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Sorghums for Forage and Grain in South Dakota

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Rows of Varieties and Strains
Sorghum Breeding Nursery—Bagged for Selfing and Crossing
(Photo by Hutton and Franzke)

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Summary of Bulletin

It is at once attempted to summarize this bulletin and answer outstanding questions which may be asked by growers and others about sorghum in South Dakota:

1. Is sorghum worth considering as a grain or forage crop in South Dakota?

Yes—more for forage than for grain.

2. Why more for forage than for grain?

Because generally South Dakota growers get as much or more grain from planting corn than from planting sorghum. In long time comparative trials reported in this bulletin where yields of grain from any kind of sorghum were measured against yields of grain from corn, the latter came out either nearly equal to or higher than sorghum in grain produced. Summary Table 13, page 44.

The contrary is true with respect to efficiency of the two crops for forage production. Wherever comparative trials are reported in this bulletin between forage production from sorghum and corn, the maximum yields from sorghum were as high or higher than those from corn.—Summary Table 13, page 44.

3. What variety of sorghum would be best to produce?

A variety that will produce the highest amount of forage of good quality—incidentally bear seed enough to reproduce the crop year after year. Such a variety might be one of the following:

Sudan (grass sorghum)
Dakota amber
Feterita
Early Sumac
Kafir corn (Western Blackhull)
Early White Milo, FCI 5886
Sooner Milo
Grohoma

Table 9, page 37
Table 15, page 47
Table 16, page 48
Table 17, page 51
Summary page 56

4. Where in South Dakota are the conditions relatively most favorable for sorghum growing?

In the area represented by Cottonwood Experiment Farm west of the Missouri.

This assertion is based upon the apparent fact that the production of both grain and forage from sorghum in that area is higher in relation to production from corn than in other areas, whether in central South Dakota at Highmore, north-central at Eureka, or eastern at Brookings.

Especially in the latter places it appears that sorghum in cropping systems should serve as an important supplement to corn rather than as

a substitute therefor. It would seem that wherever yields of sorghum for forage are only equal to or slightly higher than corn (as in central and eastern South Dakota) they may nevertheless be high enough to warrant using them either in mixtures with corn or by planting unmixed in a partial area. Table 13, page 44.

5. What conditions then might make it desirable to supplement corn with sorghum?

Prospective drought or grasshoppers, for the reason that all varieties of sorghum are relatively able to withstand these conditions.—(Sorghum interspersed with corn at Vivian Exp. Farm, page 45.)

6. How does one cultivate and handle sorghum?

Either in single or double drill rows with subsequent cultivation like, corn, or in close drills (or broadcast) like small grain. —Page 19.

At Eureka and Cottonwood higher yields of forage were secured from the method of planting either sudan or other kinds of sorghum in single or double rows for subsequent cultivation than seeding in close drills. The choice of seeding thus in drill rows 42 inches apart or close might depend upon whether later cultivation might or might not seem economical.—Table 7, page 33. Table 1, page 16.

7. How much seed of sorghum is required per acre?

About 4 to 12 pounds per acre when seeding is made in cultivated rows up to 50 pounds per acre when seeded in solid drills or broadcast. One advantage of seeding in drills for subsequent cultivation is obviously the saving of seed in the original application. —Page 14.

8. Is there danger from "sorghum poisoning"?

Yes.

Various varieties of sorghum, usually under conditions where normal growth is interferred with, may be harmful or fatal to livestock, especially mature cattle. Investigations of this matter are under way cooperatively with the departments of Animal Husbandry and Animal Health; results to be published later. Suffice it to say here that injury to livestock by **sorghum poisoning from the use of sudan unmixed with other sorghums has occurred rarely or not at all.**

Sorghum poisoning has not occurred from the use of silage made out of any kind of sorghum, either pure or in mixture with corn, so far as reports have come to this department.

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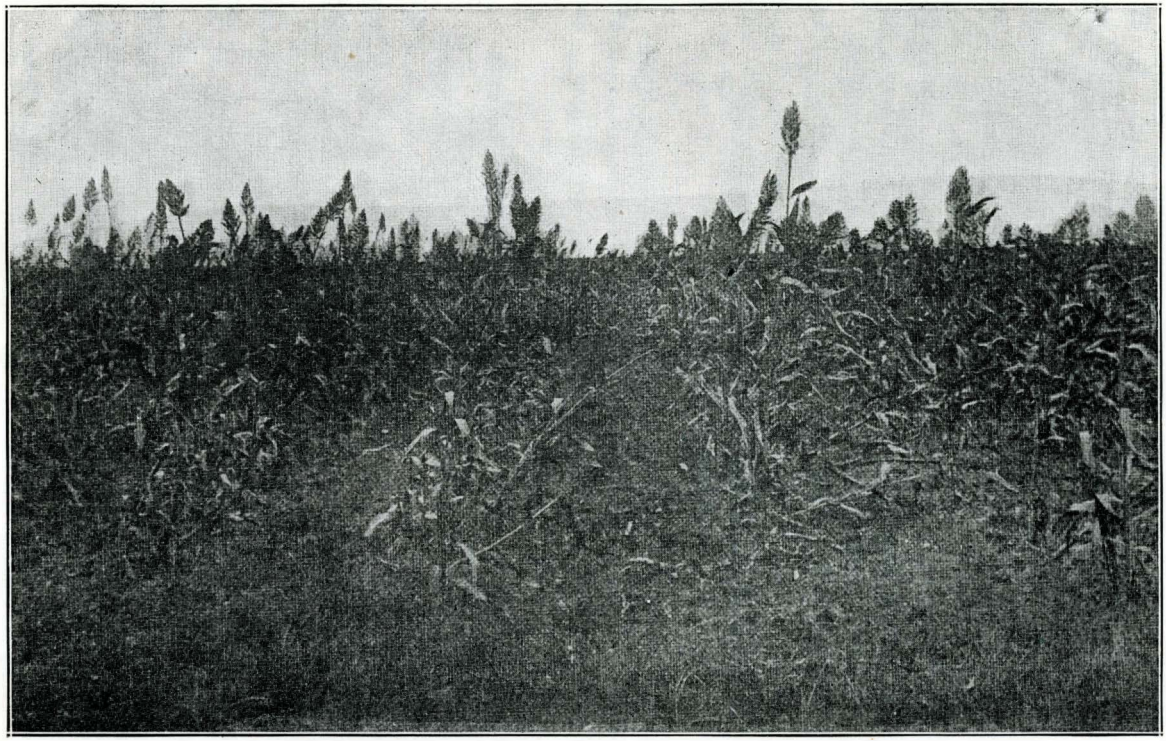
Grain and Forage from Sorghums at Highmore Experiment Farm

Grain and Forage from Sorghum and Corn at Brookings



Kaoliang, Cottonwood Experiment Farm, 1912. Kaoliang is considered to be a "grain sorghum" producing fodder of poor quality, woody, and not sweet.

Sorghums for Forage and Grain in South Dakota

By

A. N. Hume and Clifford Franzke

Numerous inquiries are made concerning the production and use of sorghum in seasons when these crops may be found relatively resistant to drought and insects, especially grasshoppers. It is attempted to give information which may lead to larger utilization of sorghums of one or another variety in regular cropping systems. In some instances sorghum may displace corn as a cultivated crop in rotations, but in a far greater area of South Dakota sorghum will be utilized as a supplement to the corn crop, especially when the latter is employed for forage or ensilage.

The observations and data put down in this bulletin may indicate that sorghum can serve to stabilize crop production under the conditions of farming in South Dakota as well as in other portions of the Great Plains area. Any crop which will stabilize production at a reasonably high level will prove valuable to that extent.

The South Dakota acreage of sorghum in 1930 was about 69,000 of which 54,000 was sudan. In 1933 the estimate had increased to 166,000, the rise in acreage due largely no doubt to unfavorable cropping conditions (including grasshoppers) which nevertheless could be resisted by sorghums better than by other crops. This increase was due largely to increased planting of sorghums other than sudan. (Crops and Markets Monthly, United States Department of Agriculture.)

The Place of Sorghums in South Dakota Farming

The use of sorghums of several kinds may be stated very briefly by saying that they may serve the purpose of being supplementary to corn for all the purposes for which corn is used in farming systems with one or two additional. These uses of sorghum might be summarized as follows:

Use for Kind of Sorghum Indicated	Name of Kind or Kinds of Sorghum Recommended
Hay and pasture	Sudan grass
Grain to supplement corn or for feeding alone	Kaoliang, Feterita, some selections of Milo, Amber Cane (limited use).
To harvest for dry fodder or make silage	Amber cane, Feterita, Milo (some hybrid strains), Kafir, Sudan.

The supplementary position of various sorghums with relation to corn has always been accepted by growers and others; it need not be over emphasized. In the years previous to 1917 when this department published Experiment Station Bulletin 174 "Sorghums for Forage" much interest was taken in the crop from the standpoint of introduction by growers. This interest resulted from studies of varieties and types introduced at the experiment farms at Brookings, Highmore, Cottonwood, Eureka, and from introduction of seed and cooperative trials made in various places throughout the state. Results were published in bulletin 174 relating to trials which were begun as early as 1912 at Eureka, Brookings, Highmore. Experimental trials were introduced at Vivian in 1915. At the latter place it was possible to make silage out of several varieties and make general observation of the utility of different sorghums for that purpose.

The early interest in the growing of sorghums may be said to have abated somewhat following the year 1917 with possibly some reduction in area of sorghum varieties. Exact acreages of sorghums produced in South Dakota by years are not available. It is, however, reasonably certain that some varieties of sorghum were much reduced in area for the reason that it proved impossible even to purchase seed of a number of them in South Dakota in the year 1930. In that year additional interest in sorghums was revived especially through the observed fact that all varieties of sorghum were relatively resistant to ravages of grasshoppers.

Dakota Amber and Sudan Grass Became Established

The outstanding general result which the foregoing work with sorghums brought about in relation to South Dakota farming was the establishment of at least two kinds of sorghum as secondary crops frequently used in farming systems. These were Dakota amber and sudan grass. The former had long been known to residents who came from other states, and although it has never been produced on a large scale it has been recognized and frequently produced over our entire area. Moreover, sudan grass has steadily become more firmly established as a pasture and hay crop in South Dakota. Its merits have been recognized as well as some of its minor shortcomings. Sudan grass was early recognized as a substitute for some kinds of millet where that crop had been previously utilized. The ease of culture of sudan and its high nutritive value, taken along with its ability to produce high yields, made it a standard crop for South Dakota. The introduction and dissemination of sudan was a contribution to South Dakota agriculture.

Classification

It is difficult to make an exact classification for all varieties and types of sorghums, if not altogether impossible, one principal reason being that all varieties and types are easily cross-fertilized so that they become mixed. Piper points out in his book (Forage Plants and Their Culture, MacMillan Company) that no other cultivated crop exhibits as great diversity as does sorghum.

Nevertheless, it is easy to set forth a simple general classification of types which will include all the common varieties and strains of sorghum with which growers are generally familiar.

The following classification is based on the simple characteristic of sweetness or sugar content, occurring as it does in greater or less degree in well known varieties. In short, some varieties of sorghum are sweet, and some are not sweet, a condition which forms a general basis for separating varieties into two general groups. In addition to the two general groups thus indicated are so called grass sorghums which differ from them in the manner of growth, and broom corn, which have special utilization.

The following outline is based on the outstanding familiar characters thus briefly indicated. (U. S. D. A. Department Bulletin 1260.)

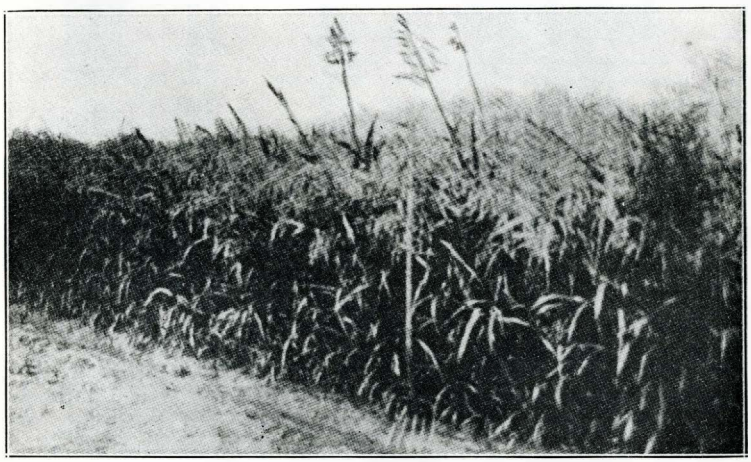
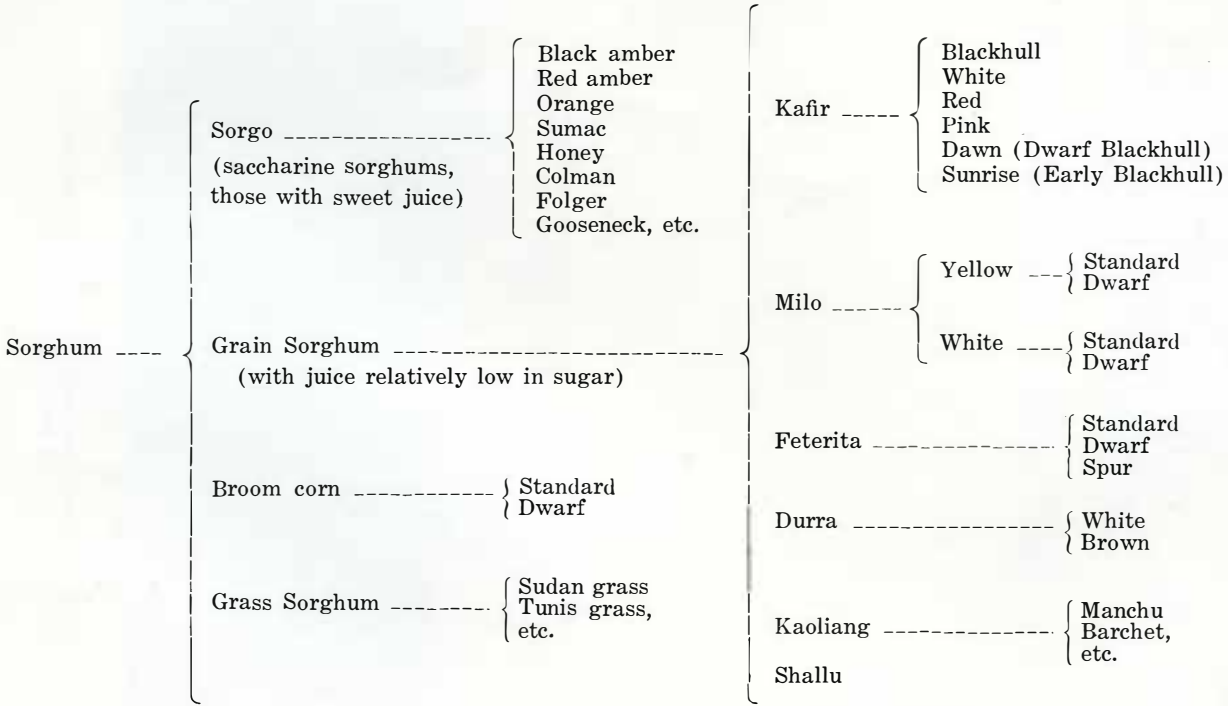


Figure 1.—Sudan (Grass sorghum). Seeded at Brookings May 1, 1912. Photographed September 1

Classification of Most Familiar Varieties of Sorghum in Common Use in This Area



History

The place of origin of species of sorghum on the earth is not very clearly established. Unlike Indian corn there seems to be no evidence produced to indicate that any kind of sorghum originated on the American continent, either North or South.

It is stated by De Candolle,[1] who is perhaps chief authority in plant origins that he considers it likely that common sorghum (apparently grain sorghum) originated in Africa, having been introduced from there into Egypt in prehistoric time. Common sorghum traveled from Egypt into India and apparently afterward into China, where it was known as late as the fourth century of the Christian era.

De Candolle also distinguishes between common sorghum and sweet sorghum, and indicates his belief that the origin was much the same for both, namely, tropical Africa.

Numerous interesting comparisons are made which go to show that kinds of sorghum produced in other countries at the time of his writing must have been introduced thereto from Egypt and apparently originated in tropical Africa. One of these mentioned is Kaoliang, or great millet of the Chinese, which was cultivated but not native in that country. The kaoliang which we know in South Dakota was introduced from the Orient; it is not easy to ascertain that the variety now cultivated here is exactly the same as that cultivated in China so many centuries ago. It may well be the same or even a closely related crop plant.

Plant Characteristics

The term sorghum includes a widely variable group of crop plants. These include all such as milo, kaoliang, shallu, durra, broom corn, kafir, introduced and now cultivated in the United States. Some of the principal varieties will be described in more detail in this bulletin.

Farmers and others who have reason to observe the manner of growth of sorghum are likely to make comparisons with corn because sorghum will often be grown as a supplementary crop with corn and at times even in a mixture with it. Some of the characters of leaf and stalk of sorghum are similar to those of corn.

Sorghums Bear Seed in a Panicle Not an Ear

The flowers which bear the seed either at the top of the main stem or at the top of the lateral branches are on stems attached to a central axis. These attachments also tend to group themselves around points or whorls some distance apart higher or lower on said central axis so that the entire group form a head or panicle. This head or panicle may be fairly compact and fusiform (spindle shaped) or it may be loose and spreading, as in broom corn. This degree of compactness or looseness depends upon the length of the side branches which bear the flower parts. The long branches in broom corn make the "brush" which is utilized practically in making brooms.

