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Revegetating Native Grass Pastures with Tame Grasses and Alfalfa in the Northern James Valley Region of South Dakota

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REVEGETATING NATIVE GRASS PASTURES WITH TAME GRASSES AND ALFALFA IN THE NORTHERN JAMES VALLEY REGION OF SOUTH DAKOTA

BY

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REVEGETATING NATIVE GRASS PASTURES WITH TAME GRASSES AND ALFALFA IN THE NORTHERN JAMES VALLEY REGION OF SOUTH DAKOTA

This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

There are 2.5 million acres classified as pasture land in the North James valley area of South Dakota. The area includes all or parts of the counties of Beadle, Brown, Edmonds, Faulk, Hand, Jerauld, McPherson, Sanborn and Spink. The Conservation Needs Study conducted in 1958 and 1959 by these respective counties' USDA Agencies (5) determined that about 1.6 million acres are in need of some treatment. These needs are classified as follows:

(1) Acres needing establishment or reestablishment of vegetation . . . . . 151,870 acres

(2) Improved cover . . . . . 302,000 acres

(3) Protection from overgrazing . . . . . 1,180,300 acres

It is with these first two classifications representing 18 per cent of the pasture acres in this north James Valley area that are of concern in this study. It may be applicable to the native pasture situation in much of eastern South Dakota.

The primary obstacles to resolving these problems are considered to include: (a) The difficulties reported by farmers in establishing stands of tame grasses and legumes once the native sod has been ripped. (b) Those that are climatic such as moisture, heat, drought and winter survival. (c) Soil fertility which may be at such a low level as to reduce seedling vigor. (d) Poor timing of land preparation and seeding. (e) Poor quality seed. (f) The use of unsatisfactory equipment to perform necessary cultural operations. (g) A combination of two or more of these factors.

Recognizing these problems, this field study was undertaken to investigate variables that are consistent to experimental design. It logically divides into seven parts:

1. To compare methods of land preparation which may affect the resulting stands of various tame grasses and alfalfa.
2. To determine if the usual farm implements found on most James Valley farms are satisfactory for performing the cultural operations necessary to establish stands of various tame grasses and alfalfa.
3. To compare late fall versus early spring cultural practices as to the climatic effects that may contribute to the success or failure of stand establishment.
4. To determine the suitability of a specific grassland drill for interseeding tame grasses and legumes into native sod without destroying all of the existing vegetation.
5. To compare the relative ease of establishing stands of the commonly grown tame grasses; Bromus inermus, Agropyron desertorum and Agropyron intermedium; each in combination with the new pasture type alfalfa commonly known as the Teton variety.
6. To determine the contribution of a commercial mixed mineral fertilizer (20-52-0), at a rate of 100 pounds per acre, may make to the resulting stands.
7. To determine the extent that grassy and broadleaf weeds will emerge to compete with the seeded grasses and alfalfa.

REVIEW OF LITERATURE

Much research conducted over a long period of years have attacked the many facets of the problem of poor, relatively unproductive native pastures throughout the United States. Mason A. Hein (8) perhaps best summarized much of the results to date in his statement:

> Reseeding of grasses and legumes into thin pasture sods have not been successful in increasing the production of permanent pastures. . . . Another practice that can be used, which is coming into prominence is renovation. It is the process of converting old run-down pastures directly to improved pastures by discing or other cultivation, applying fertilizer, seeding high yielding grasses and legumes without subjecting the land to cropping.

Cotton (4) as early as 1910 recommended plowing the old sod, growing a cultivated crop for two or three years and then reseeding with a suitable grass-legume mixture.

Scholl, Hughes and McWilliams (15) in summarizing several pasture renovation experiments in Iowa, found that renovated pastures have produced from two to two and one-half times as much animal gain as the unimproved pastures.

Ahlgren et al. (2) conducted pasture renovation trials in southern Wisconsin on hillside pastures having slopes ranging from 15 to 25 percent and 26 to 35 percent. He found in the year after seeding on all slopes production of the renovated pastures exceeded five times the production of unrenovated areas. In the second year, production on the renovated areas had decreased to just over twice that of the unrenovated pasture. The principle grasses and legumes in those trials included Kentucky bluegrass, red top, sweet clover and red clover.

Kurtz et al. (10) in a summary of Dairy Herd Improvement Association feed records in South Dakota found that pastures provided annually about 25 percent of the total digestible nutrients (TDN) needed by the herds. They estimated that TDN from pastures cost one-sixth as much as TDN from grain, about one-half as much as from hay and one-third as much as from silage. It was further estimated that on an average in South Dakota, pastures supply one-third of the nutrients for a dairy herd at one-eighth of the annual feed cost.

An experiment with beef cattle was conducted jointly by the South Dakota Experiment Station, Agriculture Research Service and the Bureau of Reclamation at the Huron Development Farm, during the five year period of 1948 to 1952. It was found that the tame grass mixture of bromegrass and alfalfa consistently produced, each year, over three times more pounds of beef per acre than the native grass. They also found that the single practice of liberal fertilization of native grass pastures produced such small increases in pounds of beef that it was not the solution to increasing maximum productivity from native grass pastures where the primary species is Kentucky bluegrass.

Hughes and Peterson (9) in Iowa compared several methods of seedbed preparation. Late fall plowing followed by discing and seeding in early spring proved most successful in destroying the old bluegrass sod. The resulting stands of legumes were good following this treatment.

Smith et al. (17) working in West Virginia, made comparisons of plowing and shallow tillage as methods of seedbed preparation for

pasture renovation. Seedbed preparation was performed in the spring with lime and mineral fertilizers incorporated into the soil. The seed was broadcast and covered by light discing and harrowing. In most cases larger yields and better establishment of legumes were on seedbeds prepared by shallow tillage.

In Pennsylvania, Sprague et al. (18) compared several farm implements for their respective adaptability for seedbed preparation in pasture renovation trials. On plowable land the moldboard plow proved slightly more rapid and was the most effective in destroying the old sod. It had the disadvantage of burying the surface mulch which resulted in puddling, run-off and erosion. The disc plow and the cut-away disc appeared adaptable to the widest range of land and sod conditions.

At the South Dakota Experiment Station, Worzella et al. (22) in a seedbed preparation study on pasture renovation found the order of effectiveness for tame grass-legume stand establishment was 1. plowing, 2. roto-tilling, 3. discing, and 4. burning.

They reported that in a similar experiment at the South Dakota Range Field Station at Cottonwood the order of seedbed preparation methods resulting in best grass-legume stands were: 1. plowing, 2. burning, 3. discing.

