AGRICULTURAL EXPERIMENT STATION

KANSAS STATE AGRICULTURAL COLLEGE
MANHATTAN, KANSAS

FORAGE CROPS IN WESTERN KANSAS

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SUMMARY

The following statements, unless otherwise modified, apply to upland conditions in the western half of Kansas. They are based chiefly on the results secured at the Fort Hays Branch Experiment Station, Hays, Kan.

Sorghums are the most productive forage crops, particularly in dry seasons. Corn produced only 44 percent as much cured fodder as did Red Amber sorgo in a six-year test. German millet yielded 61 percent, and Sudan grass 76 percent as much hay as did Red Amber.

The sweet sorghums (sorgos) give the heaviest forage yields. Red Amber has proved to be the best variety. Sumac and Orange, which mature about a month later, are valuable south and east of Hays. Western Orange and improved Black Amber are well adapted to western Kansas, but are rarely equal to Red Amber, except in seed yield.

Kafir should be planted if one wants both grain and forage. Pink, Sunrise, and Dawn are the best varieties. Feterita, milo, and Freed are better adapted to planting for grain alone, especially under adverse conditions.

Sorghum varieties widely advertised under high-sounding names have generally proved undesirable.

It pays to hand-select sorghum seed before frost.

The best time to plant sorghums for grain and forage is usually between May 15 and June 15, but early varieties may be planted for forage up to July 1.

Varying the rates of seeding has affected the forage yields but little, when the land has been well occupied. Close-drilling sorgo at the rate of 30 to 40 pounds to the acre for hay is a good practice in favorable seasons. Spacing sorghum plants 4 to 8 inches apart in the row for forage, and 8 to 12 inches apart in the row for grain, in row 3 to 3½ feet apart, gives good results.

Sudan grass is valuable for hay and pasture, and should replace much of the millet now grown. It is an uncertain seed crop, although profitable yields of seed are sometimes obtained. The best time to sow Sudan grass is between May 15 and June 15, but good yields have been obtained at Hays when planted as early as May 1 and as late as July 15. For hay

Sudan grass should be sown at the rate of 15 to 20 pounds to the acre in close drills, or 3 to 4 pounds per acre in rows 3 to 3½ feet apart. If for seed, it should be sown in rows. Sudan grass hay should be cut between the first-head and the full-bloom stage.

Millet is declining in importance, but has some use as a quick-maturing catch crop for hay. German or Golden millet yields the most hay, but such earlier varieties as Kursk, Siberian, Common, Hungarian, and Goldmine withstand drouth better.

No grass has been found that gives good results when sown for permanent hay or pasture. Brome grass, at one time considered promising, is not suitable for sowing on land too dry for alfalfa.

Alfalfa is the most desirable forage crop to grow on irrigated land or on bottom land not irrigated. It is rarely profitable on dry uplands where the annual rainfall is 25 inches or less. Common alfalfa should be planted in preference to other varieties.

Alfalfa requires a firm clean seedbed well supplied with surface and subsoil moisture. The best seeding time is from April 15 to May 15. The best rate of seeding is 10 to 15 pounds to the acre. A drill should be used for seeding.

Biennial white sweet clover can be profitably used for pasture on bottom lands too sandy or too close to ground water for alfalfa to thrive. It is not recommended for upland conditions, The directions for getting a stand of alfalfa apply to sweet clover. The two crops are similar in yield and composition.

None of the annual legume crops has given results at Hays that warrant its general planting. Those tested include field peas, cowpeas, soybeans, Tepary beans, Pinto beans, vetch, chick peas, and Spanish peanuts.

Sunflowers, sugar beets, mangel-wurzels, turnips, rape, Tunis grass, Johnson grass, and sainfoin have been found less profitable than other plants that meet the same needs.

Russian thistles may be used as an emergency hay crop.

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FORAGE CROPS IN WESTERN KANSAS[1]

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INTRODUCTION

The purpose of this bulletin is to point out the value of different forage crops and methods of growing them as shown by experiments conducted at the Fort Hays Branch Experiment Station, Hays, Kan., mostly from 1913 to 1919 inclusive. A rather full discussion of the methods followed in the experiments, and of the soil, climate, and other factors affecting crop production is given, since a clear understanding of these facts is necessary in order correctly to apply experimental data to farm practices. Allowances must, for example, be made for extreme climatic variations, and for such differences as normally exist between crop-growing conditions at Hays and elsewhere in western Kansas.

The importance of forage crops as a whole and of the different forage crops west of the 98th meridian, and in the entire state, is indicated by Table I. Approximately six million acres are devoted to forage crops (including prairie hay) in the state, and more than two and a quarter million acres of forage are grown west of the 98th meridian. In each case somewhat more than one-fourth of the total area of all crops is grown for forage. In western Kansas alfalfa and the sorghums are the principal forage crops. Timothy, redtop, Kentucky bluegrass, red clover, white clover, and other cornbelt forage crops generally do not succeed in western Kansas because of drouth and pests as later described.

ACKNOWLEDGMENT.—Credit is due the Kansas State Board of Agriculture for statistics of crop acreages, the United States Weather Bureau for climatic data, the Seed Laboratory, United States Department of Agriculture, for seed germination tests, and the Bureau of Chemistry, United States Department of Agriculture, for analyses of hay.

[1] The forage crop experiments at the Fort Hays Branch Experiment Station, Hays, Kan., since April 1, 1913, have been conducted under a cooperative agreement between the Bureau of Plant Industry, United States Department of Agriculture, and the Kansas Agricultural Experiment Station. The work was outlined and supervised by crop specialists of the Office of Forage Crop Investigations, Bureau of Plant Industry, with the concurrence of the Director and the Agronomist of the Kansas Agricultural Experiment Station and the Superintendent of the Fort Hays Branch Experiment Station. The experiments were under the author's immediate direction.

TABLE I.—ACREAGE OF FORAGE CROPS IN 46 WESTERN KANSAS COUNTIES AND IN THE ENTIRE STATE

(Average acreages for 1917 and 1918, based on data from the Kansas State Board of Agriculture, Twenty-first Biennial Report)

CROP	Acreage, 46 western counties	Acreage for entire state	Percent of state acreage in 46 western counties
Sweet sorghum	619,702	834,033	74.3
Milo	369,634	397,735	92.9
Kafir	724,458	1,393,770	52.0
Feterita	171,516	217,129	79.0
Jerusalem corn	1,345	2,193	61.3
Sudan grass	29,176	52,949	55.1
Millet	60,299	104,485	57.7
Alfalfa	210,202	1,179,624	17.8
Cowpeas	197	2,669	7.4
Timothy	44	228,478	.019
Clover	93	124,862	.075
Bluegrass	7	313,321	.002
Sweet clover	2,638	23,928	11.0
Orchard grass	102	2,640	3.9
Other tame grasses	362	52,962	6.8
Prairie hay	151,194	1,068,479	14.2
Total, forage crops	2,340,969	5,999,257	39.0
Total, all crops	8,633,278	22,251,257	38.8
Total land area	25,610,240	52,335,360	48.9

SOIL

Nearly all the experiments reported herein have been conducted on fertile upland, typical of a large part of western Kansas. Where bottom land was used the fact is mentioned. The upland is classed as a silty clay loam of the Summit series. The bottom land is a deep loam classed in the Lincoln series.

RAINFALL

Precipitation records have been kept at Hays, Kan., since 1868. Such of these data as relate to the experiments reported herein are summarized in Table II.

The rainfall is irregular in amount and seasonal distribution. The lowest annual precipitation recorded is 11.8 inches in 1894, and the highest is 35.4 inches in 1878. The normal annual precipitation in western Kansas decreases steadily from 27 inches at Salina to 16 inches at the Kansas-Colorado line. These irregularities of rainfall at different times and places make it necessary to know how crops behave under extreme as well as under average conditions. Such information may be obtained from this bulletin if in studying annual yields one has in mind the nature of each season from 1913 to 1919, the years during which nearly all the experiments were conducted.

TABLE II.—PRECIPITATION AT HAYS, 1902 TO 1919, WITH AVERAGES FOR 18 AND FOR 52 YEARS

(Compiled from records of the United States Weather Bureau)

YEAR	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1902	1.00	0.55	3.80	0.26	4.28	6.44	3.84	5.64	4.93	2.56	T	1.35	34.65
1903	.15	4.20	1.03	2.01	10.08	4.40	2.72	4.55	.55	1.95	0.88	T	32.52
1904(*a*)	.10	.06	.28	.88	4.22	2.90	2.75	2.90	.95	1.75	.06	.60	17.45
1905	.65	.54	.73	2.54	3.71	4.94	3.98	.86	1.61	1.43	2.74	T	23.73
1906	.15	.37	.73	1.67	1.51	2.29	5.79	2.87	3.39	2.94	.86	.51	23.08
1907	.64	.22	.85	.60	.83	4.97	9.15	3.12	1.75	1.40	.11	1.76	25.40
1908	T	.92	T	2.18	3.06	6.02	2.90	5.86	.81	1.76	1.79	.03	25.33
1909	.39	.28	1.16	.47	1.60	10.21	3.71	1.48	2.78	1.64	3.55	1.00	28.27
1910	.58	.26	.03	.91	3.53	2.71	2.45	3.92	1.28	.36	T	.14	16.17
1911	.12	2.12	.14	.82	2.27	.81	2.09	4.47	2.05	.30	.14	1.82	17.15
1912	.02	1.98	1.60	1.66	2.70	4.32	.88	3.52	1.85	.51	1.13	.03	20.20
1913	.36	.68	.41	2.78	5.72	3.53	.63	.11	4.80	.25	.72	3.11	23.10
1914	.04	.42	.15	2.31	2.36	3.39	2.77	2.63	.60	1.33	T	.63	16.63
1915	.68	1.80	1.74	3.13	6.82	3.97	8.18	4.11	2.44	.93	.30	.04	34.14
1916	.53	.15	.31	2.21	1.63	5.88	.30	1.97	1.26	1.14	.02	.61	16.01
1917	.11	T	.07	1.96	1.72	2.15	1.46	5.73	1.84	.09	1.64	.15	16.92
1918	.80	1.15	1.71	2.49	4.79	.53	3.04	1.76	1.42	2.41	1.1	2.3	23.58
1919	T	2.18	.33	4.51	6.85	3.51	1.16	.77	3.32	1.81	1.54	.15	26.13
Av., 1902-1919	0.35	0.99	0.84	1.86	3.76	4.05	3.21	3.13	2.09	1.36	0.92	0.80	23.36
Av., 1868-1919	.55	.88	.98	2.29	3.37	3.22	3.29	2.98	2.35	1.44	.76	.85	22.96

(*a*) May to December inclusive, interpolated.

The growing season of 1913 was unusually unfavorable because of continuous drouth and grasshopper injury from June 15 to September 15. Growing conditions in 1914 were much better because a low, but effectively distributed rainfall was supplemented by reserve moisture stored during the previous fall. Extraordinary yields were obtained in 1915, an unusually wet season. In 1916, reserve moisture from 1915 gave the crops a good start, but drouth and grasshoppers reduced the yield very materially. In 1917, severe drouth from late June until August 5 checked all crop growth; but after heavy August rains most annual crops revived and grew vigorously until frost. Forage crop growth in 1918 was about normal. The season was characterized by rains late in May, timely showers in July, and severe drouth after August 1. In 1919, there was excessive rainfall up to June 15 and the soil retained sufficient moisture to produce an exceptional sorghum crop in spite of three months of summer drouth.

LENGTH OF GROWING SEASON

The adaptation of annual forage crops, particularly the sorghums, to different localities in western Kansas, depends much on the length of the growing season. The date of the first killing frost in the fall is especially important. Frost data for Hays are shown in Table III.

TABLE III.—FROST DATA FOR HAYS, 1902 TO 1919

(Compiled from records of the United States Weather Bureau)

YEAR	Date of last killing frost in spring	Date of first killing frost in fall	Frost-free period, days
1902	Apr. 17	Oct. 28	194
1903	May 1	Sept. 17	139
1904	May 14	Oct. 25	164
1905	.....	.....	.....
1906	Apr. 14	Oct. 10	179
1907	May 27	Nov. 2	159
1908	May 8	Sept. 28	143
1909	May 1	Oct. 12	164
1910	Apr. 26	Oct. 21	178
1911	May 2	Oct. 9	160
1912	May 16	Sept. 26	133
1913	Apr. 12	Oct. 17	188
1914	May 13	Oct. 25	165
1915	Apr. 3	Oct. 5	185
1916	May 3	Sept. 29	149
1917	May 8	Oct. 8	153
1918	May 1	Sept. 20	142
1919	Apr. 17	Oct. 10	176
Average	Apr. 30	Oct. 10	163

The normal frost-free period in western Kansas becomes less by about one day for each six or seven miles one goes north, and about one day for each 100 feet increase in altitude. The normal growing season thus decreases from 190 days in Barber County to 150 days in Cheyenne County. The first killing frost in the fall may be expected in Barber County, October 20, and in Cheyenne County, October 1. Large departures from the normal occur, however, as is illustrated by the Hays records, in which the extreme dates for the last killing frost in the spring are April 3 and May 27, and for the first killing frost in the fall are September 17 and November 2. The length of the frost-free period at the Fort Hays station has varied from 133 days in 1912 to 194 days in 1902.