1. "Origin of Cultivated Plants," De Candolle (1882) p. 380. D. Appleton Co.

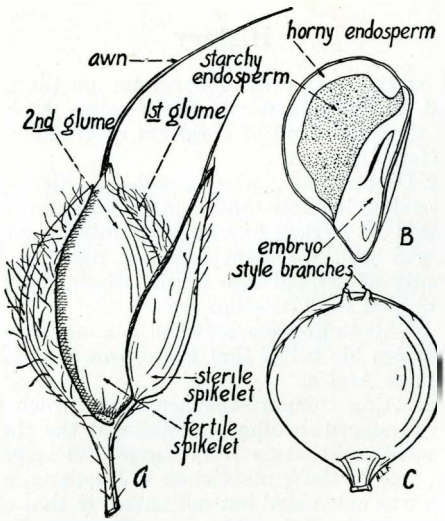


Figure 2.—Illustrating some floral and seed parts of sorghum (From: "Botany of Crop Plants"—Robbins)

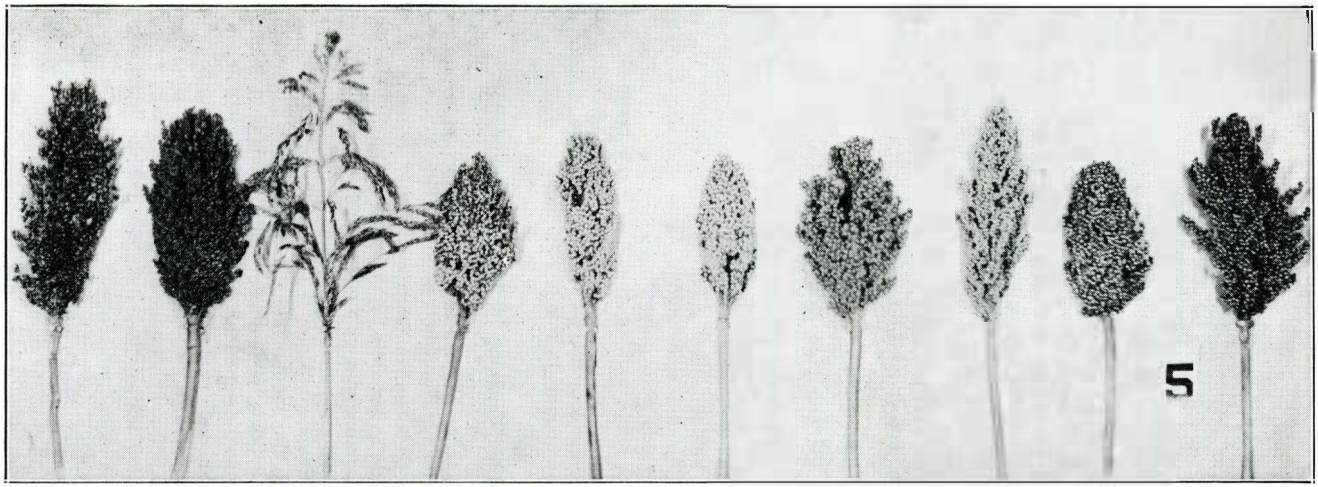
The panicles of sorghum bear flowers, the flower-bearing parts being called spikelets. These spikelets are borne usually in pairs, rarely in threes, one of the pairs being attached by a little stem or pedicel, the other being sessile, i. e. attached directly by its base. This latter flower is called "perfect" because it has both stamens and pistils within the one flower. It bears the seed. The stem-borne or pedicelled flowers are usually though not invariably staminate, i. e. have only stamens but no pistils and consequently bear no seeds.

Certain sorghums may be described as more heavily bearded than others. The awn or beard is borne in the two-cleft tip of the lemma (covering) of the fertile flower.

Roots

The roots will be found chiefly in the first eighteen inches of surface soil. Compared with maize or Indian corn the root systems are much shallower. Such a fact indicates that sorghum is more of a surface feeder than Indian corn. The roots of sorghums are likewise more fibrous and wiry than those of corn. Sorghums can resist drought perhaps largely for the reason that they have a low "water requirement." "Water requirement" is the relative number of pounds of water necessary during the process of growth of the plant, to produce one pound of the plant's dry matter. Robbins[2] points out likewise that drougth endurance may be due in part to ability to roll leaves, with approaching dry periods. Sorghums can remain alive without much active growth during a period of drought, and quickly begin growing again thereafter. Such a characteristic is possessed by corn in a more limited degree.

2. "Botany of Crop Plants" Robbins. P. Blakiston's Son & Co.



Dakota amber | Brown Kaoliang | Sudan grass | Feterita | Kafir corn | Early White Milo | Wheatland milo | Modoc pink Freed | Sooner milo | Club kafir

Figure 3.—Panicles (heads) of Variety Types of Sorghum. (Photo by Franzke and Hume).

Cultural Methods

Soil Preparation

Land is prepared for any of the sorghums including sudan in much the same way as for corn. Plowing may be done either in fall or spring. As early as possible in the spring the land should be harrowed, and later when the weeds are started it should be double disked, lapping half to avoid ridging the ground. The land can then be left till seeding time, when it should be rolled and given another harrowing. Spring plowing should be harrowed as promptly as possible and then treated the same as fall plowing.

This thorough surface culture previous to seeding time is to provide a seed bed of good tilth and especially to destroy as many weeds as possible before planting. The desirability for doing this is also involved in the following section.

Some Difficulties in Growing the Crop

One of the chief difficulties encountered in growing sorghum is low germination, due to the fact that the seeds are small and susceptible to cold moist weather. The remedy for this consists in waiting until the ground is warm and sufficiently dry before seeding. This will allow time for surface culture with disk and harrow, thus warming the soil and killing the first crop of weeds before seeding.

On account of the small size of the seed, care must be taken not to seed too deeply. When the seed is sown more than one inch deep many of the seeds fail to germinate or fail to penetrate to the surface. If a heavy beating rain crusts the surface, the same is true.

Seeding Shallow in Drills is Desirable

For the reason that sorghum demands shallow planting it is difficult to secure good stands by planting in hills with a corn planter. Many growers arrive at better results from putting in sorghum seed with an ordinary grain drill. It is possible likewise to space the rows thus either closer together like small grain or farther apart for cultivation, by stopping a certain number of the drill holes in order to secure the desired spacing between the rows.

It is better to drill the seed rather closely in the drill row. Even if the stand resulting is too thick, it is preferable to one that is uneven. Good stands have been secured year after year where sufficient care was taken to plant the seed shallow in drill rows, but hill planting has usually resulted in poor stands, largely due to planting the seed too deep.

The early growth of sorghum is very slow. That is another reason for late planting, after killing the first weed growth by surface cultivation.

Rate of Seeding

The usual amount of Sudan grass seed required when sown in drills six inches apart is from 25 to 30 pounds per acre. With drills 12 inches

Figure 4.—Two rows of Sudan grass on plot 253 at Brookings. The above picture shows the method of seeding this crop in single drill rows. Seeding in double rows produced higher yields at Eureka and Cottonwood.

apart 15 pounds is sufficient and less in proportion when the rows are wider spaced. Amber cane grown in rows far enough apart to permit cultivation should be planted at the rate of from 4 to 8 pounds per acre.

Date of Seeding

Sudan was seeded at successive dates two weeks apart, beginning May 1 and closing July 1 at Highmore; at Brookings the closing date was July 15. Results printed in South Dakota Experiment Station bulletin 174 based on the average yields of three successive years indicate that **the optimum date of seeding is the same at both places, namely, June 1.** The average yield from seeding on that date at Highmore was 2325 pounds per acre (3 years), at Brookings 7474 pounds.

Decreases in yield were decided at both places where seeding proceeded either before or after this optimum date. (South Dakota Experiment Station Bulletin 174.)

Cultivation

If the sorghum is planted in rows, with the intention of cultivating, there should be space enough between the rows to permit the use of the same machinery that would be used in cultivating corn. That is, from 36 to 42 inches. Sudan grass has been cultivated in single, double, and treble drill rows. This has a tendency to make the hay coarse, puts the land in better shape for the next crop. A six or eight shovel riding cultivator is very satisfactory for cultivating sorghum. As with all cultivation the main object is to control the weeds. When cultivating double or treble rows it is often necessary to remove the two inner shovels.

Sudan Seeded in Close Drills or in Drills Farther Apart for Cultivation

An experiment was begun in 1915 and has been continued throughout the period between that season and 1932 at Eureka Experiment Farm which yields information upon the foregoing question of seeding sudan in drills closer or farther apart without subsequent cultivation or seeding the same in single or double drill rows 36 or 42 inches apart for subsequent cultivation similar to the usual cultivation of corn.

Ordinarily the common varieties of sorghum, Dakota amber, and others have been seeded in drill rows much the same as corn. After the introduction of sudan, it was seeded in rows, varying distances apart, depending upon conditions such as supply of available seed, and plan for subsequent use of land.

At present writing, and no doubt at other times, seed supply is an important consideration.

The total and average yields of sudan forage from these several distances of planting are put down in the following table:

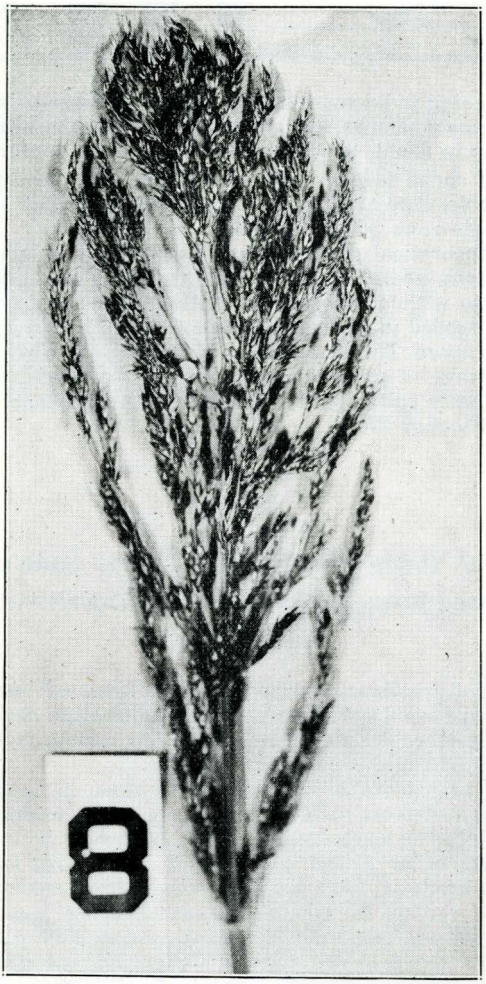
TABLE 1.—Yields of field cured forage from sudan at Eureka Experiment Farm from planting in single drills 6 inches to 42 inches apart, and 42 inches apart in single or double drills,—eighteen years (1915-1932)

Year	Yield of sudan in pounds per acre from seeding single or double rows at given distance									
	Single 6 in.	Single 12 in.	Single 36 in.	Single 42 in.	Double 42 in.	Single 6 in.	Single 12 in.	Single 36 in.	Single 42 in.	Double 42 in.
1915	7240	7600	4100	3640	4300	3600	3300	2500	1400	1900
1916	4500	3250	4000	3750	3350	3750	3750	4850	4850	5000
1917	400	850	1150	1200	2000	1950	1400	1500	1450	2400
1918	1250	1250	1250	1000	1250	2850	2400	2700	2400	3000
1919	3250	3000	2550	2250	2500	3500	3560	2350	2350	2650
1920	1750	1500	1450	1550	2050	2200	1250	2000	2050	2200
1921	8400	7300	9100	8900	8800	5050	9350	7950	6450	7650
1922	1150	1000	1600	1500	1650	1100	1150	1350	1450	1550
1923	2550	1800	3880	3550	4400	2450	2600	3600	4400	3900
1924	950	700	1250	1450	1650	850	500	1250	1200	1350
1925	1000	550	1160	900	1150	300	500	1000	1350	1000
1926	450	650	250	0	0	750	450	350	200	300
1927	4000	3400	2900	2750	3950	3900	3400	2850	2900	4200
1928	1100	1000	1850	1500	1750	1500	1250	1900	2000	2100
1929	2050	1950	2200	2050	1850	2150	2250	2400	1850	2200
1930	1600	1300	1600	1450	1500	1700	1550	1750	1150	1300
1931	2150	1800	1700	2300	2200	2100	1850	2400	2100	2300
1932	2500	1750	2750	2750	3000	2600	2500	3500	3500	3250
Av.	2572	2247	2482	2361	2636	2350	2389	2567	2392	2681

The yield per acre of forage put down in the ten vertical columns of the foregoing table are secured from the ten corresponding subdivisions or plots making up the total acre each year.

Variation in yield between the several plots for the several years is vast—extending from 0 to 9350 pounds.

The average yields of forage per acre from the foregoing separate plots are put down in the lowest horizontal line of the table. This line of averages may be observed to be comprised of five separate distances or methods of planting; two yields of each kind making a total of ten. In order to arrive at a closer examination of these averages they may be summarized as follows:



SUDAN GRASS

Sudan is the species of grass-sorghum in South Dakota for pasture, hay, sometimes ensilage.

Summary of Averages from Foregoing Table

	Yield of Sudan in Pounds per Acre from Seeding Single or Double Rows at Given Distances				
	Single 6 in.	Single 12 in.	Single 36 in.	Single 42 in.	Double 42 in.
Yield from first plot	2572	2247	2482	2361	2636
Yield from second plot	2350	2389	2567	2392	2681
Average	2461	2318	2524	2376	2658

1. The foregoing indicates that **the highest average total yield of field cured forage from Sudan in this experiment at Eureka was secured from drilling the crop in double rows 42 inches apart from center to center.**

The yield of sudan forage, 2658 pounds per acre, from this method of planting in double rows at Eureka is only slightly higher than that from planting in single rows 36 inches apart.

2. It is of theoretical and practical interest to note that the yield of sudan forage from seeding in 6 inch solid drills, as is ordinarly done with small grain, also without subsequent cultivation is only next lower than that from land seeded in cultivated single rows 36 inches apart, or double rows 42 inches apart. The desirability of seeding in cultivated rows may have the advantage of preparing a seedbed for a subsequent crop, as in the case of millet in cultivated rows. (See South Dakota Experiment Station Bulletin 272, page 27.)

Comparison of Yields from Seeding Amber Cane and Sudan in Cultivated Rows and Solid Drills (Uncultivated) at Cottonwood

Additional information from seeding two kinds of sorghum, namely Amber cane and sudan, either in rows for cultivation or in closer drills to remain uncultivated becomes available in this bulletin by turning ahead to Table 7, page 33 and the discussion on page 32.

The results of said table are commented upon in another section to make comparison of total yield secured from the two kinds of sorghum. In connection with the present topic, however, it may be emphasized that sorghum (Altamont or Amber cane) as an average at Cottonwood Experiment Farm produced 2920 pounds per acre from cultivated drill rows 42 inches apart, whereas the comparative yield from the same crop seeded in solid drills without subsequent cultivation was 2307 pounds per acre. Such is fairly decisive evidence that the higher yield came when the larger sorghums were drilled in 42 inch rows and cultivated. (13 years, 1920-1932).

In the similar trial with sudan at Cottonwood, covering the same period of time, on the same kind of soil, the crop produced an average of 1677 pounds per acre in cultivated single drill rows, and 1587 pounds per acre seeded like small grain in solid 6 inch drills without subsequent cultivation.

Sorghum in Cultivated Drills or in Close Drills Without Cultivation

Gathering up the information gained from long-time trials herein reported concerning method of seeding for sorghums, it appears that seeding of sudan in the area represented by Eureka in cultivated single or double drills (page 16) may produce a higher total yield of forage than the method of drilling solid like small grain.

Moreover, in the area represented by Cottonwood Experiment Farm seeding sorghum in drill rows for cultivation whether larger kinds (Altamont or Amber cane) or sudan, cultivated rows produce more, or as much forage as solid seeding.

Thus all indications reported herein are to the effect that any type of sorghum may be seeded in drills for cultivation in order to secure maximum yield, rather than seeding in solid drills, unless some reason other than total yield makes seeding in solid drills desirable.

Harvesting

Sorghum in cultivated rows is harvested much the same as corn, being cut either with a corn binder or with a corn knife. The crop is commonly cut for forage when the seed is in the early dough stage.

Where sorghum is sown broadcast or in close drill rows it may be cut with a mower the same as hay or in dry regions it can be cut with a grain binder and the bundles allowed to dry in the field.

Sudan grass can be cut with a mower or binder the same as millet. The best time to cut the first crop is when it is in full bloom. The second crop, if any, is cut about September 1 to 10, to avoid danger of frost.

Figure 5.—A growing crop of Minnesota Amber, S. D. 341, at Highmore. This variety and its daughter variety, Dakota Amber S. D. 887, give good returns when a coarse fodder crop is desired.

Due to the thick juicy stems, amber cane cures with difficulty. For this reason it is best to begin the curing by having the stalks in small shocks. The shocks may then be stacked in long, narrow stacks or fed directly from the shock. The shocks will stand up well for several weeks if well set up and tied with a band near the top of the shock. The same will apply to Sudan grass when cut with a grain binder or corn binder. When cut with a mower the Sudan hay is handled the same as millet. The time required to cure the hay will depend upon the yield and weather conditions. If the growth is very heavy it should be allowed to lie in the sun for about one day before raking. It should then be raked into small windrows and allowed to dry as thoroughly as conditions permit before stacking.