Most of the problems associated with the establishment of stands of improved tame grasses and legumes in the arid and semi-arid regions of the United States are climatic and are coped with by climate-orientated cultural practices.

Worzella et al. (22) reported that for South Dakota the time to seed depends mostly on moisture conditions. In eastern South Dakota spring seeding usually results in good stands and survival. If sufficient moisture is present, early fall planting, from August 15 to September 1, will give good stands of grass but is hazardous for legumes.

Wheeler (20) suggests an advantage for late fall sowing as the seed does not depend on moisture conditions at the time of sowing, but will start germination in early spring when moisture is usually more favorable.

In a study of winter survival of grass-legume plants in fall sown plots, White and Horner (21) at the Dominion Forage Crops Laboratory concluded that for all seeding of grass and possibly alfalfa it should be done in late August to mid-September if moisture is good. If moisture is not satisfactory, then just before freeze-up.

Short (16) working in Montana suggests that late fall sowing should be done somewhat in advance of the time the ground freezes, but not so early that fall germination is likely to occur.

Murphy and Arny (11) in Minnesota studied the effects of planting depths on several species of grasses and legumes. Their findings were that from one-half inch up to one-eighth inch in depth was optimum for the alfalfa and grass species used in their study. They suggest three main factors which apply to the depth of seeding grasses and legumes: 1. the soil type, 2. the moisture condition of the surface soil, 3. the method of seeding. Murphy

and Arny (11) conclude that the optimum ranges of seed coverage are from one-third to one-half inch in heavy soils and one-half to one inch in sandy soils. This suggests careful attention to seeding depth adjustment for all types of seeding equipment.

Fuelleman and Graber (6) in a study of pasture renovation in Wisconsin found that renovation significantly reduced the weed population in over-grazed native pastures.

MATERIALS AND METHODS

A pasture site on the Allen Achen farm in northern Brown county, South Dakota was selected for the experiment. The composition of the existing sward was estimated as: Kentucky bluegrass, 40%; blue grama grass, 15%; western wheatgrass, 9%; sedges, 20%; saltgrass, 10% and assorted broadleaf weeds, 6%. It was considered quite typical of native grass pastures of the northern James Valley.

The soil type on which the experiment was conducted is identified as Barnes loam. This is an upland soil resulting from the weathering of glacial drift. It is closely related to the Houdek soil type which is typical of a large area of the valley. The site has a uniform one to two percent slope to the south and east.

Plant Nutrient Supplying Ability of the Soil

Composite soil samples were taken and analyzed for each replicate. A sample was taken from each plot within the replicate and combined to make the composite. These were analyzed as shown in Table 1.

Table 1. Plant Nutrient Supplying Ability of the Soil

Replicate	Nitrogen supplying ability	Phos. lbs/A.	Potash lbs/A.	PH	Soluble salt EC x 10
I	fair to good	16.8	533	6.5	0.35
II	fair to good	11.3	533	6.3	0.30
III	fair to good	10.2	462	6.3	0.25

This state of fertility is believed to be an average condition for most native grass pastures of the North James Valley area.

A commercial mineral fertilizer analyzing (20-52-0) at a rate of 100 pounds on a per acre basis was selected to balance the nutrient supplying ability of the soil. This was applied as a top dressing across half of each replicate on June 10, 1961 to observe affects.

The experimental design is shown in Appendix A. All plots are .014 of an acre in size, having the dimensions of 12 feet by 50 feet for each treatment. Each treatment was replicated in three randomized blocks.

Plant Materials

The grass varieties selected for establishment included: Homesteader bromegrass, Nordan crested wheatgrass and Oahe intermediate wheatgrass. Under all treatments each of these was seeded separately, but each in combination with Teton alfalfa. Homesteader bromegrass is a variety resulting from five strains of South Dakota bromegrass tested and selected by Dr. J. G. Ross (17). Nordan is a superior strain of crested wheatgrass developed by the United States Northern Great Plains Field Station, ARS, Mandan, North Dakota. Oahe intermediate wheatgrass was selected by Ross (16) and released for increase by producers in South Dakota in 1958. It is a superior strain obtained from polycross testing and selection out of the Ree variety which was identified as the derivative of a cross between

A. intermedium and A. trichophorum made in Russia prior to 1937. Teton alfalfa is a new, hardy, disease resistant, multi-purpose variety bred and recently released by the South Dakota Experiment Station.

Tillage and Seeding Equipment

One of the primary objectives of this field study was to determine if satisfactory stands of small seeded grasses and legumes could be obtained by using ordinary farm equipment common to most farms of the area. The farm cooperator supplied the use of the following equipment:

1. Power: Case tractor, model 400
2. Moldboard plowing: Case tractor plow #8, 4 bottoms, 16 inch lays
3. One-way disc plowing: Case 6-foot with 26 inch discs, spaced 9 inches, and having 9 discs
4. Discing: tandem disc, 10-foot, 18 inch diameter discs spaced 6 inches
5. Packing: Standard packer, 6-foot rolling packers with 6 inch spaced wheels
6. Seeding: a. Case pony press drill, 6-foot. Drill discs, seed drops and packer wheels spaced 6 inches apart

   b. Grassland drill, "Pasture Dream", model D-2. Equipped with four sod breaking shoes spaced 20 inches apart and seed drops attached to each shoe. Sprocket type packer wheels or treaders firmed the soil over the seed. Three supply boxes, one for grass seed, one for legume seed and one for fertilizer were standard equipment. The machine is manufactured by the Taylor Machine Works, Louisville, Mississippi.

Figures I and II illustrate the equipment used.

Figure I. Tractor, packer and press drill

Figure II. Grassland drill, (top) front view, (bottom) rear view

The Timing of Tillage and Seeding Operations

Eight variables of land preparation, time of seeding and methods of seeding were selected to be applied to each of the three tame grasses in combination with alfalfa. These methods included:

1. Moldboard plowed September 19, 1960, four tandem discings October 25. Seeded with a packer and press drill October 26, 1960.
2. Moldboard plowed September 19, 1960, with two fall and two spring tandem discings, seeded with a packer and press drill April 17, 1961.
3. One-way disc plowed September 19, 1960, four tandem discings October 25, seeded with packer and press drill October 26, 1960.
4. One-way disc plowed September 19, 1960, with two fall and two spring tandem discings, seeded with a packer and press drill April 17, 1961.
5. Seeding with a grassland drill directly into sod, October 29, 1960.
6. Seeding with a grassland drill directly into sod, April 17, 1961.
7. Moldboard plowed April 16, 1961, followed by six tandem discings. Seeded with packer and press drill April 17, 1961.
8. One-way disc plowed April 16, 1961, followed by six tandem discings. Seeded with packer and press drill April 17, 1961.

