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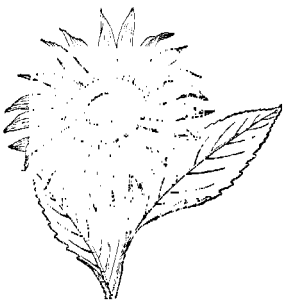
MANHATTAN, KANSAS

VARIETIES OF SORGHUM IN KANSAS



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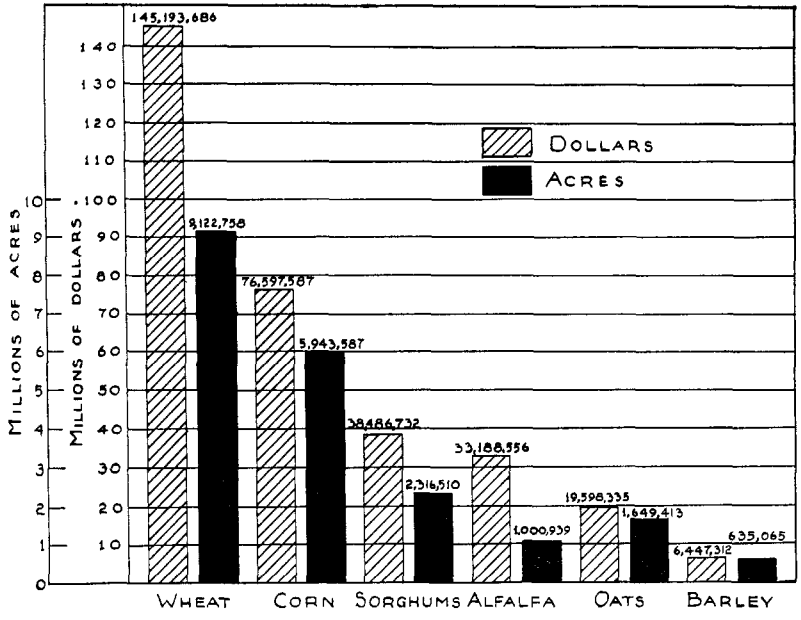

Fig. 1.—Average annual value and acreage of the principal crops grown in Kansas for the 16-year period, 1915 to 1930, as reported by the Kansas State Board of Agriculture.

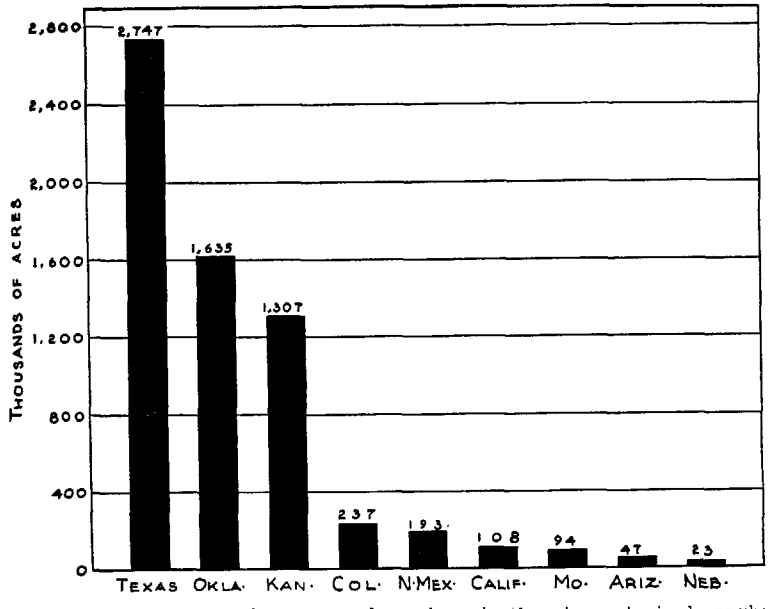

Fig. 2.—Average annual acreage of sorghum in the nine principal sorghum-producing states, 1924 to 1930, as compiled from the Yearbook of Agriculture, U. S. D. A., 1930.

VARIETIES OF SORGHUM IN KANSAS[1]

A. F. Swanson[2] and H. H. Laude

IMPORTANCE OF SORGHUM

Kansas is third among the states in the production of sorghum, being surpassed by Texas and Oklahoma. Sorghum is the third most valuable crop in Kansas, with an annual valuation from 1915 to 1930 of $38,486,732. Sorghum also ranks third in acreage among Kansas crops, being exceeded by wheat and corn. (Fig. 1.) Sorghum holds first place in the state in tonnage of feed in the form of hay, silage, and fodder.

Since sorghum is adapted to most of the 24 million acres of land under cultivation in Kansas, the potential number of tons of forage or bushels of grain which could be produced annually is very great.

Sorghum is the sixth most important cereal in the United States and ranks seventh among cultivated crops, The sweet sorghum can be grown in most of the states but is not adapted in the colder New England states and those in the Northwest which include the higher altitudes of the western mountains. Grain sorghum is most extensively grown in the southwest in an area about 400 miles wide and 1,000 miles long. This area extends like a great oval reaching southwestward from southern Nebraska, including parts of eastern Colorado and New Mexico, across Kansas, touching southwestern Missouri, and including Oklahoma and the Panhandle of Texas. (Fig. 2.) Outside the limits of this oval, except for restricted areas in California and in certain irrigated regions of Arizona, sorghum is mostly grown for forage, silage, or sirup. In the north central states many farmers grow a few acres of sorghum as a catch crop for hay on small areas of land.

UTILIZATION OF THE CROP

If Kansas were limited to the growing of one crop, sorghum would best meet its requirements for feed and grain. This is due to the many types, suited to various purposes, and to the capacity of the crop to produce in seasons of adversity. All classes of live stock make efficient use of sorghum in some form. As dry feed or silage, sorghum contributes much to the beef and dairy industries of the state. The grain when fed to poultry, hogs, cattle, and other live stock is about equal to that of corn. Sorghum grain is probably as desirable as corn in a maintenance ration, or as a feed for growing live stock when it is ground, mixed with another cereal, and supplemented with a protein concentrate. Sudan grass is of proved value for pasture, particularly when native pasture is limited, or

Acknowledgment.—The authors desire to acknowledge the valuable assistance of R. E. Getty, formerly in charge of Forage Investigations, and his successor, D. A. Savage; also A. L. Hallsted in charge of Dry-land Agriculture, Fort Hays branch station. Acknowledgment also is due L. C. Aicher, F. A. Wagner, E. H. Coles, and T. B. Stinson, superintendents of the branch agricultural experiment stations at Hays, Garden City, Colby, and Tribune, respectively; and I. K. Landon, superintendent of the Southeastern Kansas Experiment Fields. The valuable assistance of the Division of Cereal Crops and Diseases, Division of Forage Crops and Diseases, and the Division of Dry-land Agriculture, Bureau of Plant Industry, United States Department of Agriculture, in securing certain experimental results reported is also gratefully acknowledged.

1. Contribution No. 224 from the Department of Agronomy and No. 13 from the Fort Hays Agricultural Experiment Station.

2. Associate Agronomist, Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture.

when an abundance of pasture is needed during the summer months. It is also one of the best non-leguminous crops available for hay.

Broom corn is not an important crop except in a small region in the southwestern part of the state, yet Kansas ranks third in acreage of broom corn grown in the United States.

Sorghum grain is used extensively as human food in Asia Minor, India, China, and Africa. In the latter country it is the chief diet of the natives, and is reported to have found much favor with the white population since 1920, due to a special but secret process used in the preparation of the grain for food. When so processed the grain is said to have high nutritive value, particularly suited to infants and invalids. While the grain is little used, if at all, as human food in this country, it is not without potential value for this purpose.

The manufacture of sirup or molasses, and later of sugar, was the chief interest in the saccharine sorghum when first introduced. Gradually it was recognized by farmers as having value for forage. From 1878 to 1893 extensive experiments for making sugar from saccharine sorghum were conducted under the direction of the United States Department of Agriculture. Between 1886 and 1893 the Kansas Agricultural Experiment Station was extensively engaged in testing saccharine sorghum for sugar content and during the latter part of this period the manufacture of sugar from sorghum was subsidized by the Kansas State Legislature in order to encourage the industry in the state. The production of sugar from sorghum in 1893 reached nearly a million pounds in Kansas. During the period from 1880 to 1890 the production of sirup ranged from two million to six million gallons annually. After 1893 interest in saccharine sorghum as a source of sugar abated rapidly because of low prices and the inability of the sorghum factories to secure sufficient sorghum for extraction because of a series of dry years. The fact that sorghum juice must be extracted within a short period after maturity was also a handicap. It should be noted further that sugar beets, which were introduced during this period, proved to be a more reliable source of sugar.

The recent use of modern machinery which permits large-scale production may lead to an increased acreage of sorghum. The best forage sorghum compares favorably with any other forage crop in tonnage per acre in any section of the state, and the best grain sorghum varieties lead in grain production in most localities.

ORIGIN AND ANTIQUITY OF SORGHUM[3]

Sorghum was probably among the earliest of the wild plants to be domesticated. It is believed that the cultivated forms had their origin in equatorial Africa and perhaps independently in Asia from wild forms indigenous to both continents. The early history of sorghum culture is unknown but there is evidence to indicate that it was an important crop in both Africa and Asia hundreds of years before the Christian Era.

Evidence that sorghum was grown before 2200 B. C. has been found in one of the tombs of Egypt. Sorghum is still an important crop in the Nile valley. Biblical reference is made to sorghum in the book of Ezekiel in which "dochan" in the original is translated as the word "millet." The culture of sorghum in Asia particularly in India is very old and it is known that the crop was grown as early as the third century A. D. in China, where it was probably introduced.

3. For a more complete discussion of this subject see Ball, C. R. The history and distribution of sorghum. U. S. Dept. Agr. B. P. I. Bul. 175: 1-53. 1910.

Although sorghum originated in the tropics it is now grown chiefly in the temperate zones of both hemispheres. The bulk of the crop is grown south of the 40th parallel of latitude in the northern hemisphere and north of the 40th parallel in the southern hemisphere. In the United States this corresponds to the boundary line between Nebraska and Kansas. The great centers of world production are Africa, India, China, and the United States. Sorghum has also been introduced into South America and Australia and has long been grown in southern Europe and in Asia Minor.

TERMINOLOGY FOR SORGHUM

The numerous kinds of sorghum can be grouped under four general classes as follows:

1. Forage or saccharine sorghum (sorgo) grown primarily for forage or sirup.
2. Grain or non-saccharine sorghum such as kafir, milo, and feterita in which grain production is usually the principal objective.
3. Broom corn valued for the brush of the panicle which is used in making brooms.
4. Grass sorghum used chiefly for hay and pasture of which Sudan grass is the leading type.

The term "sorghum" is a general group name for the four classes mentioned and should not be limited to a particular class. "Sorghum" is used in the same sense as the words corn, wheat, barley, alfalfa, or cotton.

The word "sorgo" is preferable to the term "cane," which is often used to refer to the saccharine or sweet-stemmed varieties. "Sorgo" and "sorghum" are both derived from the Latin word "surgo" meaning to rise or tower (above other crops) and the two terms were used interchangeably in the earlier years of sorghum culture in the United States when only the saccharine varieties were grown. The term "cane" is properly applied only to the true sugar cane, a semi-tropical plant of a different genus and of no importance in Kansas.

The addition of the word "corn" to kafir (kafir corn) and maize to milo (milo maize) is undesirable and confusing. The simple terms kafir and milo are preferable. Those crops represent two groups of varieties of the non-saccharine class. Varieties of kafir are designated as Pink kafir or Red kafir, etc., and of milo as Dwarf Yellow milo, etc. Likewise, in the saccharine group, the term sorgo may be used in connection with the variety name, as Atlas sorgo.

When the stalks and heads of sorghum are harvested together, the term "fodder" is used, but when the heads have been severed from the stalks, the term "stover" is applied to the forage part of the crop. The term "butts" is also used to indicate that the heads have been removed from the bundles of sorghum. The term "hay" refers to the finer-stemmed kinds of dry forage which usually are seeded with a drill and cut with a mower.

SOURCES OF SORGHUM GROWN IN KANSAS

All sorghum grown in America was derived originally from importations. It has been 75 years since the first saccharine sorghum was established in this country, and more than 50 years since the first important permanent introduction of grain sorghum. Both forage sorghum and grain sorghum probably were grown by the Colonists, but none of these became important in agriculture.

The principal stocks of sorghum came from Africa with the exception

of the Ambers and the kaoliangs, which are from China. Although India is a very important sorghum center, having a great array of types, nearly all of the Varieties introduced from that country have been too late to be of value in the United States.

FORAGE SORGHUM

The first imported sorgo was of Chinese origin. In 1851 the French Consul at Shanghai, China, secured seed of a sorgo from the Island of Tsung-ming, at the mouth of the Yangtze river. From this seed stock the culture was begun in France. In 1863 a small importation of this seed is said to have reached America and was grown by Wm. R. Prince at Flushing, Long Island. The United States Commissioner of Patents secured a similar lot of seed in 1854. Another importation was received from the well-known seed firm of Vilmorin Andrieux and Company of Paris in 1856 and grown by the editor of the American Agriculturist. All of the above introductions became widely scattered throughout the country and in the course of time there arose in Indiana the progenitor of the strains of Amber sorghum from the original Chinese introduction. The Ambers came into Kansas with the settlers.

In May, 1857, 16 saccharine varieties were brought to this country by Mr. Leonard Wray at the request of Horace Greeley and grown in Georgia and South Carolina. Mr. Wray, an English merchant, became interested in these varieties in 1851 while at Natal, South Africa, where they were grown by the Zulu-Kafir tribes for grain and sweet stalks. In 1865, four varieties were received from China and in 1880 numerous varieties were received both from that country and from Natal, but none seems to have been equal to the first 16 introduced by Mr. Wray.

Through variation, selection, and hybridization, combined with rapid multiplication, many types resulted from Mr. Wray's introductions. Orange and Sumac, which have been of great economic value in Kansas, were among the original introductions. Other saccharine varieties of more or less importance at one time or another, which are believed to have had their origin from the Wray introductions, are Planter, Gooseneck, Honey, Sapling, African millet, and Sourless.

The introductions mentioned became the source of a number of forage

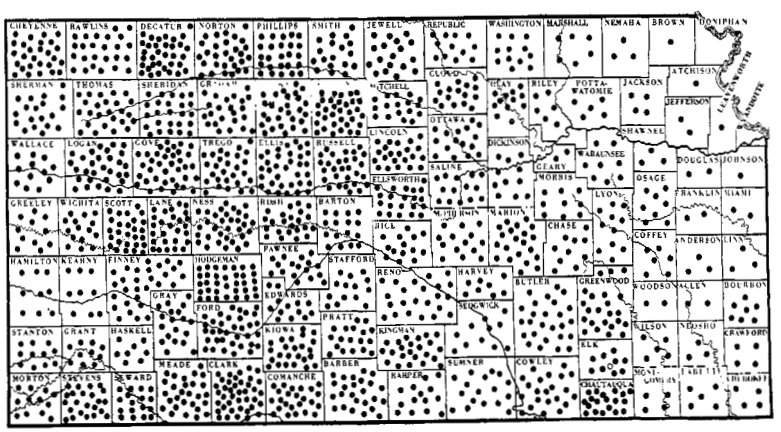

Fig. 8.—Average annual acreage of forage sorghum in Kansas, 1920 to 1929. Each dot represents 500 acres. Data obtained from the Kansas State Board of Agriculture.

varieties that are well adapted in Kansas and are extensively grown throughout the state as shown in figure 3.

GRAIN SORGHUM

The earliest grain sorghum varieties established in this country were Brown durra and White durra which reached California in 1874 from Egypt, under the names of "Brown Egyptian corn" and "White Egyptian corn." During a period of drought between 1880 and 1884 the White durra, under the name of "Rice" corn, became popular in Kansas because of its drought resistance, and for several years it was about the only grain sorghum grown in Kansas. Ten years later in another drought period a shorter strain was introduced again as "Jerusalem" corn. This introduction apparently developed from two grains which were sent by a missionary in Palestine to a farmer in Finney county. There is some evidence that durra reached this country through importation as early as colonial times but without permanent results until 1874.

Two varieties of kafir, the Whitehull White and the Red, were brought into the United States from South Africa in 1876. The former reached Kansas about 1885. The latter was first planted in 1889 at the Kansas Agricultural Experiment Station and immediately became popular because of outstanding yields. In 1895 a selection which had been grown in Oklahoma under the name of "Blackhulled White kafir corn" was grown in Kansas and became the progenitor of the modern Blackhull kafirs. In 1905 a new introduction of kafir from Africa, which later became known as Pink, was obtained by the United States Department of Agriculture. Principally from these sources kafir has been widely distributed in Kansas and is now an important crop in most sections of the state as shown in figure 4.

Milo was introduced into the United States between 1880 and 1885 and was first grown in South Carolina and Georgia. The variety probably came from Africa but this is not definitely known. It was widely advertised by M. W. Johnson Seed Company, Atlanta. Ga., in the spring of 1887 and by 1890 had reached the Great Plains. It was first grown experimentally in Kansas in 1888 but failed to produce a crop until 1889. It is best adapted in southwestern Kansas where it is now a major crop as indicated in figure 5.

Shallu was imported from India in 1890 under the name of "Egyptian Wheat" by the Louisiana Agricultural Experiment Station. Although a distinct type of sorghum, it is of little economic value in Kansas because of its late maturity and low yields.

Many introductions of the kaoliang group from China and Manchuria were made between 1898 and 1910, but they never gained a foothold in Kansas. The kaoliangs are characterized by very early maturity and low yields. Introductions as early as 1860 are believed to have occurred without permanent results.

The next important foreign introduction of grain sorghum was feterita from the Sudan region of Africa in 1906 and again in 1908. Feterita proved to be a distinct type of value and gained in popularity during a cycle of dry years on the Plains.

The last important grain sorghum introduction was Dwarf hegari received by Dr. C. V. Piper of the United States Department of Agriculture from Khartum, Sudan, Africa, in March, 1908. It was planted that season at Chillicothe, Tex. Practically all of the hegari grown in the United States is from the increase of a selection made at Chillicothe, Tex., by A. B. Conner in 1910.

