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Alfalfa as a Field Crop in South Dakota

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BULLETIN No. 133

FEBRUARY, 1912

**AGRICULTURAL
EXPERIMENT STATION**

**SOUTH DAKOTA
STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS**

**Alfalfa as a Field Crop
in South Dakota**

By **ALBERT N. HUME AND SAMUEL GARVER**

**South Dakota Experiment Station in Co-operation with the
Bureau of Plant Industry of the
United States Department of Agriculture**

**BROOKINGS, SOUTH DAKOTA
DECEMBER 1911**

**ABERDEEN
AMERICAN PUBLISHING CO.
1912**

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SUMMARY OF BULLETIN No. 133

(1) Average yields of alfalfa hay, from several strains of seed have been produced at Brookings, which have been more profitable than average crops of wheat or corn. Such a fact augurs well for permanent, profitable farming in South Dakota. Page 260.

(2) Average yields of alfalfa hay from some strains of seed have been produced at Highmore, which were at least as profitable as average crops of wheat or corn. Such a fact augurs also well for permanent, profitable farming in South Dakota. It is also exceedingly important to know that some strains failed to withstand the conditions at Highmore. Page 267.

(3) Trials of alfalfa, by a number of co-operators in several parts of the state yielded some information. Further, very carefully conducted, long-time experiments; such as those at Brookings and Highmore, at other points will be necessary to solve alfalfa problems. Page 268.

(4) "Yellow-flowered" alfalfa apparently possesses great hardiness, which quality is of exceeding importance, especially under our more severe conditions. Page 272.

(5) Seeds of alfalfa that fail to germinate, may be improved by some process of "scratching" the hard seed coats, and such treatment is apparently beneficial to all kinds of alfalfa seed. Trials with a seed "Preparator" yielded this information. Page 281.

(6) Five species of Alfalfa. Page 274.

(7) Some earlier Bulletins, relating to Alfalfa in South Dakota, are as follows:

Bul. No. 94. Alfalfa and Red Clover. By James W. Wilson and H. G. Skinner.

Bul. No. 96. Forage Plants and Cereals at Highmore Substation, 1904-1905. By W. A. Wheeler, John S. Cole and S. Balz.

- Bul. No. 101. Forage Plants at the Highmore Sub-station, 1906. By W. A. Wheeler and S. Balz.
- Bul No. 120. Progress in Variety Tests of Alfalfa. By Clifford Willis and J. V. Bopp.
- Bul. No. 150. United States Department of Agriculture, Bureau of Plant Industry. "The Wild Alfalfas and Clovers of Siberia, with a Perspective View of the Alfalfas of the World." By N. E. Hansen.

Alfalfa as a Field Crop in South Dakota

— BY —

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— AND —

SAMUEL GARVER, (Co-operative) Assistant,

In Alfalfa Investigations.

INTRODUCTORY

Interest in alfalfa as a field crop in South Dakota is perennial, like the plant itself.

Farmers are constantly asking for facts about the crop in question, and want these facts applied to the conditions of their home farms.

The present bulletin is principally an attempt to summarize and average yields of alfalfa hay from plots that have been harvested for a number of successive years in South Dakota. These actual yields of hay per acre, averaging as many years as possible, have much practical and scientific value.

The writers are not forgetful that the alfalfa plots from which the yields of the present bulletin were taken were established in many cases, by our predecessors. Some of the yields included herein have been included in previous bulletins. In summarizing the present results, it has been sought to include the longest possible periods of time in order to find out, if possible, what may be expected one year with another, by practical farmers who attempt to produce alfalfa for hay. Much that might be written about alfalfa is here omitted and may be included in later bulletins. So far as possible, demonstrated results are put down, not many opinions.

The Agronomy Department has had considerable experience with alfalfa at two points in South Dakota, namely, at Brookings and at Highmore. Some limited tests have been carried on at other points. First, then are considered the yields of alfalfa hay from the experimental plots at Brookings, second, those from Highmore, and third, the valuable miscellaneous experiments from other places.

ALFALFA AT BROOKINGS.

The following table summarizes yields, secured at Brookings. The yields are reduced to field weight of air-dried hay, per acre.

TABLE I.
Yields of Air-Dried Hay Per Acre from Brookings,
1908-1911.

(All plots 1-10 acre in size.)

Seed	Serial Plant Introduc- tion No.	South Dakota No.	No. Plot	1908	1909	1910	1911	Average	Average tons per acre
Turkestan	12409	1	160	3500	4100	3630	1660	3223	1.5
Utah	11211	5	161	3500	4500	2190	1760	2988	1.5
French	12695	6	162	2350	3700	2450	1790	2573	1.3
Montana	12747	6	163	3700	3450	2520	2170	2960	1.5
Texas	12801	7	164	3500	3750	2610	2320	3045	1.5
N. Montana	12816	23	165	3300	3750	2620	2340	3003	1.5
Nebraska	12820	9	166	3850	3450	2970	2370	3160	1.6
New York	13291	10	167	3800	3000	3080	2150	3008	1.5
Average .....	.....	.	...	3438	3713	2759	2070	2995	1.5

Before commenting on Table I, it should be explained that the plots from which the yields were taken, were sown to alfalfa in 1906. For some reason the yields for 1907 are not now available. So far as is known, however, 1907 was not specially abnormal, and it may be safely assumed that the yields for the four remaining years, 1908-1911, are not higher than would be expected from averaging all five years, 1907-1911.

Without assuming that deductions are unalterable, the following present conclusions are drawn from Table I.

(1) For this particular experiment, there is nothing to indicate that the source of the seed used on the several plots had any great influence on yield of hay, with the possible exception of the French seed. With this possible exception, it made slight difference in yield of hay whether seed was Turkestan, Utah, Montana, Texas, N. Montana, Nebraska, or New York seed.

