance. The electroconductivity (EC) was 6 to 16 millimhos per centimeter (mmhos/cm). In comparison, beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass are rated very high and have an EC rating of 13 to 26 mmhos/cm. Alfalfa is rated low and has an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates western wheatgrass as having a good salt tolerance, based on the sodium adsorption ratio (SAR) values.

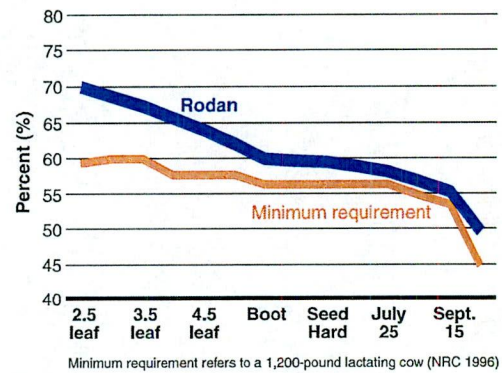
# Western wheatgrass



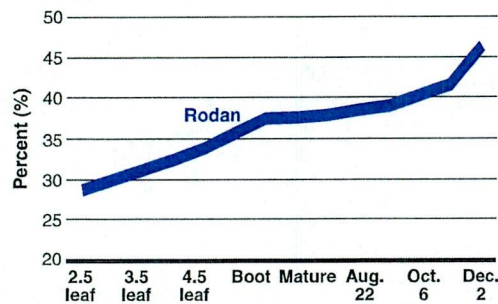
Percent of average peak standing biomass (3,075 lb/ac) for western wheatgrass



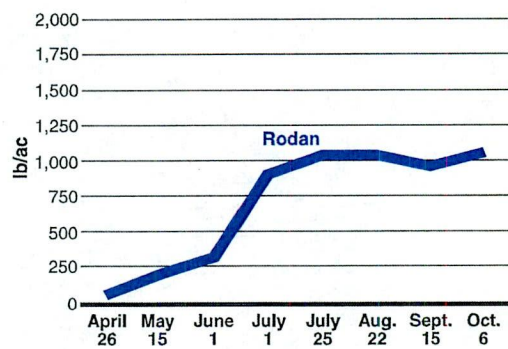
Crude protein content of western wheatgrass



Total digestible nutrient content for western wheatgrass



Acid detergent fiber content of western wheatgrass



Pounds of acid detergent fiber produced per acre for each period of western wheatgrass

### Grazing Value

Western wheatgrass would provide good grazing from early June through early October without damaging the vigor or stand quality under proper grazing management strategies. Only 36 percent of the potential plant growth of Rodan occurs by early June, with peak herbage production occurring in late July. Rodan grows most vigorously in June, with more than 54 percent of the growth occurring in this month. Rodan retained more than 86 percent of standing biomass into early October. When comparing growth patterns and nutritional value, livestock grazing from early June through mid-August will optimize quality and production if plants are allowed to mature. If immature tillers are maintained throughout the growing season, crude protein and total digestible nutrients will be adequate until early October for a lactating 1,200-pound cow, depending on regrowth.

**Recommended Grazing Season:  
early June through early October.**

### Hay Value

Western wheatgrass will make fair to good hay if harvested before the seed-set stage; however, only 70 percent to 85 percent of its growth will occur by this growth stage. Western wheatgrass is classified as a midstature plant, with much of the plant's growth occurring close to the ground surface, leaving a higher than desired level of unharvestable forage. Western wheatgrass is generally not recommended for hay as a monoculture; however, it could be used in a seed mixture. Western wheatgrass should be cut by the third week in June to maintain good CP (9 percent to 10 percent) and TDN (> 55 percent) for winter feed and early to mid-July to maintain minimum CP levels for nonlactating animals. When optimizing quality with production (lb + CP), western wheatgrass should be harvested by late June to optimize harvest efficiency.

**Recommended Haying Time: not highly recommended, early to mid-July for a nonlactating ration and optimum quality and production; third week in June for a lactating ration, optimum quality and lower production.**

### Wildlife Value

Western wheatgrass was an average producing grass in dry and wet years, compared with other cool-season grasses. This grass will provide good cover all year due to its upright structure and standing residue. When analyzing the level of herbage production and high maintenance of Rodan plant tissue late in the season, 1,970 to 3,750 lb/ac of standing crop remained in mid-October, depending on yearly production. Western wheatgrass provides medium-sized structure that is retained into the winter months, providing some winter cover for many birds, and small and midsized mammals. Used in combination with native forbs, it provides structural diversity and insect populations for brood habitat.

Western wheatgrass is a palatable grass in the spring and summer, becoming less palatable as it matures. This grass will provide a high feed value for foraging animals in the spring and early summer, moderate in midsummer and fair to good into the dormant season. It has limited use for native pollinators. Many birds and small mammals use the seeds.

#### Cover Value

Spring: Good  
 Summer: Excellent  
 Fall: Good  
 Winter: Fair

#### Forage Value

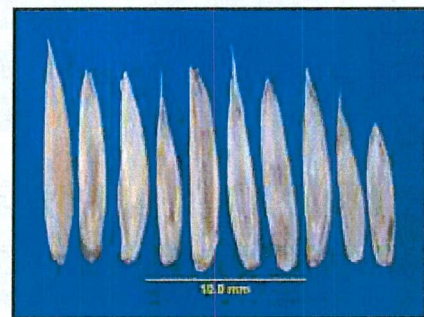
Spring: Good  
 Summer: Good  
 Fall: Good  
 Winter: Fair  
 Regrowth: Fair



## Altai Wildrye

**A**ltai wildrye was introduced into the United States from Siberia as a forage option for fall pasture. Altai wildrye is a long-lived bunch grass used as a special-purpose grass to extend the grazing season into the late fall and winter. It is a very winter-hardy grass that may be difficult to establish. The plant has coarse, erect leaves that retain leaf stature after snowfall, permitting late fall or early winter grazing. It is especially adapted to loam and clay soils, with an extensive root system penetrating to a depth of 10 feet. It possesses a high tolerance to saline-alkali soils, but it has less tolerance than tall wheatgrass.

Due to a moderate palatability, compared with other cool-season grasses, it is recommended as a single-species stand for grazing. Palatability for hay is questionable due to limited feeding trials.



### Herbage Production

Altai wildrye makes poor to fair hay and good pasture in areas where moisture is fair to excellent. Similar yields in the original study were recorded among all Altai wildrye varieties (Prairieland, Pearl and Eejay) on field trials from Fort Pierre, S.D., in three out of five years. Prairieland produced greater yields than Eejay in one year and Eejay greater yields than Pearl in one year. No differences were found among the three varieties at the Hettinger, N.D., site in three of five years. Prairieland produced greater yields than Pearl in one year and Eejay greater yields than Prairieland and Pearl in one year. The five-year mean production was 2,088, 1,928 and 1,469 lb/ac for Eejay, Prairieland and Pearl, respectively, near Hettinger. The five-year mean production was 1,080, 976 and 920 lb/ac for Prairieland, Eejay and Pearl, respectively, near Fort Pierre.

When growing season precipitation was greater than 16 inches, cumulative herbage production in the GPNS for Prairieland was 5,172 lb/ac and it was one of the top 10 most productive grasses in this study. In a dry year when growing season moisture was less than 11 inches, cumulative production was 3,280 lb/ac. When

growing season precipitation was about 14 inches, cumulative production was 3,548 lb/ac. Prairieland was very productive when moisture was high and capable of producing high production levels. When growing season moisture was 14 inches or less, production was still high, compared with other cool-season grasses, and was reduced by only 31 percent to 37 percent, indicating Altai wildrye is a fairly good water use-efficient plant. Prairieland ranked third out of 20 in terms of overall cumulative growth in the normal precipitation year (14-inch growing season) and second out of 20 in the dry year. Altai wildrye will provide a good grass for conservation practices in areas with annual precipitation greater than 8 inches; however, growing season precipitation should be greater than 10 inches when developing pastureland.

### Growth Patterns

Prairieland had moderate vigor during the spring growing season in the trial, producing 22 percent of its total growth by mid-May and 30 percent by early June, reaching peak production in late July. Once mature,

## Altai wildrye

Releases	Date Released	Released by	Statement of Use
<b>Mustang</b>	2004	ARS, Logan, Utah	Significantly taller than Prairieland, Eejay and Pearl. Higher forage production than Prairieland or Pearl. Superior seedling establishment compared with Pearl and Prairieland. Seedling emergence was better than Prairieland and similar to Pearl. Seed weight was comparable to Prairieland and Eejay but significantly lighter than Pearl.
<b>Eejay</b>	1989	Ag. Canada, Swift Current, Saskatchewan	Higher forage yield and seed production than Prairieland. Good seed quality. Resistant to leaf spot diseases.
<b>Pearl</b>	1989	Ag. Canada, Swift Current, Saskatchewan	Lower forage production and higher seed production than the variety Prairieland. Resistant to leaf spot diseases.
<b>Prairieland</b>	1976	Ag. Canada, Swift Current, Saskatchewan	First known variety of Altai wildrye. High seed yields, high forage yields, high yields of good quality seed. Resistant to leaf spot diseases.

standing biomass remained high, losing on average of only 5 percent of the total herbage produced in early October. Altai wildrye would make good pasturage for spring and early summer grazing (early June to mid-July), based on growth patterns; however, it would provide even better fall pasturage (September and October), assuming quality and palatability are good. Altai wildrye is ranked as fair to good in palatability when mature and quality is good. Altai wildrye could make fair to good hay if harvested by late June; however, only 55 percent to 75 percent of its growth is achieved by late June.

### Nutritional Quality

Prairieland was high in crude protein content (CP) in May, June and July in the vegetative to boot growth stage, dropping below 7 percent CP by mid-August when mature. The CP of the primary growth did not drop below 6 percent until early October.

Total digestible nutrients (TDN) were at or above 55 percent until the third week in July when the plant was in the seed-hardening growth stage. TDN never dropped below 50 percent until early November, when TDN content was 49.6 percent. The TDN remained adequate for a lactating cow until early October and a dry cow until early November.

### Fiber

Prairieland was similar to all other cool-season grasses, with fiber content lowest at the 2.5- and 3.5-leaf stages, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) increased dramatically from the 3.5-leaf stage through boot stage, ranging from 34 percent in the 2.5-leaf stage to 43 percent by the boot stage. ADF content declined after the boot stage, remaining stable until late July and then increasing from midsummer through early November, peaking at 46 percent.

Prairieland ranked third out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, Altai wildrye ranked very high when compared with other cool-season grasses, with only basin wildrye (Magnar)

and tall wheatgrass (Alkar) greater in fiber production. Prairieland achieved and retained high fiber content later than all other cool-season grasses, with maximum levels of fiber harvested in early October, averaging peak production of 1,501 pounds of ADF per acre. Altai wildrye would be considered a highly efficient cool-season grass, reaching peak herbage production in late July when nutrient content is high, retaining more than 90 percent of the standing biomass through early October and achieving peak fiber production late in the growing season (early October), while maintaining TDN at or slightly below and CP at or slightly below the minimum levels of a lactating cow.

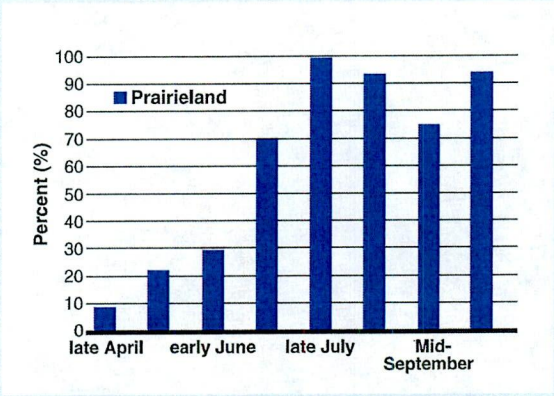
### Performance Characteristics

Prairieland, Pearl and Eejay were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. All three varieties established readily. Prairieland had the highest initial stand rating and stand density at Hettinger. Pearl had declined in stand rating by 1997, while Prairieland and Eejay still were rated good at Hettinger. Eejay had the poorest stand density at Fort Pierre. Neither site had disease problems. Seed production was rated as poor for all three entries except for 1993 at Fort Pierre.

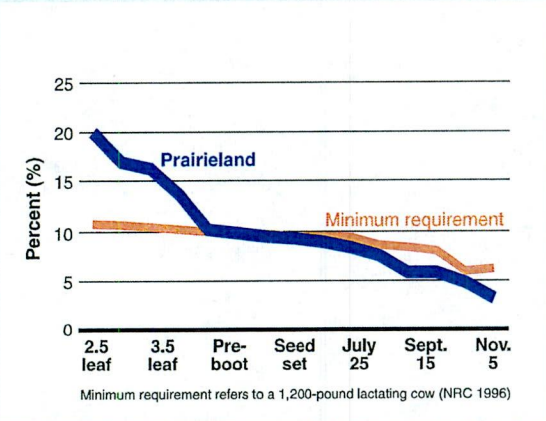
### Salinity Tolerance

The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated Altai wildrye as very high for salt tolerance. The electroconductivity (EC) was 10 to 22 millimhos per centimeter (mmhos/cm). In comparison, beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass are rated very high also and have an EC rating of 13 to 26 mmhos/cm. Alfalfa is rated low and has an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates Altai wildrye as having a fair salt tolerance based on the sodium adsorption ratio (SAR) values.

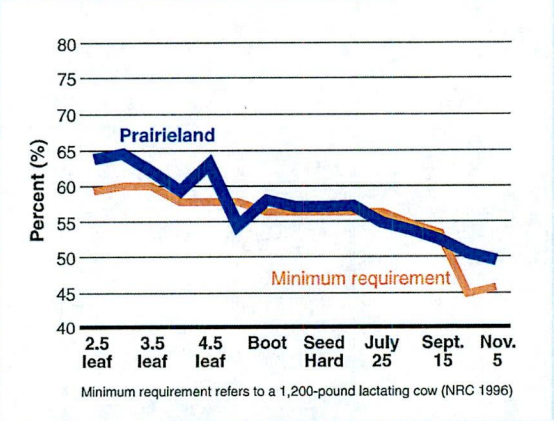
# Altai wildrye



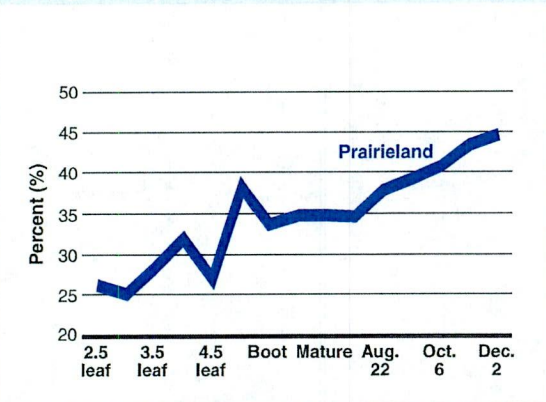
Percent of average peak standing biomass (4,000 lb/ac) for altai wildrye



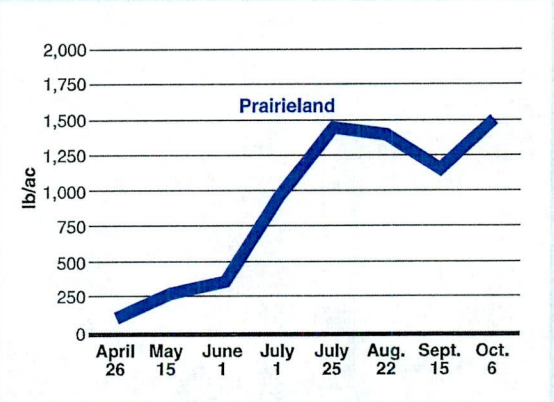
Crude protein content of altai wildrye



Total digestible nutrient content for altai wildrye



Acid detergent fiber content of altai wildrye



Pounds of acid detergent fiber produced per acre for each period of altai wildrye

### Grazing Value

Altai wildrye would provide good grazing in May and June; however, its potential use for late summer and fall pasture is much greater than spring use. Prairieland plant growth was only 30 percent by early June and 70 percent by early July. This grass grows most vigorously in June and July, maintaining standing biomass in September and October. Although forage nutritional quality is very good in May, June and July, Prairieland maintained good quality in September and October. When comparing growth pattern and nutritional value, livestock grazing could be recommended from early June through early August; however, early September through early November would provide a better choice for this grass. Weaning of offspring should be conducted by early October to maintain performance on the dam. Total digestible nutrients will be adequate throughout most of the growing season and into the early dormant season.

**Recommended Grazing Season: early September through early November.**

### Hay Value

Altai wildrye is recommended as a pasture grass, with limited information available on value for hay. Based on growth patterns and nutritional quality levels, Altai wildrye should make a good hay if harvested before the seed-hardening stage of plant development; however, only 60 percent to 70 percent of its growth will occur by this growth stage. Altai wildrye should be cut by early July to maintain good CP (9 percent to 10 percent) and TDN (> 55 percent) for winter feed and mid-July to maintain minimum CP levels for nonlactating animals.

When optimizing quality with production (lb + CP), Altai wildrye should be harvested by early July to optimize harvest efficiency.

**Recommended Haying Time: not recommended; mid-July for a nonlactating ration and optimum quality and production; late June or early July for a lactating ration, optimum quality and low production.**

### Wildlife Value

Altai wildrye was extremely productive in normal to wet years, compared with other cool-season grasses, and good producing in dry years. This grass will provide good cover all year due to its high growth and standing residue. However, in most cases, it is planted as a monoculture without an understory of legumes or forbs. As a monoculture, it will lack structural diversity and insect populations, making it less attractive to grassland nesting birds and brood habitat. It provides good winter cover due its bunch grass growth structure.

Altai wildrye is a palatable grass in the spring, becoming moderately palatable as it matures. Even though this grass provides high feed value, its use by foraging wildlife is limited. It has limited use for native pollinators and as a wildlife food seed source.

#### Cover Value

Spring: Good  
 Summer: Good  
 Fall: Good  
 Winter: Good

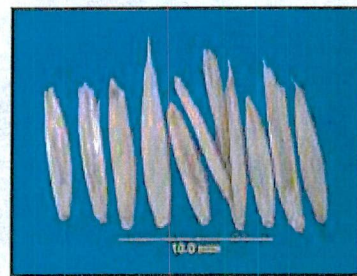
#### Forage Value

Spring: Fair  
 Summer: Fair  
 Fall: Fair  
 Winter: Fair  
 Regrowth: Fair

## Basin Wildrye

**B**asin wildrye is native to the western part of the northern Great Plains region; however, it is more abundant in the valleys of the northern Rocky Mountain region and the northern part of the intermountain area.

Basin wildrye is a long-lived bunch grass used as standing grazing forage for livestock, nesting cover and escape cover. It is a very winter-hardy grass with coarse, erect leaves that retain leaf stature after snowfall, permitting late fall or early winter grazing. Due to a moderate palatability, compared with other cool-season grasses, it is recommended as a single-species stand for grazing. Palatability for hay is questionable because feeding trials have been limited. Establishment and persistence have been variable in field trials in North and South Dakota.



## Herbage Production

Basin wildrye is native grass from the Basin Desert region of North America and a grass grazed on rangeland with limited information on hay value. Similar yields were recorded in the original study between the basin wildrye varieties (Magnar and Trailhead) on field trials from Fort Pierre, S.D., in all five years. No differences were found between varieties at the Hettinger, N.D., site in four of five years. Magnar produced greater yields than Trailhead in one year. The five-year mean production was 2,146 and 1,496 lb/ac for Magnar and Trailhead, respectively, near Hettinger. The five-year mean production was 932 and 923 lb/ac for Magnar and Trailhead, respectively, near Fort Pierre.

Basin wildrye (Magnar) was one of the most productive grasses in the GPNS, ranking first, second and fourth during the three years of study. When growing season precipitation was greater than 16 inches, cumulative herbage production was 7,332 lb/ac and second only to tall wheatgrass (Alkar). In a dry year when growing season moisture was less than 11 inches, cumulative production was 4,932 lb/ac and it was the top producing grass in the trial. When growing season moisture was about 14 inches, cumulative production was 3,480 lb/ac and it ranked fourth, behind both pubescent wheatgrass varieties and Altai wildrye.

Magnar was very productive when moisture was high and low, and always capable of producing high yields. When growing season moisture was 14 inches or less, production was still high, compared with other cool-

season grasses, indicating basin wildrye is a fairly good to moderate water use-efficient plant. Basin wildrye will provide a good grass for conservation practices in areas with annual precipitation greater than 8 inches; however, growing season precipitation should be greater than 10 inches when developing it for pastureland or hay.

## Growth Patterns

Magnar's growth patterns were quite variable among the years and dependant on moisture. During the dry year, basin wildrye had excellent vigor during the spring growing season in the trial, producing 33 percent of its total growth by mid-May, 52 percent by early June and 100 percent by the first week in July. However, during the wet year, Magnar produced only 18 percent of its total growth by mid-May and 29 percent by early June, with 100 percent by late July. Peak production always will occur in July; however, moisture will dictate aggressiveness of spring growth.

Once mature, standing crop, on average, was reduced by 45 percent to 55 percent by mid-September, rebounding to 55 percent to 95 percent of potential standing crop in early October. Basin wildrye would make good pasturage for spring and early summer grazing (mid-May to mid-July), based on growth patterns. However, it would provide even better fall pasturage (September and October), assuming quality and palatability is good. Basin wildrye is ranked as having fair to good palatability when mature and quality is good.

## Basin wildrye

Releases	Date Released	Origin	Statement of Use
<b>Washoe Germplasm</b>	2002	USDA-SCS, Bridger, Mont.	Increased overall height, vigor and survival compared with Trailhead and Magnar when tested in moderately acidic and heavy metal-contaminated sites. Very drought tolerant.
<b>Trailhead</b>	1991	USDA-SCS, Bridger, Mont.	Seed production fair. Good seedling vigor. Excellent spring forage production. Adapted to moderately saline-alkaline to acid soils. Dark green. More drought tolerant than Magnar.
<b>Magnar</b>	1979	Saskatchewan, Canada	Tall, leafy with large stems and seedheads. Good seed production. Good seedling vigor. Grows well on saline soils. Blue.

Basin wildrye would make good quality hay if harvested by late June, allowing for maximum quantity since 80 percent to 100 percent of its growth is achieved by late June or early July.

### Nutritional Quality

Magnar was high in crude protein content (CP) in May, June and July prior to the seed-set stage, dropping below 10 percent CP by early July and below 7 percent CP by mid-August when in the mature growth stage. The CP of primary growth did not drop below 6 percent until late August or early September.

Total digestible nutrients (TDN) were at or above 55 percent until mid-August and when mature. Total digestible nutrients never dropped below 50 percent until early October, when TDN content was 45.1 percent. The TDN remained adequate for lactating cows until late September or early October and dry cows until early December.

### Fiber

Basin wildrye was similar to all other cool-season grasses, with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) of Magnar was 23 percent at the 3.5-leaf stage, peaking at 53 percent in early December.

Magnar ranked first among the 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, Magnar was superior to all other grass species and varieties studied in this trial. Basin wildrye achieved high fiber content early and reached peak levels of fiber harvested in early July, declining rapidly through mid-September. Average peak production was 1,873 pounds of ADF per acre in early July, declining to 1,094 in mid-September and 1,494 in early October. Magnar would be considered a highly efficient cool-season grass,

reaching peak herbage production in early July when nutrient content is high; however, it retained only 65 percent of the standing crop through early October. Peak fiber production also occurred in early July as a function of peak herbage production, maintaining TDN at or slightly below the minimum levels of a lactating cow throughout the growing season; however, CP became deficient by late July.

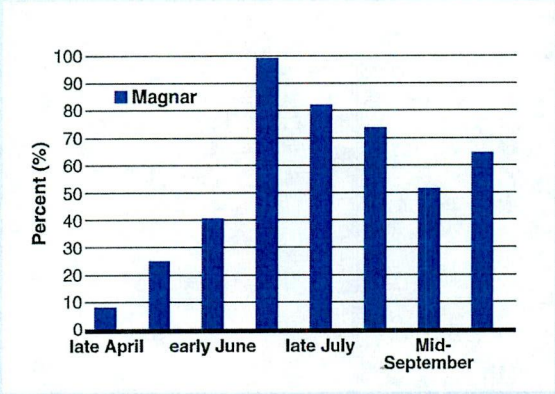
### Performance Characteristics

Magnar and Trailhead were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. Emergence and establishment were slower than in most other species in the trial. Trailhead had higher stand densities the first two years at both locations. Stand densities and ratings were lower for both entries at the Fort Pierre site. Trailhead had higher disease ratings (stem and leaf rust). Seed production was rated as poor, except in 1993 at the Fort Pierre site.

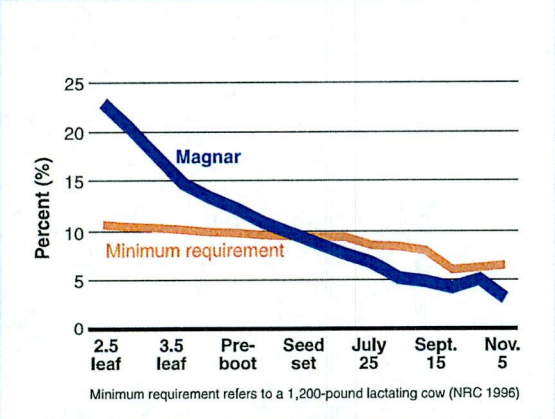
### Salinity Tolerance

Basin wildrye is tolerant of low to moderate levels (< 10 millimhos per centimeter) of saline and (sodium adsorption ratio < 15) sodic conditions (USDA NRCS PLANTS database, 2003). For comparison, a study conducted at the Plant Materials Center, Bridger, Mont., (USDA NRCS 1996) showed an electroconductivity (EC) of 13 to 26 mmhos/cm for beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass. Alfalfa was rated low and had an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates basin wildrye as having a fair salt tolerance, based on the sodium adsorption ratio (SAR) values.

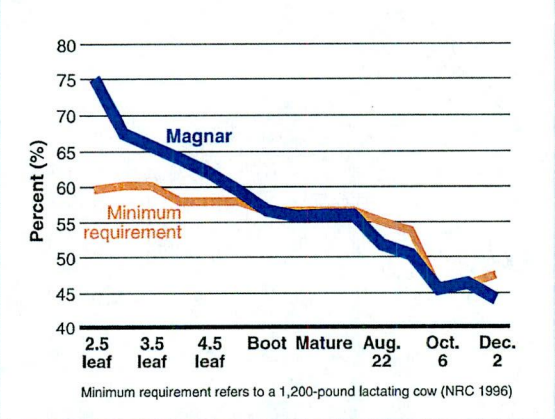
# Basin wildrye



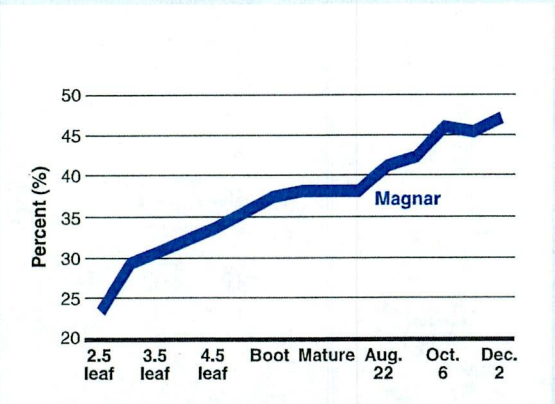
Percent of average peak standing biomass (5,248 lb/ac) for basin wildrye



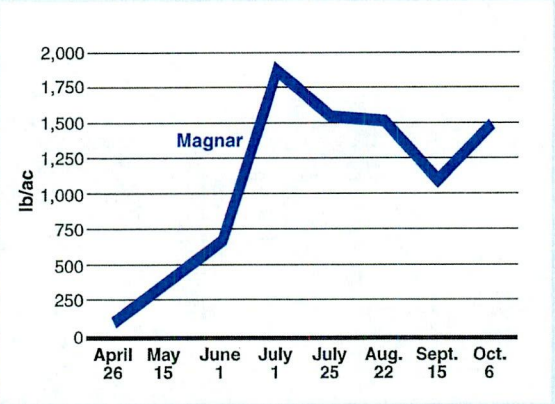
Crude protein content of basin wildrye



Total digestible nutrient content for basin wildrye



Acid detergent fiber content of basin wildrye



Pounds of acid detergent fiber produced per acre for each period of basin wildrye

### Grazing Value

Basin wildrye would provide good grazing in May and June and also potential use for late summer and fall pasturage. Magnar plant growth was 18 percent to 32 percent in mid-May and 100 percent in early to late July. This grass grows most vigorously in June, losing standing biomass in late July, August and September. Although forage nutritional quality is very good in May, June and July, basin wildrye maintains fair to good quality in September and October. When comparing growth patterns and nutritional value, livestock grazing could be recommended from mid-May through mid-July or early September through early November. Weaning of offspring should be conducted by mid to late October to maintain performance on the dam. Total digestible nutrients will be adequate through late September for a lactating cow and early December for a dry cow.