INSECT DAMAGE

Forage crops for western Kansas must often be chosen with reference to insect pests, especially grasshoppers and chinch bugs.

Corn, Sudan grass, annual legumes, and alfalfa are much relished by grasshoppers, the most common and destructive pest.[1] Milo, millet, and sweet clover are second choices, while sweet sorghum, kafir, and feterita are eaten by grasshoppers only when other food is scarce.

Corn, milo, Sudan grass, and millet are the forage crops most commonly attacked by chinch bugs at the Fort Hays station. This pest works but little on the sorghums other than milo and does not attack the legumes. Chinch bugs are not often troublesome in the western third of Kansas.

Pests of less importance are the three-lined blister beetle and the green bug. The former is often found in alfalfa and is sometimes quite injurious. In 1916 the green bug infested spring grains, corn, Sudan grass, and all sorghums; many plants turned yellow and died before dashing rain washed the bugs away.

RODENT AND BIRD DAMAGE

Rabbits, numerous over western Kansas, have never failed to destroy part or all of the soybeans on the station unless fenced out. In the drier years rabbits pasture wheat, alfalfa, or any other green crops quite injuriously in some localities.

Pocket gophers are frequently troublesome in alfalfa fields.

[1] For information on grasshopper control see bulletin 215 of the Agricultural Experiment Station, Manhattan, Kan., "Methods of Controlling Grasshoppers."

They burrow through the ground, living on the alfalfa roots and throwing up mounds of loose dirt. They are fairly easy to poison by inserting into their burrows, raisins or small pieces of potato containing particles of strychnine.[1]

Ground squirrels often steal newly planted seeds of corn and the sorghums, but may be disposed of by scattering poisoned grain here and there in the infested field.

Blackbirds, sparrows, and other birds sometimes eat more or less seed off the ripening grain sorghums. Scaring the birds once or twice a day with a shot gun keeps many of them away and is more effective than any other plan tried at this station.

EXPERIMENTAL METHODS

Previous to 1913 much of the forage crop information of the Fort Hays Branch Experiment Station was based on large fields for which specific data are not available. Several tests with alfalfa and other forage crops were conducted on one-acre plots, but it was not until 1913 that a definite project for experimental work with forage crops was organized. Since that time this project has occupied annually about 400 plots, mostly one-tenth or one-twentieth of an acre in size. The annual crops have usually followed wheat or spring grains. Forage yields for 1914and later years are on an air-dry basis.[2]

EXPLANATION OF TERMS

Forage yields in this bulletin are air-dry weights for the entire crop including seed, if any. *Hay* refers only to the finer-stemmed kinds of dry forage; *fodder* to the coarser kinds such as sorghum; and *stover* to fodder with the grain removed. *Sorghum* includes all the non-saccharine as well as the sweet varieties of the sorghum family except Sudan grass, which is excluded only for convenience in discussion. *Sorgo* refers to any variety of sweet sorghum, thus avoiding the term *cane,* which, strictly speaking, should apply only to sugar-cane. *Kafir* and *milo* are used instead of the common but less desirable terms *kafir corn* and *milo maize.*

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[1] The Department of Zoology of the Kansas Agricultural Experiment Station, Manhattan, Kan., prepares poison baits which are easily used, cheap, and effective. They may be used for the extermination of pocket gophers, ground squirrels, prairie dogs, or other rodents. Full information may be obtained from the department on request.

[2] Actual weights of field-cured forage are corrected by deducting the percent that sack samples taken at weighing time lose when hung in a shed until the samples cease to lose weight. It has been found that the percent of moisture in air-dry samples of any given crop is practically uniform. Correction of yields to an air-dry basis, therefore, removes the experimental error resulting from unequal moisture content in different lots of field-cured forage.

SORGHUMS

The sorghums are more productive than any other forage crop yet tested at the Fort Hays Experiment Station; they are also the least likely to fail completely. The best varieties have yielded from one to six tons of hay or fodder, or from three to eighteen tons of silage to the acre, depending on the season. Grain yields have ranged from entire failures up to 65 bushels to the acre.

The acreage of sorghum in western Kansas (Table I) has increased steadily during the past 30 years except following seasons of abnormally high rainfall in which farmers have realized large profits from wheat and corn. The sorghum acreage should be increased still more, particularly for silage.

SORGHUMS VERSUS CORN

A variety of corn adapted to local conditions has been planted each year from 1914 to 1919 inclusive, in the same field with the sorghum varieties. Albright White Dent was used in 1914, Minnesota No. 13 in 1915, 1916, and 1917, and Bloody Butcher in 1918 and 1919. The corn came up uniformly and grew rapidly early in the season, but later it always suffered more from grasshoppers and hot winds than did any of the sorghums. It may be noted that the average forage yield of corn was only one-third to two-fifths as much as that of the best sorghums, and that corn produced a fair grain crop in only two of the six years. The yields of corn and three of the best sorghum varieties are shown in Table IV. The yields of the corn may also be compared with those of all the sorghums in Tables V to VIII.

TABLE IV.—YIELDS PER ACRE OF CORN AND THREE OF THE BEST SORGHUM VARIETIES, 1914 TO 1919

	1914	1915	1916	1917	1918	1919	Average
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
FORAGE							
Corn	1.11	2.62	1.18	0.44	0.98	2.76	1.52
Feterita	2.45	3.47	1.17	1.44	2.18	2.17	2.15
Pink kafir	3.61	5.43	1.53	2.74	1.92	1.47	2.78
Red Amber	2.93	5.72	2.52	2.94	3.13	3.45	3.45
	Bus.	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*
GRAIN (*a*)							
Corn	2.8	43.8	0	0	0	17.4	10.7
Feterita	25.7	23.8	6.8	7.3	11.4	34.7	18.3
Pink kafir	8.8	47.1	0	0	.5	23.4	13.3
Red Amber	17.2	30.1	3.4	19.6	7.9	33.2	18.6

(*a*) Red Amber 50 pounds per bushel; others 56 pounds.

Corn does not, on the average, equal the best adapted sorghums as a forage crop anywhere in western Kansas. Farther north and west, where the seasons are shorter and the hot winds less severe, corn does, however, sometimes compete favorably as a cash grain crop. The chief argument for growing any corn in most of western Kansas is that wheat succeeds better after corn than after sorghums. Farming would, nevertheless, be much safer and more profitable in this region if the better sorghums were to replace at least half of the corn now planted, except possibly in the extreme northwestern counties.

THE KIND OF SORGHUM TO GROW

The main factors that should determine what varieties of sorghum to grow are: (1) The use to be made of the crop and (2) local conditions such as rainfall, frost-free period, and insect pests. If silage or cured fodder only is wanted, the heaviest yielding sorgo (sweet sorghum) that will mature or nearly ripen in the locality should be planted. This is because the sorgos produce more forage than do any of the non-saccharine varieties, and in quality excel all but the kafirs. If forage is important, but grain is also an object, some variety of kafir should be planted, provided the season is long enough to permit at least the earlier kafirs to mature. Kafir stover and fodder are equal to that of the sorgos in feeding value, and are superior to most of the other non-saccharine sorghums both in quality and yield. Kafir makes a heavy grain yield with favorable conditions. If grain is the main object and forage production is secondary, one should usually choose one of the milos, feterita, or Freed sorgo. These crops are more dependable for grain than are the kafirs. The feeding quality of the grain of the non-saccharine sorghums is usually rated at about nine-tenths that of corn.

In studying experimental results it must be borne in mind that the highest-yielding variety is not necessarily the best, because there is such a wide difference in quality of forage and grain and in the length of season needed to mature. The sorgos and the kafirs, for example, have leafy juicy stalks that are more valuable than the less leafy drier ones of milo and feterita. On the other hand, because of tannin in the seed and seedcoat, sorgo grain is poor feed; only half to two-thirds as valuable for any purpose as is the grain of the non-saccharine varieties.

The heaviest forage producers are usually the latest-maturing. Lighter-yielding early varieties are therefore more useful where the growing season is short.

During the period 1913 to 1919, more than 100 varieties or lots of sorghum were grown one or more years in the forage-crop tests at the Fort Hays station. These tests show strikingly the advantages of planting only well-adapted pure improved varieties. Varieties extravagantly advertised under high-sounding names nearly always were found of medium or inferior value.

SORGOS OR SWEET SORGHUMS

The fodder yields of all important sorgos that were tested for several years during the period from 1913 to 1919, are given in Table V, and the seed yields from the same plots follow in Table VI. The varieties are named in the order of their earliness.

TABLE V.—FORAGE YIELDS PER ACRE OF SORGOS, 1913 TO 1919

	1913	1914	1915	1916	1917	1918	1919	Averages	
								1914-1919	1915-1918
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Dakota Amber	.....	.....	4.25	1.77	1.04	1.74	2.43	.....	2.20
Early Amber	.....	.....	5.15	2.00	2.34	2.81	2.64	.....	3.08
Black Amber	0.61	2.51	4.88	2.18	2.87	2.44	3.28	3.03	3.09
Red Amber	1.04	2.93	5.72	2.52	2.94	3.13	3.45	3.45	3.58
Western Orange	.84	2.90	5.30	1.61	2.34	2.46	3.04	2.94	2.93
Black Dwarf	.83	3.02	5.05	2.47	1.92	.....	.....	.....	(a)3.15
McLean	.79	.....	5.45	2.90	2.57	2.79	.....	.....	3.43
Colman	.84	.....	5.60	2.45	2.93	3.27	.....	.....	3.56
Orange	.....	3.83	4.97	2.94	3.86	2.61	2.57	3.46	3.60
Sumac	.51	3.31	5.43	3.13	3.14	3.01	5.09	3.85	3.68
Collier	.....	.....	5.77	2.60	2.78	2.45	.....	.....	3.40

(a) 1915-1917.

TABLE VI.—SEED YIELDS PER ACRE AND AVERAGE LENGTH OF GROWING SEASON OF SORGOS, 1913 TO 1919

	1913	1914	1915	1916	1917	1918	1919	Average, 1914-1919	Average, 1915-1918	Average growing season
	Bus.	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Days*
Dakota Amber	.....	.....	41.7	20.8	11.4	21.3	37.5	.....	23.8	85
Early Amber	.....	.....	16.5	4.4	11.2	12.1	31.5	.....	11.1	90
Black Amber	3.6	32.2	40.5	8.0	22.2	6.2	35.5	24.1	19.2	90
Red Amber	0	17.2	30.1	3.4	19.6	7.9	33.2	18.6	15.3	95
Western Orange	0	35.2	43.1	5.8	15.6	8.2	32.3	23.4	18.2	95
Black Dwarf	0	25.6	27.6	5.4	10.8	.....	.....	.....	(a)14.6	95
McLean	0	.....	7.1	0	1.2	5.6	.....	.....	3.5	120
Colman	0	.....	9.0	0	.6	4.4	.....	.....	3.5	120
Orange	.....	4.4	7.5	0	1.2	0	21.0	5.7	2.2	120
Sumac	0	.2	.9	0	1.0	0	57.6	10.0	.5	120
Collier	.....	.....	4.8	0	0	0	.....	.....	1.2	125

(a) 1915-1917.

Red Amber (fig. 1) is considered the most useful of these varieties for western Kansas, for it combines the qualities of high forage yield, dependable seed production, early maturity, and high feeding value either as fodder or silage. From 100 to 200 acres of this variety are grown for feed at the Fort Hays station each year. Wherever this variety has been tested in western Kansas farmers have began to adopt it in place of the Black Amber and the mixed varieties so commonly grown.

FIG. 1.—Red Amber sorgo at the Fort Hays Branch Experiment Station, 1919. This variety is especially valuable for forage purposes in western Kansas

Well-selected strains of Black Amber are similar to Red Amber and rank close to it in value, but the Black Amber as commonly grown is quite inferior.

Western Orange sorghum was recommended and distributed to some extent several years ago, but Red Amber has since become more popular. Western Orange is slightly coarser and less leafy, but stands up better against wind and produces more seed. Black Dwarf is very similar to Western Orange.

Orange, Sumac, McLean, Colman, and Collier are all good forage sorghums, but mature too late for general use in western Kansas. Some farmers are growing Orange and Sumac, buying seed from the South or East. In a few cases, earlier but lighter-yielding strains have been developed locally,

Other sorgos not considered worthy of general adoption were grown one or more years under the following names: Chinese sorgo, Coles Evergreen, Dwarf Ashbourne, Early Amber, Early Iantar, Folger, Ford sorgo, Kansarita, Kansas Straightneck, Lightning cane, Red Orange, Red X, Sourless, Texas Ribbon, White African, and Whooper.

GRAIN SORGHUMS

Yields of the principal non-saccharine sorghums that have been tested are shown in Tables VII and VIII.

