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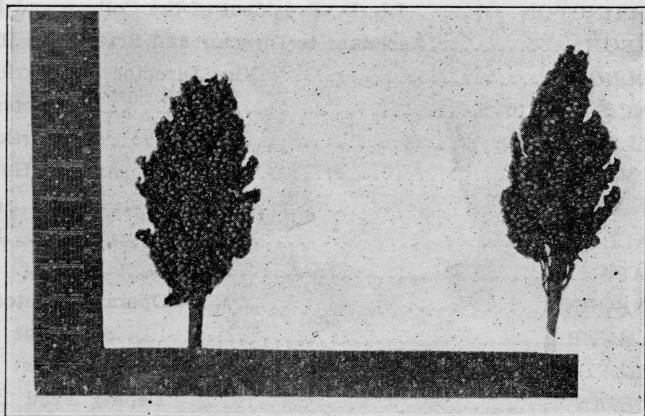
COOPERATIVE FORAGE CROP INVESTIGATIONS

Between the

TEXAS AGRICULTURAL EXPERIMENT STATION

And the

BUREAU OF PLANT INDUSTRY, UNITED STATES DEPARTMENT OF AGRICULTURE.



Desirable and Undesirable Types of Milo Heads.

Forage Crops in Northwest Texas

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Post Office
COLLEGE STATION, BRAZOS COUNTY, TEXAS.

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INTRODUCTION.

In the spring of 1905 cooperative forage crop investigations were undertaken at Chillicothe, Texas, by the Texas State Experiment Station and the Bureau of Plant Industry, United States Department of Agriculture, for the purpose of determining the best forage crops adapted to that region. The following year by a cooperative agreement between the offices of the Forage Crop Investigations and Grain Investigations, United States Department of Agriculture, forage crop work was instituted at Amarillo, Texas on the farm conducted at that place by the Office of Grain Investigations, United States Department of Agriculture. Some work with sorghum had previously been done at Channing, Texas, by the latter office, and this also has been taken into consideration at the preparation of this bulletin. In addition to ascertaining the crops best adapted, the work has included the selection and improvement of the best sorghum varieties for forage, with the view to obtaining pure and early strains, which would mature evenly and give increased yields per acre. Another object was to find a legume which could be utilized as a hay crop, and for improving the soil.

Northwestern Texas as mentioned in this publication includes what is known as the Texas Pandle, and about four tiers of counties to the southward; in other words the counties in Texas lying north and west of a line drawn from Henrietta, Texas, to Abilene, Texas, and west to New Mexico. This territory slopes from an elevation of 4700 feet in the northwestern portion to 1200 feet in the southwestern portion as shown on the accompanying map (Fig. 1). The altitude at Texline is 4694 feet; at Amarillo 3676 feet; at Clarendon 2719 feet, and at Chillicothe 1406 feet. This stretch of country is broken at intervals by ravines, which as a rule, follow river courses and smaller streams.

The following table indicates the climatic features of this region as recorded by the United States Weather Bureau, through the periods of years shown:

CLIMATIC FACTORS.

Town	County	State	Altitude	Mean an. Temp	Mean an. Rainfall	No. of Years Recorded
Mangum	Greer	Okla.	1585	61	25.4	11 years
Abilene	Taylor	Texas	1738	63.7	24.80	21 years
Ft. Sill	Comanche	Okla.	1200	61	30.1	11 years
Amarillo	Potter	Texas	3676	55.9	22.78	15 years
Mt. Blanco	Crosby	Texas	2750	59.9	16.84	15 years

These are the only data available for the region. A large portion of the rainfall comes during the summer months, while the winter season is comparatively dry. In summer the day temperature ranges from 80 to 100 degrees, but is not oppressive on account of a continual breeze. The nights are cool even in the months of July and August. The rainfall as recorded