**Recommended Grazing Season:**  
**mid-May through mid-July or early September through early December.**

### Hay Value

Basin wildrye typically has been recommended as a pasture grass, with limited information available on value for hay. Based on growth patterns and nutritional quality levels, basin wildrye should make a good hay-type grass if harvested before the seed-hardening stage of plant development. At this stage of growth, hay quality and quantity will be maximized since 80 percent to 100 percent of its growth will occur by this growth stage. Basin wildrye should be cut by late June or early July to maintain good CP (9 percent to 10 percent) and TDN (> 55 percent) for winter feed and mid-July to maintain minimum CP levels for nonlactating animals. When optimizing quality with production (lb + CP), basin wildrye should be harvested by late June to optimize harvest efficiency.

**Recommended Haying Time: not highly recommended; early July for a nonlactating ration and optimum quality and production; late June for a lactating ration, optimum quality and low production.**

### Wildlife Value

Basin wildrye was extremely productive in normal to wet years, compared with other cool-season grasses, and highly productive in dry years. This grass will provide good to excellent cover all year due to its high growth and standing residue. However, in most cases, it is planted as a monoculture without an understory of legumes or forbs. As a monoculture, it will lack structural diversity and insect populations, making it less attractive to grassland nesting birds and brood habitat in the spring and summer.

Basin wildrye is a palatable grass in the spring, becoming moderately palatable as it matures. This grass will provide a high feed value for foraging animals in the spring, good in early summer and fair from midsummer into the dormant season. It has limited use for native pollinators and as a seed food source.

Cover Value	
Spring:	Good
Summer:	Good
Fall:	Good
Winter:	Good

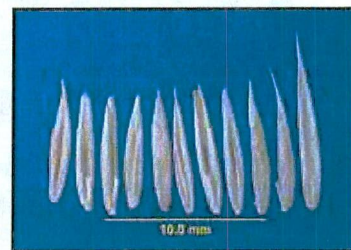
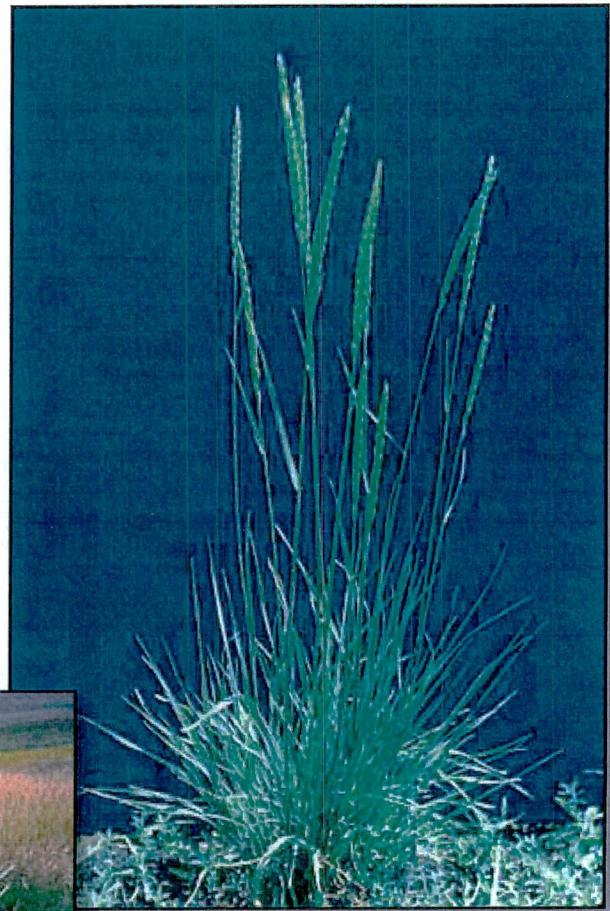
Forage Value	
Spring:	Good
Summer:	Good
Fall:	Fair
Winter:	Fair to Poor
Regrowth:	Good

# Russian Wildrye

**R**ussian wildrye was introduced from Siberia as a forage crop, brought to North Dakota in 1907 and first grown at the USDA-ARS at Mandan, N.D., in 1927. Seed from the Mandan source was released to the public in 1941 and 1942.

Russian wildrye is a early spring-growing, long-lived, drought-tolerant bunch grass used as a special-purpose grass to extend the grazing season into the late fall and early winter. It is a very winter-hardy grass classified as somewhat difficult to establish. The plant has fine basal leaves that retain nutritional quality after maturation, permitting late fall or early winter grazing. It is especially adapted to many types of soils and has moderately high tolerance to saline-alkali soils. It is highly competitive with other

plant species; however, it is recommended for a single-grass seeding pasture. Palatability for hay is questionable since feeding trials have been limited.



## Herbage Production

Russian wildrye makes poor to fair hay and good pasture in areas where moisture is fair to excellent. Similar yields from the original study were recorded among all Russian wildrye varieties (Bozoisky Select, Mankota, Mayak, Swift and Cabree) on field trials from Fort Pierre, S.D., in all five years. No differences were found among the five varieties at the Hettinger, N.D., site in four of five years. Bozoisky Select produced greater yields than Mayak and Cabree in one year. The five-year mean production was 1,021, 912, 870, 727 and 648 lb/ac for Bozoisky Select, Swift, Mankota, Cabree and Mayak, respectively, near Hettinger. The five-year mean production was 1,008, 943, 919, 840 and 555 lb/ac for Bozoisky Select, Mankota, Swift, Cabree and Mayak, respectively, near Fort Pierre.

Cumulative herbage production from the GPNS for Russian wildrye was low compared with all other cool-season grasses in this study. When growing season precipitation was greater than 16 inches, cumulative production was 3,560 lb/ac for Mankota and 2,680 lb/ac for Bozoisky Select. Mankota ranked 18th and Bozoisky Select 20th out of 20 grass varieties in the trial during the wet year. In a dry year when growing season moisture was less than 11 inches, cumulative production was 1,480 lb/ac for Mankota and 2,228 lb/ac for Bozoisky Select. Mankota ranked last among the 20 grasses in overall cumulative herbage production in the dry year. When growing season precipitation was about 14 inches, cumulative production was 1,560 and 2,228 lb/ac for Mankota and Bozoisky Select, respectively.

Both varieties were low herbage-producing grasses when moisture was high and low. No statistical

## Russian wildrye

Releases	Date Released	Released by	Statement of Use
<b>Bozoisky II</b>	2004	ARS, Logan, Utah	Good seedling vigor. High forage and seed yields.
<b>Mankota</b>	1991	ARS, Mandan, N.D.	Heading date is 2 weeks later than other varieties. Moderate to good resistance to leaf spot disease.
<b>Tetracan</b>	1988	Ag. Canada, Swift Current, Saskatchewan	Excellent seedling vigor and establishment. Larger seed than other varieties.
<b>Bozoisky Select</b>	1984	ARS, Logan, Utah	Significantly more vigorous and productive than Vinall. Stand establishment is equal or superior to Vinall. Better seedling vigor and larger seed than Vinall or Swift.
<b>Swift</b>	1978	Ag. Canada, Swift Current, Saskatchewan	Good seedling emergence and resistance to leaf spot. Improved seedling vigor.
<b>Cabree</b>	1976	Ag. Canada, Lethbridge, Alberta	Resistant to powdery mildew, leaf rust and spot blotch. Improved seed retention is Cabree's main attribute.
Mayak	1971	Canada Dept. of Ag., Swift Current, Saskatchewan	High forage and seed yields. Resistant to leaf spot. Similar to other varieties in other characteristics.
<b>Vinall</b>	1960	ARS, Mandan, N.D.	First released variety of Russian wildrye. It no longer is recommended and has been replaced by Mankota.

difference was found in herbage production between the two varieties for any year of the study. Both varieties appear to be drought tolerant, with Bozoisky Select producing the same level of herbage production in the normal and dry years and Mankota producing only 5 percent less forage in the dry year. Mankota appears to be more productive in a wet year than Bozoisky Select. Russian wildrye will provide a good grass for conservation practices in areas with low annual precipitation; however, other grasses would be rated higher than Russian wildrye when growing season precipitation is greater than 10 inches.

### Growth Patterns

Russian wildrye was a very vigorous spring-growing grass in this trial, especially the Mankota variety. Both varieties achieved almost 40 percent growth by mid-May. Mankota achieved 59 percent of its growth by late May or early June and more than 90 percent by early July. Bozoisky Select growth was vigorous through mid-May, slowing in comparison with Mankota. Bozoisky Select achieved slightly less than 50 percent of its growth by late May or early June. Both Mankota and Bozoisky Select were superior in retaining their standing herbage, with 80 percent to 100 percent of their biomass produced standing in early October. Russian wildrye would make good pasturage for spring and early summer grazing (early May to early July), based on growth patterns; however, it would provide even better fall pasturage (September and October), based on herbage retention, good quality and palatability. Russian wildrye is ranked as having fair to good palatability when mature and forage quality is good. Russian wildrye would make fair hay if harvested by late June; however, production potential will be less than most other cool-season grass species.

### Nutritional Quality

Both Russian wildrye varieties were high in crude protein content (CP) in May, June and July during the vegetative growth stage, dropping below 10 percent CP by the third week in July when seed was hardening. The CP never dropped below 7 percent until November. Russian wildrye was the only grass to maintain minimum requirements of a lactating cow throughout the growing season and minimum requirements of a dry cow in October and November. This data could be skewed low for August, September and October since we did not look specifically at regrowth quality in this study, with hand clippings collected as a swath (mature and young tissue combined).

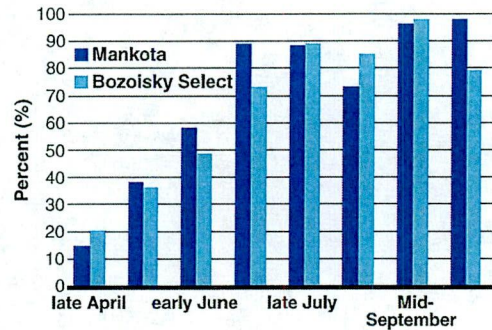
Total digestible nutrients (TDN) were at or above 55 percent until early July for Mankota and mid-August for Bozoisky Select. Total digestible nutrients never dropped below 50 percent for either variety until early November. The TDN remained adequate for a lactating cow until early October and a dry cow until early December for Bozoisky Select and Mankota.

### Fiber

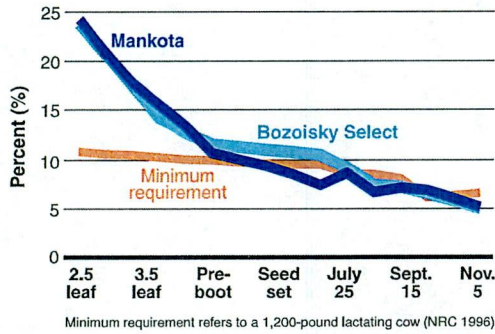
Both Mankota and Bozoisky Select were similar to all other cool-season grasses with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. No difference was found in acid detergent fiber (ADF) content between varieties at any time of the growing season. Unlike most of the cool-season grass varieties in this study, the Russian wildrye varieties did not have a lag in ADF levels, increasing during each collection period throughout the growing season. ADF increased from 27 percent to 29 percent in the 2.5-leaf stage to 48 percent in early December.

Mankota ranked 17th out of 20 cool-season grasses and Bozoisky Select ranked 19th out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, Russian wildrye ranked low when compared with other cool-season grasses. Similar to Altai wildrye, Russian wildrye achieved and retained higher fiber

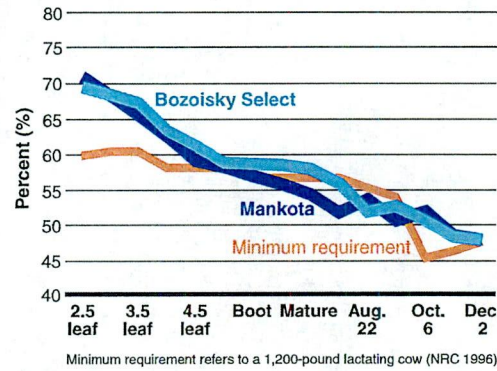
# Russian wildrye



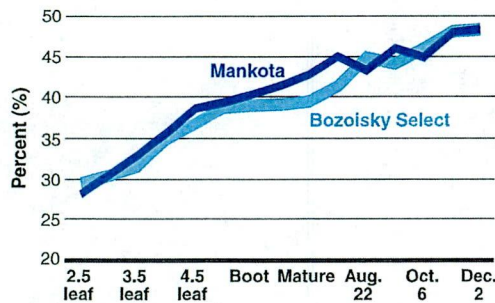
Percent of average peak standing biomass for Russian wildrye Mankota (2,200 lb/ac) and Bozoisky Select (2,379 lb/ac)



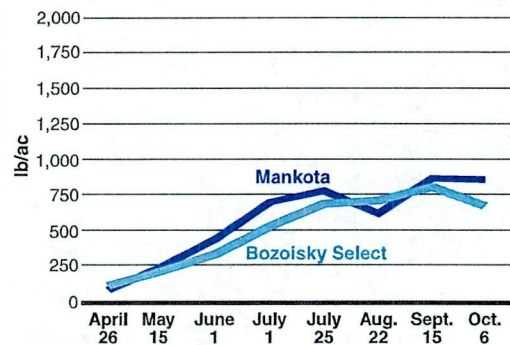
Crude protein content of Russian wildrye



Total digestible nutrient content for Russian wildrye



Acid detergent fiber content of Russian wildrye



Pounds of acid detergent fiber produced per acre for each period of Russian wildrye

content later than all other cool-season grasses, with maximum levels of fiber harvested in mid-September to early October, averaging peak production of 858 and 799 pounds of ADF per acre for Mankota and Bozoisky Select, respectively. Russian wildrye would be considered a highly efficient cool-season grass, reaching peak herbage production in mid-September while maintaining high nutrient content throughout the growing season, retaining more than 80 percent to 100 percent of the standing crop through early October and achieving peak fiber production late in the growing season (early October), while maintaining TDN at or slightly below and CP at or slightly above the minimum levels of a lactating cow.

### Performance Characteristics

Mayak, Swift, Cabree, Mankota and Bozoisky Select were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. Emergence for all entries was slower than for most other species in the trial. Stand densities were comparable, except for Swift, which had less at both locations. Disease was not a problem. Seed production was similar for all entries and greatly variable by years. The best year for seed production was the second growing season at Hettinger.

### Salinity Tolerance

The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated Russian wildrye as very high for salt tolerance. The electroconductivity (EC) is 13 to 24 millimhos per centimeter (mmhos/cm), which is similar to beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass. For comparison, alfalfa is rated low and has an EC rating of 4 to 8 mmhos/cm. Section IV of the NRCS Field Office Technical Guide (USDA NRCS 2003) rates Russian wildrye as having a fair salt tolerance, based on the sodium adsorption ratio (SAR) values.

### Grazing Value

Russian wildrye would provide good grazing in early May through June and from late summer through late fall (September through December). Russian wildrye plant growth was 35 percent to 40 percent by mid-May for both varieties. Mankota reached 59 percent of its growth by early June and 90 percent growth by early July, and retained 100 percent of its growth through early October. Bozoisky Select reached 49 percent of its growth by early June, reaching peak herbage production in mid-September and retaining 80 percent of its production through early October. Mankota's growth pattern was more vigorous than Bozoisky Select in late May and June and also retained greater standing forage in October.

Although forage nutritional quality is very good in May, June and July, Russian wildrye maintains good quality in September, October and November. When comparing growth patterns and nutritional value, livestock grazing could be recommended from early May through early July; however, early September through early December would provide a better choice for this grass. Weaning of offspring should be conducted by early October to maintain performance on the dam. Total digestible nutrients will be adequate throughout most of the growing and early winter months for Bozoisky Select and Mankota.

**Recommended Grazing Season: late September through early December, or early May through early July.**

### Hay Value

Russian wildrye is recommended as a pasture grass, with limited information available on value for hay. Based on growth patterns and nutritional quality levels, Russian wildrye should make good hay if harvested before the seed-hardening stage of plant development. Russian wildrye should be cut by mid-July to maintain good CP (9 percent to 10 percent) and TDN (> 55 percent) for winter feed and mid-September to maintain minimum CP levels for nonlactating animals. When optimizing

quality with production (lb + CP), Russian wildrye should be harvested by mid to late July to optimize harvest efficiency.

**Recommended Haying Time: not recommended; mid-July for a nonlactating ration and optimum quality and production; early July for a lactating ration, optimum quality and low production.**

### Wildlife Value

Russian wildrye was low to moderate in productivity, compared with all other cool-season grasses. This grass will provide adequate cover in the fall and winter months due to its high level of standing residue. However, in most cases, it is planted as a monoculture without an understory of legumes or forbs. As a monoculture, it will lack structural diversity and insect populations, making it less attractive to grassland nesting birds and brood habitat in the spring and summer.

Russian wildrye is a palatable grass in the spring, becoming moderately palatable as it matures. This grass will provide a high feed value for foraging animals in the spring, good in early summer and good from midsummer through the fall months. It has limited use for native pollinators and as a seed food source.

#### Cover Value



Spring: Fair  
Summer: Fair  
Fall: Good  
Winter: Good

#### Forage Value

Spring: Excellent  
Summer: Good  
Fall: Good  
Winter: Good  
Regrowth: Good

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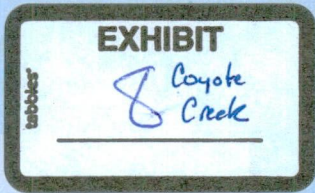
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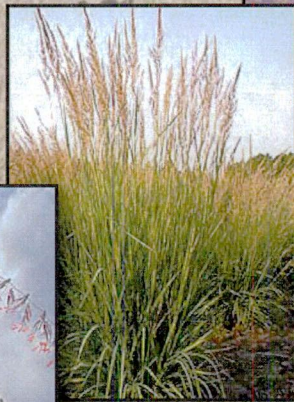
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# Grasses for the Northern Plains

Growth Patterns, Forage Characteristics  
and Wildlife Values

Volume II - Warm-season



Kevin K. Sedivec  
Dwight A. Tober  
Wayne L. Duckwitz  
David D. Dewald  
Jeffrey L. Printz  
Donavon J. Craig

*Helping People Help the Land*



U.S. Department of Agriculture  
Natural Resources Conservation Service



Extension Service  
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Cooperators and partners in the warm-season grass evaluation trials, together with NDSU and the USDA, NRCS Plant Materials Center at Bismarck, North Dakota, have included: the U.S. Department of Interior, Fish and Wildlife Service (J. Clark Salyer National Wildlife Refuge near Upham, North Dakota; the Wetland Management District at Fergus Falls, Minnesota; and the Karl E. Mundt National Wildlife Refuge near Pickstown, South Dakota); the South Dakota Department of Agriculture Forestry Division; the South Dakota Department of Game, Fish, and Parks; the Minnesota Department of Natural Resources, Division of Forestry; the U.S. Army Corps of Engineers; the USDA, NRCS field and area offices and Soil and Water Conservation District offices located at Bottineau, North Dakota; Fergus Falls, Minnesota; Lake Andes, South Dakota; Onida, South Dakota; Rochester, Minnesota, and Pierre, South Dakota; the Southeastern Minnesota Association of Soil and Water Conservation Districts; the Hiawatha Valley Resource Conservation and Development Area (Minnesota); and the North Central Resource Conservation and Development Office (South Dakota).

Background cover photo: Kenny Miller, Fort Rice, N.D. All other cover photos: NRCS and NDSU Extension Service. Seed photos: E. Brent Turnipseed, Ph.D., professor/director, Seed Testing Laboratory, South Dakota State University, Brookings.

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# Introduction

**G**rasses commonly are planted as permanent forage for livestock production, cover type for wildlife habitat and conservation practices for soil protection. They provide a major staple in the diets of domestic and wild herbivores, habitat structure for many wildlife species and ground cover to stabilize soils. Both cool- and warm-season grasses are utilized, depending on the resource needs and objectives of the land manager. Cool-season grasses are defined as plants that produce the major portion of their growth during late spring/early summer, with a second growth occurring in late summer/early fall, depending on moisture conditions. Warm-season grasses produce most or all of their growth during the late spring to early fall period. This publication will concentrate on selected warm-season grasses, listing the most pertinent releases adapted to the Northern Plains. For information on cool-season grasses, see publication “Grasses for the Northern Plains: Growth Patterns, Forage Characteristics and Wildlife Values. Volume I – Cool-season” (Sedivec et al. 2008).

Selection of the proper species and variety is an important step when choosing a grass seedling mixture. Grass species and varieties differ in growth habitat, productivity, forage quality, drought resistance, tolerance to grazing, winter hardiness, seedling vigor, salinity tolerance and many other characteristics. Therefore, selection should be based on the climate, soils, intended use and planned management. Planting the prop-

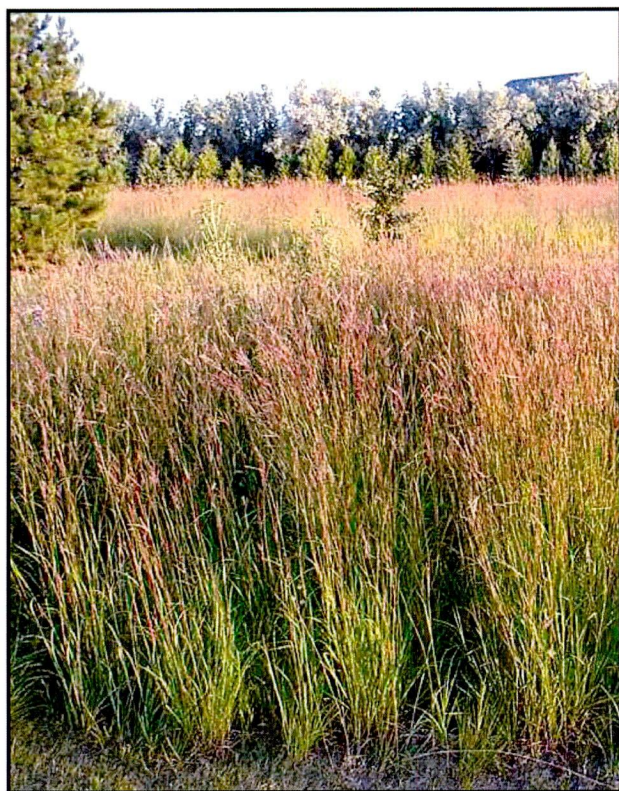
er selection also can provide long-term benefits and affect future productivity of the stand.

This publication is designed to summarize the growth patterns; forage characteristics, including nutritional value and herbage production; plant performance characteristics, including stand density index, stand rating and disease; fiber content; wildlife values; and a list of varieties suited to the Northern Plains ecoregion. This select group of warm-season grasses was studied at seven field trial locations and two experiments in North and South Dakota and Minnesota. The first experiment, or original study, was conducted during a period of 11 years beginning in 1982 under different environmental conditions at Upham, N.D.; Onida, Fort Pierre and Lake Andes, S.D.; and Fergus Falls and Rochester, Minn. The second experiment was a growth pattern and nutritional study conducted at Hettinger, N.D., and Fort Pierre, S.D., in 1999 and 2000. Recommended seeding rates and specific guidelines can be obtained by consulting your county conservation district, Natural Resources Conservation Service (NRCS) or Extension Service office.

Performance and adaptation of warm-season grasses differ by point of seed origin. Adaptation trials in the Northern Plains have shown that seed sources of warm-season grasses generally can be moved 300 miles north or 200 miles south of their origin without serious adaptation difficulties.

### Grass Species and Varieties

The six original field trials included 33 accessions/ varieties of seven different grass species (Table 1). They were evaluated for stand density index, stand rating, herbage production and phenology from 1982 to 1992. The Hettinger site was seeded in 1998 and included additional entries. The second experiment, which included 11 and 14 accessions/varieties of six and seven different grass species, were evaluated for growth pattern, forage characteristics, nutritional quality and fiber content from 1999 to 2000 at Hettinger, N.D., and Fort Pierre, S.D. (Table 1). The warm-season grasses at Hettinger and Fort Pierre were selected for this second study based upon popularity and future potential. All species are native to North America. The second study will be further referenced throughout the remainder of this document as the Growth Pattern and Nutritional Study (GPNS). The USDA PLANTS database was used for taxonomic nomenclature (USDA NRCS 2008).



**Big bluestem.**

**Table 1. List of grass species and variety of each warm-season grass tested near Upham and Hettinger, N.D.; Onida, Lake Andes and Fort Pierre, S.D.; and Fergus Falls and Rochester, Minn.**

Grass Species	Common Name	Release
<i>Andropogon gerardii</i>	Big bluestem	Bison
<i>Andropogon gerardii</i>	Big bluestem	Sunnyview
<i>Andropogon gerardii</i>	Big bluestem	Bonilla
<i>Andropogon gerardii</i>	Big bluestem	Champ
<i>Andropogon gerardii</i>	Big bluestem	Pawnee
<i>Andropogon gerardii</i>	Big bluestem	Kaw
<i>Andropogon gerardii</i>	Big bluestem	Rountree
<i>Andropogon hallii</i>	Sand bluestem	Garden
<i>Andropogon hallii</i>	Sand bluestem	Goldstrike
<i>Bouteloua curtipendula</i>	Sideoats grama	Butte
<i>Bouteloua curtipendula</i>	Sideoats grama	Pierre
<i>Bouteloua curtipendula</i>	Sideoats grama	Trailway
<i>Bouteloua curtipendula</i>	Sideoats grama	Killdeer
<i>Bouteloua gracilis</i>	Blue grama	Bad River
<i>Bouteloua gracilis</i>	Blue grama	Willis
<i>Calamovilfa longifolia</i>	Prairie sandreed	Goshen
<i>Calamovilfa longifolia</i>	Prairie sandreed	Bowman
<i>Panicum virgatum</i>	Switchgrass	Dacotah
<i>Panicum virgatum</i>	Switchgrass	Forestburg
<i>Panicum virgatum</i>	Switchgrass	Sunburst
<i>Panicum virgatum</i>	Switchgrass	Nebraska 28
<i>Panicum virgatum</i>	Switchgrass	Summer
<i>Panicum virgatum</i>	Switchgrass	Pathfinder
<i>Panicum virgatum</i>	Switchgrass	Trailblazer
<i>Panicum virgatum</i>	Switchgrass	Cave-in-Rock
<i>Panicum virgatum</i>	Switchgrass	Blackwell
<i>Schizachyrium scoparium</i>	Little bluestem	Badlands
<i>Schizachyrium scoparium</i>	Little bluestem	Camper
<i>Schizachyrium scoparium</i>	Little bluestem	Blaze
<i>Schizachyrium scoparium</i>	Little bluestem	Aldous
<i>Schizachyrium scoparium</i>	Little bluestem	Cimarron
<i>Sorghastrum nutans</i>	Indiangrass	Oto
<i>Sorghastrum nutans</i>	Indiangrass	Osage
<i>Sorghastrum nutans</i>	Indiangrass	Rumsey
<i>Sorghastrum nutans</i>	Indiangrass	Holt
<i>Sorghastrum nutans</i>	Indiangrass	Tomahawk



Plots near Fergus Falls, Minnesota.

Plots near Fort Pierre, South Dakota.