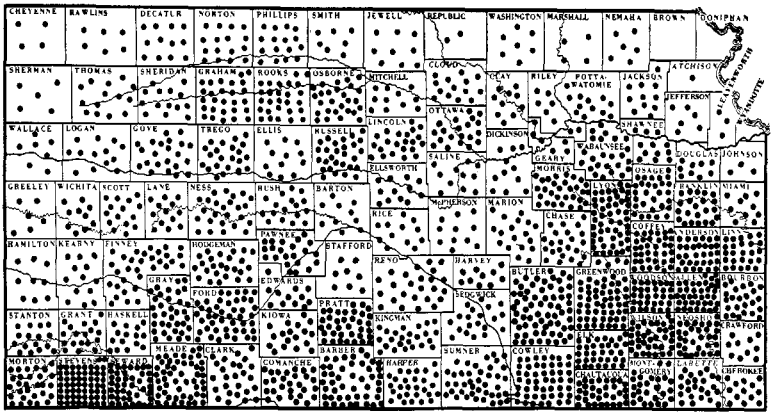

Fig. 4.—Average annual acreage of kafir in Kansas, 1920 to 1929. Each dot represents 500 acres. Data obtained from the Kansas State Board of Agriculture.

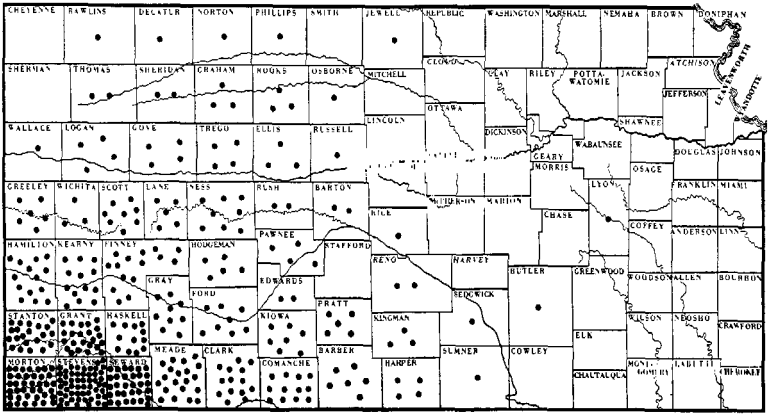

Fig. 5.—Average annual acreage of milo in Kansas, 1920 to 1929. Each dot represents 500 acres. Data obtained from the Kansas State Board of Agriculture.

GRASS SORGHUM

Sudan grass is the chief representative of this group which also includes Tunis grass, Johnson grass, and several other related plants.

Sudan grass was introduced in 1909 when a package of seed was received by Dr. C. V. Piper from R. Hewison, then Director of Agriculture and Lands, Sudan Government, Khartum, Sudan, Africa. It was first grown at Chillicothe, Tex., and was widely distributed from that point. It probably was grown first in Kansas in 1911 and was firmly established by 1915. Tunis grass was introduced about the same time but was found to be less desirable than Sudan grass. It is not so leafy as Sudan grass and its seeds shatter so easily that a great deal of care is required to obtain a sufficient quantity for planting. Johnson grass closely resembles Sudan grass but differs in having rootstocks. It is considered a noxious

weed which should be eradicated, even though it has some value as a forage and hay crop.

BROOM CORN

Broom corn was first grown commercially in the United States in the Connecticut valley near Hadley, Mass., about 1797. The early history of this crop is vague except that it was grown more than 350 years ago in Italy. The pioneers brought the crop into Kansas. The first commercial crop of broom corn in Kansas was grown by Frank G. Hawkinson in 1870 near Marquette in McPherson county from seed which he brought from Illinois.

DEVELOPMENT OF VARIETIES FROM ORIGINAL SOURCES

While introductions constitute the foundation stock of American sorghum, these introductions were frequently of mongrel or mixed types. Years of selection and testing by agronomists, plant breeders, and farmers were required before adapted types were found and made available.

The progress toward permanent establishment of the sorghum industry in this country may be divided into four periods. Up to 1893 the chief efforts in sorghum improvement centered on producing types suited to the manufacture of sirup and sugar. From 1890 to 1900 it was demonstrated that grain sorghum could be grown successfully on the semi-arid lands of the Southwest. The period between 1900 and 1920 was one of great improvement in the grain and forage types through careful selection and testing. During this period improved types were isolated and purified and their adaptations determined. The introduction of Sudan grass during the early part of this period as well as feterita and Dwarf hegari were distinct contributions. The period from 1920 to 1932 was one in which improvement by hybridization resulted in superior types, not only in yield, but also in desirable plant characteristics. These types are gradually replacing the older introductions and selections. Perhaps the chief contribution from hybridization thus far has been the dwarfing of varieties without marked loss of yield in order that the crop might be more conveniently handled by modern machinery. Resistance to disease and insect injury and improvement of quality have also been accomplished through hybridization. The possibilities of further improvement by hybridization are far from exhausted and the method offers much promise for the future.

The sorghum of America and of Kansas is among the best in the world. No new important introduction has been established since 1910. More than 250 new introductions since 1920 from several of the important sorghum centers of the world have failed to produce a single new strain sufficiently outstanding to replace the improved types grown in this country. The year 1888 marks definitely the beginning of the development of the sorghum industry in Kansas from the standpoint of grain and forage. The value of the crop to the state has risen from a little over three million dollars in 1888 to more than thirty-three million dollars in 1928.

CLASSIFICATION OF VARIETIES

Exact classification of sorghum is difficult because of confusion in names, the overlapping of groups, and the hybrid derivatives which are constantly arising. A variety is often known under several different names through local custom or the trade names of seedsmen. For illustration, Sumac is often known as Red Top. The names Honey Drip and Sugar Drip are frequently applied to saccharine sorghums of the Orange type. Many new selections, introductions, and hybrids, either have no flxed

names, or receive names which do not indicate the origin or relationship of the new types. For example, a sorgo of some local importance in Kansas is called African "millet." Schrock kafir and Wonder kafir, both apparently of hybrid origin, are not true kafirs at all.

For practical purposes, an agronomic rather than a botanical classification is presented in this bulletin for sorghum grown in Kansas. This classification covers only such varieties as have been or are now of importance in the state.

Classification of Sorghum

GROUP I

Forage sorghum (saccharine). Stalk juicy and sweet. Seed generally ranges in color from mahogany red to light brown but may be white; bitter or not bitter. Group valued primarily for silage, forage, or sirup.

A. Seed mahogany red to brown in color, bitter.
1. Black Amber.
2. Red Amber.
3. Standard Sumac.
4. Early Sumac.
5. Honey.
6. Leoti Red.
7. Red X.

E. Seed light brown to orange-yellow, somewhat bitter.
1. Kansas Orange.
2. Sourless.
3. African millet.
4. Western Orange.

C. Seed white, palatable.
1. Atlas.
2. Sunrise.

GROUP II

Grain sorghum (non-saccharine), Seed usually palatable. Stalk variable from juicy to dry, slightly sweet or not sweet. Group grown primarily for grain but juicy types have forage value also.

A. Stalk juicy to slightly juicy. Moderately sweet or not sweet. Seed palatable.

a. Kafir.
1. Standard Blackhull.
2. Dwarf Blackhull (Dawn and Western).
3. Pink.
4. Red.
5. Reed.

b. Hegari.

c. Freed
1. Standard.
2. Dwarf.

d. Hybrid derivatives.
1. Club.
2. Mocloc.
3. Weskan.
4. Greeley.
5. Kalo.

B. Stalk limited as to juiciness and sweetness. Of limited forage value. Seed brown to light brown or buff, slightly bitter to bitter.

a. Seed brown and bitter.
1. Darso
2. Schrock

b. Seed buff to light brown, not very bitter.
1. Grohoma.

C. Stalk dry or slightly juicy. Seed palatable. Forage of little value.

a. Milo
1. Standard, Yellow and White.
2. Dwarf, Yellow and White.
3. Double Dwarf.
4. Sooner.
5. Day.
6. Two-foot.

b. Feterita.
1. Standard.
2. Spur.
3. Dwarf.

c. White durra.

d. Shallu.

e. Hybrid derivatives.
1. Wheatland.
2. Beaver.
3. Fargo Straightneck.
4. Wonder.
5. Kaferita.
6. Ajax.
7. Custer.

GROUP III

Broom corn. Grown for brush. Stalk dry and not sweet.

a. Standard.
1. Black Spanish.
2. Evergreen.

b. Dwarf.
1. Scarborough.
2. Evergreen (Dwarf Acme).

c. Dwarf Whisk.
1. Japanese Dwarf.

GROUP IV

Grass sorghum. Grown primarily for hay and pasture. No rootstocks, Stem small.

a. Sudan grass.

DESCRIPTION OF SORGHUM VARIETIES

Hundreds of selections and varieties of sorghum have been tested by the Agricultural Experiment Station in Kansas during the last 45 years. A brief description is given of the principal varieties which have been or are now of importance.

FORAGE SORGHUM

Black Amber. — The Ambers are the oldest of the forage group, and Black Amber, formerly known as Early Amber, seems to have been the first recognized variety. It is said to have originated in 1859 in a field of Chinese sorgo growing in Indiana. Early Amber has been grown under the names of Minnesota, Dakota, Wisconsin, and Nebraska Amber, as well as Folger's, all indicating selections. The name Black Amber for Early Amber seems to have come into use by farmers in Kansas in 1895 and has since persisted. Black Amber is characterized by slender stalks, few leaves, and open branching heads. The stems are tender, juicy, and sweet. The variety matures in about 90 to 100 days. The seed is yellowish brown and somewhat elliptical in shape and nearly always enclosed by large pointed black glumes.

The seed of Black Amber is the most viable of all sorghums, probably because of the protection afforded by the glumes. Consequently in the

colder regions Black Amber germinates better than many other varieties. Because of its earliness and dependability Black Amber was for many years the leading forage sorghum used by the early settlers of Kansas. Until a few years ago there was a steady but limited demand from seedsmen for Black Amber seed raised in Kansas for distribution in the states of Nebraska, Iowa, South Dakota, North Dakota, and Minnesota. In recent years this demand has steadily declined.

The acreage of Black Amber is on the decline in Kansas on account of competition from superior new varieties and the introduction of Sudan grass.

Red Amber. — Red Amber (fig. 6) was selected by the United States Department of Agriculture from seed obtained in 1903 from New South Wales, Australia. Red Amber resembles a type introduced in the United States from Africa in 1857. Since many varieties of sorghum grown in Australia have been introduced from the United States or from South Africa the origin of Red Amber cannot be definitely determined. It is similar to Black Amber, but differs in having dark red glumes, in being slightly later in maturity, and in having more leafy and coarser stalks. Red Amber is susceptible to lodging and to head smut. It, like Black Amber, has declined in acreage in Kansas and probably for the same reasons.

Standard Sumac.–Sumac, sometimes called "Red Top," is almost certainly one of Mr. Wray's original introductions from Natal, Africa. In Africa it was grown under the name "Koombana." Some years after its introduction it appeared under the name of Liberian and Red Liberian, partly to promote sale of the seed. It seems to have entered Kansas under that name, and was also grown under the name of "African" and "Imphee." "Imphee" is a collective name for all sorghums in Natal, Africa. It is not certain just when the variety came into Kansas, but it was established by 1888 when it was highly regarded for sugar making. It is not known just when the name Sumac was first applied to the variety.

Standard Sumac has been an important variety in eastern Kansas, but is gradually being replaced by Atlas. It is among the sweetest and leafiest varieties of the sorgo group. It has compact, cylindrical, dark-red heads with a somewhat flattened top. The dark-red seed are small and set on very short branches, partially enclosed by short, deep-red to black round glumes. The seed protrudes beyond the glumes giving the whole head a red color. The variety does not readily cross-pollinate, which has been an important factor in maintaining its purity and trueness to type. Plants of Standard Sumac grow from 7 to 11 feet in height and have stout stalks with an abundance of broad leaves.

Early Sumac. — An early-maturing selection of Standard Sumac known as Early Sumac (fig. 6) was made by R. E. Getty, formerly of the Fort Hays Agricultural Experiment Station. It was first distributed to farmers in 1925. Plants of this variety grow from 5 1/2 to 7 feet tall and mature in about 100 days. Early Sumac is at present the most highly valued forage sorghum for western Kansas. It is replacing the Ambers and appeals to the farmers because of its uniformity, attractive appearance, earliness, ease of handling, and the fact that the stalks are juicy and sweet and not too large and coarse. It is likely to lodge and is susceptible to head smut and to kernel smut.

Kansas Orange.–The Orange sorgos and types closely related probably originated from Neeazana, one of Mr. Wray's African introductions made in 1857. The Orange group differs from the Amber group in having

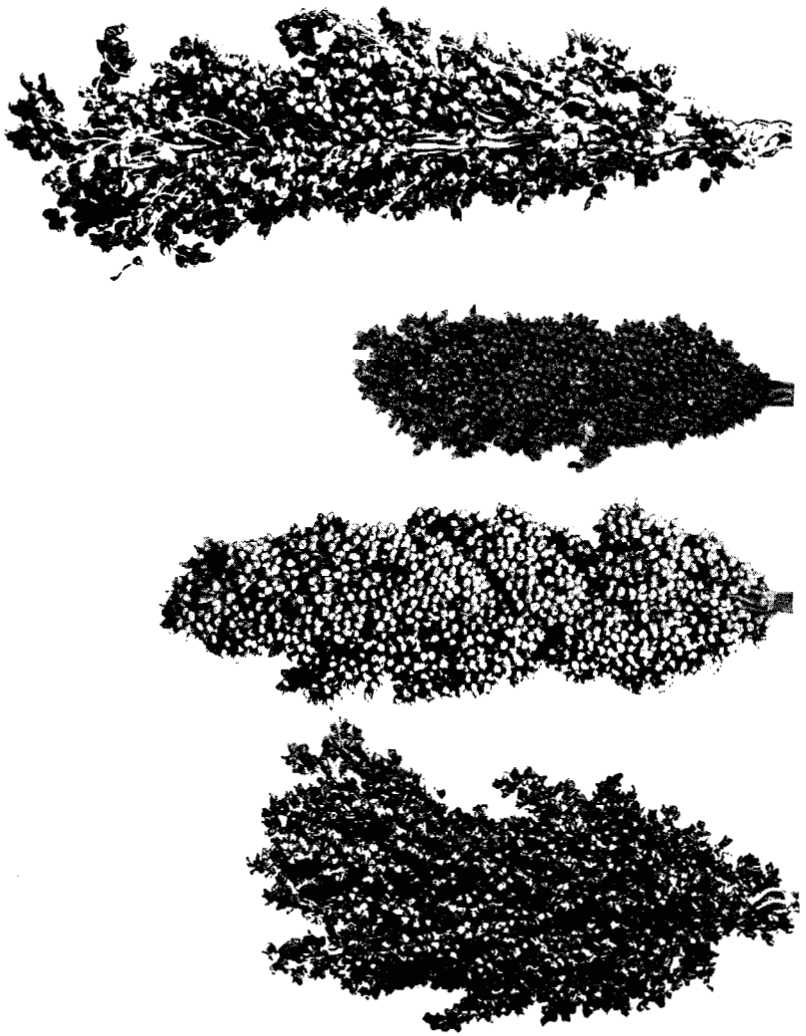

Fig. 6.—Varieties of forage sorghum. Bottom to top: Kansas Orange, Atlas, Early Sumac, Red Amber.

larger and heavier stalks, larger and more abundant leaves, and in requiring from 3 to 4 weeks more time to mature. There have been many selections from the Orange group, the chief of which is Kansas Orange known since 1880. It was one of the best suited for sugar-making purposes at the Kansas Agricultural Experiment Station in 1888. Kansas Orange has been extensively and widely grown for silage. It grows to a height from 8 to 11 feet and ripens in from 120 to 130 days. The heads are more compact than the Ambers. They are commonly about 3 inches wide and 5 to 7 inches long, varying from an oblong outline to fan-shaped,

with the top of the panicle rather loose and open or even somewhat drooping at the tip when mature. (Fig. 6.) The glumes are deep red to black at maturity but the seed are rather large reddish-yellow and protrude from between the glumes more than the Ambers do. The seed thresh clean from the glumes, are somewhat soft in texture, and are not very bitter. Just before ripening they are almost white in color, which has sometimes given rise to the name of White Orange.

Western Orange.--Some years ago an early selection of Orange known as Western Orange was developed at the Fort Hays station and distributed to a limited extent, but has since gone out of cultivation.

Sourless.--Sourless sorgo probably descended from the Neeazana variety introduced by Mr. Wray from Natal, and is closely related to the Orange group. About 1900, Sourless was being grown in the vicinity of Fort Scott, Kan., where it probably had been introduced when the sorgo sugar experiments of the Bureau of Chemistry, United States Department of Agriculture, were being conducted there. Later C. S. Hall, a cattleman at Eureka, Kan., obtained seed and grew considerable quantities of Sourless sorgo. Growers of Sourless claim that the fodder does not sour during winter, but retains its juiciness and sweetness until spring. Sourless as grown on farms is often badly mixed. It is of minor importance and is best adapted in southern and central Kansas.

African Millet.--African millet is not, as the name implies, a millet, but a vigorous sorgo. It differs from Kansas Orange in that the plant is somewhat shorter, with leaves a little closer together and heads more open and spreading at the tip. Also the seed is of a light-brown-to-white color and the glumes are straw colored. The variety matures late and often does not head well in dry seasons. It has never been extensively grown except in local areas in central Kansas. It probably has the same origin as Sourless.

Red X.--Red X resembles the Orange group of sorgos, having an elongated, somewhat open head with dull yellow seed, one-half covered with red glumes. It is grown to a limited extent in southeastern Kansas. It is sweet and juicy and is valued for sirup as well as for forage. The variety matures a little later than Kansas Orange, which limits its adaptation to southeastern Kansas.

Atlas.--Atlas sorgo is a pedigreed selection from a field cross between Sourless sorgo and Blackhull kafir found by I. N. Farr of Stockton, Kan. The selection now named Atlas was made by Dr. John H. Parker at Manhattan in 1923. After further testing at various agricultural experiment stations and in cooperative tests it was distributed to farmers in 1928.

