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Regrassing Areas in South Dakota

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Summary and Table of Contents

Regrassing Areas in South Dakota

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AS EARLY AS 1894 Shepard and Williams stated that approximately 160 species of grasses grew within the state[2]—105 native and the remainder introduced. The fact of the occurrence of this large number of native grass and grass-like species, the predominance of one over another in different areas, the later effects of agriculture upon the degree of survival of species constitute subjects of vital importance in a consideration of range and pasture improvement. The fact that some 55 species of true grass had been introduced into South Dakota previous to 1894 attests the interest of farm operators.

A Small Number of Grasses Cultivated

Although the total number of native and introduced true grass species is large, it is important to note the relatively small number of species found on a list of cultivated crops. Thus, discussion of grasses and their improvement for meadows and pastures in South Dakota will center definitely around a limited number of species. Twenty true grasses may be named that demand principal attention over the three areas where the improvement of meadows and pastures receives major attention.

The scope of the present bulletin makes it possible to present

1. An outline map of South Dakota with names of dominant grass species that grow within the several regions.
2. Descriptions and outstanding facts about the agronomic species.
3. Illustrations and descriptions of the more restricted number having major agricultural importance.
4. Results of cultural experiments which serve as a guide for their successful establishment and utilization.

Grassland is of Vital Importance in South Dakota

Grass in South Dakota is of vital economic importance for grazing, hay production, control of wind and water erosion, watershed protection and wildlife.

Of the state's 49 million acres, 29 million acres or nearly 60 percent are classed as grassland. West of the Missouri River the percentage is slightly over 80. Fourteen counties just east of the Missouri River have an average of over 50 percent. The east river portion as a whole has less than 35 percent grassland.

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2. S. Dak. Agr. Exp. Sta. Bul. 40, 1894.

Distribution and Rank of Abundance of Native Grasses and Grasslike Plants in South Dakota (Map on Page Opposite.)

SHORT GRASS TYPES

Area	Common and Botanical Name
4	Buffalo grass—*Buchloe dactyloides*
&	Blue grama—*Bouteloua gracilis*
5	Western wheatgrass—*Agropyron smithii*
	Niggerwool—*Carex filifolia*
	Needle-and-thread—*Stipa comata*

MID-GRASS TYPES

Area	Common and Botanical Name
1	Blue grama—*Bouteloua gracilis*
	Needle-and-thread—*Stipa comata*
	Niggerwool—*Carex filifolia*
	Western wheatgrass—*Agropyron smithii*
	Sandberg bluegrass—*Poa secunda*
2	Western wheatgrass—*Agropyron smithii*
	Annual saltbush—*Atriplex argentea*
	Blue grama—*Bouteloua gracilis*
	Buffalo grass—*Buchloe dactyloides*
	Feather bunchgrass—*Stipa viridula*
3	Blue grama—*Bouteloua gracilis*
&	Western wheatgrass—*Agropyron smithii*
6	Niggerwool—*Carex filifolia*
	Needle-and-thread—*Stipa comata*
	Buffalo grass—*Buchloe dactyloides*
7	Buffalo grass—*Buchloe dactyloides*
	Blue grama—*Bouteloua gracilis*
	Western wheatgrass—*Agropyron smithii*
	Niggerwool—*Carex filifolia*
	Sandberg bluegrass—*Poa secunda*

MID-GRASS TYPES (Continued)

Area	Common and Botanical Name
9	Blue grama—*Bouteloua gracilis*
	Buffalo grass—*Buchloe dactyloides*
	Western wheatgrass—*Agropyron smithii*
	Niggerwool—*Carex filifolia*
	Side-oats grama—*Bouteloua curtoipendula*
10	Blue grama—*Bouteloua gracilis*
	Western wheatgrass—*Agropyron smithii*
	Buffalo grass—*Buchloe dactyloides*
	Needle-and-thread—*Stipa comata*
	Dryland sedges—*Carex spp.*
11	Western wheatgrass—*Agropyron smithii*
	Blue grama—*Bouteloua gracilis*
	Side-oats grama—*Bouteloua curtoipendula*
	Little bluestem—*Andropogon scoparius*
	Sand dropseed—*Sporobolus cryptandrus*
12	Blue grama—*Bouteloua gracilis*
	Western wheatgrass—*Agropyron smithii*
	Needle-and-thread—*Stipa comata*
	Dryland sedges—*Carex spp.*
	Buffalo grass—*Buchloe dactyloides*
13	Blue grama—*Bouteloua gracilis*
	Western wheatgrass—*Agropyron smithii*
	Dryland sedges—*Carex spp.*
	Buffalo grass—*Buchloe dactyloides*
	Bluegrasses*—*Poa spp.*

MID-GRASS TYPES (Continued)

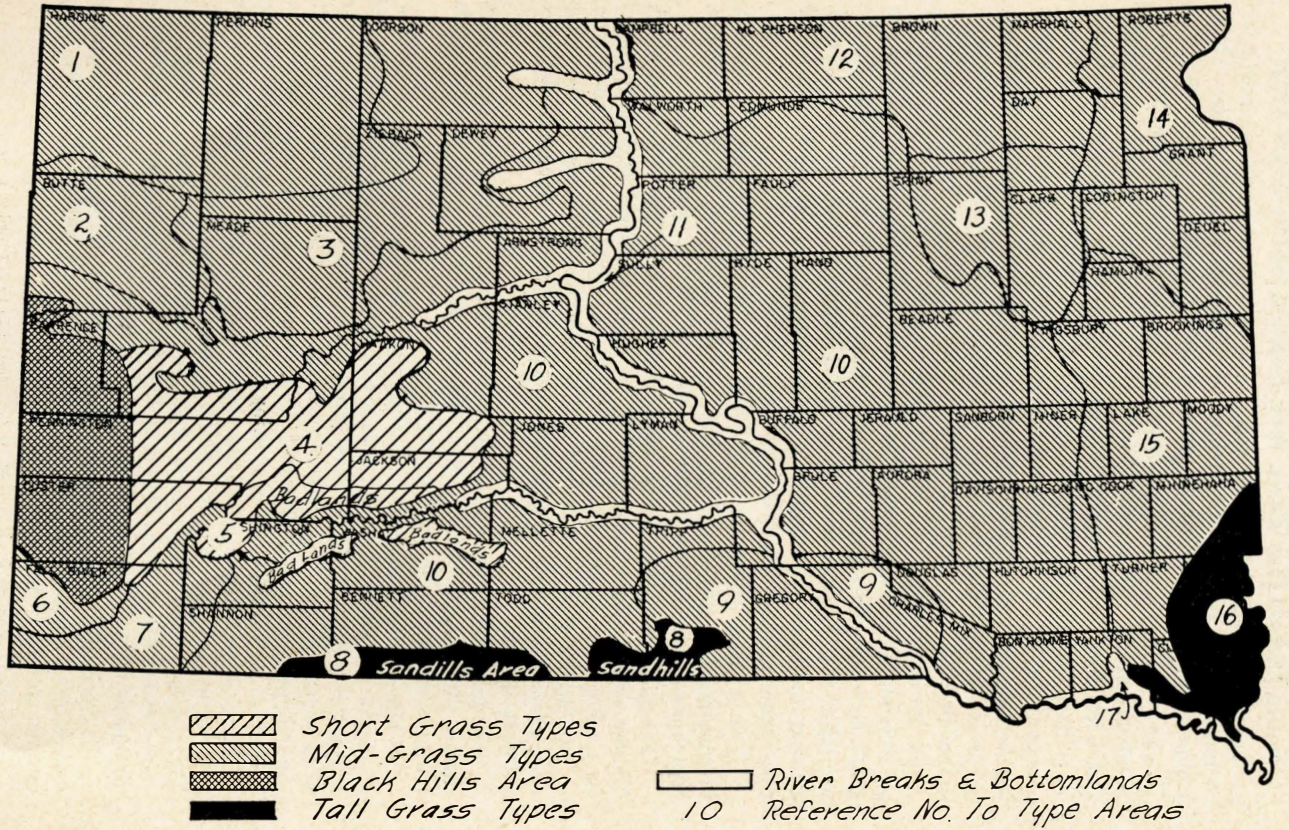
Area	Common and Botanical Name
14	Blue grama—*Bouteloua gracilis*
	Bluegrasses*—*Poa spp.*
	Dryland sedges—*Carex spp.*
	Big bluestem—*Andropogon furcatus*
	Little bluestem—*Andropogon scoparius*
15	Kentucky bluegrass—*Poa pratensis*
	Western wheatgrass—*Agropyron smithii*
	Blue grama—*Bouteloua gracilis*
	Dryland sedges—*Carex spp.*
	Side-oats grama—*Bouteloua curtoipendula*

TALL GRASS TYPES

Area	Common and Botanical Name
8	Prairie sandgrass—*Calamovilfa longifolia*
	Sand dropseed—*Sporobolus cryptandrus*
	Little bluestem—*Andropogon scoparius*
	Big bluestem—*Andropogon furcatus*
	Blue grama—*Bouteloua gracilis*
16	Kentucky bluegrass—*Poa pratensis*
	Western wheatgrass—*Agropyron smithii*
	Big bluestem—*Andropogon furcatus*
	Little bluestem—*Andropogon scoparius*
	Side-oats grama—*Bouteloua curtoipendula*
17	Big bluestem—*Andropogon furcatus*
	Western wheatgrass—*Agropyron smithii*
	Sand dropseed—*Sporobolus cryptandrus*
	Dropseed—*Sporobolus asper*
	Kentucky bluegrass—*Poa pratensis*

*Canada and Kentucky bluegrasses introduced from Europe, but considered native in this bulletin.

Fig. 1. South Dakota Native Grass Map.



Courtesy Soil Conservation Service

South Dakota Has Three Well-Defined Native Grass Areas

Originally South Dakota was nearly all grassland where dominant species comprised three well-defined groups based primarily upon stature. These groups are commonly called tall-grasses, mid-grasses and short-grasses.

The tall-grasses were more abundant in the eastern third of the state, often referred to as the "true prairie." Cultivation has reduced the grassland in this area to less than 20 percent of its original area. Intensive grazing on small pastures has modified the original vegetation so that mid-grasses and short-grasses of the "mixed prairie" have replaced many of the tall-grasses. Alternating wet and dry cycles causes a shift of the tall-grasses east and west. Drouth conditions of the 1930's pushed the western limits of the tall-grasses eastward so that by 1940 aside from the sandhills they occupied only the southeastern corner of the state. See Fig. 1. The original western limits of the "true prairie" are difficult to determine. Other limited areas of tall-grasses are found where sandy soils compensate for the lack of rainfall, the best example being the overlap of the Nebraska sandhills in South Dakota in southern Tripp, Todd, Bennett and Shannon counties. In addition, species of tall-grasses are found throughout the state where moisture is favorable.

The principal tall-grasses found are big bluestem, sandhill bluestem, bromegrass (an introduced species), prairie sandgrass, Canada wild-rye, switchgrass, Indian grass, prairie cordgrass and feather bunchgrass.

The mid-grasses have always dominated the "true prairie" of eastern South Dakota except where heavy grazing has killed them out and short-grasses have taken over. Mid-grasses have been dominants, along with short-grasses, in the "mixed prairie" of central and western South Dakota. Likewise, too close grazing here has favored the short-grasses at the expense of the taller growing species.

The principal mid-grasses of the state are western wheatgrass, needle-and-thread, little bluestem, June grass, side-oats grama, Kentucky and Canada bluegrasses, sand dropseed and dropseed.

While short-grasses were originally present in the eastern part of the state, species of this group were dominants only in the "mixed prairie" of central and western South Dakota. Short-grasses make up the greatest area of the grass vegetation over a large portion of the "mixed prairie" where overgrazing long prevailed and where rainfall and evaporation are less favorable to the growth of mid-grasses. When grazing pressure is relieved and normal or excess rainfall exists, mid-grasses are able to compete with the short-grasses on even terms, and may even completely dominate them. Localized heavy grazing, together with the dry cycle of the last decade has favored short-grasses to the extent that they are found as dominants on many ranges and pastures throughout South Dakota excepting the extreme southeastern corner.

The principal short-grasses and grasslike plants[3] (sedges) are blue grama, buffalo grass, niggerwool (sedge), dryland sedges, Sandberg bluegrass, hairy grama, and desert saltgrass.

3. Throughout this publication, grasslike plants (or sedges) will be discussed as grasses.

A carrying capacity survey was completed by the State Agricultural Experiment Station and the Soil Conservation Service in 1940, which formed the basis for the grassland type map (Fig. 1) and indicated the most important grasses and grasslike plants in each of 17 sub-areas.

Table 1 is an arrangement of grass species in order of their abundance beginning with 1 as most abundant and continuing to 5 as least abundant of the five selected most prominent species in each sub-area. Reference to the right-hand vertical column of the table will indicate the number of sub-areas out of total 17 in South Dakota where the given species is found to be one of the five predominating. The names of species at the left of the table are placed in the order of the number of times of their occurrence among the five predominating species.

Table 1. Occurence of Grass Species in the 17 Sub-areas in South Dakota (See Fig. 1 Map).

Species	Sub-Areas																Total Number of Occurrences
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Blue grama	1	2	1	2	2	1	2	5	1	1	2	1	1	1	3			15
Western wheatgrass	4	1	2	3	3	2	3		3	2	1	2	2		2	2	2	15
Buffalo grass		3	5	1	1	5	1		2	3		5	4					10
Niggerwool	3		3	4	4	3	4		4									7
Feather bunchgrass	2		4	5	5	4				4		3						7
Dryland sedges										5		4	3	3	4			5
Big bluestem								4						4		3	1	4
Little bluestem								3			4			5		4		4
Side-oats grama									5		3				5	5		4
Kentucky bluegrass															1	1	5	3
Sand dropseed								2			5						3	3
Sandberg bluegrass	5	5					5											3
Bluegrass (Canada & Ky.)													5	2				2
Prairie sandgrass								1										1
Dropseed																	4	1

Period of Growth Determines Use of Grass

Spring and Fall Grasses. Grasses that start growth early in the spring, but become more or less dormant during the hot summer and green-up and grow again in the fall if moisture conditions are favorable, include: Crested wheatgrass, Sandberg bluegrass, Kentucky bluegrass and Canada bluegrass.

Spring-Summer Grasses. Common grasses that start growth early in the spring and continue growth more or less throughout the summer are: Smooth brome, western wheatgrass, slender wheatgrass, needle-and-thread, feather bunchgrass, Russian wild-rye, Canada wild-rye, niggerwool and dryland sedges. Feather bunchgrass will typically green-up in the fall if conditions are suitable.