### Study Area and Design

The GPNS portion of this research and demonstration project was conducted on private land south of Hettinger, N.D., and public land northwest of Fort Pierre, S.D. All grass species and varieties were planted on a Shambo loam near Hettinger and Promise soil series near Fort Pierre. Shambo soils are classified as fine loamy, mixed, super-active, frigid, Typic Haplustolls with nearly level slope (Ulmer and Conta 1987). Promise soil is classified as clay with nearly level slope, somewhat poor drainage, moderate levels of organic matter and poor tilth (Borchers 1980). The other five sites were on the U.S. Fish and Wildlife Service J. Clark Salyer National Wildlife Refuge near Upham, N.D., on a Great Bend silty clay loam; U.S. Fish and Wildlife Service Karl E. Mundt National Wildlife Refuge near Lake Andes, S.D., on an Agar silt loam; South Dakota Department of Game, Fish and Parks land near Onida, S.D., on a Lowry silt loam; the U.S. Fish and Wildlife Service Wetland Management District near Fergus Falls, Minn., on a Barnes and Langhei loam; and Minnesota Department of Natural Resources land near Rochester, Minn., on a Mount Carrol silt loam.

All varieties or experimental lines were seeded in plots that varied in size from 12 to 15 feet wide and 60

to 100 feet in length. They were seeded with a native grass drill (Truax®) on June 14-16, 1982, at Upham; May 23-24, 1984, at Onida; June 7-9, 1982, at Fergus Falls; May 20-21, 1986, at Fort Pierre; June 7-8, 1983, at Lake Andes; June 4-5, 1985, at Rochester; and May 5, 1998, at Hettinger using a randomized complete block design with three replications (Figure 1). Seeding rate varied with species but followed recommended seeding rates as specified in the NRCS Field Office Technical Guide (USDA NRCS 2006).

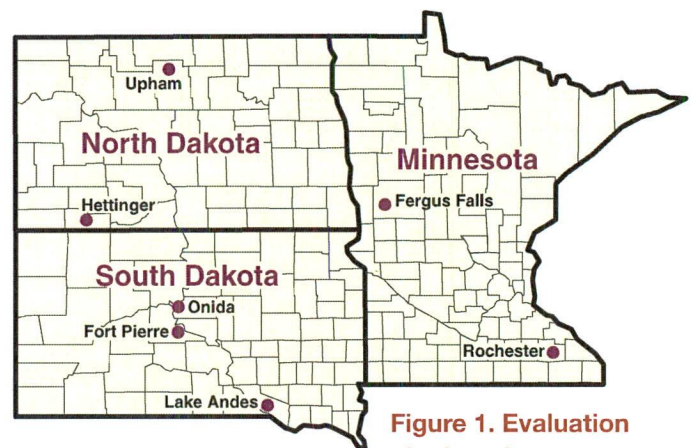


Figure 1. Evaluation plot locations.

**Climate**

North and South Dakota and Minnesota are near the geographic center of North America, resulting in a continental climate characterized by continuous air movement and large annual, daily and within-a-day temperature changes. Relative humidity is low and precipitation tends to be irregular in time and distribution in the western two-thirds of the Dakotas. Relative humidity tends to be higher and precipitation greater and more frequent in the eastern Dakotas and Minnesota.

Seventy to 75 percent of the annual precipitation falls during the spring and summer months, with 40 to 50 percent falling during May, June and July in North and South Dakota and Minnesota. Monthly precipitation and the long-term average are presented for each location during the corresponding study period (Tables 2-8).

**Table 2. Monthly precipitation at Hettinger Experiment Station, Hettinger, N.D., for 1998-2000.**

Month	1998	1999	2000	Average
January	0.24	0.29	0.14	0.30
February	1.47	0.31	0.64	0.32
March	0.60	0.59	0.83	0.60
April	0.50	0.94	1.16	1.59
May	1.37	2.05	3.07	2.54
June	2.79	3.36	2.41	2.95
July	1.17	2.44	2.61	2.16
August	1.57	3.16	0.70	1.46
September	0.57	0.77	0.32	1.40
October	4.18	0.26	1.00	1.35
November	0.62	0.52	0.54	0.53
December	0.00	0.30	0.19	0.31
<b>Totals</b>	<b>15.08</b>	<b>14.99</b>	<b>13.61</b>	<b>15.51</b>

**Table 3. Monthly precipitation from the official weather station at Fort Pierre, S.D., for 1986-1992 and 1998-2000.**

Month	1986	1987	1988	1989	1990	1991	1992	1998	1999	2000	Average
January	0.43	0.03	0.11	0.08	0.02	0.28	0.72	0.28	0.40	0.40	0.28
February	0.99	2.70	0.18	0.47	0.33	1.33	0.62	0.76	0.62	0.33	0.83
March	1.36	2.47	0.22	1.15	0.74	0.63	1.23	1.81	0.18	0.98	1.08
April	6.38	0.18	0.81	1.19	2.33	2.74	0.27	2.62	1.73	3.37	2.16
May	3.35	4.34	2.41	0.89	1.73	6.26	0.65	1.57	1.82	3.74	2.68
June	3.19	1.19	3.64	0.53	2.13	3.36	3.69	3.38	2.03	4.42	2.76
July	2.75	1.56	0.33	1.65	2.25	0.55	6.04	3.78	3.40	2.28	2.46
August	1.44	2.42	0.94	1.30	1.03	1.07	2.42	0.64	1.12	1.74	1.41
September	2.12	0.66	1.08	4.06	0.89	0.81	1.41	1.35	0.31	0.92	2.15
October	0.87	0.07	0.26	0.97	0.54	1.41	0.29	0.44	3.21	4.82	1.29
November	1.13	0.20	0.38	0.65	0.09	0.40	1.33	1.20	0.03	0.56	0.60
December	0.00	0.98	0.42	0.37	0.26	0.11	0.20	0.37	0.29	0.16	0.32
<b>Totals</b>	<b>24.01</b>	<b>16.80</b>	<b>10.78</b>	<b>13.31</b>	<b>12.34</b>	<b>18.95</b>	<b>18.87</b>	<b>18.20</b>	<b>15.14</b>	<b>23.72</b>	<b>18.02</b>

**Table 4. Monthly precipitation from the official weather station at Rochester, Minn., for 1986-1991.**

Month	1986	1987	1988	1989	1990	1991	Average
January	0.59	0.58	1.16	0.41	0.55	0.67	0.78
February	0.61	0.30	0.21	0.42	0.71	0.45	0.74
March	2.15	1.28	1.60	1.59	3.58	2.82	1.77
April	3.80	1.01	2.43	3.56	6.47	5.25	2.72
May	3.40	2.03	2.33	1.74	4.52	3.84	3.39
June	5.04	3.69	1.59	2.39	9.27	2.25	3.71
July	6.00	7.24	1.12	2.75	8.29	5.30	4.20
August	3.17	3.85	2.87	5.62	5.30	4.66	3.87
September	10.50	2.04	3.77	0.61	1.30	2.31	3.46
October	3.57	1.60	0.36	1.60	1.86	1.99	2.31
November	0.84	1.94	2.87	1.62	0.44	5.90	1.61
December	0.40	1.39	1.08	0.42	1.65	1.47	1.02
<b>Totals</b>	<b>40.07</b>	<b>26.95</b>	<b>21.39</b>	<b>22.73</b>	<b>43.94</b>	<b>36.91</b>	<b>29.58</b>

**Table 5. Monthly precipitation from the official weather station at Upham, N.D., for 1982-1987.**

Month	1982	1983	1984	1985	1986	1987	Average
January	1.18	0.40	0.50	0.50	0.30	0.33	0.46
February	0.33	0.22	0.16	0.33	0.47	0.84	0.41
March	1.12	1.39	0.57	0.85	0.12	1.39	0.49
April	0.22	0.40	4.20	1.96	3.92	0.14	1.36
May	4.29	2.05	0.18	3.13	0.96	1.78	2.11
June	2.67	3.77	2.48	2.85	1.37	2.20	3.08
July	1.17	2.75	1.45	0.41	3.91	5.06	2.15
August	3.96	1.35	0.38	4.00	1.27	2.28	2.41
September	1.83	2.71	1.06	1.11	1.44	0.66	1.77
October	3.13	0.85	3.79	1.36	0.44	0.03	0.88
November	0.15	0.82	1.55	0.95	1.63	0.12	0.48
December	1.18	0.35	0.66	0.26	0.16	0.02	0.48
<b>Totals</b>	<b>21.23</b>	<b>17.06</b>	<b>16.98</b>	<b>17.71</b>	<b>15.99</b>	<b>14.85</b>	<b>16.08</b>

**Table 6. Monthly precipitation from the official weather station at Fergus Falls, Minn., from 1982-1987.**

Month	1982	1983	1984	1985	1986	1987	Average
January	0.54	0.19	0.32	0.30	0.40	0.73	0.84
February	0.51	0.31	0.60	0.12	0.44	0.65	0.62
March	1.10	1.44	0.66	0.72	0.80	1.74	1.05
April	0.61	0.35	2.20	0.74	4.38	0.39	2.37
May	2.69	0.81	0.81	6.90	2.77	4.11	2.74
June	2.40	4.40	9.52	2.91	3.70	0.72	4.36
July	2.86	3.90	0.80	4.41	5.01	3.08	3.21
August	4.10	3.38	2.11	3.40	4.57	2.05	3.01
September	2.08	2.18	1.16	1.75	6.56	1.08	2.09
October	3.95	0.95	6.33	1.05	0.13	0.61	1.45
November	0.48	1.20	0.06	1.36	0.95	0.61	0.96
December	0.26	0.45	0.46	0.71	0.04	0.55	0.82
<b>Totals</b>	<b>21.58</b>	<b>19.56</b>	<b>25.03</b>	<b>24.37</b>	<b>29.75</b>	<b>16.32</b>	<b>23.52</b>

**Table 7. Monthly precipitation from the official weather station at Onida, S.D., from 1984-1989.**

Month	1984	1985	1986	1987	1988	1989	Average
January	0.05	0.45	0.66	0.25	0.20	0.19	0.38
February	0.40	0.02	1.25	2.05	0.34	0.79	0.63
March	1.39	2.20	1.26	2.12	0.22	1.57	0.99
April	2.73	1.10	5.47	0.26	0.67	2.69	1.96
May	2.46	1.09	3.39	3.69	2.20	1.05	2.64
June	6.33	1.39	2.79	2.31	1.58	1.10	3.09
July	2.14	2.11	3.46	0.88	2.19	3.11	1.94
August	2.17	2.78	0.89	2.59	3.64	1.26	2.38
September	0.86	1.98	1.69	0.64	0.67	3.96	1.29
October	1.71	1.38	0.79	0.13	0.17	0.91	1.13
November	0.26	2.30	1.09	0.10	0.64	0.75	0.53
December	1.10	0.80	0.00	0.59	0.88	0.42	0.51
<b>Totals</b>	<b>21.60</b>	<b>17.60</b>	<b>22.74</b>	<b>15.61</b>	<b>13.40</b>	<b>17.80</b>	<b>17.47</b>

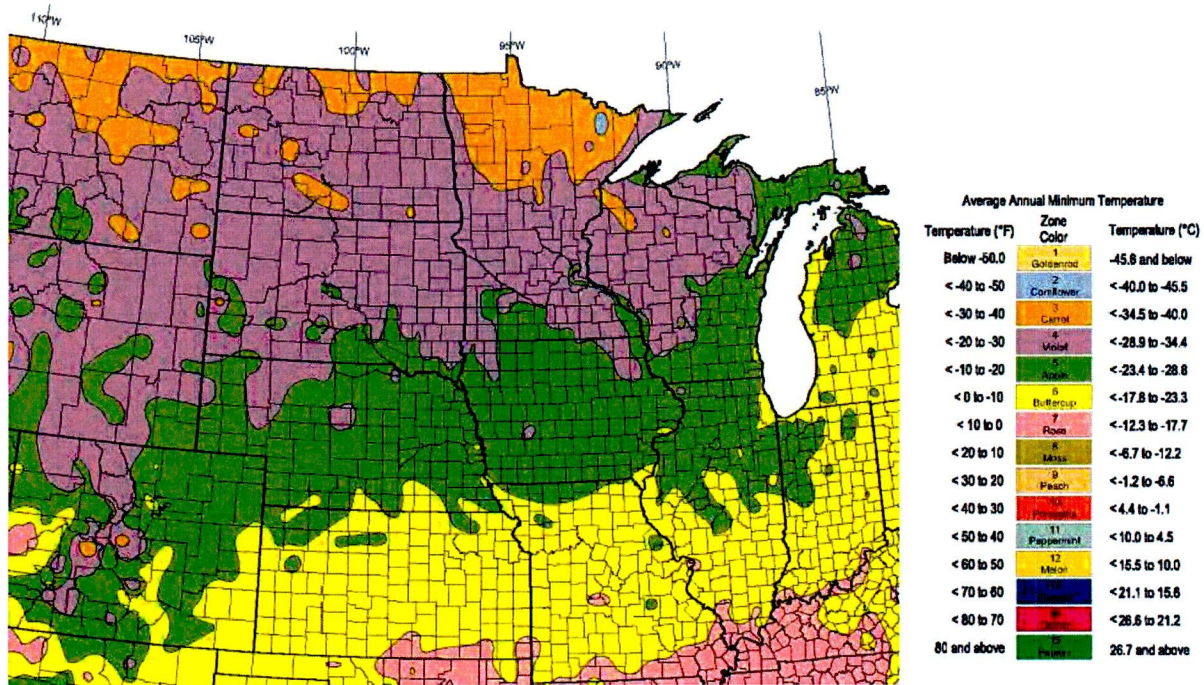
**Table 8. Monthly precipitation from the official weather station at Lake Andes, S.D., from 1983-1988.**

Month	1983	1984	1985	1986	1987	1988	Average
January	0.40	0.07	0.56	0.48	0.07	0.57	0.38
February	0.15	0.74	0.05	0.20	1.08	0.23	0.68
March	3.19	1.80	1.29	2.24	7.70	0.69	1.21
April	1.95	6.99	2.93	5.99	0.87	3.48	2.29
May	3.31	3.42	1.34	3.41	1.07	4.48	2.92
June	6.07	8.70	1.99	6.66	1.34	2.36	3.85
July	2.87	3.59	2.02	2.37	4.26	1.96	2.65
August	0.17	2.44	5.81	1.86	2.11	3.04	2.51
September	0.78	0.91	2.85	6.97	4.13	4.19	2.21
October	0.87	3.93	0.65	1.47	0.37	0.28	1.27
November	1.65	1.01	1.38	0.41	1.16	0.91	0.77
December	0.71	0.47	0.63	0.00	0.92	0.18	0.63
<b>Totals</b>	<b>22.20</b>	<b>34.27</b>	<b>21.16</b>	<b>32.06</b>	<b>25.08</b>	<b>22.37</b>	<b>21.37</b>

A plant hardiness zone recommendation is made for each release of the eight warm-season species contained in this publication. Use the plant hardiness map (Figure 2) and recommendations to determine which release will perform best at your location.

### Herbage Production from the Growth Pattern and Nutritional Study (GPNS)

Switchgrass had the highest herbage production from the GPNS at both study areas in 1999 and 2000. When yearly differences occur within a grass variety, it is due to variability and timing of year-to-year precipitation. Dacotah switchgrass produced the greatest amount of herbage at Fort Pierre in 1999; however, Forestburg switchgrass produced the greatest amount of herbage at Fort Pierre and Hettinger in 2000 (Table 9).



**Figure 2. United States Department of Agriculture (1990) hardiness zones and average annual minimum temperature.** (American Horticultural Society, Coordinated by Dr. H. Marc Cathey, President Emeritus, and USDA-ARS, Washington, D.C.)

**Table 9. Cumulative herbage production (lb/ac) of selected warm-season grasses from the Growth Pattern and Nutritional Study near Hettinger, N.D., and Fort Pierre, S.D., in 1999-2000.**

Species	Variety	Fort Pierre		Hettinger	
		1999	2000	2000	Mean
Switchgrass	Forestburg	2,992	5,343	5,447	4,594
Switchgrass	Dacotah	3,183	3,154	4,127	3,488
Big bluestem	Sunnyview	2,185	4,575	2,779	3,180
Big bluestem	Bison	2,412	3,894	3,165	3,157
Sand bluestem	Garden	—	—	3,755	3,755
Sand bluestem	Goldstrike	—	—	2,888	2,888
Blue grama	Bad River	—	—	2,714	2,714
Blue grama	Willis	—	—	2,640	2,640
Prairie sandreed	Bowman	3,208	3,809	2,076	3,031
Prairie sandreed	Goshen	1,613	3,083	1,529	2,075
Little bluestem	Camper	1,983	2,614	2,112	2,236
Little bluestem	Badlands	—	—	1,047	1,047
Indiangrass	Holt	1,903	2,261	—	2,082
Indiangrass	Tomahawk	2,059	1,729	—	1,894
Sideoats grama	Butte	376	252	3,921	1,516
Sideoats grama	Pierre	773	412	3,362	1,515



**Switchgrass varieties differ in physical characteristics.**

### **Field Evaluation for Plant Characteristics of the Original Study**

Each accession/variety was evaluated for stand rating, stand density index, herbage production and phenology at Upham, N.D.; Fergus Falls, Minn.; Lake Andes, S.D.; Onida, S.D.; Rochester, Minn.; and Fort Pierre, S.D. Stand rating was conducted midsummer for a minimum of three years for each study area and rated 1 for excellent, 5 for fair and 9 for very poor. Stand density index (percent of full rows in sample frames where a "Full Frame = 40") was collected for two or more consecutive years at each field trial location in midsummer. Herbage production was clipped annually with a forage harvester at each field trial location at the end of the growing season (USDA NRCS 1983-1993). All samples were weighed with subsamples collected and oven dried at 140 F for 48 hours. Subsamples were weighed to the nearest 0.1 gram and converted to lb/ac. Plant maturity or phenology was determined in early September at all field trial locations except Upham, N.D., where phenology was determined in early August. Plant hardiness is listed for each variety and classified by zones in the introduction section for each species.



### **Plant Description, Growth Patterns, Nutritional Quality and Use Potential for the Growth Patterns and Nutritional Study (GPNS)**

Selected warm-season grasses were analyzed for nutritional quality, herbage production and plant growth patterns at Hettinger, N.D., and Fort Pierre, S.D., in 1999 and 2000. Above-ground biomass were estimated for each variety by sampling approximately May 31, June 21, July 12, Aug. 1, Aug. 22, Sept. 12, and Oct. 3 in 1999 and 2000. Standing vegetation was clipped at 0.5 inch from ground level from each subplot of each variety using a 0.25 m<sup>2</sup> frame placed in a designated quadrant as randomly selected for each clipping period. Vegetation was placed into a paper bag with clipping date and physiological growth stage recorded at each clipping period. All samples were oven dried at 140° F until weight was constant and weighed to the nearest 0.1 gram.

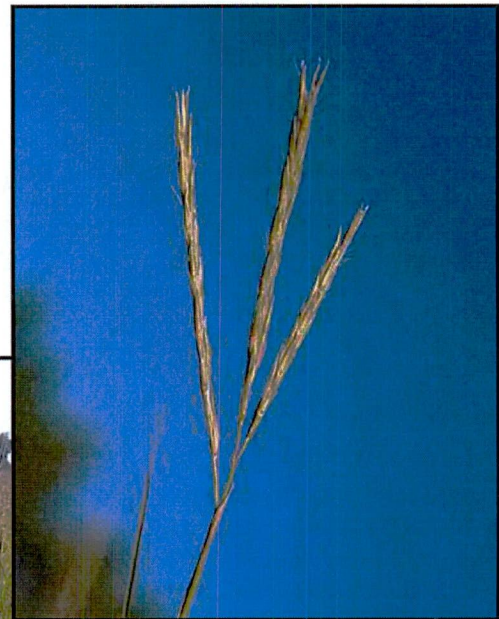
Nutritional quality and herbage (forage) production were determined from unharvested, warm-season grass clippings at the seven periods throughout the growing season beginning in late May and ending in early October. Each of the grass varieties were tested for dry-matter, ash, crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), in vitro dry-matter digestibility (IVDMD), phosphorus and calcium. All samples were ground through a 1 mm screen in a Wiley mill and analyzed at the North Dakota State University Animal and Range Sciences nutritional laboratory. Dry matter, ash and ADF were determined following standardized procedures (AOAC 1990), NDF using procedures described by Robertson and Van Soest (1982) and CP using the Kjeldahl Auto System II (AOAC 1990). In vitro dry-matter digestibility was determined for each grass species using methods described by Tilley and Terry (1973). Herbage production was determined for each of the grass varieties for each clipping period to determine peak production and growth patterns.

# Big Bluestem

**B**ig bluestem (also known as “turkey foot”) is a native, tall statured (36 to 60 inches tall), sod-forming, long-lived perennial grass that begins growth in late May and flowers in late July to mid-August. Big bluestem has scaly underground stems and an extensive root system that may reach to 12 feet in depth. Young shoots are somewhat flattened at the base, reddish to purplish tinged and usually covered with silky hairs. Leaves of mature, healthy big bluestem plants are large ( $\frac{1}{4}$  to  $\frac{1}{2}$  inch wide), numerous, and have coarse hairs. Plants remain green throughout the summer, turning red with maturity.

It is adapted to most loam, clay loam and sandy loam-textured soils but has a low tolerance to saline and/or sodic soils. Big bluestem was the

dominant grass of the tallgrass prairie and still dominates the better managed tallgrass prairie remnants. In the mixed-grass prairie, big bluestem occurs as a minor component on loamy and clayey ecological sites and a co-dominant on the overflow (run-on landscape position) and subirrigated ecological sites. Big bluestem occurs in southern Canada and from Maine to Montana, south to Florida and New Mexico and into Mexico.



## Big bluestem

Releases	Release Type	Date Released	Origin	Statement of Use
<b>Boundary Ecovar</b>	Source Identified	2009	Manitoba and eastern Saskatchewan, Canada	Native collection of big bluestem with characteristics typical for that species in that area. Recommended in plant hardiness zones 3-4.
<b>Bonanza</b>	Variety	2005	ARS, Lincoln, Nebraska	Significantly greater forage digestibility than similarly adapted varieties Pawnee, Rountree and Niagara. Bonanza was developed from the base population of the cultivar Pawnee. Recommended in plant hardiness zone 4.
<b>Goldmine</b>	Variety	2005	ARS, Lincoln, Nebraska	Improved forage quality and forage yields in some hay management systems and improved animal gains in comparison with its parent variety, Kaw, when utilized by beef cattle in well-managed grazing systems. Higher forage yields and forage IVDMD than the varieties Pawnee, Rountree and Niagara reported in replicated trials. Recommended in plant hardiness zones 5-6.
<b>Southlow Michigan Germplasm</b>	Source Identified	2001	Michigan	Native harvest from the southern half of Michigan's Lower Peninsula. No intended selection. Material does not differ from naturally occurring big bluestem found in this area. Recommended in plant hardiness zones 4-5.
<b>Northern Iowa Germplasm</b>	Source Identified	2000	Iowa	Native harvest from multiple sites in northern Iowa. No intended selection for improvement. Recommended in plant hardiness zone 4.
<b>Northern Missouri Germplasm</b>	Source Identified	1999	Iowa	Native harvest from multiple sites in northern Missouri. No intended selection for improvement. Recommended in plant hardiness zone 5.
<b>Southern Iowa Germplasm</b>	Source Identified	1999	Iowa	Native harvest from multiple sites in southern Iowa. No intended selection for improvement. Recommended in plant hardiness zone 5.
<b>Central Iowa Germplasm</b>	Source Identified	1998	Iowa	Native harvest from multiple sites in central Iowa. No intended selection for improvement. Recommended in plant hardiness zones 4-5.
<b>Sunnyview</b>	Variety	1998	South Dakota	Selected for vigor, leafiness and seed yield. Sunnyview had the highest average forage yields at 5 of 6 replicated trials conducted in South Dakota, North Dakota and Minnesota. Later maturing than Bison and Bonilla and flowers about 12-25 days earlier than Pawnee and Kaw at Brookings, S.D. Recommended in plant hardiness zones 3-4.
<b>Bison</b>	Variety	1989	North Dakota	Selected for uniform plant type with good leafiness, high plant vigor, seed yields and winter hardiness. Bison is 20 days earlier in anthesis than the variety Bonilla and 30-48 days earlier than the southern varieties Kaw, Champ and Pawnee. Bison tends to be shorter in mature height. Recommended in plant hardiness zones 3-4.

Releases	Release Type	Date Released	Origin	Statement of Use
<b>Bonilla</b>	Variety	1987	South Dakota	Selected for high seed and forage yields and winter survival. Superior winter hardiness, persistence and seed production ability. Forage production exceeds that of Bison and is equal to Champ and Kaw at northern latitudes. Average daily gains of yearling steers have been higher for Bonilla than Pawnee in grazing studies at Morris, Minn. Recommended in plant hardiness zones 3-4.
<b>Champ</b>	Variety	1963	Nebraska	Moderately late maturing, averages 7-10 days earlier in seed maturity than Pawnee. Recommended in plant hardiness zones 4-5.
<b>Rountree</b>	Variety	1983	Iowa	Increased seedling vigor, increased leaf rust resistance, superior forage and seed production, and increased resistance to lodging. Recommended in plant hardiness zone 4.
<b>Pawnee</b>	Variety	1963	Nebraska	Typical of big bluestem of the central prairies. Produces good forage yields in Nebraska; superior to native strains originating farther north and west. Improved seed yields and seed quality. Recommended in plant hardiness zones 5-6.

**Big Bluestem**

The NRCS recognizes four release types. These are variety (also commonly referred to as cultivar), tested, selected and source-identified. Variety, tested and selected release types have varying degrees of performance data collected for the release. Source-identified releases do not require performance documentation.

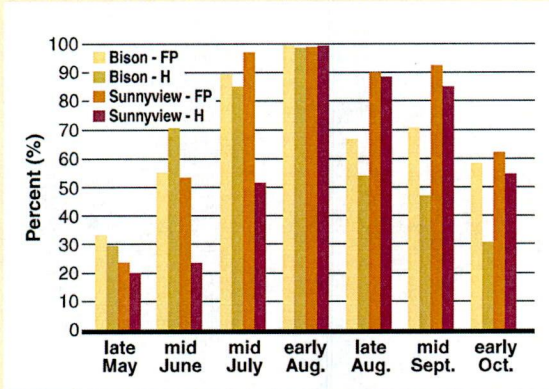
**Performance Characteristics**

Big bluestem releases were studied for stand establishment and density index ratings (Table 10). The releases compared were Bison, Bonilla, Sunnyview, Rountree, Champ, Pawnee, and Kaw. Stand establishment ratings generally were good for all big bluestem entries across all sites. Stand ratings were similar for all releases, but variation occurred among sites. The big bluestem plots at Fort Pierre, S.D., had the lowest rated stands overall. This was the only site with heavy clay soils. The low-rated stands may have been related to soil crusting during

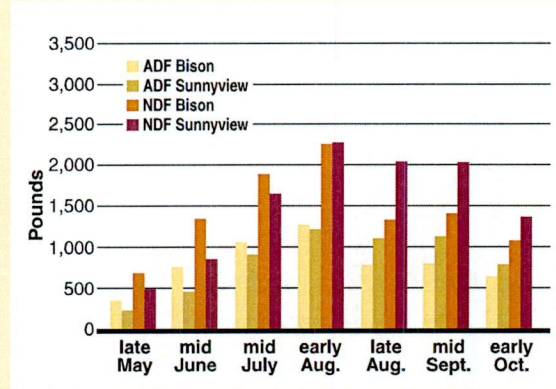
seedling emergence. The plots at Upham, N.D., and Lake Andes, S.D., had the highest rated stands and also the most productive soils.

Bison and Bonilla were the two northern-most origin releases and generally were noted to have among the highest density index ratings. Stand index density was determined by estimating the number of plants in a 9-inch by 16-inch frame. The density index rating was developed with values ranging from 0 (no stand) to 40 (full stand) to estimate density. Values ranged from 23 to 30 for Bison and 21 to 39 for Bonilla. The lower density index ratings generally were associated with the more southern-origin releases. Comparing the six sites, Lake Andes, S.D., had the highest range of values (16 to 39) and Rochester, Minn., had the lowest (10 to 25). With the exception of Kaw, no specific damage caused by winter injury was noted for any of the big bluestem entries, including those of southern origin.