Plants of Atlas grow to a height of from 7 to 10 feet and require from 120 to 130 days to mature. The variety has a sturdy, leafy stalk abundantly juicy and sweet. The heads (fig. 6) are fairly compact, somewhat cylindrical in shape with short branches well filled with white seed similar in shape and size to kafir. Atlas illustrates the possibility of combining in one variety the desirable characteristics of the two parents. Atlas is superior to Kansas Orange in resistance to lodging and in having white, palatable grain. Limited experiments indicate that Atlas grain is equal to kafir and that the forage is fully as good as Kansas Orange or Sumac. Atlas is replacing Kansas Orange in eastern Kansas and is adapted to south central and central Kansas if planted reasonably early on well-prepared fertile soil.

Sunrise.--Sunrise was selected in 1906 by A. H. Leidigh at the Cereal

Field Station, Amarillo, Tex. It has been assumed to be a natural cross between Blackhull kafir and White kafir. The seed is very similar to Blackhull but the stalk is taller, more slender, and sweeter. It is similar to Atlas except that it ripens about a week earlier, the plant is smaller, it makes lower forage yields, and is less sweet. The variety is grown to a limited extent in southern Kansas.

Leoti Red.--Leoti Red is said to have been developed near Muncie, Ind., where it was grown for sirup, but its exact origin is unknown. It may well have come from a cross between an Amber and the Orange or Planter group. The variety was found growing under the name of "Red Kentucky Sugar-cane" on the farm of V. E. F. Kleyman, Leoti, Kan., in 1921, when it was brought to the Fort Hays branch station for testing by R. E. Getty. This variety was re-named for Leoti, Kan., where it has been of local interest for 30 years. Leoti Red is an attractive, sweet, juicy forage sorgo which grows 6 to 7 feet high and matures in about 110 days. It has an open head with lax upper branches. The reddish brown seed is of medium size, covered more than one-half by red glumes. Leoti Red has had considerable distribution in southwestern Kansas. The variety is highly susceptible to head smut.

GRAIN SORGHUM

The several varieties of kafir grown in Kansas constitute about 35 per cent of the total acreage of sorghum in the state and 75 per cent of the acreage of grain sorghum. Most of the remaining acreage of grain sorghum is comprised of milo and feterita.

Standard Blackhull.--Blackhull kafir was first grown in Kansas about 1895. Standard Blackhull is an improved strain developed by the Kansas Agricultural Experiment Station and named in 1915. It matures in from 115 to 130 days and is well adapted in Kansas on the bottom lands and the more fertile uplands as far west as Dickinson, Rice, Reno, and Barber counties. Its production is limited farther west by the shorter season and lower rainfall. Standard Blackhull grows from 5 to 7 feet tall and is characterized by juicy, stout, short-jointed stems, 12 to 16 broad, stiff leaves, which are set close together especially on the lower half of the stem. The cylindrical or oblong heads (fig. 7) are 8 to 12 inches long and relatively larger in diameter than most other kafirs because of longer seed branches. The heads are square at the tip. The medium-sized, oval-shaped seed are white with a splash of red or black on the tips. The black glumes cover one-third to one-half of the seed. Standard Blackhull, in common with other varieties of kafir, is susceptible to kernel smut and has relatively high resistance to chinch-bug injury.

Western Blackhull.--Western Blackhull is similar to Standard Blackhull except that it matures earlier and the stalks are shorter. Western Blackhull grows from 4 to 5½ feet tall and ripens in from 100 to 120 days. It seems probable that Western Blackhull originated from a selection made by A. H. Leidigh, Amarillo (Texas) Field Station, and was distributed under the name Santa Fe, by H. M. Bainer, formerly colonization agent for the Santa Fe railroad. The variety was also known as Bainer kafir. A Texas station selection (No. 9195), called Texas Blackhull, and grown extensively in the Texas Panhandle, is almost identical to Western Blackhull. In 1918, seed of Western Blackhull obtained from P. E. Crabtree, Scott City, Kan., was brought to the Fort Hays Agricultural Experiment Station for testing by R. E. Getty and later by D. A. Savage. Western Blackhull was recommended for distribution in Kansas in 1931. For

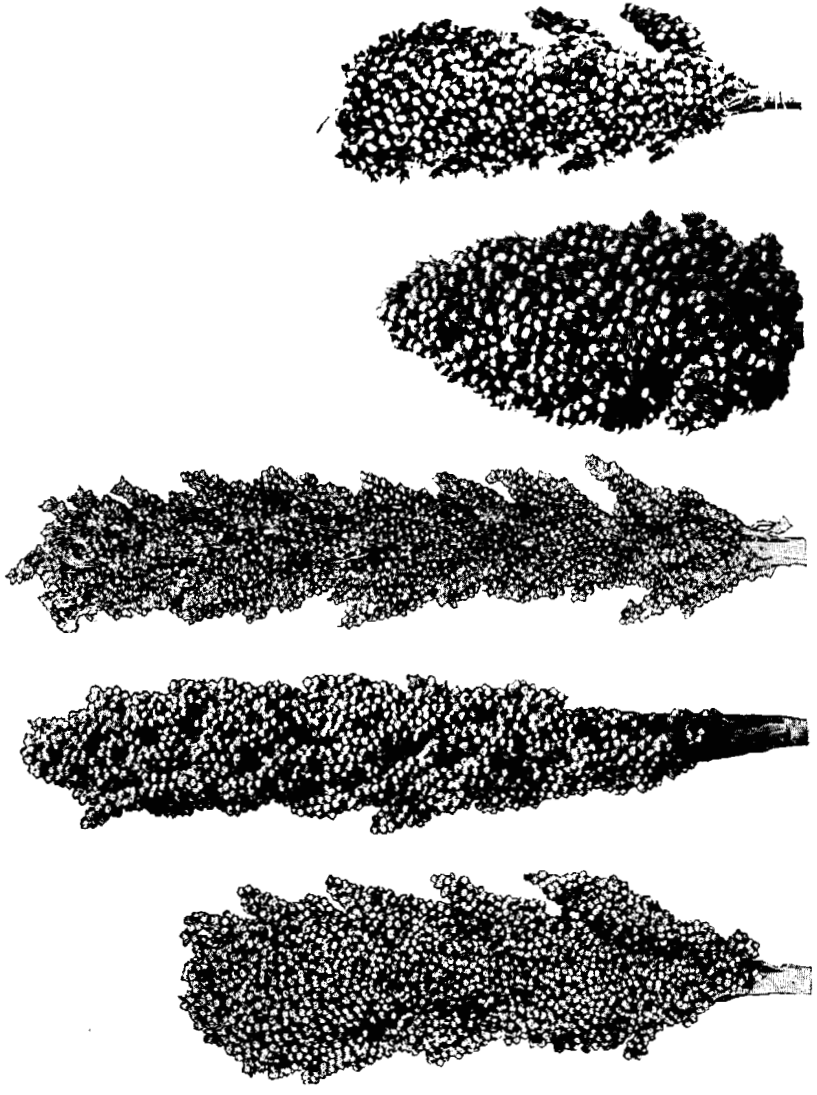

Fig. 7.—Varieties of grain sorghum. Bottom to top: Standard Blackhull, Pink kafir, Red kafir, Dwarf Yellow milo, Standard feterita.

a long period of years Western Blackhull has been one of the highest-yielding grain sorghums tested at the Fort Hays station and is particularly well adapted to south central and southwestern Kansas.

Dawn.--Dawn kafir is a dwarf blackhull originated from a hybrid head which was selected by A. H. Leidigh in 1906 at the Amarillo Field Station. Dawn was reselected at the Fort Hays station in 1919, and from 1923 to 1931, 388,000 pounds of certified seed of this variety was dis-

tributed from there. Dawn differs from Western Blackhull primarily in having heads with shorter seed branches and somewhat smaller, less lustrous seed. Since Dawn is from 3 to 5 days earlier than Western Blackhull it has some advantage over the latter in north central and northwestern Kansas.

Whitehull White.--Whitehull White was the first kafir to be grown in Kansas and was introduced about 1585. It differed from the Blackhull kafirs in having white instead of black glumes and in the tendency for the heads to remain partly enclosed in the boot or upper leaf sheath, which caused the seed to mold. It was not well adapted, usually did not make high yields, and was soon replaced by Blackhull.

Pink Kafir.--Pink kafir is a leading grain sorghum in south central and central Kansas and is also grown to some extent in eastern and southwestern Kansas. It was imported from South Africa about 1905 by the United States Department of Agriculture. As far as known, seed from this source was sent to the William Rockefeller Ranch at Russell, Kan., and soon became badly contaminated. In 1907, A. D. Colliver of the Fort Hays station obtained some of the mixed seed for testing and head selections were made in 1908 to purify the variety. The Pink kafir grown extensively in Kansas today originated from head row No. 10 selected by C. C. Cunningham at Hays in 1909. It was first known as Whitehull White, but was later named Pink to avoid confusion with another variety known as Whitehull White kafir. The variety was extensively tested by B. E. Rothgeb, A. L. Hallsted, and R. E. Getty of the Fort Hays station. Cooperative state-wide tests demonstrated the adaptation of Pink throughout the central and southern parts of the state and showed that it ripens too late for successful production in northwestern Kansas. Pink kafir is used for both grain and forage.

The normal height of Pink kafir is from 4 to 6 feet. The stalks are rather leafy and of medium size. Some plants of Pink kafir have juicy stalks, some dry. The heads (fig. 7) are from 10 to 14 inches long and cylindrical in shape with very short branches well filled with small pinkish white seed. The pink cast of the seed is due to a thin seed coat overlying a very thin layer of red-brown sub-coat.

Juicy Pink.--Juicy Pink kafir, C. I. No. 907, is a selection from Pink kafir in which all the stalks are juicy and the seed is of a pearly white cast without the sub-coat. Juicy pink is similar to Pink kafir in manner of growth and in yield of forage and grain.

Red Kafir.--Red kafir probably was an importation exhibited by the Orange Free State in Philadelphia in 1876. The United States Department of Agriculture sent seed of Red kafir to the Kansas Agricultural Experiment Station in 1889. Because of relatively high yields, it immediately gained popularity which continued for many years. Several strains of Red kafir differing principally in height and length of growing season have now been developed. The different strains grow from 4 to 8 feet tall and mature in 100 to 130 days. The heads are typically long and cylindrical. (Fig. 7.) The juicy stalks are more slender than those of Blackhull kafir. The seed are light red and slightly smaller than the seed of Blackhull. An early strain of Red kafir, C. I. No. 957, was isolated by R. E. Getty formerly of the Fort Hays station, from a field near Bazine, Kan. This selection has given satisfactory grain yields in central Kansas. Adapted strains of Red kafir compare favorably with other grain sorghum in the eastern half of Kansas, and are commonly grown in portions of that region.

Reed.--Reed kafir was distributed by E. M. Reed, Elk City, Okla. He obtained the seed from John Crammer, Okeene, Okla., who selected the variety from seed supplied to him by the Oklahoma Agricultural Experiment Station. The variety tillers sparsely and tends to lodge easily. The glumes are large and black and do not thresh freely from the seed. The variety is somewhat earlier than Standard Blackhull and grows to a height of about 5 feet. It was introduced into Kansas from Oklahoma and only a small acreage is grown in the state.

Club.--Club appeared in 1926 at the Fort Hays station in a head row (No. 31) of Dawn kafir. Club grows to a height of from 4 to 5 feet. The stalks are leafy but only slightly juicy. The club-shaped heads have short branches heavily filled with white seed splashed at the tips with red. The seed is somewhat larger than Blackhull. The glumes are reddish to reddish black and enclose about one-half of the kernel. Club matures in from 106 to 115 days, or in about the same time as Western Blackhull.

Kalo.--Kalo, formerly known as yellow kafir, originated from a natural cross of Pink kafir and Dwarf Yellow milo at the Fort Hays station in 1921. **A** strain was selected with cylindrical heads from 9 to 12 inches long. The seed is similar to Pink in shape and size but is pale yellow. The variety grows to a height of from 3½ to 4½ feet. The slender stalks have 14 to 16 leaves and are not very juicy. The plant resembles milo in color of cured forage. The variety is susceptible to chinch-bug injury and is likely to lodge if left standing after full maturity. It ripens in from 100 to 110 days. Kalo has ranked high in yield among grain sorghums where chinch bugs have not been present in large numbers.

Wonder.--Wonder originated in 1914 from a single head and was developed by C. **A.** Bowers of Wallace, Kan. It is apparently a field cross between kafir and feterita. The variety has had limited distribution in the western half of the state. Wonder is leafy and has a dry stalk. Because of long seed branches it often gives promise of much larger yields during the fruiting period than are generally realized at time of harvest. Nevertheless the variety ranks high in yield at the Fort Hays and Garden City agricultural experiment stations. Wonder grows to an average height of 50 inches and matures in about 110 days. The seed have the softness of feterita and the size of kafir. The variety is susceptible to kernel smut and under certain conditions may lodge. The soft seed have sometimes been the cause of poor stands.

Dwarf Yellow Milo.--Dwarf Yellow milo (figs. 7 and 8) appeared on the Plains of Texas and Oklahoma soon after 1900, probably as a selection by a farmer from Standard Yellow milo, which was brought to Texas previous to 1890.

Dwarf Yellow milo, C. I. No. 332, or a type similar to it, has long been an important commercial variety, not only in southwestern Kansas but in the Panhandle regions of Oklahoma and Texas and restricted areas in New Mexico, Arizona, and California. (Figs. 7 and 8.)

This variety is characterized by rather dry stalks and large oval or egg-shaped, mostly pendent or goosenecked heads. The stalks have little value for forage as compared with kafirs or sorgos. The seed of Dwarf Yellow milo are among the largest of the sorghums, obovate in outline, and somewhat flattened. The seed are pale reddish yellow without the red-brown sub-coat. They are about one-third enclosed in nearly black, hairy glumes, which are transversely wrinkled.

Dwarf Yellow milo normally grows to a height of 3½ to 4½ feet and may, with an abundance of moisture at heading time, reach a height of

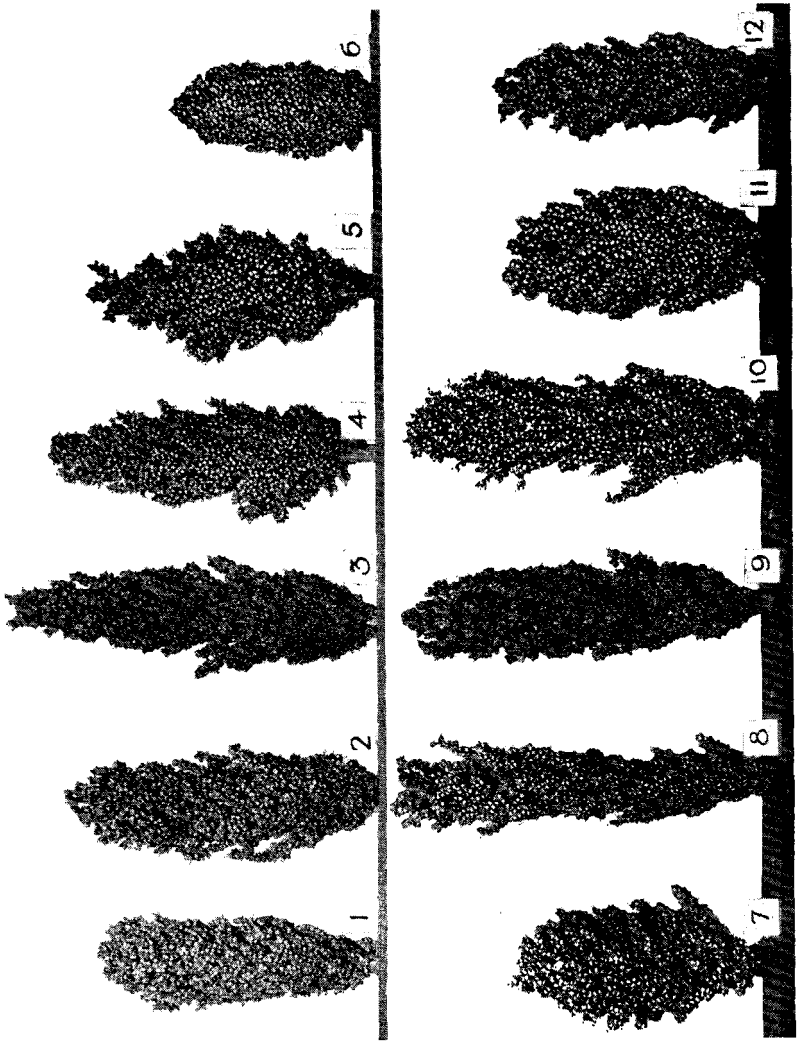

Fig. 8.—Heads of Dwarf Yellow milo and derivatives of milo. (1) Two-foot milo. (2) (MxK) x M. (3) Cuter. (4) Wheatland. (5) Beaver. (6) Sooner. (7) Double Dwarf. (8) Early Kalo. (9) Kalo. (10) Fargo Straightneck. (11) Dwarf Yellow milo. (12) Day milo.

from 6 to 7 feet. At these heights, Dwarf Yellow milo is difficult to harvest because of pendent heads and a tendency to lodge. Pendent heads in milo often occur with an abundance of moisture and warm weather at heading time. This causes such rapid growth of the heads that the tender peduncles cannot hold them erect. The large heads emerge from the side of the leaf sheath rather than from the upper extremity, and thus the heads are not supported by the sheath. Ordinarily a larger proportion of the heads is pendent in thin rather than thick stands.

Dwarf Yellow milo is important for grain production in the drier sections of the sorghum belt where the rainfall is from 15 to 25 inches, and at altitudes from 2,000 to 4,000 feet. In the eastern half of Kansas, milo is frequently attacked by chinch bugs. For this reason, the crop is grown successfully only in the western half of Kansas, especially in the southwestern counties (fig. 5) where the growing season is suffciently long for it to mature. The Kansas-Nebraska line marks the northern limit of milo.

Milo responds more favorably to irrigation than any other sorghum grown in the Southwest. On the other hand, if the moisture supply is low, milo is highly susceptible to injury from high temperature at the time of pollination, which results in a poor set of seed or blasted heads. In certain localities in southwestern Kansas, milo has been attacked by a soilborne disease. A strain that is resistant to that disease and apparently identical to Dwarf Yellow milo in other respects has been isolated at the Garden City Agricultural Experiment Station. Dwarf Yellow milo is relatively free from the various forms of smut, except one form of kernel smut to which it is susceptible.