Handling for Silage

When sorghum is used for silage essentially the same methods and machinery are utilized as for corn. It is a practice, when sweet varieties are utilized, to mix in straw every third or fourth load to absorb part of the juice and help avoid souring.

It may be even better in practice to utilize semi-sweet varieties of sorghum for silage, whether they are used alone or in mixture with corn.

Yields of Sorghum for Grain or Forage from Five Separate Points in South Dakota Over a Twenty-one Year Period.

This bulletin makes tabulated reports of yields of sorghum from the five separate experiment farms maintained by the state of South Dakota.

The several locations where these yields of sorghum have been secured are put down on the following map.

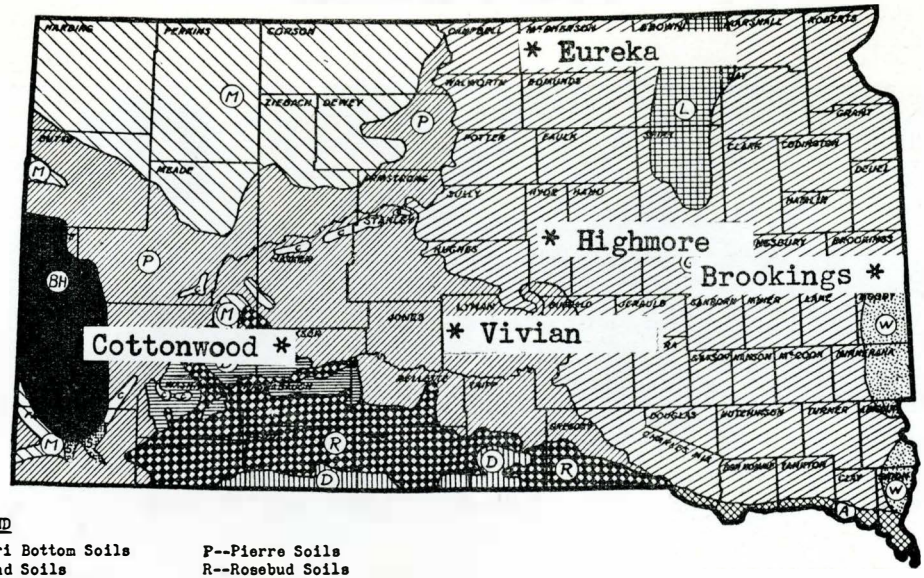
Crop yields from these several points will differ from one another according as conditions of soil and climate in the areas represented likewise vary. **The problem becomes one of finding out the adaptability of the crop (in this case sorghum) to these several sets of conditions.**

Wherever possible the yields of sorghum, whether grain or forage, are compared directly with yields of corn, for the reason that the latter is the most widely disseminated forage crop which may serve as a standard for making such comparisons. Practically, in a number of localities and on many farms the question becomes one of whether one or another kind of sorghum may displace or supplement corn in cropping systems, and if so, to what extent.

Yields of Sorghum from Cottonwood Experiment Farm

The following Table 2 puts down yields of grain in bushels per acre secured from two different kinds of sorghum and from corn, secured from different plots or small fields at Cottonwood Experiment Farm in the years extending over 1912 to 1932 inclusive. These yields were produced in Rotation No. 6: (1) corn, (2) small grain, (3) sweet clover. The acres included in this rotation are situated on Pierre soil, on the southwest quarter of the experiment farm. Some further comments upon these yields are put down following the table:

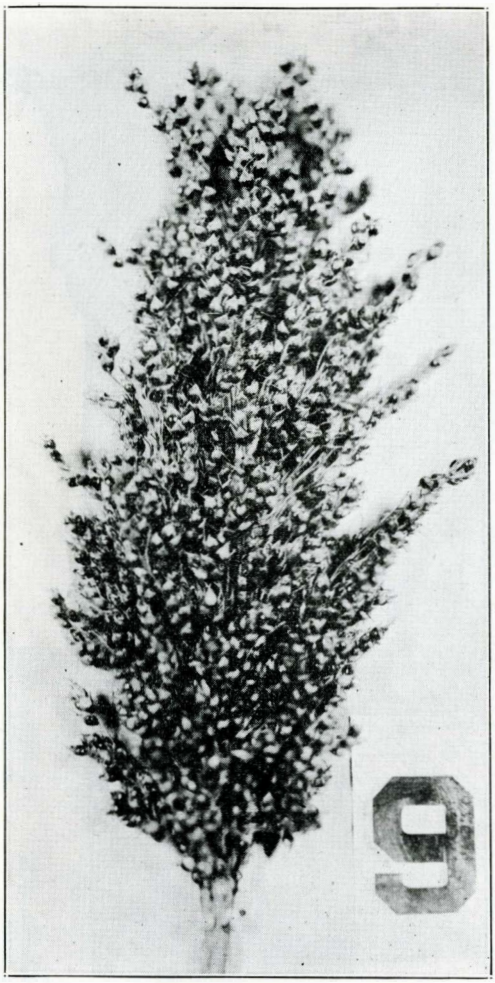
PRINCIPAL SOIL AREAS IN SOUTH DAKOTA



LEGEND

A--Missouri Bottom Soils
B--Bad Land Soils
C--Cheyenne Loam Soils
D--Dune Sand
G--Glacial Soils
L--Lacustrine Soils
M--Morton Soils
P--Pierre Soils
R--Rosebud Soils
S--Smithwick Loam Soils
W--Loessial Soils
BH-Black Hills

By J. Gladden Hutton, In Charge of
South Dakota Soil Survey. 1929.



BLACK AMBER

The sweet sorghum best known in this section for forage. Occasionally in mixtures for ensilage. Some strains for making syrup.

TABLE 2.—Comparative yields of grain in bushels per acre from two varieties of sorghums and corn within years 1912-1932, Cottonwood Experiment Farm

Year	Kind of crop	Yield from given plot in Rotation 6 in bushels per acre										Av. excluding Plot 6	
		1	2	3	4	5	6	7	8	9	10	Sorg'm	Corn
1912	Kaoliang	12.4	14.0	15.0		12.8	15.6	0.8	1.2		5.4	8.8	
	Corn				21.5					24.6			23.1
1913	Kaoliang	2.0	1.0	0.0		3.0	1.9	1.8			2.4	1.7	
	Corn				0.0				0.0	0.0			0.0
1914	Kaoliang	2.2	4.8			5.6	4.8	2.4			3.4	3.7	
	Corn			0.0	0.0				0.0	0.0			0.0
1915	Kaoliang	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	0.0	
	Corn			0.0				0.0					0.0
1916	Kaoliang	1.4	4.0		2.4	1.3	1.1		1.1	0.4	0.4	1.6	
	Corn			10.3				7.6					9.0
1917	Kaoliang	0.1	0.6		0.5	0.2	0.3		0.7	1.7	0.1	0.6	
	Corn			0.5				0.9					0.7
1918	Kaoliang	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Corn	15.5				26.4					17.4		19.8
1919	Kaoliang	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Corn	0.0				0.0					0.0		0.0
1920	Kaoliang	32.8	33.4	35.4	33.2	34.2	31.0	18.2	9.8	14.2	21.0	25.8	
	Corn	18.6				19.4					17.8		18.6
1921	Kaoliang	19.8	24.0	18.4	10.8	8.9	12.1	13.7	12.8	9.6	9.0	14.1	
	Corn	0.2				0.1					0.3		0.2
1922	Kaoliang	15.0	20.1	24.0	23.0	22.2	24.0	21.6	24.8	23.4	20.0	21.6	
	Corn	15.7				23.6					15.3		18.2
1923	Kaoliang	65.0	68.8	63.6	67.2	69.2	71.0	65.8	67.4	59.2	58.6	65.0	
	Corn	25.7				22.9					30.0		26.2
1924	Dak. amber	5.2	6.2	5.8	5.8	7.4	9.4	6.0	4.0	5.0	6.4	5.8	
	Corn	2.1				2.9					2.7		2.6
1925	Dak. amber	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Corn	0.0				0.0					0.0		0.0
1926	Dak. amber	3.8	3.6	6.0	11.0	4.0	6.4	6.0	5.2	9.6	11.2	6.7	
	Corn	3.9				5.3					3.4		4.2
1927	Dak. amber	25.2	27.8	33.4	35.4	41.2	37.8	34.2	42.2	38.4	42.4	35.6	
	Corn	23.6				30.4					22.9		25.6
1928	Dak. amber	0.5	0.4	0.5	0.4	0.5	0.5	0.6	0.4	0.6	0.4	0.5	
	Corn	0.0				0.2					0.1		0.1
1929	Dak. amber	1.6	2.4	2.1	2.4	1.6	2.1	1.4	2.0	1.2	2.2	1.9	
	Corn	7.4				5.9					5.1		6.1
1930	Dak. amber	13.4	16.6	13.6	10.4	10.6	13.4	13.0	15.2	16.0	17.2	14.0	
	Corn	4.9				1.3					1.6		2.6
1931	Dak. amber	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Corn	1.0				1.5					0.4		1.0
1932	Dak. amber	15.0	8.6	19.8	17.4	14.8	17.4	12.4	11.8	10.8	15.4	14.0	
	Corn	4.3				10.7					10.7		8.6
Av. 1912-1923												11.9	9.7
Av. 1912-1932												10.5	7.9
Av. 1924-1932												8.7	5.6

In the foregoing table are presented yields of grain in bushels per acre for different years extending from 1912-1932, of two kinds of sorghum and one of corn. It is possible to produce the following statements from an examination of average yields put down in the last two columns.

Deductions from Foregoing Table 2

1. The average yield of grain from kaoliang, a grain sorghum, for the twelve years, 1912-1923, was 11.9 bushels per acre (50 pounds per bushel) whereas the comparative yield of corn for the same years was 9.7 bushels per acre.

2. The average yield of grain from amber cane in the years 1924-1932 was 8.7 bushels per acre, the comparative yield of corn in the same years was 5.6 bushels per acre at Cottonwood Experiment Farm.

3. Considering the fact that both kaoliang and Dakota amber are sorghum, the comparative grain yield from sorghum for the entire period, 1912-1932 inclusive, was 10.5 bushels per acre, whereas the average yield of corn in the same years was 7.9 bushels.

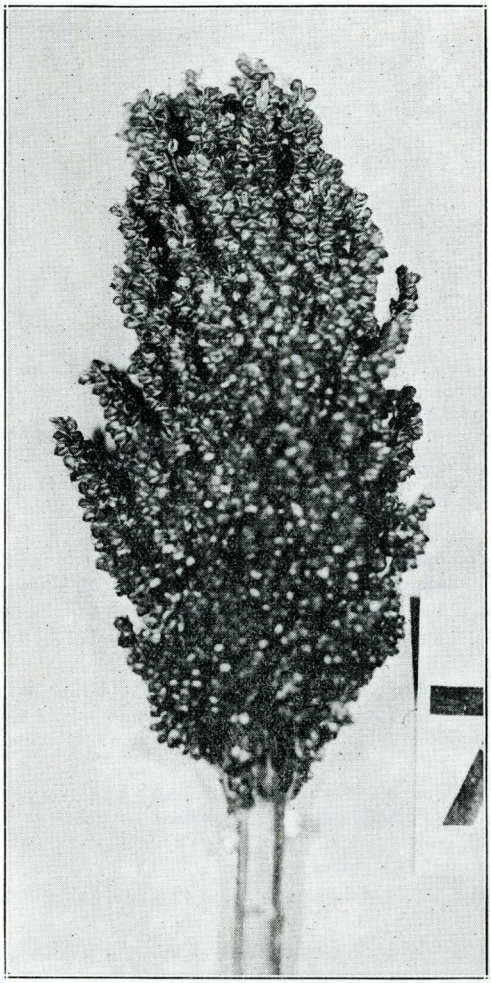
It may be desirable to recall that the foregoing yields were computed with the use of 50 pounds of grain for sorghum, and 70 pounds of ears per bushel for corn. On the foregoing basis the average yield of grain from sorghum for the entire period was 525 pounds per acre, and the average yield of corn 442 pounds per acre.

The fact that yields of grain under these conditions at Cottonwood secured from sorghum, appear to be slightly higher than those secured from corn is commented upon later in this bulletin, where it is pointed out that sorghum in this area is apparently a more important crop from the standpoint of grain production (relative to corn) than in any other area here reported upon. (See Table 13, page 44.)

Comparative Yields at Cottonwood from Altamont Grain Sorghum and Corn

Additional yields of grain from sorghum and corn extending over the years 1914 to 1932 inclusive were secured from Rotation No. 9: (1) corn, (2) winter wheat, (3) sorghum (Altamont), (4) winter rye.

Rotation No. 9 is located on the northwest quarter of the experiment farm on Orman clay soil. These yields are put down in the following Table 3. Additional comment is made thereafter.



BROWN KAOLIANG

Produces some grain but a poor quality of forage. One kind of Kaoliang is Altamont.

TABLE 3.—Comparative yield of grain in bushels per acre from grain sorghum (Kaoliang) and corn (Alta) for the years 1912-1932 at Cottonwood Experiment Farm. Rotation No. 9.

Year	Corn	Corn	Average	Kaoliang	Kaoliang	Average
1912*	23.1	23.1	23.1	11.9	11.9	11.9
1913*	0.0	0.0	0.0	2.0	2.0	2.0
1914	0.0	0.0	0.0	4.6	2.6	3.6
1915†	0.0	0.0	0.0	0.0	0.0	0.0
1916	15.1	8.8	11.9	0.1	0.4	0.3
1917	2.7	2.5	2.6	0.0	0.0	0.0
1918	13.9	16.4	15.1	0.9	0.8	0.9
1919*	0.0	0.0	0.0	2.2	2.0	2.1
1920	25.3	14.5	19.9	10.5	17.6	14.0
1921	0.5	0.0	0.3	7.5	0.9	4.2
1922	11.7	13.4	12.5	24.8	24.4	24.6
1923	26.7	15.5	21.1	23.9	20.1	22.0
1924	9.0	24.6	16.8	37.2	32.8	35 0
1925*	0.0	0.0	0.0	2.2	1.2	1.7
1926*	3.6	6.6	5.1	8.1	5.1	6.6
1927	21.1	26.4	23.7	4.0	2.5	3.3
1928*	4.8	0.6	2.7	0.0	0.0	0.0
1929	1.5	0.5	1.0	5.6	8.9	7.3
1930	0.9	1.1	1.0	2.5	3.6	3.1
1931	3.8	3.3	3.5	0.8	0.3	0.6
1932	18.1	10.2	14.1	9.2	7.5	8.4
Av.	8.7	8.0	8.3	7.5	6.9	7.2

* Yields for 1912 and 1913 are substituted from Rotation 6.

† Weights of shelled corn.

Field notes relating to seasonal conditions in several years which doubtless bear directly upon yields of sorghum, are as follows: 1915, "In this year corn was abandoned, too wet"; 1919, "Corn is reported dried up"; 1925, "Corn made no seed, dried up"; 1926, "Hail, July 26, leaves slit"; 1928 "No grain on sorghum (Kaoliang) due to unfavorable weather"; 1932, "Frost nipped corn, May 27."

The foregoing Table gives yield of grain from Kaoliang (selection Altamont) grain sorghum at Cottonwood Experiment Farm for the years 1912 to 1932 inclusive. These yields are put down in the fifth and sixth columns. Yields of grain from corn are put down for comparison in the second and third columns.

The reason for putting down yields of sorghum and corn each in two separate columns is the fact that there were two separate depths of plowing for each crop. The factor of depth of plowing is not considered in this bulletin.

The average yields of grain from Kaoliang grain sorghum produced in this rotation at Cottonwood are put down in the last column of the Table, Rotation 9, consisting of (1) corn, (2) winter wheat (3) Kaoliang (selection Altamont), (4)winter rye.

Deductions which might be made from the foregoing table are as follows:

1. The average yield of grain from Kaoliang (Altamont) sorghum under the conditions of this experiment over a period of twenty-one years, 1912-1932, was 7.2 bushels per acre, the average yield of corn being 8.3 bushels per acre.

2. The foregoing average yield of grain sorghum in pounds per acre is 360, and the comparative (computed) yield of shelled corn in pounds per acre is 465. Thus, in this instance the average computed yield of shelled corn was evidently higher than the yield of grain sorghum.

Yields of grain from sorghum at Cottonwood may be higher, if and when a variety is developed that will mature seed in a somewhat shorter season, in the area represented.

Forage at Cottonwood Produced from Sorghum and Corn

Yields of grain from Kaoliang (selection Altamont) sorghum and corn for comparison produced at Cottonwood are summarized in Tables 2 and 3, foregoing. It is likewise important to know what comparative returns in total forage, or roughage, may be expected from each of these crops under the conditions at Cottonwood.

The total weights of crops of both sorghum (Altamont) and corn arrived at by weighing the sum total of whole plots harvested in Rotation No. 9 are put down in Table 4, following. The total weights which these figures represent include weights of grain in the plants, sorghum before threshing, corn before husking. They are air-dry weights taken in the field. Obviously in years when the yields of grain are high the weight of such grain comprises a considerable share of total forage. In other years when little grain matured the weight of plants comprised in stalks and leaves made up the total yield of forage.

TABLE 4.—Comparative yields of total forage within years 1912-1932 (field weight) in pounds per acre from grain sorghum (Kaoliang) and corn (Alta) in Rotation No. 9, Cottonwood Experiment Farm.