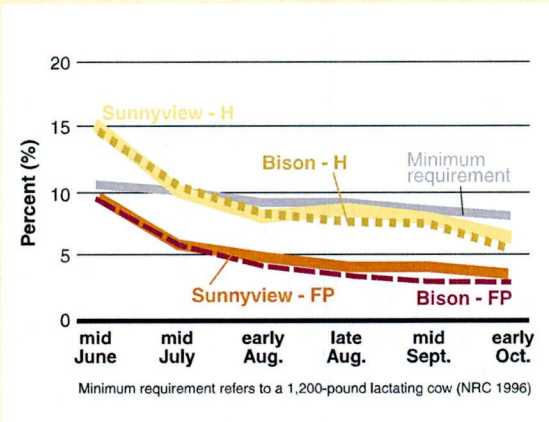
# Big Bluestem



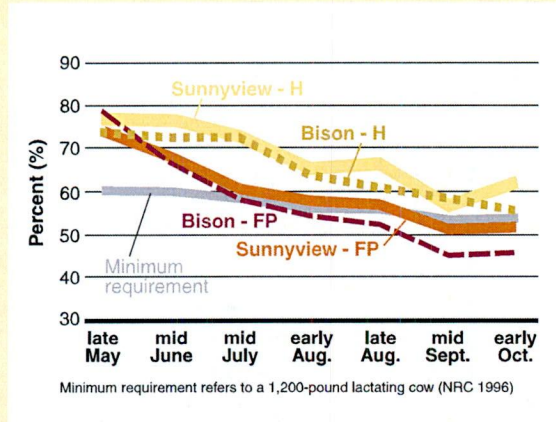
Percent of average peak standing biomass for big bluestem at Fort Pierre (FP) and Hettinger (H)



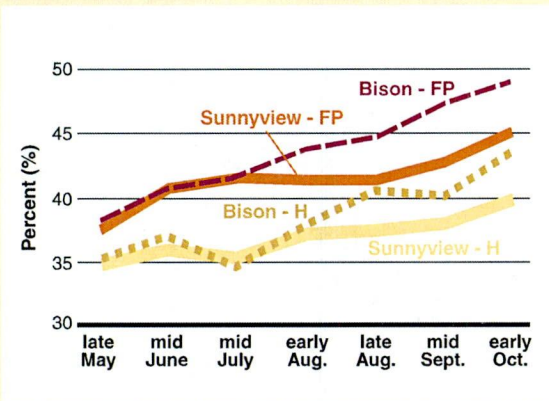
Pounds of acid detergent fiber and natural detergent fiber per acre for each period of big bluestem



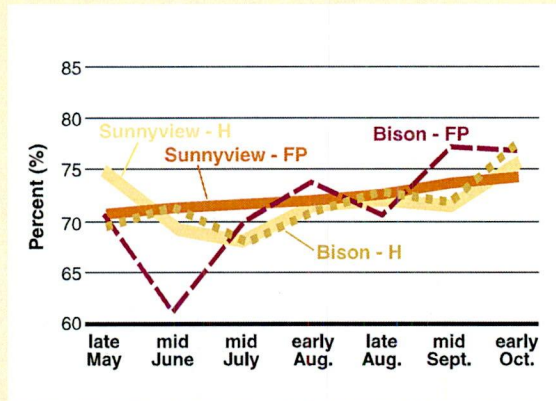
Crude protein content of big bluestem at Fort Pierre (FP) and Hettinger (H)



In vitro dry-matter digestibility of big bluestem at Fort Pierre (FP) and Hettinger (H)



Acid detergent fiber of big bluestem at Fort Pierre (FP) and Hettinger (H)



Neutral detergent fiber of big bluestem at Fort Pierre (FP) and Hettinger (H)

The varietal differences noted in phenology were similar at all six sites (Table 11). Bison had the earliest maturity. Generally, Bonilla was 15 to 30 days later than Bison. The other releases of big bluestem were later in maturity than Bison or Bonilla, but considerable variability occurred, depending on the site location. Kaw big bluestem had the latest maturity at all six sites and often had not reached anthesis by early September.

**Herbage Production**

Year and variety effects ( $P < 0.1$ ) occurred at all six sites during the six-year period in the original study. When creating an average biomass ranking across the six sites (1-7, with the lower number better), Sunnyview was the most productive variety with a rating of 1.5. Rankings from second through seventh were Pawnee (2.8), Kaw (2.8), Champ (3.2), Rountree (4.5), Bison (5.5) and Bonilla (5.8). Earlier-maturing, northern-origin varieties are less productive than later-maturing, southern-origin varieties (see Table 11 for biomass range, average and ranking for each variety and study area).

Cumulative herbage production from the GPNS for Bison was 2,412 and 3,894 lb/ac in 1999 and 2000, respectively, at Fort Pierre (Table 9). Sunnyview cumulative herbage production was 2,185 and 4,575 lb/ac in

1999 and 2000, respectively, at Fort Pierre. No difference ( $P > 0.1$ ) was found between varieties in 1999 and 2000 at both Hettinger and Fort Pierre. Mean herbage production was not different between Sunnyview and Bison (3,180 vs. 3,157 lb/ac) (Table 9). Although Sunnyview and Bison were similar in overall herbage production in the GPNS conducted at two sites for two years, Sunnyview was superior to all other varieties in the original study, which included six sites and five years.

**Growth Patterns**

Bison initiates greater growth in May and June than Sunnyview; however, both varieties reached peak herbage production in early August at both study sites. Sunnyview maintained more standing biomass than Bison through September and, depending on moisture, had less senescence and greater regrowth.

**Nutritional Quality**

Location was more critical in crude protein (CP) and in vitro dry-matter digestibility (IVDMD) than variety in the GPNS. Nutritional quality (CP, IVDMD) was similar between Bison and Sunnyview at both study locations (Hettinger and Fort Pierre); however, Fort Pierre had

**Table 10. Big bluestem stand rating (1-9)<sup>a</sup> and density index (0-40)<sup>b</sup> at Upham, N.D.; Fergus Falls and Rochester, Minn.; Onida, Fort Pierre and Lake Andes, S.D.**

Varieties	Performance	Upham	Fergus Falls	Rochester	Onida	Fort Pierre	Lake Andes
<b>Bison</b>	Stand Rating	1	2.3	3.0	2.3	2.9	2.5
	Density Index	30	23	23	28	28	27
<b>Bonilla</b>	Stand Rating	1.3	2.6	2.5	2.5	3.8	2.1
	Density Index	32	25	21	26	23	39
<b>Sunnyview</b>	Stand Rating	1	3.3	2.4	2.9	4.5	1.8
	Density Index	25	20	10	25	16	24
<b>Rountree</b>	Stand Rating	NA	NA	2.6	3.5	3.1	3.0
	Density Index			25	21	26	16
<b>Champ</b>	Stand Rating	1.4	3.6	2.3	3.0	3.6	1.6
	Density Index	21	14	25	25	28	28
<b>Pawnee</b>	Stand Rating	1.2	2.7	2.3	2.8	2.3	1.7
	Density Index	26	21	22	30	30	20
<b>Kaw</b>	Stand Rating	1.3	2.6	3.9	3.5	4.2	1.6
	Density Index	18	21	18	24	22	28

<sup>a</sup>Stand rating: 1 = highest, 9 = lowest.

<sup>b</sup>Density index: estimate of plant density, 40 = highest.

CP levels 3 percent to 5 percent lower than Hettinger throughout the growing season. The IVDMD also was similar between varieties, with initial quality similar between Fort Pierre and Hettinger; however, it was 11 percent lower by early October.

Big bluestem is nutritional and palatable for all classes of livestock from June through late August. The CP content drops below 10 percent by early July to early August, depending on location. Crude protein content was below 5 percent by early August at Fort Pierre and early October at Hettinger. In vitro dry-matter digestibility of big bluestem was below 55 percent by late August at Fort Pierre and early October in Hettinger.

**Fiber Content**

Fiber content of big bluestem was lowest at the immature growth stage (early May), increasing through maturation and peaking at the end of the growing season. Acid detergent (ADF) and neutral detergent fiber (NDF) increased linearly throughout the growing season, with ADF peaking at 43 percent and 47 percent by early October for Sunnyview and Bison, respectively. Neutral detergent fiber increased from 70 percent to 75 percent in early May to 74 percent to 77 percent in early October.

Sunnyview ranked fourth and Bison fifth out of the 16 warm-season grass varieties studied in terms of average pounds of ADF and NDF produced per acre during

**Table 11. Big bluestem biomass (lb/ac) range and average, mean biomass rank and phenology (1-9)<sup>a</sup> in early September (early August for Upham) at Upham, N.D.; Fergus Falls and Rochester, Minn.; Onida, Fort Pierre and Lake Andes, S.D.**

Varieties	Performance	Upham	Fergus Falls	Rochester	Onida	Fort Pierre	Lake Andes
<b>Bison</b>	Biomass Range	5,410–9,426	1,298–4,139	1,255–2,595	405–3,120	87–4,159	2,272–5,338
	Biomass Average	5,093	2,878	1,944	1,586	1,528	3,836
	Biomass Rank	2	6	6	6	7	6
	Phenology	7	6	6	8	7	6
<b>Bonilla</b>	Biomass Range	1,796–6,471	2,055–5,058	461–3,164	392–4,625	93–3,680	2,125–5,536
	Biomass Average	4,264	3,869	1,803	1,949	1,728	3,477
	Biomass Rank	6	4	7	5	6	7
	Phenology		5	6	6	6	6
<b>Sunnyview</b>	Biomass Range	2,469–7,981	3,439–6,623	1,844–5,878	699–5,913	322–4,611	4,200–7,809
	Biomass Average	5,988	5,022	3,346	2,255	2,143	5,317
	Biomass Rank	1	1	2	2	2	1
	Phenology	5	4	5	6	4	5
<b>Rountree</b>	Biomass Range	NA	NA	1,204–4,354	905–4,897	194–4,296	3,426–7,657
	Biomass Average	NA	NA	2,381	1,970	1,877	4,683
	Biomass Rank	NA	NA	5	4	5	4
	Phenology	NA	NA	4	5	4	5
<b>Champ</b>	Biomass Range	3,403–6,719	2,129–4,813	1,313–5,543	826–5,222	152–5,030	4,114–5,745
	Biomass Average	4,918	4,029	2,974	2,134	2,007	4,899
	Biomass Rank	3	3	3	3	4	3
	Phenology	5	4	5	5	4	5
<b>Pawnee</b>	Biomass Range	1,997–5,877	2,141–5,591	2,048–5,508	1,556–7,271	235–4,964	2,810–5,928
	Biomass Average	4,508	4,207	3,377	3,029	2,121	4,073
	Biomass Rank	5	2	1	1	3	5
	Phenology	3	3	4	4	2	5
<b>Kaw</b>	Biomass Range	2,752–6,189	1,629–4,673	1,575–4,982	540–7,597	297–4,968	3,846–7,796
	Biomass Average	4,916	3,21	2,2887	3,029	2,186	5,273
	Biomass Rank	4	5	4	1	1	2
	Phenology	1	2	4	4	1	5

<sup>a</sup>Phenology: 1 = vegetative; 2 = jointing; 3 = first emergence of inflorescence; 4 = first anthesis, 10 culms or more; 5 = 50% anthesis; 6 = first seed ripe; 7 = 50% seed ripe; 8 = seed mature; 9 = complete dormancy.

the two-year period. Harvesting maximum levels of ADF and NDF of Sunnyview occurred in early August, with 1,240 and 2,290 lb/ac of ADF and NDF, respectively. Harvesting maximum levels of ADF and NDF of Bison also occurred in early August, with 1,294 and 2,273 lb/ac of ADF and NDF, respectively.

### **Grazing Value**

Big bluestem will provide good grazing from June through September and is considered a highly palatable warm-season grass. With proper grazing management, big bluestem can withstand substantial grazing, but close grazing can decrease the stand. A stubble height of 6 inches is recommended to assure stand longevity. Bison is the earliest maturing variety, with grazing recommended from late June, when grasses reach a height of 8 to 14 inches, through early September. Bonilla matures about 10 days later and Rountree, Champ and Pawnee about 25 to 30 days later than Bison and is recommended for grazing from early July through early September. Kaw generally is not recommended for grazing in the northern Plains. When comparing growth patterns and nutritional value, livestock grazing from mid-June through early August will optimize forage use and nutrient content. In vitro dry-matter digestibility was difficult to interpret but appears to be adequate through late August. A rotational grazing system can extend immature plant growth through early September, reduce trampling loss, enhance utilization, and increase nutritional quality and palatability.

From a forage management standpoint, big bluestem should be established as a pure stand for pasture development. Recommended varieties for livestock grazing in North and South Dakota and northern Minnesota are Bison, Bonilla and Sunnyview. Recommendations for Nebraska, Iowa, southern Minnesota and southern South Dakota include Rountree, Champ, Sunnyview and Pawnee.

**Recommended Grazing Season:**  
**late June to early September (depending on variety).**

### **Hay Value**

Big bluestem can make good hay, depending on timing of harvest and variety. It is palatable when immature; however, it becomes less desirable once maturation occurs and fiber increases. The proper harvest technique for optimum stand maintenance would be to leave a stubble height of 6 inches and achieve adequate re-growth (about 10 inches) prior to the first killing frost.

Big bluestem should be cut by the early boot to boot growth stage to maintain good CP (9 percent to 10 percent) and IVDMD (> 55 percent) for winter feed and at flowering to maintain a CP and IVDMD level for nonlactating animals.

Recommended varieties for hay production in North and South Dakota and northern Minnesota are Bison, Bonilla and Sunnyview. Recommendations for Nebraska, Iowa, southern Minnesota and southern South Dakota include Rountree, Champ, Sunnyview and Pawnee.

**Recommended Haying Time:**  
**late July to early August for a nonlactating ration that achieves a maintenance quality with optimum forage production and late June to early July for lactating ration, optimum quality and lower production (variety dependent).**

### **Wildlife Value**

Birds and mammals use big bluestem for nesting and escape cover in summer and winter. It resists lodging under snow cover almost as well as switchgrass, thereby contributing to spring nesting habitat and winter thermal cover. Seeds are eaten by birds, especially in winter, while hooved browsers, such as antelope, bison and white-tailed deer, eat the vegetative parts of the plant. Big bluestem is an important host for butterflies, including the regal fritillary.

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Big bluestem should be seeded in a mixture with other native grasses, forbs and legumes to provide structure of various heights as habitat for grassland nesting birds and other wildlife species. Without proper management, cool-season invasive species (Kentucky bluegrass and smooth brome grass) will become competitive, reducing habitat quality.

### Cover Value

Spring: Good  
Summer: Excellent  
Fall: Excellent  
Winter: Good

### Forage Value

Spring: Good  
Summer: Good  
Fall: Fair  
Winter: Poor

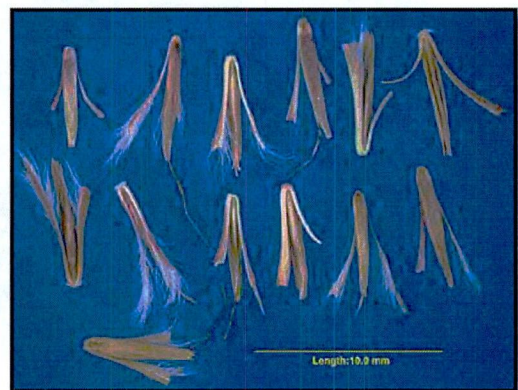


**Big bluestem provides high-quality forage during summer months.** (Photo by Paul Nyren, NDSU)

## Little Bluestem

Little bluestem is a native, midstatured (18 to 36 inches tall) perennial bunchgrass with a dense root system that may reach 5 to 8 feet in depth. Growth begins in mid-May, with seed stalks appearing from late July to August. Little bluestem can reproduce by seed or vegetatively via short underground rootstocks. Young tillers are distinctively flattened at the base, with the mature plants acquiring a reddish color late in the growing season. This color becomes very distinctive in the fall, with entire hillsides taking on a reddish hue when occupied by little bluestem.

Little bluestem is adapted to a wide range of soil textures. On rangeland, it generally is associated with dry, upland sites with soils high in calcium carbonate, such as thin loamy and limy sands ecological sites. However, little bluestem also is found on wetter sites with similar soil chemistry, such as the limy subirrigated ecological site. Little bluestem is found in southern Canada, Maine to Idaho, south to Florida and Arizona and into Mexico.



## Little bluestem

Releases	Release Type	Date Released	Origin	Statement of Use
<b>Spirit Ecovar</b>	Source Identified	2003	Alberta and Saskatchewan, Canada	Native collection of little bluestem with characteristics typical for the species in that area. Recommended for plantings in areas receiving 10" to 12" of annual precipitation. Recommended in plant hardiness zone 3.
<b>Southlow Michigan Germplasm</b>	Source Identified	2001	Michigan	Native harvest from the southern half of Michigan's Lower Peninsula. No intended selection. Material does not differ from naturally occurring little bluestem found in this area. Recommended in plant hardiness zones 4-5.
<b>Itasca Germplasm</b>	Selected	2001	North Dakota, South Dakota, Minnesota	Selected for improved vigor, leafiness and disease resistance. Broad genetic base with phenology varying up to two weeks. Plant maturity is approximately 4 weeks earlier than Blaze and Camper. Recommended in plant hardiness zones 3-4.
<b>Taylor Ecovar</b>	Selected	2000	Manitoba and Saskatchewan, Canada	Recommended for planting in areas receiving 18" to 22" of annual precipitation. Recommended in plant hardiness zone 3.
<b>Southern Iowa Germplasm</b>	Source Identified	1999	Iowa	Native harvest from multiple sites in southern Iowa. No intended selection for improvement. Recommended in plant hardiness zone 5.
<b>Northern Iowa Germplasm</b>	Source Identified	1999	Iowa	Native harvest from multiple sites in northern Iowa. No intended selection for improvement. Recommended in plant hardiness zone 4.
<b>Northern Missouri Germplasm</b>	Source Identified	1999	Iowa	Native harvest from multiple sites in northern Missouri. No intended selection for improvement. Recommended in plant hardiness zones 5-6.
<b>Central Iowa Germplasm</b>	Source Identified	1997	Iowa	Native harvest from multiple sites in central Iowa. No intended selection for improvement. Recommended in plant hardiness zones 4-5.
<b>Badlands Ecotype</b>	Selected	1996	North Dakota, South Dakota	Broad genetic base with improved plant vigor, seed production and disease resistance. Phenology may vary up to two weeks within the population. Approximately 4 weeks earlier in maturity than Blaze or Camper. Recommended in plant hardiness zones 3-4.
<b>Cimarron</b>	Variety	1979	Kansas, Oklahoma	Selected for improved forage production and disease resistance. Recommended in plant hardiness zones 4-5.
<b>Camper</b>	Variety	1973	Nebraska, Kansas	Broad genetic composition, adaptation, seed production and stand establishment compared with native harvested material. Recommended in plant hardiness zone 4.
<b>Blaze</b>	Variety	1967	Nebraska, Kansas	Leafy, mid-tall and late maturing in central latitudes. Foliage is bright to dull green, turning red in the fall. The area of reliable seed production is centered in southeast Nebraska. Recommended in plant hardiness zone 4.

Releases	Release Type	Date Released	Origin	Statement of Use
Aldous	Variety	1966	Kansas, Oklahoma	Tall, leafy and vigorous, medium late in maturity. Produces abundant forage and, under favorable conditions, good seed yield. Has some resistance to rust. Recommended in plant hardiness zones 4-5.

### Little Bluestem

The NRCS recognizes four release types. These are variety (also commonly referred to as cultivar), tested, selected and source identified. Variety, tested and selected release types have varying degrees of performance data collected for the release. Source-identified releases do not require performance documentation.

### Performance Characteristics

Little bluestem releases were studied for stand establishment and density index ratings in the original study (Table 12). The releases compared were Blaze, Camper, Aldous, and Cimarron. Badlands is a newer release and was available only for planting at the Hettinger, N.D., GNPS plots. Blaze and Camper had better stand ratings compared with Cimarron and Aldous at Upham, N.D., and Fergus Falls, Minn., the two northern-most plot

locations. This also was true for the stand density index ratings. Aldous and Camper had the best stand ratings and densities at Lake Andes, S.D. Winter injury was noted for Aldous and Cimarron at the northern-most site at Upham.

Phenology was somewhat variable among sites, but generally Blaze and Camper were earlier maturing than Aldous and Cimarron (Table 13). Mature seed was not produced at any of the six site locations by early September for any of the four releases.

### Herbage Production

Location effects ( $P < 0.1$ ) occurred for the six sites in the original study. When creating an average biomass ranking across the six sites (1-4, with the lower number better), Cimarron was the most productive variety with a rating of 2.0. Rankings from second through fourth were

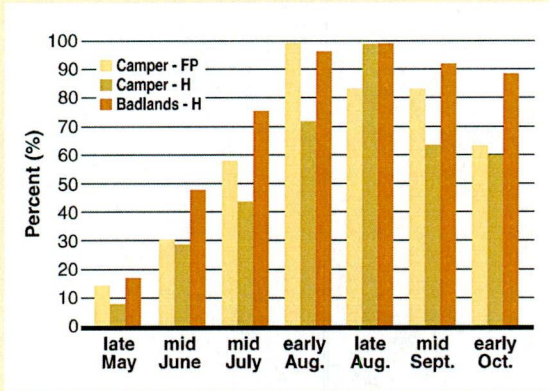
**Table 12. Little bluestem stand rating (1-9)<sup>a</sup> and density index (0-40)<sup>b</sup> at Upham, N.D.; Fergus Falls and Rochester, Minn.; Onida, Fort Pierre and Lake Andes, S.D.**

Varieties	Category	Upham	Fergus Falls	Rochester	Onida	Fort Pierre	Lake Andes
Blaze	Stand Rating	1.6	3.6	4.4	3.2	4.3	3.4
	Density Index	23	16	10	19	20	18
Camper	Stand Rating	1.1	4.2	3.8	2.7	5.7	1.9
	Density Index	23	20	15	20	14	26
Aldous	Stand Rating	2.9	4.2	4.7	2.9	4.4	2.4
	Density Index	12	11	9	18	18	17
Cimarron	Stand Rating	3.4	3.8	4.0	2.6	5.0	1.6
	Density Index	15	11	13	16	17	26

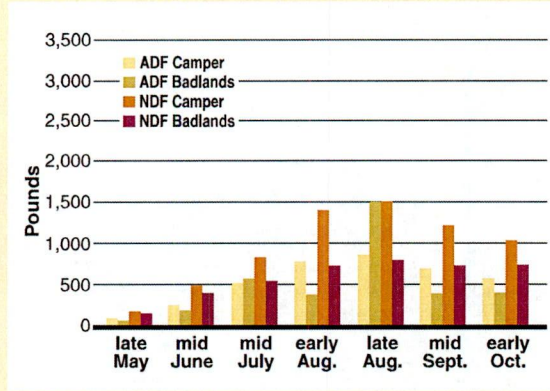
<sup>a</sup>Stand rating: 1 highest, 9 lowest.

<sup>b</sup>Density index: estimate of plant density, 40 = highest.

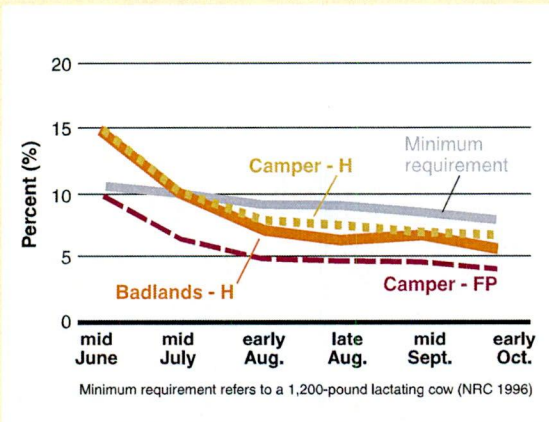
# Little Bluestem



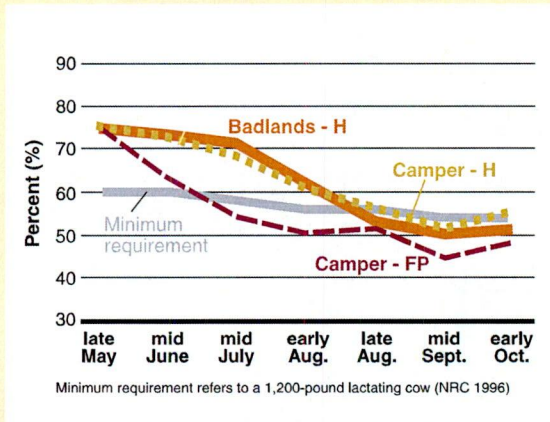
Percent of average peak standing biomass for little bluestem at Fort Pierre (FP) and Hettinger (H)



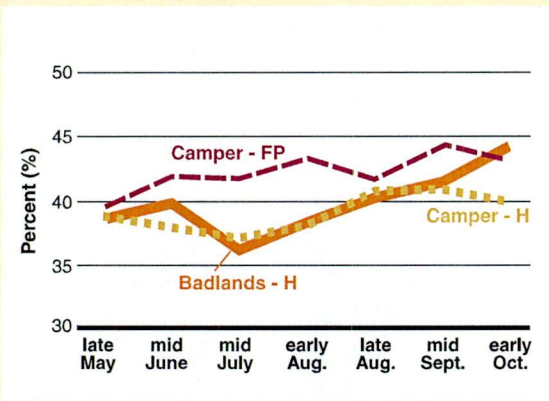
Pounds of acid detergent fiber and natural detergent fiber per acre for each period of little bluestem



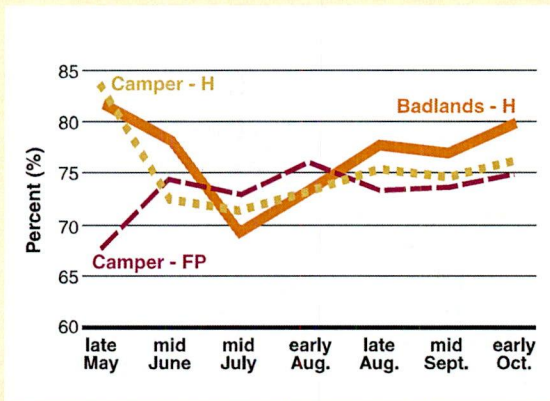
Crude protein content of little bluestem at Fort Pierre (FP) and Hettinger (H)



In vitro dry-matter digestibility of little bluestem at Fort Pierre (FP) and Hettinger (H)



Acid detergent fiber of little bluestem at Fort Pierre (FP) and Hettinger (H)



Neutral detergent fiber of little bluestem at Fort Pierre (FP) and Hettinger (H)

Aldous (2.2), Blaze (2.8) and Camper (3.0). Earlier-maturing, northern-origin varieties are less productive than later-maturing, southern-origin varieties (See Table 13 for biomass range, average and ranking for each variety and study area).

Cumulative herbage production from the GPNS for Camper was 1,983 and 2,614 lb/ac in 1999 and 2000, respectively, at Fort Pierre, S.D., and 2,112 lb/ac at Hettinger in 2000 (Table 9). Badlands was studied in this trial only at Hettinger, yielding 1,047 lb/ac in 2000. Mean herbage production for Camper was greater than Badlands (2,236 vs. 1,047) in the GPNS.

**Growth Patterns**

Badlands grows faster than Camper in June and July, with both varieties reaching peak standing crop in early to late August in the GPNS. Badlands senesces slower than Camper in September and October, with neither species achieving significant regrowth following peak production.

**Nutritional Quality**

Location was more critical in crude protein (CP) and in vitro dry-matter digestibility (IVDMD) than variety in the GPNS. Nutritional quality (CP, IVDMD) was similar between Badlands and Camper at both study locations (Hettinger and Fort Pierre); however, Fort Pierre had CP levels 3 percent to 5 percent lower than Hettinger through the growing season. The IVDMD also was similar between varieties, with initial quality similar between locations; however, it was 15 percent lower in mid-July and similar by early October.

Little bluestem in the immature growth phase is considered a nutritional, palatable grass for all classes of livestock in June and early July. The CP content drops below 10 percent by mid-July. Crude protein content was below 5 percent at Fort Pierre and about 6 percent at Hettinger in early October when fully mature. In vitro dry-matter digestibility of little bluestem was below 55 percent by early July at Fort Pierre and late August at Hettinger.