(2) As would be expected, the yields for the dry seasons of 1910 and 1911, are considerably reduced in comparison with the yields in other two years. It may therefore be assumed as possible, or even probable, that the average yield of all plots for four seasons is as low or lower than would normally be expected. This yield was 1.5 tons of air-dry alfalfa hay per acre.

(3) From a market standpoint alone, it is reasonable to say that 1.5 tons of alfalfa hay are worth forty-five bushels of corn, or twenty-eight bushels of wheat, both of which latter yields are far above the average for the state or nation.

(4) In connection with the series of plots under discussion it should be stated that plots number 168, 169 and 170 are not tabulated, due to the fact that they show lack of drainage. Apparently for this reason the yields were abnormally low. "Alfalfa will not stand wet feet".

THREE-YEAR AVERAGE YIELDS AT BROOKINGS.

In addition to the above series of four-year average yields, three comparable plots have been harvested for three seasons, 1909-1911, inclusive. Returns from these plots are summarized in the following:

TABLE II.

Yields of Air-Dry Alfalfa Hay in Pounds or Tons Per Acre.

Brookings.

Seed	Serial Plant Introduction No.	Plot No.	Pounds of Air Dry Hay Per Acre				Average	Tons
			1909	1910	1911			
Kansas Non-irrigated.....	19508	370	4000	2160	1480	2547	1.5	
Turkestan	20988	371	3150	2310	940	2133	1.1	
Grimm	21827	372	3250	2400	1150	2267	1.1	
Average .....	.....	...	3467	2290	1190	2316	1.1

The figures of the above table indicate:

(1) The slight advantage of the Kansas non-irrigated seed may be due to accidental causes.

(2) As would be expected the average yield of hay from the plots in 1910 and 1911 was much reduced in comparison with that of 1909, that of 1909 being 1.7 tons per acre.

(3) The average yield of air-dry hay per acre for all plots for three years is therefore in all probability below what would normally be expected, being actually 1.1 tons per acre.

(4) Nevertheless, from a market standpoint alone, 1.1 tons of alfalfa hay per acre are worth thirty bushels of corn or nineteen bushels of wheat per acre, either of which would mean a profitable crop and one above the average of the state or nation.

TWO-YEAR AVERAGES FROM BROOKINGS.

Certain tenth-acre plots of alfalfa were seeded at Brookings in 1909 and from these the yields have been recorded for the two unusually dry years, 1910 and 1911. They are summarized as follows:

TABLE III.
Yields of Air-Dry Hay in Pounds or Tons Per Acre.
(Brookings 1910—1911.)

Kind of Seed	Serial Plant Intro. No.	Plot No.	Pounds of air-dry hay per acre			
			1910	1911	Average	
Turkestan	22636	373	2940	1090	2015	1.0
French	25022	374	3010	930	1970	1.0
German	23481	375	3460	1020	2240	1.1
Sand Lucern	21735	376	3130	1000	2065	1.0
Grimm	23454	377	3430	780	2105	1.0
Montana	23203	378	2710	960	1835	0.9
.....	.....	379	2740	900	1820	0.9
Average .....	.....	...	3060	954	2007	1.0

It may be properly put down that the above yields indicate:

(1) So far as the sources of seed used in this experiment are concerned, the difference in seed has made no apparent difference in yield of hay, the latter difference being slight as an average.

(2) The year 1911, being the second year of drought, is so indicated in the low yield of alfalfa hay.

(3) However, as an average of these two trying years at Brookings, an average yield of 1.0 ton per acre of air-dry alfalfa was secured. This is a satisfactory crop in view of the fact that especially in 1911 many crops of small grain were not worth cutting.

A COMPARISON OF AVERAGE YIELDS FROM OLDER AND NEWER PLOTS, IN THE TRYING YEARS, 1910 and 1911.

Having arrived at the fact that average yields of alfalfa hay at Brookings, from these three sets of plots have been decidedly encouraging, even under conditions not as favorable as usual, it is still profitable to compare average yields from Tables I, II and III. Accordingly, the following table of average yields is compiled:

TABLE IV.

Comparison of Average Yields in Pounds or Tons of Air-Dry Hay Per Acre. From (1) Four-Year Plots; (2) Three-Year Plots and (3) Two-Year Plots.

(Compiled from Tables I, II and III.)

	1909	1909	1910	1911	Average	Average for 1910 and 1911	
						Pounds	Tons
Averages from 4-year plots	3438	3712	2759	2070	2995	2415	1.2
Averages fro 3-year plots .....	.....	3467	2290	1190	2316	1740	0.9
Averages from 2-year plots .....	.....	.....	3060	953	2007	2007	1.0
Average of all plots all years	3438	3590	2703	1404	2784	.....	.....

Not too much dependence must be put upon any comparison of these average yields, because though the three series of plots in question are on similar ground, they may not be absolutely comparable. Nevertheless, the following is noted:

(1) In the especially trying years of 1910 and 1911, decidedly the highest average yields of hay were harvested from the oldest plots of alfalfa.

(2) This substantiates the apparently good farm practice of getting new alfalfa fields as thoroughly established as possible before plowing up old ones.

SUMMARY OF FIELD EXPERIMENTS AT BROOKINGS.

Although one may not generalize too greatly from a given set of experiments, the following is strongly indicated:

(1) Even in face of some unfavorable years, which have obtained during this experiment, on sandy loam, similar to the plots at Brookings, where the water table is neither too high nor too low, there is average permanent profit for South Dakota in the production of alfalfa hay.

(2) On the basis of this knowledge, farmers are here urged to gradually extend the area of alfalfa for hay production where similar conditions obtain. The increased use of legume crops, is absolutely essential for permanent, profitable farming in South Dakota.