Year	Corn	Corn	Average	Kaoliang	Kaoliang	Average
1912	1916	1916	1916	1445	1445	1445
1913	868	868	868	687	687	687
1914	580	90	335	774	642	708
1915	0	0	0	0	0	0
1916	2368	1612	1990	210	444	327
1917	740	856	798	0	0	0
1918	2158	2330	2244	298	271	284
1919	2176	1576	1876	450	374	412
1920	3265	2140	2702	2160	2940	2550
1921	264	56	160	1914	394	1154
1922	1420	1770	1595	4610	4240	4425
1923	2840	3830	3335	6830	6170	6500
1924	1970	1700	1835	1630	2240	1935
1925	825	695	760	390	287	338
1926	1257	1723	1490	2070	1982	2026
1927	4110	4275	4192	3150	2690	2920
1928	338	40	189	910	1140	1025
1929	659	447	553	1780	1890	1835
1930	481	852	667	2554	2844	2699
1931	1465	1333	1399	680	200	440
1932	2061	1980	2020	2550	2660	2605
Av.	1512	1433	1473	1671	1597	1634

In explanation of the foregoing table of yields of total forage of corn and grain sorghum (Kaoliang) at Cottonwood Experiment Farm, it may be again stated that the reason for having two columns each of yields of corn and sorghum is that two separate acres of each crop were plowed at different depths. The yields are put down separately, but the discussion in this bulletin does not depend upon depth of plowing.

Deductions from Table 4

1. Rotation No. 9, consisting of (1) corn, (2) winter wheat, (3) sorghum (Altamont), (4) winter rye, maks it possible to note that the average total yield of Altamont grain sorghum in pounds of field cured forage per acre produced over a period of twenty-one years, 1912-1932, was 1634 pounds per acre. The comparative yield from corn was 1473 pounds per acre.

2. Sorghum produced more than corn in ten of the separate years out of the total twenty-one; corn produced more than sorghum in ten out of the total twenty-one; in the remaining year corn and sorghum produced the same.

3. Careful examination of the difference between the two average yields of corn in the lowest horizontal line (79 pounds) and between the two average yields of sorghum in the same line (74 pounds) indicates that these differences are lower within the same crop than the foregoing difference (161 pounds) between the separate crops. Such a fact is some indication that the difference in yield which was higher for sorghum than corn may have significance, however slight.

Further Comparative Yields of Total Forage from Sorghums and Corn at Cottonwood (Rotation No. 6).

Comparative yields of grain from sorghums and corn in Rotation No. 6 at Cottonwood were put down in Table 2 of this bulletin. In the following Table 5 total yields of forage are put down from the same rotation, and the same crops, the weights having been secured in the field before threshing of the sorghums or husking of the corn.

TABLE 5.—Comparative yields of total forage in pounds per acre from two varieties of sorghum and corn within years 1912-1932, Cottonwood Experiment Farm.

Year	Kind of crop	Yield from given plot in Rotation 6 in pounds per acre										Av. excluding Plot 6	
		1	2	3	4	5	6	7	8	9	10	Sorg'm	Corn
1912	Kaoliang	2020	2300	2150		2040	2330				1070	1916	
	Corn				2300					2570			2435
1913	Kaoliang	860	770			960	865	840			910	868	
	Corn			660	680				710	700			688
1914	Kaoliang	1410	1540			1530	1690	1470			1520	1494	
	Corn			1200	1200				950	800			1038
1915	Kaoliang	1100	900		1300	2300	2700		2350	2400	2300	1807	
	Corn			3350				2850					3100
1916	Kaoliang	640	1500		800	545	520		405	400	397	670	
	Corn			3000				2660					2830
1917	Kaoliang	245	1073		530	250	355		470	1540	150	608	
	Corn			1100				1600					1350
1918	Kaoliang	0	0	0	0	0	0	0	0	0	0	0	
	Corn	2840				3780					2840		3153
1919	Kaoliang	0	0	0	0	0	0	0	0	0	0	0	
	Corn	1230				1710					1590		1510
1920	Kaoliang	3600	5200	5200	4100	4900	4200	2000	1600	2050	2600	3472	
	Corn	2665				3065					2785		2838
1921	Kaoliang	3800	3800	3180	2520	2210	2220	2850	2760	2280	1780	2798	
	Corn	235				310					305		283
1922	Kaoliang	4050	6360	6790	7200	6800	6570	6380	6650	7080	5650	6329	
	Corn	1980				2770					1650		2133
1923	Kaoliang	9250	10700	9100	10100	11600	9000	10800	10000	9800	9500	10094	
	Corn	3350				3700					4000		3683
1924	Dak. amber	3400	3200	3200	3000	2900	3800	2900	2500	2800	2100	2889	
	Corn	1800				1500					1600		1633
1925	Dak. amber	0	0	0	0	0	0	0	0	0	0	0	
	Corn	0				0					0		0
1926	Dak. amber	1870	1740	3120	3850	2050	3300	3200	3060	3700	4000	2954	
	Corn	770				1070					900		913
1927	Dak. amber	6800	7450	7600	8200	8000	7900	7800	7600	7600	7700	7639	
	Corn	1650				2130					1600		1793
1928	Dak. amber	2400	2800	2200	3000	3200	3300	3400	3100	3500	2750	2928	
	Corn	400				1315					1010		908
1929	Dak. amber	1400	1750	1850	2000	2300	2350	2200	2050	2100	2500	2017	
	Corn	1670				1410					2060		1713
1930	Dak. amber	7300	7000	7700	8100	8640	8360	7660	7740	7300	6400	7538	
	Corn	930				800					800		833
1931	Dak. amber	2600	3200	4700	4900	3900	2900	2600	2800	2600	2400	3300	
	Corn	520				955					430		635
1932	Dak. amber	3200	3500	4200	4000	3600	3700	3100	3200	3200	3600	3511	
	Corn	490				330					440		420
Av. 1912-1923												2505	2087
Av. 1912-1932												2992	1614
Av. 1924-1932												3642	983

Comments on Foregoing Table 5

In the foregoing table yields of total forage in pounds per acre of field weight are put down so far as such yields are available from Rotation No. 6 at Cottonwood Experiment Farm within the years 1912 to 1932. It is possible to produce the following statements based on an examination of average yields put down in the last two columns.

A comparison of yields of total forage put down in pounds per acre, field cured weight from sorghum and corn, is available in foregoing Table 5.

It may be observed that the kind of sorghum included in the rotation from 1912 up to and including 1923 was Kaoliang, which is essentially a grain sorghum not usually recommended for forage. Generally, however, the yields furnished from Kaoliang have been comparable with total yields from other kinds of sorghum.

The kind of sorghum included in the rotation in years following 1923 was Dakota amber, which is well known as a sweet sorghum. It is evident that the utilization of yields from both of the foregoing types of sorghum for the several years in which one or the other was included makes it possible to secure comparative average returns from sorghum and corn for any and all of the years 1912 to 1932 inclusive.

Average yields of sorghum and corn for the several years will be found in the last two vertical columns of the table at the right.

1. In the years 1912 to 1923 inclusive, when it occurred that Kaoliang was included in comparison with corn, the total average return of the former was 2505 pounds of field cured forage per acre with a comparative return from corn of 2087 pounds.

2. In the years 1924 to 1932 inclusive, when Dakota amber was included, the average return of field cured weight from sorghum was 3642 pounds per acre with a comparative return from corn of 983 pounds.

3. The total average yield of field cured forage from sorghum for all years, 1912 to 1932 inclusive, was 2992 pounds per acre with a comparative yield of forage from corn of 1614 pounds per acre.

Comparative Yields of Grain from (1) Amber cane, (2) Sudan, (3) Millet — (a) seeded in close drill rows, or (b) seeded in drill rows for cultivation

Information has been secured at Cottonwood Experiment Farm concerning not only relative productiveness of sorghum (Amber cane) as a grain crop compared with sudan and millet, but likewise some specific information relative to the best distribution of each of these crops in seeding.

Obviously less seed is required, other things equal, for putting in rows farther apart than for putting in drill rows say six or seven inches apart.

Yields are put down in the following Table 6, so far as they are available for the several years. Also averages are computed which may be helpful in making comparisons commented upon hereafter.

TABLE 6.—Yields of grain in bushels per acre from sorghum (Amber cane), sudan, millet (Shelley), and oats from Rotation 10. (A comparison of row planting and solid planting). Cottonwood Experiment Farm.

	Amber cane			Sudan			Millet		
Year	In rows	Solid	Av.	In rows	Solid	Av.	In rows	Solid	Av.
1914	3.6								
1915	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
1916	3.3			2.0			3.5		
1917	0.0			0.0			0.0		
1918	6.0				9.0		24.3	23.8	24.1
1919	2.7				0.0		4.5	3.0	3.8
1920	31.4			8.0	5.4		26.5	25.0	26.8
1921	4.2			3.1	1.8	2.5	2.1	1.4	1.8
1922	20.1	16.5*	18.3	10.4	16.2	13.3	28.2	35.2	31.7
1923	41.9	18.0	30.0	6.2	6.9	6.6	38.2	35.2†	36.7
1924	8.0	1.9	5.0	11.6	5.5	8.6	2.5	0.8	1.7
1925	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1926	4.5	1.3	2.9	5.4	7.1	6.3	1.4	0.9	1.2
1927	18.7	16.5	17.6	10.3	12.7	11.5	22.3	10.7	16.5
1928	0.2	0.0	0.1	T	0.0	0.0	T	0.0	0.0
1929	1.5	2.7	2.1	1.7	1.2	1.5	2.6	1.0	1.8
1930	2.6	0.8	1.7	0.2	0.1	0.2	1.9	3.0	2.5
1931	6.1	2.5	4.3	0.5	0.2	0.4	0.3	0.7	0.5
1932	7.9	2.3	5.1	1.5	2.4	2.0	7.7	7.8	7.8
Av. 1922–1932	10.1	5.7	7.9	4.3	4.8	4.6	9.6	8.7	9.1
Av. of all available years	8.6	5.2		3.8	4.3		9.2	9.3	

* The corresponding yield for 1917 is here substitited.

† The corresponding yield for 1922 is here substituted.

Comments on Foregoing Table 6

Average yields of the three separate crops are put down in the next to the lowest horizontal line of the foregoing table, for the years 1922 to 1932 inclusive, in order to make possible comparison between average yields from the three separate crops.

1. Amber cane seeded in rows, 40 inches apart, produced 10.1 bushels per acre whereas the same crop seeded in rows 6 inches apart with an ordinary grain drill produced 5.7 bushels per acre in the years 1922 to 1932 inclusive.

2. The comparative yield of millet (Shelley) seeded in rows for cultivation was 9.6 bushels per acre; obviously not far from the yield of Amber cane seeded in the same manner. The average yield of grain from millet seeded in solid drill rows 8.7 bushels per acre, was higher than the yield of grain from Amber cane seeded in the same manner.

3. Yields of seed from sudan grass are lower than yields from either Amber cane or millet, regardless of method of seeding. The yields of sudan seed are nearly the same whether seeded in cultivated rows or in drill rows 6 inches apart.

4. One may draw the general conclusion from the foregoing Table 6 that yields of grain from Amber cane and millet are somewhat higher in both cases when the grain is seeded in cultivated rows; seeding in cultivated rows saves some seed.

Comparison of Yields of Forage from Two Types of Sorghum and Millet at Cottonwood—Rotation No. 10

Yields of field cured forage have been recorded from plots of Rotation No. 10 at Cottonwood Experiment Farm, for two types of sorghum and millet in comparison. Yields are available for sudan and millet, beginning with 1917, but are available for sorghum (in this instance Altamont) beginning 1920.

Likewise yields are available for all three types of forage crops from two different methods of seeding, namely seeding in rows (with subsequent cultivation) and from seeding in solid (6 inch) drills after the usual manner of putting in small grain.

The yields are tabulated in the following Table 7 in pounds of field cured forage per acre.

Comments Upon Table 7

In explanation of Table 7, Rotation 10 at Cottonwood comprises three separate acres. Up to 1925 these acres were planted, one each with sorghum (Altamont), Sudan, and millet; furthermore half of each of these acres was planted in rows for cultivation and the other half in solid (6 inch) drills. Each of these half acres was harvested as a unit which explains why the yield is repeated in the columns of the Table for the years earlier than 1925.

Beginning with 1925, oats was introduced into the rotation in such manner that half of each acre was seeded to oats every year, alternate halves in successive years. The five remaining one-tenth acre plots in each acre were then planted to sorghum (Altamont), sudan, or millet as the case may be. The yields from the corresponding plots, 1925 and succeeding, whether seeded in solid drills or cultivated rows, are put down accordingly.

In the lowest two horizontal lines of the following table are put down average yields from the separate methods of seeding, for the successive years. In the next to the lowest line, these yields are consistent in that they all represent the years 1920 to 1932 throughout. In the lowest horizontal line average yields are for Sudan and millet representing 1917 to 1932 inclusive.

In order to make examination of these average yields easier they are reassembled in the following sub-table, where are also put down comparative average yields from each method of planting, whether cultivated rows or solid 6 inch drills for all years.

	Sudan			Millet			Sorghum (Altamont)		
Average	In rows	Solid	Av.	In rows	Solid	Av.	In rows	Solid	Av.
1920-1932	1677	1587	1622	1992	2151	2072	2920	2307	2613
All years available	1671	1670	1671	1943	2157	2050			

TABLE 7.—Comparative yields of forage (pounds field weight per acre) from two types of sorghum, sudan, and Altamont (grain sorghum) with millet, at Cottonwood Experiment Farm. (1917-1932)

	SUDAN					MILLET					SORGHUM*				
Year	42"	Solid	42"	Solid	42"	36"	Solid	36"	Solid	36"	42"	Solid	42"	Solid	42"
1917	0	0	0	0	0	0	0	0	0	0					
1918	3320	4880	3320	4880	3320	4182	5212	4182	5212	4182					
1919	1627	1214	1627	1214	1627	998	1334	998	1334	998					
1920	2720	2900	2720	2900	2720	4280	4320	4280	4320	4280	6570	2000	6570	2000	6570
1921	856	1044	856	1044	856	1128	1992	1128	1992	1128	2572	2920	2572	2920	2572
1922	2200	3240	2200	3240	2200	4740	5540	4740	5540	4740	4800	4220	4800	4220	4800
1923	2970	1751	2970	1751	2970	3820	5480	3820	5480	3820	6035	4250	6035	4250	6035
1924	1510	960	1510	960	1510	1180	1260	1180	1260	1180	3020	1520	3020	1520	3020
1925	650	600	670	220	620	00	00	00	00	00	400	190	500	240	330
1926	1500	1300	1900	1960	840	1280	1300	1000	2000	1440	1200	2660	2080	1660	1860
1927	2700	3200	2900	3100	3100	3350	2950	2300	1100	1900	4000	3700	2300	4000	4000
1928	800	900	1200	700	1300	900	300	1000	500	400	1000	600	1100	1200	1300
1929	820	900	880	760	600	1200	300	1700	900	1700	1200	1700	920	1300	1700
1930	3100	2000	2940	1900	3100	600	800	760	100	760	3540	3560	3760	3640	3840
1931	220	160	240	160	140	260	500	320	380	380	1300	1000	1900	1100	1400
1932	1700	1700	1500	1900	1200	3500	3700	4000	3900	3500	2300	2000	1700	1600	1250
Av. 1920-32	1673	1589	1730	1584	1627	2018	2188	2018	2113	1941	2918	2332	2866	2281	2975
Av. of all plots	1668	1672	1715	1668	1631	1964	2187	1963	2126	1901					

* The sorghum in years previous to 1925 was Altamont. In 1925 and subsequently it was changed to Dakota amber.

Consideration of the foregoing average yields makes it possible to put down the following:

1. The highest average gross yield of forage at Cottonwood Experiment Farm from the two types of sorghum included in the foregoing experiment was produced by Altamont, a type of grain sorghum selected from Kaoliang. Numerous observations have established the apparent fact that the quality of forage from various selections of Kaoliang is inferior. Thus the fact of superior yield need not be considered as amounting to a recommendation of Kaoliang (Altamont) for forage.

2. Sudan, producing a lower average yield of total forage than Altamont sorghum (981 pounds per acre less) is generally considered as a very valuable forage.

Yields of Grain and Forage from Sorghums and Certain Other Crops for Comparison at Eureka Experiment Farm

Eureka Experiment Farm is located in McPherson county, (Sec. 36, Twp. 127 N., R. 73W) one of the northern tier of counties in the state. The farm is located on Barnes soil, which is the prevailing type in several counties of that section. The location may be called farthest north in the South Dakota corn belt. Perhaps supplementary crops as sorghums for grain and forage are of additional importance on that account.

One of the cropping systems at Eureka consists of the following sequence: (1) corn, (2) small grain, (3) sweet clover, (4) forage crops (Amber cane, sudan, millet, corn), (5) small grain.

The sorhgum (generally amber cane and sudan) in the foregoing, comes in the fourth year of the rotation, along with corn and millet for comparison.

The following Table 8 summarizes yields of grain from sorghum (Dakota amber, or kaoliang or sudan) as well as yields from millet (Shelley or Kursk) and corn for comparison. The yields are put down for the ten separate plots of each acre in the rotation.

In Table 8 separate yields for each crop are summarized under "average" in the four columns of the Table at the right. Average yields per acre for each of the several plots and for each of the several crops are put down in the lowest horizontal line of the table.

The yields of grain in the years 1915 to 1918 inclusive are omitted from the table for the reason that records for those years are incomplete.

Furthermore, in detail it appears that Rotation No. 6 started somewhat irregularly, and that accordingly no yields are recorded from some plots in 1912 and 1913—with consequently no corresponding yields in the column of averages. The average yields of grain from each of the several crops as put down in the lowest horizontal line are computed for comparison with the use of all yields from the years 1914 and 1919 to 1932 inclusive.