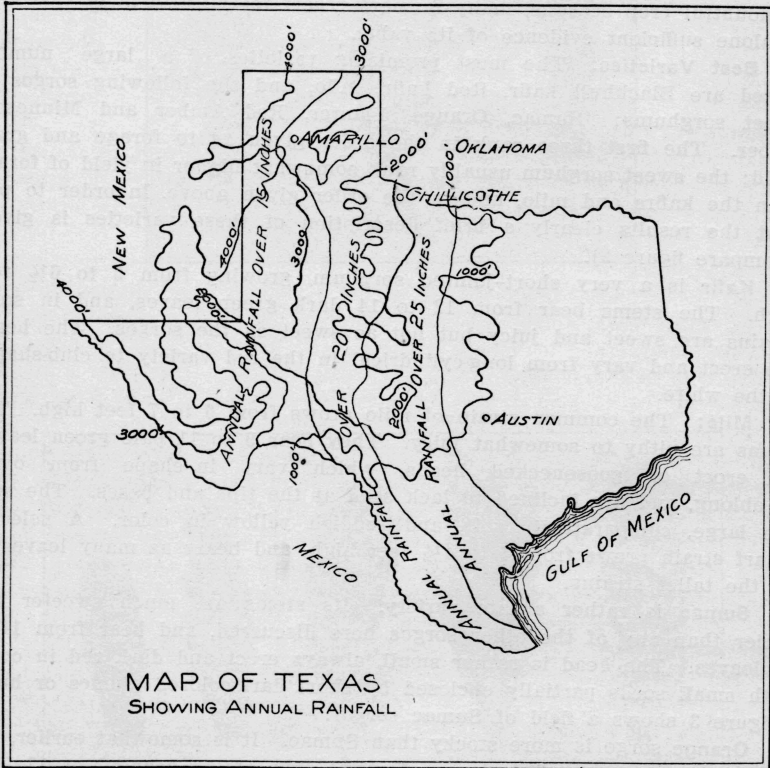
at Chillicothe for the past three seasons is about 30 inches annually. These three seasons are considered by the older settlers to have been unusually favorable. The rainfall at Amarillo for the past two seasons, 1906 and 1907, has been 24.92 and 18.09 inches, respectively.

The virgin land in the southern half of the territory is sparsely dotted with scrub mesquite, while a great portion of the section to the north is treeless. The most common grasses are the gramas and buffalo grass. The soil varies from chocolate-colored sandy loam to a dark adobe and produces large crops under favorable distribution of rainfall. The principal crops in the order of their importance are; the kafirs, milo, sorgho (the sweet sorghums), wheat, oats, melons, and alfalfa, and in the southern half considerable cotton, cowpeas and corn. Tillage as a rule is rather poor. The lister is most commonly used for planting, while the other implements of cultivation are the disk harrow, the spike-toothed harrow, the sled-cultivator, and the ordinary large shovel cultivator. In some portions of this territory from ten to twelve successive crops of sorghum have been grown on the same land; this, however, is not a common practice.

The results of the work at Chillicothe apply directly to the territory within a radius of 70 miles; those at Amarillo to a territory about as large; and the results at both places in a general way to the whole of northwestern Texas.

The work at Chillicothe in 1905 and 1906 involved the growing of over 600 plots. These included 450 lots of sorghum, 12 of alfalfa, 45 of cowpeas, 30 of moth, mung and other beans, and a large number of soy beans, vetches and other legumes, grasses and corn. This bulletin deals only with the first four crops, and results given are based on actual field tests. Soybeans have not been successful as a field crop on account of being entirely destroyed by rabbits early in the season. Spring sown vetches have so far proven entirely worthless for this section. Fall sown vetches with rye, oats and barley are of some promise. Most grasses have so far been unsatisfactory; rescue grass, however, has proved to be excellent for winter grazing. The work in 1907 has been largely the growing of the more promising crops, planted at different rates and at different dates to get information as to the best methods to secure maximum yields.

The forage crop experiments at Amarillo, Texas, during the season of 1906 and 1907 have been conducted with the assistance of Mr. A. H. Leidigh, Superintendent of the Amarillo Experiment Farm, and have included, as a rule, only varieties that were reasonably sure of success. The results of this experimental work will be taken up separately in the latter part of this publication.



FORAGE CROPS AT CHILLICOTHE.

SORGHUM.

Importance of the Crop: Sorghum as a forage crop, throughout this region, is far more important than corn. On account of the remarkable drought resistance of most varieties, it safeguards against absolute failure and produces as well heavy yields of cured forage per acre. The fact that in doubtful crop seasons, many farmers resort to the growth of this crop is alone sufficient evidence of its value.

Best Varieties: The most promising varieties of a large number tested are Blackhull kafir, Red kafir, milo, and the following sorgos or sweet sorghums: Sumac, Orange, Planter, Red Amber and Minnesota amber. The first three rank in the order given as to forage and grain yield; the sweet sorghum usually rank somewhat higher in yield of forage than the kafirs and milo, and in the order given above. In order to present the results clearly a brief description of these varieties is given. (Compare figure 2).