Summer Grasses. The grasses that start growth late in the spring (usually May) and continue growth throughout the summer include: Blue grama, side-oats grama, buffalo grass, big and little bluestem, switch grass, Indian grass, sand dropseed and prairie dropseed.

By grazing the early grasses until June and then switching pastures to those in which summer grasses predominate, excellent and nutritious pasturage on grasses can be extended for the entire grazing season. Nearly all of these native grasses cure well on the ground, retain most of their nutritive value, and can be grazed throughout the fall and winter.

Grasses classify themselves not only botanically and also as foregoing into groups which make characteristic responses to seasonal periods. These species of different growth periods are found to be variously adapted for utilization.

The following outline makes comparison of the palatability of several species which fall within growth classifications. This classification is arranged by the United States Department of Agriculture Soil Conservation Service, Region 7.

Grass Species		Percent Palatability*	
Common Name	Scientific Name	C & H	S & G
I. Perennial Grasses, Sedges and Rushes			
A. Short			
1. Grasses			
Blue grama	*Bouteloua gracilis*	80	70
Hairy grama	*Bouteloua hirsuta*	80	70
Buffalo grass	*Buchloe dactyloides*	80	80
Desert salt-grass	*Distichlis stricta*	20	10
Spiny muhly	*Muhlenbergia pungens*	20	10
Plains bluegrass	*Poa arida*	40	30
Sandberg bluegrass	*Poa secunda*	40	30
Tumblegrass	*Schedonnardus paniculatus*	10	10
2. Dryland Sedges			
Mixed dryland sedges	*Carex spp.*	70	60
Niggerwool	*Carex filifolia*	80	70
Dryland sedge	*Carex heliophylla*	60	50
Dryland sedge	*Carex pennsylvanica*	70	60
Dryland sedge	*Carex stenophylla*	60	50
B. Mid-tall			
1. Grasses			
Crested wheatgrass	*Agropyron cristatum*	70	50
Slender wheatgrass	*Agropyron trachycaulum*	70	50
Western wheatgrass	*Agropyron smithii*	70	50
Little bluestem	*Andropogon scoparius*	20†	10
Red three-awn	*Aristida longiseta*	20	10
Side-oats grama	*Bouteloua curtipendula*	70	50
Poverty oatgrass	*Danthonia spicata*	50	20
Foxtail barley	*Hordeum jubatum*	20	10
June grass	*Koeleria cristata*	60	50
Plains muhly	*Muhlenbergia cuspidata*	40	0
Marsh muhly	*Muhlenbergia racemosa*	40	20
Indian ricegrass	*Oryzopsis hymenoides*	50	20
Littleseed ricegrass	*Oryzopsis micrantha*	40	30
Canada bluegrass	*Poa compressa*	70	60
Kentucky bluegrass	*Poa pratensis*	70	60
Nuttall alkali-grass	*Puccinellia nuttalliana*	10	10
Blowout grass	*Redfieldia flexuosa*	10	10
Squirreltail	*Sitanion hystrix*	30	20
Alkali sacaton	*Sporobolus airoides*	50	40
Dropseed	*Sporobolus asper*	40	10
Sand dropseed	*Sporobolus cryptandrus*	40	20
Prairie dropseed	*Sporobolus heterolepis*	50	40
Needle-and-thread	*Stipa comata*	60	40
Porcupine grass	*Stipa spartea*	40	20

Grass Species Common Name	Scientific Name	Percent Palatability* C & H	 S & G
C. Tall			
1. Grasses			
Intermediate wheatgrass	*Agropyron intermedium*		
Big bluestem	*Andropogon furcatus*	70	50
Sandhill bluestem	*Andropogon hallii*	40	30
Smooth brome	*Bromus inermis*	80	50
Prairie sandgrass	*Calamovilfa longifolia*	20‡	10
Canada wild-rye	*Elymus canadensis*	30	30
Sandhill lovegrass	*Eragrostis trichodes*	50	30
Switch grass	*Panicum virgatum*	50	30
Reed canary grass	*Phalaris arundinacea*	80	60
Indian grass	*Sorghastrum nutans*	40	10
Prairie cordgrass	*Spartina pectinata*	10	0
Feather bunchgrass	*Stipa viridula*	60	40
2. Sedges			
Mixed meadow sedges	*Carex spp.*	50	
Meadow sedge	*Carex diandra*	70	
Thicket sedge	*Carex gravida*	50	
Nebraska sedge	*Carex nebraskensis*	50	
Thicket sedge	*Carex sprengelii*	70	
Meadow sedge	*Carex trichocarpa*	50	
3. Rushes			
Spike rush	*Eleocharis palustris*	40	10
II. Annual Grasses			
Japanese chess	*Bromus japonicus*	10	20
Downy chess	*Bromus tectorum*	10	20
Barnyard grass	*Echinochloa crusgalli*	10	10
Stink grass	*Eragrostis cilianensis*	0	0
Six weeks fescue	*Festuca octoflora*	10	10
Little barley	*Hordeum pusillum*	30	10
Pull-up muhly	*Muhlenbergia filiformis*	0	0
False buffalo grass	*Munroa squarrosa*	0	0
Witchgrass	*Panicum capillare*	0	0
Green bristlegrass	*Setaria viridis*	10	10
Annual dropseed	*Sporobolus neglectus*	0	0

* The palatability is the percent to which a species is grazed under the best practical range and pasture management. C & H, S & G stand for cattle, horses, sheep and goats.

† Palatability 70-50 in eastern South Dakota.

‡ Palatability 40-10 in Sandhills.

Fig. 2. Western wheatgrass.

Eight Outstanding Grass Species for South Dakota

Western wheatgrass *(Agropyron smithii)* is a perennial sod-forming grass spreading from vigorous creeping rootstocks. It is best adapted to well-drained bottom lands, but is commonly found on open plains, hillsides and benchlands. It is alkali-enduring and often occupies lands inhabited by few other grasses. This grass is usually the first perennial plant to appear in quantity on abandoned croplands, particularly on medium to heavy soils.

Western wheatgrass is one of the most widely distributed and valuable native forage plants of the state. It starts growth early in the spring and furnishes very good grazing throughout the spring and summer. It cures well on the ground, making very good winter forage, and also yields excellent hay of high feeding value provided it is cut at the proper time. Western wheatgrass does not withstand heavy grazing without reduction to the stand. The limited seed supply usually matures late but this handicap is offset by vigorous reproductivity from rootstocks.

Crested wheatgrass *(Agropyron cristatum)* is a hardy, long-lived perennial bunchgrass, introduced into the United States from Sibera and Russia. This grass is remarkable for its drouth-resistance, tolerance of extreme low temperatures and for its very early spring growth. It is palatable to all classes of livestock and its hay compares favorably with that of the native western wheatgrass in palatability and food value. The best quality hay is obtained if the grass is cut shortly before blooming. It has an extensive root system, which permits it to store abundant food reserves as well as to make ready use of water when available. During hot, dry spells the grass becomes dormant but resumes growth with cooler weather and more favorable moisture conditions. It is a vigorous seeder, yields well and the seeds ripen early while the plants are still green.

Buffalo grass (*Buchloe dactyloides*) is a short, leafy, perennial sod-forming grass which spreads chiefly by above ground runners, called stolons. The stolons take root at the nodes and new plants are formed. The grass plants are typically one-sexed; that is, the female flowers and seed are produced on one plant and the male flowers on another. The male flowers are borne on stems four to eight inches high somewhat resembling the spikes of blue grama grass but are much smaller. The female flowers are borne on short sessile heads which may be hidden among the leaves.

The above ground runners, the one-sexed plants, and more hairy leaves serve to distinguish buffalo grass from blue grama grass, with which it is so often confused.

Buffalo grass is abundant in South Dakota, occurring from small scattered patches to nearly pure stands on medium to heavy soils. Its tolerance to drouth and heavy grazing has enabled buffalo grass to increase at the expense of less tolerant plants during the past decade.

Buffalo grass is an excellent range grass, being highly palatable and nutritious and curing well on the ground. It makes its maximum growth during the warm season of the year and will furnish excellent pasture in July and August when many of the other grasses are dormant.

Courtesy Soil Conservation Service

Fig. 3. Crested wheatgrass.

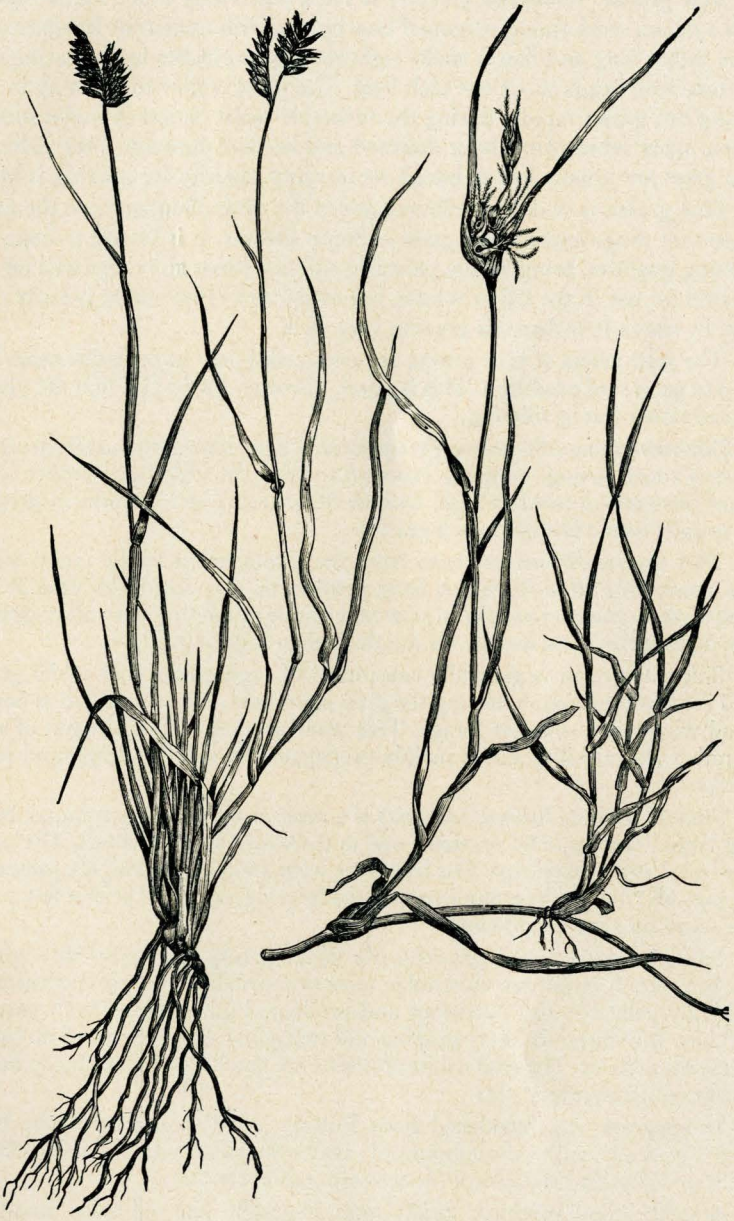


Fig. 4. Buffalo grass.

Blue grama *(Bouteloua gracilis)* is often incorrectly called buffalo grass. It is a dense, sod-forming perennial bunchgrass, with numerous leaves two to four inches long and flower stalks eight to eighteen inches high, bearing one to three seed heads about one inch long. The plant is slow to green-up in the spring but grows rapidly during the favorable moist period of mid-summer, when many other plants have matured and become dormant. Hay yields of this grass are usually low although its carrying capacity for grazing is high.

Blue grama is widely distributed and is the most abundant and the most important range and pasture grass in South Dakota. It is second to none for grazing qualities, being highly palatable and nutritious and cures well on the ground for use in the fall or winter, but owing to its low stature is easily covered by snow. It withstands grazing very well.

The seed habits of blue grama are erratic and only in favorable years is a crop of good seed produced. This is offset, however, by the fact that the plants spread rather fast by tillering.

Side-oats grama *(Bouteloua curtipendula)* is an erect perennial with coarse fibrous roots, strong, creeping rootstocks, wide flat leaves and rather leafy stems from one to two feet high. Despite the presence of rootstocks its growth is typically tufted like the bunch grasses.

This species derives its name from the arrangement of the many spikelets, commonly 20 to 60, which hang pendent on one side of the stem. It is a plains grass, growing usually in scattered stands in mixture with other grasses throughout the state, usually on rough, broken hills and ridges.

Side-oats grama is generally considered of high palatability while green and is consumed mainly during the growing season. It is recognized as both a good winter and summer forage. This plant produces a fair amount of seed of rather low viability, but is mainly propagated by short underground rootstocks.

Smooth brome (*Bromus inermis*) is a dense, sod-forming perennial, bearing large, loose panicles on stems one to three and a half feet tall. The panicles turn brown when ripe. The leaves are wide and long and highly palatable. Its growth from underground root-stocks is so vigorous that after a few years the stand becomes "sod-bound."

Smooth brome begins growth early in the spring and grows throughout the summer. It requires considerable moisture to make its maximum yields. It is highly palatable and nutritious and produces high yields of both pasture and hay. It withstands heavy grazing and trampling well because of its vigorous sodding habit. The seed habits of brome are good, a viable seed crop being produced nearly every year.

Bromegrass was introduced from Eurasia into this country about 1884 and is well adapted to the sub-humid eastern South Dakota and to the Black Hills and irrigated sections of the western part of the state.

Smooth brome produced locally from 30 and 40 year old fields usually is superior to northern grown seed with respect to heat tolerance, seedling vigor and forage yield.

Fig. 5. Blue grama.

