

# AGRICULTURAL EXPERIMENT STATION

KANSAS STATE COLLEGE OF AGRICULTURE  
AND APPLIED SCIENCE

MANHATTAN, KANSAS

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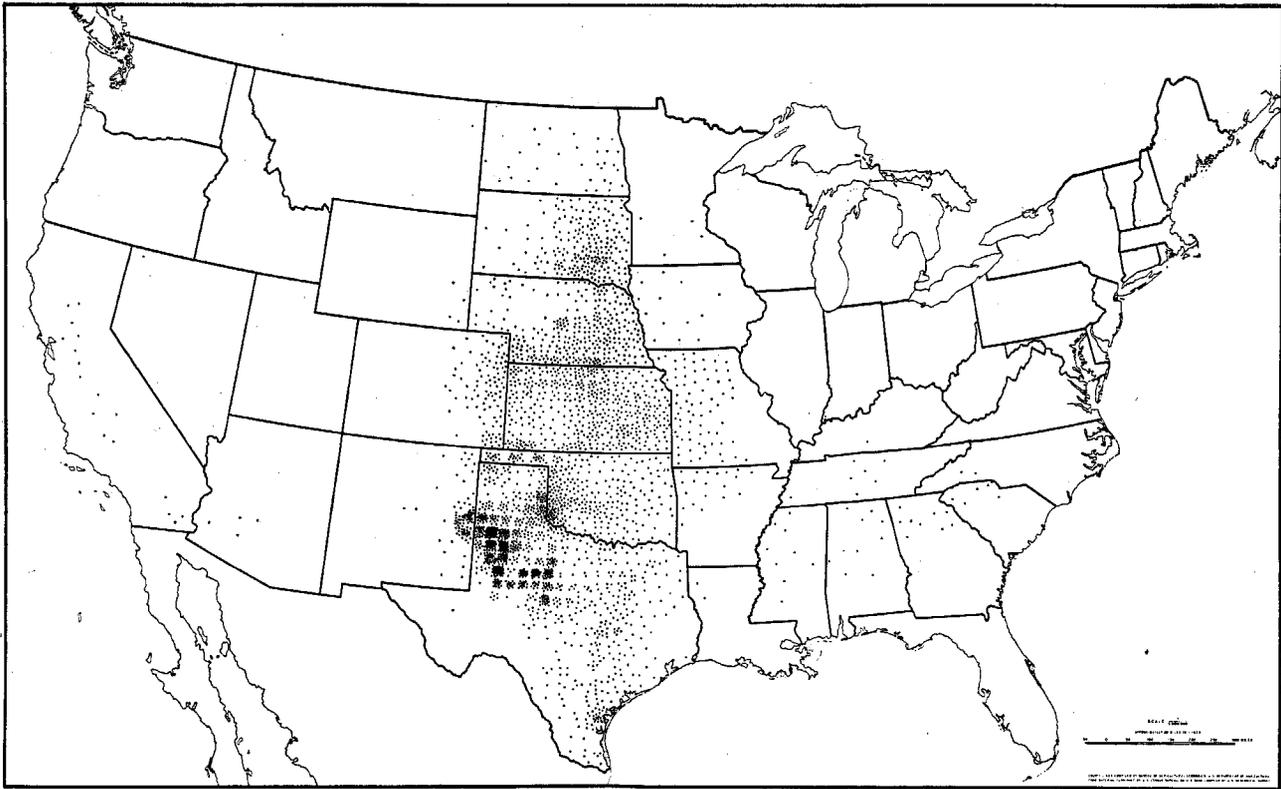
## SORGHUMS FOR KANSAS



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## TABLE OF CONTENTS

	PAGE
Importance of Sorghum.....	5
Utilization of the Crop.....	6
Origin and Antiquity of Sorghum.....	7
Terminology for Sorghum.....	8
Sources of Sorghum Grown in Kansas.....	9
Forage sorghum .....	9
Grain sorghum .....	10
Grass sorghum .....	12
Broom corn .....	12
Development of Varieties from Original Sources.....	12
Classification of Varieties.....	13
Description of Varieties.....	15
Forage sorghum .....	15
Black Amber—Red Amber—Standard Sumac—Early Sumac— Kansas Orange—Sourless—African millet—Atlas—Norkan—Sun- rise—Leoti Red .....	15-20
Grain sorghum .....	20
Standard Blackhull—Western Blackhull—Dawn—Pink kafir—Red kafir—Reed—Club—Wonder—Milo—Finney—Colby—Double Dwarf milo—Sooner and Day milos—Wheatland—Westland— Beaver—Early Kalo—Kalo—Hegari—Early Hegari—Standard Feterita—Spur Feterita—Grohoma—Standard Freed—Dwarf Freed —Modoc, Greeley, Weskan and Coes—Cheyenne—Shallu—Schrock —Darso—White Durra .....	20-33
Grass sorghum .....	33
Sudan grass .....	33
Broom corn .....	34
Black Spanish—Scarborough—Evergreen Dwarf—Japanese Whisk Dwarf .....	35
What Constitutes a Good Variety.....	35
Adaptation of sorghum.....	35
Quality factors in sorghum.....	36
Resistance to lodging—Tillering—Dwarf grain sorghum—Resist- ance to insects and diseases.....	38-39
Yields of varieties of grain and forage sorghum.....	39
Variety yields at Hays.....	40
Variety yields at Manhattan.....	41
Variety yields at Garden City.....	44
Variety yields at Tribune.....	49
Variety yields at Colby.....	52
Variety yields on Experiment Fields.....	53
Variety yields in cooperative experiments.....	54
Varieties of Sorghum Adapted to Kansas.....	57
Standard Blackhull—Western Blackhull—Club—Red kafir—Pink kafir—Early Kalo—Finney—Wheatland—Westland—Colby—Standard Feterita—Atlas—Kansas Orange—Early Sumac—Norkan—Leoti Red.....	59-62
Varieties of Sorghum for Sirup.....	62
Improvement of Sorghum Through Plant Breeding.....	63
Highest Quality of Adapted Seed is Cheapest.....	63



BUREAU OF AGRICULTURAL ECONOMICS

This map shows the distribution of acreage of grain and forage sorghums in the United States. (From the Bureau of Agricultural Economics.)

## SORGHUMS FOR KANSAS<sup>1</sup>

A. F. SWANSON and H. H. LAUDE<sup>2</sup>

### IMPORTANCE OF SORGHUM

Kansas is third among the states in the production of sorghum, being surpassed by Texas and Oklahoma. Sorghum is the second most valuable crop in Kansas, with an annual valuation from 1931 to 1940 of \$26,852,000. 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.

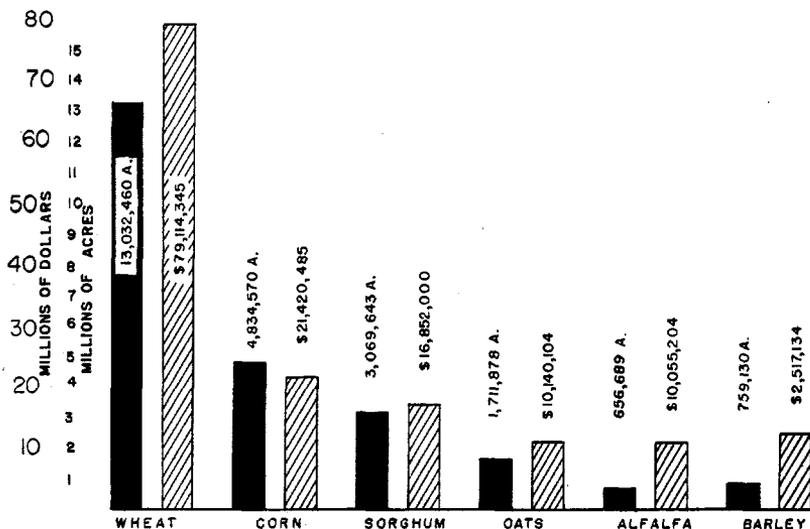


Fig. 1.—Comparative acreages and values of some Kansas farm crops. (Source: Latest available reports of the Secretary of the State Board of Agriculture.)

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.

1. Contribution No. 389 from the Department of Agronomy and No. 35 from the Fort Hays Agricultural Experiment Station.

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Sorghum is the sixth most important cereal in the United States and ranks seventh among cultivated crops. 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 Great Plains States in an area about 400 miles wide and 1,000 miles long, extending from South Dakota across Nebraska, Kansas, Oklahoma and Texas and including western Missouri and eastern Colorado and New Mexico. (See map on page 4.) Outside the limits of this area, except for restricted localities in California and in certain irrigated regions of Arizona, sorghum is mostly grown for forage, silage, or sirup.

#### 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 livestock 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 livestock, is about equal in feeding value to that of corn. Sorghum grain is probably as desirable as corn in a maintenance ration, or as a feed for growing livestock when it is ground, mixed with another cereal, and supplemented with a protein concentrate. Recent investigations conducted by various agencies indicate that the grain of sorghums may have important industrial uses. Sudan grass is of proved value for pasture, particularly when native pasture is limited, or when an abundance of pasture is needed during the summer months. It is also one of the best nonleguminous crops available for hay.

Broomcorn, which belongs to the sorghum group, is not an important crop except in a small region in the southwestern part of the state, yet Kansas ranks third in acreage of broomcorn grown in the United States.

Sorghum grain is used extensively as human food in Asia Minor, India, China, and Africa. In Africa 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 and 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. Recent research in this country has shown the possibility of utilizing for human food the grain of certain varieties of sorghum having a waxy endosperm.

The manufacture of sirup or molasses, the latter 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 inability of the sugar 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<sup>3</sup>

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.

Some authorities believe that a crop similar to sorghum was grown in Egypt 2200 B. C. from evidence found on the frescoed walls of one of the tombs. Other authorities hold that the crop represented may have been some other cereal. It is certain that as early as 700 B. C. sorghum was grown in the ancient city of Nineveh of Assyria, located on the banks of the river Tigris in what is now Mosul, Turkey. 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 and particularly in India is very old and it is known that the crop was grown as early as the thirteenth century A. D. in China, where it was probably introduced. The crop is still extensively grown in Egypt, where its history goes back to antiquity.

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. 175:1-58. 1910; also Vinall, H. N., Stephens, J. C., and Martin, J. H., Identification, History, and Distribution of Common Sorghums. U. S. Dept. Agr. Tech. Bul. 506:1-12. 1936.

Hagerty, M. J. Comments on writings, concerning Chinese sorghums. Harvard Jour. of Asiatic Studies 5 (3 and 4): 284-260. Jan., 1941.

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. During the last decade there has been a marked tendency for the northward extension of the sorghum belt beyond the 40th parallel in the Plains region, largely brought about by improved varieties developed by hybridization. The great centers of world production are Africa, India, China, and the United States. Sorghum also has 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 nonsaccharine sorghum such as kafir, milo, and feterrita in which grain production is usually the principal objective.
3. Broomcorn 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 nonsaccharine 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 about 85 years since the first saccharine sorghum was established in this country, and more than 65 years since the first important permanent culture 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 long season varieties that mature 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 1853 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, sixteen saccharine varieties were brought to the United States by 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 sixteen 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 varieties that are well adapted in Kansas and are extensively grown throughout the state. (Fig. 2.)

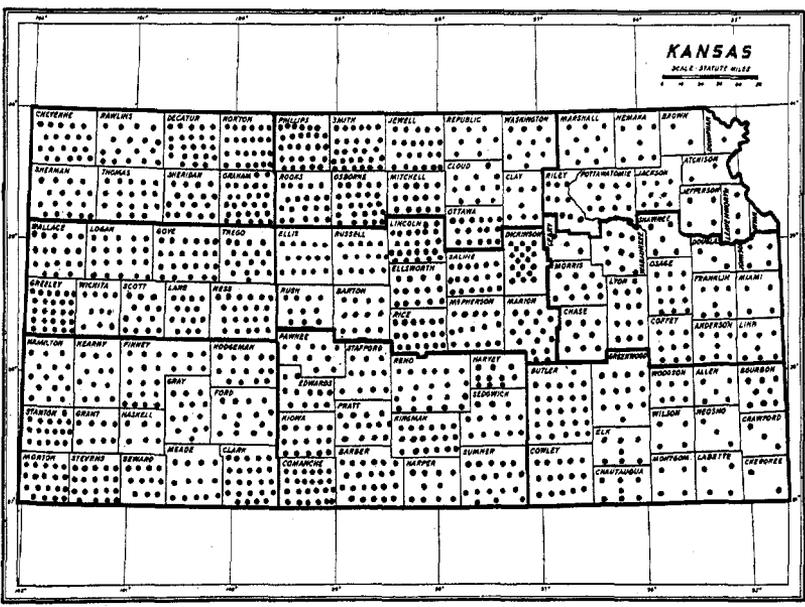


Fig. 2.—Map showing the distribution of forage sorghums throughout Kansas. (One dot equals 1,000 acres.)

**GRAIN SORGHUM**

The earliest grain sorghum varieties to become established in this country appear to be Brown durra and White durra, which were grown in California in 1874 which had been received from Egypt under the names of "Brown Egyptian corn" and "White Egyptian corn." During the period of drought 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. It was reported growing in Georgia in 1838, but it was not until 1874 that durra became permanently established. It is still grown to a limited extent in several sections of the country.

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. (Fig. 3).

Milo was introduced into the United States between 1880 and 1885, probably from Africa, and was first grown in South Carolina and Georgia. 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 (Fig. 3).