Figures III, IV, and V illustrate various methods of seedbed preparation.

Figure III. Spring seeded with pony press drill on fall moldboard plowing

Figure IV. Spring one-way disc plowing with four discings

Figure V. Spring seeded with grassland drill

Every Agronomist who has reported work on the establishment of stands of grasses and legumes in the Great Plains Region stresses the importance of timing the seeding operations to precede the most favorable climatic conditions. Operations timed so that the seeding date occurs previous to at least thirty days of anticipated favorable moisture and temperature conditions (10, 12, 19, 20, 23).

Since the seeding time is so very critical, then there is a relative importance to the timing of the seedbed preparation, so that a firm seedbed is ready at the proper time for seeding.

Under conditions where the old sod is completely destroyed by plowing it is reasonable to expect that a period of time should be allowed for partial decomposition of the sward turned under. How rapidly this takes place depends primarily on the moisture and temperature conditions, state of fertility and soil decomposing organisms present. Figures VI and VII compare the state of decomposition of the overturned furrow slice between fall and spring moldboard plowing respectively as they appeared June 7, 1961.

Figure VI. The state of decomposition of the spring turned furrow slice

Figure VII. The state of decomposition of the fall turned furrow slice

With these factors in mind it was concluded that for this study the seedings should be confined to late fall (October 15 to November 15), and early spring (April 15 to May 15). Early fall seeding, (August 15 to September 15), was excluded considering the generally poor moisture conditions that usually prevail in this period in central South Dakota.

Seeding Rates

The species of the grass, its quality, whether seeded alone or in a mixture and the use of the forage crop, whether for hay or pasture, are factors which determine the rate to seed for any given climatic area. For the James River Valley area of South Dakota the following seeding rates of high quality seed are being recommended:

Mixture A		Mixture B	
smooth bromegrass	5 lbs.	crested wheatgrass	6 lbs.
intermediate wheatgrass	4 lbs.	alfalfa or sweet clover	4 lbs.
alfalfa or sweet clover	4 lbs.		

Worzella (22) suggests that one grass may be used instead of two in the above mixture but the amount of seed should be adjusted.

It was arbitrarily decided to use a basis of ten pounds of grass seed and four pounds of alfalfa on a per acre basis for all treatments. On an individual plot basis, being .014 acres in size, the seeding rate of grass desired was 2.2 ounces and .87 ounces for alfalfa.

An official analysis of the seed quality was performed by the South Dakota Seed Testing Laboratory. All varieties analyzed over 98 percent in purity. Germinations varied as follows: Bromegrass 62 percent, crested wheatgrass 94 percent, intermediate wheatgrass 93 percent and the alfalfa 72 percent with 24 percent of that being hard seed.

Calibration of Seeding Equipment

One of the prime objectives of this study was to determine the degree of success farmers might expect by using their ordinary farm equipment to perform all the operations necessary to establish a stand of tame grass and alfalfa. In that the pony press drill has become the most common machine for seeding cereal crops in this area, its adaptability to grass-legume seedings warranted its selection. It is recognized that there are several commercial machines on the market specifically designed for grass-legume seeding, however many farmers are reluctant to purchase them when considering the average use per year and the investment costs of such equipment.

There are several recognized methods of calibrating a grain drill. Collins (3) outlines in detailed procedure a method of jacking up the machine, filling the seed cups and turning the drive wheel a specific number of revolutions. With a heavy canvas to catch the seed it is weighed and computations are made by using the diameter of the wheel, the number of revolutions and the width of

the area it would cover to compute the rate of seed output. By trial and error one would reach the proper adjustment to give the desired rate.

A less accurate method, but often used by farmers is to place a measured quantity of seed in the drill, cover a measured distance in the field and on refilling measure the quantity used for the area covered. Corresponding adjustments are then made to correct the deviations.

In this study it was desired to evaluate results on the basis of stand counts, therefore information as to the exact number of ounces per plot seeded was imperative. The procedure used was as follows:

Step 1. Weighed to nearest 1/10 ounces the desired ratio of grass to alfalfa and thoroughly mixed.

Step 2. Weighed to nearest 1/10 ounces the amount of mixture placed in the drill.

Step 3. Measured a test operating area, (hard packed soil drive for seed counts), and consistent with the length of plots.

Step 4. Operated the equipment over the test area with trial settings.

Step 5. Removed seed drop tubes, released space adjusters on the seed cups and carefully collected all seed remaining in the drill by means of a large canvas.

Step 6. Weighed back the collected seed and computed the number of ounces seeded. These results are reported in Table 2.

Step 7. Counted the number of seeds per foot of row at specified interval along the test area to determine uniformity of seeding.

Step 8. Adjusted machine settings accordingly.

This same procedure was followed in calibrating the grassland drill except the grass and legume seeds were measured and accounted for separately and seeded from separate boxes. Figure VIII shows the method of collecting the unused seed following each seeding operation. A summary of the resulting seeding rates are reported in Table 2.

Figure VIII. A canvas sheet for collecting the unused seed

Table 2. Resulting Seeding Rates

Plots	Ounces seeded grass	Ounces seeded alfalfa	Pounds per acre rates grass	Pounds per acre rates alfalfa
1a, 3a	6.3	2.5	9.6	3.8
1b, 3b	9.6	3.9	14.6	5.9
1c, 3c	7.3	2.9	11.1	4.4
2a, 4a	5.7	2.2	8.7	3.3
2b, 4b	7.8	3.1	11.8	4.7
2c, 4c	9.6	3.9	14.6	5.8
5a	5.3	3.5	8.1	5.3
5b	4.2	3.0	6.4	4.5
5c	6.1	3.0	9.3	4.5
6a	6.6	4.6	10.0	7.0
6b	8.1	4.6	12.3	7.0
6c	9.1	4.6	13.8	7.0
7a, 8a	5.7	2.2	8.7	3.3
7b, 8b	7.8	3.1	11.8	4.7
7c, 8c	9.6	3.9	14.6	5.8

Procedures for Determining Stand Counts

Several methods of measuring vegetation were considered. A variation of transect lines and abundance measurements were selected as techniques which would provide a uniform method for measuring vegetation within all plots.

