TEXAS AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 172 JANUARY, 1915



# SUDAN GRASS

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

VON BOECKMANN-JONES CO., PRINTERS, AUSTIN, TEXAS
1915

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BY

B. YOUNGBLOOD AND A. B. CONNER

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*As of November 30, 1914.
†In cooperation with United States Department of Agriculture.

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# SUDAN GRASS.

The introduction of Sudan grass is an important event in the history of Texas agriculture. It satisfies a long felt need of a satisfactory hay crop for our varying conditions of soil and climate. It will undoubtedly lend emphasis to stock farming throughout the state and withal contribute much to our general prosperity.

Seed of the first introduction, which was made in 1909, was planted that year only at the Chillicothe Forage Crop Testing Station, Chillicothe, Texas, by the junior writer of this Bulletin, Mr. A. B. Conner, who was superintendent of that station at that time.* It was grown at no other place in the United States during 1909. Seed from this single row sixteen and one-half feet long at Chillicothe Station has given rise to all the Sudan grass in the hands of the farmers at the present time.

The results secured at Chillicothe in 1909 were so favorable that increase and test plats were grown in 1910. Additional test plats from seed grown at Chillicothe were carried also at Arlington Farm, Virginia, and at several other experiment farms. The increase plat grown at Chillicothe in 1910 furnished a sufficient quantity of seed for tests in 1911 at a large number of experiment stations in various parts of the United States.

In 1912 the United States Department of Agriculture, grew under contract, near the Chillicothe Station, an increase field of seed which it proposed to use for distribution in the dry-land region of the United States in 1913. The Texas Station secured six hundred pounds of this seed for distribution among Texas farmers. This seed, together with that grown in the meantime on the Texas Experiment Stations, was distributed to nearby farmers in order that they might have the assistance of these experiment stations in the production of good planting seed. In this manner a number of centers were established in various parts of the state from which good seed could be obtained.

The success of the above plan is forcibly illustrated at Temple and Lubbock stations. Farmers about these places in 1913 grew and sold over $29,000 worth of good planting seed. The 1913 crop provided planting seed for a considerable acreage, and, at the present time, the supply of seed of Sudan grass in Texas is sufficient to meet the needs of many Texas farmers.

Usually the introduction of a new crop is a slow and tedious undertaking. In the brief period of six years Sudan grass has been firmly established in the United States. The remarkably short time it has taken to introduce this crop is due to both the excellence of Sudan grass and to the methods used by the Texas Experiment Station in its distribution and in fostering the production of good seed. If this seed

*The Chillicothe Forage Crop Testing Station is a co-operative station operated jointly by the United States Department of Agriculture and the Texas Agricultural Experiment Station.

is all planted in Texas, as it should be, this state will produce during the season of 1915, a large quantity of hay for use on Texas farms.

## HISTORY AND DISTRIBUTION.

Sudan grass was introduced from Khartoum, Sudan, Africa, in 1909, by the United States Department of Agriculture. This introduction was secured through the efforts of Professor C. V. Piper, Office of Forage Crops, United States Department of Agriculture, who had made numerous inquiries in various parts of the world for an annual form of Johnson grass. Information accompanying this introduction showed that this grass was grown only in a limited way in the Sudan region, being used principally on military hay farms.

After the introduction of Sudan grass into the United States, investigation revealed the fact that it had been carried from Egypt into the Sudan region. Whether or not Sudan grass originated in Egypt has not yet been determined.

Varying forms of sorghum-like plants which are evidently closely related to Sudan grass have been found in northwest Africa, in southeast Africa, in India and in Java. A study of these various forms and their relationship and distribution is now being made by Professor Piper and will undoubtedly reveal some interesting information as to the origin, history and development of the Sudan grass.

## DESCRIPTION.

Sudan grass is an erect growing annual plant which reaches a height of seven and one-half feet under favorable conditions. It has a fibrous root system and is entirely free from underground rootstocks. Its extensive root system provides facilities for the plant to feed heavily upon soil moisture and plant food, and is no doubt responsible, in a measure, for the greater above ground growth of this crop than that of Johnson grass.

The stem seldom grows larger than a lead pencil even when planted in cultivated rows; is pithy, not hollow, and carries from ten to fourteen leaves to the plant. The leaves are longer and broader than those of Johnson grass, and, unlike the latter crop, extend to the base of the seed-head. The seed-head ranges from ten to sixteen inches in length, and frequently attains a breadth of ten to twelve inches when the panicle is spreading.

The unripe seed-head is pale green in color. The mature seed-head and the threshed seed, which generally retain the hull, are straw yellow in color. The hull may be either smooth or hairy. The seed coat, after the hull is removed, is golden brown in color.

The Sudan grass seed is one-half to two-thirds as large as amber sorghum seed and nearly the same shape.

If harvested for hay, the crop will produce three to four cuttings under favorable conditions. More than one seed crop from one planting is seldom produced, though, under favorable conditions, it is possible to secure an early and a late crop of seed. One seed crop and one or two crops of hay may be secured from the same planting in the same season, if the rainfall is favorable.

The Sudan grass in the hands of the farmers at the present time

contains several types, differing not only in color of hulls and other botanical characters, but as well in vegetative growth. The existing types with different colored hulls are very striking and are easily recognized in the field by the farmer. The types showing variation in vegetative growth are also very noticeable on careful examination of the field.

Extensive experiments are now under way to determine which of these types is best; see chapter on improvement of the crop for information on this subject, page 22.

### FEEDING VALUE.

Sudan grass hay is very much relished by hay-eating animals. It is also healthful to the animal. Hay may be rich in nutrients contained and yet low in feeding value. Whether or not hay is relished and its good or bad effect on the animal to a large extent determines its actual feeding value. Sudan grass hay is rich in nutrients, according to analysis. That it is remarkably palatable is shown by the fact that horses and mules at Texas Substation No. 7, Spur, Texas, showed a preference for it over choice pea green alfalfa. Figure 1 shows a late crop

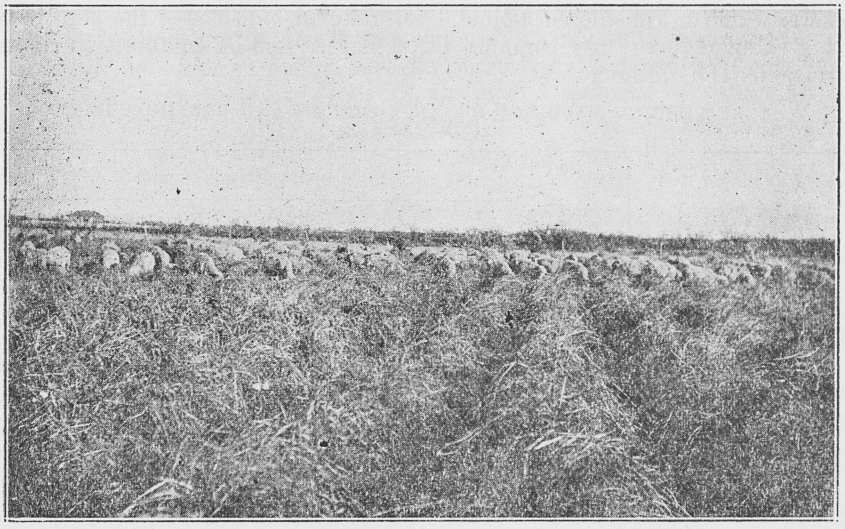


Fig. 1.—Late crop of Sudan Grass at Substation No. 7, Spur, Texas, being pastured off by sheep. Note apparent relish with which the sheep are eating the cured grass which had previously been killed by frost.

of Sudan grass, which after being killed by frost, was pastured off by sheep. Note the apparent relish with which the sheep are eating this hay.