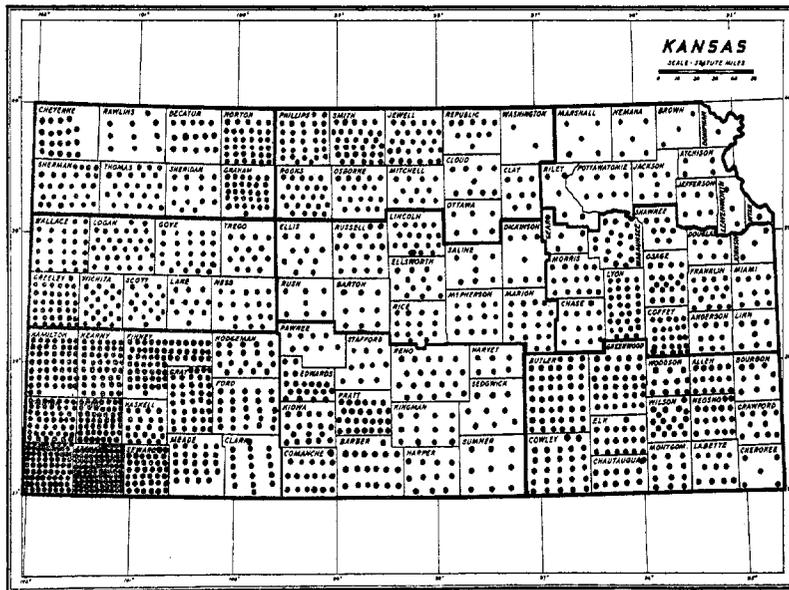


Fig. 3.—Map showing distribution of grain sorghums throughout Kansas. (One dot equals 1,000 acres.)

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 distinctly valuable type and gained in popularity during a cycle of dry years on the Plains.

The last important grain sorghum introduction was Dwarf hegari received by the late 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.

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

#### BROOMCORN

Broomcorn 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 broomcorn in Kansas was grown by Frank G. Hawkinson in 1870 near Marquette in McPherson county from seed which he brought from Illinois.

In recent years broomcorn production in Kansas has centered in southwest Kansas from Liberal to Elkhart. Areas of production have also developed in southeastern Colorado, eastern New Mexico, and certain regions in Oklahoma and the Panhandle of Texas.

#### 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. Since 1920 improvement by hybridization has 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 also have been accomplished through hybridization. The possibilities of further improvement by hybridization are far from exhausted and the method offers much promise for the future.

#### 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 called 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 fixed 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 includes varieties that have been or are now of interest or importance in the state.

#### 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.

- B. Seed light brown to orange-yellow, somewhat bitter.
  - 1. Kansas Orange.
  - 2. Sourless.
  - 3. African millet.
- C. Seed white, palatable.
  - 1. Atlas.
  - 2. Norkan.
  - 3. Sunrise.

**GROUP II**

Grain sorghum (nonsaccharine). 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. Slightly 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.
    - 1. Hegari.
    - 2. Early Hegari.
  - c. Freed.
    - 1. Standard.
    - 2. Dwarf.
  - d. Hybrid derivatives.
    - 1. Club.
    - 2. Modoc.
    - 3. Weskan.
    - 4. Greeley.
    - 5. Kalo.
    - 6. Early Kalo.
- B. Stalk intermediate as to juiciness. Not sweet or slightly sweet. 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 limited value.
  - a. Milo.
    - 1. Standard, Yellow and White.
    - 2. Dwarf, Yellow and White.
    - 3. Finney.
    - 4. Colby.
    - 5. Sooner.
    - 6. Day.
    - 7. Double Dwarf.
  - b. Feterita.
    - 1. Standard.
    - 2. Spur.
    - 3. Dwarf.

- c. White durra.
- d. Shallu.
- e. Hybrid derivatives.
  - 1. Wheatland.
  - 2. Beaver.
  - 3. Westland.
  - 4. Fargo Straightneck.
  - 5. Wonder.

**GROUP III**

Broomcorn. 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 root-stocks. 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 75 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. Black Amber is believed to be the first forage sorghum to become permanently established in Kansas and to be

used extensively by the settlers. The variety came into the state about 1880 and for the first five years was principally used by the pioneers for molasses. Quite by accident, during a period of drought, it was discovered that Black Amber also had value as a source of roughage for livestock. After 1885 the use of Black Amber for livestock purposes increased rapidly and for more than 30 years it was the leading forage sorghum grown in Western Kansas. Probably no single crop did more to stabilize livestock production in the plains region than did Black Amber during the transition period from the open range to a fixed agriculture. 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 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. Its progenitor appears to have been a variety introduced by Wray and known as Shalgoova. 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 also was 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 heads with a somewhat flattened top. The dark-red seeds 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 main-

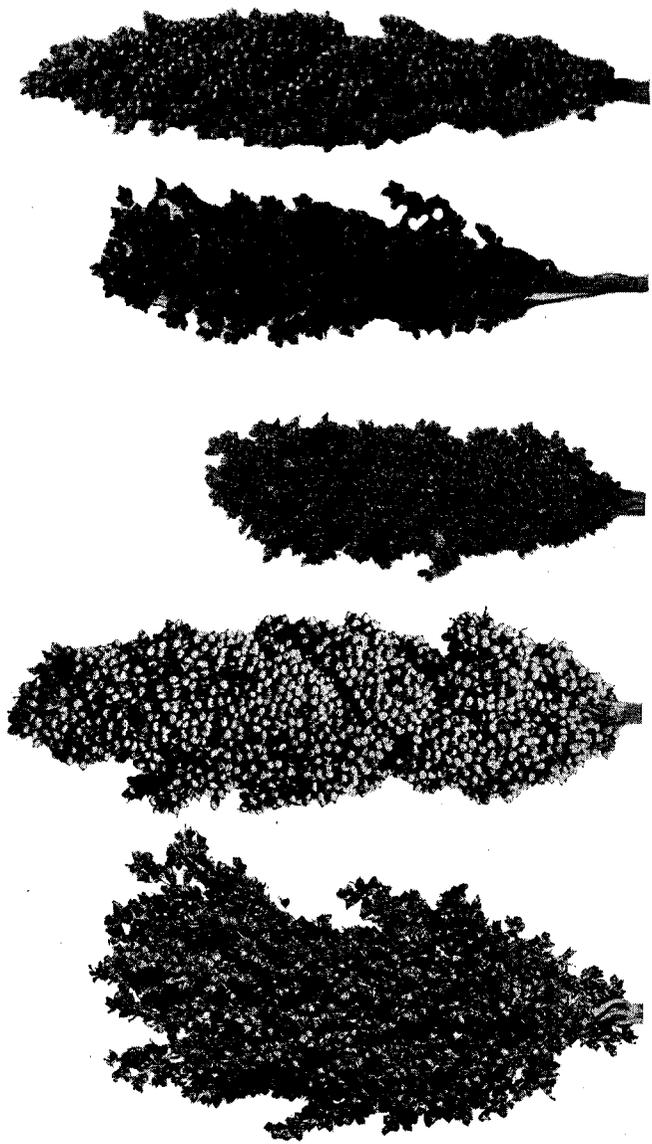


FIG. 4.—Varieties of forage sorghum. From bottom to top: Kansas Orange, Atlas, Early Sumac, Leoti Red, Norkan.

taining 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. 4) 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 5½ 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 has largely replaced the Ambers. It 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 sorghos 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 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. 4.) 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.

*Sourless.*—Sourless sorgho 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 sorgho 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 sorgho. 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 sorgho. 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. Sourless and African millet apparently are identical and probably have the same origin, but a diversity of strains can be selected from either which makes them appear different.

*Atlas.*—Atlas sorgho is a pedigreed selection from a field cross between Sourless sorgho and Blackhull kafir found by I. N. Farr, of Stockton, Kan. The selection now named Atlas was made by J. 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. 4) 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. Atlas grain is equal to kafir and the forage compares favorably with Kansas Orange and Sumac. Atlas is the leading variety in eastern Kansas and is adapted to south central and central Kansas if planted reasonably early on well-prepared fertile soil.

*Norkan.*—Norkan is a cross between Atlas and Early Sumac made by J. H. Parker in 1926 at the Kansas Station at Manhattan where the first three generations were grown. In 1930, 72 lines of the F<sub>4</sub> generation were grown at the Hays Station from which rigid selections for several years were further made by D. A. Savage. In 1938, A. F. Swanson isolated the strain which in the spring of 1941 was approved for certification and distribution to the farmers of Kansas. Before distribution Norkan and sister strains were also tested by E. H. Coles of the Colby Station (Fig. 4).

Norkan has the earliness and tonnage of Early Sumac and the white but somewhat smaller grain of Atlas. The plants are mid-early, mid-tall, stems slender, juicy and a little less sweet than Early Sumac. The variety tillers freely. The plants have 10 to 12 mid-wide leaves. The grain threshes freely from the head. Indications are that Norkan will be well adapted in a northern extension of the sorghum region where Atlas will not mature, and in north-western Kansas.

*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. In comparison with Atlas 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., where it has been of local interest for 30 years. Leoti Red is an attractive, sweet, juicy forage sorgho 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 western Kansas and in part of Nebraska. The variety is highly susceptible to head smut but highly resistant to bacterial leaf spotting. The seeds contain the so called “waxy” type of starch (Fig. 4).

#### GRAIN SORGHUM

The several varieties of kafir grown in Kansas constitute about one-third of the total acreage of sorghum in the state and three-fourths of the acreage of grain sorghum. Most of the remaining acreage of grain sorghum is comprised of milo or hybrids in which milo is one of the parents.

*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, with 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. 5) 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. In 1918, seed of Western Blackhull obtained from P. E. Crabtree, Scott City, Kan., was brought to the Hays Station for testing by R. E. Getty and later by D. A. Savage. Western Blackhull was recommended for distribution in Kansas in 1931. For a long period of years Western Blackhull has been one of the high yielding grain sorghums tested at the Hays Station and is particu-

larly well adapted to central and southwestern Kansas. The exact origin of Western Blackhull is not clear, but originally it may have been a selection made by A. H. Leidigh, Amarillo (Texas) Field Station and later distributed by H. M. Bainer, agricultural agent for the Santa Fe railroad. A Texas station selection (No. 9195), called Texas Blackhull and grown extensively in the Texas Panhandle, is almost identical to Western Blackhull.

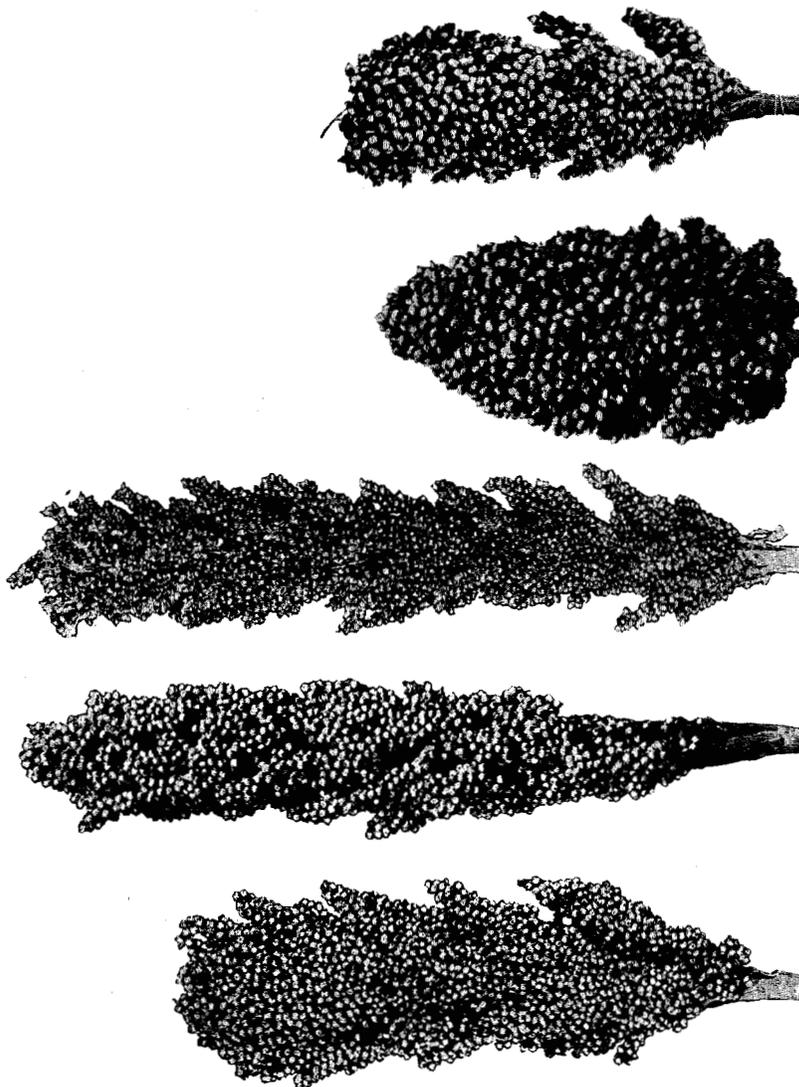


FIG. 5.—Varieties of grain sorghum. Bottom to top: Standard Blackhull, Pink kafir, Red kafir, Dwarf Yellow milo, Standard feterita.

*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. 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 northwestern Kansas. The acreage of Dawn has declined rapidly in Kansas during the last five years.

*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 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 White hull White kafir. The variety was extensively tested by B. E. Rothgeb, A. L. Hallsted, and R. E. Getty of the Hays Station. Coöperative 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. 5) 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 subcoat.

*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. 5.) The juicy stalks are more slender than those of Blackhull kafir. The seed is light red and slightly smaller than the seed of Blackhull. An early strain of Red kafir (C. 1.<sup>4</sup> 957) was isolated by R. E. Getty, formerly of the Hays Station, from a field near Bazine, Kan. This

4. "C. I." is the abbreviation for "Cereal Investigations" number assigned by the Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture.

selection has given satisfactory grain yields in central Kansas. Another strain of Red kafir (C. I. 958), originally obtained from C. E. Graves, Meade, Kan., is adapted in eastern Kansas. A selection from this strain Kansas No. 15 was distributed in 1941.

*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 was isolated at the Hays Station by A. F. Swanson in 1926 in a head row (No. 31) of Dawn kafir. It was further reselected in 1932 and approved for certification and distribution to farmers in 1939. The heads of Club are compact (Fig. 6) with large white seeds with splashes of red. The seed is softer than that of the Blackhull kafirs and therefore may not germinate so well if the seedbed is cold. The plants average 50 inches in height and require from 110 to 120 days to mature. Club kafir is more drought resistant than the Blackhull kafirs and in the dryer season usually gives higher yields. Club is potentially one of the highest yielding varieties when planted in a good seedbed with an abundance of moisture and the growing season is favorable and sufficiently long to mature the crop. Club is highly resistant to chinch bug injury and fully resistant to Pythium disease and low in smut susceptibility. Club is adapted to central and eastern Kansas and can best be harvested with a binder. Club is too late for the northern limits of grain sorghum production or in northwestern Kansas.