(3) For the conditions of this test, Turkestan, Utah, French, Montana, Texas, Nebraska, New York, (Non-irrigated), Grimm or Sand Lucerne proved equally productive of hay.

It should not be forgotten, however, that some of the strains of seed in question may prove inadequate for more severe seasons. It has been stated to the writers that similar strains of alfalfa in previous years were known to winter-kill at Brookings. The results here given apply to the test tabulated.

YIELDS OF ALFALFA HAY FROM HIGHMORE.

Certain plots at Highmore have been continuously in alfalfa since 1905. These plots have been annually harvested for hay, 1905-1911, inclusive, and all yields from these plots can here be tabulated with the exception of those for 1907, which are not recorded. It is probable that the yield in 1907 was normal and that the average yields are only a little lowered by the omission.

Turkestan seed No. 991 was brought to this country by N. E. Hansen in 1898 and Turkestan No. 13436 in 1908.

TABLE V.
Yields of Alfalfa Hay from Highmore, 1905-1911.
(Yields of plots not harvested for all years, not in averages.)

Kind of Seed	Serial Plant Intro. No.	Accession No.	Plot No.	Pounds						Average	Tons
				1905	1906	1908	1909	1910	1911		
Turkestan	991	240	B-5	3560	4132	5320	2000	540	2840	3065	1.
Oasis	12816	201	B-15	1930	Winter killed	.....	.....	.....	.....	.....	.....
Arabian	12992	202	B-16	1620	2560	3700	2200	300	1250	1938	1.0
Turkestan	13436	203	B-17a	1720	3060	3920	3660	700	750	2302	1.2
Tripoli	12847	204	B-18	1630	Winter killed	.....	.....	.....	.....	.....	.....
Average	.....	.....	.....	2092	3251	4313	2620	513	1613	.....	.....

The following deductions may be drawn from the above table.

(1) If one may conclude from the average yields of six seasons at Highmore, the strain of alfalfa seed used, under the conditions of that place, may determine success or failure.

(2) The plots sown with the two kinds of seed, Oasis and Tripoli, proved absolutely non-resistant, and winter-killed completely.

(3) "Arabian" seed, though yielding a crop of hay throughout the entire period of the experiment, yielded considerably less than Turkestan seed as an average, and this was not only true of the general average but also for the yields of the several years. In this connection however, it must be stated that the

plots of Turkestan may possibly have had some advantage in location and soil.

(4) The fact seems here well brought out that although, under the conditions of Brookings, a number of strains of alfalfa may any of them prove sufficiently hardy, of the four strains of the above test at Highmore, the Turkestan proved most able to withstand conditions, the seed having been brought from Siberia by Professor Hansen as original stock of the test above tabulated.

(5) As an average of all years, one plot of Turkestan alfalfa yielded 1.5 tons of air-dry hay per acre and another 1.2 tons, thus averaging 1.4 tons per acre for the harvests of six years.

(6) It is fair to say that a yield of 1.4 tons of alfalfa hay per acre is worth, from the market standpoint alone, as much as thirty-nine bushels of corn per acre (a profitable crop) or twenty-four bushels of wheat per acre (also a handsome profit).

(7) Naturally the average yields are much reduced, owing to the effect of drought in 1910 and 1911. (It should also be stated that a part of the hay harvested in these dry years was weeds. Nevertheless, the average quality of the hay for all years was doubtless better than would be usually marketed.)

FOUR-YEAR AVERAGE YIELDS OF HAY FROM HIGHMORE.

In addition to the preceding plots from Highmore, certain others were sown in 1907 and have been harvested since, in the four years, 1908-1911 inclusive. These four-year averages are summarized in the following table:

TABLE VI.

Four-Year Average Yields of Air-Dry Alfalfa Hay from Highmore.

Kind of seed	Accession No.	Pounds of Air Dry Hay per Acre					Average	Average tons per acre
		1908	1909	1910	1911			
Turkestan	240	4060	2000	250	1330	1910	0.95	
Baltic, South Dakota	167	3460	1800	20	1110	1598	0.80	
Baltic, South Dakota	167	2820	1960	50	1010	1460	0.73	
Baltic, South Dakota	167	2880	1600	20	930	1358	0.68	
Average .....	...	3035	1840	85	1095	1581	0.79

(1) A consideration of the above yields and averages indicate again very strongly that a proper choice of seed for Highmore conditions is a very practical consideration. Moreover, of the two strains of seed here brought into comparison, the Turkestan alfalfa has given by far the best yields. This is not only true of the average of all four years but it is true of every separate year of the four.

(3) It should not be forgotten that the years 1910 and 1911 were unfavorable and that nevertheless the Turkestan plots made a reasonable average yield of 0.94 tons per acre of air-dry hay.

In two favorable years of 1908 and 1909, the average yield of Turkestan alfalfa hay was 3.0 tons per acre.

THREE-YEAR AVERAGES AT HIGHMORE.

At Highmore certain plots seeded in 1908 have been harvested for hay three successive years, 1909-1911. These yields are as follows:

TABLE VII.

Kind of seed	No. of Plot	S. P. I. No.	Yields of Air-Dry Alfalfa Hay Per Acre—Pounds				Average Tons Per Acre
			1909	1910	1911	Average	
Kansas, Montana Irrigated..	151	19508	1650	600	2130	1460	0.73
Turkestan	150	20988	1170	550	1330	1017	0.51
German	149	21217	1230	800	1630	1220	0.61
Grimm	147	21827	1350	400	1130	960	0.48
Average .....	...	.....	1350	588	1555	1164	0.58

Needless to say the plots in these three year trials suffered exceedingly from drought in 1910 and 1911. Especially in 1911 the yields of hay from the several plots were secured from growth made by the alfalfa after the rains began in the latter part of the summer. The yields of hay although not large, are, nevertheless, not discouraging, indicating as they do the drought resistance of alfalfa, and its power to recuperate quickly after adverse conditions.