Timothy hay is considered the standard hay in the United States. Johnson grass hay is well known in Texas. The following table shows the composition on a water-free basis, of Sudan grass, Timothy and Johnson grass and other hays common in this State:

AVERAGE COMPOSITION OF VARIOUS GRASS HAYS.
Water-free Basis.

| Name of hay. | Protein. | Fat. | Crude fibre. | Nitrogen-free extract. | Ash. |
|---|---|---|---|---|---|
| Sudan | 12.42 | 1.93 | 29.93 | 45.56 | 10.16 |
| Johnson | 7.99 | 2.10 | 33.22 | 48.79 | 7.90 |
| Oat hay | 8.91 | 3.33 | 32.11 | 48.70 | 6.95 |
| Sorghum | 9.95 | 3.73 | 26.68 | 50.00 | 9.64 |
| Millet | 8.63 | 2.50 | 31.98 | 48.10 | 8.79 |
| Bermuda | 12.09 | 2.37 | 25.52 | 51.55 | 8.47 |
| Timothy | 6.79 | 2.87 | 33.41 | 51.84 | 5.09 |

These analyses, figured on a water-free basis, show the Sudan grass hay to be high in protein content. It is also lower in crude fiber than any other hay shown, except Bermuda. It appears to be somewhat lower in fat and nitrogen-free extract, or carbyhydrates, than other hays shown in table.

Sudan grass is considered equal in feeding value to any of the hays shown, with the exception of Bermuda grass. The average yield of Sudan grass hay from twenty tests at four different Texas Substations was 7,655 pounds to the acre. Estimating the yield of Bermuda grass hay at 4,000 pounds and Johnson grass hay at 4,000 pounds to the acre, which is considered a liberal estimate in both cases, the acre feeding value of these three common Texas hays, based on composition shown in table, is as follows:

ACRE FEEDING VALUE OF SUDAN, JOHNSON AND BERMUDA HAYS.
Water-free Basis.

| Kind of hay. | Acre yield. Pounds. | Acre composition in pounds. | | | | |
|---|---|---|---|---|---|---|
| | | Protein. | Fat. | Crude fiber. | Nitrogen-free extract. | Ash. |
| Sudan | 7655 | 950 + | 147 + | 2291 + | 3487 | 777 + |
| Johnson | 4000 | 319 + | 84 | 1328 | 1951 | 316 |
| Bermuda | 4000 | 483 | 94 | 1020 | 2062 | 338 |

The above figures show the remarkably high acre feeding value of Sudan grass hay as compared to other common hays in this State. A nineteen year average of Timothy hay in Ohio, according to the Ohio Experiment Station, is 3367 pounds to the acre. A two year average of Sudan grass secured by the Ohio Station shows an average yield of 8,300 pounds cured hay to the acre. On a basis of these yields, and the analyses shown in the table above, these two hays have an acre feeding value as follows:

ACRE FEEDING VALUE OF TIMOTHY AND SUDAN HAYS.
Water-free Basis.

| Kind of hay. | Acre yield. Pounds. | Acre composition in pounds. | | | | |
|---|---|---|---|---|---|---|
| | | Protein. | Fat. | Crude fiber. | Nitrogen-free extract. | Ash. |
| Timothy | *3367 | 228 | 96 | 1124 | 1723 | 171 |
| Sudan | *8300 | 1030 | 160 | 2484 | 3771 | 843 |

*Yields reported by the Ohio Experiment Station.

These figures are based on actual yields at the Ohio Experiment Station where Timothy is the standard hay crop. Based on these yields, Sudan grass has approximately twice the acre feeding value of Timothy hay. Since our average Sudan grass hay yields are approximately equal to yields of Sudan grass hay used in this comparison, it is obvious that in Sudan grass hay we have a crop much superior to the hay crop of the Central Western States.

## ADAPTATION.

Sudan grass is adapted to a very large area, including the entire southern half of the United States and much of the Great Plains region, as far north as the Dakotas. This station has had report of good results from seed sent to Illinois. It is beyond doubt well suited to the entire State of Texas, with the possible exception of extremely high altitudes where the rainfall is below twelve inches and where no irrigation is practiced.

Experiments conducted at Substation No. 4, Beaumont, which is a rice station and not provided with good drainage facilities, show that while fair yields are secured under such conditions, this crop does not find ideal conditions for growth on poorly drained soils.

Tests at stations in the western part of Texas, where the rainfall is limited, show that a reasonable amount of moisture is needed for the best yields. The extensive fibrous root system developed, makes it one of the most drouth evasive crops known to dry regions.

It is well suited to heavy clay soils, loamy soils and sandy soils, provided the last is reasonably fertile. It is not fastidious as to soil type. The rich loamy soils are considered more nearly ideal for its best growth than either the heavy clays or the sandy soils.

## PLACE IN CROPPING SYSTEM.

Sudan grass is not a legume. It is, therefore, not able to take plant food from the air and store it in the soil. Its numerous fine roots will loosen up the soil to some extent and aid in keeping it in good physical condition. On the other hand, it produces a large quantity of hay to the acre and takes a proportionately large quantity of plant food from the soil.

It is an annual crop, and therefore, may be grown without affecting crops to be planted on the land in succeeding years. It should be grown as a proportionate amount of the crop each year. This would allow for the rotation of these crops in some order that will promote the best possible yields from all.

Cotton is the main crop in many sections, and where this is the case, a rotation including Sudan grass as one of the crops is practicable, and should be adopted. The following rotation is suggested:

*Four Year Rotation.*—First year, cotton; second year, cotton; third year, corn or grain sorghum with cowpeas plowed under; fourth year, Sudan grass.

This system of rotation will allow one-half the land each year for cotton, one-fourth for corn or grain sorghum with a catch crop of cowpeas for green manure, and one-fourth for Sudan grass. Cotton will be grown every other year on the farm and corn or grain sorghum, and

Sudan grass every fourth year. This rotation is excellent for the prevention of cotton root rot disease.

Small grain is grown extensively in north and northwest Texas. The following rotation, which is similar to the one above for the cotton region, is suggested.

*Four Year Rotation.*—First year, small grain with catch crop of cowpeas plowed under; second year, small grain with catch crop of cowpeas plowed under; third year, corn or grain sorghum; fourth year, Sudan grass.

This rotation will allow one-half the crop each year to small grain followed with cowpeas plowed under for green manure, one-fourth to corn or grain sorghum and one-fourth to Sudan grass.

Rotation systems including a legume as one of the main crops would be better suited to increasing soil fertility, and where possible, the acreage of cotton or small grain in the above rotations should be reduced, substituting cowpeas for seed as a money crop. The substitution of Sudan grass and legumes, in a measure, for cotton and small grain should not affect the income on the farm. The production of an abundance of hay for the work stock and allowing them a full ration of twelve pounds daily should greatly reduce the ration of grain. The surplus grain and hay can be sold either direct or through additional farm animals.

The present system of farming very frequently makes it necessary for the farmer to buy grain and hay with money produced by the money crop. No farmer is ever justified in following such a cropping system.

## PREPARATION OF SOIL.

Land to be planted to Sudan grass should be plowed early so as to put it in condition to absorb the early fall and winter rains which are generally lost as "run-off" water on account of the hard packed condition of the surface soil. This early plowing is especially important in the western half of the State where little or no rainfall occurs during the winter months. The effect on yield of early and complete storage in the soil of all surplus water is readily understood when one recalls that Sudan grass, by means of its extensive feeding root system is able to assimilate large quantities of soil moisture and plant food in the normal rapid production of the crop. For the most nearly complete storage of water, the soil should contain a plentiful supply of organic matter, and hence, all trash and refuse from the preceding crop should be plowed under instead of being burned or otherwise wasted.