**Table 13. Little bluestem biomass (lb/ac) range and average, mean biomass rank and phenology (1-9)<sup>a</sup> in early September (early August for Upham) at Upham, N.D.; Fergus Falls and Rochester, Minn.; Onida, Fort Pierre and Lake Andes, S.D.**

Varieties	Performance	Upham	Fergus Falls	Rochester	Onida	Fort Pierre	Lake Andes
<b>Blaze</b>	Biomass Range	2,163–3,701	2,010–5,249	776–6,428	1,272–5,166	192–4,224	1,617–5,384
	Biomass Average	3,111	3,446	2,624	2,855	1,710	3,945
	Biomass Rank	2	3	3	1	4	4
	Phenology	3	3	4	4	4	4
<b>Camper</b>	Biomass Range	2,546–5,231	1,732–3,978	1,258–5,656	284–5,773	120–4,798	3,747–6,795
	Biomass Average	3,977	2,610	2,505	2,013	1,892	4,500
	Biomass Rank	1	4	4	4	2	3
	Phenology	4	3	4	5	4	5
<b>Aldous</b>	Biomass Range	1,215–4,496	2,997–5,299	1,228–6,820	590–5,171	210–4,384	3,753–7,573
	Biomass Average	3,051	4,034	3,117	2,103	1,777	5,300
	Biomass Rank	3	1	1	3	3	2
	Phenology	3	1	4	3	3	4
<b>Cimarron</b>	Biomass Range	1,330–4,061	2,742–4,654	993–6,855	410–5,487	147–5,254	3,732–8,752
	Biomass Average	2,971	3,477	2,652	2,802	1,921	5,345
	Biomass Rank	4	2	2	2	1	1
	Phenology	2	1	3	4	3	4

<sup>a</sup>Phenology: 1 = vegetative; 2 = jointing; 3 = first emergence of inflorescence; 4 = first anthesis, 10 culms or more; 5 = 50% anthesis; 6 = first seed ripe; 7 = 50% seed ripe; 8 = seed mature; 9 = complete dormancy.

### Fiber Content

Fiber content of little bluestem was lowest at the immature growth stage (early May), increasing through maturation and peaking at the end of the growing season. Acid detergent (ADF) and neutral detergent fiber (NDF) increased linearly throughout the growing season, with ADF peaking at 42 percent and 43 percent by early October for Camper and Badlands, respectively. Neutral detergent fiber was highest in early October at 75 percent and 80 percent for Badlands and Camper, respectively.

Camper ranked 12th and Badlands 16th out of the 16 warm-season grass varieties studied in terms of average pounds of ADF and NDF produced per acre during the two-year period. Harvesting maximum levels of ADF and NDF of Camper occurred in late August, with 869 and 1,531 lb/ac of ADF and NDF, respectively. Harvesting maximum levels of ADF and NDF of Badlands occurs in late August, with 424 and 811 lb/ac of ADF and NDF, respectively.

### Grazing Value

Little bluestem will provide good grazing from mid-June through early July; however, palatability is lower than in many other native warm-season grasses, especially when seed stalks are present. Proper grazing management is critical to improve grazing efficiency. Higher stock densities such as seen in rotational grazing systems will achieve greater use of more plants. Recommended stubble height of 3 to 4 inches is required to assure stand longevity.

Spirit, Taylor, Badlands and Itasca are the earliest-maturing releases, with grazing recommended from mid-June through late July. Camper and Blaze are 20 to 30 days later maturing and recommended for grazing from early July through August. Cimarron and Aldous are 20 to 30 days later maturing than Camper and Blaze. A rotational grazing system can extend immature plant growth through early September, increasing nutritional quality and palatability.

Little bluestem planted for pasture should be established with other native range species. Recommended

varieties/releases for livestock grazing in North Dakota and northern Minnesota are Badlands, Itasca and Taylor. Recommendations for South Dakota and southern Minnesota include Badlands, Camper and Blaze. Recommendations for Nebraska and Kansas include Camper, Blaze, Aldous, and Cimarron. The remaining germplasm releases are more local and recommended for the regions from which they originated.

**Recommended Grazing Season:  
mid-June to early September  
(depending on variety).**

### Hay Value

Although not usually recommended for hay production, little bluestem can make fair to good hay when part of a native hay land mixture. It is palatable when immature; however, it becomes less desirable once maturation occurs and seed stalks are present. If establishing little bluestem as forage, grazing would be recommended, with hay use the alternative option. Haying and burning to remove mature growth are viable options to improve palatability. Proper harvest technique is required by achieving a stubble height of 4 inches to assure stand longevity.

Suitable varieties/releases for hay production in North Dakota and northern Minnesota are Badlands, Itasca and Taylor. Recommendations for South Dakota and southern Minnesota include Badlands, Camper and Blaze. Recommendations for Nebraska and Kansas include Camper, Blaze, Aldous, and Cimarron. The remaining germplasm releases are more local and recommended for the regions from which they originated.

**Recommended Haying Time:  
mid to late July for a nonlactating ration  
that achieves a maintenance quality  
with optimum forage production and  
early July to mid-July for lactating ration,  
optimum quality and lower production  
(variety dependant).**

## LITTLE BLUESTEM

### Wildlife Value

Little bluestem seed is eaten by songbirds and upland game birds. It is grazed by antelope. The plant provides nesting cover for various grassland nesting birds, including meadowlarks and songbirds. Sharp-tailed grouse use little bluestem for loafing cover. Dakota skipper butterfly larvae prefer little bluestem as a food source. Small mammals will use the seeds and leaves for food.

Little bluestem should be seeded in a mixture with other native grasses, forbs and legumes to provide structure of various heights as habitat for grassland nesting birds and other wildlife species. Without proper manage-

ment, cool-season invasive species (Kentucky bluegrass and smooth brome grass) will become competitive, reducing habitat quality.

#### Cover Value

Spring: Good  
Summer: Good  
Fall: Good  
Winter: Fair

#### Forage Value

Spring: Fair  
Summer: Good  
Fall: Poor  
Winter: Fair



Seed production field of little bluestem.



## Sand Bluestem

**S**and bluestem is a native, tall statured (36 to 60 inches tall), sod-forming perennial grass that reproduces from seed and scaly rhizomes. It begins growth in early May and flowers in late July, with seed produced in August to October on tillers that are from 3 to 6 feet in height. Sand bluestem is similar in appearance to big bluestem but tends to be more bluish or grayish, has a J-shaped stem base and produces seed heads

that have a dense covering of yellow hairs. Sand bluestem is more prominently rhizomatous and more drought tolerant than big bluestem. Big and sand bluestems have been known to hybridize.

Sand bluestem tends to grow in colonies, preferring drier sites with sandy, sand or coarse sand-textured soils. This would include such ecological sites as sands, choppy sands and thin sands. Sand bluestem occurs naturally from the eastern Dakotas west to Montana south to Iowa, Texas and Arizona.



## Sand bluestem

Releases	Release Type	Date Released	Origin	Statement of Use
Cherry	Variety	1961	Nebraska	Typical of sand bluestem. Recommended in plant hardiness zones 3-4.
Garden	Variety	1960	Nebraska	Vigorous, tall, leafy variety. Good seed yields. Adapted throughout the sandhills of Nebraska and South Dakota. Recommended in plant hardiness zone 4.
Goldstrike	Variety	1953	Nebraska, Oklahoma	Typical of sand bluestem. Plants are variable in height. Recommended in plant hardiness zones 4-5.

### Sand Bluestem

The NRCS recognizes four release types. These are variety (also commonly referred to as cultivar), tested, selected and source identified. Variety, tested and selected release types have varying degrees of performance data collected for the release. Source-identified releases do not require performance documentation.

Phenology of the two releases compared was the same at each site and was similar to the releases of other warm-season species originating from the central Plains (Table 15). Average maturity was first anthesis in early September, and hard seed was produced minimally toward the end of the growing season at Onida, Fort Pierre and Rochester.

### Performance Characteristics

Sand bluestem releases were studied for stand establishment and density index ratings (Table 14). The releases compared were Goldstrike and Garden. Stand establishment ratings were good for both sand bluestem entries across all sites. Stand ratings were similar for both releases, but variation occurred among sites. The plots at Upham, N.D., had the highest rated stands and also one of the most productive soils.

Stand index density was determined by estimating the number of plants in a 9-inch by 16-inch frame. The density index rating was developed with values ranging from 0 (no stand) to 40 (full stand) to estimate density. Values ranged from 16 to 32 for Goldstrike and 15 to 28 for Garden. Comparing the six sites, Upham, N.D., had the highest value (28) and Lake Andes, S.D., had the lowest (15 to 16). Overall, both releases established readily and achieved good stands. No specific damage caused by winter injury was noted for either of the sand bluestems.

### Herbage Production

Year and variety effects ( $P < 0.1$ ) occurred at all six sites during the six-year period in the original study. When creating an average biomass ranking across the six sites (1-2, with the lower number better), Garden was the most productive variety with a rating of 1.2 and Goldstrike second in production at 1.8 (see Table 15 for biomass range, average and ranking for each variety and study area).

Cumulative herbage production from the GPNS for Garden and Goldstrike was 3,755 and 2,888 lb/ac, respectively, at Hettinger in 2000 (Table 9). No difference ( $P > 0.1$ ) was found between varieties at the Hettinger study site. Sand bluestem releases were not sampled for herbage production at Fort Pierre in the GPNS due to declining stands.

**Growth Patterns**

Garden and Goldstrike have similar growth patterns, with both varieties achieving peak herbage production in mid-September. Based on the GPNS, Garden senesced quicker than Goldstrike in October, probably explaining why Garden has better stand longevity, as noted in the original study.

**Nutritional Quality**

Nutritional quality (CP, IVDMD) was similar between Goldstrike and Garden at Hettinger. Sand bluestem is nutritional and palatable for all classes of livestock from June through late August, with palatability slightly lower than big bluestem. The CP content drops below 10 percent by early August. Crude protein content was maintained above 5 percent through early October at Hettinger. In vitro dry-matter digestibility of sand bluestem was above 60 percent through early October in Hettinger.

**Fiber Content**

Fiber content of sand bluestem was lowest at the immature growth stage (early May through mid-July), slightly increasing through maturation and peaking at the end of the growing season. Neutral detergent fiber (NDF) increased linearly throughout the growing season. ADF peaked at 39 percent by early October for both releases. Neutral detergent fiber increased from 66 percent in late June to 75 percent to 76 percent in early October.

Garden ranked third and Goldstrike eighth out of the 16 warm-season grass varieties studied in terms of average pounds of ADF and NDF produced per acre during the two-year period. Harvesting maximum levels of ADF and NDF of Garden occurred in mid-September, with 1,389 and 2,697 lb/ac of ADF and NDF, respectively. Harvesting maximum levels of ADF and NDF of Goldstrike occurred from late August through mid-September, with 1,072 and 2,030 lb/ac of ADF and NDF, respectively.

**Table 14. Sand bluestem stand rating (1-9)<sup>a</sup> and density index (0-40)<sup>b</sup> at Upham, N.D.; Fergus Falls and Rochester, Minn.; Onida, Fort Pierre and Lake Andes, S.D.**

Varieties	Category	Upham	Fergus Falls	Rochester	Onida	Fort Pierre	Lake Andes
<b>Goldstrike</b>	Stand Rating	1.2	4.0	3.1	3.2	3.3	2.9
	Density Index	28	16	23	32	27	16
<b>Garden</b>	Stand Rating	1.0	3.1	3.1	2.5	4.2	3.0
	Density Index	28	19	23	28	20	15

<sup>a</sup>Stand rating: 1 = highest, 9 = lowest.

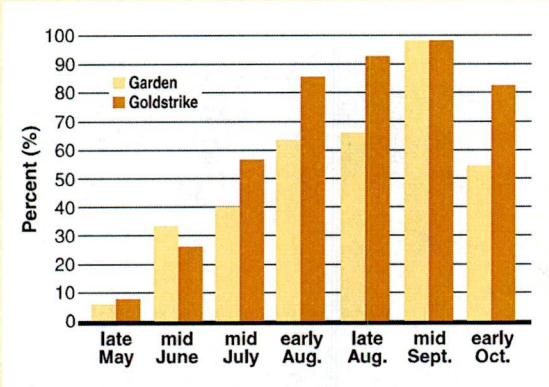
<sup>b</sup>Density index: estimate of plant density, 40 = highest.

**Table 15. Sand bluestem biomass (lb/ac) range and average, mean biomass rank and phenology (1-9)<sup>a</sup> in early September (early August for Upham) at Upham, N.D.; Fergus Falls and Rochester, Minn.; Onida, Fort Pierre and Lake Andes, S.D.**

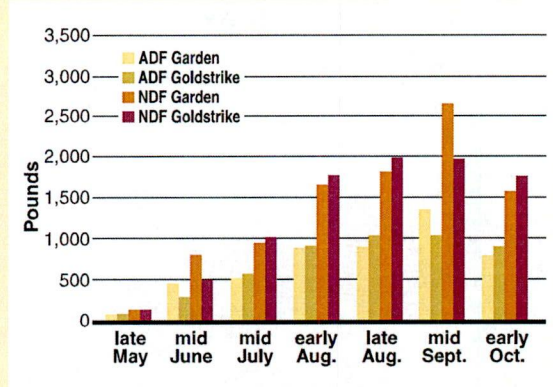
Varieties	Performance	Upham	Fergus Falls	Rochester	Onida	Fort Pierre	Lake Andes
<b>Goldstrike</b>	Biomass Range	3,357–6,324	1,325–5,347	807–3,419	669–5,332	136–3,694	2,702–7,219
	Biomass Average	4,732	2,924	1,586	2,095	1,497	4,146
	Biomass Rank	2	1	2	2	2	2
	Phenology	5	4	5	7	5	5
<b>Garden</b>	Biomass Range	3,705–7,855	2,609–4,454	2,296–4,820	1,290–6,861	191–4,955	3,073–7,433
	Biomass Average	6,303	2,900	3,379	3,081	1,993	4,578
	Biomass Rank	1	2	1	1	1	1
	Phenology	5	4	5	6	5	2

<sup>a</sup>Phenology: 1 = vegetative; 2 = jointing; 3 = first emergence of inflorescence; 4 = first anthesis, 10 culms or more; 5 = 50% anthesis; 6 = first seed ripe; 7 = 50% seed ripe; 8 = seed mature; 9 = complete dormancy.

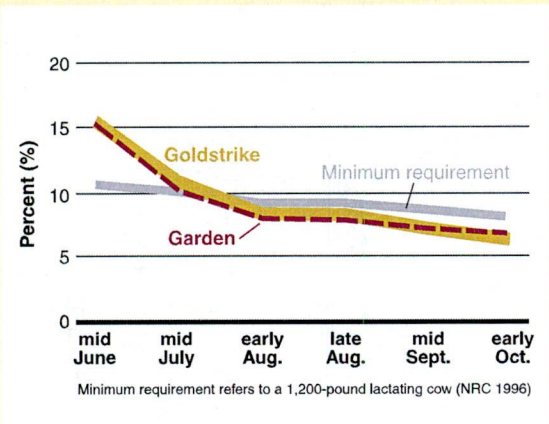
# Sand Bluestem



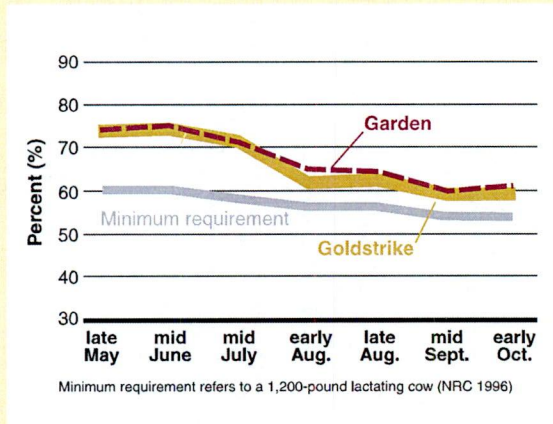
Percent of average peak standing biomass for sand bluestem at Hettinger



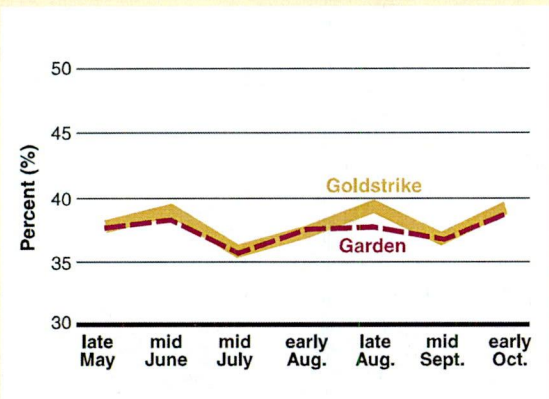
Pounds of acid detergent fiber and natural detergent fiber per acre for each period of sand bluestem



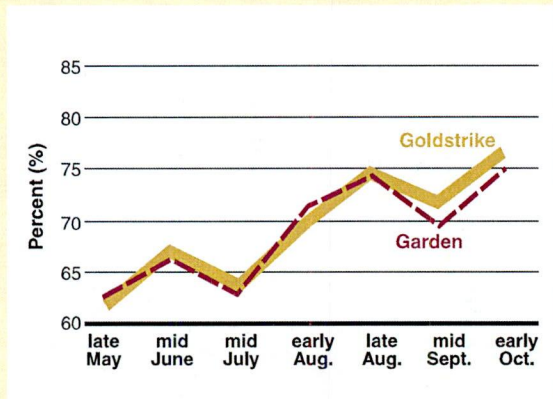
Crude protein content of sand bluestem at Hettinger



In vitro dry-matter digestibility of sand bluestem at Hettinger



Acid detergent fiber of sand bluestem at Hettinger



Neutral detergent fiber of sand bluestem at Hettinger

**Grazing Value**

Big bluestem typically is preferred over sand bluestem as a pasture grass. However, in areas of limited precipitation and droughty sites consisting of coarse, sand soils, sand bluestem may be the better option. Sand bluestem will provide good grazing from late June through September and is considered a palatable warm-season grass. With proper grazing management, sand bluestem can withstand substantial grazing, but close grazing can decrease the stand. A stubble height of 6 inches is recommended to assure stand longevity. When comparing growth patterns and nutritional value, livestock grazing from mid-June through early August will optimize forage use and nutrient content. A rotational grazing system can extend immature plant growth through early September, reduce trampling loss, enhance utilization, and increase nutritional quality and palatability.

From a grazing management standpoint, sand bluestem should be established in a native plant mixture. Recommended varieties for livestock grazing in the northern Plains are Goldstrike and Garden. Performance data is limited on Cherry.

**Recommended Grazing Season:  
late June to early September.**

**Hay Value**

The establishment of sand bluestem would not be recommended for use as hayland in a forage system.

**Wildlife Value**

Sand bluestem is good to excellent forage for many wildlife species, including white-tailed deer and pronghorn. Upland birds eat the seeds. Because it frequently grows in large clumps and retains an upright vegetative structure throughout the winter, it makes an excellent nesting habitat for many upland birds and small mammals.

Sand bluestem should be seeded in a mixture with other native grasses, forbs and legumes to provide structure of various heights as habitat for grassland nesting birds and other wildlife species. Without proper management, cool-season invasive species (Kentucky bluegrass and smooth brome grass) will become competitive, reducing habitat quality.

**Cover Value**

Spring: Good  
 Summer: Good  
 Fall: Good  
 Winter: Good

**Forage Value**

Spring: Good  
 Summer: Good  
 Fall: Fair  
 Winter: Poor



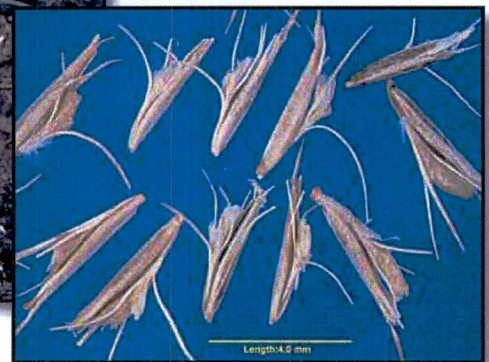
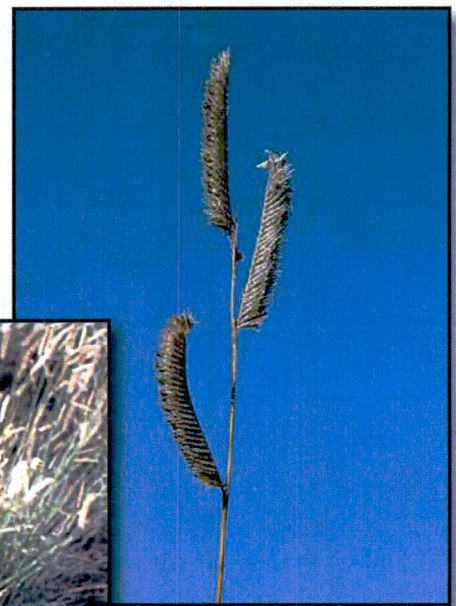
Evaluation nursery at the Bismarck Plant Materials Center.

## Blue Grama

**B**lue grama is a native, short statured (less than 18 inches tall), perennial bunchgrass that often can have a sodlike appearance. It reproduces by seed and basal tillers, beginning growth in mid-May and flowering in late July to mid-August. Blue grama leaves begin to curl as they mature and become straw-colored. Mature seed heads are curved and resemble a human eyebrow.

Blue grama has good drought tolerance and is adapted to a wide variety of ecological sites. It has fair tolerance to sodic soils but is not adapted to saline sites. It is the major component of the short-grass prairie. Within the mixed-grass prairie, blue grama usually constitutes a minor

component of the native plant community on the loamy and sandy type ecological sites; a larger component on the drier, sands and shallow sites; and a major component on the claypan and thin claypan ecological sites. Blue grama occurs throughout the Great Plains, ranging from Manitoba to Alberta and the Northwest Territories, south throughout the central and western United States and into Mexico.



## Blue grama

Releases	Release Type	Date Released	Origin	Statement of Use
<b>Butte Ecovar</b>	Selected	2003	Manitoba and eastern Saskatchewan, Canada	Native collection of blue grama with characteristics typical for the species found in that area. Tests conducted in Manitoba show Butte to have a more dense basal leaf area and earlier and longer green period than southern releases. Recommended in plant hardiness zone 3.
<b>Birdseye</b>	Informal	2000	Wyoming	Recommended in plant hardiness zones 3-4.
<b>Bad River Ecotype</b>	Selected	1996	South Dakota	Improved seedling emergence, vigor and root development compared with South Dakota native harvest. Leafier and taller with higher percent crude protein and digestibility than native harvests from South Dakota. Provides excellent quality forage for summer grazing. Recommended in plant hardiness zones 3-4.
<b>Willis</b>	-	-	Colorado	Not available.

### Blue Grama

The NRCS recognizes four release types. These are variety (also commonly referred to as cultivar), tested, selected and source identified. Variety, tested and selected release types have varying degrees of performance data collected for the release. Source-identified releases do not require performance documentation.

### Performance Characteristics

Blue grama releases were compared in the Hettinger, N.D., GPNS, but not in the general plant materials trials (original trial). The two releases compared were Bad River and Willis.

### Herbage Production

Cumulative herbage production from the GPNS at Hettinger for Bad River and Willis was 2,714 and 2,640 lb/ac, respectively, in 2000 (Table 9).

### Growth Patterns

Bad River and Willis had similar growth patterns in Hettinger. Both varieties achieve only 40 percent to 50 percent of their total growth by mid-July. Peak standing crop occurred in early to mid-August for Bad River and early September for Willis in the GPNS. Both varieties senesce at similar rates, with 60 percent to 70 percent standing biomass remaining in early October.

### Nutritional Quality

Nutritional quality (CP, IVDMD) was similar between Bad River and Willis at the Hettinger study area throughout the growing season. Blue grama is considered a nutritional, palatable grass for all classes of livestock throughout the growing season. The CP content dropped below 10 percent by early August and remained above 8 percent through early October. In vitro dry-matter digestibility of blue grama was greater than 55 percent through mid to late September at Hettinger.

**Fiber Content**

Acid detergent fiber (ADF) increased linearly throughout the growing season, peaking at 43 percent by early October for both varieties. Neutral detergent fiber (NDF) was highest in late May, decreasing through mid-July and increasing with maturation for both varieties. This fiber fraction pattern would indicate much of the fiber in May through mid-July is hemi-cellulose, or a more digestible material.

Bad River ranked sixth and Willis seventh out of the 16 warm-season grass varieties studied in terms of average pounds of ADF and NDF produced per acre during the two-year period. Harvesting maximum levels of ADF and NDF of Bad River occurred in late August, with 1,120 and 2,063 lb/ac of ADF and NDF, respectively. Harvesting maximum levels of ADF and NDF of Willis occurred in mid-September, with 1,096 and 2,006 lb/ac of ADF and NDF, respectively.

**Grazing Value**

Blue grama will provide excellent grazing starting in late June and continuing throughout the growing season. Although palatability and nutritional quality remain high late into the growing season, its grazing value is limited due to low production potential. On native rangeland, blue grama is classified as an increaser with overgrazing or poor grazing management and, depending on ecological site, should comprise only 5 percent to 30 percent of the plant community. In seed mixtures, blue grama usually comprises a small percentage due to its low productivity potential. Blue grama often is added to seed mixtures to meet the needs of a specific niche or soil type.

Blue grama cures well and maintains sufficient protein levels for a nonlactating, early gestational animal into the winter season. However, energy or total digestible nutrients often become deficient during the winter grazing period, especially under harsh environmental conditions.

Blue grama should be established in mixtures with other native plant species. However, if establishing a low-maintenance lawn, blue grama may be seeded as a single species or with buffalo grass. The Bad River ecotype is the recommended release in the Northern Plains. Performance data is limited on other releases at the time of this publication.

**Recommended Grazing Season:**  
late June to early October.

**Hay Value**

Blue grama is not recommended for hay production because of its low growth stature.

**Wildlife Value**

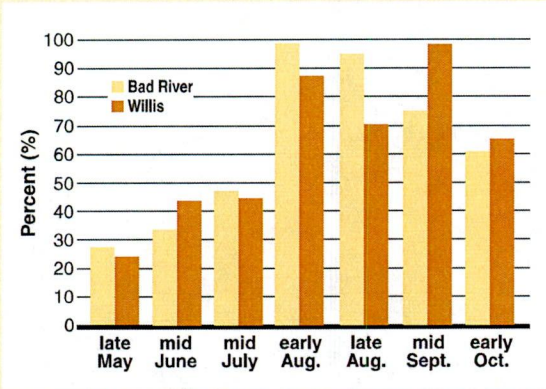
Blue grama is a very valuable species for wildlife, both as a source of seeds for birds and forage for grazers. Wild turkeys and songbirds, such as finches, longspurs and sparrows, utilize the seeds while mammals such as jackrabbits, pronghorn, white-tailed deer, elk and bison graze the vegetative plant parts. Small mammals such as pocket mice will use the seed heads and plant as food. Due to its short stature, blue grama-dominated ecological sites can provide excellent areas for prairie grouse leks.

Blue grama should be seeded in a mixture with other native grasses, forbs and legumes to provide structure of various heights as habitat for grassland nesting birds and other wildlife species. Without proper management, cool-season invasive species (Kentucky bluegrass and smooth brome grass) will become competitive, reducing habitat quality.