TABLE 8.—Comparative yields of grain from sorghum (Dakota amber and Sudan), with millet (Shelley), and corn (Northwestern Dent). Eureka Experiment Farm—(Rotation No. 6).

	Yield from given plot in bushels per acre										Average			
	Shelley millet	Sudan	Dakota amber	North-western dent	Shelley millet	Shelley millet	Sudan	Dakota amber	North-western dent	Shelley millet	Shelley millet (except plot 6)	Sudan	Dakota amber	North-western dent
Year	1	2	3	4	5	6	7	8	9	10				
	Kursk			Minn. 13	Kursk	Kursk			Minn. 13	Kursk				
1912	10.2			38.8	10.4	18.0			50.0	7.0	9.2	---	---	44.4
	Kursk		Kaoliang	Sq. Deal	Kursk	Kursk		Kaoliang	Sq. Deal	Kursk				
1913	3.4		6.0	9.3	8.4	7.0		0.0	5.6	8.6	6.8	---	0.0	7.5
	Kursk		Kaoliang	Sq. Deal	Kursk	Kursk		Kaoliang	Sq. Deal	Kursk				
1914	4.8	0.1	2.1	15.9	5.7	3.1	0.1	2.6	14.6	4.2	4.9	0.1	2.4	15.3
1919	35.6	2.6	13.6	29.3	24.0	29.8	4.4	27.0	43.3	29.0	29.5	3.5	20.3	36.3
1920	13.0	3.8	17.4	28.1	16.0	18.4	5.2	20.0	26.8	12.2	13.7	4.5	18.7	27.5
1921	29.4	6.8	31.8	34.4	33.2	36.4	8.6	33.2	47.9	36.2	32.9	7.7	32.5	41.2
1922	12.4	8.2	12.4	16.2	14.4	12.4	6.6	13.2	12.5	16.0	14.3	7.4	12.8	14.4
1923	32.1	11.2	18.2	46.6	30.6	31.6	11.6	25.8	44.0	29.4	30.7	11.4	22.0	45.3
1924	23.0	3.0	0.0	28.5	19.8	22.8	2.4	2.4	26.8	21.0	21.3	2.7	1.2	27.7
1925	13.4	24.6	9.4	11.1	15.4	17.4	15.2	12.0	14.0	23.4	17.4	19.9	10.7	12.6
1926	0.0	1.2	1.8	0.0	0.0	0.0	0.8	1.6	0.0	0.0	0.0	1.0	1.7	0.0
1927	38.0	20.4	28.0	61.4	34.0	38.8	21.4	23.6	62.0	42.8	38.3	20.9	25.8	61.7
1928	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1929	12.4	17.2	8.0	12.7	5.6	5.0	7.0	6.4	7.7	6.8	8.3	12.1	7.2	10.2
1930	22.0	2.2	19.6	18.6	15.8	16.2	1.6	13.8	8.1	26.0	21.3	1.9	12.2	13.4
1931	23.2	7.2	Lost	13.4	20.0	23.8	9.8	Lost	17.1	22.0	21.7	8.5	0.0	15.3
1932	17.0	9.2	7.8	22.9	19.4	21.2	9.0	4.0	22.4	10.8	15.7	9.1	5.9	22.7
Av. 1914-32	13.4	7.8	10.7	22.6	16.9	18.5	6.9	12.4	23.1	18.7	18.0	7.4	11.6	22.9

Yields for 1914, millet and sudan, from Rotation 7.

Comparative Yields of Grain from Sorghum in Year 1914, 1919 to 1932, at Eureka Experiment Farm

1. The average yield of grain in bushels per acre from sorghum (Dakota amber, with the exception of one year) for years 1914, 1919 to 1932 inclusive was 11.6 bushels per acre.

2. A comparison with the yield produced from corn in the same years makes it evident that corn produced nearly twice as many bushels, namely, 22.9 bushels per acre. Such comparison is emphasized in favor of corn (for grain) in view of the fact that sorghum is here assumed to weigh 50 pounds per bushel, whereas corn yields are calculated here on a basis of 70 pounds of ears per bushel, equivalent to 56 pounds of shelled corn.

3. A further interesting comparison comes out of the fact that the average yield of grain from Shelley millet, 18.0 bushels per acre, was 6.4 bushels per acre above that of Amber cane.

4. The average yield of seed from Sudan, as would be expected, is lower than that of the more strictly grain crops.

Obviously the foregoing average yields of grain from Amber cane may not invariably represent yields from all other kinds and varieties of sorghum. Nevertheless, various tests have indicated that seed yields from Amber cane are generally comparable with those from other varieties even those from grain sorghum.

Practically it may be possible to find a variety of grain sorghum that will mature earlier and utilize the season more completely under the conditions at Eureka without danger of having the grain yields shortened by early frost.

In the meantime it appears from such data as it is possible to put down in the foregoing table that average grain yields at Eureka from corn have been decidedly higher than those from Amber cane (Kaoliang substituted one year) and also that yields of grain from Shelley millet or Kursk over a period of fifteen years have been decidedly higher than yields from sorghum.

Thus there is no present indication that corn and millet will be displaced by sorghum for strictly grain crop under the conditions at Eureka.

Total Forage from Sorghum and Other Crops for Comparison at Eureka Experiment Farm

Whereas yields of grain from sorghum at Eureka are put down in the previous section and briefly discussed, corresponding total yields of air-dry forage in pounds per acre from the same crops are summarized in the following Table 9.

The weights put down include the weights of grain in all cases, the figures being arrived at by weighing the whole crops from each of the several plots before threshing or husking as the case might be.

TABLE 9.—Comparative yields of forage from sorghum (Dakota amber and Sudan), with millet (Shelley), and corn (Northwestern Dent), in pounds per plot (1/10 acre).—Eureka Experiment Farm. (Rotation No. 6.)

	Yield from given plot in pounds per plot										Average			
Year	Shelley millet 1	Sudan 2	Dakota amber 3	North-western dent 4	Shelley millet 5	Shelley millet 6	Sudan 7	Dakota amber 8	North-western dent 9	Shelley millet 10	Shelley millet (except plot 6)	Sudan	Dakota amber	North-western dent
1912	235			425	260	370			555	165	220			490
1913	135		00	161	190	190		00	264	255	193		00	213
1914	150	99	105	256	165	160	85	110	242	150	155	92	108	249
1915	190	175	475	660	250	255	185	590	655	205	215	180	533	658
1916	295	189	275	175	300	450	425	665	380	325	307	303	470	278
1918	100	300	100	113	160	300	35	200	103	350	203	168	150	108
1919	550	270	535	550	450	345	280	775	750	545	515	275	655	650
1920	240	200	595	475	275	255	225	640	490	245	253	213	618	483
1921	475	400	775	550	375	525	400	625	700	365	405	400	700	625
1922	240	190	325	405	260	250	135	275	350	280	260	163	300	378
1923	460	400	615	611	440	440	400	615	647	435	445	400	615	629
1924	400	285	395	420	325	385	215	430	443	415	380	250	413	432
1925	300	375	225	260	235	280	270	240	325	380	305	323	233	293
1926	30	95	60	45	20	60	65	50	55	15	22	80	55	50
1927	520	500	1200	815	450	560	565	1310	790	600	523	533	1255	803
1928	170	135	75	52	150	170	155	90	55	60	127	145	83	53
1929	315	330	185	320	235	240	130	215	335	305	285	230	200	328
1930	390	285	375	350	225	410	295	435	275	445	353	290	405	313
1931	340	300	400	210	330	340	300	460	245	315	328	300	430	228
1932	325	220	300	340	355	360	275	175	360	300	327	298	238	350
Av. 1914-32	305	269	389	367	278	321	247	438	400	319	300	258	415	384

Comments on Foregoing Table 9

Amber cane was used in the foregoing Rotation No. 6 at Eureka in all years subsequent to its introduction in 1915; kaoliang (a grain sorghum) having been planted in its place for two years previously. Other kinds of sorghum might have made comparison more or less different.

It may be observed from the average yields of forage put down in the lowest horizontal line of Table 9 at the right that the highest average yield of field cured forage was secured from Amber cane; next highest from corn; next from millet (either Shelley or Kursk); and next from Sudan.

These averages are computed for comparison with omitting the year 1917 for all crops for the reason that the yield of forage for Dakota amber that year was not recorded.

The foregoing may be put down in order of numerical yield as follows, also with reducing same from terms of pounds per plot (1/10 acre) to tons per acre.

Name of forage crop	Yield in pounds per plot	Average yield in tons per acre
Amber cane	415	2.08
Corn	384	1.92
Millet	300	1.50
Sudan	258	1.29

The foregoing average yields of forage secured in eighteen seasons at Eureka indicate that sorghum (Amber cane) may produce amounts of forage equivalent to corn and above those of millet. Yields of forage from sudan were lower than those of Amber cane, corn, or millet.

It is well to recall also that Amber cane and corn were here planted in cultivated rows, and millet and sudan in double rows cultivated.

TABLE 10.—Comparative yields of grain in bushels per acre from sorghum (Altamont) and corn, from ten successive plots, with and without fertility treatment, Highmore Experiment Farm, Rotation No. 1, 1912-1932

(See S. D. Experiment Station bulletin 272).

SORGHUM

Year	O	N	P	K	O	NP	NK	PK	NPK	O	Average
1912	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1913	11.0	13.1	11.9	13.6	18.8	17.2	19.2	15.2	12.2	11.0	**14.8**
1914	10.6	13.8	15.9	14.4	13.7	16.4	11.3	11.8	12.2	11.1	13.1
1915	0.0	0.3	1.1	0.9	0.0	1.1	0.3	3.1	2.6	0.1	1.0
1916	3.4	4.6	4.8	1.2	2.6	2.8	1.2	3.8	3.4	1.6	2.9
1917	14.5	16.0	18.4	12.6	12.4	14.2	13.8	13.6	9.6	10.6	13.6
1918	24.0	24.8	19.8	23.0	33.6	30.2	28.8	26.4	22.8	20.8	25.4
1919	22.6	20.4	20.6	20.8	23.6	22.4	20.2	17.4	21.6	26.6	21.6
1920	30.4	38.0	44.0	36.0	37.4	50.6	40.8	47.8	52.2	39.4	41.7
1921	31.6	32.6	23.4	22.6	25.6	20.4	25.2	20.0	23.0	27.2	25.2
1922	31.1	37.2	30.6	24.0	26.4	34.0	35.2	39.4	36.0	31.6	32.6
1923	32.0	26.2	29.8	27.8	28.0	20.6	21.6	**23.4**	23.2	26.2	25.9
1924	12.0	16.0	17.2	11.0	13.0	19.2	13.0	11.4	15.9	12.0	14.1
1925	12.3	7.2	6.7	8.7	9.9	6.6	5.0	5.7	5.1	9.0	7.6
1926	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1927	24.0	30.8	28.2	25.6	28.2	39.4	30.0	34.6	39.4	26.8	30.7
1928	2.2	1.0	0.5	0.7	1.4	1.2	1.7	0.8	0.5	0.7	1.1
1929	4.6	6.4	6.4	5.8	5.0	5.0	2.8	0.6	2.2	1.1	**4.0**
1930	23.4	25.5	24.6	21.8	24.3	26.1	**26.6**	24.4	26.0	22.3	24.5
1931	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1932	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Av.	13.8	14.9	14.5	12.9	14.5	15.6	14.1	14.3	14.7	13.2	14.3

CORN

Year	O	N	P	K	O	NP	NK	PK	NPK	O	Average
1912	14.3	11.3	8.5	14.4	15.9	10.8	10.5	14.1	15.8	20.3	13.6
1913	8.6	7.3	7.2	7.3	8.2	11.9	11.1	7.4	7.7	8.9	8.6
1914	7.9	5.0	5.0	2.9	11.7	6.7	8.6	10.0	6.3	5.1	**6.9**
1915	28.7	30.4	34.0	32.2	33.9	38.3	37.6	35.1	37.2	31.8	33.9
1916	25.9	28.8	32.1	30.1	27.7	27.8	23.6	22.0	22.0	24.2	**26.4**
1917	16.9	17.4	16.4	20.1	19.4	16.5	17.5	15.6	19.4	16.9	17.6
1918	33.4	33.2	32.9	29.2	30.2	30.7	30.5	30.0	29.9	31.1	31.1
1919	20.6	22.8	22.4	19.4	24.5	19.9	24.2	24.1	20.5	23.1	22.2
1920	33.9	36.2	39.2	35.3	36.2	44.6	42.2	36.3	44.1	36.3	38.4
1921	7.3	3.9	10.1	9.4	12.3	6.9	0.0	0.0	1.0	1.1	**5.2**
1922	54.3	47.5	46.6	51.1	56.3	47.5	46.1	50.7	49.4	56.6	50.6
1923	37.0	40.1	40.9	41.4	41.4	43.6	34.0	41.4	39.6	37.9	39.7
1924	10.7	13.9	15.1	10.7	15.6	17.9	13.1	10.9	10.9	15.4	13.4
1925	11.4	0.0	0.0	3.6	10.0	0.0	0.0	5.3	0.0	3.9	**3.4**
1926	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1927	35.9	31.0	32.9	34.6	33.6	29.4	28.9	32.4	30.7	34.3	**32.4**
1928	5.1	3.7	2.3	2.3	2.1	1.6	1.4	1.4	1.7	3.1	2.5
1929	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1930	14.9	16.3	16.1	16.7	17.0	17.7	17.0	18.3	16.4	**15.4**	16.6
1931	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1932	5.7	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0	**0.6**	0.7
Av.	17.7	16.6	17.2	17.2	18.9	17.7	16.5	16.9	16.8	17.4	17.3

Returns from Sorghum and from Corn in Comparison at Highmore Experiment Farm

One of the several cropping systems conducted at Highmore Experiment Farm through the years 1912 to 1932 consists of: (1) corn, (2) wheat, (3) peas, (4) sorghum, (5) oats, (6) alfalfa. It is evident that crop yields from this rotation in this system make opportunity for a comparison of the amount of grain harvested from sorghum and from corn under fairly similar conditions.

Observations from Table 10

The foregoing Table 10 puts down yields of grain from sorghum (Altamont) and from corn at Highmore in the years 1912 to 1932 inclusive. The succession of crops in sequence in Rotation No. 1 has been explained, and the title of the table calls attention to the fact that the soil fertility treatments are made to be one of the variants on the ten several plots in each acre. The fertility treatments are put down but they are not analyzed here.

The average yields of both sorghum and corn for the several seasons are put down in the right hand column of each part of the table and the average yield of each crop for all plots for all years is put down at the bottom of the column indicated.

1. The average yield of grain from Altamont sorghum at Highmore Experiment Farm was 14.3 bushels per acre, whereas the average computed yield of Alta corn in the same rotation was 17.3 bushels.

2. Assuming 50 pounds per bushel for sorghum, and 56 pounds for shelled corn, this would indicate that a **higher total amount of grain has been produced from corn than from sorghum.**

There would be no present indication therefore that sorghum would displace corn over large areas as a general crop for the production of grain.

Comparative Yields of Total Forage from Sorghum and Corn at Highmore Experiment Farm

The foregoing Table 10 summarized yields of grain from sorghum (Altamont) at Highmore Experiment Farm and comparative yields of corn from the same crop rotation. The following Table 11 puts down corresponding total weights of forage from the same plots.

These weights are comprised of the total weights of plants harvested from the plots, usually secured by weighing the entire crop before threshing or husking as the case might be.

TABLE 11.—Comparative yields of total forage, pounds per plot 1/10 acre each, from sorghum and corn (ten successive plots) at Highmore Experiment Farm, with and without fertility treatment, Rotation No. 1, 1912-1932

(See S. D. Experiment Station bulletin 272.)

SORGHUM

Year	O	N	P	K	O	NP	NK	PK	NPK	O	Average
1912	00	00	00	00	00	00	00	00	00	00	00
1913	121	149	148	167	219	197	228	174	140	122	167
1914	154	194	211	197	188	219	156	176	171	163	183
1915	141	197	227	218	179	222	183	224	243	196	203
1916	162	140	153	66	93	61	41	95	67	49	93
1917	238	280	252	203	207	211	249	228	148	188	220
1918	360	300	300	345	445	400	395	365	300	315	353
1919	366	348	385	362	407	370	370	340	375	431	375
1920	558	598	601	614	629	632	562	667	685	628	617
1921	470	490	563	540	523	470	482	577	467	534	512
1922	409	490	395	341	345	432	545	541	557	462	452
1923	680	565	515	600	575	500	530	570	610	615	576
1924	340	335	382	325	325	420	342	335	365	360	353
1925	221	143	186	198	198	147	128	223	161	200	181
1926	165	125	165	146	140	107	105	157	146	165	142
1927	312	390	370	358	395	499	411	450	495	354	403
1928	160	117	100	90	169	115	138	146	110	120	127
1929	120	115	130	150	125	110	110	70	125	60	112
1930	340	335	312	335	342	342	330	335	409	345	343
1931	00	00	00	00	00	00	00	00	00	00	00
1932	00	00	00	00	00	00	00	00	00	00	00
Av.	253	253	257	250	262	260	253	270	265	252	258

CORN

Year	O	N	P	K	O	NP	NK	PK	NPK	O	Average
1912	248	224	222	238	249	210	206	259	261	280	240
1913	99	88	96	93	106	134	126	94	91	106	103
1914	218	252	214	194	256	229	230	250	214	226	226
1915	333	369	407	373	370	417	387	400	403	382	384
1916	276	409	445	424	387	406	367	342	341	347	374
1917	247	262	250	300	296	254	264	261	306	275	273
1918	448	456	458	416	397	460	452	455	459	459	446
1919	282	312	309	291	336	282	338	329	285	319	308
1920	306	370	392	341	342	428	406	387	434	390	380
1921	220	192	255	252	262	221	172	173	174	197	212
1922	449	366	396	425	440	401	368	434	405	457	414
1923	393	443	472	467	435	447	430	480	437	443	445
1924	243	257	301	293	292	285	267	251	233	271	269
1925	226	175	220	160	204	170	165	185	192	142	184
1926	110	100	104	107	108	104	100	105	120	120	108
1927	420	410	420	430	425	430	400	420	425	450	423
1928	219	256	218	219	210	203	205	228	165	217	214
1929	145	165	132	135	160	185	180	140	160	105	151
1930	210	209	213	242	229	244	241	258	227	213	229
1931	39	29	47	46	28	27	21	37	41	40	36
1932	40	3	0	1	0	0	0	0	0	4	5
Av.	246	253	266	259	263	263	253	261	256	259	258

Observations from Table 11

The coincidence in Table 11, foregoing, is that the averages of all yields of forage from sorghum and from corn at Highmore put down in the right hand column of the table are exactly equal, namely 258 pounds per plot; thus 2580 pounds per acre. Reduced to tons, that would be found to be equivalent to 1.3 tons per acre of total forage from either kind of crop whether sorghum or corn, as an average of all years, 1912 to 1932 inclusive.