This incorporation of organic matter directly affects the water holding capacity of the soil; in some instances doubling its capacity. Early plowing should be followed by sufficient cultivation to prevent the growth of fall and winter weeds and to maintain a rough instead of a smooth surface, as a rough surface promotes the absorption of water. In the western part of the State, to prevent blowing, it may be necessary to list or bed the land instead of plowing. Listing prevents blowing and is cheaper than plowing. Fall or winter listing should be relisted if necessary to keep down growth of weeds. On low, wet, poorly drained soils, such as the rice lands in southern Texas, the land should be bedded or listed in order to provide the best possible drainage

and aeration. Early spring preparation should be the same as for corn or sorghum and the cultivation necessary will depend very largely on the previous cultivation given during fall and winter.

### HAY PRODUCTION.

Hay, as discussed here, refers to the grass cut and cured before the formation of any seed. How to produce large yields, when to harvest for the highest feeding value and some information as to average yields will be of much benefit to the grower.

*When to Plant.*—Sudan grass grown for hay should be planted in the spring after all danger of frost is past and after the ground is thoroughly warm. Planting may be done as late as August with reasonable assurance of a hay crop, providing sufficient moisture is available. Numerous tests at the different Texas experiment stations have been conducted to determine the best time for seeding Sudan grass for hay purposes. The results are as follows:

**DATE OF SEEDING FOR HAY YIELDS.**

**1913.**

| Station. | Yields cured hay in pounds. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | No. tests. | April 1st. | April 15th. | May 1st. | May 15th. | June 1st. | June 15th. | July 1st. |
| No. 1, Beeville | 1 | 3800 | 4400 | ..... | ..... | ..... | ..... | ..... |
| No. 11, Nacogdoches | 2 | 420 | 410 | 850 | ..... | ..... | ..... | ..... |
| No. 6, Denton | 1 | ..... | 5025 | 5935 | 2410 | ..... | 165 | ..... |
| No. 8, Lubbock | 2 | ..... | ..... | ..... | 3542 | 2459 | 2491 | 1718 |
| Chillicothe | 2 | 2385 | 1930 | 3240 | 3000 | 880 | 1240 | 2240 |

These results show highest yields of hay from plantings ranging from April 15th to May 1st. The earliest planting at Lubbock was on May 15th and it gave much greater yields than any of the three succeeding plantings ranging up to July 1st.

When the root system becomes well established, the plant is able to produce a crop of hay very quickly under favorable moisture conditions. For this reason planting should be done early, so as to utilize to greatest advantage the available rainfall during the season.

*How to Plant.*—Sudan grass may be grown in cultivated rows, in close drills or broadcast. Seedings in cultivated rows may be made with an ordinary corn planter. A special planter plate is necessary for the proper distribution of seed. Such a plate can be had by boring holes three-sixteenths of an inch in diameter in a blank planter plate. These holes should be reamed out at the bottom in order to allow seed to drop freely through the hole. The number of holes necessary to distribute seed as desired will depend on the kind of planter used and on the gearing attachment. The seeding rate may be varied from one-half pound to the acre to as much as ten pounds to the acre with such special plates. Seedings in 18-inch rows can be made with the same planter, or if available, an ordinary wheat drill with alternate feeds closed will be found a very satisfactory seeder. Close drill seedings may be made with an ordinary wheat drill, which allows a wide range in variation of the seeding rate. Broadcast seedings may be

made by hand or with a broadcast seeder, but broadcasting is considered wasteful of seed and is not recommended where a drill is available.

Tests conducted at the different Texas substations in 1913 to determine the relative hay yields show the following results. The plats were seeded in cultivated rows varying in width and broadcast, and all planted at the same time and at the same seeding rate.

**METHOD FOR SEEDING FOR HAY YIELDS.**

**1913.**

| Station. | Number tests. | Yield cured hay per acre in pounds. | | |
|---|---|---|---|---|
| | | 36-inch rows. | 18-inch rows. | Broadcast. |
| No. 5, Temple | 2 | 2050 | 2950 | ..... |
| Chillicothe | 2 | 3180 | 3510 | ..... |
| No. 8, Lubbock | 3 and 4 | 4287 | 5996 | ..... |
| No. 3, Angleton | 1 | 6281 | 9867 | 7964 |
| No. 1, Beeville | 2 | 11250 | 10420 | 9400 |
| Average | 2 | 5409 | 6548 | Not comparable. |

It is noticeable that the cultivated row seedings gave higher yields than the broadcast plantings, even at Angleton, a section well supplied with rainfall.

The difference in yield, however, in favor of cultivated rows is very small, both at Angleton and Beeville. Undoubtedly when the supply of seed is abundant broadcast seedings will be more profitable in that part of Texas well supplied with rainfall since row seeding must be cultivated. In the drier sections cultivated row plantings are considered more dependable. The tests reported in the table above indicate that when grown in cultivated rows, these should be as narrow as will allow of easy cultivation.

*Seeding Rate.*—The seeding rate affects the quantity and quality of the hay produced. The power of Sudan grass to produce suckers causes it to be less sensitive to improper seeding rates than some other crops. Its ability to produce suckers when the seeding rate is thin causes a wide range in time of heading and therefore makes it impossible to harvest it at a time when all plants are at the proper stage for the best hay. This irregularity in maturity can be overcome very largely by the use of thicker seeding rates.

Tests conducted in 1913 at Pecos, Chillicothe, Lubbock and Beeville substations, varying the seeding rate in close drills from fifteen to forty pounds to the acre showed the following results:

**CLOSE DRILL SEEDING RATE TEST FOR HAY PRODUCTION.**

**1913.**

| Seeding rate —pounds per acre. | Number Tests. | Yield cured hay per acre in pounds. | | | | |
|---|---|---|---|---|---|---|
| | | No. 9, Pecos. | Chillicothe. | No. 8, Lubbock. | No. 1, Beeville. | Average. |
| 15 | 2 | 2500 | 3040 | 4967 | 9680 | 5046 |
| 20 | 2 | 3770 | 2520 | 5066 | 9680 | 5259 |
| 30 | 2 | 4390 | 1410 | 5463 | 10065 | 5332 |
| 40 | 2 | 5160 | 1350 | 5397 | 10010 | 5479 |

The average yield for the seeding rates at the four places shows a gradual increase in production up to forty pounds to the acre. Both Pecos and Beeville show a gradual increase as the rate of seeding is increased, while the reverse is true at the Chillicothe Station. The highest yield at Lubbock Substation was had from the thirty pound seeding rate. The variation was not great, however, for the thirty, twenty and fifteen pound plantings.

Some additional work as to the best seeding rate for hay production in 1914 at Spur and Lubbock stations shows the following results:

CLOSE DRILL SEEDING RATE TEST FOR HAY PRODUCTION.

1914.

| Rate of seeding. | Number of tests. | Yield cured hay per acre in pounds. | | |
|---|---|---|---|---|
| | | No. 7, Spur. | No. 8, Lubbock. | Average. |
| 15 pounds | 2 | 10280 | 8914 | 9597 |
| 20 pounds | 2 | 10040 | 8158 | 9099 |
| 30 pounds | 2 | 10040 | 7608 | 8824 |
| 40 pounds | 2 | 10080 | 8020 | 9050 |

The results at both places show no great variation in yield due to seeding rate. The best yields were had from the fifteen pound seeding rate.