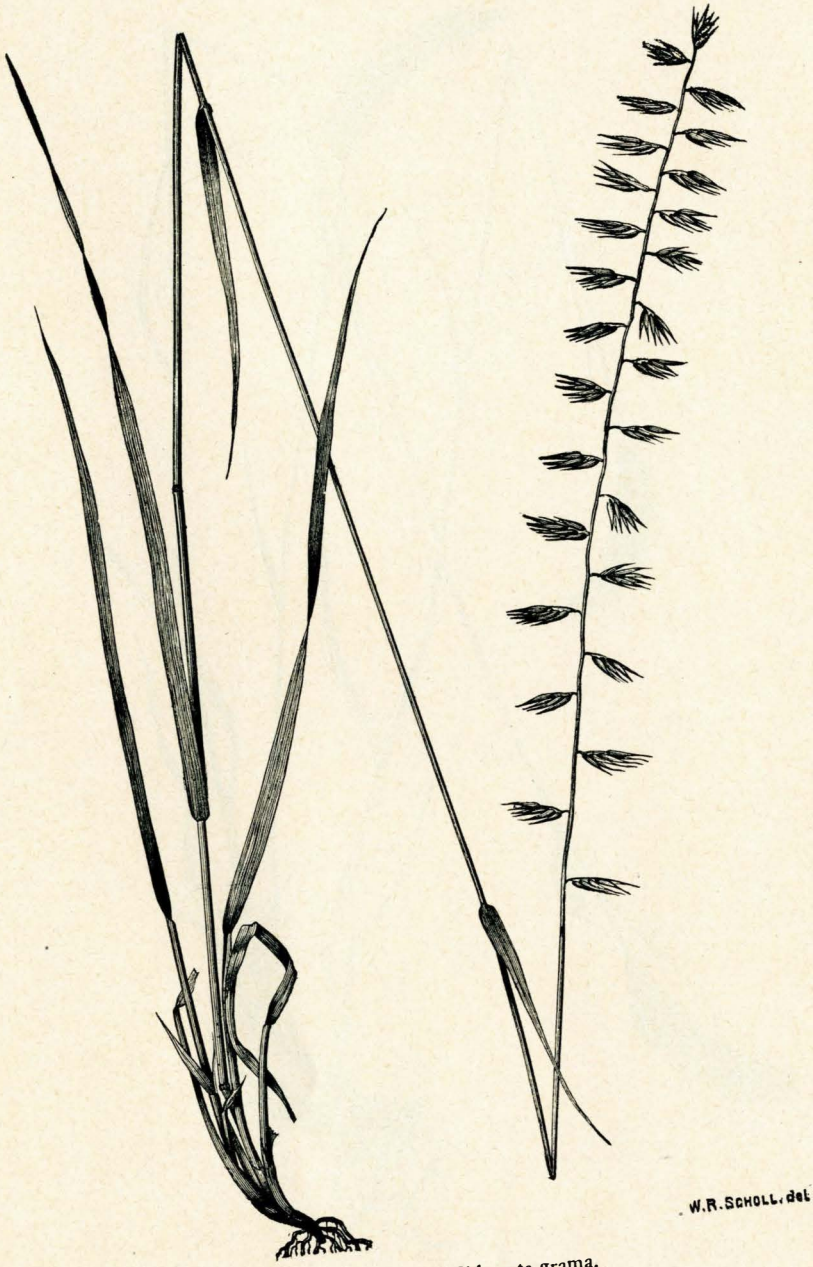


Fig. 6. Side-oats grama.

Fig. 7. Smooth bromegrass.

Russian wild-rye (*Elymus junceus*) is a new, drouth-resistant bunchgrass of the pasture type and produces an abundance of basal leaves. It was introduced into this country from Russia and has been under test in the northern Great Plains since 1928 with good success.

This is a promising grass, especially for use as pasture and can be grown under similar conditions and methods of planting as crested wheatgrass. It starts growth early in the spring and under favorable conditions will continue growth much of the summer and into late fall. It is a good seed yielder but shatters readily so that harvesting should be done before the heads completely mature, or at about the soft dough stage.

The seed of this grass possesses coverings that are provided with stiff hairs and short, sharp awns. It is desirable therefore that the seed be "processed" in some manner to remove these appendages to insure that it will feed through the grain drill.

Feather bunchgrass *(Stipa viridula)* is a rather coarse conspicuously fine-awned perennial bunchgrass, growing one and one half to three feet high or taller. Its leaves are mainly basal.

This grass is usually regarded as good forage starting growth early in the spring and remaining green until late in the season when moisture is favorable. Seldom abundant over large areas, feather bunchgrass furnishes a fair amount of forage in mixture with other grasses. It is a valuable constituent of native hay on some grass meadows throughout South Dakota. It does not withstand heavy grazing well and is readily killed out under continuous heavy grazing. Feather bunchgrass usually produces a heavy crop of seed, which is its only method of reproduction aside from tillering. Little seed is yet available from commercial sources.

Adapted Grass Species Good "Stand Insurance"

Several species of native grasses are well adapted to South Dakota and may be utilized in revegetation when their soil and climatic relationships are considered. The superior drouth-resistant and hardiness of native grasses enable them to withstand adverse climatic conditions. Throughout the centuries a process called natural selection has been going on and through this the fittest survived and geographical or localized strains of grass species adapted themselves to particular geographical locations. These geographic strains have distinct growth habits and varying degrees of hardiness.

Adaptation trials which include a wide variety of both native and introduced grasses have been under observation for several years at a number of locations.

Results of these trials to date indicate that grasses, in general, fall into two groups with respect to season of growth and optimum time of seeding in South Dakota: (1) The cool-season grasses and (2) the warm-season grasses. The cool-season grasses are those that start growth early in the spring before high temperatures occur, making most of their growth thus early and producing seed before midsummer. These grasses take on a distinct rest period during hot midsummer and resume growth again when temperatures drop and rains come in late summer and early fall.

Courtesy Soil Conservation Service

Fig. 8. Russian wild-rye.

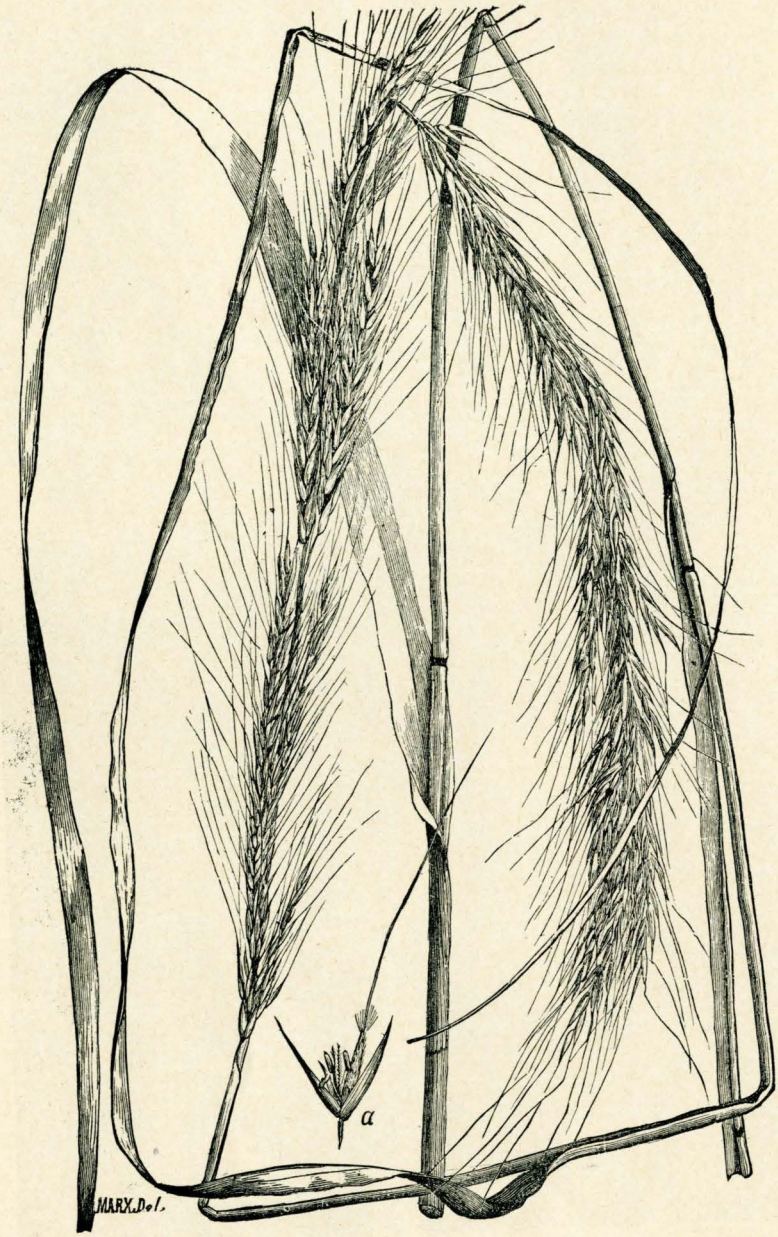


Fig. 9. Feather bunchgrass.

Warm-season grasses are those that start growth later in spring when higher temperatures prevail. These grasses likewise may become temporarily dormant at such time or times when moisture becomes scant and temperatures become high, ordinarily resuming growth when moisture again becomes available.

The following outline shows how the more important native and introduced grasses in South Dakota are classified according to cool-season and warm-season types:

I. COOL-SEASON GRASSES

A. Long Lived Perennials

1. Bunch type

Crested wheatgrass	*Agropyron cristatum*
Russian wild-rye	*Elymus junceus*
Feather bunchgrass	*Stipa viridula*
Needle-and-Thread	*Stipa comata*

2. Rhizomatous type

Western wheatgrass	*Agropyron smithii*
Smooth brome	*Bromus inermis*
Kentucky bluegrass	*Poa pratensis*
Intermediate wheatgrass	*Agropyron intermedium*

B. Short Lived Perennials

1. Bunch type

Slender wheatgrass	*Agropyron trachycaulum*
Canada wild-rye	*Elymus canadensis*
Sandberg bluegrass	*Poa secunda*
Indian ricegrass	*Oryzopsis hymenoides*

II. WARM-SEASON GRASSES

A. Long Lived Perennials

1. Bunch type

Blue grama grass	*Bouteloua gracilis*
Little bluestem	*Andropogon scoparius*
Prairie dropseed	*Sporobolus heterolepis*

2. Rhizomatous type

Big bluestem	*Andropogon furcatus*
Switch grass	*Panicum virgatum*
Side-oats grama	*Bouteloua curtipendula*
Indian grass	*Sorghastrum nutans*

3. Stoloniferous type

Buffalo grass	*Buchloe dactyloides*

B. Short Lived Perennials

1. Bunch type

Sand dropseed	*Sporobolus cryptandrus*

South Dakota Divided Into Three Regrassing Areas

It is obvious that environmental conditions of growth determine the species which will predominate. Among these conditions in each and every area, rainfall has decisive influence in determing, not only the predominance of species, but the cultural methods which may be found best adapted to their propagation.

Area I (Southeastern). The area in the southeastern part of the state has the highest average rainfall, with an average of 24 to 26 inches. The following Table 2 gives the results obtained from the grass observational nursery at Vermillion, in that area.

Table 2. Grass Adaptation Trial at Vermillion, South Dakota Planted November 3, 1937.

Species	Accession No.	Percent Stand Emerged	Percent Stand Sept. 15, 1940	Remarks
Western wheat	NE-249	70	100	
Crested wheat	N-72	95	60	Seedling loss foot-rot
Slender wheat	D-99	95	25	Stem-maggot
Agropyron intermedium	Colorado	90	85	
Galleta grass	DG-42-36	85	95	
Blue grama	Texas DG-33-35	100	100	
Blue grama	N. Dak. DG-3-37	95	98	
Big bluestem	DG-4-37	90	98	
Switchgrass	DG-52-36	90	95	
Canada wild-rye	Colo. D-36	100	80	Not adapted weak
Russian wild-rye	D-19	95	90	Seedling loss foot-rot
Sandberg bluegrass	DG-17-35	100	None	Seedling loss foot-rot
Feather bunchgrass	D-15	75	100	
Feather grass	NE-448	80	95	
Indian rice	NE-67	95	70	Seedling loss foot-rot

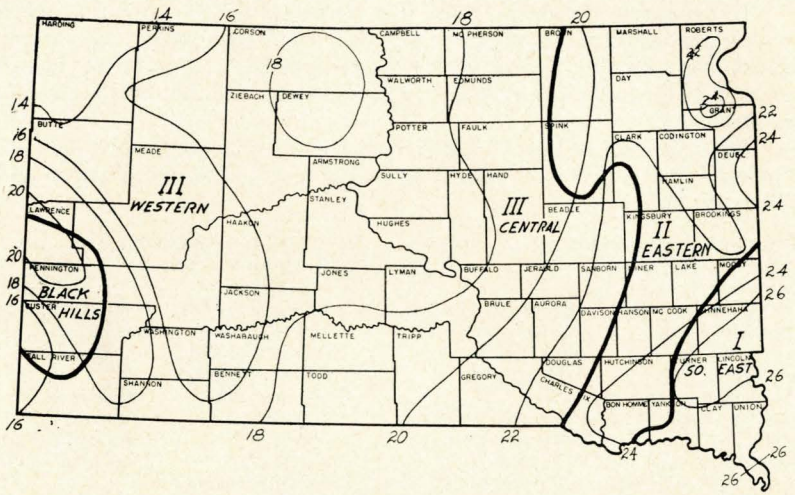


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Fig. 10. Map of South Dakota showing rainfall distribution and the location of the three regrassing areas.

Judging from foregoing Table 2, both cool-season and warm-season grasses are found among those predominant in the area represented. Rainfall is sufficient for warm-season grasses like big bluestem, switchgrass and grama grasses as well as such cool-season grasses as smooth brome, bluegrasses and Reed canary. Here also may be included Agropyron intermedium which is an introduction apparently well adapted to conditions in Area 1.

Area II (Eastern). The majority of the eastern one-fourth of the state is included in this area. The average annual precipitation will vary from 20 to 24 inches. Native grasses have stood up better throughout this area during the drouth period than smooth brome. Timothy at one time was grown quite extensively in the northeastern part but in late years it has almost completely disappeared. In the past, Kentucky bluegrass occurred extensively throughout the eastern part and although it also suffered a severe set-back during the drouth, it still persists and as moisture conditions improve it will again come into prominence as indicated by the exceptionally large crop of Kentucky bluegrass seed harvested in Brown, Marshall and Day counties during the summer of 1941.

Grass adaptation nurseries have been established both at the South Dakota Experiment Station Agronomy farm at Brookings and in the Brown-Marshall Soil Conservation district at Hecla.

Tables 3 and 4 furnish a summary of information to indicate percentages of emergence for a number of species tried at these two locations in Area II, and the corresponding percentages of survival.

The soils in the Brown-Marshall district are generally classified as fine sandy loams and are very susceptible to wind erosion. Much good produc-

Table 3. One-sixtieth Acre Plots of Grass Species Tested at Brookings, 1939-1941.