The foregoing serves as evidence that whatever advantage may accrue from producing sorghum for forage in place of corn at Highmore must arise from some quality in sorghum other than superior capacity for gross production of forage.

Comparative Returns from Sorghum and Corn in Grain or Forage at Brookings

At Brookings, in eastern South Dakota, grain sorghum and corn are produced continuously on separate pieces of ground on what is known as Agronomy West Farm. The soil of these plots may be considered as belonging to Barnes series. Returns therefrom of sorghum and corn, whether grain or forage, may be considered representative of a considerable area.

Comparative yields of both grain and forage are included in the following Table 12.

TABLE 12.—Comparative yields of grain and forage in bushels per acre or pounds per plot from sorghum and corn at Brookings, 1914-1932 inclusive. (Crops continuous on land, Rotation No. 30 and Rotation No. 11).

Year	GRAIN		FORAGE	
	Bushels per acre		Pounds per plot	
	Sorghum	Corn	Sorghum	Corn
1914	12.0*	47.7	636*	459
1915	0.0	5.6	140	119
1916	22.8	43.8	550	475
1917	0.0	42.8	00	480
1918	17.2	49.7	636	567
1919		44.3		185
1920		31.3		363
1921	0.0	50.0	550	540
1922	11.0	50.0		
1923	57.0	50.0	730	400
1924	14.8	36.3	530	359
1925	25.4	32.6	370	338
1926	12.8	51.1	340	616
1927	26.4	52.9	496	638
1928	17.0	31.1	500	534
1929	6.4	58.6	470	580
1930	0.0	26.0	770	337
1931	35.6	20.4	480	283
1932	54.8	41.4	750	410
Av. 1914-18, 1921, 1923-32	18.9	40.0	497	466

* Sudan.

Comments upon Results put down in Foregoing Table 12

In detail it is easy to observe from Table 12 foregoing, the yields of both grain and forage put down for 1914 are secured from Sudan, whereas the remaining yields in the table come from kaoliang or more frequently in later years, from Altamont, which is a selection therefrom. It seems possible that this use of data from Sudan may not vitiate the direction of average yields from sorghum and corn put down in the lowest horizontal line of the table, in view of the fact that no other yields are available from any kind of sorghum. Moreover, it may be observed that in 1919, 1920, and 1922 some places where yields would have been included are left blank. The averages in the lower line are computed, therefore, with summarizing all sorghum and corn yields that are actually available in the years when no yields are missing.

The following may be observed:

1. The average computed yield of grain from sorghum at Brookings for years available between 1914 and 1932 was 18.9 bushels per acre, whereas the comparative return from corn was 40.0 bushels per acre.

2. The corresponding yields of field cured forage from sorghum and corn are 497 pounds per plot, and 446 pounds per plot, plots being 1/10 acre each, which being reduced to terms of tons, amount to 2.5 tons per acre for sorghum, and 2.2 tons per acre for corn.

Apparently the foregoing yields of grain secured from sorghum would offer no inducement for the growing of that crop in the place of corn for grain except in cases where such grain might be desired for seed or for any special purpose.

The total yields of forage at Brookings slightly higher from sorghum may be considered almost equivalent to those from corn within usual variations. Sorghum may therefore be utilized for forage, or silage, in the area represented by Brookings with expectation of maintaining total average yield, and also under any unusual conditions where limited moisture or presence of grasshoppers might indicate that sorghum would be a desirable crop for growing either alone or in mixture with corn.

Summary of Comparative Returns from Sorghum and Corn for Forage and Grain in Four Locations in South Dakota

Foregoing sections of this bulletin have included comparative yields of grain and forage from both sorghum and corn. These are put down in Tables Nos. 2, 3, 4, 5, 8, 9, 10, 11, 12. In each of the several tables likewise the average of yields is computed and put down. Comments which follow immediately after the tables are explanatory without undertaking at that point to draw conclusions relative to amounts of grain or forage from sorghum or from corn, in comparison that can be secured as an average over such a term of years as 1912 to 1932.

It appears possible that the formation of a general conclusion with regard to productiveness may receive assistance from assembling all the average yields from the tables already cited, as in the following Table 13.

TABLE 13.—Comparative average returns of grain and forage under the several conditions of soil and climate from experiment farms from sorghum and from corn for comparison. (1912-1932)

Name of Experiment Farm	Abstracted from Tables	Page Number	Years represented	Yield of grain in bushels per acre from given crop		Yield of forage in pounds per acre from given crop	
				Sorghum	Corn	Sorghum	Corn
Cottonwood	3, 4	26, 27	1912-1932	7.2	8.3	1634	1473
Cottonwood	2, 5	23, 29	1912-1932	10.5	7.9	2992	1614
Eureka	8	35	1914, 1919-1932	11.6	22.9		
Eureka	9	37	1914-1916, 1918-1932			4150	3840
Highmore	10, 11	39, 41	1912-1932	14.3	17.3	2580	2580
Brookings	12	42	1914-1918, 1921, 1923-1932	18.9	40.0	4970	4460

Deductions from Foregoing Table 13. Summary of Comparative Average Yields of Grain or Forage from Sorghum

Examination of the foregoing Table 13 makes it possible to put down statements based thereon which may summarize what might be called **the utility of sorghum as a producer of grain or forage, under conditions of soil and climate in representative sections of South Dakota.**

1. An inspection of average yields of grain from sorghum and corn put down in bushels per acre in Table 13 makes it evident that the yields are below those of corn at all four locations in South Dakota, with the exception of those from one of the two trials at Cottonwood. In said trial the yield of grain from sorghum computed in bushels per acre is apparently higher than the yield from corn.

It may be recalled at this point that yields of grain from sorghum are computed in bushels per acre with the use of 50 pounds per bushel, whereas yields of corn are computed on a basis of 70 pounds of ears per bushel which may be the equivalent of 56 pounds of shelled corn.

In all other comparative trials carried through at the four locations in South Dakota yields of grain from corn are obviously higher than those from sorghum.

It occurs in this connection that the trials made at Cottonwood are the only ones reported in Table 13 that were carried out in the territory west of the Missouri. Production of grain from sorghum was evidently more nearly equal to that of corn in the area represented by Cottonwood than at any other point where trials were made. The data of Table 13 would indicate that sorghum may not displace corn nor become one of the major grain producing crops of South Dakota in the area represented by Eureka, Highmore, and Brookings, east of the Missouri.

2. The reverse of the foregoing is true in regard to comparative total yield of field cured forage from sorghum and corn, put down in the right hand section of Table 13. The gross weights of total forage from sorghum are invariably equal to or greater than those from corn at all points in the state east or west where these long-term trials were carried out.

Sorghum in South Dakota may be utilized mainly as a forage crop rather than as a grain crop.

Such a statement need not imply that sorghum may not be utilized to produce grain for special purposes or in certain instances. It means, however, that the principal attention given to producing sorghum over large areas in immediate future will likely be directed toward the production and utilization of sorghum for use as forage.

The data of Table 13 give reason to believe that for the purpose indicated sorghums may be expected to produce approximately as high gross yield of fodder as corn. That being the case, it may be expected that sorghum will be utilized perhaps increasingly, under conditions where drought and grasshopper resistance are required, or where for any reason it is desired to supplement corn for forage or to substitute another crop for it entirely.

Sorghum Interspersed with Corn at Vivian Experiment Farm

The similarity in amount of growth and in general productive capacity of sorghum and corn was a consideration in 1931 which made it seem feasible to plant alternate pairs of rows of each crop in question on certain acres intended to produce forage for ensilage at Vivian Experiment Farm. (For detailed description of arrangement of these acres see South Dakota Experiment Station bulletin 253, page 6.) The immediate reason for attempting this experiment was the fact that it had been noted on the Agronomy plots at Highmore, Brookings, and elsewhere that the ravages of grasshoppers on sorghum were much restricted in comparison with similar depredations on corn when both crops were equally exposed.

The plan of experiment and results are not here put down in detail in view of the fact that only two years of crop yields at Vivian are available involving it and furthermore, that yields are very uneven due to grasshoppers. Suffice it to say that the method of planting of sorghum and corn in the areas referred to was carried out with the placing of corn in one planter box and sorghum in the other, and proceeding with planting as usual, whether the crops were checked, listed, or drilled.

The following Table 14 puts down a summary of average computed yields secured from corn and sorghum taken out of the alternate pairs of rows in the two years, 1932 and 1933.

TABLE 14.—Computed average yields from corn and sorghum planted in successive pairs of rows in the same acres at Vivian Experiment Farm.

Year	Manner of planting	Computed average yield of given crop in pounds of silage per acre	
		Corn	Sorghum
1932	(checked)	2266	1964
1932	(listed)	1701	1396
1932	(drilled)	2200	4786
1933	(checked)	00	00
1933	(listed)	00	1370
1933	(drilled)	00	221

Examination of the foregoing Table 14 causes it to appear immediately that yields of both corn and sorghum (usually Grohoma) at Vivian in 1932 and 1933 were uneven. The fact is not surprising in view of the fact that the conditions of moisture and grasshoppers to which the crops were exposed were indeed uneven. It is therefore not believed that the comparison of yields put down gives additional data concerning yielding capacity of sorghum. They are included here to make mention of the method of planting sorghum in alternate rows, or alternate pairs of rows with corn, thus producing mixed forage. It is possible that such mixed forage is of superior quality to that of unmixed sorghum. It appears to the writers from observations on the ground at Vivian Experiment Farm that when sorghum and corn rows are thus alternated even under conditions of drought and grasshoppers, the chance of getting some yield of acceptable forage is measurably enhanced. This was illustrated in both years of Table 14, especially by 1933 when the only part of the crop remaining undevoured by grasshoppers were the occasional alternate rows of sorghum.

Such an outcome not only furnishes a strong suggestion for planting sorghum with corn in a mixture for forage, but serves as an additional bit of evidence of the value of sorghum for forage, in this case for silage, under conditions of limited rainfall and accompanying grasshoppers.

Comparative Yield Tests with Kinds or Varieties of Sorghum for Forage

After having arrived at the considerations summarized in Table 14 and the statements based thereon to the effect that sorghum in general is a forage crop under our conditions, the question assumes interest: What kind of sorghum for forage? Such question also would of course need to be answered with reference to the varying sets of conditions found within South Dakota.

The summary of yields put down in the following Table 15 gives information on the foregoing question for the conditions at Cottonwood Experiment Farm, for two kinds of sorghum, Sudan and Amber cane and the comparison is made with Shelley millet.

TABLE 15.—Comparative yields of forage from two kinds of sorghum, sudan, and Dakota amber, with Shelley millet at Cottonwood Experiment Farm, each crop with two methods of seeding. (Rotation No. 11).

	Average Yield in Pounds Per Acre from Given Crop with Given Method of Planting					
	Sudan		Amber cane		Shelley millet	
Year	42" rows	Solid	42" rows	Solid	36" rows	Solid
1916	3299		1808		2240	
1917	2690	00	00	00	00	00
1918	5950	4880	3340		4182	5212
1919	2500	1214	1627		1996	2668
1920	3720	2900	6570		4280	4320
1921	856	1044	1286		1128	1992
1922	2200	3240	4780		4740	5540
1923	5940	3880	12070	9500	3820	5480
1924	1550	960	3020	1520	1180	1260
1925	646	410	410	215	00	00
1926	1415	1630	1713	2160	1240	1650
1927	2900	3150	3433	3850	2517	2025
1928	1100	800	1133	900	766	400
1929	787	830	1273	1500	1533	600
1930	3047	1950	3713	3600	707	900
1931	200	160	1533	1050	320	440
1932	1467	1800	1750	1800	3667	3800
Av. 1916-32	2369		2909		2019	
Av. 1923-32	1905	1557	3005	2610	1575	1656
Av. for variety, 1923-32	1731		2807		1615	

Deductions from Table 15

A comparison of average yields of forage in the foregoing table, whether those for 1916 to 1932 or 1923 to 1932, indicates that the **gross production of forage from Amber cane is higher than that from Sudan at Cottonwood.**

It is the opinion of the writers based on observation that the apparent superiority of yield of Amber cane might be appreciably reduced if it were possible to reduce all yields to a basis of equivalent moisture.

Total yields of forage at Cottonwood from either Amber cane or Sudan are appreciably higher than yields of forage from Shelley millet.

Comparative Yields of Forage from Sorghum (Five Varieties) With Shelley Millet and Corn at Highmore Experiment Farm

Another series of tests which supply information about the relative productiveness of kinds of sorghum and other crops for forage was conducted at Highmore Experiment Farm in the years 1917 to 1932.

The returns are put down in the following Table 16, in terms of pounds per acre of field cured forage, from each kind of crop.

TABLE 16.—Comparative yields of forage from five kinds of sorghum with four other crops including corn and millet, in 42 in.† rows, at Highmore Experiment Farm, in years 1917-1932.

	Yield of Forage in Pounds Per Acre From Given Crop in Given Year								
Year	Dakota amber	Minnesota amber	Sudan	Shelley millet	Dwarf milo	Evergreen sw. corn	Feterita	Alta corn	Rainbow flint
1917	5340	3250	2560	4180	3260	4340	5900	5320	7300
1918	6330	7167	3220	4060	3970	3920	3080	4090	8060
1919	6420	7660	3000	3160	5290	5400	4110	3680	4470
1920	00	00	00	00	00	00	00	00	00
1921	2140	4440	3730	2888	6060	5833	5611	4000	4333
1922	5250	6380	3300	4000	3380	3950	4050	5600	5500
1923	5800	6850	6760	3800	6600	6030	5370	4900	5780
1924	3570	3400	1700	1700	1800	3150	1770	4350	5500
1925	2240	2050	2170	1400	2200	1600	1450	2240	2120
1926	1350	1200	1100	950	1160	950	1100	920	910
1927	3750	6000	2600	3000	3410	6000	7500	4400	4760
1928	2600	2500	2600	2140	2790	4060	1900	3930	4210
1929	00	00	750	900	00	920	00	1350	1900
1930	3100	2700*	3130	1900	3600	1930	2150	2000	1500
1931	00	00	00	00	00	00	00	00	00
1932	720	500*	280	400	460	900	370	1000	990
Av. 1917-32	3038	3381	2306	2151	2745	3061	2773	2986	3583

* Altamont substituted; 1929 was drought; 1920 too wet—no yield.
† All single rows except millet which was double rows.

Examination of Foregoing Table 16

It is possible to observe from the foregoing Table 16 that the yields of forage from the several plots in successive years vary widely, influenced largely by rainfall and other conditions in the several seasons. Nevertheless, it has proved possible to secure measured yields for all crops included in this yield test from all the small plots under observation throughout the sixteen years, 1917 to 1932 inclusive.

The average yields in pounds of forage per acre from the several crops are put down in the lowest horizontal line of the table.

In order to arrive at a possible basis for further observation the yields of the several crops are averaged, and these averages are put down in the lowest horizontal line. This series of averages is put down in numerical order as follows:

Rainbow flint corn ---------- 3583 pounds
Minnesota amber cane ---------- 3381 pounds
Evergreen sweet corn ---------- 3061 pounds
Dakota amber ---------- 3038 pounds
Alta corn ---------- 2986 pounds
Feterita ---------- 2773 pounds
Dwarf milo ---------- 2745 pounds
Sudan ---------- 2306 pounds
Shelley millet ---------- 2151 pounds

Examination of the foregoing average yields makes it appear that within the highest six of the series will be found three successive pairs in which yields from corn and sorghum occur in the order named. This fact leads to the belief that differences in yield of forage from the several varieties of two types of crop, namely sorghum and corn as here determined, may not be significant.

The several yields foregoing from varieties of sorghum and other forage types may be examined more closely by putting them down in groups, and computing the average yields from the separate groups as follows:

Corn	Rainbow flint	3583 pounds
	Evergreen sweet corn	3061 pounds
	Alta	2986 pounds
	Av.	3210 pounds
Sorghum	Minnesota amber	3381 pounds
	Dakota amber	3038 pounds
	Feterita	2773 pounds
	Dwarf milo	2745 pounds
	Av.	2984 pounds
Sudan		2306 pounds
Millet (Shelley)		2151 pounds

1. Amber cane, under conditions at Highmore, may produce more total forage per acre than Feterita or Dwarf milo.

2. Any of the foregoing may produce a higher total yield of forage than Sudan (in this connection recalling that moisture content in field weights of sorghum may serve to make this superiority more apparent than actual.)