Dwarf White Milo.--Dwarf White milo is identical to Dwarf Yellow except that the seed are white. It was first observed on farms in the Texas Panhandle about 1906. There is some evidence that Dwarf White may have been distributed in the Plains from an early importation from India. The variety is not now grown commercially in Kansas.

Standard Milo.--Standard milo, whether yellow or white in color, differs from Dwarf milo chiefly in a height greater by 13 to 30 inches. The Standard Yellow is a direct descendant of the original importation improved through selection, and the origin of the Standard White is not known. Neither one is of commercial importance in Kansas.

The Standard milo and to some extent the Dwarf milo have been grown under many obsolete names, some of which are still found listed in seed catalogs. Milo was first known as "Yellow millo maize." Other names include Branching doura, Millo, Millo maize, Dhoura milo, and Milo maize. The name "milo" is adopted and recommended because it is short, distinctive, and appropriate. The word maize should not be used for milo, as it confuses this crop with corn.

Fargo Straightneck.--Fargo Straightneck is apparently the result of a hybrid between milo and kafir made by H. Willis Smith, Kismet, Kan. It was first observed on farms near Fargo, Okla., in 1921, and became widely distributed in the Panhandle of Texas and Oklahoma and parts of southern Kansas between 1925 and 1928. The variety has since declined in popularity as rapidly as it came into prominence. Fargo Straightneck has a loose, open head somewhat similar to Shallu. (Fig. 8.) The kernels closely resemble Yellow milo. The stalks are dry. The variety is considerably later than Dwarf Yellow milo and rarely matures as far north as Hays where it is among the lowest in yield. In the Panhandle region it has been about equal to milo in yield in some tests. The chief objection to Fargo Straightneck from the standpoint of machine harvesting, is its weak stalks. It has shown a decided tendency to lodge after frost or maturity.

Wheatland.--Wheatland is from the cross, milo x kafir, produced at the United States Field Station, Woodward, Okla., by J. B. Sieglinger, and brought to the Fort Hays Agricultural Experiment Station by Supt. L. C. Aicher for testing in 1929. It was named and distributed to farmers of central and western Kansas in 1931. Wheatland grows to an average height of about 31 inches but has a range of from 24 to 39 inches depend-

ing upon seasonal conditions. The stalks are short and sturdy giving it the strength to resist lodging to a greater degree than any other known variety of commercial importance. The heads are elongated, cylindrical, and somewhat open, varying in length from 6 to 9 inches (fig. 8) depending on the season and the thickness of stand. Each plant may produce from two to five tillers and heads of uniform height. The seed of Wheatland are about the size of Yellow milo, but lack the attractive bright color of the latter variety. The glumes are black and hold the seed firmly from shattering. The variety threshes readily without cracking, giving a test weight of 56 to 58 pounds per bushel. Wheatland is susceptible to chinch-bug injury and to the soil-borne disease which affects milo.

In a normal season Wheatland will mature in about 100 to 110 days, but if moisture and warm weather prevail during the late fall Wheatland will continue growing and has been known to require 125 days to mature. The yield is considerably increased by the longer growing period. Wheatland, in common with all sorghums, is drought-evading, yet subject to considerable injury by hot, dry weather during the flowering period. Farmers have found Wheatland well suited for harvesting with the combine.

Beaver.--Beaver is from the cross, milo x kafir, made by J. B. Sieglinger at Woodward, Okla., and distributed from that station in 1928 to farmers in the Panhandle region. From there it was gradually introduced into Kansas. The heads (fig. 8) are slightly pendent, and are somewhat obscured by the upper leaves. The seed is similar to milo in size, shape, and color. The stalk is dry and not so resistant to lodging as Wheatland. Beaver has made satisfactory yields in the milo territory.

Sooner, Day, and Two-foot Milos.--These varieties (fig. 8) of milo originated at Woodward, Okla., from a cross made by J. B. Sieglinger of Dwarf Yellow milo x Early White milo. Sooner grows 3 to 4 feet high as compared to 2 to 3 feet for Day and Two-foot. The varieties mature in from 85 to 95 days but do not have the potential yielding ability of Wheatland, nor are they so resistant to lodging. The heads of these varieties are not always erect, that is, they may he goosenecked. The seed resemble milo in color and size. These early varieties may be of value in the more semi-arid regions where the seasons are short, as in northwestern Kansas.

Double Dwarf Milo.--Double Dwarf milo is so named because of its extreme dwarfness, which is fairly constant, the plants rarely exceeding a height of 3 feet. Otherwise, Double Dwarf milo (fig. 8) does not differ materially in observed characters from Dwarf Yellow milo. Double Dwarf milo apparently originated in the Salt River valley of Arizona, hut it became of commercial importance about 1920 in the Imperial valley of California, where it has replaced Dwarf Yellow milo to a large extent. A few shipments of seed of Double Dwarf milo have been made into Kansas, but experiments have shown the variety to be inferior to Dwarf Yellow milo in this state.

Custer.--Custer is from the cross, Pink kafir x milo, backcrossed to milo. The plant resembles milo and grows to an average height of about 36 inches. The heads are cylindrical and elongated (fig. 8) with attractive small red seed which thresh free from the glumes. Custer does not have the yielding ability or lodging resistance of Wheatland.

Dwarf Hegari.--Dwarf hegari has a medium juicy, slightly sweet stalk 4 to 5 feet tall. The heads are cylindrical in shape, from 7 to 8 inches long, and about 3 inches in diameter. The seed branches are well sup-

plied with seed on all sides so that each branch appears as a lobe. The seed, which are about the size of Blackhull kafir, are pure white except for red or reddish-brown markings and a red-brown subcoat. Dwarf hegari ordinarily matures in from 100 to 110 days. The variety is erratic in its behavior. Under dry-farming methods it has been early in some seasons and late in others. Its yield as compared to other varieties may be high in one season and low in the next. Under irrigation Dwarf hegari has ordinarily made high yields, but under dry-land conditions of Kansas the variety has been inferior. Hegari is resistant to kernel smut.

Standard Feterita.--Standard feterita has a slender dry stalk, normally 4½ to 6 feet tall, only medium leafy, and of relatively low value for forage. The heads are erect and compact. (Fig. 7) The seed are large, chalky-white, and tinted with reddish black blotches varying in amounts according to the seasonal conditions. The soft seed of feterita rot quickly in cold wet soil so that poor stands often result under ordinary farm conditions. Since the variety tillers freely a part of the loss in yield due to a partial stand may be overcome. Feterita is noted for its smut resistance and for its short growing season which permits it to escape drought. The best yields of feterita are obtained when planted after June 15, if the seed bed is well prepared. The variety is of value as a catch crop, An improved strain of it was introduced by the Fort Hays station in 1924. Birds are readily attracted to feterita and may frequently devour much of the crop, especially if it ripens before other sorghums.

Spur Feterita.--Spur feterita was selected from standard feterita in 1914 by R. E. Dickson at the substation at Spur, Tex. It is slightly shorter, more leafy, but somewhat later in Kansas than the Standard and is not equal to it in yield.

Grohoma.--Grohoma is a mid-season to late variety 4 to 6 feet tall with stout stems moderately juicy and slightly sweet. The variety tillers freely and branches abundantly. The heads are from 8 to 15 inches long and may or may not be well exserted from the upper leaf sheath or boot. The botanical origin of Grohoma is uncertain though the characters of the plant suggest a cross between feterita and some variety of sorgo. It was distributed in 1929 by Fred Groff of Britton, Okla. It has not proved well adapted in the drier portions of Kansas.

Ajax.--Ajax is from the cross, feterita x kafir, and was developed by the Agricultural Experiment Station at Chillicothe, Tex., and distributed to the farmers of that state in 1931. The stout stalks are from 36 to 46 inches tall with approximately 16 leaves to the plant. The heads are erect with long seed branches. The seed are white with a brown subcoat and resemble feterita. The variety matures in from 110 to 125 days. Ajax is too late to mature in western Kansas. With a long season and sufficient rainfall, Ajax has the ability to produce heavy yields.

Standard Freed.--Freed often known as Freed sorgo or "White cane" originated in Scott county, Kan., and was developed by J. K. Freed from a mixture of white-seeded sorghum brought in by homesteaders in 1908. In 1912, a selection was made which became the foundation stock of Freed. This variety has a slender semi-juicy and slightly sweet stalk with few leaves. The heads are open to sprangly with the white seed well covered by the glumes which vary from dark red to black to pale straw color. The glumes are hairy and adhere to the seed if the grain is damp when threshed. If the weather is dry after the grain has matured, the seed shatter readily. Freed is one of the earliest varieties, maturing in 80 to

90 days, and therefore has value as a catch crop. Because of its earliness Freed does not compete with the more vigorous-growing sorghums except in very dry years, or in a region where the growing season is short. It makes a low yield of forage. The variety is distributed in western Kansas and has been of considerable value in adverse seasons.

Dwarf Freed.--Dwarf Freed was selected in 1921 at the Fort Hays station from Standard Freed. It differs only in stature, growing from 40 to 48 inches tall, while Freed is usually from 60 to 70 inches tall. The variety has made higher grain yields than the Standard Freed. It is equally as early, maturing in from 80 to 90 days. Dwarf Freed has a tendency to lodge a few weeks after it is fully matured. The variety has had limited distribution in western Kansas, It is susceptible to both head and kernel smuts and cross pollinates readily with other sorghums.

Modoc, Greeley, and Weskan.--These are three hybrid derivatives from the cross, Pink kafir x Freed, made at Modoc, Kan., in 1917 by P. E. Crabtree. Three years later heads supplied by Mr. Crabtree were planted on the agricultural experiment stations at Hays, Tribune, and Manhattan where Modoc, Greeley, and Weskan, respectively, were developed. Modoc has a slender leafy somewhat juicy stalk with a range in height of from 48 to 70 inches. In earliness and drought resistance Modoc resembles Freed; in productivity, head, and seed characters, it resembles Pink kafir. Modoc has had limited distribution in northern Kansas where it seems to be adapted as a grain and forage crop. Weskan resembles the kafirs and is earlier than Dawn and Western Blackhull. Greeley is an early grain sorghum which ripens in 80 to 90 days and grows to a height of about 40 inches. The stalks are moderately juicy but the variety is limited as to yield of forage. It may have a place in high altitudes and regions of short seasons as extreme western and northwestern Kansas.

Shallu.--Shallu has been grown and exploited under many names such as California wheat, Egyptian rice, Egyptian wheat, Mexican wheat, Mexican desert wheat corn, and rice corn. The variety has dry slender stalks which are not sweet. The plants grow from 6 to 9 feet tall and are not abundantly supplied with leaves. The variety tillers freely. The long slender branches of the heads are spreading and drooping at the tips. The leaning of the slender stems as the crop matures causes all the branches of the heads to hang to one side. The greenish-yellow hulls or glumes closely envelop the young seed. As the seed ripens these glumes turn to a pale straw color and open widely. exposing the seed. The rounded somewhat flattened seed are white to pale buff and slightly smaller than Blackhull kafir. The seed have no subcoat and a very thin outer layer gives them a pearly appearance. Shallu lodges or breaks over readily. The variety is not recommended for Kansas.

Schrock.--Schrock, also known as Schrock kafir, was discovered by Roy Schrock, a mail carrier at Enid, Okla., in 1912. He noted a vigorous-growing plant in a field along his route and he obtained permission to gather the seed which he planted in his garden the following year. A wide distribution followed in subsequent years. Schrock is also grown in some of the southern states under the name of Sagrain. The variety grows from 4 to 5 feet in height, has a very dense foliage and stout moderately juicy stalks. The forage rivals that of kafirs in quality and tonnage, but falls well below the tonnage of leading sorgos. The seed are bittter, yellowish-brown, and medium size. Schrock yields well in eastern Kansas but is not adapted to western Kansas.

Darso.--Darso was developed by the Oklahoma Agricultural Experi-

ment Station from seed received in 1912 from Logan county of that state. Darso grows from 3½ to 5 feet high, has heavy foliage, and fairly juicy somewhat sweet stalks. It produces good yields of grain in eastern Kansas. In Western Kansas, it has not produced high yields of either grain or forage. Seed of Darso is bitter. Darso heads are from 10 to 12 inches long and somewhat open. The seed are yellowish brown on the back and frequently reddish brown on the germ side. They are a little smaller than milo, ovate in shape, and flattened at the germ end. The glumes are black and extend about one-half way over the seed.

White Durra.--White durra grows to a height of from 4 to 6 or more feet, depending somewhat upon the strain, and has pendent heads. The large, flat, soft white seed shatter freely because they are loosely enclosed in the white glumes. The stalks are slender and have dry pith and few leaves. The variety is extremely early and makes low yields. Considerable White durra was grown during the Eighties, but gradually it was replaced by the kafirs until now only a very small acreage is grown in Kansas. White durra is still grown in California where the grain is in demand for poultry feed.

GRASS SORGHUM

Sudan Grass.--Sudan grass is an annual hay plant with slender stems 4 to 6 feet high, numerous rather soft leaves, open panicle, numerous tillers, only occasional branches, and no rootstock. Only one variety of Sudan grass is grown, the uniformity and purity of which has been maintained by a few growers. (Fig. 9.) The late Carl Wheeler, Bridgeport, Kan., maintained for many years a good source of seed adapted to Kansas.

Fig. 9.—Sudan grass.

BROOM CORN

There are three classes of broom corn, the standard, dwarf, and whisk dwarf. The standard has been grown most extensively but the dwarf also has found favor in the broom-corn section of Kansas. At the present time the whisk dwarf is not much grown.

Black Spanish.--Black Spanish (Black Jap) is the leading standard variety grown in recent years. It has been in this country for at least 30 years but its origin is unknown. It usually grows to a height of 6 to 11 feet. The glumes are dark brown to black. It is favored by growers because of early maturity and tendency to produce a finer, straighter brush with less reddening than the older and taller evergreen type. Being shorter than the evergreen it can often be harvested without the process of tabling in the broom-corn section of the state.

Scarborough.--Scarborough is the leading dwarf type of broom corn. The variety originated in Texas county, Okla., in 1910. It differs from other varieties chiefly in bearing fewer seed, most of which are borne near the tip of the brush where they are easily removed in stripping. The many fine seed branches near the tip of the brush make the Scarborough brush valuable for the hurl or outside of brooms. The plants grow 4 to 6 feet tall. The glumes are reddish tan in color.

Japanese Whisk Dwarf.--Japanese Whisk Dwarf is the only whisk variety grown in this country. It grows to a height of 2½ to 4 feet and produces a fine slender brush 12 to 18 inches in length. Three-fourths of the brush is covered by the boot or upper leaf sheath. Red color develops in the brush more frequently than in other types of broom corn. In recent years other dwarf varieties which yield more have largely replaced Japanese Whisk Dwarf for making whisk brooms.

WHAT CONSTITUTES A GOOD VARIETY

Adaptation, quality, and yield are the three chief points to be considered in deciding what is the best variety to grow. A variety must be suited to the use for which it is grown, as for example grain, fodder, silage, hay, or brush. This determines which to choose from the four general classes of sorghum.

ADAPTATION OF SORGHUM

A variety must be adapted to the soil and general climatic conditions of the territory where it is to be grown. The best variety is usually one that makes rather full use of the rainfall, soil fertility, and the growing season available. A wise choice of varieties may go far to offset handicaps such as low rainfall, poor soil, a short season, or possible injury from wind, diseases, insects, or birds.

The normal annual rainfall in Kansas decreases steadily from 40 inches along the east boundary to scarcely 16 inches at the Colorado line. The normal frost-free period likewise shortens from 200 days at the southeast corner to only 154 days in extreme northwestern Kansas. The shortening of season is due to the rise in altitude from 1,000 to 3,500 feet in going west, and to 200 miles difference in latitude in going north. The season shortens an average of about one day for each 100 feet rise in altitude, and one day for each eight miles north. Since sorghum grows very little at less than about 65° F., the crop cannot make use of the entire frost-free period.

A few counties in northwestern Kansas, as far south and east as Wallace and Norton for example, must use relatively early types that mature within

85 to 95 days. Medium-sized varieties requiring 95 to 120 days may be grown in the region extending southeastward as far as Washington, Ellsworth, Pawnee, and Morton counties. In the remainder of Kansas where 120 to 140 days of sorghum growing weather are available the length of growing season is not a factor for the later-maturing varieties such as Kansas Orange and Standard Blackhull.

The length of time required for varieties to mature at Hays is indicated in Table I. Several varieties such as Pink and Western Blackhull require about the full available growing season at Hays, while feterita and Early Sumac ripen about two weeks earlier than is necessary to avoid frost. A somewhat shorter time may be required for a variety to mature at higher altitudes than Hays. A more complete discussion of adaptation is given in the section on "Varieties of Sorghum Adapted to Kansas."

QUALITY FACTORS IN SORGHUM

Quality is important in the choice of a variety because sorghums differ in many plant characters of practical importance. The stalks of varieties differ in sweetness, juiciness, coarseness, tenderness, leafiness, height, tillering, side shoots, and lodging. The heads vary in erectness, exsertion from the boot. size, shape, compactness, branching, and general attractiveness. In the grain, varieties differ greatly in color, palatability, size, hardness, shattering, and adherence of glumes or hulls. Varieties differ in their resistance to disease and insect injury. A knowledge of varieties and a consideration of the relative importance of the different characters will aid materially in making the right choice. In the matter of forage it should be borne in mind that weather conditions and time of cutting are important factors in obtaining quality. The height of the plants determines largely what method of harvesting can best be used. Varieties which exceed 5 to 6 feet cannot readily be harvested by any other method than the row binder. Varieties that are not more than 4 or 5 feet tall can be cut with a combine or header if standing erect. Varieties that are shorter than 2½ feet cannot be cut with a row binder.

The size and shape of head and number of branches are probably not of major importance in regard to yield, but they have a bearing on resistance to shattering, weathering, mold, and insect injury. Size of head can be greatly influenced by stand. Some varieties naturally produce large heads but in doing so require greater row space. In other varieties the heads are naturally small but the plants can be spaced closer in the row and so produce equally as high yields per acre as plants with large heads.

Certain plant characters and growing habits referring to quality are given in Table I for varieties grown at Hays.

Resistance to Lodging.--Lodging in sorghum is influenced principally by height of plant, thickness of stand, and variety. In general, lodging tends to occur more frequently and to be more severe for taller than for shorter plants and in thicker rather than thinner stands. Varieties that are ordinarily resistant to lodging may lodge readily when chinch bugs are serious.