The procedure followed was to drive steel stakes at the diagonal corner points of each plot. A galvanized stovepipe wire was then stretched across the diagonal and fastened to each stake. Measurement reference points were marked with a spot of red nail polish along the length of wire at the following intervals: 7 feet, 14 feet, 21 feet, 30 feet 3 inches, 37 feet 3 inches, and 44 feet 3 inches.

A wire measurement frame for measuring three feet of row length was shaped from a 42 inch length of number 9 wire. The frame was placed in the row nearest each reference point mark and measurements were taken from the point where the diagonal transect wire intersected the row. Figure IX shows the positions of the transect wire and the measurement frame in relation to the rows of vegetation. Figure X illustrates the contrast in growth of Nordan crested wheatgrass on fall moldboard plowing with fall seeding October 26, 1960, and spring seeding April 17, 1961.

Figure IX. The transect wire and measurement frame in position for plants counts

Figure X. The contrast in growth of Nordan crested wheatgrass on fall moldboard plowing with fall seeding October 26, 1960, to the right and spring seeding April 17, 1961, to the left

EXPERIMENTAL RESULTS

Rainfall Data

The amount and distribution of precipitation has an important influence on the success of establishing stands of grasses and legumes. The monthly precipitation data for the nine month period prior to the start of the experiment and through its duration are supplied from records kept by the farm cooperator at the plot site and are presented in Table 3.

Table 3. Precipitation in Inches of Rainfall

Month	1960	1961
January	----	.25*
February	----	.10*
March	----	.20*
April	.50	2.60
May	3.35	2.45
June	4.05	2.05
July	1.15	6.70
August	8.00	.55
September	.35	4.65
October	trace	3.10
November	trace	trace
December	.50*	.30*
Total	17.90	22.95

*Estimated from snowfall

The extremely high rainfall of eight inches in August 1960, just prior to the fall of seeding, would have justified early fall seeding had the land preparation been made a month to six weeks earlier. It was an important contributing factor to the rapid decomposition of the fall turned sod. Rainfall in the spring and early summer of 1961 may have made a strong contribution to the good stands obtained in this experiment. With over two inches of precipitation in each of the months of April, May and June plus the much above normal 6.70 inches in July, it could be considered virtually ideal.

Stand Counts of Selected Species

A summary of the means of plant counts for selected species are presented in Tables 4, 5, 6, and 7. Duncan's Multiple Range Test is used for testing the significance of the comparisons of means. A discussion of the results for each species analyzed follows each table.

Table 4. Mean Range Rank of the Tame Grasses Plant Counts Resulting From the Eight Methods of Land Preparation and Time of Seeding

Bromegrass	Mean range rank							
Method and time of seeding	6	3	1	8	5	2	4	7
Mean number of plants per square yard	13	14	19	33	38	50	60	66
Statistical Signif.**						*		

Crested wheatgrass	Mean range rank							
Method and time of seeding	5	6	3	1	8	2	7	4
Mean number of plants per square yard	40	65	68	105	134	142	163	164
Statistical Signif.**								

Intermediate wheatgrass	Mean range rank							
Method and time of seeding	6	3	5	1	8	4	2	7
Mean number of plants per square yard	30	54	62	72	85	93	101	116
Statistical Signif.**								

*Numbers appearing above a significance line are statistically different from those not underscored in the same line

**1 percent level of significance

Bromegrass stand analysis

From Table 4 it is noted that significantly better stands of bromegrass resulted from the spring seeding practices (methods 2, 4, and 7), compared to the other five methods. Significantly poorer stands resulted from fall seeding practices (method 1 and 3), and spring seeding with the grassland drill (method 6), compared to the other five methods. Moldboard plowing with either fall or spring seeding, fall seeding with the grassland drill and spring seeding on one-way disc plowing were significantly better than fall seeding on fall disc plowing and spring seeding with the grassland drill; but were also significantly inferior to spring seeding on fall disc plowing and spring seeding on spring moldboard plowing as methods for establishing stands of bromegrass.

Crested wheatgrass stand analysis

The results for crested wheatgrass stand establishment as shown in Table 4 indicates that significantly better stands of crested wheatgrass resulted from spring seedings on both the moldboard and one-way disc plowed plots (methods 2, 4, 7, and 8). Fall seeding with the grassland drill (method 5), was significantly inferior to all other methods and time of seeding. Spring seeding on spring moldboard plowed land was significantly better than spring seeding on land prepared in the spring with the one-way disc plow (method 7 over 8 respectively).

Intermediate wheatgrass stand analysis

Spring moldboard plowing with spring seeding (method 7) gave significantly better stands than all other methods while spring seeding with the grassland drill resulted in significantly poorer stands of intermediate wheatgrass compared to all other methods of land preparation and seeding. Following the pattern of the crested wheatgrass, significantly better stands of intermediate wheatgrass resulted from the spring seeding practices (methods 2, 4, and 7), than the other five methods.

Table 5. Mean Range Rank of the Alfalfa Plant Counts Resulting From the Eight Methods of Land Preparation and Time of Seeding

Bromegrass plots	Mean range rank							
Methods and time of seeding	3	1	6	8	2	4	5	7
Mean number of alfalfa plants per square yard	3	4	18	18	31	39	42	46
Statistical signif.**								

Crested wheatgrass plots	Mean range rank							
Methods and time of seeding	1	5	3	2	7	8	4	6
Mean number of alfalfa plants per square yard	9	14	21	26	39	46	48	49
Statistical signif.**								

Intermediate wheatgrass plots								
Methods and time of seeding	1	3	5	6	8	7	4	2
Mean number of alfalfa plants per square yard	14	15	19	31	49	50	51	57
Statistical signif.**								

**Significant at 1% level

Alfalfa stand analysis in bromegrass plots

The fall seedings of alfalfa on both moldboard plowed and one-way disc plowed plots (methods 1 and 3), were significantly inferior to the other six methods of land preparation and time of seeding as shown in Table 5. No significant differences were found among the six methods (2, 4, 5, 6, 7, and 8), in the bromegrass plots.

Alfalfa stand analysis in crested wheatgrass plots

Spring seedings (methods 4, 6, 7, and 8), were significantly superior to the other four methods of land preparation and time of seeding. Fall seeding of alfalfa on the moldboard plowed plots (method 1), was significantly poorer than the other seven methods compared. Alfalfa stands on the spring seeded plots on moldboard plowing (methods 2 and 7), were significantly superior to the fall seeded plots (methods 1, 3, and 5), and were significantly inferior to the other spring seeded plots (methods 4, 6, and 8).