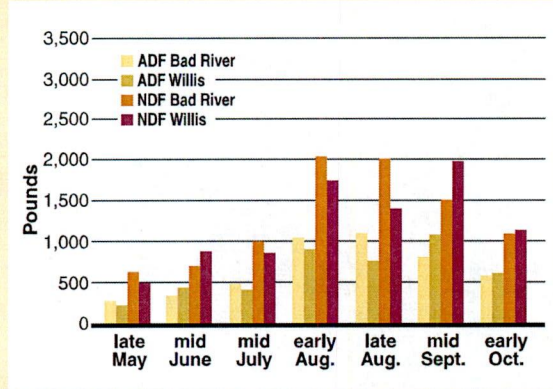
**Cover Value**  
Spring: Poor  
Summer: Good  
Fall: Fair  
Winter: Poor

**Forage Value**  
Spring: Good  
Summer: Excellent  
Fall: Good  
Winter: Good

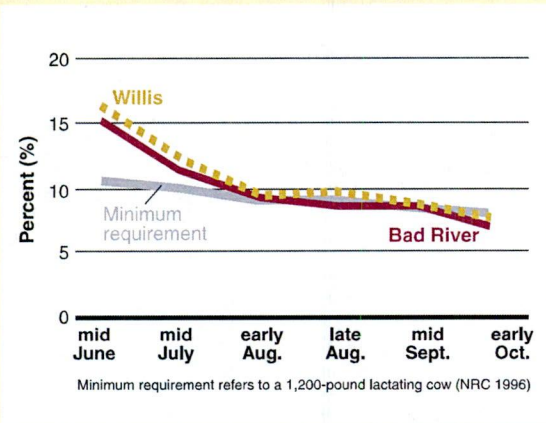
# Blue Grama



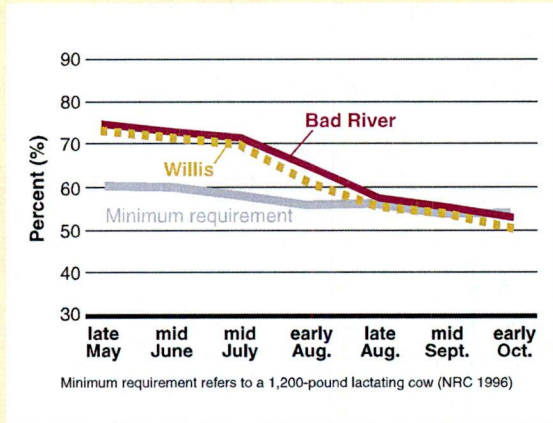
Percent of average peak standing biomass for blue grama at Hettinger



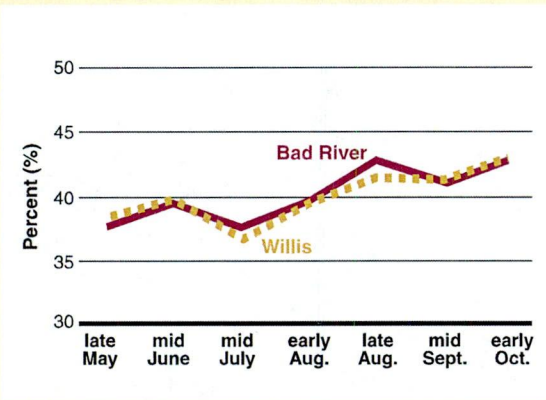
Pounds of acid detergent fiber and natural detergent fiber per acre for each period of blue grama



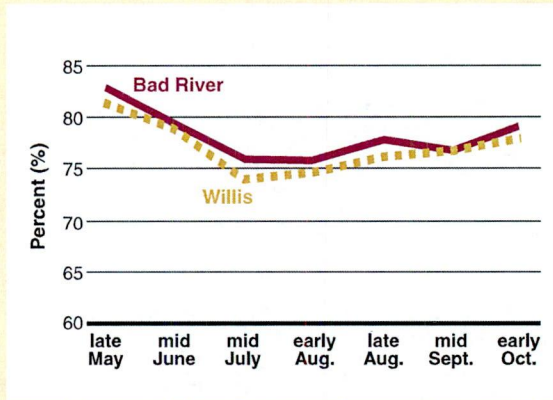
Crude protein content of blue grama at Hettinger



In vitro dry-matter digestibility of blue grama at Hettinger



Acid detergent fiber of blue grama at Hettinger



Neutral detergent fiber of blue grama at Hettinger



Seed production field of blue grama.

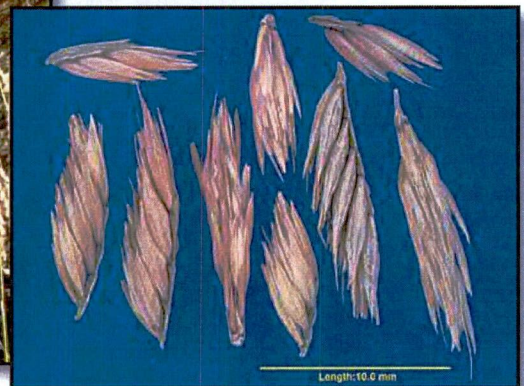
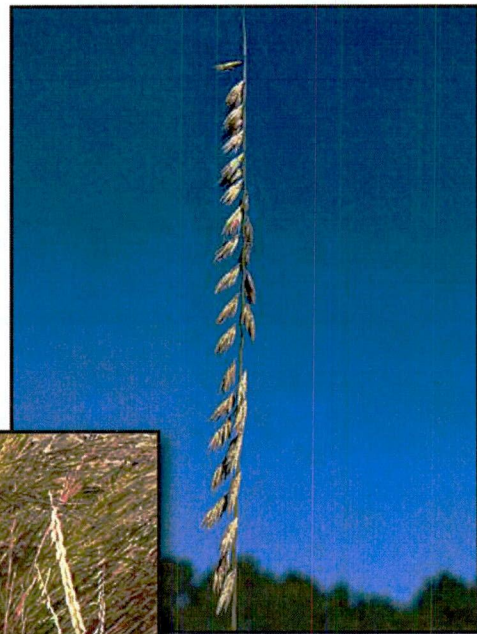


## Sideoats Grama

**S**ideoats grama is a native, midstatured (18 to 36 inches tall), perennial, weakly rhizomatous grass with short, scaly underground stems that may give the plant a bunchgrass appearance. It begins growth in mid-May. Flowering occurs in late July to mid-August. The small, oatlike seeds hang down uniformly on one side of the seed stem, hence the name "sideoats." Sideoats grama leaves, normally flat and bluish green with a purplish cast in the early stages of growth, have very distinct stiff hairs along the leaf edges. Late in the summer, the entire plant may take on a reddish cast. Upon curing, the basal leaves curl and dry to a brownish white.

Sideoats grama generally is associated with the drier upland ecological sites, growing in

association with little bluestem and prairie sandreed on the thin loamy or shallow-type ecological sites. However, it also may be found growing in association with big bluestem and Indiangrass on the overflow ecological sites. Sideoats grama occurs throughout the United States, except for the northwestern and extreme southeastern states, and most of Mexico.



## Sideoats grama

Releases	Release Type	Date Released	Origin	Statement of Use
<b>Southern Iowa Germplasm</b>	Source identified	1995	Iowa	Native harvest from multiple sites in southern Iowa. No intended selection for improvement. Recommended in plant hardiness zone 5.
<b>Central Iowa Germplasm</b>	Source identified	1995	Iowa	Native harvest from multiple sites in central Iowa. No intended selection for improvement. Recommended in plant hardiness zones 4-5.
<b>Northern Iowa Germplasm</b>	Source identified	1995	Iowa	Native harvest from multiple sites in northern Iowa. No intended selection for improvement. Recommended in plant hardiness zone 4.
<b>Killdeer</b>	Informal	1963	North Dakota	Outstanding vigor, leafiness, fair seed production, freedom from disease, good drought and cold tolerance. Recommended in plant hardiness zone 3.
<b>Pierre</b>	Variety	1961	South Dakota	Outstanding vigor, leafiness, freedom from disease, seedling vigor and persistence in a semi-arid environment. Recommended in plant hardiness zones 3-4.
<b>Butte</b>	Variety	1958	Nebraska	Long-lived winter-hardy variety, early maturing with very good seed production. Excellent seedling vigor for establishment. Recommended in plant hardiness zone 4.
<b>Trailway</b>	Variety	1958	Nebraska	Winter-hardy, long-lived, late maturing, comparable in growth type to varieties of more southerly origin. Somewhat indeterminate as to heading and flowering responses, considerable variability in maturity. Recommended in plant hardiness zone 5.

### Sideoats Grama

The NRCS recognizes four release types. These are variety (also commonly referred to as cultivar), tested, selected and source-identified. Variety, tested and selected release types have varying degrees of performance data collected for the release. Source-identified releases do not require performance documentation.

### Performance Characteristics

Sideoats grama releases were studied for stand rating and density index ratings (Table 16). The releases compared were Killdeer, Pierre, Trailway, and Butte. Stand ratings were fairly similar among sites, although Killdeer

and Pierre generally had better ratings at Upham, N.D., Fergus Falls, Minn., and Onida and Lake Andes, S.D. Stand density index ratings generally were good for Killdeer, Pierre and Butte at all locations. Trailway had the lowest stand index rating at each of the six sites.

Sideoats grama was earlier maturing than the other seven species. Mature seed was produced by Killdeer and Pierre in early August at Upham. Killdeer and Pierre were similar in phenology ratings and were earlier maturing than Trailway and Butte (Table 17). Trailway and Butte had mature seed in early September at most sites.

**Herbage Production**

Location effects ( $P < 0.1$ ) occurred for the six sites in the original study. When creating an average biomass ranking across the six sites (1-4, with the lower number better), Trailway was the most productive variety with a rating of 1.6. Rankings from second through fourth were Butte (2.0), Pierre (3.0) and Killdeer (3.3). Earlier-maturing, northern-origin varieties are less productive than later-maturing, southern-origin varieties (See Table 17 for biomass range, average and ranking for each variety and study area).

Cumulative herbage production from the GPNS for Butte was 376 and 252 lb/ac in 1999 and 2000, respectively, at Fort Pierre and 3,921 lb/ac at Hettinger in 2000 (Table 9). The Pierre variety produced 773 and 412 lb/ac in 1999 and 2000, respectively, at Fort Pierre and 3,362 lb/ac at Hettinger in 2000 (Table 9). Mean herbage production was similar between Butte and Pierre (1,516 vs. 1,515) in the GPNS.

**Table 16. Sideoats grama stand rating (1-9)<sup>a</sup> and density index (0-40)<sup>b</sup> at Upham, N.D.; Fergus Falls and Rochester, Minn.; Onida, Fort Pierre and Lake Andes, S.D.**

Varieties	Category	Upham	Fergus Falls	Rochester	Onida	Fort Pierre	Lake Andes
<b>Killdeer</b>	Stand Rating	1.0	2.7	3.1	2.3	3.3	1.4
	Density Index	25	28	21	16	24	38
<b>Pierre</b>	Stand Rating	1.0	2.8	2.6	2.5	2.5	1.3
	Density Index	23	26	23	23	29	26
<b>Trailway</b>	Stand Rating	2.1	4.4	3.4	3.0	3.1	2.7
	Density Index	14	12	13	14	23	17
<b>Butte</b>	Stand Rating	1.3	3.4	2.5	3.0	3.5	2.3
	Density Index	24	24	20	15	25	26

<sup>a</sup>Stand rating: 1 = highest, 9 = lowest.

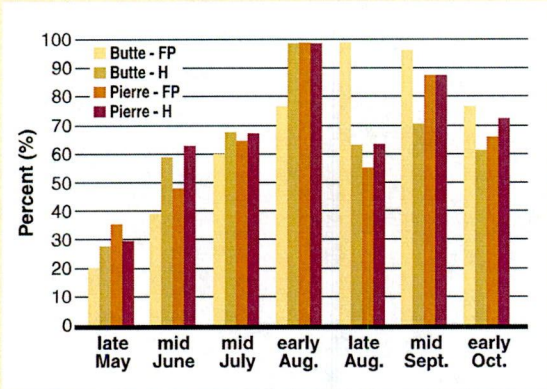
<sup>b</sup>Density index: estimate of plant density, 40 = highest.

**Table 17. Sideoats grama biomass (lb/ac) range and average, mean biomass rank and phenology (1-9)<sup>a</sup> in early September (early August for Upham) at Upham, N.D.; Fergus Falls and Rochester, Minn.; Onida, Fort Pierre and Lake Andes, S.D.**

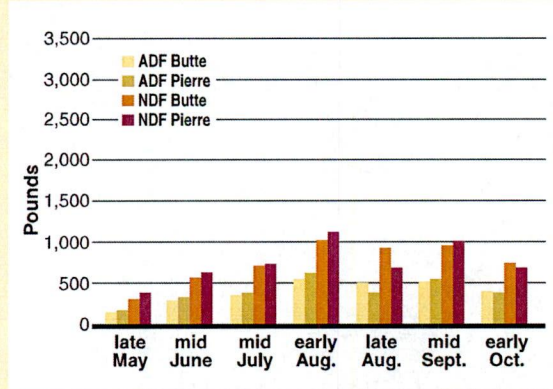
Varieties	Performance	Upham	Fergus Falls	Rochester	Onida	Fort Pierre	Lake Andes
<b>Killdeer</b>	Biomass Range	2,150–5,353	317–1,372	194–910	333–2,685	95–1,126	677–3,559
	Biomass Average	3,826	827	390	1,368	661	2,382
	Biomass Rank	1	4	4	3	4	4
	Phenology	8	8	6	8	8	9
<b>Butte</b>	Biomass Range	1,988–5,427	512–1,782	366–1,554	482–3,948	213–2,153	1,255–3,927
	Biomass Average	3,719	979	676	1,946	1,353	2,748
	Biomass Rank	2	3	2	1	2	2
	Phenology	7	7	6	8	8	9
<b>Pierre</b>	Biomass Range	1,582–4,432	436–1,789	194–1,065	340–2,734	303–1,496	1,092–3,572
	Biomass Average	3,468	1,036	539	1,043	1,049	2,388
	Biomass Rank	3	2	3	4	3	3
	Phenology	8	8	7	8	8	9
<b>Trailway</b>	Biomass Range	2,542–3,881	1,445–2,683	547–2,218	515–3,913	460–3,292	2,543–5,868
	Biomass Average	3,135	2,068	1,037	1,723	1,472	3,180
	Biomass Rank	4	1	1	2	1	1
	Phenology	6	5	6	8	8	8

<sup>a</sup>Phenology: 1 = vegetative; 2 = jointing; 3 = first emergence of inflorescence; 4 = first anthesis, 10 culms or more; 5 = 50% anthesis; 6 = first seed ripe; 7 = 50% seed ripe; 8 = seed mature; 9 = complete dormancy.

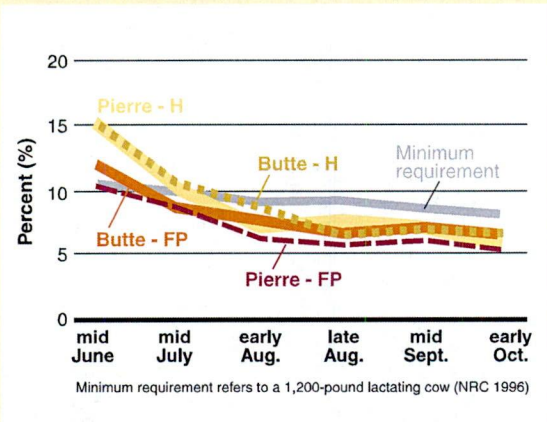
# Sideoats Grama



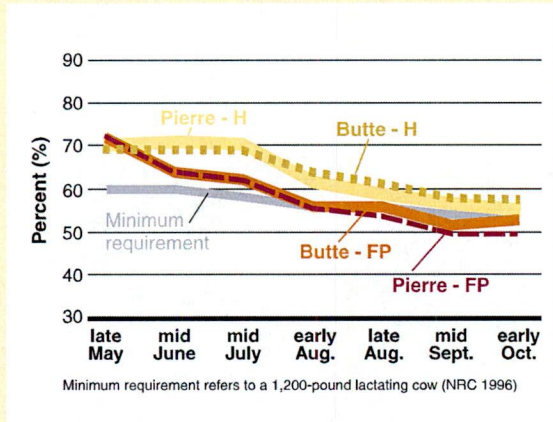
Percent of average peak standing biomass for sideoats grama at Fort Pierre (FP) Hettinger (H)



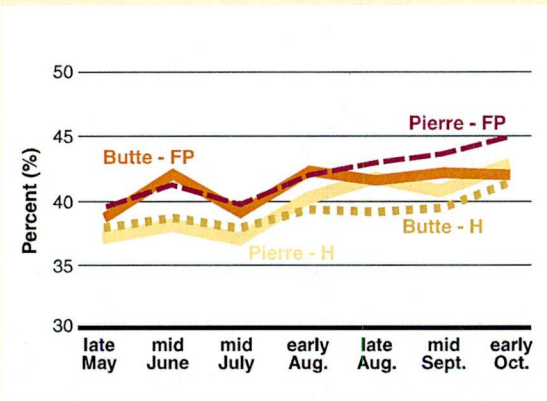
Pounds of acid detergent fiber and natural detergent fiber per acre for each period of sideoats grama



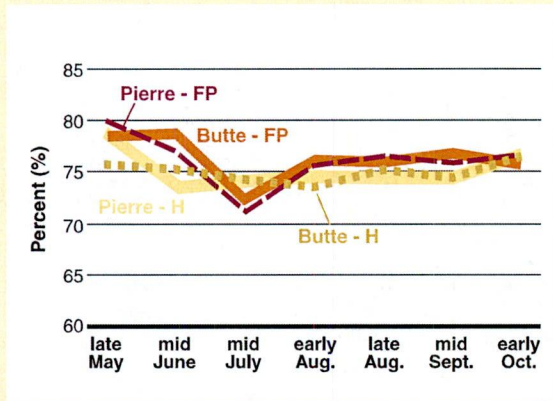
Crude protein content of sideoats grama at Fort Pierre (FP) Hettinger (H)



In vitro dry-matter digestibility of sideoats grama at Fort Pierre (FP) Hettinger (H)



Acid detergent fiber of sideoats grama at Fort Pierre (FP) Hettinger (H)



Neutral detergent fiber of sideoats grama at Fort Pierre (FP) Hettinger (H)

### Growth Patterns

The growth pattern was similar between Butte and Pierre at both study locations. Peak standing crop occurred in early to late August for both varieties in the GPNS. On average, senescence was similar between Butte and Pierre, with 60 percent to 75 percent standing biomass remaining in early October.

### Nutritional Quality

Sideoats grama is considered a palatable grass for all classes of livestock throughout the growing season; however, it can become deficient of crude protein (CP) and *in vitro* dry-matter digestibility (IVDMD) with maturation. Nutritional quality (CP, IVDMD) was similar between Butte and Pierre at both study locations (Hettinger and Fort Pierre) in the GPNS. Location was more critical for nutritional status than variety, especially as related to IVDMD. The CP content dropped below 10 percent by early to mid-July, depending on location, and was at 5 percent to 6 percent by early October. Although IVDMD of sideoats grama was significantly greater at Hettinger than Fort Pierre through early August, both sites remained greater than 55 percent through late August.

### Fiber Content

Acid detergent fiber (ADF) increased linearly throughout the growing season, peaking at 42 percent to 45 percent by early October for both varieties. Neutral detergent fiber (NDF) was highest in late May, decreasing through mid-July and increasing with maturation for both varieties. This fiber fraction pattern was similar to blue grama and would indicate much of the fiber in May through mid-July is hemi-cellulose, or a more digestible material.

Pierre ranked 14th and Butte 15th out of the 16 warm-season grass varieties studied in terms of average pounds of ADF and NDF produced per acre during the two-year period. Harvesting maximum levels of ADF and NDF of Pierre occurred from early August through mid-September, with 629 and 1,136 lb/ac of ADF and NDF, respectively. Harvesting maximum levels of ADF and NDF of Butte occurred from early August through mid-September, with 560 and 1,020 lb/ac of ADF and NDF, respectively.

### Grazing Value

Sideoats grama will provide excellent grazing starting in late June and continuing throughout the growing season. Although palatability and nutritional quality remain high late into the growing season, its grazing value is limited due to moderate production potential. With proper grazing management, sideoats grama can withstand substantial grazing, but close grazing will decrease the stand. A stubble height of 2 inches is recommended to assure stand longevity. A rotational grazing system can extend immature plant growth through early September, reduce trampling loss, enhance utilization, and increase nutritional quality and palatability.

Sideoats grama should be established in mixtures with other native plant species. Recommended varieties/releases for livestock grazing in North and South Dakota and Minnesota are Killdeer and Pierre. Butte is recommended for South Dakota and Nebraska. Trailway is recommended for southern Nebraska and Kansas. Depending on the origin of the Iowa germplasm releases, they are recommended for southern Minnesota, eastern South Dakota, Iowa, eastern Nebraska and eastern Kansas. Refer to the Release Table for specific hardiness zone.

**Recommended Grazing Season:  
late June to early September.**

### Hay Value

Sideoats grama is not recommended for hay production because of its moderate growth stature.

### Wildlife Value

Sideoats grama provides good forage for many grazer and browser wildlife species. It is utilized by antelope, mule deer and, to some extent, white-tailed deer and small rodents. The seeds are utilized by some songbirds and upland birds.

Sideoats grama should be seeded in a mixture with other native grasses, forbs and legumes to provide structure of various heights as habitat for grassland nesting birds and other wildlife species. Without proper manage-

ment, cool-season invasive species (Kentucky bluegrass and smooth brome grass) will become competitive, reducing habitat quality.

#### Cover Value

Spring: Fair  
Summer: Good  
Fall: Fair  
Winter: Poor

#### Forage Value

Spring: Good  
Summer: Excellent  
Fall: Good  
Winter: Fair

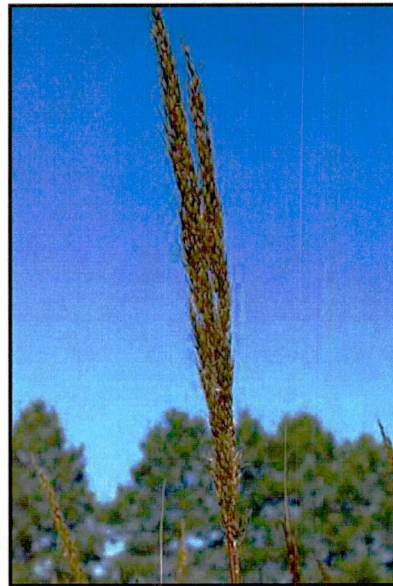


Comparing sideoats grama varieties at the Upham site.

# Indiangrass

Indiangrass is a native, tall statured (36 to 60 inches tall), perennial, deep-rooted bunchgrass. It reproduces from seed and short, scaly rhizomes. Indiangrass begins growth in mid-May. Flowering occurs in late July to mid-August. The rather dense, golden, plumelike seed heads are very striking. Leaves are lighter green than those of big bluestem and are rather stiff and straight, arising from the stems at acute angles. Even as a young plant, Indiangrass can be recognized easily by the “rifle-sight” ligule at the point where the leaf attaches to the stem.

Historically, Indiangrass was a co-dominate species with big bluestem across the tallgrass prairie and still can be found on the better managed tallgrass prairie remnants. Within the mixed-grass prairie, Indiangrass generally grows in association with big bluestem on overflow and subirrigated ecological sites. It ranges from Quebec and Maine to Manitoba and North Dakota south to Florida, Arizona and New Mexico.



## Indiangrass

Releases	Release Type	Date Released	Origin	Statement of Use
<b>Scout</b>	Variety	2008	Nebraska	Higher forage yields and improved animal gains when used by beef cattle in well managed grazing systems. The base population was Nebraska 54. Recommended in plant hardiness zone 5.
<b>Chief</b>	Variety	2008	Nebraska	Higher forage yields than Holt which is one of the parent strains. Recommended in plant hardiness zone 4 and upper plant hardiness zone 5.
<b>Southlow Michigan Germplasm</b>	Source identified	2001	Michigan	Native harvest from the southern half of Michigan's Lower Peninsula. No intended selection. Material does not differ from naturally occurring Indiangrass found in this area. Recommended in plant hardiness zones 4-5.
<b>Southern Iowa Germplasm</b>	Source identified	1998	Iowa	Native harvest from multiple sites in southern Iowa. No intended selection for improvement. Recommended in plant hardiness zone 5.
<b>Northern Iowa Germplasm</b>	Source identified	1997	Iowa	Native harvest from multiple sites in northern Iowa. No intended selection for improvement. Recommended in plant hardiness zone 4.
<b>Central Iowa Germplasm</b>	Source identified	1996	Iowa	Native harvest from multiple sites in central Iowa. No intended selection for improvement. Recommended in plant hardiness zones 4-5.
<b>Tomahawk</b>	Variety	1988	North Dakota, South Dakota	Earlier maturity and superior winter hardiness and persistence. At northern latitudes, forage production is comparable to Holt and exceeds Oto and Rumsey. Matures 33 days earlier than Holt, 71 days earlier than Oto and 82 days earlier than Osage and Rumsey. Recommended in plant hardiness zones 3-4.
<b>Rumsey</b>	Variety	1983	Illinois	Selected for increased seedling growth rate, superior forage production and increased resistance to lodging. Later maturing and should maintain its forage quality later into the growing season. Not winter hardy in tests in North Dakota, South Dakota and Minnesota. Recommended in plant hardiness zone 5.
<b>Holt</b>	Variety	1960	Nebraska	Moderately early maturing. Superior in leafiness and yield to early maturing strains from northern and western sandhill region of Nebraska. Finer leaves and stems than later maturing southern varieties. Recommended in plant hardiness zone 4.
<b>Nebraska 54</b>	Variety	1957	Nebraska	Tall, leafy, moderately late maturing. Can produce high seed yields. Good seedling vigor. Recommended in plant hardiness zones 4-5.

## Indiangrass

The NRCS recognizes four release types. These are variety (also commonly referred to as cultivar), tested, selected and source identified. Variety, tested and selected release types have varying degrees of performance data collected for the release. Source-identified releases do not require performance documentation.

## Performance Characteristics

Indiangrass releases were studied for stand establishment and density index ratings (Table 18). The releases compared were Tomahawk, Holt, Oto, Osage, and Rumsey. Stand establishment ratings were good for all Indiangrass releases except for Rumsey, which sustained some degree of winter injury at each of the six sites.

The different sites were fairly similar in density index ratings for all the releases, except those with winter injury. Rumsey had low values that ranged from 2 to 13 because of winter injury. Osage (8) and Oto (10) also sustained winter injury at the Upham, N.D., site.

Tomahawk was the most northern-origin release and had the earliest phenology at all six sites (Table 19). Tomahawk averaged 25 to 30 days earlier than Holt, the next earliest maturing release at all sites. The differences noted in phenology were similar at all six sites. Oto, Osage and Rumsey were much later maturing than Tomahawk and generally still were in the jointing stage when Tomahawk had reached mature seed and Holt was at the 50 percent anthesis or first seed ripe stage.

## Herbage Production

Year and variety effects ( $P < 0.1$ ) occurred at all six sites during the six-year period in the original study. When creating an average biomass ranking across the six sites (1-5, with the lower number better), Holt and Oto were the most productive varieties with a rating of 2.2 to 2.3. Rankings from third through fifth were Osage (2.5), Tomahawk (3.5) and Rumsey (4.5). Earlier maturing, northern-origin varieties are less productive than later-maturing, southern-origin varieties (see Table 19 for biomass range, average and ranking for each variety and study area).

Cumulative herbage production from the GPNS for Holt was 1,908 and 2,261 lb/ac in 1999 and 2000, respectively, at Fort Pierre (Table 9). Tomahawk cumulative herbage production was 2,059 and 1,729 lb/ac in 1999 and 2000, respectively, at Fort Pierre. No difference ( $P > 0.1$ ) was found between varieties in 1999 and 2000, and mean herbage production for Holt and Tomahawk was 2,082 and 1,894 lb/ac, respectively (Table 9).

## Growth Patterns

Tomahawk had slightly faster growth than Holt from late June through July; however, both varieties reached peaked herbage production in early August in the GPNS. Both varieties showed substantial regrowth in September; however, regrowth is dependent on late summer rainfall.