*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. 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 the time of harvest. 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 has sometimes been the cause of poor stands. A quantity of seed of Wonder grown by the Garden City station was sold in 1931 to the Wheat Farming Company with headquarters at Hays for growing on the lands in northwestern Kansas. The variety is now on the decline, but a few scattered fields were still found in western Kansas in 1938.

*Milo.*—Milo as a class in the grain sorghum group is represented by a number of selections which differ principally in height, seed color and resistance to the Pythium milo disease. Characteristics

common to all true milos are the rather dry stalks, and large oval or egg-shaped mostly pendent or goosenecked heads. The degree to which pendent heads occur is considerably influenced by the amount of rainfall and the thickness of the stands at the time the heads emerge. Milo is difficult to harvest when the heads are pendent. The stalks have limited value for forage as compared with the kafirs or sorgos. The seed of milo are among the largest of the sorghums, obovate in outline and somewhat flattened. The seeds are pale reddish-yellow without the brown subcoat, or may be pure white. They are about one-third enclosed in nearly black, hairy glumes which are transversely wrinkled. The transverse wrinkle is an important mark of identification to distinguish milo from Wheatland and other milo derivatives.

Dwarf Yellow milo and Pythium-resistant selections of it are important for grain production in the drier sections of the sorghum belt where the rainfall is from 20 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 where the growing season is sufficiently long for it to mature. The Kansas-Nebraska line marks the northern limits of successful Dwarf Yellow milo production.

Dwarf Yellow milo responds more favorably to irrigation than almost any other sorghum grown in the Southern Great Plains. On the other hand, if the moisture supply is low at the time of pollination, the results will often be a poor set of seed or blasted heads. In certain localities in southwestern Kansas and particularly in the irrigated region of the Arkansas Valley, milo is attacked by the soil-borne Pythium disease which has led to the selection of resistant strains described elsewhere.

The origin of Dwarf Yellow milo (C. I. 332) is somewhat obscure, but this variety may have originated as a mutation from Standard Yellow milo by the change of a single genetic factor for internode length. It was first observed in 1906 by F. B. Bradley, Memphis, Texas, from seed which had been obtained in Oklahoma. C. I. 332 normally grows to a height of 3½ to 4½ feet. For many years it was the leading grain sorghum in the southwest, but in Kansas is now being rapidly replaced by Finney.

At one time Dwarf White milo, identical with Dwarf Yellow milo except for color, was grown in Texas and Oklahoma but did not become established in Kansas. Its origin is unknown but may have come from a mutation. Early White milo (C. I. 480), while not of much commercial importance has been of considerable value in plant breeding work and is one of the parents of Colby, Sooner, and Day milo.

Standard Yellow milo was the first of this important sorghum group to be introduced into Kansas about 1888 and attained some importance, but was later superseded by Dwarf Yellow milo (C. I. 332). The Standard White milo never became established on farms

in Kansas. Standard milo usually grows to a height of from 6 to 7 feet in seasons of abundant moisture.

The several varieties of milo or milo derivatives now of commercial importance are described under the respective headings which follow.

*Finney.* — Finney milo (Fig. 5) is a Pythium disease resistant selection from Dwarf Yellow milo (C. I. 332) made by F. A. Wagner, of the Garden City Station in the fall of 1930. Two plants of Dwarf Yellow milo apparently normal in every way were found growing on an infected plot of irrigated ground where all other Dwarf Yellow milo plants had been killed by milo disease. A head from each plant was grown in head rows on infected soil the following year. One head produced both healthy and diseased plants. The other head produced only healthy plants, the progeny of which was increased and upon extensive testing over a period of years continued to be resistant to milo disease. It is very similar to Dwarf Yellow milo except in being resistant to milo disease. In February, 1937, it was named Finney, after the county in which it originated, and was distributed to farmers the same spring and has since rapidly displaced the older Dwarf Yellow milo (C. I. 332). In Texas and California independent selections of milo resistant to the Pythium disease have also been distributed.

*Colby.* — Colby milo originated at Woodward, Okla., from a cross made by J. B. Sieglinger between Dwarf Yellow milo (C. I. 332) and Early White milo (C. I. 480). Progenies of this cross were sent to the Colby Station in 1931 and further selections made by E. H. Coles. Colby Selection No. 31 was in 1938 named Colby, approved for certification and distributed to the farmers the same spring. Colby milo grows to a height of from 2 to 3 feet, has sturdy stalks with from two to three tillers which will remain standing for a considerable period after maturity if the season has not been too severe. The heads are a little more open and pointed than found in Finney milo. The seed is slightly smaller but of the same shape as dwarf milo but not quite as lustrous. The grain is accepted by the trade as yellow milo. Colby will mature in about 90 days and was developed for northwestern Kansas where earliness is of prime importance. Colby became the leading variety of grain sorghum in South Dakota by 1941 and also was grown extensively in Nebraska. In this region it is a popular and well-adapted variety because of its earliness and the fact that it can be harvested cheaply with wheat machinery. Colby is susceptible to Pythium milo disease, Weak neck, and chinch bug injury, which often limit its value in other sections of Kansas. The loss in yield from the Weak neck disease is considerably reduced if Colby, or similar early types, are planted as late as possible in June, and yet permit time for the variety to mature before frost (Fig. 6).

*Double Dwarf Milo.* — Double Dwarf milo is so named because of its extreme dwarfness, which is fairly constant, the plants rarely

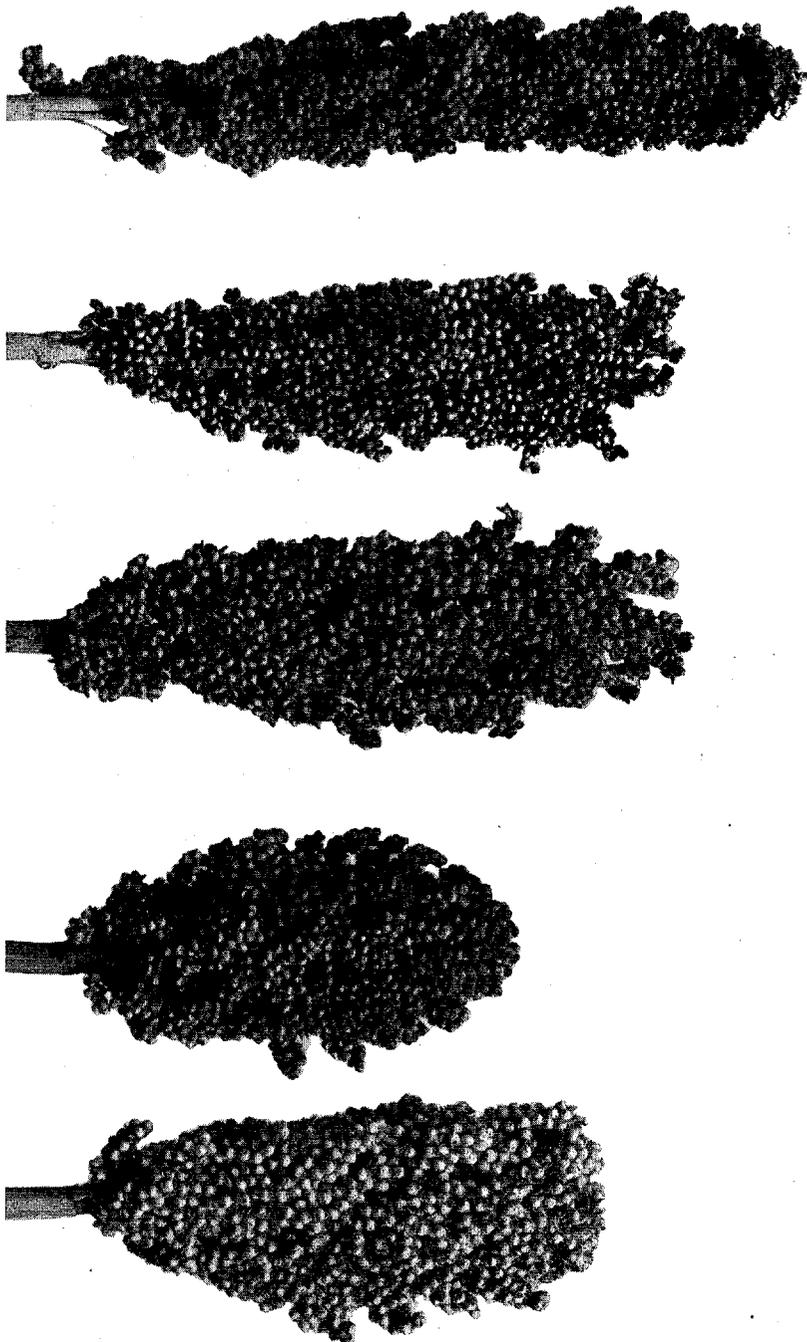


FIG. 6.—Grain sorghums of recent hybrid origin which have made good records in Kansas. From bottom to top: Early Kalo, Westland, Wheatland, Colby, Club.

1914-15  
Kansas Agricultural Experiment Station  
From top to bottom

exceeding a height of 3 feet. Otherwise, Double Dwarf milo does not differ materially in observed character from Dwarf Yellow milo. Double Dwarf milo apparently originated in the Salt River Valley of Arizona, but it became of commercial importance about 1920 in the Imperial Valley of California, where it replaced Dwarf Yellow milo to a large extent. A few shipments of seed of Double Dwarf milo have been made into Kansas, but tests have shown the variety to be inferior to Dwarf Yellow milo in this state. Very little if any Double Dwarf milo is now grown in Kansas.

*Sooner and Day Milos.*—These two varieties originated from a cross between Dwarf Yellow milo and Early White milo made by J. B. Sieglinger at Woodward, Okla. Small lots of seed of Sooner were distributed from there about 1930. Sooner was first grown rather extensively in southwestern Kansas in 1934. During the five extremely dry years which followed, Sooner spread rapidly over the Plains until it had extended from South Texas to central South Dakota. While its yields were low in the dry years it was one of the very few varieties that produced grain in the drought areas and so met with considerable favor among the farmers in urgent need of feed grain. Sooner is highly susceptible to Pythium, Weak neck, chinch bug, and lodging, so that at the present time the popularity of the variety is on the decline. Strains of Sooner resistant to Pythium are now being grown in Texas and Oklahoma. It is one of the earliest varieties to mature and therefore well adapted to regions with short growing seasons. Sooner is often called Sixty-Day milo by the farmers. Sooner is similar to Dwarf Yellow milo except in being earlier, the stalks more slender, shorter, and less leafy, and the heads and seeds somewhat smaller.

Day milo is similar to Colby milo but is slightly later, the heads are more compact, the stalks more erect, and the seeds are a brighter color. Day did not become established in Kansas, but is grown considerably in Nebraska, where it was certified and distributed as an early maturing combine type. The seed of Day resembles Dwarf Yellow milo except that it is usually slightly smaller.

*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 Hays 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, depending upon seasonal conditions. The stalks are short and sturdy, giving it the strength to resist lodging to a greater degree than most varieties of commercial importance. The heads (Fig. 6) are elongated, cylindrical, and somewhat open, varying in length from 6 to 9 inches, depending on the seasons 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 Pythium milo disease.

In normal seasons Wheatland is a high grain yielder and 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 and under such conditions the yields have not been satisfactory. Farmers have found Wheatland well suited for harvesting with the combine. Its best adaptation is in southwestern Kansas beyond the limits of chinch bugs and where Pythium disease organisms are not carried in the soil.

*Westland.* — Westland is a selection from Wheatland milo. The selection was made at the Garden City Station in 1930 by F. A. Wagner and later made ready for distribution by Alvin E. Lowe. Westland may be a cross between Wheatland and some yellow-seeded milo type since it differs in several characteristics from Wheatland and in the early generations showed some segregation. Westland was named and increased in 1941 and released to the farmers in the spring of 1942.

Westland resembles Wheatland in many respects but differs in being 3 inches taller than Wheatland and by better exertion of its heads above the leaves. The heads of Westland are uniform in type (Fig. 6). The seed is, similar in size and shape to that of Wheatland but is brighter and more closely approaches that of Yellow milo. Westland tillers less than Wheatland and matures earlier. The stalks of Westland are short and sturdy, which makes the variety resistant to lodging. The chief advantage of Westland over Wheatland is its resistance to the milo disease, and its ability to produce a crop in infected soil, where the latter variety may be almost a complete failure. Westland is especially recommended for the irrigated region of the Arkansas River Valley in areas where the Pythium disease is known to be in the soil.

*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 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 of Kansas. Pythium resistant selections of Beaver have recently been isolated at several stations.

*Early Kalo.* — Early Kalo is the result of a natural cross between Pink kafir and Dwarf Yellow milo (C. I. 332) from an F<sub>1</sub> plant found in 1921 at the Hays station. Early Kalo was isolated from

Nursery Row 248 in 1931 by A. F. Swanson and approved for certification and distribution in Kansas in 1939. Previous to this time it had also been distributed in Nebraska. Early Kalo grows to an average height of  $3\frac{1}{2}$  to 4 feet and will mature in about 95 days. The slender stalks have from 8 to 12 leaves, producing long cylindrical heads from 7 to 10 inches long (Fig. 6). The seed is similar to Pink kafir in shape and size but of a pale reddish yellow color and has a heavy test weight. Early Kalo was developed as an early-maturing variety for western Kansas which can be best cut with a power grain or corn binder at the time of ripening and threshed without so great a danger of loss from inclement weather as when the crop is left to be combined. It is not recommended that Early Kalo be harvested with a combine as there is danger of lodging, before the grain is dry enough for storage. Early Kalo responds well to irrigation when planted in 20-inch drill rows if the ground has been well worked previous to seeding and if seeding is deferred until June 15. The variety is susceptible to chinch bug injury and to Weak neck but resistant to *Pythium milo* disease. Early Kalo is widely distributed in Nebraska and is gaining favor in western Kansas.

*Kalo*. —Kalo is a sister selection of Early Kalo, having originated from the same cross at the Hays Station and was isolated in 1927. The seed is similar to Early Kalo but slightly larger. The heads are cylindrical and range from 9 to 12 inches long. The variety grows to a height of from  $3\frac{1}{2}$  to  $4\frac{1}{2}$  feet. The slender stalks have 14 to 16 leaves and are not very juicy. The variety is susceptible to chinch bugs and Weak neck disease and is likely to lodge if left standing after full maturity. It ripens in from 100 to 110 days. Potentially Kalo is a high-yielding variety and has had some distribution in Kansas and Nebraska but at the present time its acreage is on the decline in favor of Early Kalo which is much better adapted to western Kansas because of its earliness.