Alfalfa stand analysis in intermediate wheat grass plots

All five spring seeding practices with three methods of land preparation (methods 2, 4, 6, 7, and 8), were significantly superior to the fall seeding practices (methods 1, 3, and 5). The spring seeding practices (methods 6 and 8), which were significantly superior to the fall seeding practices were also significantly inferior to the other spring seeding practices (methods 2, 4, and 7).

Table 6. Mean Range Rank of the Volunteer grasses and Grass-type Weeds Plant Counts Resulting From the Eight Methods of Land Preparation and Time of Seeding

Bromegrass plots	Mean range rank							
Methods and time of seeding	1	3	2	4	7	8	6	5
Mean number of vol. grasses per sq. yard	10	11	14	17	20	52	110	111
Statistical signif.**								

Crested wheatgrass plots	Mean range rank							
Methods and time of seeding	2	1	3	4	7	8	5	6
Mean number of vol. grasses per sq. yard	5	8	13	20	29	34	88	105
Statistical signif.**								

Intermediate wheatgrass plots	Mean range rank							
Methods and time of seeding	1	2	3	7	4	8	5	6
Mean number of vol. grasses per sq. yard	7	8	14	21	30	49	85	94
Statistical signif.**								

**Significant at 1% level

Volunteer grasses and grass-type weeds stand analysis

No attempt was made to sort out and classify the volunteering grass plants which emerged with the seeded tame grasses. With moldboard plowing as the method of tillage the common annual grass type weeds, predominately green and yellow foxtail, were prevalent. With the one-way disc plow, in spots where complete destruction of the old sod did not take place, the native perennials such as Kentucky bluegrass and Western wheatgrass were the principal volunteer species.

Where seeding was performed with the grassland drill the native perennial grasses extended their stolons and rhizomes rapidly into the ripped furrow slice. This made accurate stand counts of volunteer grasses near impossible to determine. All volunteer grasses within the distinct furrow slice were counted.

Table 6 presents the Mean Range Rank of the volunteer grass plants in the experiment.

A highly significant number of volunteer grass plants resulted from the grassland drill seedings (methods 5 and 6). This could be anticipated since the stolons and rhizomes of the standing sward adjoining the ripped furrow slice would naturally revegetate that area. This caused severe competition for the seeded tame grasses and alfalfa which were nearly eliminated as the growing season progressed.

In both the bromegrass plots and the intermediate wheatgrass plots, spring one-way disc plowing and spring seeding (method 8), resulted in significantly more volunteer grasses and grassy weeds

than moldboard plowing performed in either spring or fall (method 1, 2, and 7). This was also true compared with fall one-way disc plowing and seeding (methods 3 and 4).

No significant differences in the number of volunteer grasses were found in comparing fall moldboard plowing, fall one-way disc plowing or spring moldboard plowing and spring seeding (methods 1, 2, 3, 4, and 7).

Table 7. Mean Range Rank of the Broadleaf Weed Plant Counts Resulting From Eight Methods of Land Preparation and Time of Seeding

Bromegrass plots	Mean range rank							
Methods and time of seeding	6	2	7	8	1	5	3	4
Mean number of weed plants per sq. yard	11	13	16	22	23	28	34	36
Statistical signif.**								

Crested wheatgrass plots	Mean range rank							
Methods and time of seeding	5	7	8	2	6	1	4	3
Mean number of weed plants per sq. yard	13	14	14	15	16	16	21	23
Statistical signif.**								

Intermediate wheatgrass plots	Mean range rank							
Methods and time of seeding	7	6	2	5	8	1	3	4
Mean number of weed plants per sq. yard	10	11	12	18	19	20	29	31
Statistical signif.**								

**Significant at 1% level

Broadleaf weeds stand analysis in bromegrass plots

Table 7 summarizes the mean number of broadleaf weed plant counts resulting from the eight methods of land preparation and time of seeding.

The spring seeding practices with the grassland drill (method 6), and the fall and spring moldboard plowed plots (methods 2 and 7), had significantly fewer broadleaf weeds than the other five methods in the bromegrass plots. Significantly more broadleaf weeds resulted from the one-way disc plow method of land preparation (methods 3 and 4), and the fall grassland drill seedings (method 5), when compared with the other five methods. It was also found in the bromegrass plots that methods 1, 5, 7, and 8 resulted in significantly fewer broadleaf weeds than methods 3 and 4 but had significantly more weeds than methods 2 and 6.

Broadleaf weeds stand analysis in crested wheatgrass plots

In the crested wheatgrass plots only the fall seeding by the grassland drill (method 5), resulted in significantly fewer broadleaf weeds than any of the other methods of land preparation and time of seeding. No significant differences were found between the other seven methods.

Broadleaf weeds stand analysis in intermediate wheatgrass plots

As in the case of the bromegrass plots, significantly more broadleaf weeds resulted in the one-way disc plowed plots (methods 3 and 4), than with the other six methods. A significantly smaller number of broadleaf weeds resulted from moldboard plowing and spring seeding (methods 2 and 7), and also spring seeding with the grassland drill (method 6), than from the other five methods.

Seeding Rate Effect on Tame Grass and Alfalfa Stands

The bar chart in Figure XI shows the influence of the rate of seeding for each method of land preparation and time of seeding on the resulting stand counts of the tame grasses.

The bar chart in Figure XII compares the mean number of alfalfa plants per square yard as affected by the rate of seeding for each of the eight methods of land preparation and time of seeding.

The bar charts in Figure XI and XII are drawn to the same scale and therefore provide direct comparisons of the plant numbers per square yard for both the tame grass and the alfalfa resulting from each of the eight methods of land preparation and time of seeding.