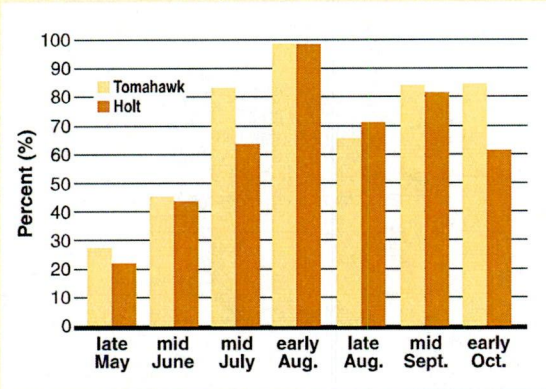
**Table 18. Indiangrass stand rating (1-9)<sup>a</sup> and density index (0-40)<sup>b</sup> at Upham, N.D.; Fergus Falls and Rochester, Minn.; Onida, Fort Pierre and Lake Andes, S.D.**

Varieties	Category	Upham	Fergus Falls	Rochester	Onida	Fort Pierre	Lake Andes
Tomahawk	Stand Rating	1.2	3.1	2.9	4.1	5.8	2.5
	Density Index	18	23	7	20	17	16
Holt	Stand Rating	1.4	3.6	3.3	2.5	4.5	2.8
	Density Index	19	17	13	27	25	15
Oto	Stand Rating	4	3.3	4.2	2.7	3.5	1.7
	Density Index	10	21	15	23	31	20
Osage	Stand Rating	3	3.1	3.8	2.9	4.3	1.0
	Density Index	8	16	11	19	24	20
Rumsey	Stand Rating	6.7	5.6	4.4	5.8	6.4	4.9
	Density Index	8	6	4	9	13	2

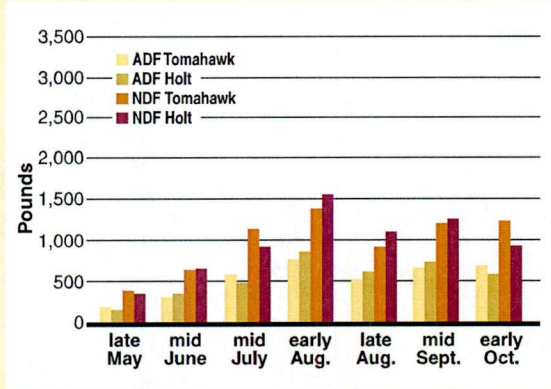
<sup>a</sup>Stand rating: 1 highest, 9 lowest.

<sup>b</sup>Density index: estimate of plant density, 40 = highest.

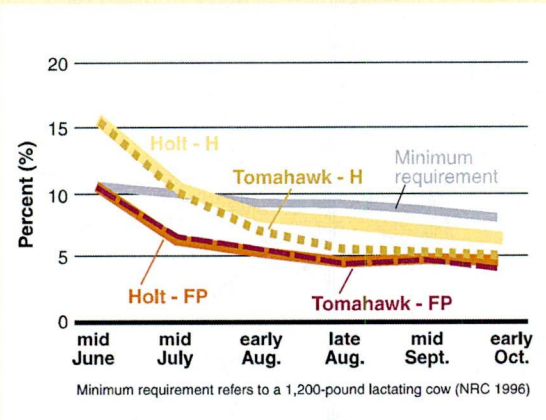
# Indiangrass



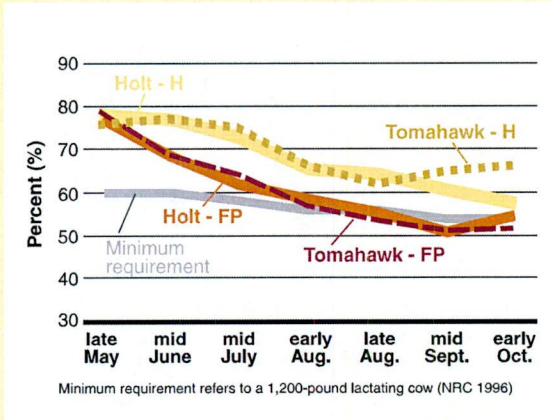
Percent of average peak standing biomass for indiagrass at Fort Pierre



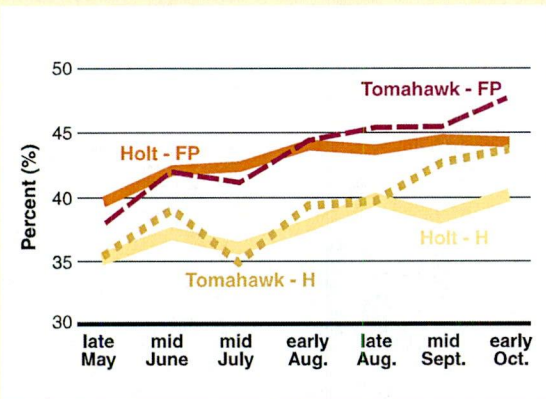
Pounds of acid detergent fiber and natural detergent fiber per acre for each period of indiagrass



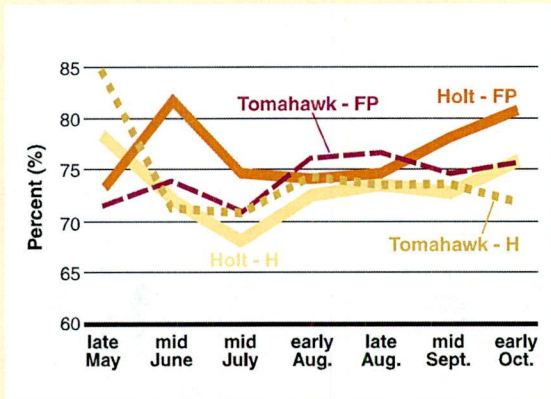
Crude protein content of indiagrass at Fort Pierre



In vitro dry-matter digestibility of indiagrass at Fort Pierre



Acid detergent fiber of indiagrass at Fort Pierre



Neutral detergent fiber of indiagrass at Fort Pierre

### Nutritional Quality

Location was more critical in crude protein (CP) and in vitro dry-matter digestibility (IVDMD) than variety in the GPNS. Nutritional quality (CP, IVDMD) was similar between Tomahawk and Holt at both study locations (Hettinger and Fort Pierre); however, Fort Pierre had CP levels 3 percent to 5 percent lower than Hettinger throughout early August, becoming similar by early October. The IVDMD also was similar between varieties, with initial quality similar between Fort Pierre and Hettinger; however, it was 5 percent to 10 percent lower by early October.

Indiangrass is nutritional and palatable for all classes of livestock from June through late August/mid-September. The CP content drops below 10 percent by mid-July to early August, depending on location. Crude protein content was below 5 percent by early October at Fort Pierre and Hettinger. In vitro dry-matter digestibility of Indiangrass was below 55 percent by mid-September at Fort Pierre and early October in Hettinger.

### Fiber Content

Fiber content of Indiangrass was lowest at the immature growth stage (early May), increasing through maturation and peaking at the end of the growing season. Acid detergent (ADF) and neutral detergent fiber (NDF) increased linearly throughout the growing season, with ADF peaking at 43 percent and 46 percent by early October for Holt and Tomahawk, respectively. However, NDF was greater in Holt in early October at 77 percent, compared with Tomahawk at 73 percent. Higher NDF levels indicate a greater level of cellulose, thus an overall coarser plant.

Holt ranked 11th and Tomahawk 13th out of the 16 warm-season grass varieties studied in terms of average pounds of ADF and NDF produced per acre during the two-year period. Harvesting maximum levels of ADF and NDF of Holt occurred in early August, with 874 and 1,562 lb/ac of ADF and NDF, respectively. Harvesting maximum levels of ADF and NDF of Tomahawk occurred in early August, with 776 and 1,392 lb/ac of ADF and NDF, respectively.

**Table 19. Indiangrass biomass (lb/ac) range and average, mean biomass rank and phenology (1-9)<sup>a</sup> in early September (early August for Upham) at Upham, N.D.; Fergus Falls and Rochester, Minn.; Onida, Fort Pierre and Lake Andes, S.D.**

Varieties	Performance	Upham	Fergus Falls	Rochester	Onida	Fort Pierre	Lake Andes
<b>Tomahawk</b>	Biomass Range	2,419–5,729	973–4,566	1,184–2,814	365–5,127	81–1,494	2,413–4,824
	Biomass Average	4,156	2,908	2,133	2,041	981	3,508
	Biomass Rank	1	3	4	4	4	5
	Phenology	6	6	6	8	7	8
<b>Holt</b>	Biomass Range	2,668–4,937	1,743–5,791	1,266–5,451	1,014–6,183	242–2,991	3,412–9,860
	Biomass Average	3,869	4,127	2,501	2,800	1,282	5,250
	Biomass Rank	2	1	3	1	3	4
	Phenology	4	4	5	6	5	5
<b>Oto</b>	Biomass Range	1,695–4,980	818–4,623	769–9,136	457–7,439	214–5,142	5,063–10,223
	Biomass Average	3,094	2,318	3,034	2,504	2,091	6,938
	Biomass Rank	3	5	1	2	1	1
	Phenology	1	1	2	3	2	3
<b>Osage</b>	Biomass Range	716–3,725	1,494–5,262	1,059–8,752	483–6,071	256–4,662	4,857–9,720
	Biomass Average	2,656	3,158	2,898	2,402	1,634	6,614
	Biomass Rank	4	2	2	3	2	2
	Phenology	1	1	3	2	2	3
<b>Rumsey</b>	Biomass Range	538–3,852	1,712–3,844	1,151–3,461	197–1,887	376–729	3,612–9,077
	Biomass Average	1,743	2,588	2,082	861	452	5,552
	Biomass Rank	5	4	5	5	5	3
	Phenology	1	1	4	2	2	3

<sup>a</sup>Phenology: 1 = vegetative; 2 = jointing; 3 = first emergence of inflorescence; 4 = first anthesis, 10 culms or more; 5 = 50% anthesis; 6 = first seed ripe; 7 = 50% seed ripe; 8 = seed mature; 9 = complete dormancy.

### Grazing Value

Indiangrass will provide good grazing from June through September and is considered a highly palatable warm-season grass. A stubble height of 6 inches is recommended to assure stand longevity. Tomahawk is the earliest maturing variety, with grazing recommended from late June when grasses reach a height of 8 to 14 inches through mid-September. Holt matures about 15 to 30 days later than Tomahawk and is recommended for grazing from early to mid-July through early September. When comparing growth patterns and nutritional value, livestock grazing from late June through early September will optimize forage use and nutrient content. A rotational grazing system can extend immature plant growth through early September, reduce trampling loss, enhance utilization, and increase nutritional quality and palatability.

From a grazing management standpoint, Indiangrass could be established as a pure stand for pasture development or incorporated into a native plant mixture. The recommended variety for livestock grazing in North and South Dakota and northern Minnesota is Tomahawk. Holt is recommended for Nebraska, Iowa, South Dakota and southern Minnesota.

**Recommended Grazing Season:**  
late June to early September  
(depending on variety).

### Hay Value

Indiangrass can make good hay; however, it typically is not recommended in pure stands for hay land in the Northern Plains. Hay land development with Indiangrass may be applicable when mixed with big bluestem and switchgrass. It is palatable when immature; however, it becomes less desirable once maturation occurs and fiber increases. Proper harvest technique for optimum stand maintenance would be to leave a stubble height of 6 inches and achieve adequate regrowth (about 10 inches) prior to the first killing frost.

Indiangrass should be cut by the early boot to boot growth stage to maintain good CP (9 percent to 10 percent) and IVDMD (> 55 percent) for winter feed and at flowering to maintain a CP and IVDMD level for nonlactating animals.

The recommended variety for hay production in North and South Dakota and northern Minnesota is Tomahawk. Holt is recommended for Nebraska, Iowa, South Dakota and southern Minnesota.

**Recommended Haying Time:**  
late July to early August for a nonlactating ration that achieves a maintenance quality with optimum forage production and early to mid-July for lactating ration, optimum quality and lower production (variety dependant).

### Wildlife Value

Indiangrass provides limited feed value for songbirds, white-tailed deer and antelope. Seeds are used sparingly by upland game and songbirds. Meadow and pocket mice make some use of the seed. Indiangrass provides good wildlife nesting cover with limited winter (thermal) cover since it does not hold up under snow as well as switchgrass or big bluestem.

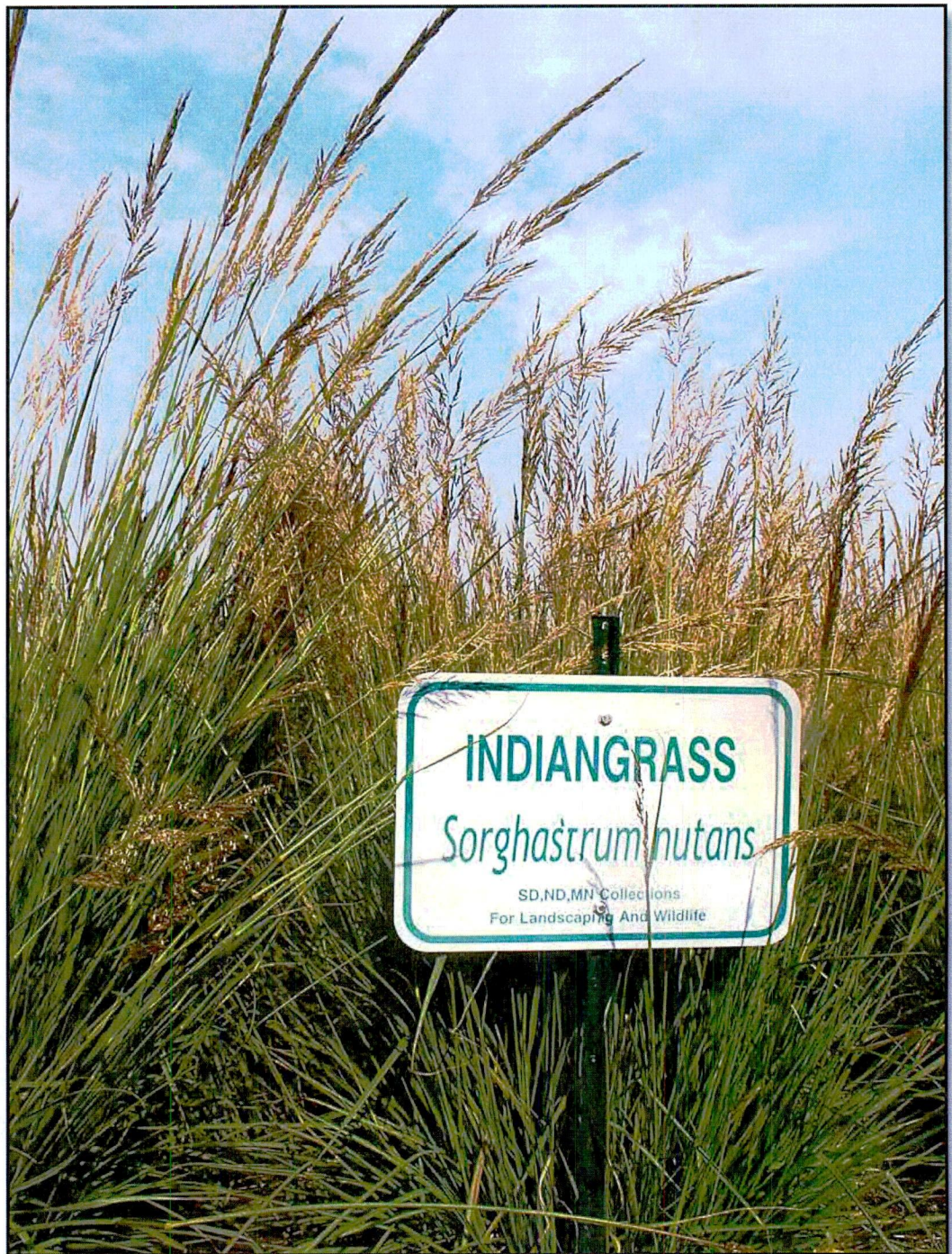
Indiangrass should be seeded in a mixture with other native grasses, forbs and legumes to provide structure of various heights as habitat for grassland nesting birds and other wildlife species. Without proper management, cool-season invasive species (Kentucky bluegrass and smooth brome grass) will become competitive, reducing habitat quality.

#### Cover Value

Spring: Good  
Summer: Good  
Fall: Good  
Winter: Good

#### Forage Value

Spring: Good  
Summer: Good  
Fall: Fair  
Winter: Poor



Evaluation nursery.

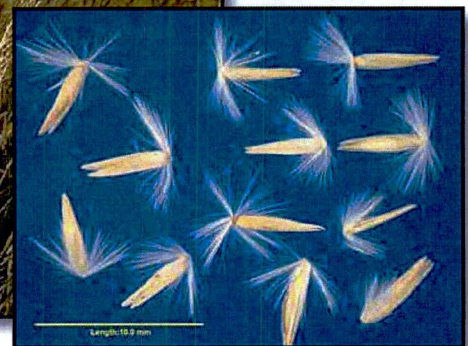
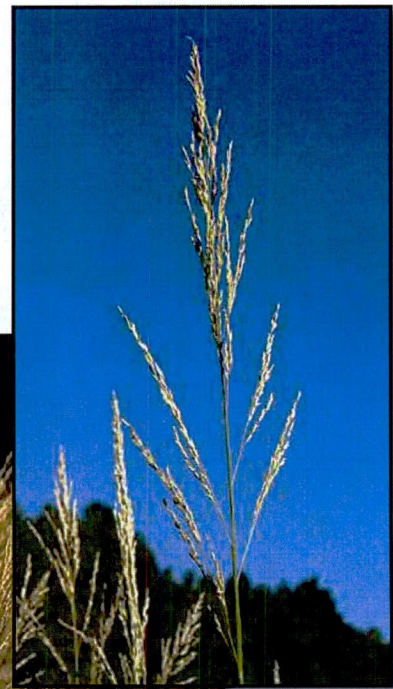


## Prairie Sandreed

**P**rairie sandreed is a native, tall statured (36 to 60 inches tall), rhizomatous perennial grass with a coarse, fibrous root system. Reproduction is by seed or vegetatively from scaly rhizomes. Rhizomes are extensive, horizontally creeping, pale whitish, stout, scaly and shiny, with the very sharp pointed tips, much like a rooster's spur. Prairie sandreed begins growth in mid-May and flowering occurs in late July to mid-August, with seed set in September. The foliage of prairie sandreed is pale green to light straw colored with single tillers arising from the stout, spreading rhizomes.

Prairie sandreed occurs primarily on coarser textured, drier ecological sites such as sandy,

sands, choppy sands, thin sands, shallow sands and limy sands. The pale green to light straw color makes the colonies of prairie sandreed very noticeable on these sites. Prairie sandreed is found throughout the northern Great Plains and occurs from Manitoba to Alberta south to Idaho, Kansas, Colorado and Indiana.



## Prairie sandreed

Releases	Release Type	Date Released	Origin	Statement of Use
<b>Badger Ecovar</b>	Selected	Pending	prairie Canada	Increased rust resistance. Recommended in plant hardiness zone 3.
<b>Koch Germplasm</b>	Selected	2007	Michigan	Selected for upright growth habit, improved seed production and vigor. Recommended in plant hardiness zones 4-5.
<b>Bowman (ND-95)</b>	Informal	2000	North Dakota	Leafy northern type with good, vigorous growth. Forage production is comparable to Goshen in the northern US but ND-95 has demonstrated improved performance in parts of Canada. Recommended in plant hardiness zone 3.
<b>Pronghorn</b>	Variety	1988	Nebraska, Kansas, South Dakota	Broad genetic base. Higher degree of rust tolerance than Goshen but similar to Goshen in forage and stand attributes. Recommended for use in revegetating sandy sites in the Nebraska Sandhills and northwestern Kansas. Recommended in plant hardiness zones 4-5.
<b>Goshen</b>	Variety	1976	Wyoming	Leafy with excellent seed production. Late maturing with basal leaves and mildly rhizomatous. Drought tolerant, adapted to sandy sites. Recommended in plant zone hardiness zone 4.

### Prairie Sandreed

The NRCS recognizes four release types. These are variety (also commonly referred to as cultivar), tested, selected and source identified. Variety, tested and selected release types have varying degrees of performance data collected for the release. Source-identified releases do not require performance documentation.

### Performance Characteristics

Prairie sandreed releases were studied for stand establishment and density index ratings (Table 20). The releases compared were Goshen and Bowman. Stand ratings were similar for both releases at each site, but variation occurred among sites. The plots at Upham, N.D., had the highest stand ratings (1.2 for Goshen and 1.4 for Bowman), and the plots at Fort Pierre, S.D., had the lowest ratings (7.0 for Goshen and 6.6 for Bowman). The Fort Pierre plots were on heavy clay soils and the poor stand ratings may have been related to soil crusting during seedling emergence.

Density index ratings generally were less for prairie sandreed, compared with the other species and ranged from a low of 2 for Goshen at Fort Pierre to a high of 18 for Bowman at Lake Andes, S.D. Comparing the total average density index ratings at all six sites, Bowman (11.2) was slightly higher than Goshen (8.3). Leaf and stem rust was a severe problem on the higher rainfall sites. The prairie sandreed plots at Lake Andes were destroyed by rust the sixth year after seeding and no biomass data was collected. No specific damage caused by winter injury was noted for either entry.

No significant differences occurred in phenology between the two releases (Table 21). Bowman was rated slightly earlier in maturity than Goshen at Lake Andes and Onida, S.D. Average maturity at the six locations was first seed ripe in early September.

### Herbage Production

No year and variety effects ( $P < 0.1$ ) occurred at all six sites during the six-year period in the original study. When creating an average biomass ranking across the six sites (1-2, with the lower number better), both Bowman and Goshen ranked the same at 1.5 (see Table 21 for biomass range, average and ranking for each variety and study area).

Cumulative herbage production from the GPNS for Bowman was 2,076 lb/ac at Hettinger in 2000, and 3,208 and 3,809 lb/ac in 1999 and 2000, respectively, at Fort Pierre (Table 9). Cumulative herbage production from the GPNS for Goshen was 1,529 lb/ac at Hettinger in 2000, and 1,613 and 3,083 lb/ac in 1999 and 2000, respectively, at Fort Pierre. Bowman had greater ( $P < 0.1$ ) cumulative herbage production than Goshen at the Fort Pierre study site but not different ( $P > 0.1$ ) at Hettinger.

### Growth Patterns

Goshen appears to grow slightly quicker than Bowman through July. On average, both varieties reach peak herbage production in mid-September. Bowman and Goshen have a similar midsummer growth pattern; however, Bowman appears to senesce more rapidly in October.

### Nutritional Quality

Location was more critical in crude protein (CP) and in vitro dry-matter digestibility (IVDMD) than variety in the GPNS. Nutritional quality (CP, IVDMD) was similar between Bowman and Goshen at both study locations (Hettinger and Fort Pierre); however, Fort Pierre had CP levels 3 percent to 5 percent lower than Hettinger throughout the growing season. The IVDMD also was similar between varieties, with initial quality similar

**Table 20. Prairie sandreed stand rating (1-9)<sup>a</sup> and density index (0-40)<sup>b</sup> at Upham, N.D.; Fergus Falls and Rochester, Minn.; Onida, Fort Pierre and Lake Andes, S.D.**

Varieties	Category	Upham	Fergus Falls	Rochester	Onida	Fort Pierre	Lake Andes
Bowman	Stand Rating	1.4	4.5	4.6	2.1	6.6	4.9
	Density Index	12	15	6	15	4	18
Goshen	Stand Rating	1.2	4.6	4.9	2.4	7	6.2
	Density Index	10	12	6	12	2	5

<sup>a</sup>Stand rating: 1 highest, 9 lowest.

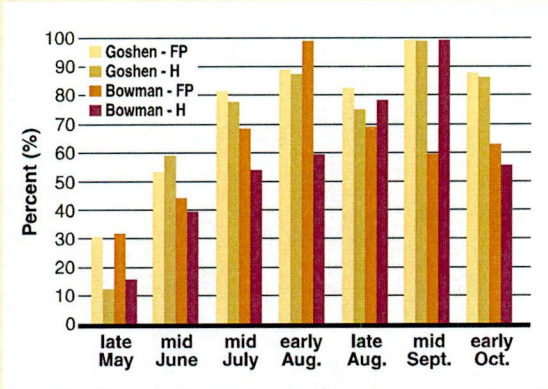
<sup>b</sup>Density index: estimate of plant density, 40 = highest.

**Table 21. Prairie sandreed biomass (lb/ac) range and average, mean biomass rank and phenology (1-9)<sup>a</sup> in early September (early August for Upham) at Upham, N.D.; Fergus Falls and Rochester, Minn.; Onida, Fort Pierre and Lake Andes, S.D.**

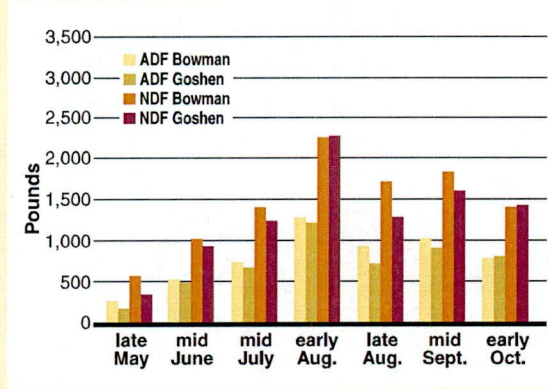
Varieties	Performance	Upham	Fergus Falls	Rochester	Onida	Fort Pierre	Lake Andes
Bowman	Biomass Range	4,389–8,352	1,203–3,786	456–1,482	1,181–7,791	1,256–3,714	179–2,000
	Biomass Average	5,359	2,592	787	3,282	2,660	1,080
	Biomass Rank	2	2	1	2	1	1
	Phenology	7	4	6	6	5	7
Goshen	Biomass Range	3,626–7,295	1,635–3,376	168–773	1,529–7,578	844–3,927	0–995
	Biomass Average	5,620	2,642	596	4,060	2,490	535
	Biomass Rank	1	1	2	1	2	2
	Phenology	7	5	6	5	5	5

<sup>a</sup>Phenology: 1 = vegetative; 2 = jointing; 3 = first emergence of inflorescence; 4 = first anthesis, 10 culms or more; 5 = 50% anthesis; 6 = first seed ripe; 7 = 50% seed ripe; 8 = seed mature; 9 = complete dormancy.

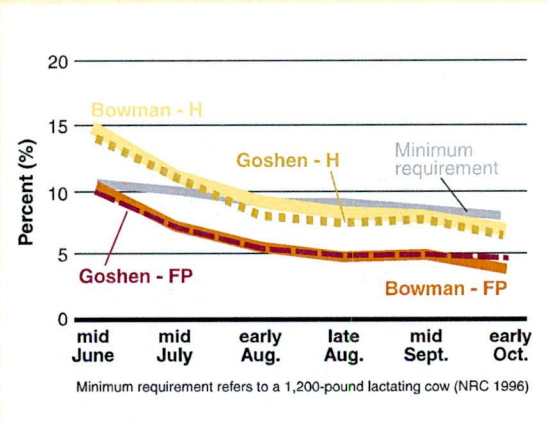
# Prairie Sandreed



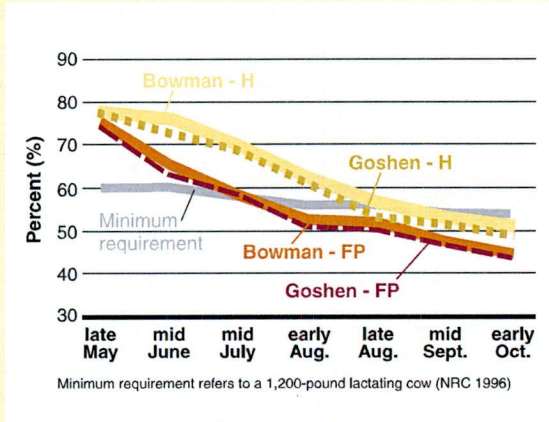
Percent of average peak standing biomass for prairie sandreed at Fort Pierre (FP) and Hettinger (H)



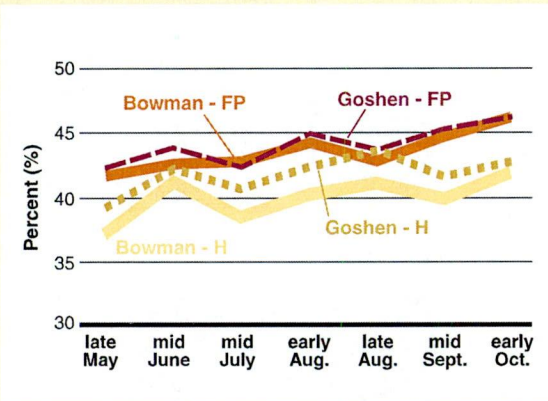
Pounds of acid detergent fiber and natural detergent fiber per acre for each period of prairie sandreed



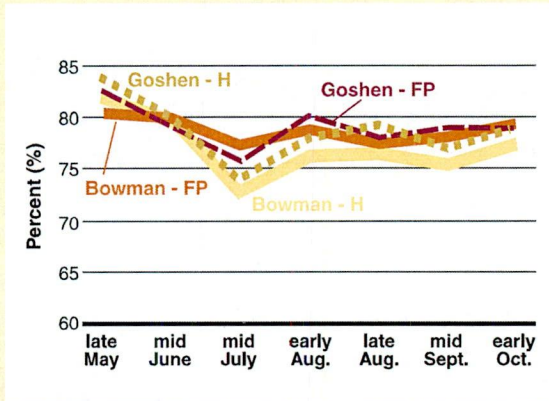
Crude protein content of prairie sandreed at Fort Pierre (FP) and Hettinger (H)



In vitro dry-matter digestibility of prairie sandreed at Fort Pierre (FP) and Hettinger (H)



Acid detergent fiber of prairie sandreed at Fort Pierre (FP) and Hettinger (H)



Neutral detergent fiber of prairie sandreed at Fort Pierre (FP) and Hettinger (H)

between Fort Pierre and Hettinger; however, it was 4 percent to 8 percent lower throughout the remaining growing season.