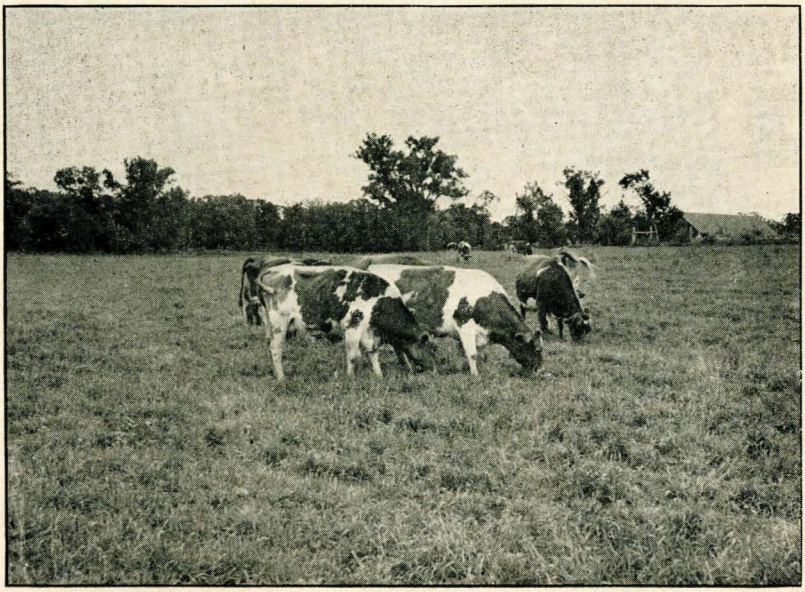
Plot No.	Common Name	Scientific Name	Percent Emerged	Percent Stand '41
3	Western wheatgrass	*Agropyron smithii*	50	95
10	Crested wheat (Standard)	*Agropyron cristatum*	90	3
11	Crested wheat (Fairway)	*Agropyron cristatum*	85	1
13	Slender wheatgrass	*Agropyron trachycaulum*	85	60
19	Beardless wheatgrass	*Agropyron inerme*	95	1
8	Redtop	*Agrostis alba*	40	0
21	Little bluestem	*Andropogon scoparius*	2	10
4	Big bluestem	*Andropogon furcatus*	25	70
20	Tall oat grass	*Arrhenatherum elatius*	99	0
14	Side-oats grama	*Bouteloua curtipendula*	20	95
15	Blue grama	*Bouteloua gracilis*	17	25
1	Smooth brome	*Bromus inermis*	80	75
2	Parkland brome	*Bromus inermis*	70	75
9	Buffalo grass	*Buchloe dactyloides*	1	2
5	Sand reedgrass	*Calamovilfa longifolia*	35	0
12	Russian wild-rye	*Elymus junceus*	75	1
24	Creeping red fescue	*Festuca rubra stolonifera*	95	0
17	Switch grass	*Panicum virgatum*	35	95
23	Reed canary grass	*Phalaris arundinacea*	75	50
22	Timothy	*Phleum pratense*	80	0
16	Sandberg bluegrass	*Poa secunda*	80	0
6	Kentucky bluegrass	*Poa pratensis*	65	1
7	Canada bluegrass	*Poa compressa*	15	0
18	Feather bunchgrass	*Stipa viridula*	5	99

Table 4. Final Stands Secured with Various Grasses Planted on Corn Ground at Hecla, South Dakota, in cooperation with the Brown-Marshall Soil Conservation District.

Species	Source	Planted Oct., 6, 1938* Percent Emerged	Planted Oct., 6, 1938* Percent Final Stand	Planted April 14, 1939 Percent Emerged	Planted April 14, 1939 Percent Final Stand
Crested wheat (Standard)	Mandan, N. D.	80	25	92	85
Crested wheat (Fairway)	Mandan, N. D.	95	45	95	92
Western wheat	Glasgow, Mont.	75	85	85	100
Slender wheat	Commercial	85	65	85	82
Agropyron pungens	Bozeman, Mont.	88	95	—	—
Bromegrass	Mandan, N. D.	90	65	85	90
Big bluestem	Cannonball, N. D.	45	25	85	73
Switch grass	Mandan, N. D.	40	20	90	86
Tall oat grass	Commercial	78	60	—	—
Side-oats grama	Mandan, N. D.	55	38	85	74
Blue grama	Center, N. D.	65	25	88	76
Russian wild-rye	Mandan, N. D.	89	72	92	88
Red fescue	Commercial	80	Trace	—	—
Reed canary	Mandan, N. D.	38	Trace	89	92
Feather bunchgrass	Glenrock, Wyo.	89	92	95	99
Indian rice	Torington, Wyo.	65	35	42	18
African love grass	Arizona	—	—	90	None†
Giant reed grass	Woodward, Okla.	—	—	None	None
Sand reed grass	South Dakota	—	—	42	56
Hay mixture		85	80	88	90
Pasture mixture		90	85	95	98

* Many young seedlings were lost because of soil blowing during month of March. Corn stalk did not afford sufficient protection during March.

† Winter killed.



Courtesy Soil Conservation Service

Fig. 11. Smooth bromegrass, the basic component of all grass mixtures in Areas I and II.

tive crop land has become so badly hummocked through wind action that it has been abandoned. Types of soil and immediate seasonal conditions strongly characterized the environment under which the tests of Table 4 were conducted.

It may be observed from the right hand columns of foregoing Tables 3 and 4 that species which become established on a basis of final stand included the following: Western wheat, slender wheat, big bluestem, side-oats grama, smooth brome and Parkland brome, switchgrass and feather bunchgrass. Evidently the foregoing grasses thus observed would be among those recommended for utilization in Area II.

Fibrous rooted grasses such as crested wheatgrass, smooth bromegrass and intermediate wheatgrass *(Agropyron intermedium)* will help control soil blowing in this part of the area. Smooth bromegrass seed produced from old fields in South Dakota and adjoining states to the east and south is very well adapted in this part of the area but it has been somewhat difficult to obtain satisfactory stands even with adapted seed in recent years due to adverse weather conditions. Once brome is established, however, it can be expected to produce exceptionally high yields of forage on the deeper more fertile soil during periods of favorable moisture. Crested wheatgrass being more drouth-resistant will stay in better when not subjected to "foot-rot" and is much more likely to produce satisfactory stands. Intermediate wheatgrass appears superior in many respects to smooth brome in that it is not difficult to establish satisfactory stands, is more drouth-resistant than brome and produces a

greater yield of forage. Although this grass has not as yet been released for commercial production, small quantities undoubtedly will soon be available for distribution. This grass was first introduced into the state by the Soil Conservation Service Division of Nurseries and since that time a large number of selections have been made by the Agronomy Department of the Agricultural Experiment Station and these are now under test on the Experiment Station Agronomy farm at Brookings.

Area III (Central). The eastern portion of this grass area takes in the extreme western part of the glaciated soils of South Dakota. The average annual precipitation here will vary from 18 to 20 inches in the northern part, increasing to 22 inches in the southern part. The rolling topography and pot-hole formation is largely glacial in origin.

Most of the uncultivated land is still in native grass. Drouth, grasshoppers and over-grazing have often weakened the stand and permitted annual weeds to invade the native grass lands. These grasses have recovered to some extent with the return of more moisture. There is also a considerable acreage of abandoned crop land in the eastern portion of Area III available for regrassing.

In the past, smooth brome and slender wheat were the only grasses available for regrassing cultivated land in this eastern part of Area III. These grasses were used to some extent and did fairly well during years of high rainfall but they obviously were not too well adapted, because during periods of low rainfall they were almost entirely eliminated. Today there are a number of grasses available that have proven their ability to stand up under adverse conditions when they occur.

A large number of grasses and legumes have been tested on the Central Experiment Farm at Highmore. Table 5 lists the grasses which were tested in the grass observational adaptation nurseries at Highmore, South Dakota.

Crested wheatgrass has been outstanding in all of the foregoing trials and is the foremost cool-season grass for this part of the area. Western wheat-

Table 5. Grass stands obtained on seedings made at the Central Substation, Highmore, South Dakota in the fall of 1938 and spring of 1939 on sorghum land.

Species	Seed Source	Seeded Oct. 5, 1938* Percent Stand		Seeded April 2, 1939 Percent Stand	
		Rows	Drilled	Rows	Drilled
Crested wheat (Standard)	Montana	40	50	80	65
Crested wheat (Fairway)	Mandan	42	----	85	----
Russian wild-rye	Mandan	46	52	89	95
Western wheatgrass	Montana	25	28	82	68
Slender wheatgrass	Mandan	28	----	75	----
Slender wheatgrass	Montana	20	24	35	----
Smooth bromegrass	North Dakota	15	10	10	15
Feather bunchgrass	Wyoming	20	25	85	80
Indian ricegrass	Wyoming	33	35	87	89
Side-oats grama	North Dakota	None	None	78	80
Big bluestem	North Dakota	None	None	15	----
Switch grass	North Dakota	None	None	None	----
Blue grama	Spur, Texas	None	None	85	70
Blue grama	North Dakota	None	None	79	65
Sandberg bluegrass	Wyoming	None	30	75	55
Highmore mixture		26	33	80	65

* Heavy loss of seedling due to crusting of soil in spring.

grass, Russian wild-rye, feather bunchgrass follow in order with smooth brome at the bottom of the list. Blue grama and buffalo grass are the only grasses in the warm-season group which can be recommended for use in this part of the area.

Area III (West River). It will be noted (Fig. 10) that this part of Area III lies entirely west of the Missouri River. The predominant soil types are clay and clay loams with only a scattering of lighter soils. The average annual precipitation is low, ranging from 12 inches in the northwest up to 20 inches in the southeastern part of the area.

In the past, sizeable areas of native sod were broken and seeded to wheat. The Soil Conservation Service has regrassed a little more than 35,000 out of 87,281 acres of the abandoned land which was purchased under its land utilization program. A number of grass adaptation plantings were made at various locations in this area. Such locations were: Range Field Station, Cottonwood; Soil Conservation Service Demonstration Project, Winner; U. S. Dryland Experiment Station, Ardmore; Pine Ridge Indian Reservation, Pine Ridge.

The outcome of trials at these several locations in the western part of Area III is stated for each of the locations in Tables 6, 7, 8, and 9.

In the process of making the following trials and in observations on cooperative fields, two additional grasses, one native and one introduced were found to be adapted to this west river area. One of these is Russian wild-rye (*Elymus junceus*), which was recently introduced into this country from

Table 6. Adaptation Trials of Grass Species Made at Range Field Station, Cottonwood in Area III.

Species	Seeded October 21, 1937		Seeded March 24, 1938		Remarks
	Emerged Stand	Final Stand	Emerged Stand	Final Stand	
Western wheatgrass	Very good	Very good	Fair	Good	
Crested wheatgrass	Very good	Very good	Very good	Fair	Damaged by hoppers
Slender wheatgrass	Very good	Poor	Good	None	Destroyed by hoppers
Smooth brome	Very good	Poor	Very good	Very poor	Badly damaged by hoppers
Mountain brome	Very good	Fair	Good	Poor	Winter killed
Blue grama (N. D.)	Poor	Poor	Fair	Fair	
Blue grama (Texas)	Poor	Poor	Good	Fair	Some winter killing
Side-oats grama	Poor	Poor	Good	Fair	
Cool season mixture	Very good	Very good	Good	Fair	
Warm season mixture	Poor	Poor	Fair	Fair	
Big bluestem	Poor	Poor	Poor	None	Not adapted
Galleta grass	Good	Fair	Good	Good	
Switchgrass (Kans.)	Poor	Poor	Poor	None	
Switchgrass (Nebr.)	Fair	Fair	Good	Fair	
Reed canary grass	Good	Fair	Good	Poor	Not adapted
Indian rice grass	Very good	Good	Fair	Good	
Feather bunchgrass	Very good	Very good	Good	Very good	
Needle-and-thread	Very good	Very good	Good	Very good	
Canada wild-rye	Very good	Very good	Very good	Very good	
Russian wild-rye	Very good	Very good	Very good	Good	Damaged by foot rot
Stiffleaf quackgrass	Very good	Very good	Very good	Very good	
Sandberg bluegrass	Fair	Fair	Poor	Poor	

Table 7. Adaptation Trials of Grass Species Made at Soil Conservation Demonstration Project, Winner.

Species	Row Seedings		Drilled Seedings		Remarks
	Emerged Stand	Final Stand	Emerged Stand	Final Stand	
Russian wild-rye	Very good	Good	Good	Fair	Damaged by foot rot
Crested wheat (Standard)	Good	Good	Good	Good	
Crested wheat (Fairway)	Good	Good	Good	Good	
Western wheatgrass	Fair	Good	Fair	Good	
Smooth brome grass	Good	Poor	Fair	Very poor	Hoppers, heat, drouth
Intermediate wheat	Very good	Very good	——	——	
Blue grama grass	Fair	Poor	None	None	Fall planted, too deep
Side-oats grama	Poor	Poor	Poor	None	Fall planted, too deep
Slender wheatgrass	Good	Fair	Good	Fair	Hoppers & drouth
Big bluestem	Good	Poor	Fair	Very poor	Fall planted, too deep
Switchgrass	Poor	Poor	Poor	None	Fall planted, too deep
Indian rice grass	Very good	Very good	Good	Good	
Feather bunchgrass	Very good	Very good	Very good	Very good	
Canada wild-rye	Very good	Very good	Very good	Very good	Short lived perennial
Mountain brome	Very good	Poor	——	——	Winter killed
Sandberg bluegrass	Good	Good	Good	Good	
Michels rye*	Very good	Very poor	——	——	Winter killed
Timothy	Poor	None	——	——	Hoppers & drouth
Tall oatgrass	Poor	Very poor	——	——	Hoppers & drouth
Big bluegrass	None	None	——	——	Not adapted
Bulbous barley	Good	Fair	——	——	
Alfalfa	Good	Good	Very good	Good	
Yellow sweetclover	Very good	Very good	Very good	Very good	

* More commonly known as Wonder grass. It cannot, however, be considered a perennial grass because of its lack of winter hardiness. It is similar in many respects to ordinary winter rye in that it will survive the first winter when fall planted but fails to survive the second winter.

Table 8. Adaptation Trials of Grass Species Made at U. S. Dryland Experiment Station, Ardmore.

Species	Seeded April 11, 1936		Remarks
	Emerged Stand 1937	Final Stand 1941	
Crested wheatgrass	Fair	Very good	1936 was an exceptionally dry year so most of the seed didn't even germinate until the spring of 1937.
Western wheatgrass	Poor	Fair	
Feather bunchgrass	Poor	Good	
Indian rice grass	Poor	Very good	
Smooth brome	Poor	None	

Russia. The other is feather bunchgrass (*Stipa viridula*) which is native in this area. Both of these grasses are highly resistant to grasshoppers yet they are relished by livestock.

Western wheatgrass has the longest standing as an all round cool-season forage type for the West River area. Crested wheat in recent years has produced outstanding results in numerous locations as a valuable supplementary grass. Two other valuable grasses are Russian wild-rye and feather bunchgrass. Smooth brome and slender wheat have done poorly and can be recommended only on the more favorable sites where supplementary water is available.

Blue grama, buffalo grass and side-oats grama were the outstanding grasses in the warm-season group. They have proven to be poor weed competitors

Table 9. Adaptation Trials of Grass Species Made at Pine Ridge Indian Reservation, Pine Ridge, S. Dak.