COMPARISON OF AVERAGE YIELDS IN 1910 AND 1911.

A comparison of average yields from the several plots in the several years of the tests at Highmore is put down in the

following table, with a view to discovering whether the older or the younger plants withstood drought better in the years 1910 and 1911.

TABLE VIII.

Average Yields of Alfalfa Hay at Highmore from Older and Newer Plantations for the Seasons of 1910 and 1911.

(Compiled from Tables V, VII and VII.)

	1905	1906	1908	1909	1910	1911
Average of six-year plots	2092	3251	4313	2620	513	1613
Average of four-year plots .....	....	....	3305	1840	85	1095
Average of three-year plots .....	....	....	....	1350	588	1555
Average of three and four-year plots.	....	....	....	1595	337	1325

(1) Not enough trials are included in the above table to give absolute results. It is shown however, that as an average, the older plants growing from seed sown in 1905, yielded better in the trying years 1910 and 1911 than the younger plants growing from seed sown in 1907 and 1908. This again indicates the importance of retaining established fields of alfalfa until new ones become firmly fixed.

GENERAL DEDUCTIONS FROM HIGHMORE YIELDS.

(1) As an average of six years, 1905-1911 (omitting 1907) plots of Turkestan alfalfa, on suitable soil yielded an average of 1.4 tons of air-dry hay per acre. The data are not cited to prove the superiority of any given variety, but rather to indicate that alfalfa may be depended upon, with proper selection and care, to yield permanently profitable crops, under average conditions, at Highmore.

MISCELLANEOUS TRIALS WITH ALFALFA IN SOUTH DAKOTA.

In addition to yields from alfalfa plots, from which average yields have been secured for two or more successive years, some more or less isolated yields are recorded which furnish information of value. Moreover, some observations have been made upon the growth of individual plants that have yielded knowledge. Some of these miscellaneous notes come, not only from the experiment fields at Brookings and Highmore, but also from the sub-station field at Cottonwood and from several co-operative points.

Co-Operative Trials of Alfalfa, Made By Co-Operators at Several Points in South Dakota.

Trial Number	Post Office of Co-operator	Type of Soil	Previous Crop	Nurse Crop	Date of Sowing 1909	Stand Secured 1909	Spring Stand 1910	Uniformity of Stand 1910	Vigor of Growth 1910	Amount of winter Killing 1910-11	Late Spring Stand 1911	Estimated Yield Per Acre 1911	Remarks
1	Lebanon	Clay loam	Corn		May 21	100	75	Spotted	Varies				Sown on spring plowing
2	Beresford	Yellow clay	Corn	No	May 17	55	75	Good	Satisfactory	Small	Good	1 3/4 ton	Sown on spring plowing
3	Highmore	Loam	Corn	No	May 20	90	Good	Good	Strong			1/2 T. hay-3 1/2 bu.	Sown on corn ground
4	Ipswich	Clay loam	Oats - Potatoes	Yes	May 27	95	99	Good	Strong	Small	Too thick	3/4 ton (seed)	Sown on spring plowing
5	Lake Norden	Clay loam	Potatoes		May 29	65	Thin						Sown on fall plowing
6	Pierre	Sandy loam	Wheat		May 26	100							
7	Hiland	Sandy loam	Wheat		May 25	95	100	Uniform	Strong	20 per cent			Sown on spring plowing
8	Cresbard	Dark loam	Alfalfa	No	June 10	100	Good	Good	Quite Strong	4 per cent	Good	Small	Sown on spring plowing
9	Yankton	Sandy loam	Corn		May 21	95-100	100	Good	Strong				Sown on corn ground
10	Rapid City	Loam. Small per cent	Oats	No	June 29	80-85	Good	Good	Quite Unif'm			No crop	
11	Oacoma	Clay loam	gumbo Corn		May 28	80							Sown on spring plowing
12	Pierre	Black loam - some gumbo	None		May 28	95	90-150	Uniform	Strong				Sown on spring plowing
13	Draper	Clay loam - hard pan	Oats	No	May 27	95-98	95-98	Uniform	Strong	Small	Good	No crop	Sown on spring plowing
14	Fedora	Clay loam and loam	Oats		June 2	100	100						Sown on spring plowing
15	Reliance	Sandy loam	Corn		June 1	75	75	Good	Good	Small	Thin		Sown on spring plowing
16	Ipswich	Black loam	Barley		May 31	100	100						Sown on spring plowing
17	Redfield				May 16	Good	Good	Fair	Strong				
18	Kidder	Clay loam	Barley		June 3	100	100			Small		1 ton	Sown on spring plowing
19	Redfield	Clay loam	Alsike C	No	June 3	100	100						Sown on fall plowing
20	Sioux Falls	Sandy loam	Cats		June 3	100	100						Sown on fall plowing
21	Frankfort	Dark loam	Potatoes		May 20	75	75			2 per cent by	Good		Fall plowing. High land
22	Spencer	Sandy loam	Wheat	No	June 10	100	100			0 (count)		No crop	

TABLE XI.

Germination Tests of "Scatched" and "Unscratched Alfalfa Seed. Figures Indicate the Total Percent of Seeds Germinated on the Given Days in the Several Tests.