TABLE VII.—FORAGE YIELDS PER ACRE OF NON-SACCHARINE SORGHUMS, 1913 TO 1919

	1913	1914	1915	1916	1917	1918	1919	Av., 1914-1919
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Pink kafir	.....	3.61	5.43	1.53	2.74	1.92	1.47	2.78
Dawn kafir (*a*)	.....	3.17	3.42	1.04	2.90	1.78	2.57	2.48
Sunrise kafir (*b*)	.....	3.60	4.04	1.35	1.95	2.49	2.18	2.60
Dwarf white kafir	.....	2.49	3.00	1.79	2.62	1.95	1.22	2.18
Red kafir	.....	2.93	4.02	1.21	2.60	2.04	2.03	2.47
Schrock kafir	.....	2.25	3.45	1.41	2.33	1.98	2.36	2.30
Dwarf hegari	0.66	3.14	3.53	1.90	(*c*)	2.16	2.44	2.63
Feterita	.98	2.45	3.47	1.17	1.44	2.18	2.17	2.15
Dwarf yellow milo	0	2.44	4.88	1.32	.66	2.11	2.74	2.36
White milo	.....	2.51	4.33	1.26	.26	2.01	2.40	2.13
Freed	.42	2.34	3.50	1.15	.86	1.56	1.96	1.90

(*a*) Formerly known as Dwarf Blackhull kafir.
(*b*) Formerly known as Early Blackhull kafir.
(*c*) Failed to germinate; average does not include 1917.

TABLE VIII.—GRAIN YIELDS PER ACRE OF NON-SACCHARINE SORGHUMS AND AVERAGE LENGTH OF GROWING SEASON, 1913 TO 1919

	1913	1914	1915	1916	1917	1918	1919	Average, 1914-1919	Average growing season
	Bus.	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Days*
Pink kafir	.....	8.8	47.1	0	0	0.5	23.4	13.3	115
Dawn kafir	.....	30.6	24.7	2.7	1.3	4.6	34.1	16.3	105
Sunrise kafir	.....	26.7	0	0	.6	6.8	24.1	9.7	115
Dwarf white kafir	.....	22.5	28.3	0	.4	1.9	16.8	11.7	110
Red kafir	.....	7.4	0	0	0	5.6	27.6	6.8	120
Schrock kafir	.....	7.5	8.5	4.8	.5	3.4	34.6	9.9	120
Dwarf hegari	0	11.2	40.7	0	.....	4.9	27.8	16.9	100
Feterita	0	25.7	23.8	6.8	7.3	11.4	34.7	18.3	95
Dwarf yellow milo	0	14.2	40.9	2.0	2.1	1.3	41.3	17.0	105
White milo	.....	31.9	42.1	5.0	3.9	17.9	37.0	23.0	90
Freed	2.0	25.4	28.7	7.7	4.6	9.7	22.1	16.4	85

Among the general purpose sorghums pink kafir (fig. 2) is the best for forage, but for grain it is not as dependable in unfavorable seasons as are feterita and milo. This variety was developed at the Fort Hays station and grown there from 1907 to 1914 under the name of Whitehull kafir. It is now properly called Pink kafir because of considerable pink color in its seeds and glumes. Records show that Pink kafir was a promising grain crop on the station's commercial fields from

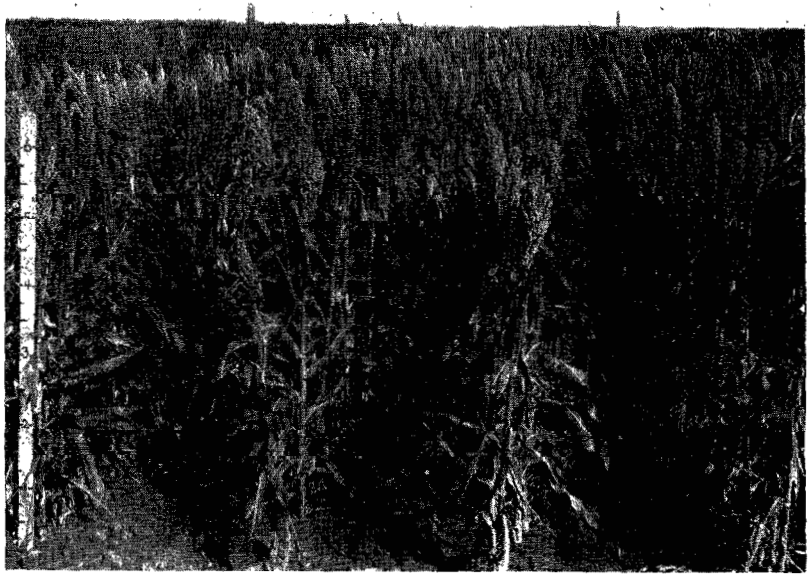

FIG. 2.—Pink kafir at the Fort Hays station in 1915. This variety is one of the best sorghums for both grain and forage in west central Kansas

1908 to 1915 inclusive, except in the severe seasons of 1911 and 1913. Considerable Pink kafir has been distributed. Because the crop is only medium-early maturing and requires favorable conditions to produce good grain yields, Pink kafir is not well adapted for growing north of Hays, nor more than one or two counties west, except for forage. It is best adapted to a district in Kansas lying south and east of Hays, where a slightly earlier and hardier variety than Standard Blackhull is needed.

Dawn (Dwarf Blackhull) kafir shows only medium forage value, but it ranks high as a dependable early grain crop. It is considerably dwarfer and somewhat earlier than Pink kafir and therefore adapted to less favorable conditions. Dawn kafir is adapted to the western third of Kansas as a general purpose grain and forage crop, but its value for grain production is chiefly from Scott City southward, in which area it is a close second to Dwarf Yellow milo.

Sunrise (Early Blackhull) kafir is about two feet taller and is slightly later and leafier than Dawn. It may be profitably grown wherever Dawn and Pink kafirs do well. The exact value of Sunrise kafir for Kansas conditions is not fully determined, but it seems to rival Pink kafir in both forage and grain value.

Dwarf White kafir is well adapted to western Kansas, but not sufficiently productive to warrant planting it in preference to the varieties already named.

Red kafir has not matured early enough nor yielded enough grain in these tests to warrant recommending it for western Kansas. One lot, however, obtained in the spring of 1918 from Bazine, Kan., appears to be as early as Pink kafir and possibly more drouth-resistant.

Schrock kafir, a dwarf and quite leafy variety of good forage quality, has proved only medium in yield. It cannot be recommended in preference to other varieties, because it is too late-maturing to make satisfactory grain yields, and the grain is bitter like that of the sweet sorghums.

Dwarf hegari has the appearance of a dwarf kafir of good forage quality. It is about intermediate between Pink kafir and feterita in form and color of heads, individual grains, and season of maturity. Dwarf hegari is a promising grain crop in some seasons, but in other years it heads so poorly and shows so much variability that the results, as a whole, do not justify planting it, except experimentally.

Feterita (fig. 3), though comparatively poor for forage, has earned a distinct place as a grain crop in western Kansas. It is particularly useful as insurance against entire failure in dry seasons, as is shown by the grain yields obtained in 1916, 1917, and 1918. Because of its early maturity, feterita is not only especially valuable west of Hays, but is also useful for late planting farther east. It makes good silage if cut and

stored promptly at maturity. The chief limitation to feterita culture consists in the difficulty that farmers have in getting good stands. This can be overcome, for good stands have been obtained in the experiments at this station every year by planting high-testing seed on well-prepared land.

Dwarf Yellow milo is much like feterita as to its forage value, it being useful but not first-class. Plots of this milo at the Fort Hays station were destroyed by chinch bugs in 1910,

FIG. 3.—Feterita at the Fort Hays station in 1915. Feterita, milo, and Freed sorghum are the most certain sorghums for grain in western Kansas, but are inferior to the best varieties of sorgo and kafir as forage crops

1911, 1913, and 1917. In the western third of Kansas where chinch bugs are usually not troublesome, Dwarf Yellow milo is a valuable grain crop, especially along the Arkansas River and southward. Standard Yellow milo, a taller variety grown at the station during several seasons, is considered inferior in grain yield, but makes a fair silage crop for the region to which the dwarf variety is adapted.

White milo, a slender-stemmed variety similar to feterita in height, but with fewer leaves, has an excellent grain record, except that it was destroyed by chinch bugs in 1917. It was not grown at Hays previous to 1914. It produces still poorer fodder than Dwarf Yellow milo and feterita, and there are not sufficient data to prove that it is a more desirable grain crop. The earliness of White milo makes it more nearly adapted to northwestern Kansas than any other grain sorghum except Freed. Besides this White milo, there are regular dwarf and standard strains of White milo which have been grown one or more seasons at Hays and found practically identical with the dwarf and standard strains of Yellow milo, except in seed color.

Freed sorghum, often called white cane, has given the lowest forage yield of any variety, but is a valuable grain crop for extreme western and northwestern Kansas because it is very early-maturing and hardy. It is useful farther east for late planting. The forage is of better quality than that of the milos and feterita, and according to several growers in Greeley, Wallace, and Cheyenne Counties, Freed sorghum grain is equal to that of other grain sorghums in feeding value.

Numerous varieties of minor value not mentioned in the tables have been grown one or more years. The following are included in this list: African kafir, Kafirita, Jerusalem Corn or White Durra, Early Buff Durra, Schribar Corn, Darso, and quite a number of hybrids.

IMPROVING THE SORGHUM VARIETIES

The use of better varieties should be the first step in producing more profitable sorghum crops. The preceding tables and discussion have shown that even the best varieties differ greatly in yield, quality, and adaptation; yet these varieties were superior to many others that were tested. It costs no more to grow the best varieties than to grow the many mixed inferior ones so commonly planted.

Improving sorghum varieties by crossing is not a paying business for the average farmer. Many disappointments await his efforts. There are many possibilities, but these are usually outweighed by the difficulties in making selections and in making careful comparisons so that all but the best may be discarded.

Then, too, there is no opportunity for long continued financial gain from selling seed because each buyer can become a

competitor after one year. It seldom pays a farmer to spend time and money experimenting with hybrids, introductions, or other advertised novelties, for very few of them turn out to be of value. The creation of new varieties, and testing those of uncertain value is work for the Department of Agriculture and the state experiment stations. Credit is due the former for most of the valuable varieties of sorghum now grown, and to the latter for their further improvement and distribution to meet local needs. The Fort Hays Branch Experiment Station, for example, has not only tested several hundred lots of sorghum that proved to be of no special value but has distributed during the past 10 years much pure seed of Pink kafir, Dawn kafir, feterita, Dwarf milo, Red Amber, and Western Orange sorghums.

Western Kansas does not need more varieties; there are already far too many. It needs to concentrate on a few of the best sorghums already produced. If all farmers in each neighborhood would raise the same varieties and select their own seed each year, higher yields and purity could be obtained, and better prices secured for the grain.

Keeping valuable established varieties pure, and improving them for his own conditions are things that every farmer may easily do with profit. This requires: (1) That each be planted in a separate field, preferably at least 40 rods from all other varieties, including Sudan grass; (2) that all impure types be rogued out before they bloom; and (3) that first-class heads for the next year's use be selected from the best plants in the field before frost. Such selections should follow a uniform type, having in mind some definite and useful feature such as more leafiness or vigor in forage sorghums; and early-maturity, dwarfness, and compact erect heads in grain sorghums.

HOW TO BE SURE OF GOOD SEED

Selecting the best heads by hand from the field before frost, storing them in a dry but well-ventilated place, and flailing the seed out in the spring has been practiced at Hays in getting seed for experimental purposes. Several farmers are also known to be following this plan. One can usually select and store in a day enough seed to plant 100 acres or more in rows.

The value of selecting seed before frost is shown by germination tests of head samples collected at the station in 1916 and 1917.

In the fall of 1915, samples of 10 heads each were selected from the field at different stages before and after frost from each of four sorghums—Red Amber, Dawn kafir, Dwarf Yellow milo, and feterita. The heads hung in a dry building all winter and were flailed out the next spring. A composite sample of each 10-head lot was then sent to the Seed Laboratory, Washington, D. C., for germination tests. A summary of the results is given in Table IX.

TABLE IX.—SUMMARY OF RESULTS OF GERMINATION TESTS MADE IN MAY, 1916, FROM SAMPLES OF SORGHUM SEED SELECTED FROM THE FIELD AT DIFFERENT STAGES OF MATURITY IN THE FALL OF 1915

Stage of maturity when selected	Selected before frost		Selected after frost	
	Number of samples	Av. percent of germination	Number of samples	Av. percent of germination
Milk	12	68	0	.....
Soft dough	12	81	0	.....
Hard dough	12	87	4	81
Fully mature	12	90	4	81

The injury to seed when frosted in the milk and soft dough stages was determined in the fall of 1917. Seed was gathered from 19 varieties immediately after first killing frost; viz., a frost of 24° F. on October 8. Late that fall these lots of seed were tested for germination in comparison with 14 lots that had been selected before frost (Table X). A comparison of the results shows that the germination was much higher in the seed selected before frost.

These results show that good seed can be secured from very immature heads if selected before frost, and that this practice

TABLE X.—SUMMARY OF RESULTS OF GERMINATION TESTS OF 33 LOTS OF SORGHUM SEED COLLECTED IN THE FALL OF 1917

Stage of maturity when selected	Selected before frost		Selected after frost	
	Number of samples	Av. percent of germination	Number of samples	Av. percent of germination
Milk	0	.....	2	3
Soft dough	0	.....	12	28
Hard dough to ripe	14	86	5	54

is better than permitting the seed to be injured by frost in hopes of securing mature seed.

The results also show that it pays to test sorghum seed before planting, even when the heads are selected and well stored. This suggests that all seed purchased should be bought subject to test, since much of the seed offered for sale is of poor quality due to immaturity, exposure to the weather, and heating in storage. A simple test which can be made by any farmer may prevent loss of many dollars from poor seed and replanting.