Considering all close drill seeding rate tests conducted thus far, it is concluded that the most dependable seeding rate ranges from fifteen to twenty pounds to the acre.

A seeding rate test in cultivated rows for hay production at the Lubbock Substation in 1914, showed results as follows:

ROW SEEDING RATE TEST FOR HAY PRODUCTION.

| Seeding rate in pounds per acre. | Number of tests. | Yield cured hay per acre—pounds. |
|---|---|---|
| 1.3 | 2 | *8803 |
| 2.1 | 2 | 8078 |
| 3.9 | 2 | 8490 |
| 6.9 | 2 | 8903 |

The results shown in this table indicate that when grown in cultivated rows for hay the seeding rate should be at least as thick as seven pounds to the acre.

*Cultivation.*—Row plantings will require cultivation in order to keep down growth of weeds and grass until the Sudan grass has become well established. This cultivation will be unnecessary in close drilled or broadcast seedings, because Sudan grass is a very vigorous grower and hence when planted in close drills or broadcast will allow little or no chance for the growth of weeds and other grasses. Row seedings should be cultivated quite early and in the same manner as for cultivating sorghum or corn. The crop can be harrowed to advantage soon after it comes up, but as soon as possible it should be given a rather

*Not dependable on account of probable error.

deep cultivation with shovels or sweeps. Succeeding cultivation should be shallower than the preceding one, as this crop establishes a very extensive feeding root system and it is undesirable to break up or disturb these roots.

*Harvesting.*—Sudan grass fields grown for hay should be harvested as soon as they are in full head and before the formation of any seed. If cut at this time the hay will be palatable and nutritious. If harvesting is delayed until the plant begins to set seed, or until it is ripe, it becomes less palatable and of lower feeding value as hay.

Harvesting may be done with a mower, with a broadcast binder or with a row binder. Either the mower or the broadcast binder may be used for harvesting of hay crops regardless of method of planting, but the row binder can only be used successfully on crops grown in cultivated rows. Undoubtedly it will be found convenient to cut small acreages with a corn hook or a scythe, afterwards tying into bundles. When cut with a mower, the crop should be raked into windrows the day after cutting and left to cure. If not to be baled or stacked for some time it should be placed in cocks. If the baling is to be done at the earliest possible date after cutting, the hay should be left in windrows and baled directly from the field. It should, however, be sufficiently well cured not to heat when baled. The expense of transporting this hay to the baler from the windrow is very small, especially when a buck-rake is used, which makes it possible for one man and two mules to keep a horse-power baler well supplied with hay.

The essential points to be observed therefore in properly harvesting the hay crop are: (1) harvesting must be done early and before the formation of seed; (2) the hay should be raked into windrows or cocks so as to prevent over-exposure to the sun; (3) it should be cured sufficiently not to mold when baled or stored.

*Yields.*—Sudan grass does not require a long growing period to produce a hay crop. When the root system becomes well established, as is the case after the first cutting, a second hay crop may be secured in thirty-five days, if conditions are favorable. This rapidity of growth makes it a dependable hay crop in nearly every section of the State. The following table shows the average yields of cured hay in pounds and tons to the acre at four substations. The yields given show considerable variation, due to climatic conditions, but altogether the average yield for all tests at all stations listed are considered very fair and dependable.

**TABLE SHOWING YIELDS CURED SUDAN GRASS HAY AT DIFFERENT TEXAS SUBSTATIONS.**

| Station. | Number of years. | Number of tests averaged. | Average hay yield in pounds. | Average hay yield in tons. |
|---|---|---|---|---|
| No. 9, Pecos | 1 | 4 | 3955 | 1.97 |
| No. 8, Lubbock | 2 | 8 | 6699 | 3.34 |
| No. 1, Beeville | 1 | 4 | 9858 | 4.92 |
| No. 7, Spur | 1 | 4 | 10110 | 5.05 |
| Average | 1+ | 5 | 7655 | 3.82 |

The relatively low average yield secured at Pecos Station was due

to rather unfavorable conditions. The average yield for eight tests at Lubbock Station covering a period of two years is considered dependable for that section, as are results at Beeville. The yields reported for the one year at Spur Station are exceptionally high and were secured under very favorable growing conditions. The average for all tests is considered dependable.

## SEED PRODUCTION.

The production of Sudan grass seed has been very profitable during the seasons of 1913 and 1914, generally due to the fact that this is a new crop and the seed supply very limited. The demand for planting seed will probably always be great for the following reasons:

1. It can be grown for hay in practically every part of the United States.
2. The seed producing region is limited, owing to the sorghum midge, a small insect which destroys the seed crop in humid regions.
3. Comparatively few farmers within the seed producing region will give seed fields sufficient care for the production of high grade planting seed.
4. Some of the best seed growers will find the production of hay as well as seed very profitable especially under certain conditions.

The seed producing area in Texas is a considerable part of the Sudan grass seed producing region of the United States. The following map shows the regions in Texas where dependable seed crops can and cannot be grown.

This map is based on results of seed production tests conducted at Texas Agricultural Experiment stations in different parts of the state. That section of Texas represented by the heavily shaded portion of map will include practically the entire Sudan grass seed producing region of Texas. The unshaded portion will not produce dependable seed crops, since conditions there are favorable to the rapid development of the sorghum midge, which entirely destroys the seed crop. Seed production tests at substations in this section during 1912, 1913 and 1914, show the following results:

**SUDAN GRASS SEED PRODUCTION TESTS IN EAST TEXAS.**

| Station. | Year. | Seed yield per acre—pounds. | Cause of low yield. |
|---|---|---|---|
| No. 2, Troup | 1912 | ..... | Midge |
| No. 2, Troup | 1913 | ..... | Midge |
| No. 2, Troup | 1914 | ..... | Midge |
| No. 11, Nacogdoches | 1912 | ..... | Midge |
| No. 11, Nacogdoches | 1913 | ..... | Midge |
| No. 11, Nacogdoches | 1914 | *50 | Midge |
| No. 4, Beaumont | 1913 | 436 | No Midge |
| No. 4, Beaumont | 1914 | ..... | Midge |
| No. 3, Angleton | 1913 | ..... | Midge |
| No. 3, Angleton | 1914 | ..... | Midge |
| College | 1913 | 300 | No Midge |
| College | 1914 | ..... | Midge |

*Estimated.