Species	Seeded Nov. 2, 1939 Emerged Stand	Seeded Nov. 2, 1939 Final Stand	Seeded April 2, 1940 Emerged Stand	Seeded April 2, 1940 Final Stand	Remarks
Smooth brome	Good	None	Very good	None	Stand destroyed by hoppers and drouth
Slender wheat	Very good	None	Very good	None	Stand destroyed by hoppers and drouth
Western wheat	Good	Fair	Good	Fair	
Crested wheat (Std)	Good	Good	Very good	Good	
Crested wheat (Fairway)	Fair	Good	Very good	Fair	
Grass mixture RN 2	Fair	Fair	Very good	Poor	All grasses dead except Crested wheat, W. wheat, Russian wild-rye and Feather bunchgrass
Grass mixture RN 10	Fair	Good	Very good	Fair	
Russian wild-rye	-------	-------	Good	Fair	Damaged by hoppers and drouth
Mountain brome	Very good	Poor	-------	-------	

Grass Mixture RN 2		Grass Mixture RN 10	
Crested wheatgrass	2 lbs.	Crested wheatgrass	2 lbs.
Slender wheatgrass	1 lb.	Western wheatgrass	2 lbs.
Western wheatgrass	1 lb.	Russian wild-rye	1 lb.
Smooth brome	1 lb.	Blue grama	1 lb.
Russian wild-rye	1 lb.	Sandberg blue grass	1 lb.
Sandberg bluegrass	1 lb.		
Blue grama	1 lb.		
Feather bunchgrass	1 lb.		
Yellow sweetclover	1 lb.		

when seeded alone. They are, however, extremely drouth-resistant and otherwise well adapted to this area.

The results obtained from a number of grass observational nurseries planted at several locations within the state, show that native grasses are sensitive to movement from south to north or vice versa. In selecting grasses for reseeding it is desirable to use seed from those species which have grown within a limited distance either north or south from where they are to be seeded. Bringing of southern seed of a given species of native grass too far north may result in a heavy loss of stands because of winter killing. Northern species moved too far south will be found lacking in forage yields and consequently are not desirable. In most cases it is better to move southern seed north than it is to move northern seed south due to the higher forage yields of the southern grass types, but this is only accomplished with the risk that the species may not prove sufficiently hardy.

Introduced grasses (Appendix Tables No. 1 and 2) adapted to any of these areas are relatively few. Most of the introduced grasses will not withstand our climate. They are either unable to endure high temperatures along with limited moisture or they are winter killed. The eastern part of South Dakota will be able to use more introduced grasses than the drier areas of the state. It is best to depend mostly upon crested wheatgrass and the adapted native grasses for reseeding the greater part of Area III.

Courtesy Soil Conservation Service

Fig. 12. Western wheat, a cool-season grass, makes an outstanding range and hay grass. It forms one of the basic components of grass mixtures in Area III.

Courtesy Soil Conservation Service

Fig. 13. Blue grama, a warm-season grass, makes an outstanding range grass. It forms one of the basic components of grass mixtures in Area III.

What Are The Factors Affecting a Regrassing Program?

Recommendations for methods used in establishing stands of grass are determined by a large number of factors. Among these are soil fertility, adaptability of the land, topography, soil type, abundance and distribution of moisture, weed growth, hot winds, wind or water erosion, insect pests, diseases, whether or not the land is tillable, unbroken sod land, and need for hay or pasture.

It is beyond the scope of this bulletin to include all methods of establishing grass stands that will be encountered by farmers and ranchers. Only those methods which are generally applicable under South Dakota conditions will be discussed.

Many acres of steep, rocky, eroded or infertile cropland in the state should be returned to grass. Much idle and abandoned cropland which is not now yielding any appreciable income or is slow in regrassing itself naturally, should be seeded to adapted grasses. Many acres of productive cropland in eastern South Dakota should be seeded to grass for permanent pastures to supplement the forage needs of individual farms. Native pastures and ranges which have become so depleted that there are not enough native grass plants remaining on them to revegetate the area naturally under reduced stocking or total protection should be artificially reseeded to hasten their return to high productivity.

Cropland. Many farms have some cropland which should be seeded to grass. Some of this land needs regrassing because it is subject to erosion. Other farms need additional permanent pasture in order to adequately care for livestock.

Clean cultivated land or summer fallow may have one outstanding advantage over abandoned land, idle weedy land or unbroken sod land, in that it usually contains a more adequate supply of soil moisture. On the other hand such lands have the disadvantage of being very susceptible to wind and water erosion, are apt to be too loose, tend to dry out in the upper surface soil and may bake or crust badly.

The seed bed for grasses on cultivated land or summer fallow should be well worked down, level and firm. It should be firmed from the bottom up rather than from the top down. The preparation of a good seed bed for grasses is different from that for small grain. Most seed beds for small grain are too loose for seeding grasses or legumes. The importance of a firm, well prepared, weed-free seed bed cannot be over emphasized. Quick, uniform germination gives the young grass seedlings time to take root and become well established before the hot dry weather sets in. Grass seedlings generally are more drouth enduring than alfalfa or sweet clover. It is advisable to delay seeding rather than sacrifice on seed bed preparation. Early fall or very early spring seeding is preferable providing conditions are favorable. Grass and alfalfa that becomes well established in the fall will be a year ahead of that seeded in the following spring.

Observations made in the course of these investigations and elsewhere, make it evident that firmness and other conditions including absence of

weeds in the seed bed are decidedly important in securing stands of grass but also that these conditions are influenced by previous kind and culture of crops.

Table 10 gives data secured in two separate years with three kinds of grass seeded on oats stubble with three treatments and on comparatively clean corn ground.

Table 10. Emergence and survival of crested wheat, brome and western wheat grasses with four types of seed bed preparation at Brookings (Two year average, 1939 and 1940—1940 and 1941).

Seed Bed	Species	% Emerged		% Survival	
		Drilled	Broadcast	Drilled	Broadcast
Early Fall Plow Oat Stubble	Crested wheat	66	27	38	14
Early Fall Plow Oat Stubble	Bromegrass	45	17	31	14
Early Fall Plow Oat Stubble	Western wheat	52	23	68	30
	Average	**51**	**22.3**	**45.7**	**19.3**
Double Disked Oat Stubble	Crested wheat	45	27	21	17
Double Disked Oat Stubble	Bromegrass	26	7	28	19
Double Disked Oat Stubble	Western wheat	52	16	56	26
	Average	**41**	**16.7**	**35**	**20.7**
No Preparation Oat Stubble	Crested wheat	39	6	10	3
No Preparation Oat Stubble	Bromegrass	23	2	19	4
No Preparation Oat Stubble	Western wheat	29	2	40	10
	Average	**30.3**	**3.3**	**23**	**5.7**
Clean Corn Stubble	Crested wheat	55	25	32	12
Clean Corn Stubble	Bromegrass	49	10	35	5
Clean Corn Stubble	Western wheat	49	19	64	31
	Average	**51**	**18**	**41.7**	**16**

Examination of Table 10 will make clear that crested wheat, brome and western wheat all produced higher emergence and higher survival when seeded on either prepared oat stubble or clean corn stubble, than on unprepared oat stubble. The same was true whether seeding on prepared oat stubble was done in the fall or spring and whether seed was applied broadcast or with a drill. In all cases there was a delayed emergence of the three grasses on the unprepared oat stubble from five to six weeks depending upon the time of seeding and soil moisture. Pigeon grass caused heavy loss in stand of the untreated stubble land. Grass stands can be secured by drilling directly in grain stubble without preparation, but generally poorer stands are secured. Thus grass seedings made on cereal stubble without preparation and on drilled sudan grass stubble have proven very satisfactory in drier parts (Area III) of South Dakota where soils blow and where rapid surface drying prevents seed bed preparation on intertilled cropland or summer fallow. It is necessary on such fields, with as little preparation as possible, to establish a cover crop of either cereal grains or sorghum. The stubble and other crop residues will help prevent wind and water erosion. Such stubble or crop residue can be grown much cheaper than it can be applied artificially. The grasses should be planted with the least possible destruction of this protective cover. Where soil blowing is not a factor the seed bed can be prepared similar to that of cultivated land excepting where the soils dry out readily or where they crust. Sudan grass or rye used as pasture provide a hard, weed-free seed bed which is ideal for grass and alfalfa.

Abandoned Cropland. Idle and abandoned cropland which has become covered with a heavy growth of weeds such as Russian thistle, can be used to good advantage as a seed bed for planting cool-season grasses. They should be planted either in the fall or very early spring with little or no seed bed preparation. The disadvantage of this type of land is that it may be badly infested with seeds of such weed type grasses as pigeon grass and annual drop seed. These weeds may emerge and choke out the slow-growing grass seedlings. Usually some type of seed bed preparation is necessary in the eastern part of the state in the early spring to control this weed growth (Areas I and II, Fig. 10).

In parts of the state that are subjected to wind erosion especially in Area III it is essential that the preparation of the seed bed does not entirely destroy the weed residue cover. Grass seeds are usually light and often blow away or are uncovered if sufficient residue is not present to tie the soil down. Grass seedlings are small and readily damaged by moving soil particles; therefore, soils must be prevented from blowing to protect them.

Unbroken Grass Lands. Numerous attempts to establish grasses on unbroken grass lands or depleted range lands (Area III) have been made with application of additional seed, without seed bed preparation. The greater number of such trials have failed. The seeds generally fail to germinate when broadcast on the range without seed bed preparation. Slightly better stands have been secured where the grasses were drilled on very badly depleted weedy pastures or range land with some seed bed preparation, such as disking or even plowing.

One of the most satisfactory methods of reestablishing grasses on depleted ranges is by deferred grazing, allowing the grasses to reseed and spread naturally. This method will frequently require a longer time to reestablish grasses than that required with reseeding on cultivated lands.

Drilling Versus Broadcasting. The method of seeding grasses will vary with the type of seeding equipment, topography and soil type of land to be seeded. Drilling has proven more satisfactory than broadcasting as a method of seeding grasses in regions where the conditions are favorable for the use of farm machinery.

The following Table 11 is made with averages of eight trials for each kind of grass in each of two years.

Table 11. Two Year Average 1939 and 1940—1940 and 1941
Methods of seeding crested wheatgrass, bromegrass and western wheatgrass at Brookings.

Species	% Emerged		% Survivals	
	Drilled	Broadcast	Drilled	Broadcast
Crested wheat	54.2	22.0	23.0	13.0
Brome grass	30.5	9.8	30.0	9.0
Western wheat	43.2	15.2	67.0	23.0
Average	**42.6**	**15.4**	**40.0**	**15.0**

As a method of seeding grass, the drill distributes the seed with greater uniformity, places the seed more nearly at the proper depth and less seed per acre is required. In Area II and III better stands of grasses have been secured by spacing the drilled rows one foot apart instead of the regular six inch drill spacings.

The double disk press drill is often preferred to the single disk drill as it does not cover the seeds so deeply. The furrow drill in some areas is superior to the disk type because it is capable of cutting through heavy weed growth and will place the seeds in contact with firm moist soil. Furthermore, the ridges left by a furrow drill reduce soil blowing. The furrow drill used on abandoned weedy land without preparation may be superior to the surface type drill. Thick stands of weeds usually emerge early in the spring on fields of this kind and nearly always choke out slow-growing grass seedlings. The furrows left by the furrow drill are more likely to be free from weed growth, enabling the young grass seedlings to become established.

It may well be accepted as an established fact that the method of drilling is superior to broadcasting. Drilling should always be employed for the seeding of grass where a drill by any practicable means can be made available. In cases where broadcasting becomes the only practicable way for seeding grass, careful attention needs to be given to applying a sufficient amount of seed and to being sure that such seed is covered. This covering can usually be accomplished with harrow or disk. Even though broadcast, seeds are usually covered with some farm implement such as the harrow or disk. These are less efficient for covering seeds than a regular grain drill. Broadcast seed will germinate on the surface of the soil only if moist conditions are maintained. Broadcast seeding without some provisions for coverage cannot be recommended.

Grass seeds planted with a drill generally emerge sooner than seeds which are broadcast. In some instances there is 5 to 6 weeks difference in time of emergence of brome, western wheat, and crested wheatgrass in studies recorded in Tables 10 and 11. The greatest differences were generally on the oat stubble which received no preparation. The early fall or late spring seedings showed the greatest spreads in emergence on plots compared for time of seeding. The methods of seeding the grasses on fall plowed oats stubble and clean corn ground had the least spread in emergence regardless of the dates of seeding. The general average difference between drilled and broadcasted seedings of these grasses on prepared seed beds varied from five to twelve days; it taking longer for the broadcasted grass seedlings to emerge after planting.

Spreading Matured Hay. The spreading of grass hay containing mature seed may be resorted to as a seeding method. The hay spread thus will afford some protection to the emerging grass seedlings in the same manner as crop or weed residue on other seed beds. The cost of spreading the hay and pressing. The general average difference between drilled and broadcasted seedings hay containing seed has practical application only where matured hay is conveniently available and the area to be covered is comparatively small. This method is particularly adapted for unstable soils.

Method of Packing the Seed Bed. All small seeded forage crops seeded on clean tilled land respond favorably to some form of packing of the seed bed before or after seeding. Drills equipped with heavy press wheels or any other heavily weighted surface packer can be used to firm the soil over the newly seeded grasses. Packing the seed bed after seeding, leaving the soil surface smooth is not advisable under conditions where soils are likely to blow. Gen-

erally additional packing of the soil after seeding grasses on a firm stubble field or weedy land is not necessary. Any implement used to cover the grass seed may eventually contribute to the firmness of the seed bed.

Rate of Seeding. The rate of seeding grasses has considerable range and many influencing factors. The rate of seeding depends upon the size of seed, purity, relative freedom from foreign or inert matter, germination, method and time of seeding, condition of seed bed, cost of seed, growth habit of the grass whether spreading or bunch, whether cool-season or warm-season type. When these various conditions are known and considered, rates of seeding can be calculated.

Warm-season grasses usually require a heavier rate of seeding than cool-season grasses. A minimum rate of ten pounds and a maximum rate of twenty-five pounds is generally recommended for warm-season grasses. When processed seed is used the rate will usually run between eight and fifteen pounds per acre. Thinner seeding of warm- and cool-season grasses is preferable under drier conditions and generally advisable because of the shortage and high cost of seed for some species. In drier regions the seeding rates used for a given species of grass may vary from four to ten pounds per acre, while in the more humid sections of the state the seeding rate may vary from ten to eighteen pounds per acre.