HOW TO GROW SORGHUM

Cultural tests with sorghums on the forage crop project at the Fort Hays station have been confined to experiments to determine the best date and rate of planting, and the best time to harvest sorghums. General directions regarding methods of planting, cultivation, etc., may be found in bulletin 218 of the Kansas Agricultural Experiment Station.

TIME OF PLANTING

Five varieties of sorghum were planted on five different dates each year from 1914 to 1918 inclusive. In all cases the land was worked the preceding fall or early in the spring and was kept well tilled and clean until planting time. The crops were all in rows 40 inches apart, listed in 1914, 1917, and 1918, and surface planted in 1915 and 1916. The average yields per acre, both of forage and of grain, together with the average number of days required to mature, are given in Table XI.

Plantings before May 15 rarely result satisfactorily in farm practice because the soil is usually too cold for full and prompt germination and weeds become troublesome. In these experiments the good results from May 1 planting were due to special care. The best period for planting at the station is usually during the last 10 days of May.

The following practice is suggested as to time of planting sorghums where varieties for both grain and forage are to be grown:

Plant the later-maturing grain sorghums first. The kafirs should be planted as soon after May 15 as conditions are favorable; occasionally still earlier planting pays. If fields of grain sorghums remain to be planted or replanted between June 1 and June 15, feterita should be substituted as it is more likely

TABLE XI.—AVERAGE YIELDS PER ACRE AND AVERAGE LENGTH OF THE GROWING SEASON FOR FIVE SORGHUM VARIETIES PLANTED ON FIVE DATES EACH YEAR, 1914 TO 1918

Variety and approximate date of planting	Average yields			Av. date ripe (c)	Av. growing season (c)
	Cured forage	Green forage (a)	Grain (b)		
FREED	*Tons*	*Tons*	*Bus.*		*Days*
May 1	1.59	4.77	15.7	Aug. 14	105
May 15	1.81	5.43	15.7	Aug. 21	98
June 1	1.97	5.91	16.8	Aug. 26	86
June 15	2.11	6.33	18.0	Sept. 6	83
July 1	2.05	6.15	15.7	Sept. 19	80
BLACK AMBER					
May 1	2.48	7.44	22.4	Aug. 17	108
May 15	2.47	7.41	18.9	Aug. 25	102
June 1	2.57	7.71	20.1	Aug. 30	90
June 15	2.76	8.28	23.7	Sept. 11	88
July 1	2.62	7.86	19.2	Sept. 24	(d) 85
RED AMBER					
May 1	2.60	7.80	12.6	Aug. 21	112
May 15	2.45	7.35	10.3	Aug. 27	104
June 1	2.97	8.91	10.5	Sept. 5	96
June 15	3.03	9.09	12.5	Sept. 13	90
July 1	2.94	8.82	8.6	Sept. 28	(e) 89
FETERITA					
May 1	1.81	5.43	14.2	Aug. 20	111
May 15	1.94	5.82	15.9	Aug. 27	104
June 1	2.31	6.93	18.3	Sept. 5	96
June 15	1.84	5.52	13.1	Sept. 13	90
July 1	1.98	5.94	8.6	Sept. 29	(f) 90
DAWN KAFIR					
May 1	2.14	6.42	9.1	Sept. 7	129
May 15	2.57	7.71	16.0	Sept. 12	120
June 1	2.88	8.64	16.8	Sept. 20	111
June 15	2.69	8.07	14.1	Oct. 1	(g) 108
July 1	2.61	7.83	1.9	Frosted every year	

(a) Green or silage weight is computed as three times the air-dry weight.
(b) Freed, feterita, and Dawn kafir are computed at 56 pounds per bushel; Black Amber and Red Amber at 50 pounds per bushel.
(c) The season of 1917 is not included in the average date of ripening and the number of days required to mature. An abnormal late growth caused by heavy rains following a long drouth lengthened the 1917 season from two to six weeks beyond normal.
(d) Includes only 1914, 1915, and 1916.
(e) Includes only 1914.
(f) Includes only 1914 and 1916.
(g) Includes only 1914 and 1915.

to mature than kafir, After June 15, Freed is the most likely to mature for a grain crop, as it matured well during five consecutive years when planted as late as July 1. The sorghums intended only for hay, fodder, or silage, may be planted over a wide period of time, preferably between May 15 and June 15, but July 1 is not usually too late for a fair crop.

These dates apply to those portions of western Kansas where the growing season is of the same length as at Hays. Elsewhere a variation of from five to ten days from these dates may have to be allowed, as already explained under discussion of frost-free periods in western Kansas.

To obtain good yields from planting as late as June 15 and July 1, the soil must be worked enough during the spring to keep down all weeds.

Replanting fields which are very thin or weedy is a good practice and usually pays. Replanting ought to be done promptly and with an early variety. It pays to keep on hand extra seed of some early variety like Freed, feterita, Black Amber, or Red Amber for such emergencies.

RATE OF PLANTING

Experiments comparing different rates of planting were conducted from 1914 to 1918 inclusive, with Red Amber in 8- and 16-inch drills and in cultivated rows 40 inches apart; also with feterita in rows 40 inches and 80 inches apart. The results are given in Tables XII, XIII, and XIV. In the tests in rows 40 inches apart, the seed was sown thick and thinned as indicated in the tables.

Varying the rate of seeding within the limits of these experiments affected the forage yields but little. The thinner

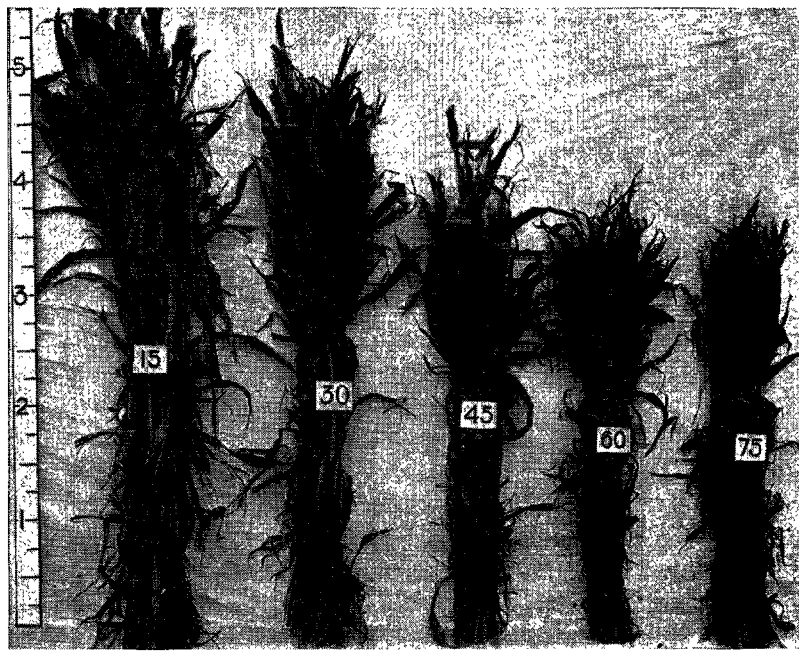

FIG. 4.—Sheaves of Red Amber sorgo from plots seeded at different rates for hay. The figures indicate the rates of seeding in pounds per acre. The yields from all rates were practically the same

rates in close drills usually produced rather coarse hay and were sometimes a little weedy. (Fig. 4) It is unnecessary to drill more than 30 to 40 pounds of good seed per acre if the seedbed is in good condition. The five-year average yield of the close-drilled Red Amber sorgo was 3.68 tons per acre as compared with 2.77 tons in 40-inch rows. However, the poorer quality of the close-drilled sorghum, which often dries up before normal maturity, offsets to a considerable extent its higher tonnage. Seeding in rows 3 to 3½ feet apart at the rate of 3 to 5 pounds per acre is considered the safer practice with most varieties where the annual rainfall is 20 inches or less.

Feterita, which often germinates rather poorly, should be planted enough thicker to allow for this factor and secure a

TABLE XII.—YIELDS OF RED AMBER SORGHUM PLANTED AT DIFFERENT RATES IN CLOSE DRILLS, 1914 TO 1918

Pounds sown per acre	Row width, inches	Tons per acre of air-dry hay					
		1914	1915	1916	1917	1918	Av.
15	16	4.24	6.81	1.79	2.99	3.25	3.82
30	8	3.98	6.91	1.83	2.67	3.16	3.71
45	8	3.74	7.16	1.84	2.65	2.52	3.58
60	8	3.62	7.13	1.82	3.10	2.53	3.64
75	8	3.75	7.17	1.64	2.59	3.17	3.66

TABLE XIII.—YIELDS PER ACRE OF RED AMBER SORGHUM PLANTED THICK AND THINNED TO DIFFERENT RATES IN 40-INCH ROWS, 1914 TO 1918

Row space per plant, inches	1914	1915	1916	1917	1918	Av.
FORAGE	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
2	3.69	4.98	1.44	2.89	2.77	3.15
4	3.41	4.41	1.07	2.23	2.75	2.77
6	3.57	4.40	1.00	2.26	2.74	2.79
8	3.66	3.78	1.08	1.89	2.62	2.61
12	3.16	3.68	1.44	1.78	2.66	2.54
GRAIN (*a*)	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*
2	11.1	30.4	0.7	12.0	3.0	11.4
4	17.0	32.9	1.0	7.2	4.7	12.6
6	20.5	31.6	1.3	9.4	3.8	13.3
8	26.0	27.2	2.0	9.0	4.5	13.7
12	24.7	29.5	2.2	9.2	8.6	14.8

(*a*) Fifty pounds per bushel.

TABLE XIV.—YIELDS PER ACRE OF FETERITA PLANTED THICK AND THINNED TO DIFFERENT RATES, 1914 TO 1918

Row space per plant, inches	Distance between rows, inches	1914	1915	1916	1917	1918	Av.
FORAGE		*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
4	80	.....	2.18	1.36	1.52	1.98	1.76
4	40	3.11	3.59	1.58	2.17	2.51	2.59
8	40	3.16	3.28	1.43	1.82	2.45	2.43
12	40	3.09	2.98	1.09	1.95	2.53	2.33
16	40	2.95	2.81	.92	1.71	2.45	2.17
24	40	2.25	2.59	.91	1.37	2.18	1.86
GRAIN (*a*)		*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*
4	80	.....	22.1	11.4	11.4	16.5	15.4
4	40	24.6	34.9	5.0	17.5	12.1	18.8
8	40	28.9	33.9	10.5	13.2	19.2	21.1
12	40	29.6	26.9	6.4	15.0	16.8	18.9
16	40	28.3	22.1	5.4	15.0	18.2	17.8
24	40	21.5	18.4	6.1	10.4	13.9	14.1

(*a*) Fifty-six pounds per bushel.

spacing of plants in the rows (fig. 5) that will produce maximum yields. The experiments show that the rate of planting either variety should be considerably thicker for maximum yields of forage than of grain.

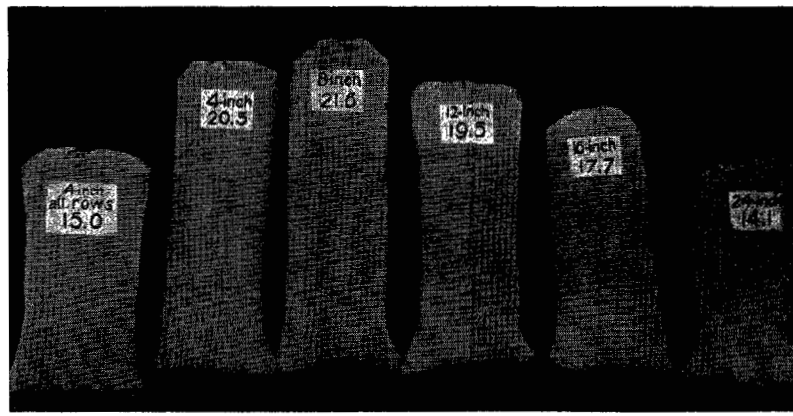

FIG. 5.—Results of a rate-of-seeding test with feterita at the Fort Hays station, 1914-1917. The upper figures indicate the spacing of the plants in the row; the lower figures the yields in bushels per acre

TIME OF HARVESTING

Experiments were conducted for three years to determine the best stage at which to cut close-drilled Red Amber sorgo for hay. Samples of each cutting were analyzed by the Bureau of Chemistry, United States Department of Agriculture. The

hay yields from these tests are given in Table XV, and the analyses in Table XVI.

It will be noted that the yields increased with the season, the fourth stage of cutting averaging one ton an acre more than the first stage. The percent of nitrogen-free extract increased with the advance of the season, while the percents of

TABLE XV.—YIELDS PER ACRE OF RED AMBER SORGHUM IN CLOSE DRILLS FOR HAY CUT AT FOUR STAGES OF MATURITY, 1917 TO 1919

Stage No.	Condition of plants when cut	Av. number of days after seeding	Yields of hay			Av.
			1917	1918	1919	
			Tons	*Tons*	*Tons*	*Tons*
1	Normal growth; heading around edges of plots	70	1.57	1.61	2.16	1.78
2	Growth and heading checked by drouth	80	1.97	2.07	2.95	2.33
3	Growth and heading still checked by drouth; plants badly hurt; heads around edges about ripe	91	1.93	2.54	3.10	2.52
4	Frosted in 1917; almost dead from drouth in 1918	115	2.33	2.84	3.39	2.85

TABLE XVI.—COMPOSITION OF RED AMBER SORGHUM HAY CUT AT FOUR STAGES OF MATURITY, 1917 TO 1919

Stage No.	Number of analyses	Protein	Ash	Fats	Nitrogen-free extract	Crude fiber
		Percent	*Percent*	*Percent*	*Percent*	*Percent*
1	3	12.75	11.92	2.18	33.18	39.97
2	3	11.28	11.67	2.13	39.84	35.08
3	3	11.03	10.84	2.19	47.97	27.97
4	3	8.94	9.66	1.95	55.01	24.44

other substances decreased. The differences in composition, however, are probably less important than the differences in yield.