**Fiber Content**

Fiber content of sand bluestem was lowest at the immature growth stage (early May to early June), increasing through maturation and peaking at the end of the growing season. Neutral detergent fiber (NDF) did not change much throughout the growing season, while ADF increased linearly, peaking at 43 percent and 46 percent in early October, depending on site.

Bowman ranked ninth for consistency and Goshen 10th out of the 16 warm-season grass varieties studied in terms of average pounds of ADF and NDF produced per acre during the two-year period. Harvesting maximum levels of ADF and NDF of Bowman occurred from early August through mid-September, with 1,043 and 1,867 lb/ac of ADF and NDF, respectively. Harvesting maximum levels of ADF and NDF of Goshen occurred in mid-September, with 913 and 1,649 lb/ac of ADF and NDF, respectively.

**Grazing Value**

Prairie sandreed has low palatability during the growing season and therefore is not a preferred pasture grass. However, once exposed to a killing frost, lignin is reduced and palatability improves. With proper grazing management, prairie sandreed can withstand grazing pressure, but close grazing will decrease the plant populations. A stubble height of 4 inches is recommended to assure stand longevity. When comparing growth patterns and nutritional value, livestock grazing from mid-June through late August will optimize forage use and nutrient content. A rotational grazing system can extend immature plant growth through early September, reduce trampling loss, enhance utilization, and increase nutritional quality and palatability.

From a grazing management standpoint, prairie sandreed should be incorporated into a native plant mixture. Bowman and Goshen are the recommended varieties for livestock grazing in the western Dakotas and western Nebraska. Koch appears to be more disease

resistant and better adapted to Minnesota, Iowa, eastern Nebraska and eastern South Dakota. Pronghorn also appears to be more disease resistant and adapted for Kansas, Nebraska and southern South Dakota. Badger is a new ecovar pending release from Prairie Canada and is expected to be better adapted at northern locations.

**Recommended Grazing Season:**  
**mid-June to late August and after early October.**

**Hay Value**

The establishment of prairie sandreed would not be recommended for use as hay land in a forage system.

**Wildlife Value**

Prairie sandreed provides good to fair forage for grazing wildlife in early spring and summer. The plant’s forage value increases in importance in late fall and winter as the plant cures well on the stem and provides upright and accessible forage. Seeds are thought to be used by songbirds and small rodents.

Prairie sandreed should be seeded in a mixture with other native grasses, forbs and legumes to provide structure of various heights as habitat for grassland nesting birds and other wildlife species. Other adapted grass and forb species are somewhat limited because prairie sandreed primarily occurs on coarser textured, drier ecological sites. Without proper management, cool-season invasive species (Kentucky bluegrass and smooth brome-grass) will become competitive, reducing habitat quality.

<b>Cover Value</b>	<b>Forage Value</b>
Spring: Good	Spring: Good
Summer: Good	Summer: Fair
Fall: Good	Fall: Good
Winter: Good	Winter: Good

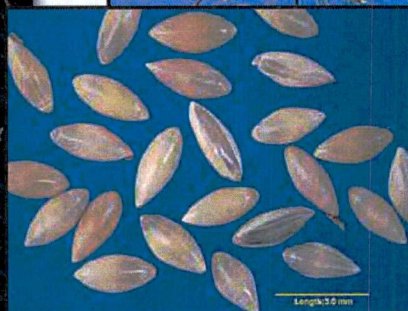
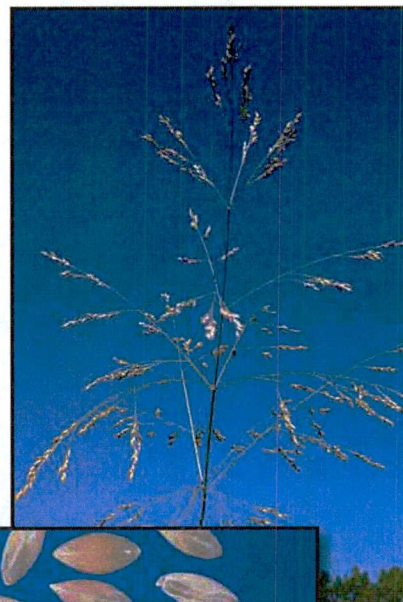


Evaluation nursery.

# Switchgrass

**S**witchgrass is a native, tall statured (36 to 60 inches tall), sod-forming perennial grass with stout rhizomes. It has a deep, vigorous root system that may grow to a depth of 9 feet. Switchgrass is capable of reproducing from underground stems and seed. Switchgrass begins growth in mid-May and flowers from late June to early August, with seed dispersal occurring in late August to early September. The seeds germinate readily and possess good seedling vigor. Switchgrass can be distinguished

from other warm-season grasses by the patch of hair at the point where the leaf attaches to the stem. Although switchgrass is adapted to a wide range of soils, it is better adapted to moist ecological sites, such as overflow and subirrigated. Switchgrass has a fair tolerance to salinity. In seeded situations, it performs well on drier sites, such as loamy or sandy ecological sites. Switchgrass is especially valuable for hay, pasture, erosion control and wildlife habitat. It is considered a desirable biofuel resource to meet emerging energy needs.



## Switchgrass

Releases	Release Type	Date Released	Origin	Statement of Use
<b>Southlow Michigan Germplasm</b>	Selected	2001	Michigan	A multiorigin germplasm assembled from 11 native stands in the southern half of Michigan's Lower Peninsula. A genetically diverse seed source that has had no purposeful selection. Recommended in plant hardiness zones 4-5.
<b>Dacotah</b>	Variety	1989	North Dakota	A winter-hardy, leafy variety. High plant vigor and seed yields. 27 days earlier in anthesis than Forestburg and 45-50 days earlier than Blackwell, Summer, Cave-in-Rock, Pathfinder and Nebraska 28. Shorter in mature height and has less coarse growth than southern varieties. Appears to have increased drought tolerance for the species. Recommended in plant hardiness zone 3.
<b>Forestburg</b>	Variety	1987	South Dakota	Superior winter hardiness, persistence and seed production. Earlier maturing than most other varieties. Forage production at northern latitudes exceeds that of Dacotah and is equal to or greater than Nebraska 28. Forestburg is similar in performance and adaptation to Sunburst. Average daily gains of yearling steers were slightly higher for Forestburg than Pathfinder in grazing studies at Morris, Minn. Recommended in plant hardiness zones 3-4.
<b>Trailblazer</b>	Variety	1984	Nebraska	Similar to Pathfinder in maturity, appearance and area of adaptation. Higher in vitro dry-matter digestibility than Pathfinder. Recommended in plant hardiness zones 4-5.
<b>Cave-in-Rock</b>	Variety	1974	Illinois	Very good seedling vigor, more resistance to damping off or leaf spot, higher seed yields, resistant to lodging, lowland type of switchgrass. Tolerant to flooding and will withstand droughty soils but is better adapted to moderately wet soils. Recommended in plant hardiness zones 5-6.
<b>Pathfinder</b>	Variety	1967	Nebraska	Winter hardy, vigorous, leafy, late maturing and rust resistant in regions where it is adapted. Good stand establishment and forage production for late spring and summer grazing. Most favorable area for seed production is in eastern third of Nebraska south of Platte River. Recommended in plant hardiness zones 4-5.
<b>Summer</b>	Variety	1963	South Dakota	Tall, upright with abundant, somewhat coarse leaves. Starts growth after June 1 and matures seed in mid-September. Produces high yields of forage and seed. Seed is small in size compared with other varieties of switchgrass. Recommended in plant hardiness zone 4.
<b>Nebraska 28</b>	Variety	1949	Nebraska	Relatively early maturing strain of switchgrass, representative of Nebraska sandhill types. Considerable variation in plant type. Matures seed in mid-August to early September. In areas with longer growing seasons, is susceptible to rust, which is likely to be a serious factor in production. Recommended in plant hardiness zones 4-5.

Releases	Release Type	Date Released	Origin	Statement of Use
<b>Blackwell</b>	Variety	1944	Oklahoma	Upland type of switchgrass of medium height with rather large stems. High in leafiness, total forage produced, and resistance to rust and other diseases. Good seedling vigor. Adapted to Kansas, Oklahoma, southern Nebraska and northern Texas in areas of 19.7 inches or more of annual precipitation. Recommended in plant hardiness zone 5.

**Switchgrass**

The NRCS recognizes four release types. These are variety (also commonly referred to as cultivar), tested, selected and source identified. Variety, tested and selected release types have varying degrees of performance data collected for the release. Source-identified releases do not require performance documentation.

**Performance Characteristics**

Switchgrass releases were studied for stand establishment and density index ratings in the original study (Table 22). The releases compared were Dacotah, Sunburst, Forestburg, Nebraska 28, Summer, Pathfinder, Cave-in-Rock, and Blackwell. Stand establishment ratings generally were good for all switchgrass entries across all sites. Stand ratings were similar for all releases, but variation did occur among sites. The switchgrass plots at

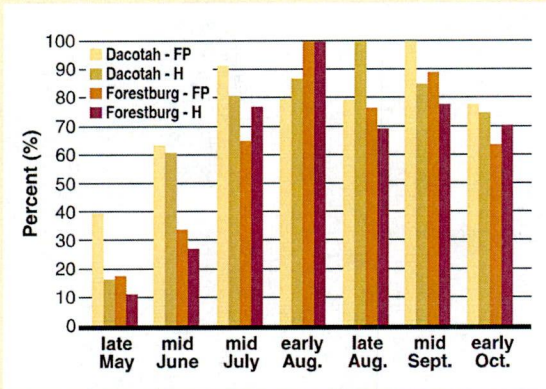
Fort Pierre, S.D., had the lowest rated stands overall. This was the only site with heavy clay soils and the low-rated stands may have been related to soil crusting during seedling emergence of the small seed. The plots at Upham, N.D., and Lake Andes, S.D., had the highest rated stands and also the most productive soils.

Dacotah and Forestburg were the two northern-most origin releases and generally were noted to have among the highest density index ratings. Stand index density was determined by estimating the number of plants in a 9-inch by 16-inch frame. The density index rating was developed with values ranging from 0 (no stand) to 40 (full stand) to estimate density. Values ranged from 23 to 29 for Dacotah and 23 to 34 for Forestburg. The lower density index ratings generally were associated with the more southern origin releases. Comparing the six sites, Lake Andes, S.D., had the highest range of values (20

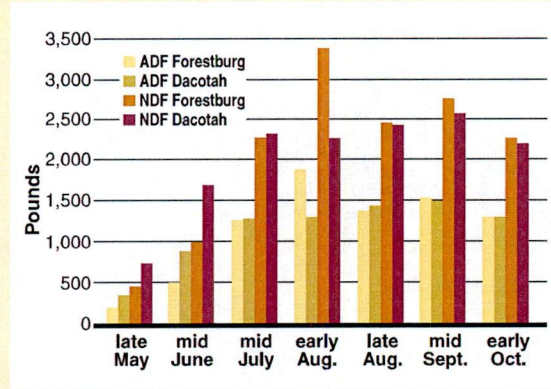


**Dacotah switchgrass (left) matured about 3 weeks earlier than Sunburst (right) at the Onida site.**

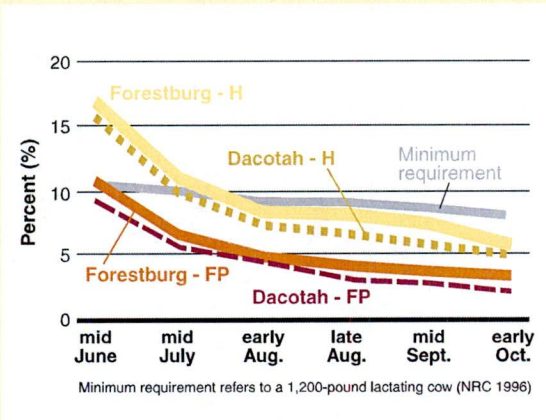
# Switchgrass



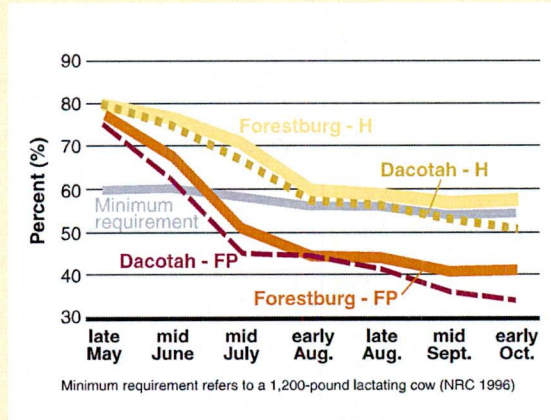
Percent of average peak standing biomass for switchgrass at Fort Pierre (FP) and Hettinger (H)



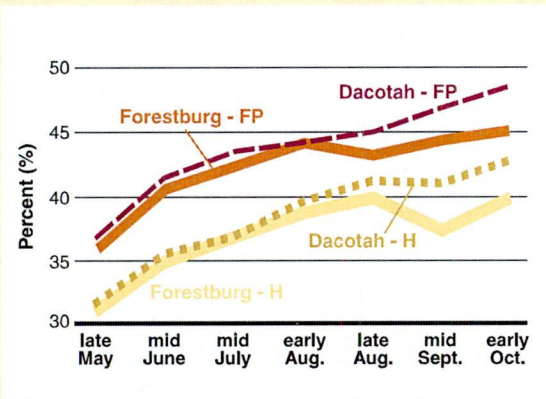
Pounds of acid detergent fiber and natural detergent fiber per acre for each period of switchgrass



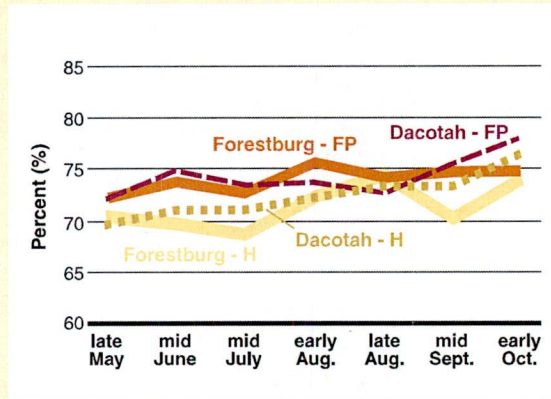
Crude protein content of prairie switchgrass at Fort Pierre (FP) and Hettinger (H)



In vitro dry-matter digestibility of switchgrass at Fort Pierre (FP) and Hettinger (H)



Acid detergent fiber of switchgrass at Fort Pierre (FP) and Hettinger (H)



Neutral detergent fiber of switchgrass at Fort Pierre (FP) and Hettinger (H)

to 34) and Rochester, Minn., had the lowest (12 to 24). No specific damage caused by winter injury was noted for any of the switchgrass entries, including those of southern origin.

The varietal differences noted in phenology were similar at all six sites (Table 23). Dacotah had the earliest maturity. Generally, Forestburg, Nebraska 28 and Sunburst were about 25 to 30 days later than Dacotah. Summer, Pathfinder, Cave-in-Rock and Blackwell matured later and still were vegetative or just jointing when Dacotah had reached mature seed at the Upham and Lake Andes sites.

### Herbage Production

Year and variety effects ( $P < 0.1$ ) occurred at all six sites during the six-year period in the original study. When creating an average biomass ranking across the six sites (1-8, with the lower number better), Summer was the most productive variety with a rating of 1.8. Rankings from second through eighth were Sunburst (3.0), Pathfinder (3.2), Blackwell (3.2), Cave-in-Rock

(4.8), Nebraska 28 (5.7), Forestburg (6.3) and Dacotah (8.0). Earlier-maturing, northern-origin varieties are less productive than later-maturing, southern-origin varieties (See Table 23 for biomass range, average and ranking for each variety and study area).

Cumulative herbage production for Dacotah was 3,183 and 3,154 lb/ac in 1999 and 2000, respectively, and for Forestburg 2,992 and 5,343 lb/ac in 1999 and 2000, respectively, at Fort Pierre from the GPNS (Table 9). Although no difference ( $P > 0.1$ ) occurred between varieties in 1999, Forestburg was greater ( $P < 0.1$ ) than Dacotah at Fort Pierre in 2000. Cumulative herbage production of Forestburg also was greater ( $P < 0.1$ ) than Dacotah (5,447 vs. 4,127 lb/ac) at Hettinger in 2000 (Table 9).

### Growth Patterns

On average, a yearly difference in timing of peak standing crop occurred in the GPNS. Forestburg reached peaked herbage production in early August at both study sites and years. Dacotah reached peak herbage produc-

**Table 22. Switchgrass stand rating (1-9)<sup>a</sup> and density index (0-40)<sup>b</sup> at Upham, N.D.; Fergus Falls and Rochester, Minn.; Onida, Fort Pierre and Lake Andes, S.D.**

Varieties	Category	Upham	Fergus Falls	Rochester	Onida	Fort Pierre	Lake Andes
<b>Summer</b>	Stand Rating	1	2.5	1.6	1.8	5	1.3
	Density Index	21	22	14	24	14	27
<b>Sunburst</b>	Stand Rating	1	2.6	1.9	2.2	3.5	1.3
	Density Index	18	20	15	28	22	20
<b>Pathfinder</b>	Stand Rating	1.1	2.9	2.5	1.6	4.1	1.6
	Density Index	27	18	24	27	20	33
<b>Trailblazer</b>	Stand Rating	NA	NA	2.3	NA	NA	4.1
	Density Index	NA	NA	12	NA	NA	21
<b>Blackwell</b>	Stand Rating	1	2.9	2.3	1.7	3.7	1.6
	Density Index	20	23	21	25	23	28
<b>Cave-in Rock</b>	Stand Rating	1.3	3.3	2.2	2.5	5.6	1.7
	Density Index	19	18	18	21	12	20
<b>Nebraska 28</b>	Stand Rating	1	3.5	2.2	2.0	2.8	1.6
	Density Index	12	16	17	31	26	28
<b>Forestburg</b>	Stand Rating	1.7	3.3	3.0	1.8	3.3	1.5
	Density Index	27	27	23	28	26	34
<b>Dacotah</b>	Stand Rating	1	2.8	2.3	2.0	4.0	1.5
	Density Index	29	26	23	27	24	29

<sup>a</sup>Stand rating: 1 highest, 9 lowest.

<sup>b</sup>Density index: estimate of plant density, 40 = highest.

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tion in mid-July to late August, depending on study site and year. Timing of precipitation had a greater impact on plant growth of Dacotah than Forestburg in this study.

### Nutritional Quality

Location was more critical in crude protein (CP) and in vitro dry-matter digestibility (IVDMD) than variety in the GPNS. Nutritional quality (CP, IVDMD) was similar between Forestburg and Dacotah at both study locations (Hettinger and Fort Pierre); however, Fort Pierre had CP levels 4 percent to 6 percent lower than Hettinger

throughout the growing season. The IVDMD also was similar between varieties, with initial quality 2 percent lower at Fort Pierre, compared with Hettinger; however, it was 18 percent lower by early October.

Switchgrass is nutritional and palatable for all classes of livestock in June and early July. The CP content drops below 10 percent by early July to early August, depending on location. Crude protein content was below 5 percent by early October when fully mature for both study locations. In vitro dry-matter digestibility of switchgrass was below 55 percent by early July at Fort Pierre and early October in Hettinger.

**Table 23. Switchgrass biomass (lb/ac) range and average, mean biomass rank and phenology (1-9)<sup>a</sup> in early September (early August for Upham) at Upham, N.D.; Fergus Falls and Rochester, Minn.; Onida, Fort Pierre and Lake Andes, S.D.**

Varieties	Performance	Upham	Fergus Falls	Rochester	Onida	Fort Pierre	Lake Andes
<b>Summer</b>	Biomass Range	5,410–9,426	4,024–9,011	3,849–4,931	1,468–9,140	837–6,101	6,376–9,322
	Biomass Average	6,910	6,821	4,511	4,234	3,239	7,711
	Biomass Rank	4	1	1	2	2	1
	Phenology	1	4	5	6	4	6
<b>Sunburst</b>	Biomass Range	4,848–9,639	4,703–9,113	3,063–4,323	1,901–7,221	578–5,320	5,808–6,398
	Biomass Average	7,499	6,794	3,646	4,060	2,763	6,162
	Biomass Rank	1	2	2	3	5	6
	Phenology	6	5	6	7	4	6
<b>Pathfinder</b>	Biomass Range	6,058–8,782	2,226–9,551	1,221–3,724	1,994–8,662	498–5,186	6,417–8,109
	Biomass Average	7,043	5,603	2,252	4,750	3,211	7,235
	Biomass Rank	3	4	6	1	3	3
	Phenology	3	3	4	5	3	5
<b>Blackwell</b>	Biomass Range	5,221–9,335	2,964–8,613	2,370–5,528	827–9,266	608–5,808	6,664–8,293
	Biomass Average	6,804	5,805	3,218	4,052	3,270	7,487
	Biomass Rank	5	3	4	4	1	2
	Phenology	3	3	5	5	2	5
<b>Cave-in-Rock</b>	Biomass Range	5,023–6,900	1,876–5,916	2,487–5,253	999–6,794	627–5,751	5,044–8,764
	Biomass Average	5,703	4,151	3,497	3,467	2,646	6,278
	Biomass Rank	7	5	3	5	6	4
	Phenology	3	3	5	5	4	5
<b>Nebraska 28</b>	Biomass Range	5,703–8,925	2,994–6,104	1,127–2,716	404–6,623	384–4,900	5,543–7,010
	Biomass Average	7,216	4,143	1,835	2,876	2,305	6,179
	Biomass Rank	2	6	8	7	8	5
	Phenology	6	5	6	7	4	7
<b>Forestburg</b>	Biomass Range	4,825–8,037	2,279–5,909	1,158–2,598	1,040–6,576	273–4,884	5,238–6,672
	Biomass Average	6,529	3,997	1,909	3,307	2,580	5,898
	Biomass Rank	6	7	7	6	7	7
	Phenology	6	5	6	7	5	6
<b>Dacotah</b>	Biomass Range	2,177–6,498	1,551–3,798	995–2,133	952–5,473	209–4,574	3,141–4,329
	Biomass Average	4,572	2,883	1,578	2,448	2,037	3,716
	Biomass Rank	8	8	9	8	9	8
	Phenology	8	8	7	8	7	8

<sup>a</sup>Phenology: 1 = vegetative; 2 = jointing; 3 = first emergence of inflorescence; 4 = first anthesis, 10 culms or more; 5 = 50% anthesis; 6 = first seed ripe; 7 = 50% seed ripe; 8 = seed mature; 9 = complete dormancy.

## Fiber Content

Fiber content of switchgrass was lowest at the immature growth stage (early May), increasing through maturation and peaking at the end of the growing season. Acid detergent (ADF) and neutral detergent fiber (NDF) increased linearly throughout the growing season, with ADF peaking at 45 percent and 48 percent by early October for Forestburg and Dacotah, respectively. Neutral detergent fiber increased from 70 percent to 72 percent in early May to 74 percent to 78 percent in early October.

Forestburg ranked first and Dacotah second out of the 16 warm-season grass varieties studied in terms of average pounds of ADF and NDF produced per acre during the two-year period. Harvesting maximum levels of ADF and NDF of Forestburg occurs in early August, with 1,907 and 3,400 lb/ac of ADF and NDF, respectively. Harvesting maximum levels of ADF and NDF of Dacotah occurs in mid-September, with 1,531 and 2,599 lb/ac of ADF and NDF, respectively.

## Grazing Value

Switchgrass will provide good grazing from June through August; however, palatability is lower than in most other native warm-season grasses. Proper grazing management is critical, with a stubble height of 8 to 12 inches required to assure stand longevity. Dacotah is the earliest maturing variety, with grazing recommended from mid-June through late July. Forestburg, Nebraska 28 and Sunburst were about 25 to 30 days later maturing than Dacotah and recommended for grazing from early July through August. Summer, Cave-in-Rock, Blackwell and Pathfinder were 45 to 60 days later in maturity than Dacotah and remained in a vegetative growth stage in August and much of September. When comparing growth patterns and nutritional value, livestock grazing from mid June through early August will optimize forage use and nutrient content. In vitro dry-matter digestibility was difficult to interpret but appears to be adequate through late August. A rotational grazing system can extend immature plant growth through early September, increasing nutritional quality and palatability. Switchgrass is reported to be toxic to horses, sheep and goats when grazing pure stands. Toxicity can cause photosensitivity

and affect internal organs and liver function (USDA NRCS 2001/2002). No problems have been noted for cattle.

Switchgrass planted for pasture should be established as a pure stand because livestock tend to prefer other species if given a choice. Recommended varieties for livestock grazing in North and South Dakota and northern Minnesota are Forestburg, Dacotah and Sunburst. Recommendations for Nebraska, Iowa, southern Minnesota and southern South Dakota include Sunburst, Summer, Nebraska 28, Pathfinder, Trailblazer and Cave-in-Rock.

**Recommended Grazing Season:  
mid-June to early September  
(depending on variety).**

## Hay Value

Although not usually recommended for hay production, switchgrass can make fair to good hay, depending on timing of harvest and variety. It is palatable when immature; however, it becomes less desirable once maturation occurs and fiber increases. If establishing switchgrass as forage, grazing would be recommended, with hay use the alternative option. Proper harvest technique is critical, with a stubble height of 10 to 12 inches required to assure stand longevity.

Switchgrass should be cut by the late boot growth stage to maintain good CP (9 percent to 10 percent) and IVDMD (> 55 percent) for winter feed and at flowering to maintain a CP and IVDMD level for nonlactating animals.

Suitable varieties for hay production in North and South Dakota and northern Minnesota are Forestburg, Dacotah and Sunburst. Recommendations for Nebraska, Iowa, southern Minnesota and South Dakota include Sunburst, Summer, Nebraska 28, Pathfinder, Trailblazer and Cave-in-Rock.

**Recommended Haying Time:**  
mid to late July for a nonlactating ration that achieves a maintenance quality with optimum forage production and late June to early July for lactating ration, optimum quality, and lower production (variety dependant).

songbirds. Switchgrass provides fair to good forage value for white-tailed deer and some rodents in the immature growth stage but becomes unpalatable when mature.

Switchgrass should be seeded in a mixture with other native grasses, forbs and legumes to provide structure of various heights as habitat for grassland nesting birds and other wildlife species. Without proper management, cool-season invasive species (Kentucky bluegrass and smooth brome grass) will become competitive, reducing habitat quality.

### Wildlife Value

Switchgrass provides excellent year-round cover for a variety of wildlife species, including pheasants, white-tailed deer and rabbits. It provides high-quality nesting cover for grassland birds, especially pheasant and prairie grouse. Since switchgrass remains standing in heavy snow, it provides excellent winter thermal cover. Seeds provide food for pheasant, quail, turkey, dove and

#### Cover Value

Spring: Excellent  
Summer: Excellent  
Fall: Excellent  
Winter: Excellent

#### Forage Value

Spring: Good  
Summer: Good  
Fall: Fair  
Winter: Poor



Seed field of forestburg switchgrass.

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