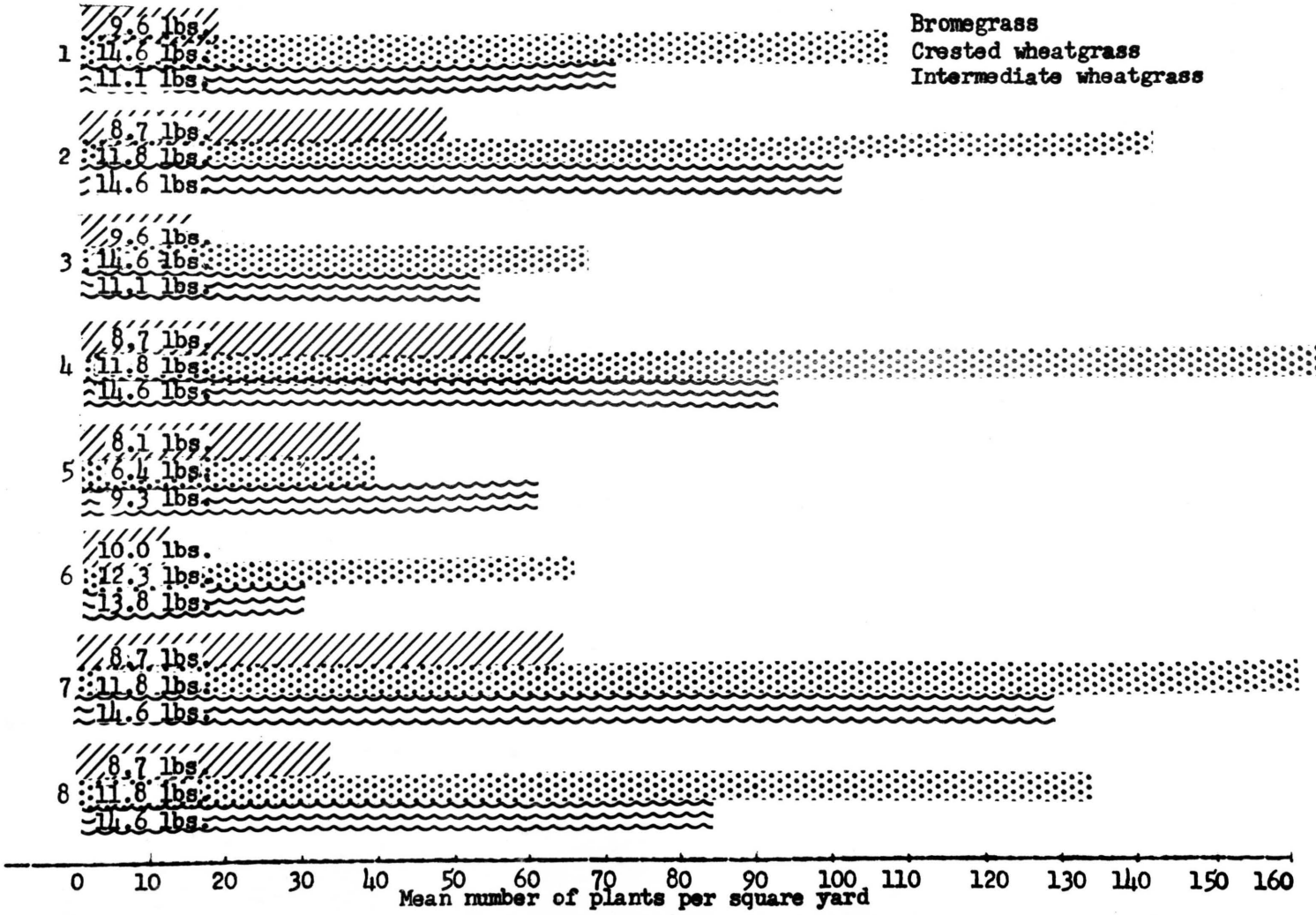

Figure XI. Seeding rate effect on tame grass stands

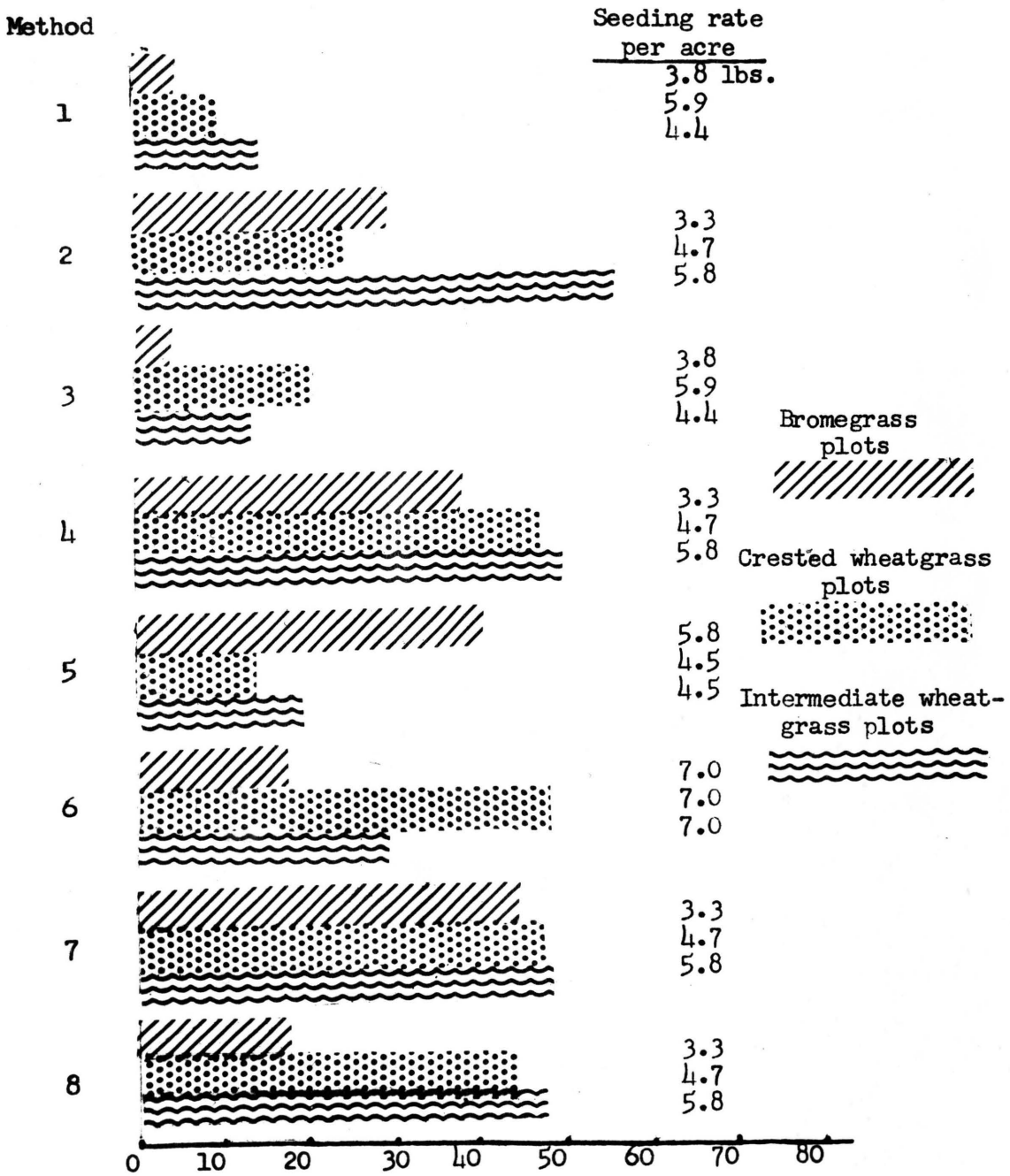

Figure XII. Seeding rate effect on alfalfa stands

Fertilizer Treatment

The fertilizer treatment of 100 pounds per acre basis of a mixed commercial fertilizer analyzing (20-52-0), applied broadcast across half of all plots in each replicate was not performed until after the stand counts were taken. Complications in obtaining spreading equipment prevented incorporating this phase into the total experiment. The fertilizer material at the rate of application as indicated above was applied on June 10, 1961.