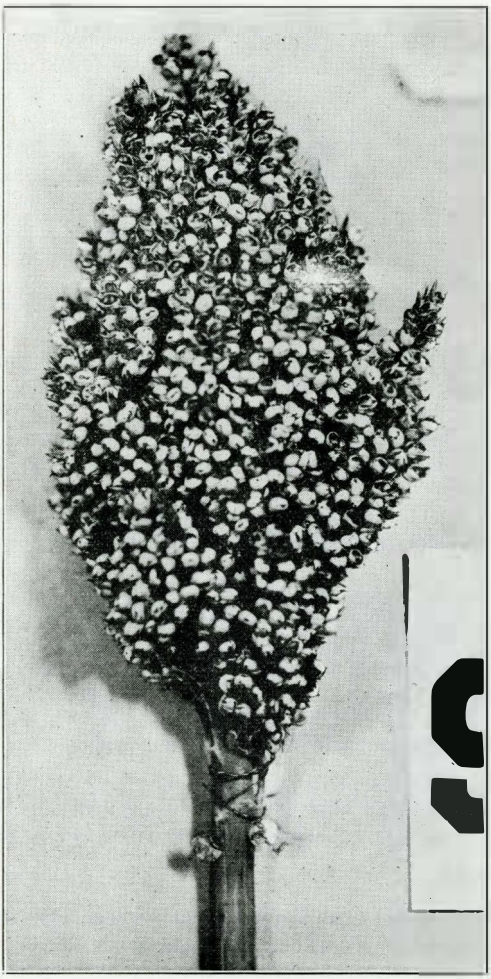
3. The total yield of forage from Shelley millet at Highmore was somewhat lower than that from the several kinds of sorghum and also lower than corn.

4. The foregoing order of average total production of forage from amber cane, Sudan and Shelley millet at Highmore is the same as that developed at Cottonwood (Table 15, page 47). The fact that the total average yield of forage from three kinds of corn was only slightly higher than yields from Amber cane is in fairly close agreement with the fact brought out in Table 13, namely, that average yields of forage from corn and sorghum at Highmore are generally equivalent.

Incidental to the present discussion it may be noted that the highest yield of forage from any kind of corn was produced by Rainbow flint; flint corn, like sorghum is more resistant to grasshoppers than other kinds of corn.

Yields of Forage (and Grain) from Several Varieties and Strains of Sorghum at Brookings, 1932-1933

It is possible to present tentative yields from varieties and strains tested at Brookings on Agronomy West Farm in two successive years. These results are put down in the following Table 17.



FETERITA

Often produced in this state. May mature grain and make fair forage for livestock.

TABLE 17.—Computed yields of forage and grain from varieties and strains in nursery rows of sorghum at Brookings in two seasons (1932 and 1933) in pounds and bushels per acre.

Name of Variety	Source of Introduction	South Dakota Number	Yield of forage or seed in given year						Rank	
			Forage			Grain			For-age	Grain
			1932	1933	Av.	1932	1933	Av.		
Early Sumac	Hays, Kansas	1443	15400	7250	11325	22.0	2.0	12.0	1	19
Western Blackhull	Hays, Kansas	1444	11500	5750	8625	33.2	4.8	19.0	2	13
Kafir corn	Seed Co.	1445	12000	4700	8350	26.8	3.5	15.2	3	17
Early White Milo, FCI 5886	Redfield	1446	9200	4650	6925	33.2	19.3	26.3	4	9
Sooner Milo, CI 917	Hays, Kansas	1447	8400	5100	6750	47.2	16.9	32.1	5	1
Dakota amber (bulk)		1448	8684	4467	6575	43.6	16.0	29.8	6	4
Feterita	Seed Co.	1449	8800	4200	6500	28.8	7.8	18.3	7	14
Grohoma	Vivian, S. D.	1450	13000	00	6500	22.0	0.0	11.0	8	21
Sel. of Dakota amber (Av. of 48 strains)		1448 Sel.	8388	4521	6454	42.9	19.6	31.3	9	2
Modoc Pink Freed, CI905	Hays, Kansas	1451	9200	3500	6350	47.2	11.5	29.4	10	5
Club Kafir, CI 901	Hays, Kansas	1452	8600	3700	6150	19.2	4.8	12.0	11	20
Early White Milo, FC 5886	Hays, Kansas	1453	8400	3750	6075	26.8	8.5	17.7	12	16
Sooner Milo, CI 917	Woodward, Okla.	1454	8200	3750	5975	44.8	17.0	30.9	13	3
Red amber (Redfield 1534)		1455	8600	2622	5611	46.4	10.7	28.6	14	6
Kalo, CI 902	Hays, Kansas	1456	7000	3200	5100	31.6	4.3	18.0	15	15
Dakota amber (Redfield 6586)		1457	7200	2520	4860	38.8	12.2	25.5	16	11
Brown kaoliang, SPI 62428	Redfield	1458	6500	2171	4336	43.6	10.6	27.1	17	7
Kaoliang (bulk)		655	5700	2833	4267	44.0	8.8	26.4	18	8
Day milo	Woodward, Okla.	1459	6800	1500	4150	41.6	1.0	21.3	19	12
Wheatland milo	Hays, Kansas	1460	6300	1800	4050	23.6	4.0	13.8	20	18
Sel. from Kaoliang (Av. of 14 strains)	Selections	655 Sel.	5200	2514	3857	42.4	8.9	25.7	21	10

Examination of the foregoing table will make it clear that computed yields of forage and grain are put down for each of two separate years, 1932 and 1933 in separate columns and that the averages of these are put down at the right in each case. Also at the extreme right of the table the rank of the several varieties and strains is put down, first for the production of forage beginning with the highest and extending to the lowest, 1-21. The corresponding rank in seed production is put down opposite, in the column at the extreme right.

These yields of sorghum for forage from nursery rows indicate high production in a number of strains. Moisture content of field cured sorghum is likely to be high. Also the seasons in which these yields were produced were favorable ones for sorghum, relatively.

The highest ranking six strains foregoing in forage production are as follows: Early Sumac, Western Blackhull, Kafir corn, Early White milo F. C. I. 5886, Sooner Milo C. I. 917, and Dakota amber (bulk).

Types of the foregoing sorghums may be in order as follows:

Early Sumac.—Listed as sorgo (sweet sorghum) in U. S. Department bulletin 1260. Early Sumac, FCI 02552, is an early strain of Sumac developed at Hays, Kansas; matures in 100 days—good yields of forage and seed, leafy, slight tendency to lodge.

"Sumac, or red top sorghum, may have been one of Mr. Wray's original varieties from Natal. . . . . Stout stalky variety, large broad leaves, panicles stout, thick, cylindrical, erect, blunt, sometimes spreading at the top. The branches of the seed head are short, the seed smallest of any variety grown in this country, brownish-red in color, egg shaped with large end outermost. The red color of the head is due to the seeds which project beyond the glumes." Farmers' Bulletin 246.

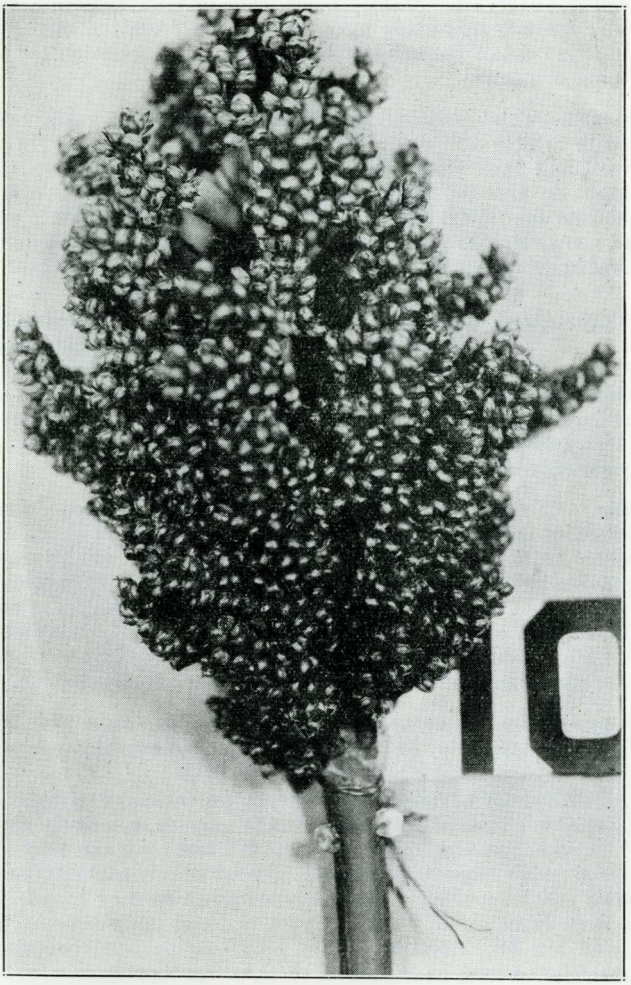
Western Blackhull.—Listed as grain sorghum. (Oklahoma Bulletin 210). This apparently is a selection from Blackhull kafir. Standard Blackhull has short black glumes and ovate shaped white seed. Heads are cylindrical, semi-compact. Plants are four to six feet in height, with juicy, somewhat sweet stalks.

Early White Milo, FCI 5886.—Listed as grain sorghum, U. S. Department Bulletin 260.

The foregoing states also Early White Milo, the highest grain yielder is unfortunately almost worthless as forage.

Sooner Milo.—Very nearly the same may be said of Sooner Milo as the foregoing about Early White Milo, one exception being that the seed of Sooner Milo is not so white—yellower in color. It is the understanding of the writers that neither one is recommended for very high quality of fodder.

Dakota amber.—The most common variety of sweet or saccharine sorghum. Generally produced because of its comparative early maturity. Early productions were named Minnesota amber and apparently selections made therefrom and developed by this Experiment Station and others in cooperation with the United States Department of Agriculture are called Dakota amber.



WHEATLAND MILO

Milo, or Milo maize, is grain sorghum. A newer selection is Wheatland, adapted for combining. (Kansas Exp. Sta. Bu. 265).

It will be noted from the foregoing table that this Experiment Station now has 48 selected strains of Dakota amber made by the Junior author of this bulletin. These produced an average of 6454 pounds per acre, which however, was slightly below that of bulk Dakota amber (See Table 17.) Superior production may be expected from the increase of the most productive out of the selected strains. Further selection for this purpose is being continued.

Kafir corn.—This is listed as one of the group of grain sorghums. "Forms with white seed and compact panicles, but having in addition rather sweet and juicy stems, seem to belong to the kafir as well as to the sorgo group. So also the kafirs grade imperceptibly into the durras and the durras into the milos, and kaoliangs and forms of the grass sorghums are found growing wild in Africa that are nearly as large and coarse as the cultivated sorghums." (U. S. Department of Agriculture bulletin 1260.)

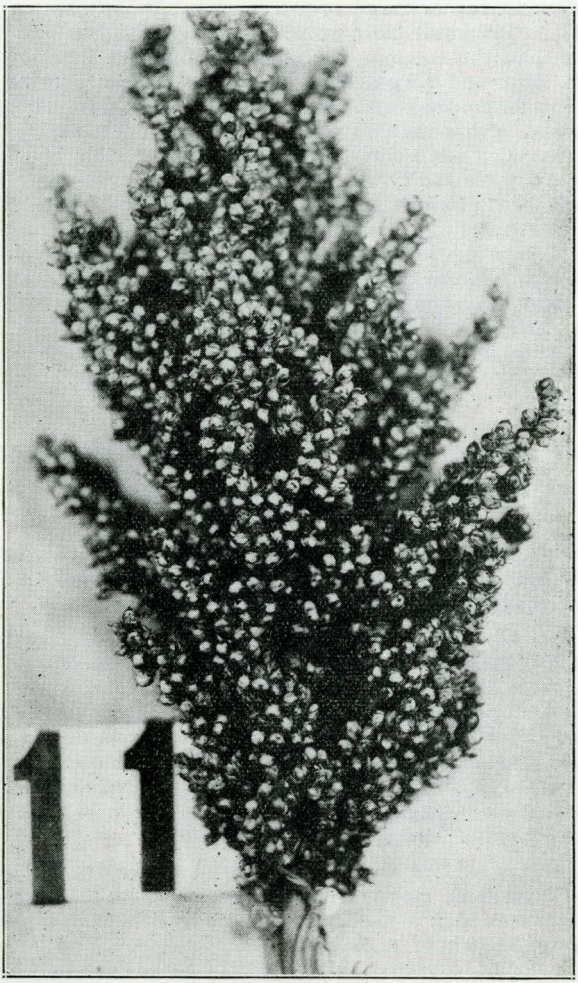
"The kafir group includes Red kafir, White kafir, Black-hulled white kafir . . . . . all characterized by erect, rather long and compact cylindrical heads full of ovate seeds (egg-shaped with the large end outermost) which are either white or red, as indicated by the name. White milo may be separated from black-hulled white kafir by its much taller growth longer internodes (space between joints of the stem) and larger light colored yellowish leaves." (Farmers' bulletin 246.)

Feterita.—"Feterita or Sudan durra is an erect-headed durra introduced in 1906. It is much cultivated in Sudan in the region about Khartum. Feterita has rather slender stems, 5 to 7 feet high, slightly juicy and sweet, and inclined to produce branches; heads erect, cylindrical, dense but not so compact as milo; grains bluish white, subglobose, much larger than those of milo or kafir; glumes black, shiny, densely hirsute on margins only half inclosing the seeds; early, maturing about one week before milo". (Forage Plants and Their Culture—Piper. MacMillan Co.)

Kaoliang.—"The kaoliangs comprise a group of grain producing sorghums from eastern Asia, introduced into the United States from China and Manchuria, at various times previous to 1913.

"There is diversity of habit and color among various varieties. All have dry, pithy stalks, 1 to 3 centimeters in butt diameter, relatively few (8-13) leaves which are comparatively small, 1 to 2.5 feet long and 1 to 2.5 inches wide; glumes never exceeding the seed; almost wholly glabrous or smooth, and lemmas (seed coverings) always bearing an awn or beard. Panicles or heads vary from small, oval, compact to long, umbelliform (umbrella shaped) and lax or spreading. Glumes or outside seed coverings vary from two-thirds as long as the seeds to equaling them.

"Seeds vary from 3 to 6 millimeters long; in color from chalky white through buff and orange-buff to various shades of reddish-brown and brown." (The Kaoliangs, U. S. Department of Agriculture Bureau of Plant Industry Bulletin No. 253. Also South Dakota Bulletin 156.)



KAFIR

One of the varieties grown farther south mainly for grain, along with milo and feterita. Some kafirs have forage value—more than milo and feterita.

(Kansas Bu. 265).

Grohoma.—"The characteristics of Grohoma indicate that it is . . . . a hybrid between feteria and some variety of sorgo.

"Grohoma is about four to five and one-half feet in height, with large bushy heads, and rather large brown kernels. It matures in about the same period as Blackhull kafir grown in eastern Kansas and Oklahoma, but is later than the common varieties of Milo and Feterita and early varieties of kafir and sorgo. The heads are seldom exerted from the 'boot' and in consequence are often moldy at the base. The stalks are thick and leafy, with a marked tendency toward objectionable branching. They are less juicy than sorgo (sweet sorghum), kafir and hegari, but are similar to dry stalked types of sorghums such as feterita. The juice of Grohoma is somewhat sweet as compared with most other grain sorghums, but it is less sweet than many of the sorgos. The leaves are broad and wrinkled and have a white midrib which is evidence of a relatively dry stalk. Grohoma, because of its late maturity and leafiness, is less resistant to drought than many well-known varieties of grain sorghum. It is not a pure variety, but bears a mixture of several types of heads and brown and white seeds." (Grohoma—John H. Martin, Bureau of Plant Industry, Division Cereal Crops and Diseases, Circular.)

Summary Statement of Maximum Yields from Kinds of Sorghum in Several Areas

Gathering up the indications in this bulletin, mostly from pages 46 to 56, of the kind or variety of sorghum that may be most likely to combine high production with utility, we find as follows:

At Cottonwood, **Amber cane** yielded more pounds of forage (average 17 years) than Sudan, and both of said sorghums more forage than Shelley millet (Table 15, page 47). Likewise at Highmore, **Amber cane** produced more total forage than even Feterita, or Dwarf Milo (average 16 years. Discussion of Table 16, page 48.) Also at Brookings, **Early Sumac** which is also a saccharine sorghum, in tentative trials (2 years) in nursery rows, ranked first in yield of forage. (Table 17, page 51). At Eureka, (returning to Table 9, page 37) **Amber cane** (average 18 years) produced a higher total yield of forage than corn or millet.

Thus it seems evident that either some variety or strain of **Amber cane or perhaps some closely related kind of saccharine sorghum will probably return as high a yield as any kind of sorghum available which may be planted anywhere in South Dakota.** Such an indication seems fortunate in view of the admitted desirability of sorgo (saccharine sorghum) for forage. It is only necessary to mention in this connection that amber sorghums are susceptible to generating prussic acid, though apparently not more so than other sorghums.

The indications are clear that **Sudan grass produces a somewhat lower total yield of forage than Amber cane in South Dakota.** The well known palatability of Sudan, and its comparative freedom from tendency to generate poison even under strenuous conditions nevertheless give it a high place as sorghum for forage in South Dakota.