The tendency to lodge is a great disadvantage when varieties are left to be combined and is of importance when the crop is harvested by any other method. Lodging tends to increase with the length of time the crop is left standing in the field. In experiments at Hays, Wheatland was the most resistant among the dwarf types several weeks after the varieties were fully ripe. Adapted varieties of kafir are more resistant to lodging than feterita and Dwarf Yellow milo. Among the tall varieties, Atlas is

TABLE I.—PLANT CHARACTERS AND GROWING HABITS OF SORGHUM VARIETIES.

Fort Hays Agricultural Experiment Station, Hays, Kansas.

Identification No.	VARIETY	Days to mature		Tillers per plant		Height of plants (ins.)		Lodging per cent		Test wt. (lbs. per bushel)	
		2-yr. av., 1930 to 1931	7-yr. av., 1925 to 1931	2-yr. av., 1930 to 1931	7-yr. av., 1925 to 1931	2-yr. av., 1930 to 1931	7-yr. av., 1925 to 1931	2-yr. av., 1930 to 1931	7-yr. av., 1925 to 1931	2-yr. av., 1930 to 1931	7-yr. av., 1925 to 1931
6610†	Leoti Red sorgo	116	110	2.1	1.9	71	76	8	6	50	49
6611†	Early Sumac sorgo	110	107	2.1	1.9	61	67	14	14	57	58
35038‡	St. Sumac sorgo	120	(a)118	1.9	1.8	71	74	0	5	52	56
18605†	Atlas sorgo	130	(a)123	2.6	2.1	71	77	0	2	50	55
957*	Red kafir	124	117	1.5	1.6	58	63	0	5	53	57
432*	Pink kafir	126	118	1.7	1.6	60	65	0	8	52	57
907*	Juicy Pink kafir	125	119	1.7	1.6	61	63	T	2	53	58
906*	W. Blackhull kafir	128	118	1.7	1.6	53	57	T	1	52	57
340*	Dawn kafir	122	116	1.7	1.6	58	55	2	1	54	58
182-1*	Standard feterita	102	104	2.7	2.3	60	63	0	1	57	57
332*	Dwarf Yellow milo	123	114	2.4	1.9	44	50	0	7	56	57
905*	Modoc	108	108	2.0	1.7	52	55	0	2	57	59
904*	Dawn kafir sel	120	116	1.7	1.7	55	56	2	1	54	58
872*	Wonder	111	109	1.8	1.7	47	50	0	5	58	58
971*	Dwarf Freed	93	98	2.1	2.0	44	48	0	2	57	58
809*	Fargo Straightneck	131	....	1.8	....	48	..	2	..	54	..
865*	Tex. Bl'hull kafir	123	....	1.6	....	53	..	T	..	53	..
868*	Double Dwarf milo	116	....	2.0	....	31	..	0	..	56	..
871*	Beaver	113	....	1.7	....	31	..	0	..	56	..
901*	Club	123	....	2.7	....	50	..	1	..	52	..
902*	Kalo	113	....	1.9	....	46	..	0	..	59	..
919*	Custer	112	....	1.6	....	35	..	0	..	58	..
917*	Sooner milo	97	....	2.3	....	38	..	1	..	59	..
968*	Ajax	122	....	2.6	....	42	..	0	..	50	..
918*	Wheatland	112	....	2.2	....	31	..	0	..	56	..

*Number of the Division of Cereal Crops and Diseases. †Number of the Division of Forage Crops and Diseases. ‡Number of the Division of Foreign Plant Introduction.

(a) Killed by frost in dough or milk stages in some seasons, therefore, these figures are not comparable with other varieties.

more resistant than Standard Sumac or Kansas Orange, as shown in figure 17.

Tillering.--Tillering in a sorghum variety may be of advantage in overcoming a deficiency in stand or in making it possible with a normal stand for a variety to produce more by taking advantage of an unusually favorable season.

In some varieties such as the kafirs, tillering tends toward variations in height and uneven ripening causing a part of the grain to be immature at harvest. In the earlier-maturing varieties the main heads may be subject to considerable weathering and shattering before the tiller heads are ready to harvest. In milo and some of its derivatives the tiller heads are usually about the same height as the main heads.

Varieties of kafir including Red, Pink, Juicy Pink, Western Blackhull, and Dawn tiller relatively less than Standard feterita, Dwarf Yellow milo, and Atlas and other sorgos.

Dwarf Grain Sorghum.--Dwarfness is a desirable character in varieties of grain sorghum that are to be harvested with a combine or a header. A dwarf sorghum intended for combine harvesting should not exceed a height of 40 inches under the most favorable conditions for growth. The best range of height is from 20 to 36 inches, Varieties taller than 40 inches can also be harvested with a combine, but such types are more likely to lodge.

Some dwarf sorghums have two genetic factors for dwarfness, which prevent those varieties from attaining excessive plant height. Such varieties are usually very dwarf, and will not grow tall even under the most favorable conditions. Dwarf Yellow milo, however, with only one factor for dwarfness, may often grow to considerable height in seasons of abundant rainfall, or under irrigation. As a consequence lodging often occurs in such types causing difficulty when they are harvested with a combine.

Many dwarf varieties of sorghum have been developed since about 1920. The best representatives of the group tested in Kansas are Wheatland, Beaver, Custer, and several early-maturing very dwarf milos including Day, Sooner, Double Dwarf, and Two-foot. Greeley, Kalo, and a selection known as Early Kalo are somewhat taller and have merit where the dump box is attached to a swather and the heads placed in small piles over the field. Any of the above varieties can be cut equally as well with a header and barge as with a combine or swather. The shorter types cannot readily be cut with a binder.

Resistance to Insects and Diseases.--The differences among varieties of sorghum in their resistance to insects and diseases may determine the best variety to grow or the region in which a variety can be grown successfully. The kafirs in general are fairly resistant to chinch-bug injury while milo and many of the varieties derived from milo are highly susceptible. Feterita is resistant to kernel smut; milo is resistant except to one form; and most other sorghums are more or less susceptible to various forms of this disease. Leoti Red is highly resistant to leaf spot, kafirs and milos in general are somewhat resistant, and feterita and Wonder are highly susceptible to it. The insect enemies and diseases of sorghum are discussed more fully in another bulletin.[4]

YIELDS OF VARIETIES OF GRAIN AND FORAGE SORGHUM

Dependable comparative yields of varieties of sorghum can best be obtained by testing varieties under comparable conditions for many years. The average yields of adapted varieties tested for a few years may differ greatly because of wide fluctuations in seasons, but in long periods of testing the yields will approach more nearly the true averages for the respective varieties and will usually not differ more than a few bushels.

Variety tests with sorghums have been made in Kansas on the agricultural experiment stations at Hays, Manhattan, Garden City, Tribune, and Colby; on the Southeastern Kansas Experiment Fields: and in cooperative tests with farmers throughout the state.

It is recognized that high yield alone is not the final criterion of the value of a variety. A variety may produce high yields and still possess certain characteristics which make it undesirable for general practical use, or for a specific purpose. Yield of forage and grain, however, is perhaps the most important index as to the value of a variety since it measures to a large extent the adaptation of the variety and its resistance to adverse conditions.

A satisfactory variety test must be comparable in all respects except for the inherent differences among varieties. To conduct such a test it is necessary to plant, cultivate, and grow all varieties under like conditions. By carefully observing the response of varieties under uniform treatment over a period of years, the comparative value of varieties can be fairly well determined. In the cooperative tests conducted by the Kansas Agri-

4. Laude, H. H. and Swanson, A. F. Sorghum production in Kansas. Kan. Agr. Expt. Sta. Bul. 265. 1933.

cultural Experiment Station, the leading varieties are planted under many varying farm conditions which tend to bring out differences among varieties due to soil and climatic variations.

Variety Yields at Hays[5]

The experiments with sorghum have been more extensive at the Fort Hays Branch Agricultural Experiment Station than at any other place in Kansas, because of availability of land, personnel, and equipment to conduct such work; and because the station is centrally located with respect to sorghum production in Kansas.

Each variety was planted on three dates; namely, May 15, June 1, and June 15. The average yield of the three dates is taken as the variety yield, Each variety was planted on a single plot for each date.

The sorghum variety experiments at Hays were conducted on upland and followed either wheat or barley. The average annual rainfall for Hays is 22.9 inches, the altitude is 2,000 feet, and the average frost-free period 171 days. About 77 per cent of the rainfall at Hays falls during the growing season including the six months between April 1 and September 30. The rainfall during July and August, and sometimes September, determines largely the yield of sorghum. The rainfall for the same period during the preceding year is also important because of the amount of moisture that may be stored in the soil. These conditions apply generally to western Kansas.

In Table II are presented the forage and grain yields of sorghum varieties grown at Hays during the period, 1924 to 1931, in comparison with corn. Colby Bloody Butcher corn was grown from 1924 to 1928, and since then Hays Golden has been used. During the eight-year period, the rainfall was below normal only in 1924 and 1926 when 14.51 and 16.45 inches, respectively, were recorded as compared to 22.9 inches for normal.

The forage varieties or sorgos listed in Table II include Leoti Red, Early Sumac, Standard Sumac, Atlas, Black Amber, Red Amber, Kansas Orange, Sourless. and African millet.

Atlas and Standard Sumac, the two latest sorgos, averaged 4.37 and 4.3 tons of cured forage, respectively, for an eight-year period as compared to 3.85 for Leoti Red and 3.45 for Early Sumac. Other varieties of sorgo tested for a shorter time were not superior in yield to Atlas or Standard Sumac.

The other sorghum listed in Table II are valued for grain rather than forage, although the kafirs are often used for both grain and forage. During the seven-year period, 1925 to 1931, Western Blackhull, Modoc, and Wonder were among the highest in yield. Kalo and Club, which were originated recently at the Fort Hays station, have made the highest average yields for the three-year period, 1929 to 1931, when they were included in the test.

Among the numerous varieties tested at Hays during the last 20 years, Dwarf Yellow milo, Standard feterita, Dawn, Pink, and Red kafir were good enough to be continued throughout the entire period. The yields

5. The tests at Hays were conducted from 1912 to 1931 in cooperation with the Division of Cereal Crops and Diseases, and from 1913 to 1931 with the Division of Forage Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture. Beginning in 1924, the sorghum variety tests at Hays have been conducted jointly by the two cooperating agencies. The results previous to 1924 have been published in two bulletins as follows:

Swanson, Arthur F. Cereal experiments at the Fort Hays branch station, Hays, Kansas, 1912 to 1923. U. S. Dept. Agr. Tech. Bul. 14:1-56. 1927.

Vinall, H. N., Getty, R. E., and Cron, A. B. Sorghum experiments on the Great Plains. U. S. Dept. of Agr. Dept. Bul. 1260:1-88. 1924.

TABLE II.—YIELDS OF SORGHUM VARIETIES AT HAYS, KANSAS.

Fort Hays Agricultural Experiment Station, 1924 to 1931.

Identification No.	VARIETY	1924	1925	1926	1927	1928	1929	1930	1931	5-yr. av., 1924 to 1928	3-yr. av., 1929 to 1931	7-yr. av., 1925 to 1931	8-yr. av., 1924 to 1931
		Yields of Grain in Bushels (56 Lbs.) per Acre											
6610†	Leoti Red sorgo	32.2	31.7	0.5	37.0	45.4	23.9	35.5	12.9	29.4	24.1	26.7	27.4
6611†	Early Sumac sorgo	31.0	36.8	1.6	42.9	45.9	27.2	22.9	13.2	31.6	21.1	27.2	27.7
350381‡	St. Sumac sorgo	3.7	29.4	.0	44.1	42.9	18.4	17.2	5.9	24.0	13.8	22.6	20.2
13605†	Atlas sorgo	11.9	25.1	.0	42.9	53.0	20.9	5.7	6.8	26.6	11.1	22.1	20.8	
.....	Coro	13.4	26.6	.0	52.1	38.6	28.4	18.9	15.0	26.1	20.8	25.7	24.1
957*	Red kafir	33.8	33.8	.4	53.9	60.0	44.8	42.9	21.3	36.4	36.3	36.7	36.4
432*	Pink kafir	28.3	38.0	.0	59.1	71.4	50.0	26.9	15.7	39.4	30.9	37.3	36.2
907*	Juicy Pink kafir	45.1	37.9	.0	46.6	70.0	51.6	33.2	18.6	39.9	34.5	36.8	37.9
906*	W. Bl'khull kafir	46.3	42.3	.2	64.3	64.8	48.4	50.2	28.2	43.6	42.3	42.6	43.1
310*	Dawn kafir	45.2	34.8	.9	50.7	60.9	45.0	44.5	22.1	38.5	37.2	37.0	38.0
182–1*	Feterita	38.1	51.7	6.8	47.3	42.1	46.6	39.8	35.5	37.2	40.6	38.5	38.5
332*	Dwarf Yellow milo	40.2	39.3	1.6	39.5	68.8	40.4	49.4	26.8	37.9	38.9	38.0	38.3
905*	Modoc	....	46.7	3.2	53.6	61.1	52.2	41.1	29.7	....	41.0	41.1	....
901*	Dawn kafir sel.	....	41.9	.5	53.2	58.6	38.6	41.1	20.0	....	33.2	36.3	....
879*	Wonder	....	55.0	5.5	52.1	56.1	42.1	49.1	34.8	....	42.0	42.2	....
971*	Dwarf Freed	....	31.7	12.1	34.1	42.3	39.7	25.2	40.5	....	35.1	32.2	....
869*	Fargo Straightneck	....	....	....	41.1	55.9	7.1	.0	6.6	....	4.6	....	....
865*	Tex. Bl'khull kafir	....	....	....	62.0	55.4	45.9	52.1	24.1	....	40.7	....	....
868*	Double Dwarf milo	....	....	....	27.0	58.0	38.2	29.6	27.5	....	31.8	....	....
958*	Red kafir	....	....	....	.....	59.6	45.2	32.7	13.9	....	30.6	....	....
871*	Beaver	....	....	....	.....	50.9	40.9	25.7	24.3	....	30.3	....	...
901*	Club	....	....	....	.....	.....	63.6	58.0	27.1	....	49.6	....	....
902*	Kalo	....	....	....	.....	.....	60.9	50.2	36.4	....	49.2	....	....
919*	Custer	....	....	....	.....	.....	35.5	20.4	28.0	....	28.0	....	...
917*	Sooner milo	....	....	....	.....	.....	54.1	25.7	44.1	....	41.3	....	....
968*	Ajax	....	....	....	.....	.....	.....	41.1	23.2	....	....	....	....
918*	Wheatland	....	....	....	.....	.....	.....	39.3	19.7	....	....	....	....
7038†	Black Amber sorgo	28.9	30.1	5.0	32.9	33.4	.....	.....	.....	26.1	....	....	....
17548‡	Red Amber sorgo	20.3	16.3	.9	30.9	32.7	.....	.....	.....	20.2	....	....	....
9108†	Kansas Orange sorgo	10.9	25.2	.0	48.6	43.2	.....	.....	.....	25.6	....	....	...
9674†	Sourless sorgo	12.2	22.3	.0	44.3	48.7	.....	.....	.....	25.5	....	....	....
9111†	Afr. Millet sorgo	.6	27.7	.0	52.7	57.9	.....	.....	.....	27.8	....	....	....
9033†	Freed	23.2	21.2	12.2	29.8	35.5	.....	.....	.....	24.4	....	....	....
473*	Sunrise	34.6	32.7	.4	50.4	54.6	.....	.....	.....	34.5	....	....	....

TABLE II—Concluded.

Identification No.	VARIETY	1924	1925	1926	1927	1928	1929	1930	1931	5-yr-av., 1924 to 1928	3-yr. av., 1929 to 1931	7-yr. av., 1925 to 1931	8-yr. av., 1924 to 1931
	Yields of Cured Forage in Tons per Acre												
6610‡	Leoti Red sorgo	3.10	4.76	1.49	5.22	5.16	4.90	3.50	2.64	3.95	3.68	3.95	3.85
6611‡	Early Sumac sorgo	2.79	4.19	1.38	4.82	4.69	4.37	2.62	2.73	3.57	3.24	3.54	3.45
35038‡	St. Sumac sorgo	3.14	4.86	1.28	6.23	5.68	7.47	2.98	2.77	4.24	4.41	4.47	4.30
13605†	Atlas sorgo	3.75	4.66	1.60	6.02	5.09	7.34	3.72	2.75	4.22	4.60	4.45	4.37
.....	Corn	1.24	3.25	1.04	3.24	3.83	2.91	1.47	1.60	2.52	1.99	2.48	2.32
957*	Red kafir	2.57	2.95	1.10	4.09	3.97	3.88	3.01	2.46	2.94	3.12	3.07	3.00
432*	Pink kafir	2.94	3.51	1.28	4.98	4.76	4.90	2.88	2.76	3.49	3.51	3.58	3.50
907*	Juicy Pink kafir	3.15	3.54	1.33	4.39	4.84	5.30	3.09	2.54	3.45	3.64	3.58	3.52
906*	W. Bl'khull kafir	3.10	3.59	1.31	5.07	4.34	4.75	3.65	2.70	3.48	3.70	3.63	3.56
340*	Dawn kafir	3.09	3.31	1.35	4.52	4.39	5.46	3.42	2.77	3.33	3.88	3.60	3.54
182-1*	Feterita	2.80	3.80	1.30	3.67	3.33	3.28	2.83	2.65	2.98	2.92	2.98	2.96
905*	Modoc	....	3.73	1.20	4.33	4.07	4.48	2.82	2.67	....	3.32	3.33	....
904*	Dawn kafir sel	....	3.76	1.37	4.40	4.25	4.76	3.43	2.83	....	3.67	3.54	....
809*	Fargo Straightneck	....	....	....	4.87	5.31	5.19	2.45	1.83	....	3.16	....	....
865*	Tex. Bl'khull kafir	....	....	....	4.80	3.97	4.53	2.84	2.70	....	3.36	....	....
958*	Red kafir	...	....	....	....	4.00	4.70	3.04	2.28	....	3.34	....	....
901*	Club	....	....	....	....	....	5.14	3.06	2.70	....	3.63	....	....
7038†	Black Amber sorgo	2.50	4.14	1.48	4.23	4.25	....	....	....	3.32	....	....	....
17548‡	Red Amber sorgo	2.88	3.71	1.56	4.47	4.42	....	....	....	3.41	....	....	....
9074‡	Sourless sorgo	3.06	5.10	1.50	5.85	5.23	....	....	....	4.15	....	....	....
9111‡	Afr. Millet sorgo	3.51	4.84	1.44	5.94	5.09	....	....	....	4.16	....	....	....
9033‡	Freed	2.33	3.18	1.50	3.54	3.46	....	....	....	2.80	....	....	....
332*	Dwarf Yellow milo	2.87	3.60	.87	3.63	4.68	....	....	....	3.13	....	....	....
472*	Sunrise	3.15	3.83	1.24	4.78	4.53	....	....	....	3.51	....	....	....