*Hegari*. —Hegari grows to a height of from  $3\frac{1}{2}$  to 5 feet. The stalks are mid-slender to stout and more or less juicy. The plants tiller freely. The heads are cylindrical in shape, from 7 to 8 inches long and about 3 inches in diameter. The seed branches are well supplied with seed on all sides so that each branch appears as a lobe. The seed, which are about the size of Blackhull kafir, are a chalky white except for red or reddish-brown markings and red-brown subcoat. Hegari ordinarily matures in from 105 to 115 days, but the maturity is often markedly affected by the season, making the variety one of the most erratic in ripening. Under irrigation or favorable rainfall Hegari is potentially a high grain yielder, but under dry land conditions often fails, or produces low grain yields. When Hegari fails to produce grain the fodder is one of the most palatable of all the grain sorghums for bundle feed. Hegari is resistant to kernel smut.

*Early Hegari*. —Early Hegari has many of the same characteristics of Hegari except that it is much earlier in maturity and more likely

to produce a crop of grain. It is not as vigorous a grower as Hegari nor as erratic in its ability to produce a grain yield. Early Hegari is of recent but somewhat uncertain origin. It was first found growing in Washington county, Colorado, where it appears to have been brought from Taylor county, Iowa. C. E. Crews, Kingman, Kan., then in charge of the South Central Experiment Fields, secured the seed in Colorado and in 1937 sent it to Chillicothe, Tex., and Woodward, Okla. It has since been tested at the various Kansas Stations and in 1940 a limited amount of seed was released from the Experiment Station at Lubbock, Tex. The new variety is of interest and may eventually have more widespread distribution.

*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. 5). The seed is 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 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. The acreage of feterita is on the decline in Kansas partly due to the introduction of varieties that can be more easily handled by machinery and which potentially are higher yielding. Over a long period of favorable and unfavorable years, feterita is still one of the highest yielding varieties.

*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. Very little if any Spur feterita is grown in Kansas.

*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 seldom are well exerted 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 to be well adapted in the drier portions of Kansas. At one time it became rather widely scattered over the state but the acreage is now on the decline.

*Standard Freed*.—Freed, often known as Freed sorgo, or “White Cane” originated in Scott county, Kansas, and was developed by

J. K. Freed, a pioneer farmer-plant breeder, from a mixture of white-seeded sorghum brought in by the homesteaders in 1908. This mixture contained White durra and seed which produced white-seeded sorgo plants along with seed of Black Amber. From this mixture Freed was isolated about 1910 and became the foundation stock.

This variety has a slender semijuicy 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.

Freed sorgo was at one time widely distributed in western Kansas and other states and was for many years of considerable value to the settlers in adverse seasons. Freed has been widely used as parent in many crosses and is still one of the best sources for earliness in plant breeding work. A number of hybrid selections in which Freed was one of the parents are more and more becoming established in the plains where earliness is of prime importance.

*Dwarf Freed.*—Dwarf Freed was selected in 1921 at the Hays Station by A. F. Swanson 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. It has made somewhat higher yields than Freed and is equally as early, maturing in from 80 to 90 days. Dwarf Freed has a tendency to shatter its seed or lodge a few weeks after it is fully ripe. It is susceptible to kernel smut. The variety had a limited distribution in Scott county in 1926 and at a few scattered points but is no longer in commercial production. It has frequently been used in recent years in plant breeding because of its source of earliness and dwarfness.

*Modoc, Greeley, Weskan and Coes.*—These four hybrid derivatives are 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 at the experiment stations at Hays, Tribune, and Manhattan where Modoc, Greeley, and Weskan were, respectively, developed by A. F. Swanson, T. B. Stinson, and J. H. Parker. About 1921 selections from the cross were also sent to the experiment station at Akron, Colo., where J. F. Brandon developed Coes from Modoc 241 in 1926. These selections range from very early to mid-early in maturity and have in common a medium-sized white seed but differ as to compactness and shape of heads. In respect to earliness and drought resistance Modoc resembles Freed; but in productivity, head, seed and stalk characters it resembles Pink kafir at the same time being earlier in maturity. Modoc had at one time a

limited distribution in northern Kansas but is now principally used at several stations for plant breeding purposes. Greeley ripens in from 80 to 90 days and grows to a height of 40 inches. It is a grain type producing little forage. Greeley was certified and distributed from the Tribune station but did not become firmly established in Kansas. One objection to the variety is that the grain does not thresh free from the glumes. To overcome this Greeley has been crossed with Weskan, and several new selections of this cross as developed at the Tribune station are of promise, one of which may eventually become distributed. Weskan is the latest of the group to mature and is of promise where earliness is not a factor. It is a kafir type of sorghum and while not under distribution has been used in plant breeding work. The variety ranks well with the best improved types and is therefore under close observation. Coes has been certified and distributed from the Akron, Colo., station and is widely grown in the eastern part of that state and to some extent in Nebraska and in extreme northwestern Kansas. Further inland in Kansas it comes in competition with varieties better adapted to the region because of lower altitude and where extreme earliness is not quite so important. Coes has a long cylindrical head from 10 to 15 inches long, usually not well filled at the base. The fine stemmed juicy stalks are usually 3½ to 4 feet tall. The leaves are narrow and somewhat scant.

*Cheyenne*. — Often called Sweet Stalk Kafir and sold under this name was originated by the late Albert Weaver at Bird City, Kan. It is believed to be a cross between Standard Freed and a kafir and became widely distributed in Western Kansas and Nebraska and Eastern Colorado after 1930. The heads are semicompact with white seed and straw-colored glumes. Cheyenne usually grows to an average height of 4 to 5 feet and has a somewhat juicy stalk, unless a fairly heavy crop of grain has been produced. The variety was of considerable usefulness during the drought years but in more normal seasons cannot compete with the newer and improved varieties. Cheyenne is also highly susceptible to kernal smut and the seed is inclined to shatter easily as soon as matured.

*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 Black-hull kafir. The seed have no subcoat and a very thin outer layer gives them a pearly appearance. Shallu lodges or breaks over read-

ily. The variety is not recommended for Kansas, and is only occasionally grown from seed ordered in small lots through seed houses.

*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 bitter, yellowish-brown, and medium size. It contains the waxy type of starch. Schrock yields well in eastern Kansas but is not adapted to western Kansas. The acreage in the state at the present time appears to be very limited.

*Darso*.—Darso was developed by the Oklahoma Agricultural Experiment 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. There it is grown under the name of "Gyp" corn or Egyptian corn.

#### 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 root stock. For many years after the introduction of Sudan grass into this country in 1909 only one variety was grown, the uniformity and purity of which has been maintained by a few growers. In Kansas much credit should be given to the late Carl Wheeler, Bridgeport, Kan., for many years of careful selection of Sudan grass to maintain its

purity. The work has since been carried on by Mrs. Caroline Wheeler. Within the last five years several of the state stations outside of Kansas have carried on extensive selection work with Sudan grass for low prussic acid content. Types of Sudan grass varying in height and size of stems have also been isolated. In Kansas no new selection of Sudan grass has as yet been introduced to replace the original introduction (Fig. 7).

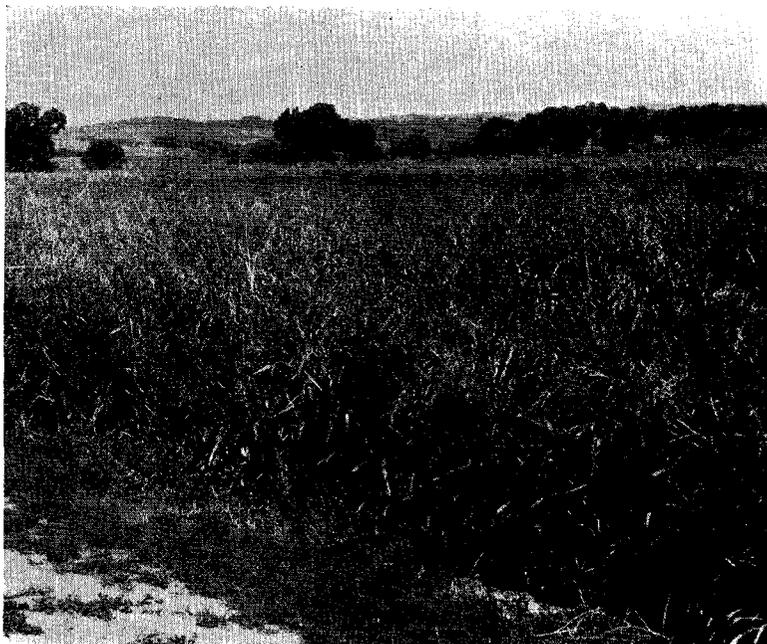


FIG. 7.—Sudan grass.

#### BROOMCORN

There are three classes of broomcorn, the standard, dwarf, and whisk dwarf. The standard has been grown most extensively but in recent years the several dwarf varieties have increased in favor. At the present time the whisk dwarf is little grown in this country.

*Black Spanish.* — Black Spanish (Black Jap) is the leading standard variety grown in recent years and is extensively grown in the Kansas and Oklahoma broomcorn-producing areas. It has been in this country for at least 40 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 Standard Evergreen it can often be harvested without the process of

tabling in the broomcorn section of the state. Black Spanish, however, tends to produce a more coarse brush as compared with Scarborough, and if not harvested quickly, also becomes twisted and curled. There is a considerable tendency for Black Spanish to produce "Crooks" which are heads that come out of the boot too rapidly and bend over, a condition that is intensified by thin stands and high rainfall at heading time.

*Scarborough.*—Scarborough is the leading dwarf type of broomcorn. 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 quality of the brush of Scarborough is the best produced by any of the broomcorn varieties grown in Kansas. The plants grow 4 to 6 feet tall. The glumes are reddish-tan in color.

*Evergreen Dwarf.*—There are several strains or selections of Evergreen Dwarf, but Acme was for many years the leading dwarf type. At the Hays Station Acme has given somewhat higher brush yields as compared with Scarborough but the quality of the latter variety has always been much superior. Because of its quality Scarborough is more and more replacing Acme and related strains.

*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 broomcorn. 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 8 miles north. Since sorghum grows very little at temperatures less than about 60° 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 1. Several varieties such as Pink and Western Blackhull require about the full available growing season at Hays, while feterita, Early Kalo 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, exertion 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. Also that the fodder of varieties vary considerably in palatability and feeding quality has been determined by tests at the Hays Station. 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

TABLE 1. *Plant characteristics and growing habits of sorghum varieties. Fort Hays Agricultural Experiment Station, Hays, Kansas.*

VARIETY.	C. I. No.	Days to mature.		Tillers per plant.		Height of plants (ins.).		Lodging percent.		Test wt. (lbs. per bushel).	
		5-yr. av. 1932 to 1941.	12-yr. av. 1925 to 1941.	9-yr. av. 1932 to 1941.	16-yr. av. 1925 to 1941.	10-yr. av. 1932 to 1941.	17-yr. av. 1925 to 1941.	6-yr. av. 1932 to 1941.	13-yr. av. 1925 to 1941.	5-yr. av. 1932 to 1941.	12-yr. av. 1925 to 1941.
Leoti Red.....	1120	111	110	1.7	1.8	58	66	12	9	50	50
Early Sumac.....	1119	106	107	1.7	1.8	54	59	18	16	57	58
Atlas.....	899	124‡	123‡	2.1	2.1	57	65	19	10	.....	.....
Red kafir.....	957	116	117	1.5	1.6	48	54	1	3	59	58
Pink kafir.....	432	120	119	1.5	1.6	55	59	2	5	58	57
Western Blackhull kafir.....	906	118	118	1.4	1.5	44	49	2	1	56	57
Standard feterita.....	182-1	98	102	2.2	2.2	50	55	13	6	58	57
Finney milo*.....	1089	118	116	1.9	1.9	39	44	5	6	59	58
Dawn kafir sel.....	904	114	115	1.5	1.6	45	50	6	3	57	58
Club kafir.....	901	113	.....	2.2	.....	42	.....	3	.....	55	.....
Kalo.....	902	115	.....	1.5	.....	40	.....	6	.....	60	.....
Sooner milo.....	917	90	.....	1.9	.....	37	.....	5	.....	58	.....
Wheatland.....	918	110	.....	1.8	.....	27	.....	1	.....	58	.....
Norkanf.....	1116	106	.....	1.7	.....	52	.....	16	.....	61	.....
Early Kalo.....	1009	96	.....	1.5	.....	35	.....	7	.....	60	.....
Colby milo.....	1118	92	.....	1.8	.....	27	.....	5	.....	59	.....

NOTE.—Not all of the years indicated are represented in either short or longtime averages.  
 \* Dwarf Yellow milo, C. I. 332 previous to 1937.  
 † Atlas X Early Sumac F. C. 9165 previous to 1938.  
 ‡ Four-year and eleven-year averages. Atlas killed by frost or in dough or milk stages in some seasons.

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 1 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 tests 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 more resistant than Standard Sumac or Kansas Orange.

*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, Western Blackhull, and Dawn and also Early Kalo tiller relatively less than Standard feterita, Dwarf Yellow milo, Colby, 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 be more than 40 inches high 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.

Many dwarf varieties of sorghum have been developed since about 1920. The best representatives of the group tested and suited to combine methods of harvesting in Kansas are Wheatland, Beaver, Westland, Colby, Day, and Double Dwarf. Such varieties cannot easily if at all be cut with a binder. Early Kalo is an excellent ex-

ample of a somewhat taller type than is well suited to be cut with power grain or corn binder. When so cut it can often be threshed in the same manner as bound wheat. All of the above types can be readily harvested with header and the heads placed in long narrow ricks. The use of a swather and a dump box arrangement may also be used in harvesting the crop when it is ripe, after which it can be threshed ahead of inclement fall weather, thus avoiding losses due to lodging.