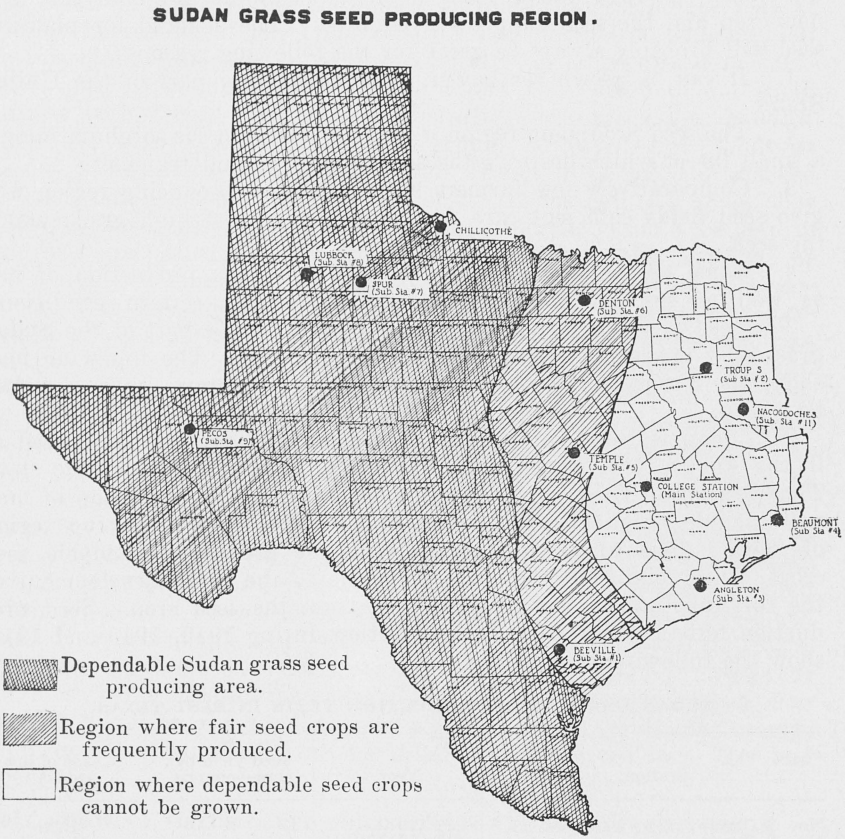



Fig. 2.—Map showing regions in Texas where dependable seed crops can and cannot be grown.

Failures of Sudan grass and sorghum to set seed due to midge are frequently referred to by farmers as "blight" or "blast." Sufficient quantities of seed may occasionally be grown in the humid region for planting seed, but attempts to produce Sudan grass seed for commercial purposes should not be considered.

*Selection of Land.*—Lands to be planted to Sudan grass for seed production should be entirely free from Johnson grass, sorghum, or any plants of the sorghum family and the field should not adjoin other fields containing such plants. Such a field very naturally requires that no sorghum or Johnson grass has been grown on the land the preceding year, as volunteer plants will cause a great deal of cross pollination which will result in the deterioration of the seed the next year. Suitable soils have been described in a preceding chapter on adaptation and soil preparation.

*When to Plant.*—Early plantings are considered preferable to either medium early or late seedings for seed production. Planting, however, should be delayed until all danger of frost is past. Early plantings are recommended in sections subject to the sorghum midge, as early plantings may bloom before the midge has increased in numbers sufficient to do serious damage. Very late plantings are less likely to be destroyed by midge than medium early seedings.

*How to Plant.*—Sudan grass for seed production may be planted in either cultivated rows or in close drills. Much of the planting done in the past has been in cultivated rows because of the scarcity of seed and the desire to get the greatest possible increase from a given amount of seed by forcing the plant to produce suckers. Tests have been conducted at substations No. 5, Temple, and No. 1, Beeville, using the same number of pounds of seed to the acre, but varying the method of planting. The following table gives the results of these tests:

METHOD OF SEEDING FOR SEED YIELDS.

1913.

| Station. | Number of tests. | Yield of seed per acre in pounds. | | |
|---|---|---|---|---|
| | | 36-inch rows. | 18-inch rows. | Broadcast. |
| No. 5, Temple | 1 | 361 | 556 | ..... |
| No. 1, Beeville | 1 | 400 | 360 | 380 |

It is noticeable that at Temple there was an increase in seed yield when planted in cultivated rows eighteen inches apart over rows thirty-six inches apart, whereas, at Beeville the yield was in favor of cultivated rows thirty-six inches apart over either eighteen-inch rows or broadcast seeding. From the tests conducted it appears that for seed production the crop should be planted in cultivated rows only wide enough to allow of easy cultivation.

*Rate of Seeding.*—The rate of seeding Sudan grass is an important factor in seed production, inasmuch as the seeding rate affects the uniformity of the crop, and hence, the percentage of immature seed in the sample at threshing time. It also has a fundamental bearing on seed yield, since the proper seeding rate will make it unnecessary for the plant to expend its energy in producing suckers and in otherwise at-

tempting to adjust itself to conditions. This station has authentic record of the production of 1,686 pounds of seed from one acre planted at the rate of one pound of seed to the acre; nevertheless, the conditions in this particular case were ideal for suckering and for the continued growth of the crop after the suckers were well started. Had conditions been less favorable, the yield would undoubtedly have been much reduced, due to lack of ability on the part of the plant to produce a sufficient number of suckers for the maximum yield per acre.

A test was conducted in 1914 at the Spur Station to determine the effect of the seeding rate on seed production. The seeding rate was varied from seven to forty pounds to the acre, with the following results:

RATE OF SEEDING FOR SEED YIELDS.

Substation No. 7, Spur—1914.

| Seeding rate—pounds per acre. | Method of seeding. | Number of tests. | Seed yield per acre in pounds. |
|---|---|---|---|
| 7 | Close drills | 2 | 1017 |
| 14 | Close drills | 2 | 1154 |
| 18 | Close drills | 2 | 1141 |
| 22 | Close drills | 2 | 1209 |
| 32 | Close drills | 2 | 1113 |
| 40 | Close drills | 2 | 797 |

This table shows the heaviest seed production when the seeding ranged from fourteen to twenty-two pounds to the acre. The seven pound seeding rate, which was the lowest used, was less productive of seed than the heavier seedings, up to thirty-two pounds to the acre. Heavier seedings than twenty-two pounds did not increase the seed yield. While some excellent yields have been secured from seedings as thin as one pound to the acre, these and other results indicate that where seed is available, thicker plantings are desirable for heavy seed production and that the quality of the seed will be improved by thicker seeding.

*Cultivation.*—The cultivation of Sudan grass grown for seed should be the same as cultivation of hay crops grown in cultivated rows. The spike-tooth harrow may be used soon after the crop first comes up, but as soon as possible a moderately deep and thorough cultivation should be given with shovels or sweeps. Succeeding cultivations should be shallower each time, being careful not to disturb or destroy surface feeding roots, as this is harmful to the crop.

The cultivation of seed crops should be somewhat more thorough than crops grown for hay and this should include the cutting out of any weeds or grass that might escape cultivation in the middle or in the drill, and which might be harvested with the seed, thus causing adulteration.

*Rogueing.*—Every grower of seed should inspect his field carefully just prior to heading time for any plants that appear to be off-type and these should be removed, not by cutting them off at the surface, but by uprooting the whole plant. This rogueing for off-types and for any volunteer plants that may appear in the field must be done prior to heading time. It can be done after these plants have headed, but the greatest caution should be taken not to delay their removal until

they have produced blossoms which generally occurs within four or five days after the heads first appear. These undesirable plants should be removed as soon as they are recognized as being unlike the general plants of the field. This rogueing should also include adjacent fields, so as to avoid having near the field any volunteer plants which might cross pollinate with the crop grown for seed.

*Field Inspection.*—Field inspection is perhaps unnecessary for the production of good seed. Such inspection, however, provides information as to the purity of a given lot of seed. This information as regards crossing that might have taken place in the field can be obtained only by inspection of the growing field and conditions surrounding it. On inspection of the field, a certificate of purity is issued which may be used by the grower as proof of the purity of that lot of seed. This inspection may be done either by an officer of the Experiment Station or by an inspection committee receiving instructions from an officer of the Experiment Station. The inspector or committee of inspectors should visit the fields at heading time in order that information may be had as to whether or not rogueing has been properly done, both in the field and in adjacent fields. A second inspection should be made preferably as soon as the seed is ripe. If this second inspection is impossible, a sample of seed should be submitted to the inspector of the field for his information and for the determination of the percentages of the various types contained. Local inspection committees are in position to do very satisfactory work, inasmuch as they are generally acquainted in detail with the farm of every grower and have an intimate knowledge of the probable impurities to be found in the field.