S. D. Accession Number	Species Medicago	Strain	Number of Days Since Beginning of Test																																	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31			
35	ruthenica	Gebi Desert	U	1	3	9	9	20	20	23	38	40	43	46	50	51	51	51	51	54	55	55	55	55	55	55	55	55	55	55	55	55	55	55		
			S	7	27	85	96	97	98	98	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	
36	sativa	Turkestan	U	5	13	65	85	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89		
			S	5	32	84	94	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
*23454	sativa	Montana	U	0	9	55	84	92	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93		
*21735	sativa	Grimm	U	16	29	57	85	98	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
			S	2	9	53	77	91	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92
*23481	media	Sand Lucerne	U	10	36	79	90	93	95	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	
			S	3	19	71	84	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88
54	media	North Sweden	U	3	19	62	78	86	91	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	
			S	7	13	45	71	76	82	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
41	falcata	Omsk	U	0	3	7	11	22	29	36	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	
			S	0	0	2	8	13	14	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
42	falcata	Obb	U	2	6	15	27	42	56	72	75	80	83	84	84	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88
			S	1	1	3	14	22	34	45	49	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
47	falcata	Kharkov	U	0	5	29	42	43	50	56	58	58	64	65	74	74	77	77	77	77	77	77	77	77	77	77	77	77	77	77	77	77	77	77	77	77
			S	0	1	2	9	19	33	47	54	56	63	79	80	80	80	81	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
49	falcata	Samara	U	2	3	4	6	16	21	41	44	44	48	48	50	53	53	56	57	60	60	64	64	64	66	67	67	68	68	68	68	68	68	68	68	68
			S	0	0	0	1	4	9	29	30	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
56	falcata	Stadkoff	U	1	6	16	30	33	38	40	42	42	48	51	52	53	53	53	53	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54
			S	0	4	7	14	21	28	30	32	32	33	33	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
61	falcata		U	2	8	16	30	31	34	48	49	51	66	66	72	73	74	75	78	78	79	80	82	84	84	85	86	86	86	86	86	86	86	86	86	86
			S	2	7	11	12	15	17	21	22	22	30	37	45	47	48	48	49	53	53	53	53	54	54	56	57	57	57	57	57	57	57	57	57	57
Average	sativa		S	9 3/4	32 3/4	75 1/4	91 3/4	98	99 3/4	91 1/2	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	
Average	media		S	6 1/2	27 1/2	70 1/2	84	89 1/2	93	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	
Average	falcata		S	1 1/2	5 1/2	14 1/2	24 1/2	31 1/2	38	48 1/2	55 1/2	61 1/2	63 1/2	67	68 1/2	69 1/2	70	71 1/2	71 1/2	72 1/2	73 1/2	73 1/2	73 1/2	75	76	77	77	77	77	77	77	77	77	77		
			U	1 1/2	2 1/2	4 1/2	9 1/2	15	22 1/2	31 1/2	37 1/2	38	42	46 1/2	48 1/2	49 1/2	50	51	52 1/2	53 1/2	53 1/2	53 1/2	54 1/2	54 1/2	55 1/2	56	56	56	56	56	56	56	56	56		

*S. P. I. No.

At Highmore during six years 1899-1904 inclusive, a series of trials were conducted, with three kinds of alfalfa seed, namely, Turkestan, French and Samarkand (in Turkestan). Four of the plots were seeded with Turkestan seed and one with each French and Samarkand. The yields secured from this series of plots were so irregular that they cannot properly be averaged and are hence not tabulated. It is important to know, however, that whether or not the plots were strictly comparable, the plots of Turkestan lived and made yields of hay in the year 1904, whereas the records of that year show that the plots of French and Samarkand were "winter killed." This not only points again to the fact that not all varieties and strains of alfalfa may be equally hardy for South Dakota conditions, but also that Turkestan compares favorably, all in all, with a number of other strains in this respect.

In 1906 at Highmore, yields are recorded from sixteen "square-rod" plots. Seven of these were sown with ordinary commercial seed. The average yield of hay from these in 1906 was 0.91 tons per acre. Two of the plots were put in with "Grimm" seed and these averaged 1.08 tons per acre. Three Turkestan plots averaged 1.25 tons per acre, one plot of Baltic, S. D., 1.67 tons, one plot of Wyoming seed 1.04, one of Montana 0.88 tons, one of Arabian 1.28 tons.

Some Tests of Hardiness.

In a later section of this Bulletin, it is explained in some detail that there are five general kinds of alfalfa that may be considered of importance from the standpoint of field crops.

1. *Medicago sativa*, common alfalfa.
2. *Medicago falcata*, yellow flowered alfalfa.
3. *Medicago media*, supposed to be a "cross."
4. *Medicago ruthenica*, a low-growing type.
5. *Medicago platycarpa*, with flat pods.

Within each of these general kinds are a number of "strains," a fact which one should keep in mind while making studies of alfalfa.

In the season of 1910-1911 the South Dakota Experiment Station, in co-operation with the Bureau of Plant Industry of the United States Department of Agriculture, made some studies, the results of which have some bearing upon the relative

hardiness of the several kinds and strains of alfalfa. It is desired here to put down these results without attempting to deduce general conclusions therefrom.

Plan of Tests of Hardiness.

In November, 1910, numerous alfalfa plants of the several strains and species, which had previously been grown from seed, were taken up and re-set. Some of these plants were re-set at Brookings, some at Highmore, some at Cottonwood. The various species of these plants, the strains, the numbers set out, and numbers surviving, are summarized in the following:

TABLE IX
Percentage of Alfalfa Plants of Several Species and Strains.
Surviving Winter 1910—1911.