Kafir is a very short-jointed sorghum, growing from 5 to 6½ feet high. The stems bear from 12 to 14 dark green leaves, and in some strains are sweet and juicy but not as sweet as the sorgos. The heads are erect and vary from long-cylindrical in the red variety to club-shaped in the white.

Milo: The common strain of milo grows from 6 to 7 feet high. The stems are pithy to somewhat juicy. They bear 9 to 11 pale green leaves, and erect or goosenecked heads, which vary in shape from ovate to oblong, and are inclined to lack seed at the tips and bases. The seed are large, comparatively soft, and reddish yellow in color. A selected dwarf strain grows from 4 to 4½ feet high, and bears as many leaves as do the taller strains.

Sumac is rather a late variety. Its stems are much sweeter and juicier than any of the other sorgos here discussed, and bear from 14 to 16 leaves. The head is rather small, always erect and dark red in color, with small seeds partially enclosed by short dark-colored glumes or hulls. (Figure 3 shows a field of Sumac sorgo).

Orange sorgo is more stocky than Sumac. It is somewhat earlier, but lacks in sweetness and juiciness of stem. The stalks bear 12 or 13 light green leaves and produce erect, rather compact heads, considerably larger than Sumac heads, and with much larger seeds and hulls.

Planter sorgo has been grown in the United States for a number of years but has been lost sight of until recently. In habit of growth it resembles Orange. It is about as early as Sumac, and has in some cases proven a heavier yielder. In leafage and sugar contents it is about equal to Orange. It seeds more heavily than any other variety of sorgo. The heads are large, light brown in color, and may have either drooping or erect branches. The seeds and hulls are as large as those of Orange.

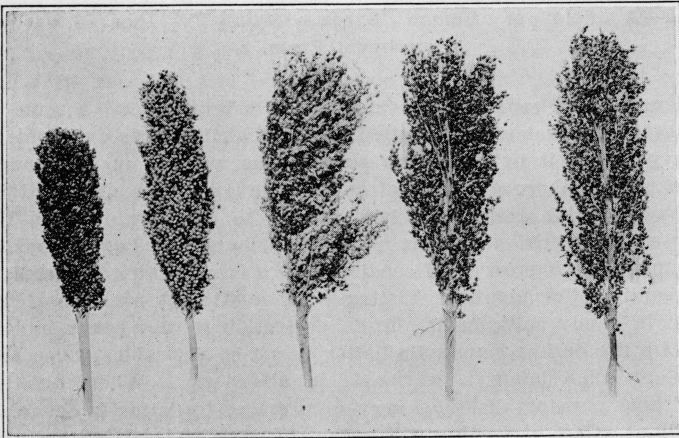
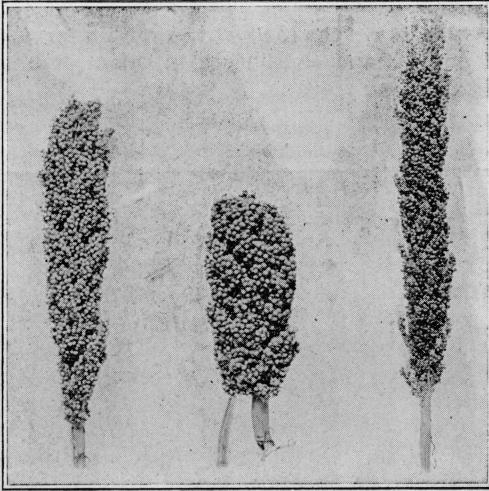


Figure 2—Typical heads of sorghum varieties. Upper figure from left to right showing Blackhull Kafir, Milo and Red Kafir. Lower figure showing Sumac, Orange, Planter, Minnesota Amber and Red Amber.

Red Amber is a new variety not yet on the market. It grows from 6 to 8 feet high, and bears 9 or 10 narrow light green leaves. The stem is very tender, juicy and sweet, and bears a large loose head. It is one of the best Amber sorghums.

Minnesota Amber is a very early strain, with a large open black head. The hulls are large, flat and bluish-black in color. It is an excellent Amber strain.