A visual inspection of the plots in mid-August showed the following obvious effects of the fertilizer:

1. The fertilizer material had encouraged the formation of seed heads in all tame grasses while the unfertilized areas showed only an occasional seed head.

2. The growth of the broadleaf weeds was greater in the fertilized areas than where no fertilizer had been applied.

3. In the grassland drill seeded plots (methods 5 and 6), the undisturbed sward showed a much greater growth, darker green in color, and a heavy seed set on the native grasses.

DISCUSSION

Eight combinations of tillage methods and time of seeding were used in the renovation of native pasture sod to establish three different tame grasses; Bromus inermus, Agropyron desertorum and Agropyron intermedium, each in combination with a pasture type alfalfa named Teton. The typical native pasture site in the northern James Valley region of South Dakota was selected for this study. A USDA land use study of this area completed in 1959 showed nearly a half million acres of native pasture land in the nine county region were in need of re-establishment of vegetation or improved cover treatment.

The equipment selected for the renovation and seeding operations were implements most common to farms of the region to determine their suitability or adaptability to renovating and re-seeding native grass pastures to improved cover.

The criteria for establishment of an improved cover were the resulting stand counts of the new vegetation found on uniformily measured areas within each seeded plot. The stand counts were made about two months following the final seedings. This was considered sufficient time to be certain of plant establishment and to readily distinguish between species of vegetation in the cover. Four categories of plant species were selected for measurement as influenced by the eight combinations of tillage and seeding methods and the time of seeding. These included the number of plants per

square yard of the tame grasses, the alfalfa, the volunteer grasses and the broadleaf weeds.

The importance of completely destroying the existing vegetation to remove competition from the new seeding was evidenced in this study. The grassland drill as used for introducing tame grasses and legumes in rows into the turf of native sod proved unsatisfactory. New seedlings of the three tame grasses and alfalfa could not compete with the native plants of the remaining sward. It does, however, suggest a study of modifying the grassland drills sod ripping shoes by adding some type of furrow-openers to remove the sod for several inches on each side of the planted row.

Both the moldboard plow and the one-way disc plow are satisfactory implements for destroying the existing vegetation. From the standpoint of broadleaf weed emergence the moldboard plow had a significant advantage over the one-way disc plow for two of the three grass seedings in that a smaller number of broadleaf weeds emerged to compete with the new seedings. Considering volunteer grasses and grassy weeds, the one-way disc plow when used for spring land preparation had a significantly higher count of these species in two out of the three grass plots compared to fall disc plowing or when compared to moldboard plowing. Depending on the density of the existing sod and soil conditions, it may be necessary to operate a one-way disc plow with a 50 percent overlap as was found necessary in this experiment. If one is limited to the disc plow for seedbed

preparation its use is most satisfactory when operated in the fall with seeding operations performed in the early spring.

The advantages found for the moldboard plow for seedbed preparation agreed with the studies of Cotton (4), Hughes and Peterson (9), Sprague (18), Worzella (22) and Adams (1).

Considering seeding equipment, the pony press drill can be adapted to seeding mixtures of crested wheatgrass or intermediate wheatgrass with alfalfa. Bromegrass, due to its bridging tendency, would not feed uniformily through the press drill. This suggests that there is a necessity of mixing bromegrass seed with small amounts of either oats or barley to assure uniform feeding through this type of drill. This is a common practice in using standard makes of grain drills.

The calibration of the drill is a necessity to obtain a desired seeding rate. Due to the variety of species of tame grasses, the variation in seed size and the inert content of most grass seed supplies many drill manufacturers do not indicate drill settings for grass seeding. This necessitates following some calibration of equipment procedure for each grass-legume mixture to be seeded. Such a procedure is outlined in the Methods and Procedure, page 21.

By weighing the exact ratio of the grass seed to the alfalfa seed in the mixture into the drill and again weighing the remaining mixture after seeding, it was possible to calculate exact seeding rates for each plot. Even with careful calibration there were

variation extremes of 36 percent under to 46 percent over the desired rate of seeding for tame grasses.

Adequate packing or firming of the seedbed before and after seeding is an important consideration to obtaining satisfactory stands in renovated sod. Due to the high organic content of the top growth and roots of the sward incorporated into the soil considerable packing is necessary.

The ratio of stand of one tame grass to another is proportional to the rate of seeding, the number of seeds per pound and the percentage of pure seed of the respective grasses or legumes for a given set of cultural practices. This is evidenced in the high degree of uniformity in the stands of the respective grasses and alfalfa as influenced by the factors of land preparation and time seeding. Of these three major factors influencing resulting stands the effect of the seeding rate was the greatest influence.

Considering the mean stands of the three tame grasses, the spring seeding practices (methods 3, 4 and 7) were significantly superior to the other five methods of land preparation and time seeding. A near similar situation was true for alfalfa stands. The fall seeding practices (methods 1, 3 and 5) produced significantly poorer stands of alfalfa in the crested wheatgrass and intermediate wheatgrass plots and for brome plots (methods 1 and 3) were significantly poorer than the other practices. It should also be noted from the intermediate wheatgrass plots that the alfalfa

stands from the spring seeding practices (methods 3, 4 and 7) were significantly superior to the other methods as were the grass stands. There is therefore, evidence that the methods producing the best stands of tame grasses are also highly favorable to alfalfa stand establishment.

The stands of the volunteer grasses and the grassy weeds were significantly higher for all three grass varieties where the grassland drill was used than for the other six methods. In both the bromegrass and intermediate wheatgrass plots, spring one-way disc plowing and spring seeding (method 8), was significantly higher in volunteer grass and grassy weed numbers than the other methods except for the grassland drill operations.