Species of Alfalfa	Serial Plant Intro.	S. D. No.	Plants Reset at								
			Brookings			Highmore			Cottonwood		
			Live Plants 11-10	Plants Surviv- ing 4-11	Per cent Surviv- ing	Live Plants Set 11-10	Plants Surviv- ing 4-11	Per cent Surviv- ing	Live Summer 1910	Plants Surviving 4-11	Per cent Surviving
M. Sativa...	20711	36	238	231	97.4	112	15	13.3	46	00	0.0
M. Media...	20571	54	256	252	98.4	119	85	71.4	100	1	1.0
M. Media...	20714	38	497	488	98.1	111	18	16.2	38	0	0.0
M. Media...	20716	39	298	287	96.6	74	20	27.0	19	0	0.0
M. Falcata...	20718	40	318	305	95.9	148	144	97.3	194	63	32.4
M. Falcata...	20719	41	245	242	98.7	323	323	100.0	...	...	...
M. Falcata...	24452	42	771	771	100.0	185	182	98.3	95	4	4.2
M. Falcata...	20724	43	39	39	100.0	...	...	...	...	...	...
M. Falcata...	24454	61	501	501	100.0	...	...	...	...	...	...
M. Falcata...	20720	46	65	65	100.0	...	...	...	...	...	...
M. Falcata...	24456	62	61	61	100.0	...	...	...	...	...	...
M. Falcata...	20725	46	259	259	100.0	354	334	94.3	322	17	5.3
M. Falcata...	20717	47	265	264	99.6	355	344	96.0	314	8	2.5
M. Falcata...	20726	48	311	311	100.0	...	...	...	...	...	...
M. Falcata...	20721	49	261	257	98.4	350	297	84.8	244	20	8.2
M. Falcata...	20722	50	250	244	97.6	286	245	85.6	...	...	...
M. Falcata...	24455	51	322	322	100.0	...	...	...	...	...	...
M. Falcata...	24453	63	56	56	100.0	...	...	...	...	...	...
M. Falcata...	.....	55	193	188	97.4	291	291	100.0	...	...	...
M. Falcata...	.....	56	238	237	99.5	75	72	96.0	...	...	...
M. Ruthenica	24451	35	511	403	78.8	62	51	82.2	18	3	16.6
M. Platycarpa	24457	37	223	162	72.6	...	...	...	...	...	...

It should be noted that the plants were re-set at Brookings in July, 1909, and at Highmore and Cottonwood in May and early June, 1910. One may, therefore, not make direct comparisons as between the three places. In this connection, it is not surprising that many of the plants at Cottonwood perished under the conditions of the past season, but it is gratifying that a good many of the plants did live.

Moreover, the results from the several strains of the species are consistant enough so that in order to get the statement of general facts, it is fair to average the per cents of the strains. This is done by the following table:

TABLE X
Average of Alfalfa Plants Surviving from the Several Strains in the Species:

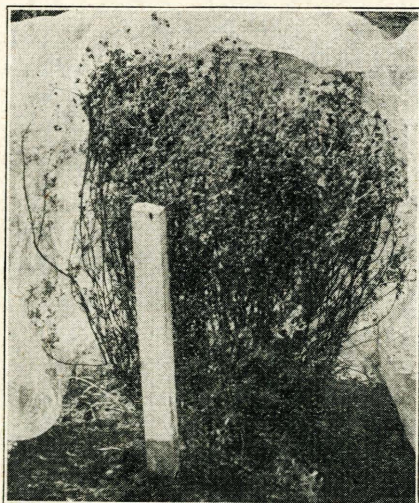
Species	Average per cent of plants surviving, found by averaging the per cents of all separate trials			
	Brookings	Highmore	Cottonwood	Average
M. Sativa.....	97.4	13.3	00.0	36.9
M. Media.....	97.7	38.2	00.3	45.4
M. Falcata...	99.2	94.8	10.5	68.2
M. Ruthenica.	78.8	82.2	16.6	....
M. Platycarpa	72.6	....	....	....

(1) The above averages substantiate the general conclusion reached from the yields of hay from the several plots at Brookings, namely, that almost all strains of alfalfa tried at that place were sufficiently hardy to withstand the conditions of the test recorded.

(2) In this one trying season, 1910-11, at Highmore, a far greater percentage of *Medicago falcata* plants that were re-set, survived than of *sativa* or even *media*.

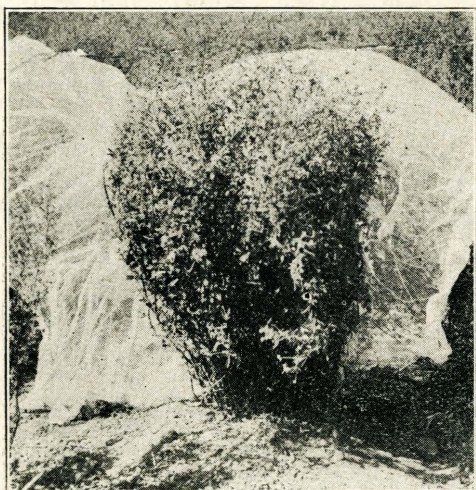
(3) At Cottonwood, of all the plants re-set, practically the only ones to survive were either *M. falcata* plants or *Medicago ruthenica*. Delay in resetting however, combined with extreme drought, made the test at Cottonwood exceptionally severe.

(4) It would seem safe to conclude that not all alfalfa plants are equally hardy, and as a corollary that although nearly any strain may produce good yields of hay under the more favorable conditions of South Dakota, it may be necessary to search diligently for strains that will prove profitable under the most rigorous conditions of our state.



F. C. I. No. 5968

A close ascending plant of *Medicago Media*. One of Professor Hansen's Chernos. A good seeder.



F. C. I. No. 5938

A fine plant of *Medicago Sativa*.
Turkestan alfalfa

Description of Species of Alfalfa.