Seeding Mixtures. The seeding of grass in mixtures has some definite advantages over pure seedings. The various hazards of seeding two or more kinds of grass may not affect them equally, so that a mixed seeding is more certain to give a stand of some one or more grasses than a pure seeding. Few fields have uniform soil conditions over all parts. Climate and distribution of rainfall may be such that drouth occurs. This would affect a pure seeding of grass possibly more than the mixture. Diseases and insect pests may not attack the grasses equally. The foregoing are some of the reasons why seeding grasses in mixture may distribute the risks over several species thus making the securing of a stand more certain than seeding one species alone.

An advantage of making pure grass seedings is that it makes possible the maximum use of each grass thus seeded at the proper season of the year. Moreover, should a seed crop be harvested there will be no trouble with mixtures.

Table 12 presents relative amounts of ground cover secured from seeding 10 separate species of grass and one legume (alfalfa) singly and in mixture.

In explanation of Table 12 it may be stated that the grasses from which the data were secured were seeded in equal portions by weight. The seedings were made in the early spring of 1937 just previous to a snow storm on a well prepared, firm seed bed. Conditions for seeding were ideal for establishing grass stands. As noted in the table, the species which makes up a mixed grass vary in ability to grow and produce ground cover. In all cases where alfalfa appears in the mixed seeding the amount of alfalfa seed used per acre in the mixture was apparently high. Nearly all stands of alfalfa in the mixtures were equal to a pure normal stand of alfalfa, thus largely covering up any effect the grass included in the mixture may have had.

On the basis of the following Table 12 and many other observations by

Table 12. Grasses and alfalfa seeded alone and in mixtures at Brookings in 1937.

Species	Percent Ground Cover from Seedings Alone and in mixture taken in Fall of 1940. Mixture Numbers*																	
	Alone	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Crested wheat	15						1					1	2						1
Brome	45				15								20			1		20	8
Big bluestem	1		1			1		1		0				0	1	0			
Prairie beardless	1					0					1		1		1	0			
Blue grama	25	10	10		5	3	5		1	10		5			2	1	5		
Canada wild-rye	0																		
Russian wild-rye	70							45						75		35			
Switch grass	40		1			8								1	5				
Feather bunchgrass	60	25		1	5		40				3		25			3			
Alfalfa	99			95					45		85							60	
Western wheat	75	5		1	1		1		1	1	2	3			5	1	1	3	8
Total Cover for Mixture		40	12	97	26	12	47	46	47	11	91	9	48	76	14	41	6	83	17

* In mixtures, species are in equal proportion.

the Soil Conservation Service and others, the following grass mixtures are offered as being likely to prove effective in the areas indicated.

Areas I and II. The following grass mixtures are recommended for the southeastern and eastern part of the state:

Cool-season Mixtures

Smooth bromegrass	12 parts	Smooth bromegrass	4 parts
Alfalfa	4 parts	Western wheatgrass	6 parts
	—	Crested wheatgrass	4 parts
Total per acre	16	Feather bunchgrass	1 part
Smooth bromegrass	8 parts	Yellow sweetclover	1 part
Crested wheatgrass	5 parts		—
Feather bunchgrass	2 parts	Total per acre	16
	—		
Total per acre	15		

Warm-season Mixtures

Blue grama	14 parts	Big bluestem	15 parts
Buffalo grass	3 parts	Switch grass	3 parts
Side-oats grama	3 parts	Side-oats grama	2 parts
	—		—
Total per acre	20	Total per acre	20

Area III. The following mixtures are best adapted for use in the central and western areas:

Cool-season mixtures

Pasture mixture		Hay mixture	
Western wheatgrass	2 parts	Western wheatgrass	3 parts
Crested wheatgrass	4 parts	Crested wheatgrass	4 parts
Feather bunchgrass	2 parts	Feather bunchgrass	2 parts
	—	Yellow sweetclover	1 part
Total per acre	8		—
Crested wheatgrass	4 parts	Total per acre	10
Western wheatgrass	2 parts		
	—		
Total per acre	6		

Warm-season Mixture

Hard land	
Blue grama	12 parts
Buffalo grass	3 parts
	—
Total per acre	15

Nurse Crops. When a nurse crop is used, it is employed for one or more of three reasons: First, such a crop may produce a return from the land in the seeding year; second, if a nurse crop is not used a more harmful companion crop of weeds may ensue; third, on sloping land or land that may blow, a nurse crop may help control erosion while the small grass seedlings are becoming established. Nevertheless, the nurse crop is always a competitor of, and to that extent, a detriment to the grass seeding. The nurse crop in that respect makes a stand of grasses less certain, and results in small and weaker grass seedings which may not endure short drouths and winter as well as those which have not had such competition. In dry seasons, roots of nurse crops outgrow those of the grass seedlings and rob them of moisture, stunting or killing the young grass seedlings. In wet seasons the rank growth of a nurse crop may over-shade the young grass seedlings so much that it will weaken or kill them. Lodging of the nurse crop, common in wet seasons, is detrimental to the young grass seedlings.

Under most of South Dakota conditions it is better to seed grasses without a nurse crop because moisture may become a limiting factor. If a nurse crop is used and moisture becomes short before its maturity it should be cut early for green feed or hay. Where soils drift it is a good practice to sow the nurse crop early, possibly also spacing the drill rows at greater distances, two or more feet, then drill in the grass seed later as soon as the grain is three to five inches in height. If a nurse crop of small grain is seeded it is a better practice not to seed the grasses along with the grain. Grain is drilled in deeper than the depth best suited for grasses. In this case the grain should be drilled in first at the usual depth and the grass drilled immediately afterward, drilling on the field crosswise of the grain at a shallower depth.

Depth of Planting. The importance of shallow planting in relation to stand establishment for grasses cannot be over emphasized. The optimum depth of seeding under field conditions is one inch or less; ¼ to ½ inch is usually best. Results of some tests made under controlled conditions all emphasize this point. They are averaged in the following Table 13.

Table 13. Depth of planting crested wheatgrass and alfalfa on unsteamed and steamed soils in the greenhouse.

Depth Planted Inches	Soil Unsteamed				Soil Steamed 2 Hours			
	Number per 100 Seeds							
	Emerged		Survived		Emerged		Survived	
	Crested	Alfalfa	Crested	Alfalfa	Crested	Alfalfa	Crested	Alfalfa
¼″	69	66	50	54	80	84	80	84
½″	68	65	48	41	77	82	77	82
1″	53	54	37	39	70	72	70	72
2″	30	32	14	19	49	54	49	54
3″	1	2	0	0	6	3	6	3

The following table gives the effect of depth of planting upon the final stand of grass when seeded in clean small grain stubble at Winner.

Table 14. The effect of depth on seeding grass on final stand when planted on a heavy clay soil at Winner, South Dakota.

Species	Broadcast	Percent Stand	
		Surface Seeded ¼ to ½ in.	Deep Seeded ¾ to 1 inch
Crested wheatgrass (Standard)	None	78	34
Crested wheatgrass (Fairway)	48	90	None
Western wheatgrass	None	82	43
Russian wild-rye	43	85	22
Canada wild-rye	36	92	72
Blue grama grass	60	74	None
Side-oats grama	59	76	10
Big bluestem	None	68	15
Switch grass	None	65	20
Indian rice grass	10	78	83
Slender wheatgrass	15	90	25
Smooth brome	12	86	30
Feather bunchgrass	8	93	75
Sandberg bluegrass	70	74	None
*Cool-season mixture	18	88	74
†Warm-season mixture	55	62	None
Alfalfa	58	89	78

*Cool-season mixture		†Warm-season mixture	
Feather bunchgrass	1 lb.	Blue grama grass	10 lbs.
Western wheatgrass	1 lb.	Buffalo grass	3 lbs.
Crested wheatgrass	2 lbs.	Side-oats grama	2 lbs.
Russian wild-rye	1 lb.		
Brome	2 lbs.		
Slender wheatgrass	1 lb.		

The optimum depth of seeding will vary somewhat as to size of seed, soil texture, type and firmness of seed bed, amount of organic matter in the soil, amount of stubble and other trash material worked into the surface soil and the type and amount of organic cover. Smaller seeded grasses should be seeded shallower than most larger seeded grasses; ½ inch or less. Grasses have a limited food supply available in the seed itself. If seeded too deeply the seedlings are unable to penetrate deep coverage of soil. Deeply planted seedlings are weakened and will not withstand adverse soil and climatic conditions.

Time of Seeding Grasses for Areas I and II. Grasses, as explained herein, fall into two classes; cool-season grasses and warm-season grasses. These two classes have been previously discussed under adaptability. It is found further that they respond differently to such conditions as time of seeding, type of seed bed, amount of residue cover, distribution of rainfall, amount of soil moisture, soil type, degree of winter protection and freedom or presence of weeds. The foregoing are determining factors with regard to success in establishing these grasses.

Table 15 states percentage of emergence and of survival for species of grass seed planted at Brookings in four periods of the year.

Table 15. Time of Seeding Grasses at Brookings.*

Species	Three year Average 1939-1941 Percent Emergence Early Fall	Late Fall	Early Spring	Late Spring	Percent Stand Early Fall	Late Fall	Early Spring	Late Spring
Western wheat	96	80	54	97	95	92	78	98
Western wheat	70	63	40	49	77	58	63	51
Slender wheat	83	45	55	75	28	50	35	45
Standard crested	80	63	94	94	42	60	68	58
Fairway crested	87	55	91	78	44	60	67	65
Russian wild-rye	67	42	91	97	30	41	64	83
Average	**61**	**56**	**71**	**82**	**53**	**60**	**63**	**67**
Parkland brome	82	7	89	80	18	7	60	69
Standard brome	83	3	87	73	4	1	75	67
Switch grass	77	13	59	48	3	8	69	40
Side-oats grama	62	5	71	65	1	1	74	55
Blue grama	43	12	75	70	1	12	71	65
Big bluestem	67	12	61	51	1	2	52	50
Average	**69**	**9**	**93**	**65**	**5**	**5**	**67**	**58**
Reed canary	58	10	59	73	20	10	31	43
Sandberg bluegrass	63	7	58	4	18	1	4	0
	Two Year Average 1940-1941							
Timothy	90	90	99	95	80	90	95	75
Kentucky blue	20	23	32	26	20	23	22	21
Feather bunchgrass	60	93	32	43	92	88	63	48
Little bluestem	65	20	75	30	1	20	75	50
Indian rice	50	60	18	1	55	48	10	31
Buffalo	43	63	1	1	51	63	36	20
Beardless wheat	60	4	63	63	20	1	20	1

* U. S. D. A. Soil Conservation Service, Division of Nurseries, Cooperating.

The seeding tests (Table 15) made at Brookings were on fallow land. The time of seeding the two strains of western wheatgrass, slender wheatgrass, standard crested wheatgrass, Fairway crested wheatgrass, Russian wild-rye, Kentucky bluegrass, timothy and feather bunchgrass had very little influence in establishing good stands.

The early and late spring seeding gave better stands of bromegrass, switch grass, side-oats grama, blue grama, big bluestem and little bluestem. The better stands of buffalo and Indian rice grass were established by either early or late fall seeding. Reed canary grass, Sandberg blue and beardless wheat had the better stands established either on the early fall or the spring seedings.

On a basis of these trials with adapted species in eastern South Dakota at Brookings, seeded on cultivated (fallowed) land, spring seeding resulted in decidedly higher percentages of emergence and survival than fall seeding, either early or late.

Experiments were also conducted at Brookings in Area II, over a two year period with finding emergence and later survival for three species of grasses (Table 16). These latter experiments were conducted on types of seed bed different from the one reported in Table 15.

The three grass varieties were seeded at four separate seasons of the year —three on oat stubble land with three different kinds of further preparation and one on clean corn land.

Observation of emergence and later survival was made on the three kinds of grass, all of which were considered to be standard types for the location thus belonging to one general group.

Table 16. Two years average 1939 and 1940—1940 and 1941 time of seeding crested wheatgrass, western wheatgrass and brome grass on different types of seed bed (Brookings).

	Percent of Emergence							
	Early Fall		Late Fall		Early Spring		Late Spring	
	Drilled	Broadcast	Drilled	Broadcast	Drilled	Broadcast	Drilled	Broadcast
Fall Plowing Oat Stubble	44	25	66	34	55	23	53	7
Double Disked Oat Stubble	45	26	56	25	43	10	27	4
No Preparation Oat Stubble	24	3	43	6	29	4	25	1
Clean Corn Stubble	47	19	53	21	38	17	39	15
Average	**40**	**18**	**55**	**22**	**41**	**14**	**36**	**8**
	Percent of Survival							
Fall Plowing Oat Stubble	51	27	54	35	38	9	39	5
Double Disked Oat Stubble	60	41	58	30	20	8	4	2
No Preparation Oat Stubble	32	7	44	13	13	2	2	1
Clean Corn Stubble	43	24	54	26	35	8	15	5
Average	**47**	**25**	**53**	**26**	**27**	**7**	**15**	**3**

Table 16 shows the average percentages of emergence and of survival as arranged in separate groups, the first in the upper part of the table and the second in the lower part.

It is fairly easy to observe from the upper part of Table 16 that the average percentage of emergence of all grasses seeded in this experiment was highest for those seeded in late fall. Same was true for all four kinds of seed bed preparations employed. Survival of these three grasses was higher on the four kinds of seed bed with exception of the oat stubble prepared by double disking, where survival was somewhat higher for early fall seeding.

The weed growth was heavier for the late spring planting on double disked oat stubble and clean corn land as compared with the fall plowed oat stubble.

The drilled grasses seeded in the late fall on oat stubble without any preparation emerged and established stands equal to those on the prepared seed beds. Their respective emergences were as follews: Crested wheat, 53 percent; western wheat, 38 percent; brome, 52 percent. Their ground cover survivals were crested wheat, 52 percent; western wheat, 45 percent; brome, 34 percent. Residue cover apparently is important for late fall seedings of grasses. The stubble left standing holds the snow and also gives the young seedlings protection. It also prevents the crusting of the soil in the early spring. This was a very noticeable factor in reducing grass stands which were seeded in the late fall on a clean, well prepared seed bed.

Table 17 presents data on date of seeding, including emergence of plants per square meter and survival expressed in pounds per acre.

Table 17. Effect of date of seeding grasses on stand and forage yield at Vermillion, South Dakota.*

Species	Date Seeded: Sept. 9, 1939 Plants†	Sept. 9, 1939 Yield‡	Oct. 15, 1939 Plants	Oct. 15, 1939 Yield	April 1, 1940 Plants	April 1, 1940 Yield	May 15, 1940 Plants	May 15, 1940 Yield	June 1, 1940 Plants	June 1, 1940 Yield
Smooth brome	295	5058	258	2275	186	3033	24	1138	15	252
Western wheat	260	4803	281	4044	161	3539	95	1138	30	505
Crested wheat	88	3792	73	2528	162	2781	66	1011	0	0
Russian wild-rye	195	4297	189	3033	354	2528	157	1264	34	1517
Grass, alfalfa mixture	150	6067	275	5056	439	4297	332	2781	132	1643
Ave. Four grasses	**210**	**4488**	**200**	**2970**	**216**	**2970**	**86**	**1138**	**20**	**568**
Average-all	**198**	**4803**	**215**	**3387**	**260**	**3236**	**135**	**1466**	**42**	**783**

* Plantings made on the Soil Conservation Nursery.
† Number of plants per square meter.
‡ Pounds per acre.