Of the eight combinations of tillage and time of seeding methods those resulting in the fewest broadleaf weeds, which were uniform in the bromegrass and intermediate wheatgrass plots, were spring seedings (methods 3, 6 and 7). Those resulting in the largest number of broadleaf weeds for all plots were those one-way disced (methods 3, 4 and 8).

SUMMARY AND CONCLUSION

This study was conducted with two underlying questions to resolve. The first was what degree of success could farmers of the northern James Valley region of South Dakota anticipate in using their ordinary or usual farm implements for the renovation of native grass pastures? The second was what effect will the cultural practices such as methods of seedbed preparation, fertilizing, rate of seeding and time of seeding have upon the resulting stands of the introduced tame grasses and alfalfa?

What was considered a typical native grass pasture site in the region was selected in the summer of 1960. Fall tillage operations, using the farm cooperator's equipment, were performed in mid-September and the late fall seeding practices were completed in late October of that year. Early spring tillage and seeding operations were performed in mid-April of 1961. Uniform area stand counts of the tame grass, alfalfa, volunteer grasses, grassy weeds and broadleaf weeds in all plots were made approximately two months later, June 7, 8, 9, and 10, 1961.

The following conclusions are suggested:

1. It is highly important to destroy all or nearly all of the existing vegetation when renovating native pastures. The grassland drill, which was tested in this study, was not designed for this purpose. Both the moldboard plow and one-way disc plow were satisfactory with the moldboard plow having several distinct advantages.

2. If a one-way disc plow is to be used for renovation, its operation is best done in the fall with seeding performed the next spring from the standpoint of volunteer grasses and broadleaf weed emergence.

3. For spring plowing more discing operations are required to destroy the sod.

4. For seeding mixtures of grass and legume seed the pony press drill was satisfactory for both crested wheatgrass and intermediate wheatgrass but unsatisfactory for bromegrass because of the bridging tendency of that seed.

5. A pony press drill is difficult to calibrate for seeding mixtures of grasses and legumes but this should be performed to approach accurate seeding rates.

6. Because of the high organic content of the vegetative cover, adequate firming of the seedbed prior to and after seeding is highly important in obtaining stands.

7. The ratio of stand of one tame grass to another is proportional to the rate of seeding, the number of seeds per pound, and the percentage of pure, live seed of the respective grasses for any given set of cultural practices.

8. Early spring seeding for all three grasses and alfalfa, regardless of the seedbed preparation method, produced superior stands.

9. The practice of late fall seeding of alfalfa, if considered at all, should consider a seed source which is high in

hard seed content.

10. The largest number of broadleaf weeds resulted from the use of the one-way disc plow.

11. The use of a commercial fertilizer applied broadcast after the grass and legume seedlings are established will encourage the volunteer grasses and broadleaf weeds to greater competition with the new seeding. Its use should be considered either prior to seeding or possibly at the time of plowing to hasten the decomposition of the organic matter.

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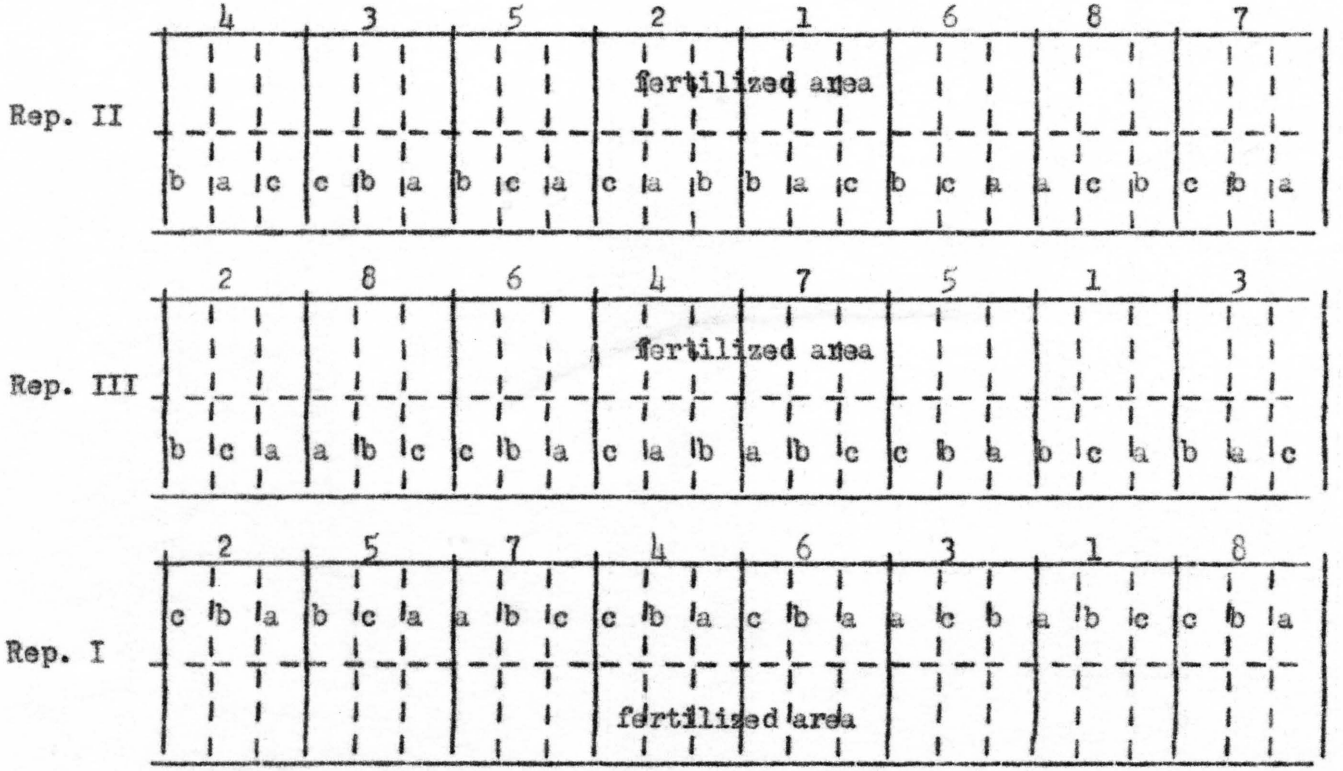
Table 8. Experimental Design



Location: S.E. ¼ of the S.E. ¼ of the S.W. ¼, Section 13, T-127, R-63
Brown County South Dakota

Direction: Seven miles west, three miles north and ½ mile west of
Houghton, South Dakota