*Harvesting.*—Harvesting of large fields should begin early so as to avoid waste of seed on that part of the field to be harvested last. If fields are left until they are over-ripe, the earliest heads not only shatter seed, but many of them break off just below the head and fall to the ground and are thus entirely lost. The time for harvesting extends for a considerable period under our present system of planting at thin seeding rates, due to the fact that the main heads and sucker heads do not ripen uniformly. With an abundance of seed and thicker plantings, the crop will ripen more uniformly and harvesting will necessarily have to be done more promptly.

Crops grown in cultivated rows for seed are invariably harvested with a corn binder. The bundles, which are much riper than crops cut for hay, can be put into shocks immediately and left for a week or ten days, at the end of which time they will be ready to thresh, if the weather is fair. If the crop is not to be threshed for a considerable time, it is a good idea to stack these bundles as soon as they are sufficiently cured, or cover each shock with a cap cover of canvas to protect them from weather and birds.

*Threshing and Cleaning.*—Sudan grass may be threshed with an ordinary wheat and oats separator. Care must be taken, however, not to blow the seeds over with the chaff. Small fields may be threshed with a flail, placing the bundles on a wagon sheet in the field after the shocks have been torn apart and exposed to the sunshine for a half day. After this first flailing it will be necessary to reclean this seed and flail a part of it the second time. The whole operation of flailing can be done at a cost of six to ten cents per bushel, when $1.50 labor is used, ex-

clusive of the cost of cleaning, which must be done even where a separator is used.

A fanning mill is the best machine available for recleaning Sudan grass seed, since all straw and chaff can be removed. It will be necessary, in some instances, to run the seed through the fanning mill twice in order to remove all the light chaff and straw. Figure 3 shows a very good type of fanning mill.

Where a fanning mill is not available, the seed may be cleaned by pouring it from one bucket to another in a fair breeze which blows out the chaff leaving the heavier seeds to fall into the bucket. Such a method of cleaning the seed requires much work and patience, but in the absence of a fanning mill it is satisfactory.

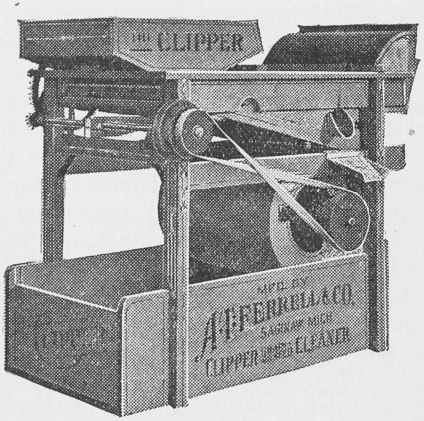



Fig. 3.—A good type of fanning mill for cleaning Sudan Grass seed.

*Seed Yield.*—The yields of seed from various plantings of Sudan grass have shown great variation, ranging from less than fifty pounds to 1,686 pounds of seed from a single acre. The great fluctuation in yield is due very largely to the presence or absence of sorghum midge, and to the existence of favorable or unfavorable conditions for the proper growth and support of a large number of seed stalks. The following table gives average seed yields from a large number of tests made at different stations during the season of 1914:

SUDAN GRASS SEED YIELDS.

1914.

| Station. | Number of tests. | Seed yield per acre in pounds. |
|---|---|---|
| No. 7, Spur | 12 | 1026 |
| No. 8, Lubbock | 4 | 910 |
| No. 5, Temple | 3 | 229 |
| No. 1, Beeville | 18 | 110 |

From these figures it is evident that a yield of 1,000 pounds of seed to the acre can be expected only under very favorable conditions, such as existed during 1914 at both Lubbock and Spur. Less than three hundred pounds to the acre is considered a low yield and not likely to be secured except in fields infested with midge. Under average conditions in the seed producing region, yields of from 500 to 700 pounds of seed to the acre should be secured.

The per cent of seed to the whole plant as determined from five tests at Lubbock Station in 1913 is as follows:

**PER CENT OF SEED TO WHOLE PLANT.**

**Lubbock Station—1913.**

| Forage and seed—pounds per acre. | Seed yield—pounds per acre. | Per cent of seed to whole plant. |
|---|---|---|
| 2357 | 343 | 13.7 |
| 1540 | 509 | 23.7 |
| 1164 | 580 | 19.4 |
| 1188 | 356 | 23.1 |
| 2528 | 294 | 10.4 |
| Average 1775 | 356 | 16.7 |

It is interesting to note that the per cent of seed to the whole plant varied within the season from ten to twenty-three. It is further noticeable that the two highest total forage yields gave the lowest percentage of seed to the whole plant. The average seed yield for all tests was sixteen and seven-tenths per cent.

*Labeling and Marketing.*—Sudan grass seed produced for market will be used for two purposes: (1) as planting seed for seed production; (2) as planting seed for hay. In either case the seed offered should be plainly labeled, giving (1) name and address of grower; (2) source of the original planting seed and when obtained; (3) name and grade as determined by inspection of the field and sample of seed offered. This information printed on the bag, or on the tag accompanying the bag, will serve as a guarantee of purity which is desired by purchasers. Certain growers may desire to seal bags to protect the guarantee in case the seed is to go on the general market. The sealing of assorted bags, properly labeled, would be perfectly feasible, inasmuch as it would be possible to draw samples for observation with a sampling tube and the grower would be protected absolutely against adulteration from the time the seed leaves his hands until it reaches the planter. Few farm seeds at this time carry with them any record of where they were grown, or of the conditions under which they were grown. These are important factors to the prospective purchaser of Sudan grass seed and without such information good seed will fall into the class with the poorest. The market demand for Sudan grass seed and other seed with a pedigree is always great, whereas seed without such record must be sold on the general market.

The satisfactory marketing of Sudan grass seed will require that a product of the best grade is produced. The seed should be recleaned so as to be entirely free from straw, chaff, dirt and other foreign matter. It should be packed in closely woven cotton sacks ranging one, five, ten, twenty, fifty and one hundred pounds in size. Seed offered for

market in substantial bags and properly labeled as suggested above will be preferred to seed improperly prepared and without information as to the purity as determined by inspection of the field.

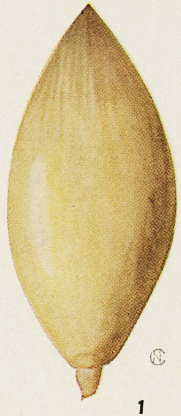
## IMPROVEMENT OF THE CROP.

The readiness with which Sudan grass allows sorghum and Johnson grass to mix with it, and the evident ease with which the different types cross with each other, show the importance of selecting and perpetuating valuable types. That the several types differ in productiveness and forage value, as well as in appearance, is beyond question. A description of the more important types and how to separate and perpetuate them as pure strains will be of material value to the grower.