*Resistance to Insects and Diseases.*—The differences among varieties of sorghum in their resistance to insects and diseases may determine 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 and since they are also somewhat late find their best adaptation in southern and eastern Kansas, where it would not be the best recommendation to plant the highly susceptible varieties such as Colby and Early Kalo which have been developed for the western end of the state where chinch bugs are not a factor and where earliness is needed. Wheatland and Colby are, in certain irrigated sections and regions in Kansas, highly susceptible to the Pythium milo disease which is soil borne. When this situation is known it is much better to plant Finney, Westland, and Early Kalo in as far as these varieties are adapted to the region. 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 bacterial leaf spot, kafirs and milos in general are somewhat resistant and feterita and related types are highly susceptible.

The chief sorghum diseases in Kansas, however, are Pythium, Weak neck, Charcoal Rot, Kernel smut and leaf spot. Control lies to a considerable degree in the use of plant breeding methods to develop resistant strains and this work is constantly being carried on at the several Kansas experiment stations. The insect enemies and diseases of sorghum are discussed more fully in another bulletin.<sup>5</sup> Seed treatment is another control for such diseases as kernel smut.

#### 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 agricultural experiment fields in south-

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

eastern, southcentral, and southwestern Kansas; 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 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 Agricultural 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.

In some of the Kansas tests sorghum yields go back many years and all of the data cannot be shown in the tables to follow. The yields for the decade 1931 to 1940 are relatively low, due to the fact that during this period one of the most severe and protracted droughts occurred since the state was settled by the pioneers. The early or mid-early maturing varieties tend to show the higher yields. In another decade with more seasonable climate the later maturing varieties may well show a substantially higher trend in yields.

#### VARIETY YIELDS AT HAYS

The experiments with sorghum have been more extensive at the Hays 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, about 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 22.67 inches, the altitude is 2,000 feet, and the average frost-free period 172 days. About three-fourths 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 2 are presented the grain yields of the sorghum varieties

grown at the Hays Station during the period 1933 to 1941 in comparison with Hays Golden Dent corn. From 1934 to 1939 the rainfall was below normal and the grain yields are much lower than for previous periods when growing conditions were more favorable for crop production. These data indicate near crop failures in grain yield for the unfavorable years 1934 to 1937 and again in 1940. During the last decade the early maturing sorghums have made substantially higher yields than the late maturing varieties. In years of more nearly normal rainfall, grain yields of the magnitude or even greater as shown for 1941 can be expected under good management.

The yield of corn for all of the period considered in Table 2 has been from one-third to one-half lower than for the better grain sorghums. Feterita has been one of the highest-yielding grain sorghums at the Hays Station even though a number of other varieties will often outyield it in seasons of abundant rainfall. Early Kalo is the second highest-yielding variety of the early types during the unfavorable period 1933 to 1941, followed by Day and Weskan, while the older established varieties such as Western Blackhull, Pink kafir, and Dwarf Yellow milo made low yields during this period. The yields for Western Blackhull, Pink kafir and similar types for the long time period of 1924-1941 are shown in the first column of averages. Norkan made the highest grain yield of the forage group in the years tested at Hays. As a rule the forage sorghums do not yield as much grain as do the grain sorghums, but the total crop tonnage per acre is about the same for a forage and grain sorghum when both types reach about the same maturity.

In Table 3 are presented the annual forage yields for both the forage and grain sorghums for the period 1932 to 1941 as well as long time yields for the 18-year period 1924 to 1941 for which not all of the yearly data are shown. The late maturing varieties Atlas and Kansas Orange are the highest in yield. The tonnage yields of Norkan, Early Sumac, and Leoti Red are somewhat lower, probably because they mature earlier. The sorghums produced a much lower tonnage during the dry years from 1933 to 1941 than during the preceding nine years as shown by the comparison of the 9- and 18-year average yields. All the yields at Hays are shown as oven dry weights. From one-third to one-half of the tonnage of early maturing combine types is made up of grain.

#### VARIETY YIELDS AT MANHATTAN

The results of the 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 for the 6, 11, 18, and 23-year averages are shown in Table 4, together with annual yields from 1931 to 1941. Darso has been the highest yielding variety but because of the some-

TABLE 2. Grain yields of sorghum varieties at the Hays, Kansas, Branch Agricultural Experiment Station, 1924-1941.

VARIETY.	C. I. No.	1932.	1933.	1934.	1935.	1936.	1937.	1938.	1939.	1940.	1941.	18-yr. av. 1924- 1941.	12-yr. av. 1930- 1941.	9-yr. av. 1933- 1941.	5-yr. av. 1937- 1941.
Atlas.....	899	34.4	3.9	0	0	0	0	0	1.1	0	35.9	13.4	7.3	4.5	7.4
Early Sumac.....	1119	43.9	16.2	0	0	0	0	8.9	4.3	0	28.9	18.0	11.5	6.5	8.4
Leoti Red.....	1120	43.2	18.8	0	0	0	0	15.4	6.4	1.1	39.6	19.1	14.4	9.0	12.5
Pink kafir.....	432	66.3	20.4	0	0	0	0	10.2	5.4	0	48.0	24.4	16.1	9.3	12.7
Red kafir.....	957	63.6	19.1	0	0	0	0	14.5	7.5	0	42.9	24.4	17.6	9.3	13.0
Western Blackhull.....	906	65.7	17.0	0	0	0	0	13.4	2.2	0	41.0	26.9	18.1	8.2	11.3
Feterita.....	182-1	51.8	24.6	0	11.8	14.7	9.0	21.5	23.6	13.9	38.9	28.8	23.8	17.6	21.4
Dwarf Yellow milo*.....	332	60.3	15.7	0	0	4.9	0	5.8	19.3	0	42.9	25.3	18.8	9.8	13.6
Hays Golden corn.....		29.2	4.8	0	0	0	0	0	4.3	4.3	16.4	14.0	7.7	3.3	5.0
Dawn Selection.....	904	58.7	12.9	0	0	0	0	5.9	4.9	3.6	35.6		15.2	7.0	10.0
Beaver milo.....	871	62.3	10.0	0	0	1.8	7.1	15.2	14.0	3.6	34.0		16.5	9.5	14.8
Kalo.....	902	73.1	37.7	0	0	3.6	0	18.9	11.8	7.5	42.9		23.5	13.6	16.2
Club.....	901	61.9	22.1	0	0	0	0	18.0	12.4	4.3	43.4		20.6	11.1	15.6
Wheatland.....	918	74.0	16.6	0	0	1.8	8.5	7.1	12.9	3.9	34.9		18.2	9.5	13.5
Dwf. Fet. X (M X K).....	1121	72.8	28.9	0	0	0	0	13.3	7.5	5.7	48.2			11.5	14.9
Norkan†.....	1116		27.7	0	0	0	0	16.1	15.6	0.4	41.8			11.3	14.8
Cheyenne.....	1109		34.6	0	2.2	3.1	1.0	8.1	10.8	1.4	27.6			9.9	9.8
Weakan.....	1117		26.4	0	0	1.3	0	20.4	20.9	2.5	45.6			13.0	17.9
Early Kalo.....	1009		33.9	0	0	10.7	5.5	21.2	23.6	10.7	44.0			16.6	21.0
Day milo.....	959		21.4	0	0	5.8	14.9	27.5	20.9	4.7	31.9			14.1	20.0
Kansas Orange.....	107				0	0	0	0	0.6	0	25.5				5.2
Hegari.....	620				0	0	0	4.0	0	0	39.9				8.8
Colby milo.....	1118				0	10.3	13.7	22.1	20.4	6.4	33.0				19.1
Sooner milo.....	917						11.4	18.0	15.6	4.3	31.4				16.1
Finney milo.....	1089						0	5.8	19.3	0	42.9				13.6

\* Finney milo substituted for Dwarf Yellow milo C. I. 332 since 1938.

† Atlas X Early Sumac H. C. 381 and later designated as Norkan C. I. 1116 substituted for Atlas X Early Sumac F. C. 9165, since 1939.

TABLE 3. Forage yields of sorghum varieties at the Hays, Kansas, Branch Agricultural Experiment Station, 1924-1941.

VARIETY.	C. I. No.	1932.	1933.	1934.	1935.	1936.	1937.	1938.	1939.	1940.	1941.	18-yr. av. 1924- 1941.	12-yr. av. 1930- 1941.	9-yr. av. 1933- 1941.	5-yr. av. 1937- 1941.
Atlas.....	899	4.25	2.93	.39	.98	1.49	1.59	3.10	1.42	2.51	4.10	3.21	2.44	2.06	2.54
Early Sumac.....	1119	4.33	2.60	.33	1.10	1.16	1.68	2.53	1.51	1.71	3.23	2.65	2.13	1.76	2.13
Leoti Red.....	1120	4.35	2.88	.36	1.18	1.31	1.58	2.52	1.61	1.79	3.17	2.86	2.24	1.82	2.13
Pink kafir.....	432	4.49	2.71	.34	1.18	1.22	1.46	2.02	1.77	1.77	3.17	2.67	2.15	1.74	2.04
Red kafir.....	957	4.00	2.04	.29	1.09	1.76	1.19	1.68	1.81	1.64	2.91	2.36	1.99	1.60	1.85
Western Blackhull.....*	906	4.05	2.32	.32	1.04	1.06	1.24	2.31	1.54	1.85	2.86	2.62	2.08	1.62	1.96
Peterita.....	182-1	3.73	2.26	.29	.96	1.71	1.53	1.89	1.48	1.26	2.55	2.30	1.93	1.55	1.74
Hays Golden corn.....		2.74	1.19	.07	.59	.47	.38	.81	.96	.65	1.38	1.55	1.03	.72	.84
Dawn Selection.....	904	3.92	2.62	.38	1.20	1.22	1.37	2.08	1.62	1.82	2.93	.....	2.12	1.69	1.96
Club.....	901	3.63	2.07	.19	1.00	.82	1.14	2.07	1.44	1.45	2.58	.....	1.85	1.42	1.74
Norkan*.....	1116	.....	2.69	.32	1.18	1.25	1.47	2.28	1.99	1.77	3.46	.....	.....	1.82	2.19
Cheyenne.....	1109	.....	2.23	.24	.92	1.32	1.24	1.52	1.22	1.16	2.14	.....	.....	1.33	1.46
Weskan.....	1117	.....	2.51	.29	1.10	1.81	1.10	1.96	1.79	1.80	2.61	.....	.....	1.65	1.83
Kansas Orange.....	107	.....	.....	.....	1.09	1.39	1.48	2.70	1.97	1.97	3.79	.....	.....	.....	2.38
Hegari.....	620	.....	.....	.....	.97	1.34	1.46	2.03	1.73	2.03	2.34	.....	.....	.....	1.92
Kalo.....	902	.....	.....	.....	.59	1.53	1.03	2.03	1.41	1.37	2.58	.....	.....	.....	1.68
Dwf. Fet. X (M X K).....	1121	.....	.....	.....	1.01	1.53	1.25	2.06	1.22	1.63	2.98	.....	.....	.....	1.83
Early Kalo.....	1009	.....	.....	.....	.67	1.62	1.53	1.59	1.58	1.30	2.56	.....	.....	.....	1.71
Beaver milo.....	871	.....	.....	.....	.56	1.62	1.52	1.81	1.47	1.00	2.28	.....	.....	.....	1.62
Wheatland.....	918	.....	.....	.....	.52	1.49	1.70	1.64	1.33	1.10	2.14	.....	.....	.....	1.58
Day milo.....	959	.....	.....	.....	.47	1.22	1.49	1.96	1.29	.94	1.70	.....	.....	.....	1.48
Colby milo.....	1118	.....	.....	.....	.42	1.61	1.51	1.84	1.28	1.06	1.98	.....	.....	.....	1.53
Sooner milo.....	917	.....	.....	.....	.....	.....	1.70	1.59	.99	1.11	2.04	.....	.....	.....	1.49
Finney milo.....	1089	.....	.....	.....	.....	.....	1.93	2.25	2.01	1.30	3.08	.....	.....	.....	2.11

\* Atlas X Early Sumac H. C. 381 and later designated as Norkan C. I. 1116 substituted in 1939.

what bitter seed it is considered less desirable for grain than Red and Standard Blackhull kafir and Club sorghum. The average yield of Club for 11 years has been 1 bushel below Darso. The yields of Western Blackhull and Ajax during the same period were about equal to Standard Blackhull. The relatively low yield of Kalo was probably due to its early maturity and susceptibility to chinch bug injury. Hegari during the six years it was tested was exceeded in yield by all of the other varieties of grain sorghum. The forage sorghums, including Atlas, Kansas Orange, Leoti Red, and Norkan, made lower yields of grain than adapted varieties of grain sorghum.

Atlas and Kansas Orange during long periods of testing yielded about twice as much forage as did the better varieties of grain sorghum as shown in Table 5. The forage yield of Leoti Red was about midway between Atlas and Standard Blackhull kafir. The forage yields of Club and Darso were considerably below the kafirs.

#### VARIETY YIELDS AT GARDEN CITY

The average annual rainfall at the Garden City Station is about 18 inches as compared to 23 inches at Hays. The precipitation for the six summer months is nearly 14 inches or about three-fourths 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 are shown in Table 6. In the longtime 18-year period Dwarf Yellow milo and Feterita have given the highest yields of 19.3 and 19.0 bushels, respectively. In the 10-year period, 1932-1941, the highest yields have been made by Dwarf Feterita X (Milo X Kafir) H. C. 312, Club, Day milo, and Wheatland. For the short 3-year period 1939-1941 as shown in Table 6 are a number of new promising strains with high yields which need further testing to determine their value and adaptation.

In Table 7 are shown the forage yields for both the grain and forage sorghums at Garden City. Atlas is the highest forage yielding variety, followed by Leoti Red, Early Sumac, and Norkan. The yield of Early Sumac and Norkan are almost identical in forage but the grain yield is considerably higher for Norkan than for Early Sumac. Since the grain of Norkan is more palatable this is an advantage, but on the other hand, the forage of Early Sumac is slightly more palatable than Norkan to livestock.

Several varieties including both forage and grain types were grown under irrigation at the Garden City Station. Comparing the two late maturing forage varieties Atlas outyielded Standard Sumac

TABLE 4. Grain yields of sorghum varieties at the Kansas Agricultural Experiment Station, Manhattan, Kansas, 1919-1941.