Aside from the fact that highest yields of pounds per acre are always produced by alfalfa-grass mixture, production from the several grasses is somewhat evenly distributed.

Observation of the separate yields reveals the fact that the highest in every case was produced from seeding September 9, the earliest fall date. The highest remaining yields were produced either from seeding October 15, the latest fall date, or April 1, the earliest spring date.

At Vermillion, which is in Area I, southeastern South Dakota, the highest average numbers of grass plants were produced from fall seedings. Likewise the highest yield in pounds per acre was produced from fall seeding with the advantage for seeding early rather than late.

Seeding as late as May or June, late spring seeding, under conditions represented by Vermillion produced notably fewer plants and lower yields per acre than seeding at other times.

Time of Seeding Grasses for Area III. Discussion of time of seeding grasses in preceding paragraphs, based largely on data in Tables 15, 16, and 17 relate to experiments made at Vermillion and Brookings in Areas I and II.

The Soil Conservation Service makes the following recommendations for seeding cool-season grasses in Area III: Early fall (August 20 to September 30), late fall (October 20 to time of freezing) and early spring (not later than April 10 to 15). Early fall seeding is only recommended when certain prerequisites are available; namely, moisture, freedom from grasshoppers, suitable weed or stubble cover to prevent blowing.

Such conditions have to prevail to protect young grass seedlings which are bound to result from early fall seeding. It is possible to know in advance when such conditions are present. If all or any of them are absent, seeding should be delayed until late fall with the idea that seed applied at that time will remain dormant over winter and germinate in the early spring.

In case seeding of cool-season grasses is not accomplished until spring, it should be done early at a time when moisture is available.

Summary of Time of Seeding Grasses in Areas I, II, and III. It is probable that growers of grass, like the writers, would be gratified to somehow arrive at an average or specific date or time of seeding which could be stated as applying to the entire state or at least to the several sections, without further qualification. That cannot be mathematically done from present information.

The present objective had better be that of becoming as thoroughly informed as possible about optimum requirements for germination and growth of grass species to be seeded, then note as carefully as possible the time of seeding when those conditions are most likely to be obtained.

It is a seeming truism, not so simple as it seems, that the best time for seeding grass is when it will germinate and grow. It may be assumed that at locations where the most equable seasonal conditions can be obtained, there it will be most nearly possible to fix a time when such germination and growth will take place.

At Vermillion, Area I, it has been pointed out (Table 17) that one of the highest average survivals and the highest average yield per acre came from early fall seeding. Knowing that to be a fact, it helps to remember and recall that in that area, conditions of growth for cool-season grasses are likely to be satisfactory in the early fall.

At Brookings, representing Area II, moisture and other climatic conditions are a bit more variable than they are in Area I. It is more necessary to avoid hazards such as crusting of ground after seeding, winter freezing of young seedlings without cover after emergence. Judging by Table 15 and also by Table 16, likely the safest time to seed cool-season grasses in Area II is early spring. There is no evidence in this publication to indicate that seeding may be delayed in Area II until late spring, though there is indication that when conditions in late fall are observed to be satisfactory (moisture, soil texture, seed-bed) seed may well be applied in the late fall.

In Area III where hazards of moisture, crusting over, winter killing are progressively greater than in Areas I and II, it is correspondingly necessary to base time of seeding not on an established date, but upon conditions observed to favor growth. Seed cool-season grass in this area at a time when conditions favor, whether in early fall, late fall or early spring.

Cool-season grasses are most likely to succeed when planting is done in the fall or very early spring, because it is during these periods that they make their most rapid growth. Warm-season grasses make their maximum growth during the late spring and early summer which corresponds quite closely to the frost free part of the year. Consequently, early to mid-May dates have proven to be the best time to seed these warm-season grasses. Earlier spring seedings are also successful providing the ground is free of weeds and other factors are favorable, but fall seedings are almost sure to fail.

Care of Grass Stands

Weed Control on Newly Seeded Grassland. Grass seedlings grow slowly during the first year; consequently they cannot compete with rapid growing weeds during this period. Newly seeded pastures which are badly infested with weeds can be controlled by mowing. In controlling weeds by clipping with a mower there are three points of importance—the size and maturity of

the weeds when cut, kinds and the height of clipping. The kind, height, amount and stage of maturity of weeds should, however, be taken as a criterion of the proper time to cut or mow rather than a specified time. Mowing should be done when the greatest possible number of weeds can be destroyed before they produce seed. Weeds should be allowed to make a fair growth before clipping. When weeds are cut before seed production, most annuals are killed. Such cutting allows young grass seedlings to make top and root growth. A tall, dense growth of weeds is more apt to be killed by clipping than a young, scattered, open weed growth since in the former the buds on the weed stubble will have been killed by shading. The lower weeds are cut, the more will be killed. Too high clipping of weeds merely favors the weeds instead of the newly seeded grasses. Too close clipping of weeds on newly seeded grasses, even though more weeds are killed, may cause failure of the grass stands. Young grass seedlings, if cut too closely, may fail to produce sufficient root reserves and root system to go through the winter. The mower should be set at a medium height to minimize the injury to the grasses. If the weeds are not causing too serious competition for nutrients and light, the field may be left undisturbed. Russian thistle should not be cut because mowing only forces it to spread more. Small piles of cut weeds left on the ground will almost always kill all the young grass under them. If the clipped weed growth is not too heavy, it is not necessary to remove it, as it will give considerable protection for the newly seeded grass seedlings.

Weed Control on Old Established Grass Lands. On land level enough to permit the use of machinery, weeds are best controlled by mowing before the weeds produce seed. Land badly infested with weeds may require two mowings each year for two or more years. Thereafter one mowing each year is sufficient to keep the weeds in check. Land too rough to permit the use of a mowing machine makes weed control a difficult problem. The weeds can be cut with a scythe. This practice requires so much labor that it is justifiable only with small pastures.

Ample time should be allowed for newly seeded grasses to become established. Grass seedlings generally make little coverage the first year. Probably by fall of the first year, young grass seedlings will have some tillers, especially bunch types. What may appear to be a poor grass stand the first year after seeding may, in the second or third year become a very good grass stand. The rapidity with which grass stands thicken up depends upon fertility and kind of soil, moisture, weeds, seed bed, and the kind and type of grass used whether bunch grass or those spreading by underground root-stalks. Therefore, it is advisable to wait at least two years or more before plowing up thin stands of newly seeded grasses.

Grazing. Newly seeded grasses should be protected from grazing during their first year. Grazing should be carefully regulated thereafter until the grass plants are thoroughly established. Premature grazing of newly seeded grasses before they are well established not only kills the plants by trampling and removal of leaves, but an even more critical consideration is the actual pulling up by animals of the young grass plants before they become well established.

Grasshopper Injury. Grasshopper injury is often severe on newly seeded grasses. Injury may be reduced by timely and thorough destruction of the egg deposits in the fall before planting the grasses and by timely and thorough application of poison bran mash. Seeding in the fall should be delayed until all danger from adult grasshoppers is past.

Culture Treatments. Culture treatments used to improve stands and growth of grasses may include harrowing, springtoothing, disking, plowing. Old established grass lands that have become unproductive may often be restored by cultural treatments. The condition and its cause, however, is difficult to determine in many cases. Breaking up sod in such cases, so that plant food and moisture relations may be so improved, will often cause grasses to grow vigorously.

It should be emphasized in this connection, however, that the process of rejuvenating unproductive grass land is long and expensive, and may not always give satisfactory results. On tillable land, improvement is more certain, and more permanent, if the land is plowed and planted to a clean cultivated crop for two or more years before returning the land to grass. Thereafter the productivity of the grass land will be determined largely by the practice of weed control, usage and grazing.

Reseeding Scanty Spots. After land has been put in a favorable condition for the growth of grasses through the destruction of weeds, the grasses will naturally come in and gradually make a good stand. A good stand, however, may be secured quicker by adding additional seed where grasses are thin or the ground bare. On untillable grass lands or ranges, the cheaper method to use in restoring grass stands is usually by deferring or controlling grazing, thus allowing the grasses to re-establish themselves.

Why Grass Seedings Fail. Grass seedings may fail for a wide variety of reasons, some of which are specific and local. Established grass stands are the summation of these specific local effects. Grass stand failures generally can be attributed to three major hazards: Poor seed, early seedling hazards and late seedling hazards.

Seed of poor quality, may be light weight seed which is mostly chaff or hulls and no kernels, immatured seed, injured seed either damaged by weathering, heating in storage, disease and low germination. It is more economical to purchase high quality seed and seed a lower rate per acre than to purchase low quality seed and seed a higher rate per acre.

Early seedling hazards may be due to unfavorable seeding conditions, lack of moisture, poor seedbed preparation, diseases, insect pests, soil blowing, too deep coverage of the seed and crusting or baking of the surface soil. Most of these early seedling hazards can be overcome by proper seedbed preparation, method and depth of seeding.

Late seedling hazards are similar to those of the early seedling hazards. They are generally due to poor seedbed preparation, drouth, competition of a nurse crop, competition of weed growth, soil blowing, poorly adapted seed, diseases, insect pests, winter killing and not allowing ample time for the young grasses to become established before grazing or plowing up so soon after seeding.

Conclusions

The findings of this bulletin indicate that it is practicable to take measures which will promote the reestablishment of grass in locations comprising a considerable part of the three outlined areas of South Dakota. Attempts at regrassing therefore become a feasible project in smaller or larger scale operations of land management.

Regrassing must obviously be brought about with the use of species that are adapted to the conditions of growth within the specific area. It is indicated herein that the number of species is indeed small, confined largely to the familiar native grasses, western wheatgrass, blue grama, buffalo grass, feather bunchgrass, side-oats grama, big and little bluestem, sand dropseed, Sandberg blue and June grass.

Introduced species proved well adapted for many conditions are blue grasses, smooth brome, crested wheatgrass, Russian wild-rye, and intermediate wheatgrass. Eight detailed illustrations are included which may serve to make characteristics of the predominant species familiar and more recognizable.

In addition to discussing adaptability of these species, cultural methods are described both from the standpoint of observation and experiment. The object of cultural methods is to provide optimum conditions of germination and growth. A firm seed bed for seeding grasses and residue covers for protection against wind erosion and soil incrustation is necessary.

The drilling of grass seed is superior over broadcasting of seed due to the fact that this method insures placing of seed at an even depth with shallow covering.

As a general rule warm-season grasses should be seeded in the spring. Optimum conditions for germination and growth of cool-season grasses is more difficult to determine. It is not attempted, therefore, to state an invariable time based on season when cool-season grasses should be seeded.

Appendix Table 1. One-rod square plot grass species adaptation test planted in 1935; discontinued 1940 at Brookings.

Plot No.	Common Name	Scientific Name	Accession No. or source	Percent emerged	Percent stand
1	Coast wheatgrass	*Agropyron pungens*	Kansas	80	100
3	Crested wheatgrass	*Agropyron cristatum*	22136	80	55
10	Crested wheatgrass	*Agropyron cristatum*	344-61	100	90
68	Crested wheatgrass	*Agropyron cristatum*	NE-414	75	1
6	Crested wheatgrass	*Agropyron cristatum*	North Dakota	95	65
11	Fairway wheatgrass	*Agropyron cristatum*	North Dakota	80	35
4	Slender wheatgrass	*Agropyron trachycaulum*	South Dakota	70	55
9	Slender wheatgrass	*Agropyron trachycaulum*	221-46	20	45
7	Violet wheatgrass	*Agropyron violaceum*	344-70	50	1
5	Blue bunch wheatgrass	*Agropyron spicatum*	341-70	50	1
70	Blue bunch wheatgrass	*Agropyron spicatum*	NE-491	15	0
56	Western wheatgrass	*Agropyron smithii*	South Dakota	40	95
69	Western wheatgrass	*Agropyron smithii*	NE-491	10	45
8	Western wheatgrass	*Agropyron smithii*	341-20	20	85
31	Beardless wheatgrass	*Agropyron inerme*	Washington	35	1
34	Red top	*Agrostis alba*	North Dakota	50	85

Appendix Table 1. (Continued)

Plot No.	Common Name	Scientific Name	Accession No. or source	Percent emerged	Percent stand
35	Red top	*Agrostis alba*	22006	50	20
61	Creeping bent	*Agrostis palustris*	NE-637	45	0
18	New Mexico little bluestem	*Andropogon scoparius*	Nebraska	1	3
19	Big bluestem	*Andropogon furcatus*	Nebraska	1	4
59	Sweet vernalgrass	*Anthoxanthum odoratum*	19256	15	0
37	Tall oatgrass	*Arrhenatherum elatius*	20134	65	5
45	Slough grass	*Beckmannia syzigachne*	NE-273	10	1
36	Hairy grama	*Bouteloua hirsuta*	Colorado	35	1
73	Hairy grama	*Bouteloua hirsuta*	NE-447	1	0
38	Blue grama	*Bouteloua gracilis*	Texas	50	0
46	Blue grama	*Bouteloua gracilis*	Nebraska	95	65
72	Blue grama	*Bouteloua gracilis*	NE-423	35	0
48	Side-oats grama	*Bouteloua curtipendula*	South Dakota	30	65
71	Side-oats grama	*Bouteloua curtipendula*	NE-644	1	0
88	Smooth brome	*Bromus inermis*	19237	1	0
13	Smooth brome	*Bromus inermis*	South Dakota	85	100
87	Smooth brome	*Bromus inermis*	Canada	30	1
74	Smooth brome	*Bromus inermis*	NE-649	25	70
12	Nodding brome	*Bromus anomalus*	342-1685	10	1
15	Wooly nodding brome	*Bromus var. lanatipes anomalus*	341-12	1	0
14	Large mountain brome	*Bromus marginatus*	Washington	20	0
86	Rescue grass	*Bromus catharticus*	Texas	1	0
91	Wooly nodding brome	*Bromus var. lanatipes anomalus*	341-12	35	0
2	Chee grass	*Calamagrosis epigeios*	South Dakota	75	100
4	Sand reedgrass	*Calamovilfa longifolia*	Nebraska	15	0
60	Feather fingergrass	*Chloris virgata*	NE-165	60	0
38	Crested dogtail	*Cynosurus cristatus*	22049	1	0
33	Orchard grass	*Dactylis glomerata*	22005	60	20
92	Tufted hairgrass	*Deschampsia caespitosa*	3487	20	0
21	Virginia wild-rye	*Elymus virginicus*	D4-N. Dak.	30	0
22	Canada wild-rye	*Elymus canadensis*	D3-Montana	65	0
75	Canada wild-rye	*Elymus canadensis*	NE-419	10	40
43	Giant wild-rye	*Elymus condensatus*	342-1606	10	0
44	Macoun wild-rye	*Elymus macounii*	342-1690	85	40
84	Hairy scale Colo. wild-rye	*Elymus ambiguus var. strigosus*	341-11	10	0
83	Hairy cupgrass	*Eriochloa villosa*	3434 FC101659	20	0
82	Fineleaf fescue	*Festuca tenuifolia*	20131	20	0
16	Arizona fescue	*Festuca arizonica*	341-62	1	3
17	Meadow fescue	*Festuca elatior*	North Dakota	25	1
20	Meadow fesuce	*Festuca elatior*	19252	20	0
81	Blue bunch fescue	*Festuca idahoensis*	Washington	15	0
76	Blue bunch fescue	*Festuca idahoensis*	NE-327	35	0
67	Hard fescue	*Festuca ovina var. duriuscula*	19251	10	0
49	Sheep fescue	*Festuca ovina*	19173	10	0
89	American manna	*Glyceria grandis*	3485	6	0
66	June grass	*Koeleria cristata*	North Dakota	55	3
85	Perennial ryegrass	*Lolium perenne*	19241	75	50
25	Indian ricegrass	*Oryzopsis hymenoides*	NE-670	1	20
52	Switch grass	*Panicum virgatum*	341-159	70	50
77	Switchgrass	*Panicum virgatum*	NE-441	25	60