*Description of Types.*—Sudan grass, at the present time, contains several types differing in vegetative growth, in color of hulls and in other characters. The large percentage of tall and dwarf plants appearing

Fig. 4.—Tall and dwarf forms selected from Sudan grass No. 1052. Note dwarfness of No. 1052-E as compared to No. 1052-A. These dwarf types, with small and leafy stems, offer possibilities as hay producing sorts, inasmuch as tallness is not necessarily the controlling factor in yield.

in the fields have led some to believe that this apparent splitting up into types is due to hybridization of Sudan with sorghum since its introduction in 1909. That Sudan as grown in Africa contains several types is shown by the fact that a field grown in 1914 from an introduction made in that year from Khartoum, Africa, by Mr. W. E. Mountain, Pilot Point, Texas, shows talls and dwarfs in approximately the same numbers as fields having descended from the 1909 introduction. It is apparent, therefore, that this multiplicity of forms exists also in Africa, and that it is not due to treatment here since the introduction of this crop. Figure 4 shows tall and dwarf types of Sudan grass. In this field the dwarfs were quite common and generally three and one-half feet high. Over three hundred dwarfs were found in a plat of three rows 132 feet long. These dwarfs are generally quite leafy and offer great possibilities for the development of types suited to



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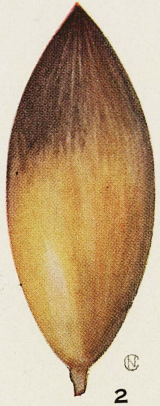

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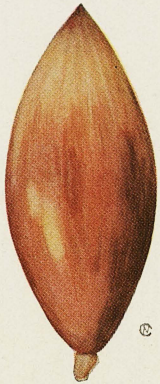

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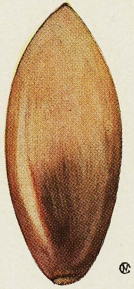

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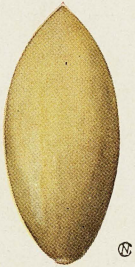

8

TOP ROW — SUDAN GRASS SEED WITH DIFFERENT COLORED HULLS.
BOTTOM ROW — JOHNSON GRASS SEED WITH DIFFERENT COLORED HULLS.

1.—CREAMHUL SUDAN SEED.
4.—BLACKHUL SUDAN SEED.
2 AND 3.—INTERMEDIATE FORMS.
5 —BLACKHUL JOHNSON GRASS SEED.
8.—CREAMHUL JOHNSON GRASS SEED.
6 AND 7.—INTERMEDIATE FORMS.

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special localities and for special purposes. The seed-head of the dwarf type is generally semi-compact, because of its short branches. The common dwarfs appear to be somewhat later in maturity than the talls.

The tall sorts in the above field generally ranged from seven to eight feet high and were naturally somewhat coarse, seldom growing larger, however, than a lead pencil. Some of these tall plants carried fifteen leaves. The tall plants nearly always produced a spreading panicle. (See Figure 5.)

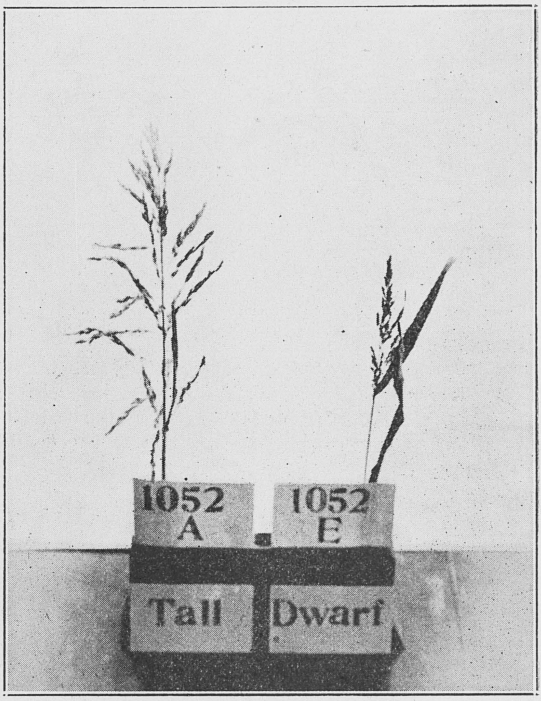


Fig. 5.—Note the spreading panicle of the tall, in contrast to the rather compact head of the dwarf. These forms seem to be characteristic of the two types.

Aside from the talls and the dwarfs, several other plants appeared in this field. One of these plants was evidently a sorghum-sudan hybrid. Another very striking plant was an exceedingly tall individual (see figure 6), which over-topped the common talls by two feet. These are mentioned merely to show the diversity of types existing in this 1914 introduction.

The color of the hull seems to have no fixed relation to the vegetative growth of the plant, there being both light hull and dark hull forms in the talls and dwarfs. The original introduction received in 1909 contained 98 per cent seed with a light straw or cream-colored hull. The 1914 introduction, carried under T. S. No. 1052, showed by separation of 710.2 grams or about $1\frac{1}{4}$ pounds, the following percentages of seed, based on color or hull:

Fig. 6.—Field of Sudan grass grown from seed of T. S. No. 1052, an introduction made in 1914 from Khartoum, Africa. Note the tall plants, and the apparent diversity in type.

| | |
|---|---|
| Creamhul | 98.00 per cent. |
| Blackhul | 1.09 per cent. |
| Pinkhul | .69 per cent. |
| Purplehul | .22 per cent. |

The relatively high percentage of seed with light straw or cream-colored hull contained in both samples is evidence that this light straw colored form is typical of the Sudan grass introduced from Africa.

Because of the large proportion of seed with light straw or cream colored hull in both introductions, and the ease with which the light straw or cream colored hull can be distinguished from Johnson grass and sorghum seed, this form has been designated as *"Creamhul"* and is recommended as a standard type to be used as a basis for selection of types differing in vegetative characters.

The Blackhul seems to be entirely distinct from the Creamhul.

In making the separation of the Blackhul and the Pinkhul it was found very difficult to distinguish between the two, and, after growing them in the field, it is considered that the Pinkhul is an immature Blackhul form and merges into Blackhul, if the seed is thoroughly mature.

The so-called Purplehul may be an intermediate between the Creamhul and the Blackhul. The concentration of color at the tip of the glume or hull would prevent its further development into Creamhul. It would also make it necessary that this color be transferred from the tip to the base of the hull, if the seed is to develop into Blackhul, for in every instance noted thus far, the development of color in the blackhul begins at the base and not at the tip of the hull. The colored plate shows the actual color of representative seeds of these four groups, based on color of the hull. This plate also shows similar groups of Johnson grass seed, which it is interesting to note are found in approximately opposite proportions to those of the Sudan grass.

The appearance of heads showing a reddish color in the field before maturity does not necessarily indicate the presence of Johnson grass or Johnson grass hybrids, as types which have this reddish tinge before maturity exist in all forms of Sudan grass at this time. The pale green color, however, is characteristic of what has been designated as the Creamhul type. The hulls are light yellow in color and may be either smooth or hairy, or may be beardless or bearded. The seed generally break from the panicle or head with a short stem attached, whereas seed of Johnson grass usually break off squarely at the base of the hull. (See colored plate.)

Sudan grass seed are somewhat larger than Johnson grass seed, depending on conditions under which they were grown. A sample of Sudan grass may contain both large and small seed and yet be free from Johnson grass seed. The color of the seed coat, after the hull has been removed, is golden brown, which is nearly the identical color of the seed coat of Johnson grass. Such characters as form, size, and color of seed-head, color of hull and the manner in which the stem breaks off at the base of the hull will be of some value in distinguishing Sudan grass seed from Johnson grass seed, but the final test is the presence or absence of rootstocks, and this must be determined in the field.