VARIETY.	C. I. No.	1930.	1931.	1932.	1933.	1934.	1935.	1936.	1937.	1938.	1939.	1940.	1941.	23-yr. av. 1919-1941.	18-yr. av. 1924-1941.	11-yr. av. 1931-1941.	6-yr. av. 1936-1941.
Standard Blackhull kafir...	613	46.1	77.0	77.9	43.9	0	13.2	0	17.3	55.2	12.2	41.6	27.6	42.53	37.92	33.26	25.66
Pink kafir.....	432	39.7	76.9	72.3	42.3	0	8.4	0	23.5	53.6	16.6	42.6	28.7	42.71	38.93	33.17	27.50
Red kafir.....	958	50.5	83.1	66.7	48.9	0	16.0	0	26.6	55.0	15.6	45.8	33.7	46.59	42.12	35.58	29.45
Darso.....	615	51.8	79.7	74.6	52.8	0	28.1	0	36.7	74.4	13.9	35.2	40.1	49.69	45.17	39.59	33.38
Kansas Orange.....	107	45.6	76.0	77.5	32.2	0	9.4	0	13.0	40.5	12.4	43.8	11.5	38.05	37.35	28.75	20.26
Atlas Sorgo.....	899	32.1	64.7	70.5	37.3	0	1.7	0	5.4	36.9	11.0	43.2	27.4	.....	33.53	27.10	20.65
Western Blackhull.....	906	35.1	80.3	64.2	48.8	0	11.2	0	23.0	55.0	14.1	38.1	29.8	.....	.....	33.13	26.66
Club.....	901	45.1	90.6	78.9	55.2	0	11.7	0	21.7	66.3	11.8	50.7	37.6	.....	.....	38.59	31.35
Kalo.....	902	41.6	82.0	63.4	50.1	0	19.2	0	22.8	65.9	2.5	16.9	19.7	.....	.....	31.13	21.30
Ajax.....	968	.....	68.9	73.2	53.1	0	20.6	0	26.7	69.2	6.8	31.5	19.6	.....	.....	33.60	25.63
Leoti Sorgo.....	1120	.....	43.3	50.2	39.5	0	14.3	0	24.4	49.6	11.6	32.4	27.3	.....	.....	26.60	24.21
Hegari.....	620	.....	.....	.....	.....	.....	.....	0	12.9	57.0	2.6	33.3	10.4	.....	.....	.....	19.20
Norkan.....	1116	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	32.4	21.9	.....	.....	.....	.....

SORGHUMS FOR KANSAS

TABLE 5. Forage yields of sorghum varieties at the Kansas Agricultural Experiment Station, Manhattan, Kansas, 1919-1940.

VARIETY.	C. I. No.	1928.	1929.	1930.	1931.	1932.	1933.	1934.	1935.	1936.	1937.	1938.	1940.	21-yr. av. 1919-1940.	16-yr. av. 1924-1940.	10-yr. av. 1930-1940.	4-yr. av. 1936-1940.
Kansas Orange.....	107	9.7	7.1	9.7	10.0	9.7	9.9	4.7	10.2	7.3	7.7	11.5	6.7	8.14	8.50	8.74	8.30
Standard Blackhull.....	613	3.6	2.6	5.4	5.4	3.9	4.6	3.2	6.1	6.0	4.1	6.5	4.8	4.19	4.41	5.00	5.35
Pink kafir.....	432	2.2	2.8	5.6	4.5	3.3	3.8	2.4	4.9	4.4	3.5	4.7	3.9	3.52	3.63	4.10	4.12
Red kafir.....	958	3.8	3.8	6.1	5.6	2.8	3.7	2.1	4.4	4.1	3.6	6.0	4.0	4.09	4.13	4.24	4.42
Darso.....	615	3.3	2.9	4.6	4.2	3.3	2.7	1.7	3.7	2.2	3.0	5.6	1.9	3.19	3.25	3.29	3.17
Atlas Sorgo.....	899	7.5	7.1	12.0	9.5	8.9	9.2	4.6	10.5	8.2	7.4	11.2	7.4	.....	8.29	8.89	8.55
Western Blackhull.....	906	.....	.....	4.4	4.6	2.5	4.0	2.7	4.6	4.2	3.2	6.3	2.9	.....	.....	3.94	4.15
Club.....	901	.....	.....	3.0	4.3	3.2	3.7	2.0	3.6	3.6	3.0	5.8	2.5	.....	.....	3.47	3.72
Kalo.....	902	.....	.....	3.4	4.0	1.8	3.2	3.0	4.6	2.0	2.1	4.9	0.7	.....	.....	2.97	2.43
Leoti Red.....	1120	.....	.....	.....	8.4	7.1	6.6	3.1	7.2	6.0	6.7	9.5	5.0	.....	.....	.....	6.80
Ajax.....	968	.....	.....	.....	3.8	2.2	2.6	2.0	3.1	3.2	2.2	4.7	1.8	.....	.....	.....	2.97
Hegari.....	620	.....	.....	.....	.....	.....	.....	.....	.....	6.3	4.9	7.8	3.6	.....	.....	.....	5.65
Norkan.....	1116	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.3	.....	.....	.....	.....

TABLE 6. Grain yields of sorghum varieties at the Garden City, Kansas, Branch Agricultural Experiment Station, 1921-1941.

VARIETY.	C. I. No.	1932.	1933.	1934.	1935.	1936.	1937.	1938	1939.	1940.	1941.	18-yr.* av. 1921- 1941.	10-yr. av. 1932- 1941.	3-yr. av. 1939- 1941.
Dwarf Yellow milo.....	332	24.4	22.0	1.6	0	4.2	24.2	0	8.7	3	36.2	19.3	12.2	15.1
Feterita.....	182-1		21.1	4.7	0	3.0	32.1	0	11.2	3.7	42.0	19.0		19.0
Dawn kafir.....	904	26.6		.6	0	.2	23.8	0	8.5	.6	23.6	16.7		10.9
Sunrise.....	472	24.4	21.9	3.1	0	0	9.6	0	0	5.2				
Pink kafir.....	432		17.8	0	0	1.0	1.8	0	0	11.3	27.2	13.6		12.8
Dwarf Hegari.....	620		0		0	0	.2	0	0	9.0	49.6	13.5		19.5
Red kafir (Meade)†.....	958		18.9	0	0	2.7	1.8	0	0	10.5	27.1	11.5		12.5
Dwarf Freed.....	971	40.5	19.2	7.7	0	0	6.6	0	9.7	4.3	35.8		12.4	16.6
Sooner.....	917	31.6	12.4	4.8	0	6.7	19.5	0	8.4	3.2	28.1		11.5	13.2
Day milo.....	959	31.4	16.6	6.0	0	8.2	20.9	0	9.7	8.8	35.8		13.7	18.1
Beaver milo.....	871	26.4	20.1	0	0	1.4	19.7	0	8.7	9.3	29.4		11.5	15.8
Wheatland.....	918	33.0	24.0	.3	0	.8	25.0	0	8.4	7.0	34.5		13.3	16.6
Dwf. Fet. × (M × K) H. C. 312	1121	38.0	23.6	.4	0	2.0	41.0	0	11.8	2.3	40.9		16.0	18.3
Club kafir.....	901	33.4	25.0	.3	0	1.6	35.6	0	13.0	1.5	48.4		15.9	21.0
Western Blackhull.....	906	24.7	27.0	0	0	0	24.5	0	5.8	.8	40.7		12.6	15.8
Finney Milo.....	1089		15.5	4.0	0	.6	24.0	0	8.0	.4	50.3			19.6
Early Kalo.....	1009		22.6	.8	0	4.6	30.6	0	8.9	4.1	46.1			19.7
Weskan.....	1117		21.5	5.6	0	6.7	6.8	6.6	7.8	25.6	31.0			21.5
Cheyenne.....	1109		15.2		0	0	3.3	6.4	3.0	23.1	24.4			16.8
Sedan Red kafir.....	1103				0	8.0	34.4	0	10.3	2.4	40.0			17.6
Greeley.....	972	43.0	10.6	.4					2.7	25.6	28.8			19.0
Wonder kafir.....	872	30.6	21.0	1.2	0	1.8	20.4	0	2.9					
Kalo.....	902	31.4	24.0	.3	0	1.8	5.8	0	1.0	16.6				
Tricker.....	1112					3.6	32.2	0	8.1	3.5	32.8			14.8
Quadroon.....	1091						11.9	0	0	19.1	46.8			22.0
Ajax.....	968	19.2	24.6	0	0	0	.8	0	0					
Colby milo.....	1118			0	0			0	9.7	7.5	31.6			16.3
Highland.....								0	3.8	22.6	27.1			17.8
Coes.....	1104							5.8	3.1	22.2	33.4			19.6
Westland.....									9.5	10.4	49.0			23.0
Yellow Darso Wd. 36-12.....	1122								8.8	28.8	53.2			30.3
Early Hegari S. A. 281.....	1111									21.2	58.5			
Atlas.....	899			1.1	0		3.4	0	3.3	.5	39.8			14.5
Early Sumac.....	1119			0	0		10.8	0	7.1	.8	39.9			15.9
Leoti Red.....	1120			0	0		26.0	0	13.4	3.1	39.2			18.6
Norkan.....	1116								9.8	4.0	46.6			20.1

\* Years 1932, 1933, 1934 not included.

† Bazine Red kafir C. I. 957 grown from 1921 to 1935, Meade Red kafir C. I. 958 since 1936.

TABLE 7. Forage yields of sorghum varieties at the Garden City, Kansas, Branch Agricultural Experiment Station, 1921-1941.

VARIETY.	C. I. No.	1932.	1933.	1934.	1935.	1936.	1937.	1938.	1939.	1940.	1941.	11 yr. av. 1921- 1931.	10-yr. av. 1932- 1941.	3-yr. av. 1939- 1941.
Dwf. Yellow milo.....	332	2.78	1.33	1.61	0	1.12	3.18		1.17	.75	2.56	2.06		1.49
Feterita.....	182-1		1.00	1.83	0	1.19	2.52	.84	.59	.98	2.82	1.60		1.46
Dawn kafir.....	904	4.08		.33	0	1.40	2.92	1.00	1.34	1.14	3.30	2.25		1.93
Sunrise kafir.....	472	2.95	1.68	2.88	0	2.74	2.36	1.40		2.20		2.25		
Pink kafir.....	432		2.08	0	0	1.55	1.76				4.44	2.06		
Dwarf Hegari.....	620		3.20		0	1.22	1.90				4.88	2.27		
Red kafir (Meade).....	958		2.18	0	0	1.80	1.82				5.21	2.33		
Dwarf Freed.....	971	1.54	.92	.63	0	1.06	1.06	.48	.63	.86	2.80		1.00	1.43
Sooner milo.....	917	1.16	.78	.46	0	.80	1.48	.42	.65	.66	2.27		.87	1.19
Day milo.....	959	1.14	.74	.49	0	.74	1.36				1.82			
Beaver milo.....	871	1.76	.96	0	0	1.14	1.40				2.98			
Wheatland.....	918	1.09	.93	.17	0	.98	1.40				3.30			
Dwf. Fet. X (M X K) H.C. 312	1121	1.45	1.15	.33	0	1.10	2.69	.72	.84	.96	2.89		1.21	1.56
Club kafir.....	901	2.48	1.40	.58	0	1.08	2.86	.73	.82	1.12	3.43		1.45	1.79
Western Blackhull.....	906	2.78	1.72	0	0	1.28	3.08	1.08	1.12	1.18	3.29		1.55	1.86
Finney milo.....	1089		1.06	1.49	0	1.08	2.80		1.47	.80	3.67			1.98
Early Kalo.....	1009		.92	.25	0	.88	2.26		.59	.78	3.44			1.60
Weskan.....	1117		1.14	1.39	0	1.00	1.36				3.20			
Cheyenne.....	1109		1.12		0	1.04	1.09				3.14			
Sedan Red kafir.....	1103				0	1.58	2.56	.90	.92	1.02	2.93			1.62
Greeley.....	972	1.50	.44	.33							2.51			
Wonder kafir.....	872	2.38	1.06	.58	0	1.42	2.40	1.13						
Kalo.....	902	2.23	.92	.42	0	1.10	1.70							
Tricker.....	1112					1.59	2.98	1.10	1.88	1.20	3.21			2.10
Ajax.....	968	2.03	1.29	0	0	1.08	1.70							
Atlas.....	899	3.06	2.89	3.47	0	.98	3.62	1.69	2.40	1.66	6.51		2.63	3.52
Early Sumac.....	1119	1.92	1.46	0	0	1.00	2.36	1.32	1.78	1.25	4.63		1.57	2.55
Leoti Red.....	1120	3.04	1.52	0	0	.87	2.78	1.22	1.67	1.26	5.02		1.74	2.65
Norkan.....	1116								1.60	1.39	4.57			2.52

both in forage and grain. Among the four earlier maturing forage varieties a new selection designated as Yellow Sumac Wd 97-14 made the highest yield followed by Leoti Red, Early Sumac and Norkan. In yield of grain the varieties ranked in reverse order. Finney yielded slightly more grain than Club and yields of both were considerably higher than any of the forage varieties and higher than the early varieties of milo. Westland in each of two years made about one-half more grain under irrigation when planted in rows 22 inches apart than in rows 44 inches apart as shown in Table 8. Westland does not tiller as heavily as some varieties and a thickening up of the stands by the drill method when grown under irrigation has given strong evidence of increasing the yields. When the drill method is used the need for a thoroughly prepared seed bed is important with relatively late planting. One of the dangers of the drill method is the failure to properly control the weeds.