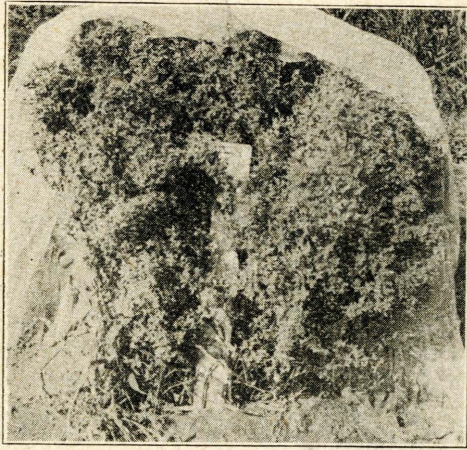
The South Dakota Agricultural Experiment Station has under field test at the present time, five species of alfalfa which are as follows: *Medicago sativa*, *Medicago media*, *Medicago falcata*, *Medicago ruthenica* and *Medicago platycarpa*.

Medicago sativa. The *Medicago sativas* comprise a group of alfalfas, an example of which is our ordinary alfalfa. This plant is a perennial and has a long tap root that often extends many feet into the ground. In general, the flowers are borne in racemes, the pods are coiled and the stems are erect and slightly hairy. The stems also show a tendency to woodiness when old, and are inclined to be four-angled. The flowers approach a violet in color.

The common alfalfa is a native of the warmer parts of Southern Asia from the northwest frontier of India to the shores of the Mediterranean. As to the bounds or the extent of this area, there is a considerable difference of opinion among botanists. The growth of this plant has been extended over all of Southern Asia, into Northern Africa and Southern Europe, thence to nearly all known portions of the world where this type of alfalfa is able to withstand climatic conditions and soil is favorable. This is at present the best known species of alfalfa.

Medicago falcata. *Medicago falcata* has a very wide distribution over Europe and Asia, but in the milder sections of this territory it is not of such great value because the *Medicago sativa* can be grown successfully. The name "falcata" refers to the sickle shaped seed pods that are found on this type of alfalfa.

As regards erectness and general shape of plant, there are very marked variations among the *Medicago falcatas*. The type varies from a spreading to an erect form. There are decided variations in the number, size, quality, shape and color of the leaves. The flowers of this species are uniformly yellow and are borne on racemes of from five to twenty flowers on each raceme. The pods are crescent shaped and turn brown when ripe. Between strains there are variations in size of seed, in shape of seed, and in the tightness with which the pods hold the seed. In the nursery work at Brookings, it is found that the plants vary strikingly in the abundance of seed produced.



F. C. I. No. 5925.

An outstanding good plant of *M. Falcata*. Erect.
Many leaves. Good seeder.



F. C. I. No. 5924

A good plant of *Medicago falcata*—Yellow flowered
Alfalfa. This one was a good seed producer.

The outstanding quality of this type is its hardiness—its ability to withstand cold and drouth.

Medicago media. The *Medicago media* is supposed to be a natural hybrid of *Medicago sativa* and *Medicago falcata*. It

is found that where these two species overlap, in Europe and Asia, the natural hybrids are more numerous than elsewhere. It is also found that the hybrid form is found further north than the *Medicago sativa*, which is an indication of greater hardiness of the hybrid.

The type of plants are, as a rule, intermediate between the *Medicago sativa* and *Medicago falcata*, partaking of characters common to both species. Variation is found in color of the flowers of the *Medicago medias*, varying from a pale yellow to green and yellow. The seed pods are spiral, but not so tightly twisted as in *Medicago sativa*.

Medicago ruthenica. *Medicago ruthenica* is a type of alfalfa found naturally, extending from the east shore of Lake Baikal, Asia, to the Pacific ocean. In Siberia, it extends as far south as Manchuria, Mongolia, Korea and Northern China. The seed of the type under test at the South Dakota Experiment Station was obtained from Charonte, which is in an arm of the Gobi Desert of Manchuria, a region of small rainfall.

The size of this plant is about equal to that of the spreading type of the *Medicago falcata*. The seed pods are flat and oval, tapering toward both ends, and each containing, as a rule, not over four seeds. The leaves are small and narrow, but quite numerous.

Medicago platycarpa. This type of alfalfa may be found in Central Siberia, growing along edges of forests and in timber clearings.

Medicago platycarpa is a perennial. It has yellow flowers and large flat pods. The stems are hard and smooth and almost trailing. In size, the plant is about the same as that of the spreading *Medicago falcata*.



ALFALFA NURSERY, BROOKINGS

Some *Medicago falcata* plants are of a low, spreading type.

Some are quite erect.

Co-Operative Trials.

In the spring of 1909, small quantities of imported Turkestan alfalfa seed were sent to over forty farmers in different sections of the state. This seed was sown in plots without a nurse crop in nearly every case, and received such care as the farmers were able to bestow. The results obtained were results from a great variety of conditions, and the results of many kinds of care. Successful stands of alfalfa were secured in many sections of the state. From a number of farmers no reports were received and two farmers reported total failures. Explanations of these trials is condensed into the table which is placed on pages 268-9.

Conclusions are not attempted from the data of the above table. The table may serve, however, as an illustration of the varying degrees of success which may be attained with alfalfa growing under varying conditions of soil and climate.

Results of Germination Tests

Made with

ALFALFA SEED

—From—

Several Different Species and Several Different Strains

Already in this Bulletin has been given resume of the five so called species of alfalfa commonly grown. Suffice it at the present point to say that it has been occasionally urged that some strains of alfalfa seed germinate with difficulty. For instance, it is the understanding of the writers that the Grimm alfalfa seed is popularly supposed to have rather a poor germination capacity. It has been occasionally urged that the yellow-flowered alfalfas also yield seed of very difficult germination.

The writers, accordingly, have considered it worth while to arrive at some definite information relative to this point.

The difficult germination of the seed of some alfalfas has been attributed to so-called "hard seeds." By this latter term, it has been understood that seed coats of the seed in question have been extraordinarily thick so that under conditions which would make normal seeds germinate and grow, these have been unable to absorb moisture and to break the thick seed coats and take on processes of germination and growth. The studies made by the writers are adapted so far as possible to answer the following questions: (1) Do some varieties and strains of alfalfa germinate and grow with more difficulty than others? (2) If so, which varieties germinate most readily and which least readily? (3) If some varieties and strains germinate with difficulty, what may be done practically to increase the ease of germination? (4) May it be possible to treat all varieties and strains of seed, even those that commonly germinate readily so that they will grow better than ordinarily?