*Number of the Division of Cereal Crops and Diseases. †Number of the Division of Forage Crops and Diseases. ‡Number of the Division of Foreign Plant Introduction.

for these varieties are shown in figure 10. Feterita averaged 29.6 bushels over the 20-year period, 1912 to 1931. It should be noted that under average farm conditions poor stands occur more frequently with feterita than with kafir or milo. Both Pink and Red kafir are inclined to be late, which probably has influenced the yields somewhat adversely.

The average yields at the Fort Hays station for five years, 1924 to 1928, show that grain sorghums have yielded 27 per cent more grain than

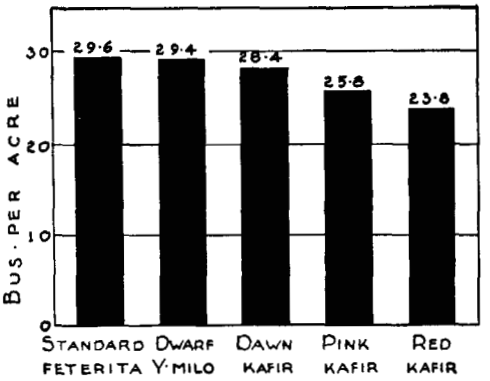

Fig. 10.—Comparative average grain yields of five varieties of grain sorghum for 20-year period, 1912 to 1931, Fort Hays Agricultural Experiment Station, Hays, Kan.

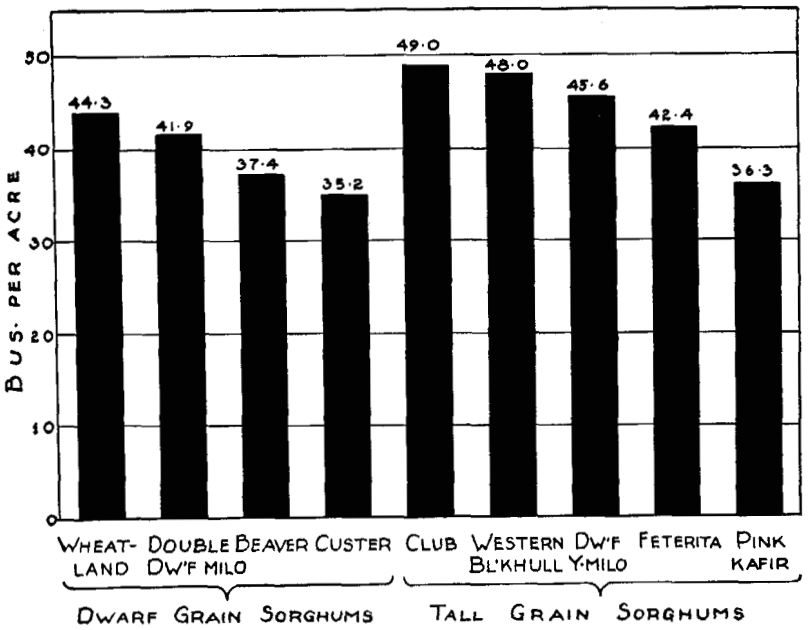

Fig. 11.—Comparative average grain yields of dwarf and tall grain sorghums for the three-year period, 1930 to 1932, Fort Hays Agricultural Experiment Station, Hays, Kan.

have forage sorghums and that the latter have yielded 19 per cent more forage than grain sorghums and 36 per cent more than corn. Corn has yielded 31 per cent less grain than have the grain sorghums. Early sorgos have yielded 15 per cent less forage than late sorgos, whereas the latter have yielded 5 per cent less grain than the early sorgos.

Included among the grain sorghums at Hays is a group of dwarf varieties which seldom exceed 3 feet in height and therefore are fairly resistant to lodging. The more important varieties in this group are Wheatland, Beaver, Custer, and Double Dwarf, which because of their dwarf stature should be better for harvesting with the combine than the taller varieties.

Comparative yields of the dwarf varieties and several of the standard varieties for three years are shown in figure 11. The dwarf varieties have not been equal in yield to the best taller varieties, but the period of testing has been too short to justify final conclusions.

Variety Yields at Manhattan

The results of sorghum variety tests at Manhattan apply fairly well to eastern Kansas where the annual precipitation averages from 28 to about 43 inches and the frost-free period from 170 to 200 days. Later-maturing varieties may be grown in this region than farther west in the state.

Comparative yields of grain and forage for the major varieties tested since 1919 are given in Table III. Those results, as well as flgure 12, indicate that the forage yield is about twice as high from the sorgo as from the grain types, whereas high yields of grain may be secured from varieties of either type, Both the yield and quality of the grain of forage varieties are of practical importance when the crop is used for silage or fodder.

Kansas Orange, Standard Sumac, and Atlas outyielded all other varieties and have produced about the same yields of air-cured forage, the eight-year average being 8.5, 8.6, and 8.2 tons per acre, respectively. Early Sumac yielded about three-fourths as much as Standard Sumac and Kansas Orange, probably because of its earlier maturity and smaller size. The forage yield of the kafirs from 1919 to 1930 averaged 3 to 4 tons per acre. Red kafir, Sunrise, and Blackhull outyielded Pink and Dawn.

Among the grain sorghums with light-colored seed, Blackhull and Pink, which averaged 51 and 51.5 bushels per acre, respectively, outyielded Dawn and Sunrise an average of about 4 bushels per acre over a period of 12 years. Blackhull is a more dependable variety than Pink in eastern, particularly in southeastern, Kansas, probably because Pink is less resistant to chinch bugs.

Red kafir produced an average of about 5 bushels per acre more than Blackhull and Pink, and is the best colored-grain sorghum for eastern Kansas. Darso yielded about 2 bushels higher than Red kafir, but unlike Red and the light-colored kafirs, Darso grain is somewhat bitter and therefore less palatable.

Dawn selection and Western Blackhull, like Dawn, do not utilize the entire growing season in eastern Kansas and probably for that reason yielded less than Standard Blackhull.

The tests for four years have shown a slight difference in yield of forage and grain in favor of Pink kafir over Juicy Pink.

Club, which has been tested for two years, made the highest average

TABLE III.—YIELDS OF SORGHUM VARIETIES AT MANHATTAN, KANSAS.
Kansas Agricultural Experiment Station, 1919 to 1931.

Identification No.	Variety	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	4-yr. av., 1928 to 1931	8-yr. av., 1924 to 1931	12-yr. av., 1919 to 1930
Yields of Grain in Bushels (56 Lbs.) per Acre																	
613*	St. Bl'khull kafir	22.3	75.9	76.0	52.9	68.5	56.2	43.0	18.6	61.6	35.1	53.2	46.1	77.0	52.9	49.2	51.0
432*	Pink kafir	20.8	67.0	75.9	53.9	64.1	56.5	49.7	23.7	66.9	35.1	64.3	39.7	76.9	54.0	51.6	51.5
34*	Red kafir	26.0	80.4	82.2	52.1	72.6	72.5	52.0	27.6	65.8	39.6	58.9	50.5	83.1	58.0	56.3	56.7
340*	Dawn kafir	17.5	72.3	70.5	37.0	57.9	66.0	36.6	27.8	59.6	32.4	50.9	40.9	....	....	....	47.5
472*	Sunrise	22.2	59.8	70.0	44.4	64.4	62.0	38.9	23.2	60.4	26.1	57.2	35.1	....	....	....	47.0
615*	Darso	32.6	75.0	95.6	47.7	78.9	51.3	51.3	39.7	77.9	40.5	65.2	51.8	79.7	59.3	57.2	59.0
9108‡	Kansas Orange sorgo	15.0	19.6	45.1	36.1	86.8	45.4	41.8	40.6	56.6	56.1	69.7	45.6	76.0	61.9	52.8	45.8
35038‡	St. Sumac sorgo	21.9	33.8	68.5	43.1	88.2	50.0	36.8	34.2	63.8	38.7	71.1	49.7	77.3	59.3	52.7	50.0
....	Dwarf Sumac sorgo	19.5	61.4	80.9	56.1	63.0	61.2	41.7	21.4	74.8	31.5	61.6	20.0	....	....	....	49.1
13805†	Atlas sorgo	....	....	....	....	....	46.0	39.3	16.9	59.3	45.9	66.1	32.1	61.7	52.2	46.3	....
6611†	Early Sumac sorgo	....	....	....	....	....	....	....	....	....	28.8	58.0	31.2	75.2	49.1	....	....
872*	Wonder kafir	....	....	....	....	....	....	....	....	....	36.0	56.3	40.9	72.7	51.5	....	....
907*	Juicy Pink Kafir	....	.. .	....	....	....	....	....	....	....	36.0	65.2	35.1	73.8	52.5	....	....
901*	Dawn kafir sel.	....	....	....	....	....	....	....	....	....	31.5	42.0	31.2	73.9	45.4	....	....
906*	W. Bl'khull kafir	....	....	....	....	....	....	....	....	..	....	....	35.1	80.3	....	....	....
901*	Club	....	....	....	....	....	....	....	....	....	....	....	45.1	90.6	....	....	....
902*	Kalo	....	....	....	....	....	....	....	....	....	....	....	41.6	82.0	....	....	....
Yields of Cured Forage in Tons per Acre																	
9108‡	Kansas Orange sorgo	5.1	4.9	6.5	6.7	11.8	8.9	4.3	6.9	11.7	9.7	7.1	9.7	10.0	9.13	8.54	7.78
35038‡	St. Sumac sorgo	3.6	5.7	6.3	7.5	9.4	7.5	4.5	7.5	12.0	8.7	8.8	10.9	9.1	9.38	8.63	7.70
....	Dwarf Sumac sorgo	2.0	3.4	3.7	4.8	5.2	3.0	2.3	4.1	7.6	4.2	3.0	6.9	...	....	....	4.18
472*	Sunrise	2.3	5.0	6.3	4.1	4.3	2.4	1.8	2.8	7.2	3.8	2.9	4.6	...	....	....	3.96
613*	St. Bl'khull kafir	2.9	4.1	3.3	3.5	3.6	2.4	2.0	3.6	6.5	3.6	2.6	5.4	5.4	4.25	3.94	3.63
432*	Pink kafir	1.5	3.4	4.2	3.4	3.4	2.3	1.7	2.4	5.8	2.2	2.8	5.6	4.5	3.78	3.41	3.23
34*	Red kafir	1.5	4.1	4.8	4.8	4.7	3.2	2.1	3.7	7.1	3.8	3.8	6.1	5.6	4.83	4.43	4.14
340*	Dawn kafir	2.4	3.3	4.1	2.8	3.3	2.2	1.5	2.2	5.3	2.1	2.3	4.7	...	....	....	3.02
615*	Darso	1.4	3.6	2.9	3.3	3.7	1.7	2.0	2.6	6.7	3.3	2.9	4.6	4.2	3.75	3.50	3.23
13805†	Atlas Sorgo	...	...	...	...	...	7.0	4.2	6.0	12.0	7.5	7.1	12.0	9.5	9.03	8.16	....
6611†	Early Sumac sorgo	...	...	...	...	...	...	...	...	...	8.8	6.2	7.3	6.1	7.10	....	....
907*	Juicy Pink kafir	...	...	...	...	...	...	...	...	...	1.9	2.5	4.9	4.4	3.43	....	....
901*	Dawn kafir sel.	...	...	...	...	...	...	...	...	...	2.1	1.9	4.6	5.4	3.50	....	....
872*	Wonder	...	...	...	...	...	...	...	...	...	3.3	2.0	4.2	4.7	3.55	....	....

*Number of the Division of Cereal Crops and Diseases. †Number of the Division of Forage Crops and Diseases. ‡Number of the Division of Foreign Plant Introduction.

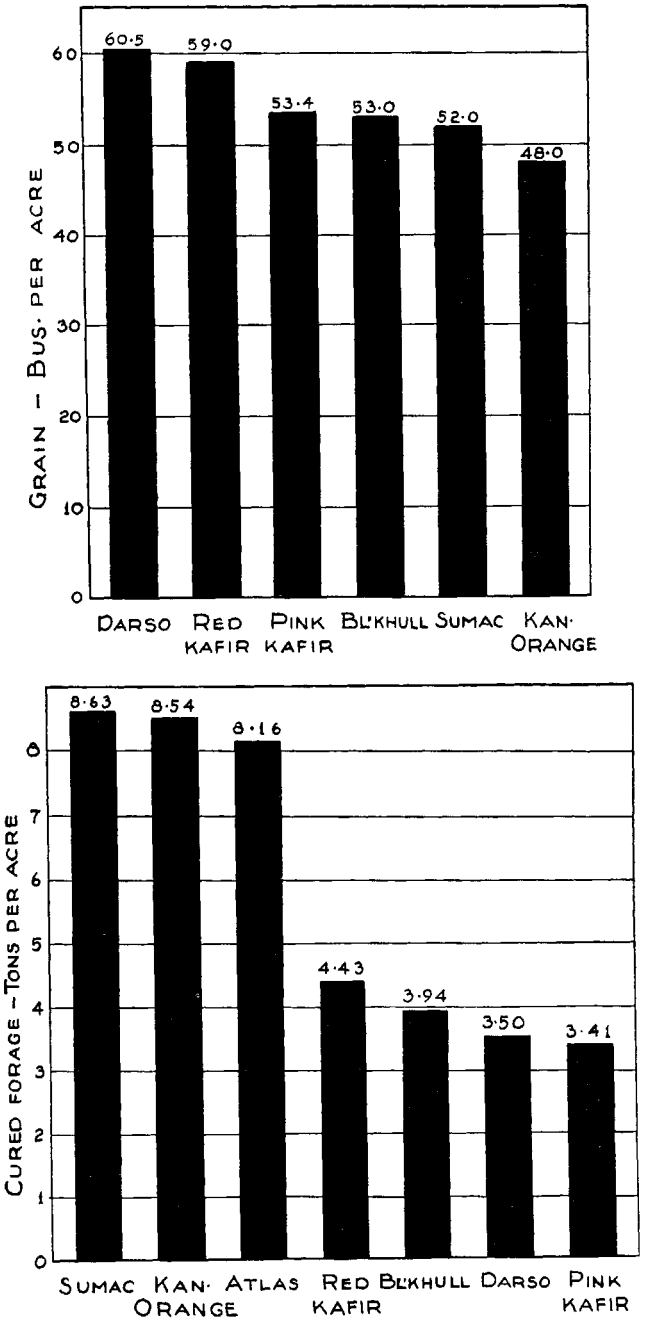

Fig. 12.—Comparative average yields of varieties of sorghum grown at Manhattan. Upper: Average yields of grain, 1919 to 1931. Lower: Average yields of forage, 1924 to 1931.

TABLE IV.—YIELDS OF SORGHUM VARIETIES AT GARDEN CITY, KANSAS.
Agricultural Experiment Station, 1921 to 1931.

Identification No.	Variety	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	8-yr. av., 1921 to 1928	11-yr. av., 1921 to 1931	10-yr. av., 1921 to 1930
	Yields of Grain in Bushels (56 Lbs.) per Acre														
	DRY LAND														
332*	Dwarf Yellow milo	27.9	13.4	31.7	55.4	3.6	20.1	5.4	69.2	8.9	8.5	29.5	28.3	21.9	24.4
182-1*	Feterita	17.6	21.0	11.2	46.4	6.9	24.6	19.2	41.5	14.7	14.7	31.7	23.6	22.7	21.8
340*	Dawn kafir	14.5	14.3	21.0	49.1	4.2	17.9	10.7	61.2	9.2	6.7	35.7	24.1	22.2	20.9
472*	Sunrise	22.8	20.1	13.4	42.9	5.4	19.6	14.3	53.1	6.3	6.3	32.6	24.0	21.5	20.4
432*	Pink kafir	21.2	16.5	24.6	33.0	2.2	3.6	9.6	51.3	7.8	3.6	29.5	20.3	18.4	17.3
620*	Dwarf hegari	24.1	17.4	13.8	37.5	.0	8.5	10.3	45.5	2.7	1.6	22.3	19.6	16.7	16.1
958*	Red kafir	26.8	9.8	17.0	28.6	.0	6.3	9.4	38.8	6.3	3.1	17.9	17.1	14.9	14.6
613*	St. Bl'khull kafir	20.5	11.6	29.5	17.9	2.2	3.1	4.0	45.5	2.7	.0	22.8	16.8	14.5	13.7
615*	Darso	15.4	10.7	27.7	35.7	6.9	17.9	14.3	39.3	....	....	....	21.0	....	....
350*	Freed	17.9	8.9	8.5	14.7	.0	17.9	20.1	36.2	....	....	....	15.5	....	....
8027†	Dwarf White milo	22.3	12.1	33.0	49.6	.0	14.5	8.9	45.1	....	....	....	23.2	....	....
623*	Spur feterita	18.5	20.5	10.3	42.4	4.5	25.4	12.5	35.7	....	....	....	21.2	....	....
480*	Early White milo	14.1	14.7	11.2	30.4	.0	16.5	7.6	52.2	....	....	....	18.3	....	....
971*	Dwarf Freed	....	....	....	....	....	....	....	....	....	13.4	21.6	....	....	....
919*	Custer	....	....	....	....	....	....	....	....	....	6.3	31.0	....	....	....
	WINTER IRRIGATED LAND														
332*	Dwarf Yellow milo	49.1	34.4	25.0	56.3	55.4	52.2	53.1	73.7	30.4	30.8	....	....	....	46.0
472*	Sunrise	49.8	35.7	16.5	48.2	58.0	33.9	39.7	53.6	47.3	46.4	....	....	....	42.9
340*	Dawn kafir	27.2	27.7	32.1	50.9	55.4	42.0	54.9	48.2	53.6	52.7	....	....	....	44.5
432*	Pink kafir	48.4	35.7	39.7	43.8	37.1	37.1	42.9	50.0	37.9	54.5	....	....	....	42.7
613*	St. Bl'khull kafir	53.6	43.8	52.7	32.6	37.5	39.3	45.1	43.3	44.2	37.9	....	....	....	43.0

TABLE IV—Concluded.