TABLE 8. Yield of sorghum under irrigation, Garden City, Kansas, Branch Agricultural Experiment Station, 1939-1941

VARIETY.	Air-dry forage—tons per acre.				Yield in grain—bushels per acre.				
	1939.	1940.	1941.	3-yr. av. 1939-1941.	1939.	1940.	1941.	3-yr. av. 1939-1941.	2-yr. av. 1940-1941.
Atlas .....	5.85	8.32	8.85	7.67	34.3	35.6	60.7	43.5	48.2
Standard Sumac .....	4.20	6.92	8.14	6.42	17.3	43.3	50.5	37.0	46.9
Early Sumac .....	4.81	4.61	6.08	5.17	33.6	48.9	51.2	44.6	50.0
Norkan .....	3.68	4.40	6.28	4.79	32.6	51.8	66.4	50.3	59.1
Yellow Sumac Wd. 97-14 .....	4.95	6.80	6.88	6.21	26.8	39.8	54.8	40.5	47.3
Leoti Red .....	4.22	6.23	6.39	5.61	26.5	56.6	47.7	43.6	52.2
Finney .....	2.45	5.38	5.48	4.44	35.2	73.0	71.9	60.0	72.5
Club .....	2.50	4.64	5.23	4.12	38.8	64.3	73.0	58.7	68.7
Sooner sel. GC 3858 .....	1.77	2.13	5.25*	3.05	27.1	38.9	58.2*	41.4	48.6
Day sel. GC 38311 .....					13.9	43.2	38.9	32.0	41.1
Westland .....					20.2	51.7	53.7	41.9	52.7
Westland* .....						80.2*	82.9*		81.6

\* Grown in 22-inch rows, all other plots 44-inch rows.

VARIETY YIELDS AT TRIBUNE

The Tribune station is near the western boundary of Kansas at an elevation of 3,600 feet, or 2,600 feet higher than eastern Kansas. The 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 early maturing varieties of sorghum be grown for grain. Later varieties may be used for hay or fodder.

The grain yield for the sorghum varieties are shown in Table 9. In the 6-year average for 1927-1932 for which yearly data are not

TABLE 9. Grain yields of sorghum varieties at the Tribune, Kansas, Branch Agricultural Experiment Station, 1927-1941.

VARIETY.	C. I. No.	1933.*	1935.	1936.	1937.	1938.*	1940.	1941.	6-yr. av. 1927- 1932.	13-yr. av. 1927- 1941.	6-yr. av. 1935- 1941.
Finney milo†	1089	10.2	0	0	0	29.7	4.6	17.4	12.1	10.3	8.6
Western Blackhull	906	5.7	0	0	0	19.9	12.1	33.2	9.2	8.1	10.9
Greeley	972	13.4	0	0	0	23.4	10.4	36.6	18.4	15.0	11.7
Early Sumac	1119	8.1	0	0	0	8.0	5.2	21.7	7.7	6.2	5.8
Leoti Red	1120	9.5	0	0	0	19.7	13.0	22.4	9.2	9.2	9.2
Feterita	182-1	10.6	0	0	0	12.5			12.0		
Modoc	905	6.0	0	0	0	19.3			11.6		
Kalo	902	12.5	0	0	0	41.4	10.2	37.6			14.9
Sooner	917		0	0	0	19.7	5.1	27.2			8.7
Day milo	959		0	0	0	23.9	5.8	26.7			9.4
Wheatland	918	6.1	0	0	0	1.1	6.4	29.6			6.2
Early Kalo	1009	12.3	0	0	0	25.1	9.3	40.9			12.6
Colby milo	1118		0	0	0	21.1	3.4	20.1			7.4
Norkan	1116		0	0	0	15.3	13.8	32.4			10.3
Freed	350								13.3		
Sunrise	472								7.4		
Red Amber	F.C. 6608								11.8		
Black Amber	F.C. 7038								11.9		
Kansas Orange	107								0		
Atlas	899								0		
Dwarf Freed	971								10.1		

\* No yields obtained in 1934 and 1939 because of drought.

† Dwarf Yellow milo C. I. 332 grown previous to 1938.

TABLE 10. Forage yields of sorghum varieties at the Tribune, Kansas, Branch Agricultural Experiment Station, 1927-1941.

VARIETY.	C. I. No.	1931.	1932.	1933.*	1935.	1936.	1937.	1938.	1939.	1940.	1941.	4-yr. av. 1927- 1930.	14-yr. av. 1927- 1941.	10-yr. av. 1931- 1940.	4-yr. av. 1938- 1941.
Finney milo†	1089	1.66	2.31	1.41	0	0	.56	2.40	.98	.90	1.68	2.87	1.67	1.19	1.49
Western Blackhull	906	1.39	1.83	2.94	0	0	1.18	3.54	1.27	2.44	2.97	3.77	2.33	1.76	2.55
Greeley	972	2.07	1.90	1.86	0	0	.84	2.87	2.33	.75	2.66	3.19	2.00	1.53	2.15
Early Sumac	1119	2.51	2.28	2.77	0	0	1.31	3.80	1.49	2.71	4.62	4.65	2.86	2.15	3.16
Leoti Red	1120	2.88	2.20	2.47	0	0	1.38	4.39	1.51	3.45	4.20	5.03	3.04	2.25	3.39
Peterita	182-1	1.88	1.51	1.50	0	0	0	1.31	.....	.....	.....	2.77	.....	.....	.....
Modoc	905	1.89	1.58	1.91	0	0	1.06	2.99	.....	.....	.....	3.40	.....	.....	.....
Early Kalo	1009	.....	.....	1.26	0	0	.75	2.59	1.51	.81	2.65	.....	.....	.....	1.89
Norkan	1116	.....	.....	.....	0	0	.....	3.75	2.05	2.46	4.43	.....	.....	.....	3.17
Freed	350	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.23	.....	.....	.....
Sunrise	472	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.58	.....	.....	.....
Red Amber	F.C.6608	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.21	.....	.....	.....
Black Amber	F.C.7038	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.37	.....	.....	.....
Kansas Orange	107	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.09	.....	.....	.....
Atlas	899	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.58	.....	.....	.....
Pink kafir	432	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.78	.....	.....	.....
Dawn kafir	904	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.73	.....	.....	.....
Dwarf Freed	971	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.11	.....	.....	.....

\* No yields in 1934 because of drouth.

† Dwarf Yellow milo C. I. 332 grown previous to 1938.

shown, the early-maturing Greeley grain sorghum ranked highest in yield followed by Freed, Finney and Feterita. Rainfall was more abundant during this period than for the six-year period 1935-1941 in which Early Kalo, Kalo, Greeley and Western Blackhull are among the highest in yield. Kalo is not commercially grown. Varieties best suited to the Tribune area would probably be Early Kalo, Greeley, Norkan and Colby, depending on the purpose for which intended.

The forage yields for the Tribune station are shown in Table 10. Early Sumac and Leoti Red and Norkan have good adaptation to this region. The choice of any of these three varieties can be depended upon to give good tonnage for the amount of rainfall generally available for the region.

#### VARIETY YIELDS AT COLBY

The Colby Station is located in northwestern Kansas and 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, but since the temperatures are relatively low for a part of this period the need for early maturing sorghums is of great importance. Varieties which can mature in less than 100 days will have the best adaptation to this region.

Both the grain and forage yields are shown in Table 11 for the Colby Station. In the short time four-year averages, Early Kalo followed by Day, Sooner milo, and Colby milo have given the best yields. Atlas has slightly outyielded Early Sumac, Leoti Red and Norkan in forage yields, but it has not matured before frost. The last three varieties have the same tonnage of 2.4 tons to the acre on the basis of field cured weight while that for Atlas is 2.79 tons.

Sooner lodges easily and recently has lost favor with farmers in this region. Colby milo is extensively grown, since it can be cut for grain with a combine. Early Kalo will not always stand sufficiently long to become dry enough to be cut with a combine. Day is well adapted to combine methods of harvesting. Cheyenne, an early maturing tall type, has made a low yield of forage as indicated in Table 11. Coes and Highland are grown in Colorado and have come into northwestern Kansas to a limited extent. Except in the extreme northwest corner Coes and Highland are probably inferior to somewhat later and better adapted varieties in seasons of normal rainfall.

Occasionally a variety with the lateness of Western Blackhull will make a satisfactory grain yield in the Colby territory, but generally the seed is not sufficiently matured that it can be safely stored.

TABLE 11. *Yields of sorghum varieties at the Colby, Kansas, Branch Agricultural Experiment Station, 1937-1941.*

VARIETY.	C. I. No.	1937.	1938.	1939.	1940.	1941.	4-yr. av. 1938-1941.	5-yr. av. 1937-1941.
Yields of grain in bushels (56 lbs.) per acre								
Western Blackhull.....	906	0	16.2	0	12.0	25.5	13.4	10.7
Sooner milo.....	917	7.6	19.4	0	16.1	27.0	15.6	14.0
Colby milo.....	1118	6.7	21.3	0	12.5	18.3	13.0	11.8
Early kalo.....	1009	.....	27.3	0	22.1	29.2	19.7	.....
Day milo.....	959	.....	24.5	0	15.4	22.3	15.6	.....
Coes.....	1104	.....	7.6	0	11.8	29.9	12.3	.....
Highland.....	.....	.....	11.9	0	10.9	27.3	12.5	.....
Yields of cured forage in tons per acre								
Atlas.....	899	1.94	2.21	1.38	3.02	5.42	.....	2.79
Kansas Orange.....	107	1.50	2.67	1.50	3.15	.....	.....	2.21*
Early Sumac.....	1119	1.29	1.96	2.25	2.00	4.67	.....	2.43
Leoti Red.....	1120	1.21	2.25	2.04	2.20	4.60	.....	2.46
Cheyenne.....	1109	.87	1.43	.75	.98	2.25	.....	1.26
Norkan.....	1116	1.94	2.00	1.42	1.96	4.68	.....	2.40

\* Only four-year average—not comparable.

VARIETY YIELDS ON EXPERIMENT FIELDS

Varieties of sorghum have been tested on experiment fields in southeastern, southcentral and southwestern Kansas at points shown in Table 12. From southeastern to southwestern Kansas the rainfall varies from 40 to about 18 inches a year with a corresponding decrease from about 200 to 175 days in the length of the growing season.

A report of the grain yields of the varieties that are of commercial importance or of experimental interest are shown in Table 12. In southeastern Kansas the later maturing varieties have generally made the highest yield. Among these Blackhull and Pink kafir, and Club sorghum represent well adapted types in this area. Darso made high yields but the grain is less palatable than that of other varieties. Of the forage group, Atlas and Kansas Orange have made about the same grain yields but the seed of the former is preferred because of its white color and higher palatability.

At the Wichita, Kingman, and Hutchinson fields in southcentral Kansas, Club sorghum, Pink kafir and Red kafir have been found well adapted and all can be safely grown. The yield for Wheatland has been low partly because of chinch bug damage. Pierce is a hybrid between feterita and kafir selected by Walter Pierce, Hutchinson, Kan. It has made a good record at the Hutchinson field and will be tested at other places.

The Dodge and Meade fields in southwestern Kansas represent an area where the rainfall is more limited and the need for early maturing varieties somewhat greater. In favorable seasons the later

maturing varieties may yield satisfactorily, but during the period 1939 to 1941 the best varieties have been Early Kalo, Colby, Sooner and Wheatland. In southwestern Kansas farmers prefer to combine the crop, partly because machinery is readily available for the work, and also the fall season is usually more favorable for the use of this method of harvesting since there is less likelihood of extended wet weather.

The forage yields of varieties tested on the Experiment Fields are shown in Table 13. In the southeastern and southcentral sections Atlas and Kansas Orange have shown their usual superiority over other varieties, yielding one and one-half to two times as much as the kafirs. The average forage yields of Kansas Orange have been slightly higher than of Atlas, but the later variety is less likely to lodge and has the white palatable grain making it preferable. In the southwestern section the yields of Early Sumac, Leoti Red and Norkan were nearly the same and about midway between the yields of Atlas and the kafirs. Although the yield of Atlas is high in that section, the quality is sometimes inferior because of failure to mature.

#### VARIETY YIELDS IN COOPERATIVE EXPERIMENTS

Sorghum variety tests were made in cooperation with farmers in all parts of Kansas from 1911 to 1941. Numerous varieties were tested during that time and many were discontinued for various reasons.

The relative yields of grain of the better varieties during the eleven year period, 1931 to 1941, are shown in Fig. 9 for different sections of the state. The average yields of some of the newer varieties are shown for periods of two or three years.

In the two eastern sections of Kansas, Standard Blackhull, Club, and Red kafir made the best yields and Western Blackhull averaged only slightly less. In the east southcentral section Red kafir was somewhat superior to the others and Pink was fully equal to Standard Blackhull. Farther west and northwest Standard Blackhull and Red kafir have matured too late and have made lower yields than Western Blackhull and Pink kafir. Club made slightly higher yields than the other varieties in the east sections and has been among the higher yielding varieties in central Kansas.

In the west southcentral section and the east northcentral section Western Blackhull kafir has outyielded all other varieties as shown by the long term averages.

In southwest Kansas the kafirs have been outyielded by milo and derivatives of milo, including Wheatland, Finney, and Colby. Early Kalo in the short time period has outyielded these three varieties in southwest Kansas as well as in the northwest and west northcentral sections. The yield of Greeley was about equal to Wheatland in southwestern Kansas during the three years, 1939 to 1941, and about equal to Early Kalo in northwestern Kansas. Norkan, a forage

TABLE 12. Grain yields of sorghum varieties on the Experiment Fields in Southeastern, Southcentral and Southwestern, Kansas, 1925-1941.

VARIETY.	Southeastern.				Southcentral.				Southwestern.		
	Columbus.	Moran.	Thayer.	Rest.	Wichita.		Kingman.		Hutchinson.	Dodge.	Meade.
	5-yr. av. 1937-41.	9-yr. av. 1932-40.	3-yr. av. 1939-41.	3-yr. av. 1925-27.	4-yr. av. 1938-41.	9-yr. av. 1933-41.	5-yr. av. 1937-41.	10-yr. av. 1932-41.	4-yr. av. 1938-41.	3-yr. av. 1939-41.	3-yr. av. 1939-41.
Pink kafir.....	33.8	21.3	22.6	25.9	44.1	33.3	20.6	17.5	36.6	20.1	9.8
Club kafir.....	38.0	25.1	20.9	.....	47.2	31.6	22.2	17.7	37.6	21.8	10.6
Atlas.....	28.8	24.5	27.0	.....	31.3	23.0	8.7	9.4	31.4	13.9	6.0
Blackhull kafir.....	35.3	27.5	31.4	27.3	39.2	29.7	14.7	14.4	37.2	.....	.....
Kansas Orange.....	29.7	23.3	29.5	13.9	35.8	25.7	5.5	4.9	26.4	.....	.....
Darso.....	36.8	30.0	31.4	.....	43.3	31.5	20.2	18.1	32.5	.....	.....
Hegari.....	32.3	.....	12.3	20.0	.....	.....	.....	.....	.....	.....	.....
Red kafir (Meade).....	.....	22.9	24.2	.....	44.7	31.7	20.0	17.3	38.4	20.5	10.2
Western Blackhull.....	.....	23.0	24.4	.....	36.5	28.8	17.7	20.3	34.3	17.3	8.7
Early Sumac.....	.....	.....	.....	20.1	33.8	22.5	10.7	10.2	25.1	21.4	13.8
Wheatland.....	.....	.....	.....	.....	.....	.....	.....	.....	22.9	28.9	17.3
Pierce.....	.....	.....	.....	.....	.....	.....	.....	.....	49.2	.....	.....
Sooner.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	26.0	22.3
Colby milo.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	26.5	22.4
Early Kalo.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	30.9	19.3
Finney milo.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23.3	15.3
Day.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	24.3	18.8
Leoti Red.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20.4	13.8
Norkan.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16.8
Highland.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18.3
Coes.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18.4
Weskan.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15.1
Sedan Red kafir.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.2

SORGHUMS FOR KANSAS

TABLE 13. Forage yields of sorghum varieties on the Experiment Fields in Southeastern, Southcentral and Southwestern Kansas, 1925-1941.