With a view to answering these questions, duplicate samples of twelve different "strains" of seed were selected, each sample containing one hundred seeds for germination. These samples were of four different species as follows:

One sample of *Medicago Ruthenica*.
 Three samples of *Medicago Sativa*.
 Two samples of *Medicago Media*.
 Six samples of *Medicago Falcata*.

One of the duplicate samples was passed through a machine known as a "Preparator." The other sample was left untreated. In table X the samples which were passed through the preparator are called "scratched." Those not so treated are called "unscratched." These are indicated throughout either by the letter "S" or by the letter "U."

It should be explained that the so-called "Preparator" is the machine devised by Dr. Nilsson, the director of the experiment station, Svalof, Sweden, and in use there. The particular machine used by the writers in making the present trials was brought to America by Professor N. E. Hansen, Horticulturist of the South Dakota Experiment Station. Credit is here given to Professor Hansen for having suggested to the writers that some such treatment of seed as that herein described might prove to have not only scientific but practical significance.

The machine consists essentially of a hopper for holding seed, so arranged that seed may run through it and drop upon a revolving disk, to be thrown by centrifugal force against the concave surface of a circular, rough stone, within which the disk revolves. The revolving disk is turned by the revolutions of a crank wheel belted to a similar wheel.

The philosophy of the process of treating seed through this "Preparator," is that the seeds rebounding from the disk and striking the rough stone surface, have their seed-coats indented or scratched and thereby weakened slightly so that the seed may more easily absorb water, and the seed-coat may be more easily broken by the expanding germ when the seeds are subjected to conditions which promote growth.

The seeds used in the tests of Table XI were germinated by ordinary methods which need hardly be described here except very briefly. One hundred seeds were placed between moistened blotters which were in turn laid between ordinary dinner plates in order that the blotters should not lose moisture too rapidly by evaporation. The seeds thus subjected to conditions of moisture and room temperature, were allowed to sprout and grow. Each day the number germinated were counted and re-

moved. The tests were continued usually for some days after the period when no more seeds would germinate. Eventually, the total number of seeds germinated out of one hundred on any particular day would indicate the percentage of germination up to that time. These percentages are tabulated in table XI, pages 268-9.

Conclusion from Table XI.

A study of results tabulated in table XI show certain interesting comparisons. Among these is the fact that from a comparison of the total percents of germination of seed samples marked "S" and "U," of each strain, shows that in all cases but one (South Dakota accession number 47) the scratched seed gave a higher total percentage of germination. Furthermore, in all cases but this one, the scratched seed reached its complete germination as early or earlier than the unscratched seed. In other words, the scratched seed germinated quicker as well as better than the unscratched seed. The lower part of table XI shows the results of averaging all tests of the several species.

From these one may get the following comparisons:

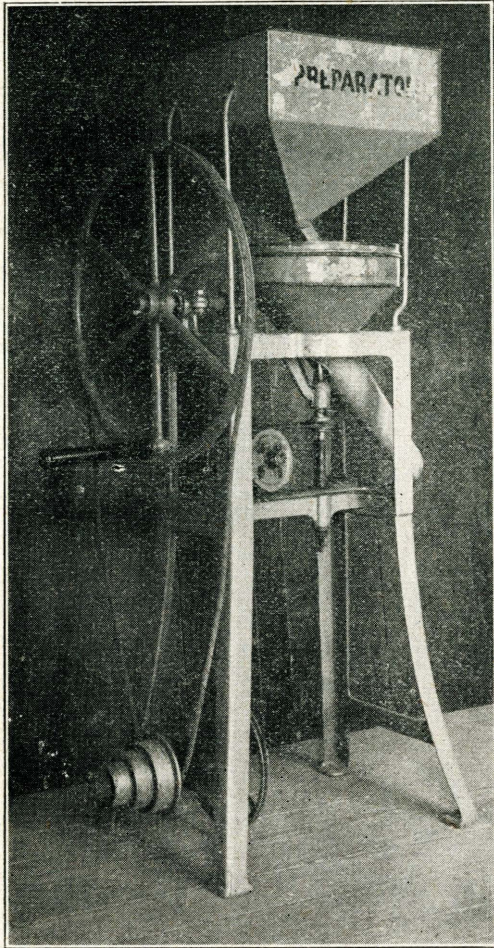
Average Per cent of Germination.

	Medicago sativa	Medicago media	Medicago falcata
Scratched	99 1-3	94 1-2	81 1-4
Unscratched	91 1-3	86 1-2	62 3-4
Per cent difference in favor of scratched seed	8	8	18 1-2

In answer to the general questions which were attempted by this investigation, the above facts may fairly lead to the following conclusions: (1) The ease and quickness of germination of the three species of alfalfa ranks in the following order: First, Medicago Sativa; second, Medicago Media; third, Medicago Falcata.

(2) The completeness and the quickness of germination of all kinds of alfalfa seed appears to be increased by such treatment as was given by the "Preparator."

Practically speaking, it seems to be indicated by these results that the yellow-flowered alfalfa seed germinates with difficulty as compared with Medicago media and especially Medicago sativa. Some processes of treatment which will scratch the seed coats of this variety would therefore be beneficial and apparently might be exceedingly practical. The idea of thus treating seeds, especially of legumes, has long since been utilized in Europe, is not entirely new in this country, and is apparently worthy of further study.



THE "PREPARATOR"

Works upon the principle of scratching the seed-coats
of Alfalfa and other seeds, thus aiding
germination.