On the general fields at the Fort Hays station sorghum for hay is usually left to make all the growth it will. Such sorghum is planted later than the row crops, usually from June 10 to July 1, and is mowed shortly before or just after frost.

Sorghums for silage and seed are allowed to become as mature as the season and labor conditions permit. The sweet sorghums in particular make very acid silage if cut before practically ripe. Frost does not hurt the feeding value of sorghums if they are cut at once, but wind may cause loss of leaves and much lodging if the crop is allowed to stand even a few days after frost.

SUDAN GRASS

Since 1914 Sudan grass has grown in favor as an annual hay crop in western Kansas. It is drouth-resistant, heavy-yielding, and makes a good feed, especially for horses and beef cattle. (Fig. 6.) The crop is used mainly for hay, but is often pastured. At the Fort Hays station it usually makes one good hay crop and a light second growth. Farther south or east it generally makes two good cuttings, but north and west of Hays only one is to be expected. Sudan grass has been successfully used as summer and fall pasture for all kinds of livestock. It will carry two to three times as many animals as an equal area

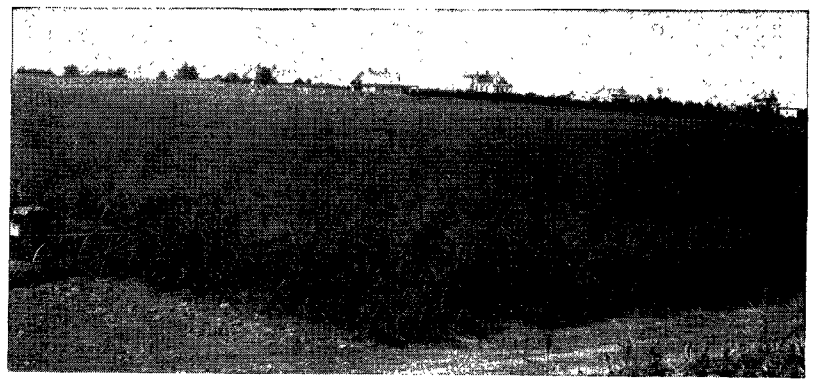

FIG. 6.—Sudan grass grown in 40-inch surface-planted rows at the Fort Hays station in 1915

of native range. It is fairly safe for pasture, but two cases in western Kansas are known in which cattle grazing on its stunted second growth were poisoned. The crop can be used for silage, but is not recommended for that purpose because sorghums yield more to the acre, and because Sudan grass can be fed dry without much waste.

The relative yields of Sudan grass, millet, and sorgo (the chief annual hay crops of western Kansas) were determined at the Fort Hays Branch Experiment Station in a six-year test, the results of which are shown in Table XVII. Sudan grass produced 76 percent and millet 61 percent as much hay as the Red Amber sorgo. Sudan grass hay is the most valuable of the three, especially for horses. Its lighter yield is offset by the finer quality and ease of curing as compared with sorgo.

TABLE XVII.—YIELDS PER ACRE OF HAY AND LENGTH OF GROWING SEASON OF SUDAN GRASS, MILLET, AND SORGO GROWN IN CLOSE DRILLS, 1914 TO 1919

CROP	Rate sown, pounds per acre	Yields of hay							Growing season, days
		1914	1915	1916	1917	1918	1919	Av.	
Red Amber sorgo....	30	3.98	6.91	1.83	2.67	3.16	2.85	3.57	95
Sudan grass.....	20	3.80	4.26	2.07	2.02	1.96	2.20	2.72	75
German millet.....	20	3.11	3.31	1.17	1.95	1.85	1.68	2.18	70

The chief objection to Sudan grass is the cost of seed. This can be reduced by seeding in rows as far apart as 42 inches. Grasshoppers attack Sudan grass more than the other two crops and chinch bugs work on it and millet more than on sorgo. The yields of millet are not only light, but the hay is generally unsafe for feeding continuously to horses in large amounts. Sudan grass is the best of the three for pasture. It is more vigorous than millet and more palatable, and is much less likely to cause prussic acid poisoning of cattle than are the sorghums.

THE TIME TO SOW SUDAN GRASS FOR HAY

Like the other early-maturing sorghums, Sudan grass can be sown for a considerable period after warm weather comes in the spring. The best time to sow seems to be just as soon as favorable conditions are present after May 15. It pays to wait several weeks after May 15 if necessary in order to get a warm, clean, moist seedbed and promising weather. The crop may be sown from 5 to 10 days earlier in southern Kansas. Planting Sudan grass at any favorable time up to July 15 is worth trying in fields where corn or sorghums planted earlier have failed. Because of lack of moisture, Sudan grass does not usually succeed when sown in western Kansas after a small-grain crop has been removed.

These statements are based on experiments conducted at the station for six years. (Fig. 7.) Each year Sudan grass was drilled at the rate of 20 pounds of seed per acre at 15-day intervals from April 15 to August 1. The hay yields are given in Table XVIII. It will be noted that the largest yields have been secured from seeding between May 15 and June 15.

Cold weather always caused poor weak stands from the April 15 seedings, and weeds usually smothered them out. These

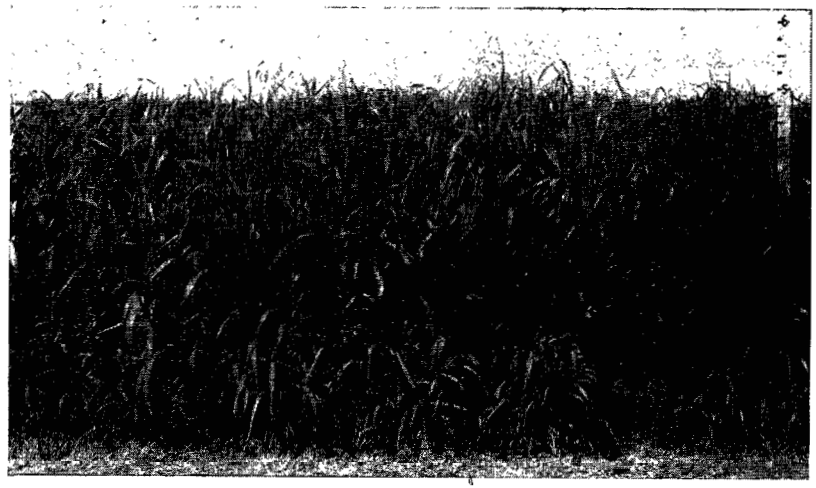

FIG. 7.—Sudan grass seeded June 1, 1915, in close drills at 20 pounds per acre. Grass at the left, not yet in head, seeded June 15. Photograph taken August 12

factors affected the May 1 plantings to some extent each year, and also the May 15 seedings from 1915 to 1918 inclusive. After warm weather arrived, however, the Sudan grass sown May 1 or later usually became vigorous enough to smother the weeds and produce a good yield. Fair crops were usually obtained from seeding Sudan grass as late as July 15 on well-prepared soil not previously cropped that season.

Seeding Sudan grass after harvesting small grains has been profitable only in the abnormally wet year, 1915. In that year a nine-acre field was sown after cutting a rank growth of rye

TABLE XVIII.—YIELDS PER ACRE OF SUDAN GRASS HAY FROM DIFFERENT DATES OF SEEDING IN CLOSE DRILLS, 1913 TO 1918

Approximate date sown	Tons of air-dry hay (a)						
	1913	1914	1915	1916	1917	1918	Av.
April 15	.03	.00	.00	1.23	.18	.76	0.37
May 1	.12	2.42	4.31	1.01	.33	.85	1.51
May 15	1.08	2.61	3.61	0.75	1.75	1.21	1.84
June 1	.26	2.44	3.54	1.19	2.11	1.49	1.84
June 15	.10	2.12	4.59	.86	2.15	1.42	1.87
July 1	.00	1.66	3.25	1.01	2.63	1.13	1.61
July 15	(b) .00	1.68	2.46	.93	1.64	1.06	1.30
August 1	(b) .00	(b) .45	1.25	.10	1.17	.56	.59

(a) Yields for May 1 to June 15 inclusive, in 1914, 1915, and 1916, and for April 15, 1916, consisted of two cuttings; all other seedings in this test made but one cutting or none.
(b) Estimated.

for hay. The land was plowed and harrowed immediately after cutting the rye early in June; Sudan grass was then surface planted in 42-inch rows, June 18, and grew rapidly to a height of six feet. This field produced three tons of stover and 260 pounds of seed per acre. In 1916 a similar attempt failed entirely, the Sudan grass getting less than a foot high.

RATE AND METHOD OF SEEDING SUDAN GRASS FOR HAY

The amount of seed to sow and the methods of seeding it vary in farm practice because of the cost, quality, and amount of seed available; the use to be made of the crop; the machinery and labor available; and the soil conditions. Because Sudan grass seed is usually expensive, and sometimes scarce, the lowest amount consistent with good yield and quality of hay should be used.

Experiments to determine the most profitable rate of seeding and the best spacing for the rows have been conducted for six years, These tests have all been made with good viable seed planted with a grain drill at the most favorable time on thoroughly prepared land. The yields are shown in Table XIX.

TABLE XIX.—YIELDS PER ACRE OF SUDAN GRASS HAY FROM DIFFERENT SEEDING RATES AND DISTANCES BETWEEN ROWS, 1913 TO 1918

Pounds sown per acre	Row width, inches (a)	Tons of air-dry hay						
		1913	1914	1915	1916	1917	1918	Av.
35	6 or 8	0.71	4.44	4.12	1.83	1.83	1.76	2.45
25	6 or 8	.60	3.85	4.45	1.76	1.92	1.79	2.40
20	6 or 8	.49	3.80	4.26	2.07	2.02	1.96	2.43
15	6 or 16	.39	4.16	4.22	2.04	2.23	1.93	2.50
10	16	(b) .60	4.18	4.21	1.93	2.00	1.93	2.48
7	18 or 24	.76	4.17	4.39	2.46	2.84	1.91	2.67
4	36 or 40	.64	4.32	3.77	2.59	1.65	1.70	2.45

(a) Six-inch rows, 1913 and 1914 only; 18- and 36-inch rows, 1913 only.
(b) Estimated.

The results vary little for different rates of seeding and methods of planting. The lowest average yield is only 10 per cent less than the highest average, and in no year has any rate or method shown outstanding superiority. The yields appeared to depend chiefly on the season.

As far as these tests show, no better rate nor method can be recommended than the common practice of seeding 15 to 20 pounds to the acre in drills 6 to 8 inches apart. Five to ten pounds of seed is required when the rows are 12 to 24 inches

apart, and 3 to 4 pounds when the rows are 3 to 3½ feet apart.

The methods of seeding practiced with sorghums can be used for Sudan grass. Most grain drills when set for 2 pecks of wheat to an acre may be expected to sow 2 pecks of Sudan grass, which is about 20 pounds. Sudan grass should not be covered as deeply as wheat, but press wheels should be used to insure good germination. Corn planters or listers fitted with sorghum plates can be used for Sudan grass. In 40-inch rows, with well-graded seed, one seed to the inch is about equivalent to three pounds to the acre. Rows 18 to 24 inches apart can be put in with a corn planter by going over the field once and then straddling the first rows, but this method is too tedious when grain drills can just as well be used to sow three to six such rows at once. Broad-casting Sudan grass seed is not recommended, for this requires more seed than drilling, and in dry weather the seed is quite certain to germinate poorly.

THE TIME TO CUT SUDAN GRASS FOR HAY

Experiments relating to the best stage to cut Sudan grass were carried on for the five years, 1915 to 1919 inclusive. In these experiments, eight plots of one-twentieth of an acre each were drilled annually at the rate of 20 pounds per acre. Two plots were mowed just before heading and two more at each of three later stages. Whatever second growth came on was also harvested at the time of frost each year. The average yields of hay are summarized in Table XX.

TABLE XX.—AVERAGE ANNUAL YIELDS OF SUDAN GRASS HAY CUT AT DIFFERENT STAGES, 1915 TO 1919

STAGE OF CUTTING	Tons per acre		
	First cutting	Second cutting	Total
Cut each time just before heading; two cuttings	0.92	0.94	1.86
Cut at first head, and again at frost; when 18 to 24 inches high,	1.61	.62	2.23
Cut at full head, and again at frost; when 12 to 18 inches high,	1.82	.33	2.15
Cut in milk to soft dough stage; only one cutting	2.28		2.28

Samples of each cutting were analyzed by the Bureau of Chemistry, United States Department of Agriculture. A summary of all the analyses is given in Table XXI.