Appendix Table 1. (Continued)

Plot No.	Common Name	Scientific Name	Accession No. or source	Percent emerged	Percent stand
29	Reed canary	*Phalaris arundinacea*	North Dakota	35	95
30	Reed canary	*Phalaris arundinacea*	22007	65	35
78	Reed canary	*Phalaris arundinacea*	NE-356	1	25
32	Bulb canary grass	*Phalaris tuberosa var. stenoptera*	13620	1	0
39	Timothy	*Phleum pratense*	South Dakota	50	85
93	Tall reed	*Phragmites phragmites*	341-334	25	0
24	Kentucky bluegrass	*Poa pratensis*	19234	35	100
26	Kentucky bluegrass	*Poa pratensis*	North Dakota	55	100
65	Wood bluegrass	*Poa nemonalis*	22050	20	0
64	Rough bluegrass	*Poa trivialis*	21937	1	0
27	Nevada bluegrass	*Poa nevadensis*	Washington	15	0
47	Nevada bluegrass	*Poa nevadensis*	Washington	60	15
79	Nevada bluegrass	*Poa nevadensis*	NE-361	1	30
28	Canada bluegrass	*Poa compressa*	20122	1	85
63	Sandberg bluegrass	*Poa secunda*	Washington	75	1
90	Rabbitfoot grass	*Polypogon monspeliensis*	341-14	20	0
53	Indian grass	*Sorghastrum nutans*	Nebraska	20	0
94	Prairie cordgrass	*Spartina pectinata*	341-336	40	20
41	Alkali sacaton	*Sporobolus airoides*	NE-443	35	1
55	Sand dropseed	*Sporobolus cryptandrus*	341-251	35	15
40	Needle-and-thread	*Stipa comata*	Nebraska	35	60
54	Feather bunchgrass	*Stipa viridula*	North Dakota	80	95
57	Sleepy grass	*Stipa robusta*	341-39	15	55
58	Letterman needle	*Stipa lettermani*	344-108	35	0
23	Purpletop	*Triodia flava*	342-1595	55	25
62	Japanese lawngrass	*Zoysia japonica*		3	0

Appendix Table 2. One-rod row grass species adaptation test at Brookings, 1939-41.

Plot No.	Accession No.	Common Name	Scientific Name	Source	Percent emerged	Percent stand
1	1655		*Aeluropus litoralis*	Turkey	30	0
4	8575	Awned wheatgrass	*Agropyron caninum*	Russia	70	0
5	8576		*Agropyron cilarae*	Russia	75	8
6	1770	Crested wheatgrass	*Agropyron cristatum*	Turkey	65	15
85		Crested wheatgrass rhizome	*Agropyron cristatum*	Wyoming	100	75
102	11167		*Agropyron desentonium*	New Mex.	100	50
103	W1822	Thickspike wheatgrass	*Agropyron dasystachyum*	Washington	50	1
7	1876	Tall wheatgrass	*Agropyron elongatum*	Russia	90	90
8	1115		*Agropyron popovii*	Russia	70	60
9	8578	Coast wheatgrass	*Agropyron pungens*	Europe	95	100
84		Coast wheatgrass	*Agropyron pungens*	Kansas	100	75
83	3126	Slender wheatgrass	*Agropyron trachycaulum*	Wash.	100	75
10	8579	Drooping wheatgrass	*Agropyron semicostatum*	Russia	20	0
11	3102	Bluebunch wheatgrass	*Agropyron spicatum*	Washington	5	0
12	1487	Stiffhair wheatgrass	*Agropyron trichoporum*	Turkey	40	0
104	W41	Stiffhair wheatgrass	*Agropyron trichoporum*	Washington	70	60
2	2100	Red top	*Agrostis alba*	Spain	15	0
75	7163	Red top	*Agrostis alba*	New York	15	1
3	1119		*Agrostis transcaspica*	Russia	20	1
105	DG146-38	Meadow foxtail	*Alopecurus pratensis*	Wyoming	50	1
16	85	Bluestem species	*Andropogon sp.*	Africa	35	0
17		Big bluestem Sel. I	*Andropogon furcatus*	Arizona	5	0

Appendix Table 2. (Continued)

Plot No.	Accession No.	Common Name	Scientific Name	Source	Percent emerged	Percent stand
18		Big bluestem Sel. 2	*Andropogon furcatus*	Arizona	35	1
19		Big bluestem Sel. III	*Andropogon furcatus*	Arizona	1	0
20		Big bluestem Sel. II	*Andropogon furcatus*	Arizona	60	85
21		Big bluestem Sel. II	*Andropogon furcatus*	Arizona	50	10
14	2966	New Mexico Little bluestem	*Andropogon scoparius*	Texas	10	0
88	DG1-37	New Mexico Little bluestem	*Andropogon scoparius*	N. Dak.	75	50
91	DG114-38	New Mexico Little bluestem	*Andropogon scoparius*	N. Dak.	15	1
15	2967	Prairie beardgrass	*Andropogon scoparius var. neomexicana*	Texas	50	0
13	1787		*Andropogon ischaemum*	Turkey	10	0
94		Tall oat grass	*Arrhenatherum elatius*	S. Dak.	80	75
22	2969	Side-oats grama	*Bouteloua curtipendula*	Arizona	35	65
23	3359	Side-oats grama	*Bouteloua curtipendula*	Arizona	95	25
24	3603	Side-oats grama	*Bouteloua curtipendula*	Arizona	75	75
25	8599	Black grama	*Bouteloua eriopoda*	Arizona	8	0
26	2368	Blue grama	*Bouteloua gracilis*	Arizona	95	100
27	2971	Blue grama	*Bouteloua gracilis*	Arizona	8	10
28	3682	Blue grama	*Bouteloua gracilis*	Arizona	5	0
30	11323	Hairy grama	*Bouteloua hirsuta*	Arizona	5	0
29	10105	Rothrock grama	*Bouteloua rothrockii*	Arizona	12	0
31			*Brachypodium caespitosum*	Russia	5	0
32	1419	Smooth brome	*Bromus inermis*	Russia	80	60
95	DG12-37	Large mountain brome	*Bromus marginatus*	Wyoming	95	35
33	3732	Mountain brome	*Bromus polyanthus*	Arizona	75	55
41	11348	Giant reedgrass	*Calamovilfa giganteus*	Arizona	60	0
89		Giant reedgrass	*Calamovilfa giganteus*	Texas	70	0
87	DG117-38	Prairie sand reed	*Calamovilfa longifolia*	N. Dak.	75	45
74	1917	Spineless sandbur	*Cenchrus biflorus*	Australia	50	0
34	2086		*Chloris berrol*	Armenia	45	35
35	2978	Rhodes grass	*Chloris gayana*	Arizona	15	1
106			*Dassia isotefolia-silvstue*	Argentina	5	0
37	74		*Elymus sabulosus*	Russia	40	50
92		Giant wild-rye	*Elymus condensatus*	Montana	95	50
93	DG101-38	Canada wild-rye	*Elymus canadensis*	N. Dak.	95	45
109	W208	Mammoth wild-rye	*Elymus giganteus*	Washington	20	0
110	W2662	Blue wild-rye	*Elymus glaucus*	Washington	95	0
36	8022	Teff grass	*Eragrostis abyssinica*	Arizona	95	0
38	67	Weeping lovegrass	*Eragrostis curvula*	Arizona (Africa)	100	1
77	DG118-38	Weeping lovegrass	*Eragrostis curvula*	North Dakota (Africa)	90	70
107	948-19		*Eragrostis arcuttiana*	California	20	0
39	68	Lehman lovegrass	*Eragrostis lehmanniana*	Africa	40	1
76		Sand lovegrass	*Eragrostis trichodes*	Oklahoma	30	1
108	1927	Sand lovegrass	*Eragrostis trichodes*	Nebraska	50	0
100	TP9144	Fescue species	*Festuca sp.*	Colorado	85	0
40	1565	Meadow fescue	*Festuca elatior*	Arizona	20	0
112	FC29366	Meadow fescue	*Festuca elatior*	Oregon	95	0
111	W274	Sheep fescue	*Festuca ovina*	Washington	80	0
72		Chewings Creeping red fescue	*Festuca rubra genuina stolonifera*	Hungary	50	25

Appendix Table 2. (Continued)

Plot No.	Accession No.	Common Name	Scientific Name	Source	Percent emerged	Percent stand
98	C4059	Creeping red fescue	*Festuca rubra genuina stolonifera*		95	12
99	2177	Creeping red fescue	*Festuca rubra genuina stolonifera*	New York	40	1
42	3575	Galleta	*Hilaria jamesii*	Arizona	20	0
43	4968	Galleta	*Hilaria jamesii*	Arizona	10	0
113	3575	Galleta	*Hilaria jamesii*	New Mexico	3	0
114	CI1396	Galleta	*Hilaria jamesii*	New Mexico	0	0
101	DG43-36	Galleta	*Hilaria jamesii*	Colorado	50	15
44	1719	Bulb barley	*Hordeum bulbosum*	Russia	70	0
45	8581		*Lolium westivoldicum*	Arizona	100	0
46	2343	Bush muhly	*Muhlenbergia porteri*	Arizona	15	0
47	3401	Green muhly	*Muhlenbergia racemosa*	Arizona	65	0
49	1894		*Oryzopsis coerulescens*	Russia	60	0
48	2691		*Oryzopsis holciformis*	Turkestan	50	0
50	1895	Smilo grass	*Oryzopsis miliacea*	Turkey	80	0
86	DG96	Switch grass	*Panicum virgatum*	Nebraska	50	85
53	2992	Switch grass	*Panicum virgatum*	Arizona	30	0
51	130	Blue panic	*Panicum antidotale*	Arizona	60	0
52	8499	Vine mesquite	*Panicum obtusum*	Arizona	35	0
57	3290		*Pogonarthria falcata*	Africa	40	0
115	1760	Chinese Pennisetum	*Pennisetum alopecuroides*	Nebraska	3	0
54	131	Oriental Pennisetum	*Pennisetum orientale*	Arizona	5	0
116	T3196	Purple prairie clover	*Petalostemum purpureum*	Texas	10	0
	136	Bulb canary grass	*Phalaris tuberosa*	Australia	20	0
96	3185-S-59	Timothy	*Phleum pratense*	New York	80	0
97		Timothy	*Phleum pratense*	S. Dak.	90	0
78	DG61-37	Bluegrass species	*Poa sp.*	Wyoming	50	0
82	W2716	Big bluegrass	*Poa ampla*	Washington	40	0
119		Big bluegrass	*Poa ampla*	Oregon	20	0
56	1287	Bulbous bluegrass	*Poa bulbosa*	Arizona	70	0
79	DG66-38	Canada bluegrass	*Poa compressa*	N. Dak.	45	0
81	1880	Alkali bluegrass	*Poa juncifolia*	Washington	60	0
118	2444		*Poa glaucifolia*	Wyoming	20	0
117	W4140-39	Seashore bluegrass	*Poa macrantha*	Oregon	30	0
80		Kentucky bluegrass	*Poa pratensis*		70	0
120	NDG163-38	Blowout grass	*Redfieldia flexuosa*	Colorado	3	0
58	2820	Plains bristlegrass	*Setaria macrostachya*	Arizona	1	0
59	3125	Indian grass	*Sorghastrum nutans*	Arizona	1	0
60	3004	Indian grass	*Sorghastrum nutans*	Arizona	65	0
61		Indian grass	*Sorghastrum nutans*	Arizona	5	0
62	3325	Alkali sacaton	*Sporobolus airoides*	Colorado	20	0
121	KG940	Tall dropseed	*Sporobolus asper*	Kansas	20	0
122	933	Tall dropseed	*Sporobolus asper*	Nebraska	30	0
63	8763	Spike dropseed	*Sporobolus contractus*	Arizona	5	0
64	3007	Sand dropseed	*Sporobolus cryptandrus*	Texas	15	0
123	KG1248	Sand dropseed	*Sporobolus cryptandrus*	Kansas	10	0
124	2709	Sand dropseed	*Sporobolus cryptandrus*	Nebraska	15	0
65	69	African dropseed	*Sporobolus fimbriatus*	Arizona	1	0
66	3008	Texas dropseed	*Sporobolus texanus*	Texas	3	0
90	DG93-38	Needle-and-thread	*Stipa comata*	N. Dak.	30	90
125	1932	Purpletop	*Triodia flava*	Kansas	30	0
126	M2-9819	Purpletop	*Triodia flava*	Iowa	45	0
67		Cottontop	*Trichachne californica*	Arizona	25	0
68	3499	Natal grass	*Tricholaena rosea*	Arizona	30	0
70	2063	Chinese lawn grass	*Zoysia chinesis*	Arizona	1	0
71	2064	Japanese lawn grass	*Zoysia japonica*	Arizona	1	0
69	1211	Manila grass	*Zoysia pungens*	Arizona	3	0