Identification No.	Variety	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	8-yr av., 1921 to 1928	11-yr. av., 1921 to 1931	10-yr. av., 1921 to 1930
	Yields of Cured Forage in Tons per Acre.														
	DRY LAND														
332*	Dwarf Yellow milo	2.33	0.75	2.78	3.30	1.05	2.00	0.75	4.13	1.63	1.31	2.63	2.14	2.06	2.00
182-1*	Feterita	1.65	1.13	1.10	2.84	.88	1.90	1.65	2.63	.93	1.03	1.88	1.72	1.60	1.57
175*	Sunrise	1.60	1.50	1.65	3.43	1.63	2.80	2.03	3.90	2.00	1.75	2.49	2.32	2.25	2.23
310*	Dawn kafir	1.60	1.25	1.51	3.30	1.53	2.50	1.43	4.50	2.48	1.49	3.18	2.20	2.25	2.16
132*	Pink kafir	1.55	1.75	1.91	3.28	1.53	1.83	1.48	3.80	1.70	1.32	2.50	2.14	2.06	2.01
620*	Dwarf hegari	1.85	1.38	1.58	4.31	1.48	3.03	1.65	3.70	1.88	1.52	2.58	2.37	2.27	2.24
958*	Red kafir	2.33	1.48	2.85	4.74	1.38	2.45	1.38	3.63	1.83	1.19	2.40	2.53	2.33	2.32
613*	St. Bl'khull kafir	2.38	1.25	2.29	4.23	1.68	2.13	2.20	5.00	2.38	1.84	3.33	2.65	2.61	2.54
615*	Durso	1.63	1.05	2.50	2.89	.76	2.08	2.03	4.44	....	....	....	2.17	....	....
350*	Freed	1.78	1.13	1.19	1.83	.51	1.00	1.53	3.00	....	....	....	1.50	....	....
8927†	Dwarf White milo	1.95	1.25	2.31	3.18	1.40	1.38	1.23	3.20	....	....	....	1.99	....	....
622*	Spur feterita	2.10	1.38	.91	3.21	1.09	1.43	1.28	2.50	....	....	....	1.74	....	....
480*	Early White milo	1.98	1.13	1.69	1.95	.75	1.40	.78	3.55	....	....	....	1.65	....	....
971*	Dwarf Freed	....	....	....	....	....	....	....	....	....	.76	1.58	....	....	....
919*	Custer	....	....	....	....	....	....	....	....	....	1.04	1.58	....	....	....
	WINTER IRRIGATED LAND														
332*	Dwarf Yellow milo	5.13	1.88	2.56	3.33	4.48	3.18	3.13	3.31	2.25	2.28	....	....	....	3.15
472*	Sunrise	5.43	3.43	2.80	3.83	6.13	5.20	4.68	4.63	4.33	4.38	....	....	....	4.48
340*	Dawn kafir	3.30	2.63	2.91	3.53	5.39	4.58	5.08	3.80	5.00	4.83	....	....	....	4.11
482*	Pink kafir	4.75	2.90	3.85	3.63	5.53	4.65	4.03	3.81	3.15	4.50	....	....	....	4.08
613*	St. Bl'khull kafir	5.58	3.98	5.08	4.08	7.49	7.13	7.68	4.63	5.83	6.00	....	....	....	5.75

*Number of the Division of Cereal Crops and Diseases. †Number of the Division of Forage Crops and Diseases.

yield for that period. Kalo, also tested for only two years, made a relatively high yield, but is susceptible to chinch-bug injury, which makes it Unsatisfactory for growing in eastern Kansas. Its good yield may be the result of abundant tillering and the production of good tiller heads, which because of its early maturity have ample time to ripen at Manhattan.

Dwarf Yellow milo was tested for several years and made relatively low yields because of chinch bug injury. Feterita which was tested for a part of the time matured too early to make satisfactory yields.

Variety Yields at Garden City

The average annual rainfall at the Garden City Agricultural Experiment Station is about 18 inches as compared to 23 inches at Hays. The

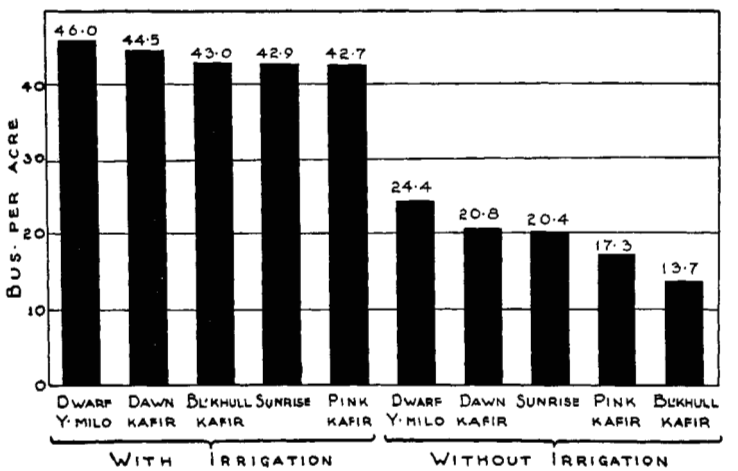

Fig. 13.—Comparison of yields of five varieties of sorghum grown with winter irrigation and without irrigation for the 10-year period, 1921 to 1930, at the Garden City Agricultural Experiment Station.

precipitation for the six summer months is nearly 14 inches or 77 per cent of the total. The average evaporation from a free water surface during the six growing months is 52 inches as compared to 46 inches at Hays. The elevation at Garden City is 2,836 feet, which is about 800 feet higher than Hays. The average length of the frost-free period at Garden City is 165 days, The slightly shorter growing season and the somewhat drier climate at Garden City, as compared to Hays, seem to account for the differences in relative yields of varieties at the two places.

Varieties of sorghum have been tested on dry land and with winter irrigation at the Garden City station. The yields of grain and forage are shown in Table IV. Dwarf Yellow milo outyielded the other varieties, averaging 24.9 bushels per acre for 11 years on dry land. Feterita yielded 22.7 bushels per acre, Dawn, 22.2, and Sunrise, 21.5. Pink kafir, Dwarf hegari, Red kafir, and Standard Blackhull, which are less adapted, averaged 18.4, 16.7, 14.9, and 14.5 bushels, respectively.

The yields on winter-irrigated land were higher and the differences in yield among the varieties were less than on dry land, as shown in figure 13. Dwarf Yellow milo made the best yield, averaging 46 bushels

over a period of 10 years. Standard Blackhull and Pink yielded about the same as Dawn and Sunrise when soil moisture was supplied by winter irrigation.

The comparative yields of additional varieties which were recently included in a test on fallow land, indicate that Club, Modoc, and Kalo averaged considerably higher in yield for the two-year period than Dwarf Yellow milo, as shown in figure 14. Wheatland yielded about the same as Dwarf Yellow milo.

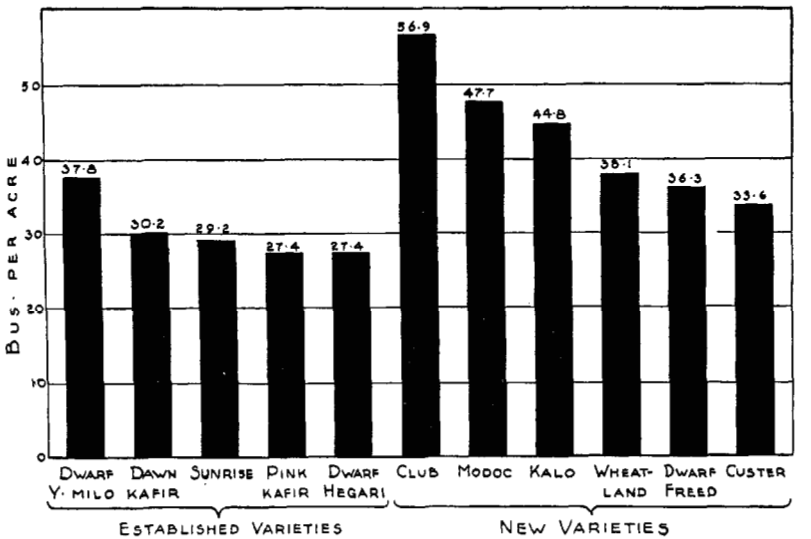

Fig. 14.—Average yields of five established varieties of sorghum in comparison with six new varieties grown on fallow land at the Garden City Agricultural Experiment Station for the 2-year period, 1930 and 1931.

Variety Yields at Tribune

The Tribune Branch Agricultural Experiment Station is near the western boundary of Kansas at an elevation of 3,600 feet, or 2,600 feet higher than eastern Kansas. The average annual rainfall is 17 inches and the length of the frost-free period is 160 days.

The high altitude, the short growing season, and the low precipitation require that only early-maturing varieties of sorghum be grown for grain. Later varieties may be used for hay or fodder.

Dwarf Yellow milo, Standard feterita, and Sunrise made the highest yields of grain for the 10-year period, 1921 to 1930, as shown in figure 15. The relatively low yields of Dawn and Pink kafirs are due to the later maturity of those varieties.

In recent years new varieties have been grown at Tribune and comparative yields with the older varieties are shown in Table V.

A number of the new strains are early and probably for that reason produced relatively high yields. Greeley, which made the highest yield in comparison with standard varieties for the long period, also yielded highest in comparison with the new strains for the three-year period, 1929 to 1931. Greeley averaged 21.8 bushels per acre in the short period as compared to 19.3 for Kalo, 16.5 for Sooner, 13.9 for Modoc, 14.5 for

TABLE V.—YIELDS OF SORGHUM VARIETIES AT TRIBUNE, KANSAS. Agricultural Experiment Station, 1926 to 1931.

Identification No.	Variety	1926	1927	1928	1929	1930	1931	2-yr. av., 1930 to 1931	6-yr. av., 1926 to 1931
Yields of Grain in Bushels (56 Lbs.) per Acre									
332*	Dwarf Yellow milo	0.0	3.9	15.4	1.9	23.0	18.7	20.9	10.5
182-1*	Feterita	1.1	10.4	15.2	6.1	15.2	18.9	17.1	11.2
972*	Greeley	3.8	10.7	22.7	12.9	34.1	18.3	26.2	17.1
973*	Pink Freed No. 14	3.3	16.9	27.0	13.3	29.8	17.6	23.7	18.0
974*	Pink Freed No. 36	4.1	10.7	28.3	10.9	17.7	15.3	16.5	14.5
350*	Freed	5.2	9.8	26.2	8.9	7.0	17.0	12.0	12.4
472*	Sunrise	.0	12.2	11.5	2.2	3.4	15.1	9.3	7.4
6611†	Early Sumac sorgo	.0	2.0	11.7	8.2	19.3	4.8	12.1	7.7
6610†	Leoti Red sorgo	.0	3.1	13.5	11.9	22.6	3.4	13.0	9.1
6608†	Red Amber sorgo	.0	2.9	12.2	13.7	32.6	9.0	20.8	11.7
7038†	Black Amber sorgo	.0	5.2	17.3	14.4	24.8	9.0	16.9	11.8
9108†	Kansas Orange sorgo	.0	.0	.0	.0	.0	.0	.0	.0
13605†	Atlas sorgo	.0	.0	.0	.0	.0	....	....	....
432*	Pink kafir	.0	2.6	10.2	.0	3.9	....	....	....
340*	Dawn kafir	.0	4.3	10.2	.0	9.6	....	....	....
907*	Juicy Pink kafir	....	4.6	10.9	.0	5.2	4.6	4.9	....
906*	W. Bl'khull kafir	....	3.3	15.4	2.2	11.5	16.1	13.8	....
905*	Modoc	....	10.2	17.8	2.4	23.7	15.5	19.6	....
971*	Dwarf Freed	....	11.5	13.5	4.3	8.9	16.7	12.8	....
902*	Kalo	....	....	....	15.9	31.1	10.9	21.0	....
901*	Club	....	....	....	14.1	6.3	4.8	5.6	....
871*	Beaver	....	....	....	4.3	22.6	9.4	16.0	....
917*	Sooner milo	....	....	....	11.9	21.5	16.2	18.9	....
919*	Custer	....	....	....	....	16.3	5.6	11.0	....
959*	Day milo	....	....	....	....	21.9	20.9	21.4	....
918*	Wheatland	....	....	....	....	18.9	5.2	12.1	....
Yields of Cured Forage in Tons per Acre									
332*	Dwarf Yellow milo	0.34	4.25	3.51	0.93	2.78	1.66	2.22	2.24
182-1*	Feterita	.48	4.40	2.34	1.29	3.03	1.88	2.46	2.24
972*	Greeley	.72	5.31	3.38	1.33	2.75	2.07	2.41	2.59
973*	Pink Freed No. 14	.53	4.27	2.98	1.09	2.20	1.60	1.90	2.11
974*	Pink Freed No. 36	.70	5.81	3.00	1.35	2.49	1.70	2.10	2.51
350*	Freed	.59	2.05	3.94	1.70	1.22	1.78	1.47	....
472*	Sunrise	.67	4.70	4.75	2.61	2.24	1.44	1.84	2.74
6611†	Early Sumac sorgo	.59	6.10	4.81	2.99	4.71	2.51	3.61	3.62
6610†	Leoti Red sorgo	.70	4.56	5.58	5.06	4.92	2.88	3.90	3.95
6608†	Red Amber sorgo	....	6.22	5.02	4.77	4.83	2.36	3.60	....
7038†	Black Amber sorgo	....	5.14	5.16	3.11	4.07	2.32	3.20	....
9108†	Kansas Orange sorgo	.50	7.26	5.31	2.82	4.96	3.23	4.10	4.01
13605†	Atlas sorgo	.62	6.55	4.92	3.03	3.82	....	....	....
432*	Pink kafir	.51	4.89	4.44	3.02	2.76	....	....	....
340*	Dawn kafir	.61	5.19	4.44	2.16	3.13	....	....	....
907*	Juicy Pink kafir	....	....	....	3.03	3.07	2.54	2.81	....
906*	W. Bl'khull kafir	....	5.18	4.42	2.49	2.97	1.39	2.18	....
905*	Modoc	....	5.31	3.82	1.43	3.03	1.89	2.46	....
971*	Dwarf Freed	....	4.15	2.09	.71	1.49	1.33	1.41	....
902*	Kalo	....	....	....	2.41	2.95	1.73	2.34	....
901*	Club	....	....	....	3.32	1.31	1.45	1.38	....
917*	Sooner milo	....	....	....	.62	1.15	1.15	1.15	....
919*	Custer	....	....	....	....	2.74	1.09	1.92	....
959*	Day milo	....	....	....	....	1.31	1.09	1.20	...
918*	Wheatland	....	....	....	....	1.68	.96	1.32	...

*Number of the Division of Cereal Crops and Diseases. †Number of the Division of Forage Crops and Diseases.

Dwarf Yellow milo, and 13.4 for Standard feterita. Wheatland, which was grown for two years, averaged 12.1 bushels per acre as compared to 17.1 for feterita and 26.2 for Greeley.

The late sorgos, such as Kansas Orange and Atlas, have made relatively high yields of forage even though they have not matured grain.

The earlier sorgos such as Early Sumac, Leoti Red, Black Amber, and Red Amber have generally ripened before frost but have required the full season to do so. Other varieties of sorghums, such as Pink, Sunrise, and Western Blackhull, have produced about three-fourths as much forage as the better varieties of sorgos.

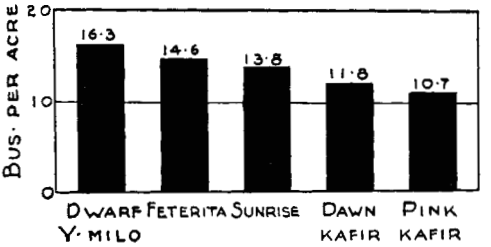

Fig. 15.—Comparative yields of five leading grain sorghums for the 10-year period, 1921 to 1930, at the Tribune Agricultural Experiment Station.

Variety Yields at Colby

The Colby Agricultural Experiment Station located in northwestern Kansas has an elevation of 3,138 feet with an average annual rainfall of 18 inches. The precipitation for the six summer months is 14 inches and the evaporation from a free water surface is 41 inches. The average number of days without frost is 159.

The growing season is so short at Colby that only the earliest-maturing varieties will ripen with regularity but later-maturing varieties may be grown for forage. Feterita and other varieties maturing equally as early are fairly dependable. The average yield of grain of feterita for eight years was 16.8 bushels. Standard Freed during the same period yielded 14.1 bushels; Dwarf Yellow milo, 8.8; Dawn, 8.5; and Pink, 3.4 bushels.

A few early-maturing varieties have recently been tested. Among these, Dwarf Freed averaged 15.2 bushels as compared to 15.4 for feterita.

In the seven-year period from 1925 to 1931, Early Sumac averaged 2.03 tons of cured forage per acre and Leoti Red, 3.21 tons, as compared to 3 tons for Kansas Orange and 3.17 tons for Atlas. Kansas Orange and Atlas cannot be expected to mature seed while Early Sumac and Leoti Red will ordinarily ripen if planted reasonably early on well-prepared land.

Variety Yields on Southeastern Kansas Experiment Fields

The yields of a few of the varieties of sorghum tested on the Southeastern Kansas Experiment Fields are of interest in connection with results obtained elsewhere in the state.

In an eight-year period at Moran, Standard Blackhull kafir averaged 36.9 bushels per acre as compared to 33.2 bushels per acre for Dawn. Red kafir tested in six of the years averaged 2.3 bushels higher than Blackhull in the same tests. Pink yielded 1.3 bushels lower than Dawn, and Sunrise 2.5 bushels lower than Pink. At Columbus, Red made the highest yield, followed by Dawn, Pink, Standard Blackhull, and Sunrise in order. At Rest, over a period of three years, Standard Blackhull averaged 27.3 bushels; Dawn, 26.1; Pink, 25.9; and Sunrise, 23.7 bushels per acre. Feterita yielded lower than the other varieties mentioned, at each

of the four experiment fields, Thus Red Kafir made the highest yields on the experiment fields where it was tested.