VARIETY.	Southeastern.				Southcentral.			Southwestern.	
	Columbus.	Moran.	Thayer.	Rest.	Wichita.	Kingman.	Hutchinson.	Dodge.	Meade.
	5-yr. av. 1937-41.	9-yr. av. 1932-40.	3-yr. av. 1939-41.	3-yr. av. 1925-27.	6-yr. av. 1935-40.	6-yr. av. 1934-39.	3-yr. av. 1938-40.	3-yr. av. 1939-41.	3-yr. av. 1939-41.
Pink kafir .....	2.37	3.22	1.70	2.88	2.99	2.16	3.63	2.84	2.10
Club kafir .....	2.47	2.97	1.76	.....	2.79	1.96	3.21	2.22	1.46
Atlas .....	6.92	6.23	5.42	.....	6.80	4.49	6.96	4.36	3.53
Blackhull kafir .....	3.17	3.87	2.86	3.29	3.61	2.91	3.95	.....	.....
Kansas Orange .....	7.14	6.85	5.54	6.19	6.97	4.61	7.43	.....	.....
Darso .....	3.70	3.32	2.62	.....	2.89	1.57	3.07	.....	.....
Hegari .....	2.35	.....	1.26	2.82	.....	.....	.....	.....	.....
Red kafir (Meade) .....	.....	2.92	1.54	.....	3.10	2.31	3.80	2.85	2.20
Western Blackhull .....	.....	3.81	2.08	.....	3.09	2.44	3.75	2.43	1.79
Early Sumac .....	.....	.....	.....	4.28	4.67	3.08	5.38	3.31	3.00
Early Kalo .....	.....	.....	.....	.....	.....	.....	.....	1.93	1.48
Leoti Red .....	.....	.....	.....	.....	.....	.....	.....	3.50	2.82
Norkan .....	.....	.....	.....	.....	.....	.....	.....	.....	2.81
Weskan .....	.....	.....	.....	.....	.....	.....	.....	.....	1.74
Sedan Red kafir .....	.....	.....	.....	.....	.....	.....	.....	.....	1.74

type, has made high yields of grain, exceeding the other varieties in the northcentral and northwestern sections and ranking second only to Early Kalo in the southwest section. Highland and Coes averaged lower in yield than Early Kalo and Greeley in northwest Kansas. Cheyenne in the northwest section ranked lower in yield of grain than Early Kalo, Greeley, and Colby in the long time period. Among these varieties Colby is best suited for harvesting with the combine.

Hegari was outyielded by all of the other grain varieties in the southeast and the east southcentral sections. Atlas produced relatively low yields of grain but it has marked advantage in producing the highest yields of excellent quality forage.

#### VARIETIES OF 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 the growing season, the quality of grain, and the yield are perhaps the major factors in determining the suitability of grain varieties.

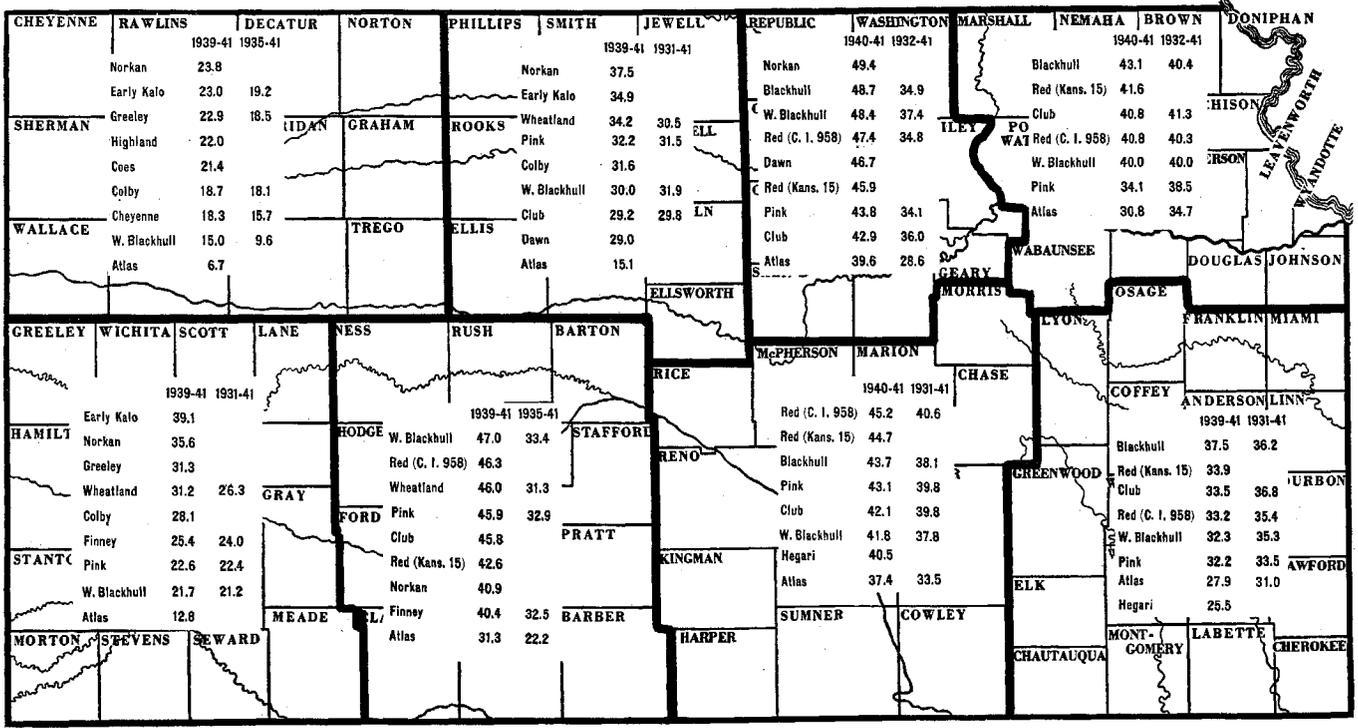
Bitterness is highly undesirable in grain sorghum and therefore only varieties with palatable seed are recommended for grain production.

Ordinarily the higher-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.

In Kansas among the better adapted grain sorghums in successive zones from east to west are Standard Blackhull, Red kafir, Pink kafir, Club, Western Blackhull, Finney milo, Wheatland, Early Kalo, Westland, and Colby, while feterita may be used as a catch crop over a considerable portion of the state. A number of new grain sorghum varieties are under observation, several of which may be distributed in a few years.

Among the better varieties suited primarily for forage are Atlas, Kansas, Orange, Early Sumac, Norkan, and Leoti Red. These are of two classes as to size and length of growing season. The larger, later, and higher-yielding varieties include Atlas, and Kansas Orange, and the smaller, earlier types, Early Sumac, Norkan, and Leoti Red. Standard Sumac and several late maturing types such as Sourless are grown on a limited acreage.

Sunrise is intermediate between the forage and the grain types. Varieties of kafir and several of the other sorghums ordinarily



grown chiefly for grain may make forage of good quality, if the grain yield has been low. The yield per acre of forage is usually considerably lower for the kafirs than for the sorghos.

Detailed statements regarding the adaptation of the different varieties follow.

*Sunrise Kafir.*—Sunrise is best adapted in southcentral Kansas. 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 of maturing. In eastern and central Kansas it is generally inferior to Atlas for forage and to adapted varieties of kafir for grain.

*Standard Blackhull Kafir.*—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 that is somewhat inferior to that of the sorghos, especially Atlas and Kansas Orange, 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.

*Western Blackhull Kafir.*—Western Blackhull is somewhat similar to Standard Blackhull except that it ripens earlier and does not grow as tall. It is well adapted to the western portion of the Pink kafir region and as far west as Rooks, Lane, and Stanton counties. In this region in seasons of normal rainfall it has been one of the highest-yielding dual-purpose grain sorghums now available and is in direct competition with Club. If Western Blackhull fails to make grain the juicy stalks make the fodder of considerable value for forage, as is true for most kafirs.

*Club Sorghum.*—Club is best adapted in eastern and southcentral Kansas and comes in competition with Standard Blackhull and Western Blackhull kafir. Club is better able to develop heads and grain in unfavorable drought periods than are most kafirs and its heavier tillering tendency gives it a greater capacity for high yields under more abundant rainfall.

*Red Kafir.*—Red kafir C. I. No. 958 is adapted to eastern and southcentral Kansas and will ripen as far northwest as will Standard Blackhull. It has a red, mild flavored grain and forage of good quality. A selection, Kansas No. 15, is somewhat more uniform in plant characteristics, is adapted to the same region and has been distributed. Red kafir, C. I. No. 957, and Sedan Red kafir C. I. No. 1103 have been grown experimentally in western Kansas and differ mainly from Red kafir, C. I. No. 958, in earlier maturity, but have not proved superior to other grain sorghums in yield.

*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 de-

velopment. In this central region it is superior to other white-seeded varieties, except perhaps 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.

*Early Kalo.*—Early Kalo has the high yielding characteristics of its two parents, Pink kafir and Dwarf Yellow milo, but is much earlier in maturity and has shorter stalks than either parent. Its best adaptation is in the western part of the state where chinch bugs are not a factor. It responds particularly well to irrigation and because of its early maturity is suited for planting in seasons of low rainfall. The best results with Early Kalo are obtained by planting it relatively late, the best date at Hays being June 15. The stalks of Early Kalo are slender and if the grain yield is low, the fodder has considerable feeding value. It is an excellent variety to harvest with a binder, or top with a header. The bundles can be threshed in the same manner as bound wheat, or be put through a hammer mill.

*Finney Milo.*—Finney milo, because of its resistance to the Pythium disease, is rapidly replacing the older Dwarf Yellow milo in southwestern Kansas. It is about equal in yield to any of the white-seeded grain sorghums in the western half of the state except north of a line from Graham to Greeley counties where the growing season is too short for it to mature. Finney milo is not adapted in the east half of Kansas because of its susceptibility to chinch-bug injury. The crop is sometimes difficult to harvest particularly under irrigation because the heads have a decided tendency to “goose-neck” or become pendent. Its forage is of less value than the kafirs. Finney milo or other strains of Dwarf Yellow milo resistant to Pythium respond 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, southcentral 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, ordinarily it does not grow tall enough to be harvested successfully with the row binder.

*Westland.*—Westland has some of the characteristics of Wheatland but is earlier and less inclined to tiller and so may not compete with the latter variety in favorable seasons when the Pythium disease is not a factor. The chief advantage of Westland over Wheatland is its resistance to the Pythium milo disease. Westland was

therefore distributed to be grown particularly in the Arkansas Valley where the prevalence of the disease in the soil is quite common. Westland will often produce a crop on disease infected soil in this region where Wheatland may be a failure. Westland is yet a new variety and its state-wide adaptation has not yet been fully determined. Its recommendation is therefore confined to the irrigation region or where trouble may be expected from Pythium.

*Colby Milo.* — Colby milo is noted for its dwarfness and earliness. It is best adapted in northwestern Kansas where chinch bugs and Pythium milo disease are less likely to occur. The variety can be readily and cheaply harvested with a combine if the season has not been too severe to cause injury from a disease known as Weak neck which is often responsible for broken heads. Best results are obtained from Colby milo when planted relatively late and yet in time to permit the crop to ripen normally. About June 15 is usually early enough to plant Colby. When properly handled and with a fairly normal season Colby will produce a cheap source of grain either for the market or for farm feed.

*Standard Feterita.* — Standard Feterita, chiefly because of its early maturity, 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 seedbed.

*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. 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.

*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 lodge and its less palatable seed, it is not as desirable as Atlas. It may be expected to produce about the same yields of forage and may withstand adverse seasons somewhat better than Atlas.

*Standard Sumac.* — standard Sumac is similar to Kansas Orange in its adaptation and uses. The seed is 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.

*Norkan.*—Norkan has the same general adaptation as Early Sumac and will mature farther north and in regions of shorter season than will Atlas. The forage of Norkan is not quite equal to that of Early Sumac in sweetness and palatability but the seed is similar to that of Atlas. The tonnage of Norkan and Early Sumac are about the same but less than of Atlas.

*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 the bacterial leaf diseases, but shatters easily. Leoti Red is one of the sweetest forage sorghums but sometimes the outside hull of the stalks tends to be somewhat hard. For this reason Leoti Red is not always consistently as high in palatability as is Early Sumac.

#### VARIETIES OF SORGHUM 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, and when the crop has not been retarded by adverse growing conditions. 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 for Kansas. Kansas Orange is probably the best variety for sirup in eastern, southeastern, and southcentral Kansas, if planted at the normal time. Atlas has also been used with good success. 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.<sup>6</sup>

6. Cogwill, H. B. Sorgho for sirup production: Culture, harvesting, and handling. U. S. Dept. Agr. Farmers' Bul. 1619; 38 pp. 1930.  
Walton, C. F., Ventre, E. K., and Byall, S. Farm production of Sorgho Sirup. U. S. Dept. Agr. Farmers' Bul. 1791, 44 pp. 1938.

### 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 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-pollination of individual plants is also used to maintain the purity of a variety and to fix and stabilize new types. 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 8 to 12 years.



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