The highest yields were obtained in this test when the Sudan grass was allowed to reach the milk or the soft dough stage,

TABLE XXI.—COMPOSITION OF SUDAN GRASS HAY CUT AT DIFFERENT STAGES, 1915 TO 1919

STAGE OF CUTTING	Number of analyses	Protein	Ether extract	Ash	Nitrogen-free extract	Crude fiber
		Percent	*Percent*	*Percent*	*Percent*	*Percent*
Young second growth frosted at 12 to 24 inches high	5	13.58	1.52	10.77	48.59	25.54
Just before heading; 24 to 42 inches high	8	14.02	1.95	10.91	44.82	28.30
First heads out	6	11.30	1.66	10.22	46.86	29.96
Fully headed	5	9.53	1.58	9.53	48.68	30.68
Seed in milk or soft dough stage	5	8.18	1.56	8.73	49.99	31.54
Average (*a*)	29	11.60	1.68	10.13	47.45	29.14

(*a*) The average in each case is that of the twenty-nine samples and not of the five sub-averages.

but the increase is small as compared with cutting when the first heads appear or a little later. The quality of the hay is better from the first-head to the full-head stages, for thereafter the percent of protein decreases and that of crude fiber increases until maturity.

It is probably a good practice to cut at any convenient time after the first heads appear. Cutting before this time may be advisable if grasshoppers become very destructive or drouth checks the growth of the crop. Otherwise the crop should be left until in the head stage. Sudan grass is not at all exacting as to time of cutting, for even the threshed stover makes good feed.

SUDAN GRASS SEED PRODUCTION

Extensive planting of Sudan grass is western Kansas for seed production alone is not recommended. Drouth, winds, frosts, or insect pests usually cut down the yield. By using the stover, however, a profit is often obtained even though the yield of seed is small.

Experiments conducted for seven years with methods and rates of seeding indicate that the best way to plant Sudan grass for seed is in rows 3 to 3½ feet apart, either surface planted or listed. Close drills ripen most evenly, but except under very favorable conditions they head too poorly. Narrow cultivated rows are not adapted to average farm machinery, and rows more than 40 inches apart do not produce a maximum stover yield with the seed. The results obtained in this experiment are given in Table XXII. No method of seeding produced satisfactory yields of seed, for the crop suffered each year from one or more of the injurious factors already named.

Seeding in rows 24 inches apart gave the best average, but the difference as compared with rows 40 inches apart is not enough to warrant the extra work in cultivating.

TABLE XXII.—YIELDS PER ACRE OF SUDAN GRASS SEED FROM DIFFERENT WIDTHS OF ROWS, 1913 TO 1919

Row width, inches	Rate seeded, pounds per acre	Pounds of seed							
		1913	1914	1915	1916	1917	1918	1919	Av., 1915-1919
6 or 8	20	0	66	63	0	0	41	.....	(a) 26
24	7	0	117	90	33	300	62	209	139
40	4	0	118	75	33	260	78	217	132
80	2	.....	.....	45	28	260	92	203	126

(a) Four years, 1915 to 1918.

MILLET

The acreage of millet in Kansas has steadily declined to one-fifth what it was 30 years ago. Most of the remaining millet acreage might well be replaced by sorgo or Sudan grass because these latter crops produce larger yields superior in quality. Because of the short period required to mature, there is, however, a limited use for millet all over the state as a quick-maturing catch crop for hay. The growing of early varieties for seed is sometimes profitable in western Kansas. The foxtail millets, of which there are 10 or more, are considered superior to other varieties such as Pearl, Proso, and Barnyard millet. The yields of hay from five varieties of foxtail millets are shown in Table XXIII. The varieties are named in the order of their earliness, which with one minor exception is also the reverse order of their yields. These plots were seeded in close drills at 20 pounds to the acre about June 1 each year, and located so as to afford a fair comparison with sorghum and Sudan grass tests.

TABLE XXIII.—YIELDS OF MILLET VARIETIES, 1913 TO 1919

VARIETY	Growing season, days (a)	Tons of hay per acre							
		1913	1914	1915	1916	1917	1918	1919	Av., 1914-1919
Kursk	53	0.97	2.64	1.67	1.29	1.30	.....	1.01	1.58
Common	57	.....	2.57	1.57	1.02	1.61	1.59	1.54	1.65
Hungarian	60	.....	.....	2.06	1.27	1.52	1.64	1.37	1.57
Goldmine	62	.95	3.08	1.98	1.25	1.86	1.69	1.16	1.84
German	68	.....	3.11	3.31	1.17	1.95	1.85	1.68	2.18

(a) Days from planting until cut for hay.

These results show that German, sometimes called Golden, is the best variety of millet to raise for hay under average western Kansas conditions. The other varieties mentioned are, however, finer-stemmed, earlier, and, under dry conditions, so much better seed producers that they may well be planted instead of German when a quick hay crop or a drouth-resistant seed crop is desired. Variety tests conducted in the hot summers of 1910 and 1911 showed such early varieties as Siberian and Hungarian to be much superior to German millet in ability to produce under adverse conditions.

Proso, also known as Russian, hog, and broomcorn millet, is sometimes grown in about a dozen counties of northwestern Kansas. Proso yields less hay than any of the foxtail millets, but it has a very limited use as a drouth-resistant, early maturing grain crop used chiefly for chicken feed. Proso millet yielded nine bushels of grain per acre in 1904. Limited tests in later years were less successful, and the crop was discarded.

Pearl millet, also known as Penicillaria, cat-tail, and Egyptian millet, is a tall, late, coarse variety not valuable in Kansas. Pearl millet has not been grown at the Fort Hays station except from 1902 to 1905. During that time detailed tests proved it a poorer forage crop than sorghum, both in yield and feeding quality. In a feeding test beginning December 16, 1904, eight beef cows that were fed for 22 days on 35 pounds of Pearl millet stover a day per animal, lost 30 pounds each in weight and wasted 59 percent of the feed. Another lot of eight similar cows that were fed 32 pounds of kafir stover daily per animal, gained 7 pounds a head and wasted only 12 percent of the feed.

OTHER GRASSES

Some tame grass suitable for sowing for permanent pasture on the upland is greatly needed in western Kansas. Numerous grasses have been tested for this purpose at this and other dry-land stations, but none have proved entirely satisfactory.

Brome Grass.—The only grass that has appeared to offer any solution to the above problem is brome grass. It has been grown at the Fort Hays station since 1902 under varying conditions in areas from one-tenth of an acre to 10 acres, chiefly

on upland. It was promising in a few of the best seasons, but the final conclusions reached were that brome grass is not worth sowing on land that is too dry for alfalfa, and is of but doubtful value on any land in the western half of Kansas.

Nineteen seedings of brome grass were made on the Dry-Land Agriculture project during the period, 1906 to 1918 inclusive. These resulted in fifteen failures to hold a stand through the summer, three poor to fair stands, and one good stand. The seed was broadcasted or drilled without a nurse crop at about oats-seeding time each year on fall-plowed wheat stubble land. The brome grass nearly always came up well, but gradually died out within one to three months on account of weeds, drouth, and grasshoppers. The only year in which brome grass grew tall enough to mow and rake was in 1916, when 1.04 tons per acre was obtained from two plots sown April 2, 1916.

Tunis Grass.—Tunis grass is an annual crop closely related to Sudan grass. Tests of Tunis grass from 1913 to 1915 inclusive, showed that it was not equal to Sudan grass in quality of hay, nor in seed habits. Tunis grass is the coarser-stemmed, and shatters its seed quickly at maturity.

Johnson Grass.—Johnson grass is a southern perennial plant related to Sudan grass. It is a serious weed pest in some places south of 38° latitude. In trials at this station in 1913 and 1914 it was found much inferior to Sudan grass as forage, both in yield and leafiness. Johnson grass winterkilled when its roots were left exposed by fall plowing or listing. It may, however, prove more difficult to eradicate in extreme southern Kansas. Care should therefore be taken not to introduce it into this district in buying southern Sudan grass seed.

ALFALFA

Alfalfa is the most desirable hay crop to grow in western Kansas under irrigation or on bottom lands not irrigated. Nearly all the present acreage of alfalfa in this region is thus located, and on such lands alfalfa growing can and should be increased. On uplands without irrigation, and where the annual rainfall is 25 inches or less, alfalfa is not usually profitable.

THE KIND OF ALFALFA TO GROW

Several of the more promising commercial varieties have been grown on upland both in close drills and cultivated rows. Seven varieties were seeded in close drills, on duplicate one-tenth of an acre plots, May 11, 1915. The stands of all varieties were excellent and remained so during the tests. The yields of these varieties are shown in Table XXIV, arranged in the same order as the plots were planted so that the value of each variety may be judged by comparing it with the closest plots of Kansas alfalfa.

TABLE XXIV.—YIELDS OF ALFALFA VARIETIES GROWN IN CLOSE DRILLS, 1916 TO 1919

Plot No.	Name of variety or origin of seed	Tons of hay per acre				
		1916	1917	1918	1919	Av.
1	Canadian variegated	1.17	1.49	0.86	0.95	1.12
2	Kansas common	1.31	1.43	.81	.90	1.11
3	Baltic	1.50	1.29	.89	1.06	1.19
4	Grimm	1.29	1.16	.84	1.02	1.08
5	Kansas common	1.20	1.15	.73	.99	1.02
6	Utah non-irrigated	1.11	1.10	.70	.96	.97
7	Utah irrigated	.96	1.10	.69	.92	.92
8	Kansas common	1.13	1.24	.72	1.05	1.04
9	Blackhills (South Dakota)	1.09	1.12	.77	1.07	1.01

Five varieties of alfalfa were drilled in 36-inch rows on duplicate one-tenth of an acre plots, May 9, 1913. Fairly good stands were obtained and were maintained during the tests, except that the Kansas alfalfa was somewhat the thickest and the Turkestan a little the thinnest. These differences in stand probably account in part for the differences in yield. **(Table XXV.)**

TABLE XXV.—YIELDS OF ALFALFA VARIETIES IN 36-INCH ROWS, 1914 TO 1919

VARIETY	Tons of hay per acre						
	1914	1915	1916	1917	1918	1919	Av.
Kansas	1.26	2.27	0.71	0.73	0.58	0.36	0.99
Utah	.91	2.06	.80	.76	.68	.32	.92
Grimm	.94	2.03	.72	.59	.67	.33	.88
Brott	.81	2.16	.67	.56	.60	.28	.85
Turkestan	.76	1.71	.63	.52	.51	.19	.72

Neither the close-drilled nor the cultivated row tests show very marked differences in the value of the varieties. Common Kansas grown seed has generally given slightly higher yields

than the others. It is to be recommended also because it is less expensive than certain other varieties, and there is less danger of getting poor seed than when one buys seed that has been shipped in from an unknown source,

HOW TO GROW ALFALFA

Considerable general experience has been accumulated at the Fort Hays Branch Experiment Station since 1902 with reference to the choice of land for alfalfa, soil preparation, rate and date of seeding, and other factors involved in handling the crop. This experience may be briefly summarized by stating that bottom land should be selected, that the soil should be as free from weeds as possible, that plenty of soil moisture to a depth of several feet should be available at seeding time, and that drilling 12 to 15 pounds of seed to the acre at an opportune time between April 15 and May 15 has been the most successful way of getting a stand. Only such phases of alfalfa culture as have been the subjects of definitely executed plot experiments will be discussed further in this bulletin.[1]

ALFALFA IN ROWS FOR HAY

Attempts to establish stands of alfalfa in cultivated rows on the upland were begun in 1907 in order to learn whether greater drouth-resistance and more profitable yields could be obtained than from seeding in close drills or broadcast. The first eight seedings in rows all failed entirely, because of washing and crusting from rains, weed competition, and drouth. These seedings each consisted of 1½ to 10 acres with at least one trial a year from September, 1907, to April, 1913.

Plots seeded May 8 and 9, 1913, produced excellent stands at an unusual expense for cultivation, hoeing, and grasshopper poison. These seedings consisted of quadruplicate one-tenth of an acre plots in rows 12, 24, 30, 36, and 42 inches apart, with 6-inch drills every third plot as checks. (Fig. 8.) Full stands were maintained in the rows 24 inches or farther apart during all years of the tests, but the stands in some of the 6-inch and 12-inch plots began to die out in 1917, and declined to about 80 percent of a satisfactory stand by the close of 1919. All of the plots were cultivated each spring with some type of renovator, and those in 24- to 42-inch rows received two to four

[1] For general information on alfalfa production in this section of the country, see station circular 73, "Growing Alfalfa in Western Kansas."

later workings with shovel cultivators each year. The numbers of cuttings made annually were as follows: 1914, two; 1915, three; 1916, two; 1917, two 1918, one; 1919, one. The alfalfa grew rapidly on all plots during the brief periods when the moisture supply was above normal, but made almost no growth at other times on any of the plots. The annual hay yields are presented in Table XXVI.