The order of yield of the other varieties at each of the fields was Standard Blackhull, Dawn, Pink, and Sunrise except in one case where Blackhull made less than Dawn and Pink. The forage yield for Kansas Orange was higher than for Atlas at each of the four experiment fields. In 14 tests Kansas Orange averaged 8.2 tons of cured forage per acre as compared to 7.6 tons for Atlas.

Varriety Yields in Cooperantive Experiments

Sorghum variety tests were made in cooperation with farmers in all parts of Kansas from 1911 to 1930. Numerous varieties were tested during that time and many were discontinued for various reasons.

The relative yields of grain of the better varieties are shown in figure 16 for different sections of the state. Comparatively few tests were made in the northeast corner of the state and therefore the relative standing of varieties is not shown for that region.

The yields of each variety are reported in comparison with Pink kafir in the same tests. Pink was compared directly with Dawn in 280 tests; with Standard Blackhull in 260; Sunrise, 223; Standard feterita, 202; Dwarf Yellow milo, 175; and Red kafir in 107 tests.

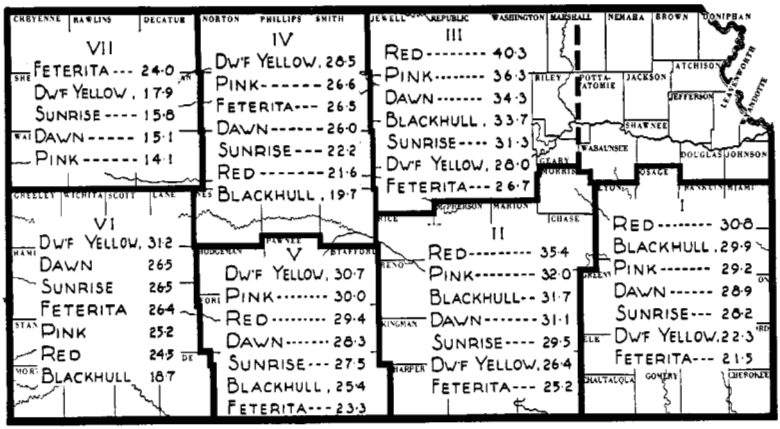

Fig. 16.—Relative yields of grain of varieties of sorghum grown in cooperative experiments, 1911 to 1930. The yields of each variety are in comparison with Pink in the same tests.

Except for Standard Blackhull the grain yields of the varieties were in the same order in each of the three sections in eastern Kansas. Red kafir outyielded the other varieties in each region and was followed by Pink and Dawn kafirs, Sunrise. Dwarf Yellow milo, and Standard feterita in the order named. Standard Blackhull made the second highest yield in the southeastern section and ranked third in Section II and fourth in Section III, indicating its poorer adaptation westward and northward from the southeast corner of the state.

The experiments at Manhattan as previously reported show that among these varieties Red kafir made the highest yield, followed by Pink kafir, Blackhull, Dawn, and Sunrise. Feterita and Dwarf Yellow milo, which

were tested for shorter periods, yielded appreciably lower as they did in the cooperative tests.

Greater changes in the relative yields of varieties were found in western than in eastern Kansas. Dwarf Yellow milo yielded relatively high throughout western Kansas, in fact it outyielded other varieties except in the northwestern section where the season is too short for it.

Pink kafir ranked second in Sections IV and V and yielded relatively low in the west end of the state where the season is too short for it. Red kafir did fairly well in Section V but made relatively low yields farther north and west where the growing season is shorter. Dawn and Sunrise maintained intermediate places throughout western Kansas as they did in the eastern part of the state. Standard Blackhull was decidedly inferior in all parts of western Kansas because of its late maturity.

Standard feterita, which made the lowest yields in the east half of Kansas and in Section V, is relatively much better adapted northwestward since it ranked fourth in Section VI, third in Section IV, and first in Section VII.

In general the results on farms agree with those obtained on the western branch agricultural experiment stations. (Figs. 10, 13, and 15, and Tables II, IV, and V.)

Standard feterita and Dwarf Yellow milo made the highest yields among these varieties at the Fort Hays station in Ellis county, followed by Dawn, Pink, and Red kafir in order. Standard Blackhull was tested for a shorter time but was discontinued because of low yields. At the Garden City station in Finney county, Dwarf Yellow milo made the highest average yield followed by Standard feterita, Dawn, Sunrise, Pink, Red, and Standard Blackhull. At the Tribune station in Greeley county, which is located near the boundary between Sections VI and VII, the order of the varieties was Dwarf Yellow milo, Standard feterita, Sunrise, Dawn, and Pink, Standard Blackhull and Red kafir, which were tested for shorter periods, made very low yields. At the Colby station in Thomas county, the varieties yielded in the same order as in the cooperative tests in Section VII.

The forage yields of varieties of sorghum grown in cooperative tests show that the large varieties, such as Kansas Orange, Atlas, and Standard Sumac are more productive than the smaller varieties, such as Early Sumac, Red Amber, and Leoti Red in all parts of Kansas except possibly in the northwestern section of the state. The large varieties of sorgo averaged about a ton per acre higher in yield of cured forage than the smaller varieties of sorgo, and the latter yielded about a ton more than adapted varieties of kafir.

VARIETIES OR SORGHUM ADAPTED TO KANSAS

The suitability of a variety of sorghum is determined by its adaptation, its quality, and its yield, as previously discussed. Varietal recommendations for sorghum in Kansas are, therefore, not based on yield alone, but also on such factors as adaptation to climate and soil; resistance to lodging, disease, and insect injury; palatability, sweetness, and juiciness of stalks; market factors; and attractiveness of the crop to the grower.

When grain is the primary objective high yield of forage is ordinarily not desirable because of the difficulty in harvesting and the greater tendency of tall varieties to lodge. The length of growing season, the quality of grain, and the yield are perhaps the major factors in determining the suitability of grain varieties.

Bitterness is highly undesirable in grain sorghum and therefore only varieties with palatable seed are recommended for grain production.

Ordinarily the highest-yielding varieties require about the full available growing season and for this reason later-maturing varieties are superior in eastern Kansas and earlier varieties are best farther west.

Among the best varieties suited primarily for forage are Atlas, Kansas Orange, Sumac, Early Sumac, and Leoti Red. These are of two classes as to size and length of growing season. The larger, later, higher-yielding varieties include Atlas, Kansas Orange, and Standard Sumac and the smaller, earlier ones, Early Sumac and Leoti Red.

Varieties of kafir and some other sorghums ordinarily grown chiefly for grain make forage of good quality, but the yield per acre is considerably lower than for the sorgos.

Atlas.--In eastern and south central Kansas preference is given to Atlas because of its resistance to lodging, superior quality of grain, high yield, and excellence of forage. The yields of grain are somewhat lower than for Kansas Orange and Standard Sumac. The quality of the grain, however, is in favor of Atlas, which is mild flavored like kafir whereas the other varieties are brown and somewhat bitter. Atlas is more resistant to lodging than Kansas Orange as shown in figure 17.

If planted at the normal time Atlas may be expected to ripen seed as far northwest as Nemaha, Clay, Ellsworth, Pawnee, and Meade counties. Under favorable conditions, particularly on bottom land, Atlas has matured satisfactorily at Hays and at points even farther northwest. Where Atlas does not ripen, it can be depended upon to produce excellent forage. More than 200,000 pounds of Atlas seed have been distributed by the agricultural experiment stations in Kansas since 1928.

Kansas Orange.--Kansas Orange is adapted to the same region and for the same uses as Atlas but chiefly because of its greater tendency to

Fig. 17.—Relative resistance of Atlas and Kansas Orange to lodging. Atlas, left. Kansas Orange, right.

lodge and its less palatable seed, it is inferior to Atlas. It may be expected to produce about the same yields of forage and may withstand adverse seasons somewhat better than Atlas. During the 10 years, 1922 to 1931, 134,000 pounds of Kansas Orange seed were distributed to growers from the Agricultural Experiment Station at Manhattan.

Standard Sumac.--Standard Sumac is similar to Kansas Orange in its adaptation and uses. The seed are small, hard, and bitter.

Early Sumac.--In western and northwestern Kansas Early Sumac is superior to Atlas, Kansas Orange, and Standard Sumac because of its early maturity. Although it yields less than the larger varieties the difference is not so great in that region as farther east in the state. In northwestern Kansas Early Sumac may not withstand adverse seasons so well as Black Amber, but it is superior to Black Amber in having more leaves, greater uniformity, and less tendency to volunteer.

Early Sumac, because of its shorter stalks, is easier to handle for silage or fodder than the larger varieties and for this reason some growers in eastern Kansas prefer to plant it, realizing that more acres of land are required than if Atlas were used. Early Sumac has bitter seed similar to Standard Sumac. From 1925 to 1932, more than 321,000 pounds of certified seed of Early Sumac have been distributed by the Fort Hays station.

Leoti Red.--Leoti Red is adapted to about the same conditions as Early Sumac and may have some advantage in southwestern Kansas. It is resistant to leaf diseases but shatters easily.

Sunrise.--Sunrise is best adapted in southwestern Kansas where it will ripen grain. Its forage yield is lower than Early Sumac and Leoti Red but the grain is more palatable. It is not adapted in northwestern Kansas because of its relatively low yield of forage and its uncertainty to mature. In eastern and central Kansas it is inferior to Atlas for forage and to adapted varieties of kafir for grain.

Standard Blackhull.--Among grain varieties with light-colored, mild-flavored seed, Standard Blackhull is the best one for southeastern Kansas as far north and west as Manhattan and Wichita. It requires about the full growing season in that region. Its relatively lower yields farther north and west are probably due to shorter seasons and to drought.

Standard Blackhull produces lower yields of forage than the sorgos, especially Atlas and Kansas Orange, and is somewhat inferior although it has abundant leaves and juicy stalks. Its superiority for grain is due to its quality, high yield, resistance to chinch bugs, and resistance to lodging. From 1922 to 1931 the Kansas Agricultural Experiment Station distributed 285,000 pounds of Blackhull seed.

Red Kafir.--Red kafir, as has been noted, was the highest-yielding variety with palatable grain at Manhattan, on the Southeast Kansas Experiment Fields, and in cooperative experiments in the east half of Kansas. It will ripen throughout that region except perhaps in the extreme northwestern portion of the area. It is among the better varieties in resistance to chinch bugs and resistance to lodging. It has red mild-flavored grain and forage of good quality. Strains of Red kafir differ widely and most of those tested have been inferior.

Pink Kafir.--Pink kafir is adapted north and west of the Standard Blackhull area as far as Mitchell, Ellis, Ness, and Meade counties, beyond which the growing season is too short for its best development. In this central region it is superior to other white-seeded varieties, except per-

haps Western Blackhull. Pink has relatively high forage value among the kafirs, which together with its good grain yield make it a desirable dual-purpose variety on farms.

Pink is more susceptible to chinch-bug injury than Standard Blackhull and probably for that reason, as well as its early maturity, is less well adapted in eastern Kansas. Since 1923, 625,000 pounds of certified seed of Pink kafir have been distrbiuted from the Fort Hays Agricultural Experiment Station.

Western Blackhull.--Western Blackhull, which is similar to Dawn except that it ripens a few days later, is well adapted in the western portion of the Pink kafir region and as far west as Rooks, Lane, and Stanton counties. In this region it is the highest-yielding white-grained sorghum now available. It is somewhat inferior to Pink kafir for forage. Western Blackhull should largely replace Dawn except along the western border of its territory where Dawn will more surely ripen before frost. In 1932 more than 123,000 pounds of certified seed were made available from the Fort Hays station for distribution to farmers.

Dwarf Yellow Milo.--Dwarf Yellow milo is superior to any of the white-seeded grain sorghums in southwestern Kansas and yields relatively high throughout the west half of the state except in the region northwest of a line from Graham to Greeley counties, where the growing season is too short for it to mature. Dwarf Yellow milo is not adapted in the east half of Kansas because of its susceptibility to chinch-bug injury. The crop is difficult to harvest because the heads have a decided tendency to "goose-neck" or become pendent. Its forage is of less value than the kafirs. If grown too long on the same land it may be affected by a soil-borne disease. Dwarf Yellow milo responds better to irrigation than any other variety of grain sorghum in western and southwestern Kansas.

Wheatland.--Wheatland is well suited for harvesting with the combine since it is short, has erect heads, and is resistant to lodging after it is ripe. It has made high yields and is adapted in central, south central, and southwestern Kansas. Wheatland is highly susceptible to chinch-bug injury and therefore is not a safe crop east of Rice and Reno counties. It is susceptible to the soil-borne disease that affects milo and is resistant to kernel smut except the one form that attacks milo. It has relatively low value for forage; in fact it does not grow tall enough to harvest successfully with the row binder.

Standard Feterita.--Standard feterita, chiefly because of its early maturity, is the best grain sorghum now available in northwestern Kansas as far southeast as Smith, Trego, and Wichita counties. In other parts of the state it has value as a catch crop and for late emergency planting. It has the disadvantage of soft seed which often cause a poor stand especially if planted early or in a poor seed bed.

New Varieties.--A few new varieties of sorghum are promising and may with further study prove satisfactory for certain conditions. Among these are Greeley, a dwarf, very early grain variety which possibly may be adapted in northwestern and extreme western Kansas. Sooner may prove of value in the same territory and Modoc a little farther east. Club and Ajax may prove to be superior for grain in central and eastern Kansas. Kalo has possibilities for grain in central and perhaps western Kansas.

VARIETIES OF SORGHCM FOR SIRUP

Varieties of sorghum that are juicy and have high sugar content may be used for sirup. The best grade of sirup is made from sorghum that is nearly ripe. If harvested either earlier or later it makes sirup of poor flavor. The cane should be ground soon after harvest. The grinding season, therefore, necessarily is short if only one variety is grown. The season may be extended by using varieties that differ in time of ripening and by planting them at different times.

Varieties that are well adapted make the best quality of sirup since they ordinarily make a normal thrifty growth and mature before frost. Late-maturing varieties that are grown for sirup in states south of Kansas are not satisfactory. Kansas Orange is probably the best variety for sirup in eastern, southeastern, and south central Kansas, if planted at the normal time. Red X and Atlas also may be used. Early Sumac and Leoti Red are good varieties in western and northwestern Kansas. These early varieties grow well in the eastern part of the state and if planted on a part of the acreage provide cane for grinding before Kansas Orange or other standard varieties in that section are ready to harvest.

Full information regarding the production of sorghum for sirup and the manufacture of sirup are given in two Farmers' Bulletins of the United States Department of Agriculture.[6]

IMPROVEMENT OF SORGHUM THROUGH PLANT BREEDING

The creation of new varieties of sorghum through plant breeding methods cannot be discussed in detail in this bulletin. There are, however, certain phases of plant breeding in sorghum which are of interest to farmers.

Frequently a few tall plants are observed in a relatively uniform sorghum field. Such plants usually are hybrids which were produced by the crossing of two varieties the previous year. Ordinarily the first plants from crosses between varieties that differ widely show greater vigor than from varieties that are closely related, The first-generation hybrid, that is, the first plant after the cross, will not be like either of the parental varieties and will likely be intermediate between the two parents, except for some characters as for example height and maturity. The first-generation hybrid is generally taller than the tall parent and often matures later than either parent.

Seed from these tall, first-generation hybrids will not produce their kind the second year, but rather each kernel will produce a different type of plant. Hybrid seed if permitted to remain in bulk seed intended for planting will greatly contaminate the next year's crop and continue to do so for years to come. Instead of one off-type plant the following year, there may be many hundreds of off-type plants all differing in some characteristics from the variety being grown. All hybrids and off-type plants or rogues should therefore be removed early in the season, before they shed pollen.

Bulk or mass selection and pedigree selection are used to maintain the purity of a variety, and to improve it by eliminating undesirable types and isolating superior types. Self-pollinating of individual plants is also used to maintain the purity of a variety and to fix and stabilize new types.

6. Bryan A. Hugh and Sherwood, Sidney, F. Sorgo-sirup manufacture. U. S. Farmers Bul. 1389:l-28. 1924.

Cogwill H. B. Sorgo for sirup production: Culture, harvesting, and handling. U. S. Farmers' Bul. 1619:l-38. 1930

It consists of placing a paper bag over heads of sorghum so as to exclude foreign pollen from other plants. Heads which come from several generations of self-pollinated plants will produce a crop that is very uniform for all characters. Seed from self-pollinated heads should be made the source of the foundation stock of a new variety, or of an improved strain.

Hybrid plants may be produced and new types created by controlled methods of plant breeding. Very few of the many types so produced may become of value to agriculture. The necessary careful selection and testing requires a knowledge of the laws of inheritance and much patience and time. In fact, no new variety created by plant breeding methods can be fully tested, increased, and made ready for distribution in less than eight to twelve years.

HIGHEST QUALITY OF ADAPTED SEED IS CHEAPEST

The acre cost of planting pure sorghum seed is very low since only a few pounds of seed per acre are required. The requirements for good sorghum seed are: (1) That it be pure and true to type and of a variety adapted to the locality and suited to the purpose for which it is intended; (2) that it be sound and have high vitality which is best indicated by germination tests; (3) that it be graded and free from immature or cracked kernels and foreign material; (4) that it be treated for smut if necessary or be known to have come from smut-free fields.

In Kansas the agricultural experiment stations originate and produce a limited amount of high-quality seed of adapted varieties, which is sold to farmers at seed prices. This seed stock later finds its way into trade channels and into hands of reliable seed dealers, or is often grown by members of the Kansas Crop Improvement Association for certification as to purity. Thus pure varieties of sorghum are always available, and there is little justification for planting mongrel seed which produces an uneven crop, is difficult to harvest, and inferior in yield

When once a good seed stock has been obtained, it can be kept pure by isolating the field from other varieties of sorghums. Fifty hand-selected normal heads will plant an acre the following year. An acre or two of choice seed can be grown economically and can be kept pure by roguing out all off-types, and by isolation. This small acreage can then be used for seed stock for the larger field, while the process of hand selecting can be continued from year to year, or until a new source of seed seems desirable. Many farmers, however, find it more convenient to buy their seed each year directly from reliable sources.

Seed heads should be selected before frost and when the kernels at the base of the head have hardened. A satisfactory method of storing is to string the heads on a strong cord with a sacking needle. The heads may then be hung for drying in a place where air will circulate freely and where birds and rodents cannot reach them.