Acknowledgements

The writers wish to acknowledge that the series of crop trials which began about 1912 and which have extended with minor interruptions until 1933, have furnished the basis of this bulletin.

The crop rotations and culture experiments including sorghums were installed under direction of the senior author. A number of years they received first-hand superivision by Professor Manley Champlin. Foremen at the several experiment farms planted the crops and made record of the harvests, with fidelity. These men included S. W. Sussex, Joseph Hoffman, Walter Schonbrod, Frank Hussey, L. W. Sutton, Gus B. Ulvin, Rex Bankert.

Field records have been transferred and tabulated by Miss Elva Feurhelm, clerk.

Other members of this department have contributed directly and indirectly to the completion of the various series of crop yields. Without their help the work could not have been accomplished.

Annual Rainfall by Months at the Several Stations

Brookings

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1905	0.22	1.00	0.68	1.01	6.14	6.09	0.98	4.54	2.16	1.50	2.45	T	22.77
1906	0.17	0.02	0.58	1.40	3.51	4.87	1.86	4.28	5.13	3.01	0.89	0.52	26.26
1907	1.06	0.28	0.55	1.07	2.36	5.65	3.77	1.41	1.28	0.96	0.10	1.12	20.21
1908	0.26	1.80	1.16	2.10	6.46	6.35	4.69	2.37	3.89	1.43	1.30	0.42	32.17
1909	1.20	1.57	0.37	1.16	4.85	2.29	2.44	3.39	1.67	1.71	0.65	1.14	22.44
1910	1.07	0.40	0.35	2.34	0.87	1.85	1.68	2.46	0.96	0.38	0.17	0.10	12.63
1911	0.61	0.53	0.53	1.62	1.90	3.78	3.32	3.81	3.08	5.12	0.23	0.42	24.95
1912	0.28	0.24	0.26	3.36	6.98	2.09	2.52	4.68	1.61	0.96	0.00	0.20	23.18
1913	0.02	0.09	0.45	2.24	3.60	1.96	2.99	1.33	1.55	1.18	0.81	0.09	16.31
1914	0.22	0.40	0.42	1.64	4.16	6.67	1.62	3.16	3.32	2.21	T	0.33	24.15
1915	0.18	1.12	0.18	2.03	2.12	3.28	3.04	3.52	2.68	1.37	0.28	0.62	20.42
1916	1.47	0.32	0.40	2.95	3.72	4.27	0.40	2.03	0.84	0.45	0.03	0.36	17.34
1917	1.54	0.47	1.09	3.09	3.08	3.49	2.03	1.20	2.89	0.12	0.04	0.31	19.35
1918	0.19	0.14	0.44	1.28	3.40	1.85	3.95	4.19	0.72	1.56	1.61	1.09	20.42
1919	0.07	0.63	0.73	1.90	3.87	9.30	5.60	1.48	1.69	1.14	1.35	0.10	27.86
1920	0.34	0.24	1.85	2.95	3.84	7.27	5.45	2.15	1.99	0.66	1.30	0.30	28.34
1921	0.09	0.05	1.49	1.42	2.99	0.85	3.44	2.11	4.25	0.27	0.50	0.10	17.56
1922	0.40	1.73	0.79	0.42	1.82	3.75	2.81	1.70	0.36	0.81	3.08	0.20	17.87
1923	0.27	0.07	0.29	3.00	2.59	5.74	1.94	3.03	1.73	1.41	0.23	0.23	20.53
1924	0.10	0.31	1.34	1.82	1.32	6.88	1.22	3.89	1.02	0.84	0.11	0.35	19.20
1925	0.11	0.06	0.22	1.88	0.49	6.17	1.26	0.64	0.77	0.26	0.57	0.33	12.76
1926	0.70	0.06	0.14	0.13	1.44	3.64	3.14	1.46	2.10	0.68	0.56	0.63	14.38
1927	0.14	0.35	0.83	4.04	4.29	1.46	4.88	0.35	1.98	0.49	0.49	1.10	20.40
1928	0.09	0.30	0.44	0.96	0.53	2.97	2.69	4.52	1.37	1.68	0.78	0.15	16.48
1929	0.96	0.45	0.68	3.32	2.11	1.12	3.25	2.33	4.80	2.41	0.04	0.07	21.54
1930	0.42	0.40	0.25	1.25	2.04	1.68	0.27	1.50	3.28	1.84	2.01	0.10	15.14
1931	0.03	0.04	0.30	1.33	0.68	2.42	1.62	3.24	2.00	1.11	1.89	1.07	15.73
1932	0.54	0.13	0.27	1.34	2.23	3.07	2.34	4.07	2.07	0.81	0.32	0.24	17.43
1933	0.07	0.18	1.08	0.98	1.44	0.67	1.42	2.40	3.82	0.05	0.09	0.50	12.40

Annual Rainfall by Months at the Several Stations (Cont'd.)

Cottonwood

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1910	0.66	0.97	0.76	1.06	2.54	1.30	1.11	0.48	0.82	0.32	0.53	3.00	12.65
1911	T	0.15	T	0.85	1.10	0.64	0.59	2.41	3.59	1.15	0.20	0.42	11.10
1912	0.17	0.05	3.00	3.32	1.18	0.95	2.42	2.42	1.30	0.11	T	0.12	16.04
1913	0.16	0.10	0.43	1.15	2.95	0.59	0.81	1.84	1.15	0.76	0.14	0.38	10.46
1914	0.03	1.18	0.35	2.26	2.35	1.64	1.04	1.88	1.19	2.23	0.02	0.84	15.28
1915	0.39	1.57	0.46	2.80	6.61	4.79	4.58	2.51	2.42	0.90	T	0.10	27.31
1916	0.04	0.02	0.04	0.81	3.87	1.83	1.80	2.22	0.18	0.57	0.15	0.14	11.67
1917	0.45	1.50	0.31	0.80	3.30	0.62	0.90	2.00	1.17	0.14	0.39	0.50	12.08
1918	0.32	1.50	0.34	2.27	2.78	1.37	2.29	3.43	1.43	0.28	0.11	0.25	16.37
1919	0.04	0.29	0.71	3.57	1.29	4.97	2.05	0.20	0.25	2.03	0.71	0.20	16.31
1920	0.27	0.54	0.58	2.80	5.83	4.02	0.67	1.87	1.63	0.93	0.36	0.18	19.68
1921	0.17	0.10	0.17	0.40	2.91	0.78	3.58	1.10	0.41	3.43	0.29	0.21	13.55
1922	0.94	0.32	0.00	1.25	2.37	5.43	6.48	0.72	0.16	0.92	2.32	0.00	21.41
1923	0.00	T	0.00	0.66	2.41	4.87	5.28	3.08	3.05	1.89	0.18	4.00	25.42
1924	0.00	0.00	0.32	0.06	0.29	3.03	1.78	1.48	3.05	0.85	0.31	0.17	11.34
1925	4.00	0.20	1.07	1.17	0.72	4.80	0.60	0.39	0.49	0.48	0.08	2.10	13.41
1926	0.00	0.50	0.00	0.75	2.77	1.97	3.52	1.56	0.37	1.12	1.06	0.00	13.62
1927	2.00	0.00	0.03	2.74	5.16	3.26	2.38	2.21	0.63	T	0.00	0.00	16.61
1928	0.00	0.03	0.86	0.35	1.14	3.83	3.11	0.94	1.65	1.19	0.77	T	13.87
1929	0.46	0.03	4.34	2.51	2.20	3.56	1.74	0.89	1.44	0.61	0.10	0.03	17.91
1930	0.35	0.49	3.59	1.85	0.94	0.97	0.99	7.82	1.20	3.98	0.05	0.05	21.77
1931	0.00	0.05	1.23	0.17	1.27	0.62	0.84	0.82	1.65	0.71	T	0.00	7.36
1932	0.00	0.00	T	3.67	3.60	4.34	2.35	0.74	0.26	0.51	T	0.00	15.47
1933	0.04	T	0.58	2.72	4.65	0.56	0.43	3.14	0.32	0.03	0.27	0.02	12.76

Annual Rainfall by Months at the Several Stations (Cont'd.)

Highmore

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1908	T	0.53	0.00	1.35	2.68	5.78	2.49	3.53	0.62	2.19	1.39	0.31	28.87
1909	0.26	0.34	0.13	0.30	4.72	1.69	1.81	3.74	1.70	1.04	0.71	1.41	17.85
1910	0.82	0.19	0.58	1.40	0.94	3.74	0.85	0.66	0.89	0.24	0.40	0.44	9.05
1911	0.11	0.39	2.54	0.32	2.31	0.09	2.69	2.52	3.06	1.05	0.35	0.44	15.87
1912	0.13	0.11	0.27	1.05	2.20	1.31	1.44	3.39	0.71	0.20	0.00	0.35	12.00
1913	0.05	0.30	0.87	1.27	4.56	0.97	1.79	1.20	0.53	0.61	0.03	0.28	12.46
1914	0.13	0.62	0.45	3.65	2.23	4.09	2.01	1.16	1.01	1.92	----	0.25	17.52
1915	0.43	1.28	0.37	2.50	3.48	4.87	5.55	0.78	2.36	1.15	0.32	0.20	23.29
1916	1.40	0.27	0.74	0.89	4.15	4.54	2.10	4.10	2.75	0.58	0.13	0.47	22.12
1917	1.12	0.52	1.27	2.79	2.04	2.04	1.91	0.68	2.03	0.06	0.07	0.27	14.80
1918	0.60	0.25	0.45	2.57	3.57	1.59	5.26	1.88	0.62	0.49	1.10	0.86	19.24
1919	0.10	1.35	1.24	1.96	6.63	1.95	2.65	0.82	0.54	2.16	1.80	0.15	21.35
1920	0.27	0.33	1.20	2.56	6.04	7.05	3.56	2.47	1.51	0.75	0.34	0.20	27.08
1921	0.25	T	0.49	1.78	2.60	0.55	3.10	3.68	4.79	1.20	0.33	0.20	18.97
1922	0.45	0.93	1.05	0.93	2.78	3.65	2.85	0.41	0.48	0.39	2.83	0.35	17.10
1923	0.42	0.01	1.01	1.63	2.04	5.15	3.81	5.01	1.17	0.87	0.21	0.19	21.52
1924	0.07	0.58	1.63	1.40	0.50	5.66	2.11	1.13	2.69	1.10	0.34	0.82	18.03
1925	0.60	0.21	0.08	1.30	1.08	5.39	0.70	1.49	0.71	0.12	0.20	0.52	12.40
1926	1.56	0.00	0.03	0.16	1.96	9.50	2.53	2.09	1.07	2.78	0.16	0.36	14.20
1927	0.21	0.08	0.85	3.35	5.80	2.22	1.04	1.77	1.47	0.83	0.71	0.76	19.09
1928	0.04	0.22	0.48	1.11	0.96	2.94	2.50	2.32	0.76	1.66	0.91	0.09	13.99
1929	0.67	0.22	1.75	2.76	1.89	1.71	0.69	1.55	1.76	3.08	0.33	0.05	16.46
1930	0.07	1.36	0.74	2.90	4.37	2.48	0.55	2.45	0.74	2.69	0.81	T	19.16
1931	0.10	1.83	0.68	1.60	1.64	0.38	0.38	0.56	1.53	0.75	0.83	0.93	10.94
1932	0.12	0.08	0.80	1.60	2.82	3.31	1.52	1.75	2.11	0.88	T	0.12	15.11
1933	0.05	0.20	1.83	1.43	2.55	1.38	1.44	1.36	1.34	0.05	0.06	0.88	12.57

Annual Rainfall by Months at the Several Stations (Cont'd.)

Eureka

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1909	0.10	0.45	0.14	0.50	2.65	3.35	2.21	1.39	1.25	0.17	0.60	2.40	15.21
1910	0.60	1.70	1.23	0.82	0.42	3.80	0.53	2.60	3.65	0.18	T	0.25	15.78
1911	0.50	0.73	0.63	2.24	0.97	1.29	0.43	3.27	1.15	0.61	0.88	0.80	13.79
1912	0.25	0.40	1.05	1.29	3.37	1.50	2.19	3.27	1.43	0.07	T	0.11	14.93
1913	0.10	0.03	0.09	0.68	1.97	2.91	2.16	1.53	0.54	1.52	0.06	0.52	12.11
1914	0.22	0.05	0.13	2.07	2.20	4.28	1.25	2.11	0.70	0.87	T	0.53	14.41
1915	0.90	1.08	0.23	1.83	2.58	4.66	3.38	2.47	3.74	3.10	0.56	0.36	24.89
1916	0.79	0.13	1.78	0.88	3.57	4.16	----	4.62	1.05	0.29	0.14	0.06	17.47
1917	0.40	0.20	1.46	2.18	1.30	1.61	1.04	0.93	0.67	0.06	2.00	0.75	12.60
1918	0.14	0.50	0.58	1.98	1.97	0.93	1.03	1.77	0.36	0.55	0.53	0.20	10.54
1919	0.07	1.04	0.52	1.28	3.68	2.29	4.08	0.77	0.04	1.13	0.12	0.32	15.34
1920	0.16	0.08	0.27	1.63	1.82	4.26	2.49	2.05	3.90	0.36	0.54	0.09	17.65
1921	0.44	0.06	1.27	3.74	3.31	0.52	4.57	4.45	3.29	1.64	0.36	0.24	19.90
1922	0.16	0.94	0.30	0.89	3.39	3.38	1.66	0.45	0.54	0.63	3.90	0.23	16.47
1923	0.13	0.17	0.35	1.31	3.55	4.17	3.67	1.72	2.56	1.52	0.22	0.20	19.57
1924	0.02	0.24	0.48	1.28	0.44	5.24	3.29	1.35	2.65	2.16	0.00	0.27	17.42
1925	0.41	0.01	0.17	2.37	1.08	6.56	0.70	1.38	1.38	0.31	0.17	0.09	14.63
1926	0.00	0.00	0.00	0.25	2.66	1.18	1.16	2.45	3.21	0.81	0.16	0.00	11.88
1927	0.00	0.27	0.19	1.31	3.72	2.90	6.39	3.43	1.15	1.89	0.05	0.39	21.69
1928	0.36	0.07	0.12	1.05	0.11	4.55	3.68	2.56	3.80	1.15	0.52	0.06	17.53
1929	0.52	0.24	0.36	1.06	1.57	0.77	2.42	0.70	1.55	2.57	0.17	0.09	12.02
1930	0.11	1.08	T	1.43	2.65	1.00	1.06	3.94	0.74	1.94	0.63	0.18	14.77
1931	0.10	0.38	0.86	0.81	2.54	5.12	1.30	5.34	0.99	1.43	0.62	0.59	20.08
1932	0.18	0.02	0.31	1.98	5.15	5.19	1.95	1.18	1.28	1.08	0.02	0.08	18.33
1933	0.24	0.10	0.74	1.23	3.03	3.28	3.27	1.28	0.60	0.05	0.26	0.15	14.23

Annual Rainfall by Months at the Several Stations (Cont'd.)

Vivian

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1915	0.50	1.77	1.19	2.62	3.02	4.31	6.76	1.12	3.16	1.12	0.38	0.03	25.98
1916	1.00	0.04	0.29	1.08	3.46	4.49	3.53	3.52	0.90	0.57	0.12	0.04	19.04
1917	1.35	0.18	1.00	2.38	5.20	1.18	1.02	2.01	2.64	0.00	----	4.32	17.28
1918	1.10	0.50	0.50	3.92	3.33	1.70	2.07	3.32	0.75	0.82	0.22	0.90	19.13
1919	0.00	0.33	0.66	4.14	3.23	5.01	4.00	0.94	1.70	1.95	1.91	0.13	23.99
1920	0.00	0.58	1.52	4.55	7.51	5.54	3.42	1.86	0.80	2.09	1.32	0.28	29.47
1921	0.19	0.01	0.68	1.53	4.23	1.22	4.34	0.44	3.55	1.68	0.63	0.28	18.78
1922	0.47	0.40	0.75	0.71	2.49	5.85	3.44	3.86	0.27	0.45	2.32	0.15	21.16
1923	0.03	0.03	0.00	1.47	1.59	4.04	1.98	3.19	1.03	1.03	0.33	1.50	16.22
1924	0.00	0.70	0.85	0.90	0.05	4.44	2.14	1.16	1.79	1.17	0.28	0.40	13.88
1925	0.17	0.12	0.04	1.00	0.49	7.53	2.00	1.16	0.02	0.28	0.08	0.35	11.03
1926	1.37	0.17	0.00	0.04	2.17	3.05	1.40	0.60	1.28	1.15	0.03	0.29	11.55
1927	0.03	0.02	1.06	6.65	6.41	1.88	1.38	1.40	0.59	1.54	0.35	0.73	21.99
1928	T	0.16	0.92	0.17	2.24	4.70	1.26	0.55	0.71	1.74	0.78	0.07	13.30
1929	0.75	0.53	1.19	4.17	1.96	2.27	0.37	0.42	2.33	5.59	0.57	0.13	20.28
1930	0.19	1.00	0.45	1.13	3.52	2.17	0.38	4.71	2.49	2.71	1.80	0.00	20.55
1931	0.20	0.08	2.52	0.37	2.74	1.77	1.45	2.35	1.06	1.00	0.55	1.05	15.14
1932	0.33	0.39	0.90	0.68	2.45	5.26	3.42	1.38	0.65	0.93	T	0.39	16.78
1933	T	0.17	2.12	1.72	3.87	1.37	2.12	1.33	1.09	0.03	0.32	0.70	14.84