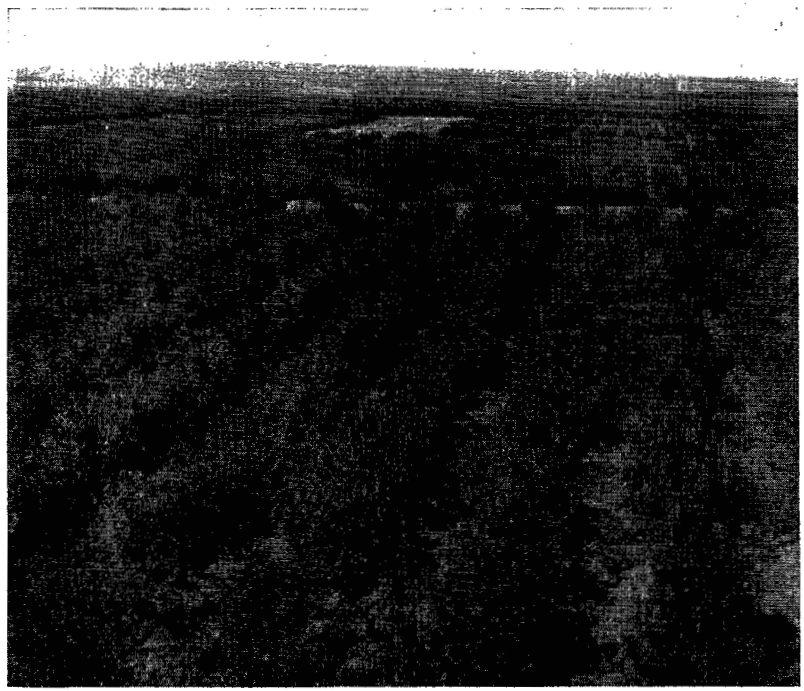

FIG. 8.—Alfalfa in 36-inch cultivated rows at the Fort Hays station in 1915. This method has proved less profitable than the usual method of growing alfalfa broadcasted or in close drills

TABLE XXVI.—HAY YIELDS FROM UPLAND ALFALFA IN DIFFERENT WIDTHS OF ROWS, 1914 TO 1919

Width of row, inches	Tons per acre						
	1914	1915	1916	1917	1918	1919	Av.
6	1.02	2.49	0.65	0.76	0.79	0.64	1.06
12	1.16	2.63	.63	.76	.78	.62	1.10
24	1.22	2.40	.56	.70	.66	.36	.98
30	1.18	2.32	.53	.65	.57	.40	.94
36	1.26	2.27	.58	.71	.58	.36	.96
42—single	1.02	2.02	.62	.62	.56	.38	.86
42—double	1.05	2.14	.57	.74	.57	.41	.91

The cultivated rows produced a poorer quality of hay and lower yields than the close drills, and the hay cost more. Enough dirt to be at least noticeable was usually raked up with the hay from the cultivated rows. These rows made so spreading a growth in 1914 and 1915 that extension guards about 18 inches long, such as are used in cutting pea vines, had to be attached to every third or fourth guard on the mower in order to lift up reclining stems. Mower sickles quickly become dull and gummed up in cutting row alfalfa because of working through considerable dirt.

ALFALFA IN ROWS FOR SEED

Profitable seed yields have not been obtained from alfalfa in rows. Each year, from 1915 to 1918 inclusive, part of an acre in 36-inch rows was reserved for seed. Almost no seed set in 1915, owing to excessive rains. Light seed crops, less than a bushel to the acre, were produced in the dry years, 1916, 1917, and 1918. Grasshoppers usually injured the alfalfa considerably during the seed-maturing period in spite of the fact that great numbers were poisoned.

The results obtained with alfalfa in rows by several western Kansas farmers interviewed by the writer have also been unfavorable. Only a few of the most careful have obtained good stands. Owing to unusual rainfall in 1915, several farmers, especially at Quinter, cut promising hay crops of one-half to two tons per acre in 1915 and 1916, but got no crops exceeding one-half of a ton per acre in 1917 and 1918. Grasshoppers and drouth caused seed production to fail except in one case at Wallace, where W. E. Young in 1915 threshed 1.1 bushels per acre from 10 acres.

Russian thistles usually occupied the spaces between rows after the first year or two and in some cases crowded out the alfalfa. Several farmers plowed up their row alfalfa in 1917 and 1918, but a few still believed that alfalfa in rows might prove profitable in wet years.

CULTIVATION OF ALFALFA

Experiments in cultivating broadcast alfalfa on bottom land have been conducted with a number of machines since 1907 at the Fort Hays station. After several years of general experience without obtaining conclusive results, a new series of more detailed tests was begun in 1915. Each tillage method was

practiced on duplicate three-fortieths of an acre plots. These plots had been seeded in 1914, obtaining excellent stands which were maintained on the entire series throughout the period of the experiments. The yields are summarized in Table XXVII.

TABLE XXVII.—YIELDS OF HAY FROM CLOSE-DRILLED ALFALFA ON BOTTOM LAND WITH DIFFERENT CULTURAL TREATMENTS, 1915 TO 1918

CULTURAL TREATMENT	Tons per acre				
	1915	1916	1917	1918	Av.
No cultivation	4.00	1.75	1.48	1.37	2.15
Double disked and harrowed in early spring	3.59	2.02	1.65	1.57	2.21
Single disked and harrowed in early spring	3.75	1.97	1.43	1.43	2.15
Single disked in early spring and after each cutting	3.79	1.44	1.60	1.86	2.17
Single disked only in early spring	3.65	1.56	1.69	2.12	2.26
Renovator with hoe drill type of rounded shovels used in early spring and after each cutting	3.69	1.80	1.47	1.14	2.03
Renovator used only in early spring	3.95	1.53	1.46	1.44	2.10
Spring tooth harrow with 1¼-inch teeth used in early spring	4.11	1.51	1.22	1.48	2.08
Spring tooth harrow with 2½-inch flat shovels used in early spring	4.11	1.58	1.64	1.82	2.29

The differences in yield are due mainly to uneven and very inferior growth during dry periods on spots of varying size within most of the plots. Because of this fact, no fine distinctions can be drawn. It is clear, however, that, on the average, no form of cultivation affected the yields to any extent and that the labor of cultivating was unprofitable.

IRRIGATION OF ALFALFA

The possibilities of profit from pumping creek water to irrigate adjacent alfalfa were studied at the Fort Hays station from 1904 to 1909. A 4-inch centrifugal pump set on Big Creek at a total cost of $868.75, was used to irrigate 11 one-acre plots of various crops. Two of these plots were in alfalfa continuously, and the yields from them were compared with those two adjoining alfalfa plots that received no irrigation. The results are given in Table XXVIII.

TABLE XXVIII.—YIELDS PER ACRE OF ALFALFA HAY IN IRRIGATION EXPERIMENTS, 1904 TO 1909

Year	1904	1905	1906	(a) 1907	(b) 1908	1909	Av.
Rainfall, Apr. 1 to Oct. 1 (inches)	14.60	17.64	17.52	20.42	20.83	20.25	18.54
Depth of water pumped on irrigated plots (inches)	15.25	13.59	19.07	No record	No record	4.90	.....
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Irrigated	3.22	4.02	5.50	3.74	4.72	4.47	4.28
Not irrigated	2.41	2.99	3.86	3.48	4.52	4.09	3.56

(a) Because the first cuttings on June 4 were killed by frost, May 27, they are not included in the yields.

(b) First cuttings on June 5 are not included in yields because ruined by rains after cutting.

In 1904 one plot was irrigated April 16–18, the other July 27–29. In 1905 one plot was irrigated April 13–17, the other May 11 and June 9. In 1906 both plots were irrigated before each cutting; namely, May 9–11, June 15–16, July 19, and August 24. In 1907 the plots were irrigated June 7–11. In 1908 both plots were irrigated February 27 to March 14. In 1909 the plots were irrigated March 15 and 16.

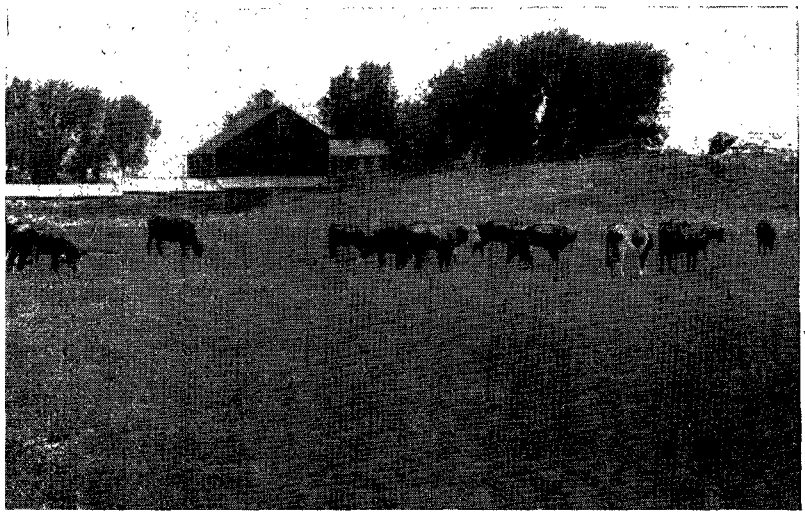

FIG. 9.—Cattle pasturing sweet clover on sandy land along the Smoky Hill River in Trego County, 1916

The irrigation seems to have been worth while in the comparatively dry seasons, 1904, 1905, and 1906, but not in the wet summers of 1907, 1908, and 1909. Cost records were not kept in sufficient detail to show exact profits and losses. Even the largest increase of yield from irrigation, 1.64 tons per acre in 1906, was less profitable than the increases obtained from irrigating potatoes, corn, and sugar beets.

During the first three years of the experiments, spring was considered the best time for pumping water upon alfalfa be-

cause labor was cheaper and the creek water more abundant than in the summer. During the last three years, there were such heavy summer rains that the irrigation did not pay, and the conclusion was reached that it might be better, on the average, to defer pumping until the alfalfa actually needed water.

SWEET CLOVER

Sweet clover has been found of considerable value in western Kansas on bottom lands too sandy or too close to ground water for alfalfa to thrive. (Fig. 9.) It succeeds on any good alfalfa land, but in such locations alfalfa is the more profitable crop. It has not proved profitable on uplands that are too dry for alfalfa. Sweet clover is more useful for pasture than for hay.

Experiments with sweet clover at Hays have had to do chiefly with the problems of getting a stand on upland, and then comparing it with alfalfa as a hay crop.[1]

GROWING SWEET CLOVER

Of 36 sweet clover seedings made in a nine-year test, only 15 produced stands that survived the first season. The best time for sowing was from April 15 to May15, it being desirable to kill one or more weed crops before seeding. A moist, clean, and very firm soil is essential for best results.

A five-year experiment was conducted with reference to seeding sweet clover with or without a nurse crop. Plots were seeded at the rate of 15 pounds of scarified seed[2] to the acre in April, as follows: (1) Alone; (2) with four pecks of barley; and (3) with six pecks of oats. From all three methods equally good stands of sweet clover were obtained in 1915 and 1916, but in 1917, 1918, and 1919, all methods failed to secure a stand. The grain was cut for hay before fully mature, and did no more injury to the sweet clover than did the weeds which grew rank in the plots seeded without a nurse crop. The average yield of barley hay was 0.9 ton per acre, and of oats, 1.02 tons per acre. Hay yields of sweet clover the second year showed no differences due to the use of a nurse crop.

[1] Biennial white sweet clover (*Melilotus alba*) is the only variety used in experimental tests at Hays. General information on sweet clover may be obtained from circular 44 of the Kansas Agricultural Experiment Station.

[2] Scarifying is a process for scratching the seed coat so that all the seeds will germinate promptly. Untreated sweet clover seed, either in or out of the hull, often has from 10 to 90 percent of seed with such hard coats that they do not germinate until the second season after planting.

The only returns from sweet clover during the first year of its growth were obtained in 1915 and 1918. In 1915, a very wet season, a first year's hay crop of 1.24 tons per acre was harvested on October 20. In 1918, sweet clover seeded alone on March 25 made considerable spring growth, which was mowed on June 15, and yielded 1.29 tons per acre of sweet clover and Russian thistle mixed. The sweet clover, however, died because of close mowing and subsequent drouth.

A fair cutting of hay is usually secured by June 1 or earlier during the second year of the sweet clover's growth. It should be mowed when not more than 20 to 30 inches high and before any sign of bloom develops. If left until the bloom stage, the hay becomes too coarse to be palatable, and most of the plants die after cutting. If cut at the stage recommended, high enough from the ground to leave a few shoots on each plant, a light second growth usually comes on.

SWEET CLOVER VERSUS ALFALFA AS A HAY CROP

Comparative yields of sweet clover and alfalfa hay are summarized in Table XXIX. The sweet clover in each case was in its second year. The alfalfa yields for 1914 and 1915 are from 1913 seeding, and those for 1916 to 1918 are from 1915 seeding.

TABLE XXIX.—YIELDS OF SWEET CLOVER AND ALFALFA HAY, 1914 TO 1918

	Tons of hay per acre					
	1914	1915	1916	1917	1918	Av.
Sweet clover	1.13	2.40	2.62	0.87	1.04	1.61
Alfalfa	1.02	2.49	1.21	1.25	1.08	1.41

It should be noted that only in 1916 did sweet clover outyield alfalfa materially. Sweet clover was actually less productive, on the average, for, except in 1916, each annual yield represents two years' use of the ground. Considering also that sweet clover is much the more exacting as to its time of cutting and methods of curing and lives but two years, alfalfa may be considered the better crop.

The chemical composition of sweet clover hay as compared with alfalfa hay was determined from each crop at both the first and second cuttings in 1916. The sweet clover was fine-

stemmed, about two feet tall, and not yet in bud. The alfalfa was one-fourth in bloom. The analyses are summarized in Table XXX.