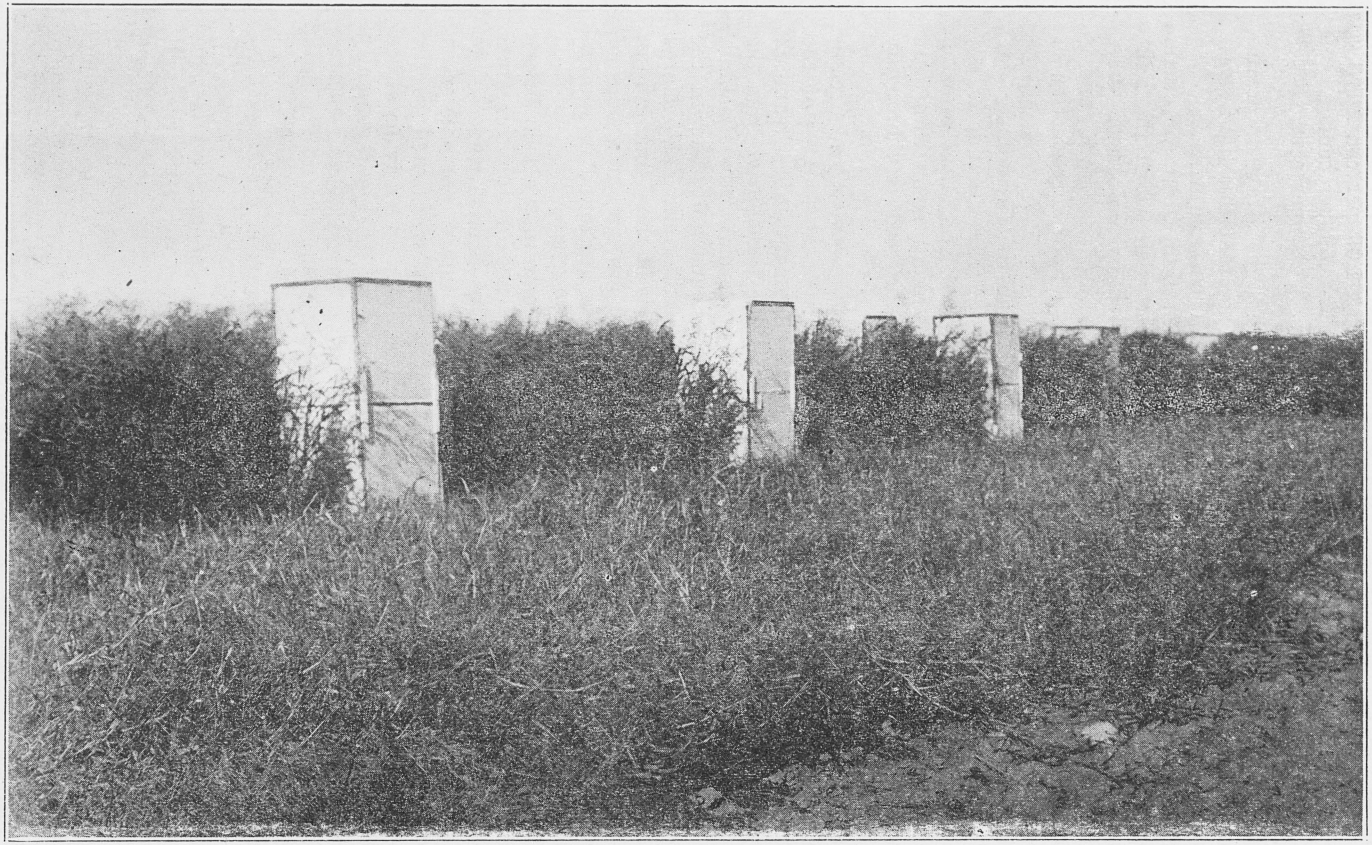

Fig. 7.—Canvas cages covering individual plants of Sudan grass at the Main Station, College Station, Texas. These cages prevent further crossing of types and give a large increase of seed from a single plant. This method practiced for two or three successive seasons will afford pure seed of types or strains for increase.

*Selection of Types.*—Selection of desirable individual plants from the field will result in improvement of the crop. Such open field selection, however, does not prevent the better types from crossing with the poorer ones. Much more rapid progress will be made if an individual head or the whole plant is covered so as to prevent further crossing with undesirable types. The seed thus secured by bagging or covering should be planted and the selection and bagging process repeated. Such a process of improvement, if properly followed up, may develop one or more pure strains from the progeny of a single plant, for little or no work has been done up to the present time toward purifying types and strains of Sudan grass. The selection and bagging method ought to show much improvement in type and variety by the end of the second year.

The Texas Agricultural Experiment Station has this year bagged individual heads, or caged a large number of individual Sudan grass plants. (See Figure 7.) The seed from these individuals will be planted and from each a number of plants will be selected and bagged for pure seed. In addition to these self-fertilized plants, over 1,000 individual selections have been made from field plats for tests and material from which to make selection of desirable types next year. This material, comprising a large number of selections, affords great opportunity for securing superior and valuable forage types. The limited amount of seed available because of necessity of bagging is of no importance, since from a few seed a large increase can be had in a very short period of time.

*Maintenance of Selected Strains.*—The maintenance of types and varieties secured by selection and self-fertilization of individuals will require the same precautions as those necessary to keep Sudan grass free from Johnson grass and sorghum. The selected strains if allowed to grow in the same field or adjacent to other fields of Sudan grass, will cross to such an extent that in one season the results of selection will be lost. Selected seed should be planted in isolated seed patches not nearer than one-half mile to any other field of Sudan grass, sorghum or Johnson grass. The greatest care should be used also in preventing any volunteer plants of other types of Sudan grass, sorghum or Johnson grass from coming into the field or in nearby fields. Selected strains which have been grown under the above precautions will have many advantages over common seed made up of a mixture of types and ought to command a much better price than unselected seed.

## SUMMARY.

Sudan grass was introduced into this country in 1909 by the United States Department of Agriculture and first tested at Chillicothe, Texas. Increase fields grown at Chillicothe gave rise to all seed now in the hands of farmers.

The short time required for establishing this crop has been due to the excellence of Sudan grass, and the methods used by the Texas Experiment Station in distributing seed.

Varying forms of sorghum-like plants closely resembling Sudan grass have been found in different parts of Africa, in India, and in Java.

Sudan grass is a fine stemmed, leafy annual grass, without under-

ground rootstocks. It will produce two to four cuttings during the season if grown for hay, or one seed crop if grown for seed. One seed crop and one or two hay crops from the same planting are frequently obtained.

Sudan grass has an acre feeding value twice as great as that of Johnson, Bermuda, or Timothy hays.

Sudan grass is adapted to all of Texas and to the greater portion of the United States.

Every farm should grow its own hay. A full hay ration will reduce the amount of grain needed.

Tests show that Sudan grass for hay should be planted after the ground is thoroughly warm and as soon as all danger of frost is past.

Method of seeding tests indicate that where the rainfall is limited hay crops should be planted in rows as close as will allow of easy cultivation. Where rainfall is abundant close drill seeding is preferable to row seeding.

Seeding rate tests show that fifteen to twenty pounds to the acre in close drills gives highest hay production. Tests indicate that row seedings should be thicker than seven pounds to the acre.

Hay crops should be harvested before the formation of any seed, and should be cured sufficiently not to mold when baled.

The average hay yield from twenty tests at four different stations was three and eighty-two hundredths (3.82) tons to the acre.

Conditions affecting seed production are such that there will always be a great demand for good seed.

Lands devoted to seed production should be free from sorghum or Johnson grass.

Plantings for seed crops should be made early and in cultivated rows. Heavy seed yields have been had from seedings at twenty-two pounds to the acre and the quality of the seed was considered better than from thinner seeding.

Growers of seed should carefully rogue fields for off types, and should have such fields inspected by an Experiment Station official. Seed offered for market should be properly labeled.

Several types exist in the Sudan grass seed now in the hands of the farmers, and practically the same types were found in a new lot introduced from Africa in 1914. Ninety-eight per cent of each of two introductions from Africa have been Creamhul type.

Great improvement in the forage value can be accomplished by selection and separation of types from the many found in Sudan grass at the present time.