TABLE XXX.—CHEMICAL COMPOSITION OF SWEET CLOVER AND ALFALFA HAY, 1916

(Averages of first and second cuttings on water-free basis)

	Protein	Ash	Fats	Nitrogen-free extract	Crude fiber
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Sweet clover leaves	29.87	12.01	3.16	45.38	9.58
Alfalfa leaves	26.69	12.30	3.25	41.61	16.15
Sweet clover stems	11.33	9.23	.84	39.04	39.56
Alfalfa stems	9.78	7.70	.76	35.66	46.15

The results are slightly in favor of sweet clover, showing it to contain more protein and less crude fiber than the alfalfa. The comparative immaturity of the sweet clover no doubt accounts for the differences, because most crops increase in percent of crude fiber and fall off in percent of protein as they mature.

ANNUAL LEGUMES

Several annual legumes have given fair results under the most favorable conditions at the Fort Hays station, but none of them so far tested can be recommended for extensive planting in western Kansas. Farmers in this region are not growing any of the annual legumes except in an experimental way.

Field peas, cowpeas, and soybeans were all tried during three or more seasons previous to 1913. Field peas and cowpeas usually started out well, but later suffered so much from weeds, drouth, and grasshoppers, that they were not worth harvesting, Soybeans grown under open field conditions were always destroyed at an early stage by rabbits.

Yields from the most promising variety of each annual legume for all seasons since 1913 are summarized in Tables XXXI and XXXII.

TABLE XXXI.—YIELDS PER ACRE OF ANNUAL LEGUME CROPS, 1913 TO 1919

(Grown on upland under open field conditions)

	Dry weights							
	1913	1914	1915	1916	1917	1918	1919	Av.
ENTIRE CROP	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Field peas	0.32	1.38	1.03	0.96	0.00	0.77	.....	0.74
Cowpeas	.00	1.87	.62	.47	.20	.72	.76	.66
Soybeans	.00	.54	.07	.00	.00	.00	.00	.09
Tepary beans	.....	2.04	1.05	.85	.00	.00	.79	.79
Pinto beans	.....	.....	.....	.....	.10	.36	.40	.29
SEED (*a*)	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*
Field peas	1.5	7.0	4.6	8.0	0	3.0	.....	4.0
Cowpeas	0	1.1	1.8	3.8	2.9	0	4.6	2.0
Soybeans	0	4.4	0	0	0	0	0	.6
Tepary beans	.....	2.7	10.7	0	0	0	3.8	2.9
Pinto beans	.....	.....	.....	.....	.5	0	0	.2

(*a*) Sixty pounds per bushel.

TABLE XXXII.—YIELDS PER ACRE OF ANNUAL LEGUME CROPS, 1915 TO 1919

(Grown on upland but fenced against rabbits; partly protected against wind by small trees)

	Dry weights					
	1915	1916	1917	1918	1919	Av.
ENTIRE CROP	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Cowpeas	.....	0.72	0.61	0.45	0.61	0.60
Soybeans	1.88	.80	.66	.59	.65	.92
Tepary beans	.....	1.17	.43	.90	1.13	.91
Pinto beans	.....	.....	.70	.50	1.05	.75
SEED	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*
Cowpeas	.....	5.8	8.5	6.3	5.8	6.5
Soybeans	18.0	9.3	4.5	0	3.3	7.0
Tepary beans	.....	0	2.2	0	7.0	2.3
Pinto beans	.....	.....	6.8	0	0	2.3

The date and method of planting, season of growth, and date of harvesting the field peas referred to in these tables were the same as for oats. The cowpeas, soybeans, Tepary beans, and Pinto beans were surface planted in rows 3 to 3½ feet apart between May 15 and June 15, and were harvested shortly before or just after frost. All of these crops suffered considerably each year from one or more of the following: Weeds, cold, drouth, grasshoppers, and rabbits.

Field Peas.—Field peas resemble garden peas in appearance and habits of growth. They require a cool moist growing season for best results, and are therefore not well adapted to western Kansas. They start out well in the spring, but suffer greatly from drouth and grasshoppers during June, the month that precedes maturity.

Spring-sown varieties have been tried out under the names of Hubert, Golden Vine, Kaiser, French June, and Paragon. The data presented are for Hubert, a reddish-purple flowered variety which has given the best results. Several varieties of field peas have been tried for fall seeding. The only one that survived any of the winters is a variety received by the station from Austria in 1911. This variety proved 50 to 90 percent winter-hardy when fall-sown for five successive seasons, They nearly all winterkilled, however, in the unusually dry winter of 1916-17 when but little winter wheat in the county survived.

Cowpeas.—Cowpeas require a warmer and more humid climate than that of western Kansas for profitable results. They are valuable in the cotton belt and the southern part of the corn belt. The varieties that have been grown one or more years at the Fort Hays station include Early Buff, Groit, Early Red, Brabham, Catjang, Iron, Monetta, New Era, Taylor, Whippoorwill, Blackeye, Warren's New Hybrid, and Gray Goose. The yields presented are for Early Buff, an early variety that has matured in from 80 to 110 days.

Soybeans.—Failures with soybeans in western Kansas are due chiefly to rabbits, which feed on this crop in preference to all other legumes tested. The yields, however, have seldom been profitable even when protected from rabbits. The varieties tried include Tashing, Early Green or Guelph, Black Eyebrow, and several early sorts obtained from central Manchuria. The yields presented for 1915 to 1918 are from S. P. I. No. 36648, a Manchurian variety which gave the best results. The yield data for 1913 and 1914 are averages for such other varieties as were tested. Rabbits destroyed the crop before it was six inches high in nearly all cases, except when fenced out with woven wire.

Tepary Beans.—Tepary beans are quite drouth-resistant, but need a warmer and longer growing season than that of western Kansas. They are grown more successfully in the southwestern part of the United States, where the beans are used for human food. In western Kansas Tepary beans are not usually considered equal to Pinto beans in earliness, seed yield, and quality as human food. There are several varieties of Tepary beans distinguished largely by seed color, but only the white

is important. This variety resembles the small white navy bean in size and color of seed. Tepary beans under favorable conditions produce a vigorous leafy fine-stemmed growth. (Fig. 10.) In quality of forage they excel any of the other annual legumes tested. The vines remain green during long drouth periods, but do not bloom and set seed until rains come. Rabbits destroyed the Tepary beans in the open field tests in 1917 and 1918, preferring them to the other legumes except the soybeans.

FIG. 10.—Tepary beans at the Fort Hays station in 1915. This crop usually makes a good vegetative growth, but is not recommended for extensive culture in western Kansas

Pinto Beans.—Pinto beans have proved useful at the Fort Hays station only as a garden crop. They are able to withstand considerable drouth, and yet mature a good seed crop if rains come in time. The forage of Pinto beans is relatively light, but one field near the station made good hog pasture in 1917 after the owner gave up hope of a seed crop. Failures often result from seeding Pinto beans on weedy ground and before the soil is warm. Experiments conducted from 1917 to 1919 inclusive, with reference to the date, rate, and method

of planting Pinto beans, indicate that they should be either surface planted or listed shortly after the best corn-planting date, with a plant every 6 to 12 inches in rows about 40 inches apart.

Vetch.—The vetches are not sufficiently drouth-resistant and hardy to be recommended for more than limited trial in western Kansas. Only the hardiest variety, hairy vetch, should be tried and it should be seeded with a little rye to keep it from lodging. A mixture of 10 to 12 pounds of rye and 30 to 50 pounds of hairy vetch to the acre was seeded in the fall of 1914 on a farm near the station, with the result that most of the vetch either winterkilled or was crowded out by the thin stand of rye. When seeded alone in close drills at the Fort Hays station for five successive seasons, hairy vetch winterkilled twice, produced thin light weedy crops in two other seasons, and produced a clean but badly lodged crop of 1.16 tons of hay to the acre in the one season, 1915, when the rainfall was abnormally high.

Chick Peas.—Chick peas are grown to a limited extent for human food in Mexico and occasionally in the southwestern part of the United States. When planted at Hays in rows on upland in 1913 and 1914, they showed no promise of either seed or forage value. The foliage of chick peas is not only light, but somewhat poisonous to stock.

Spanish Peanuts.—Spanish peanuts are used in the South as pasture for fattening hogs. When planted in rows on bottom land in 1913 at the Fort Hays station, they produced a fair crop of peanuts, but too light a growth to be of value, even in comparison with Tepary beans and cowpeas as forage crops.

MISCELLANEOUS CROPS

Sunflowers, sugar beets, mangel-wurzels, turnips, rape, and sainfoin have been tested for forage during one or more seasons. Most of these crops are known to be of little or no value for this purpose in western Kansas, or are less profitable than others that meet the same needs.

Sunflowers.—Mammoth Russian sunflowers were grown in 1913 and 1914 in surface planted rows 3 to 3½ feet apart, with plants 12 to 20 inches apart in the row like corn, In

1913 they died of drouth when 2 to 3 feet high, but in 1914 they matured a fair crop averaging 5½ feet, high, with a seed yield estimated at 200 to 300 pounds per acre. As silage, this crop was found valuable in a Montana test.[1] The seed is also good for chicken feed. Growing sunflowers on a field scale in Kansas, however, is not recommended, because the best sorghums are preferable for either of the purposes just mentioned.

Root Crops.—Several kinds of roots were grown on bottom land with or without irrigation at various times from 1902 to 1909 inclusive. Yields of 10 tons an acre were not uncommon. They were grown to furnish succulent winter feed for cattle, particularly dairy cows, but also for hogs and poultry. Root crops have not been grown at the station since silos came into use, for corn and sorghum silage serve the same purpose and can be more economically produced and stored.

Rape.—Like the root crops, rape needs a cooler, more humid climate for best results. While it is a good pasture crop for hogs, and may also be grazed by cattle and sheep, it is not as desirable to grow in western Kansas for these purposes as is alfalfa on bottom land or Sudan grass on upland.

Dwarf Essex rape was tested for six seasons. On upland in the dry seasons, 1910, 1911, and 1916, it made an unprofitable growth, because of drouth and grasshoppers. When planted on bottom land in the favorable seasons, 1902, 1912, and 1915, either in 12-inch or 36-inch rows, rape made a satisfactory growth for hog pasture. Hogs having access to both rape and alfalfa pasture in 1912 seemed to prefer the alfalfa. When taken off pasture, the hogs ate freshly cut green rape as readily as cured alfalfa. Attempts in 1915 to feed cured rape to hogs were unsuccessful.

Sainfoin.—Sainfoin, a deep-rooted perennial legume grown in Europe on soils too poor for alfalfa, was tried in rows on upland in 1913 and 1914. It proved quite inferior to alfalfa in yield and showed no promise of value for Kansas conditions.

[1] Atkinson, Alfred et al. Growing and feeding sunflowers in Montana. Agr. Expt. Sta., Univ. of Mont. Bul. 131:1-29. Figs. 4. 1919.

RUSSIAN THISTLES

The use of the Russian thistle as an emergency hay crop has been increasing in western Kansas for several years. Though wide differences of opinion exist as to its feeding value, most stockmen who have used it agree that Russian thistle hay properly handled has some value for wintering cattle. Some stockmen have also reported favorably on its use for sheep and mules.

Cheapness and hardiness are two distinct advantages of the Russian thistle. On nearly all neglected farm land in western Kansas it comes up without seeding and grows vigorously without attention even in adverse seasons. The only expense is for cutting and stacking. The spiny nature of the plant makes it unpleasant to handle, but it is claimed that the spines do not injure stock nor prevent them from eating the hay. It is probably neither advisable nor practicable to seed Russian thistles. It is good management, however, to take advantage of volunteer thistles by cutting them for hay, especially if by so doing seed production can be prevented.

Most of the thistles yet harvested have been from fields where small grain failed or was harvested earlier in the season. In extreme western Kansas, however, a few ranchmen recommend that land be spring disked and harrowed, and then left purposely to produce thistles.

Thistle hay is usually cut after the plants bloom and begin to set seed. If cut earlier they are sappy and may spoil in the stack; if left to mature, the plants get too woody and the spines too hard. It is important to stack the thistles partly green, for at that stage they may be handled more easily than if left to cure fully. No exact data are available as to the yields of Russian thistles, but they may be estimated at from one-half to one and one-half tons of cured hay per acre.

The usual method of feeding thistle hay is to let cattle eat it direct from the stack. Russian thistle meal has been successfully fed to calves in Rooks County, but it is doubtful whether the grinding is a profitable process.

Some ranchmen in Logan and Wallace Counties claim that thistles are nearly equal to alfalfa in feeding value, while some other feeders regard thistle hay only as a last resort.

One cattleman reports that thistles are eaten best in damp weather. It is generally agreed that the stock should also have access to pasture or to such roughage as that of sorghum, corn, Sudan grass, or millet, because thistles are too low in carbohydrates and far too high in soda and other mineral alkali to be an ideal sole ration.

Russian thistles may be pastured during their first six or eight weeks' growth, but the plants later become too spiny.

Silage has been made from the thistles in several instances, but the plant is not well suited to this purpose. Thistles do not pack well enough to exclude air and secure proper fermentation unless put through a cutter and feeding thistles into a cutter is a very tedious process. Their composition, like that of alfalfa, is also too high in protein and low in carbohydrates to make very good silage. A mixture of corn or sorghums with the thistles makes much better silage.