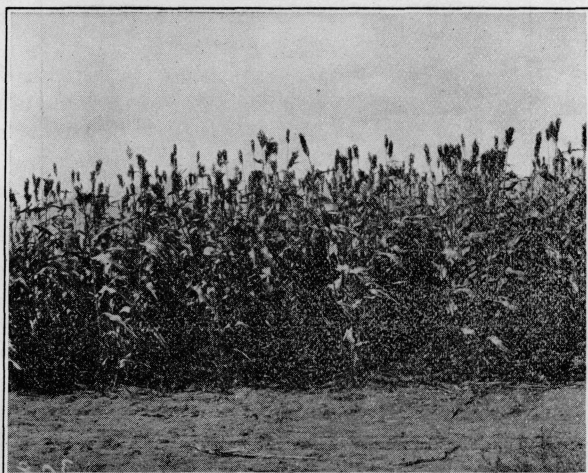


Figure 3—A field of Sumac Sorgho yielding $7\frac{1}{2}$ tons. Amarillo Experiment Farm.

Soil and Soil Preparation: On the newly broken land sorghum is one of the best crops that can be planted, and though it makes excellent growth and heavy yields, it by no means succeeds as well as on old land. Rich sandy loam in a thorough state of cultivation is most nearly ideal for the best growth of this crop. The land should be deeply plowed in the fall or early spring with a turning plow, and should be kept in good tilth with a smoothing harrow until seeding time. It may later be listed or left flat in readiness for planting. Listing with or without previous plowing is desirable in sandy soils, as it affords protection to the young and tender plants. On the darker loam soils listing is not so desirable. Deep plowing, however, on such lands is advisable in all cases. Where the land is listed without plowing, disking sometime previous to listing is desirable.

Seeding: Careful seeding will not only insure a stand, but an increased yield of forage per acre. Hand thrashed seed will give a much more regular stand than seed from a thrashing machine ordinarily planted. The earliest seeding can be made about April 15th. This is two or three weeks later than the season for planting corn. Later plantings may be made at any time up to July 15th. The sorghos are preferably seeded late in the season as this affords less opportunity for the cured forage to be dried out

by the winds before feeding time. In the kafirs and milo, however, this loss would be overcome by the much heavier yield of seed produced by the early plantings. If seeded in rows 3 or 3½ feet apart, the sorghos require from 12 to 20 pounds per acre; the kafirs and milo from 6 to 10 pounds per acre. Where grown in close drill rows or sown broadcast from 1 to 2 bushels of seed will plant an acre of sorgho, while the kafirs and milo require from 20 to 30 pounds. A common practice is to plant sorghum in the lister furrow. It is claimed that aside from the protection the furrow gives the young plants, listing enables the crop to gain access to a greater amount of moisture than when planted on the surface. In either case it is very desirable to use a planter that has a pack-wheel following, as this guards against planting too deep or losing a stand by the surface soil drying out.

Cultivation: Sorghum in rows should have at least two early and thorough harrowings with spike-tooth harrow. As soon as the crop will permit the field should be cultivated deeply, preferably with small shovels, so as to leave the surface flat. On account of the ridges, listed crops are seldom cultivated early and deeply. Harrowing a third time across the rows or with a heavily weighted harrow length-wise to them, will pull down the ridges sufficiently to allow the necessary early and deep cultivation. This crop may be cultivated without harrowing quite satisfactorily with a sled cultivator. Two or three later and shallower cultivations are necessary for the best growth. Sorghums planted in drills 8 to 24 inches apart should be harrowed once early in the season, and later cultivated length-wise to the rows with a weeder.

Harvesting: The usual practice is to harvest the crop at the most convenient time after the seed reaches the soft dough stage. In many cases harvesting is so long delayed that the fodder is of poor quality. If cut in the late dough stage excellent fodder may be obtained, but the cutting of large fields should be started somewhat earlier so as to get as much of the crop as possible harvested in the best condition. If the crop is to be headed in the field and used as feed it should stand until the stem at the base of the head is dry. This is usually from two to four weeks after the grain is mature. The remaining forage can then be pastured in the field.

If planted in three and one-half foot rows, the crop is best cut with a corn harvester and put in shocks of 30 to 40 bundles each. If planted in close drill rows or sown broadcast for hay, the crop may be cut with a binder or with a mower and cured in shocks. Fields of kafir and milo grown for seed are frequently headed by hand, though kafir or a dwarf, erect headed variety of milo can be headed with machinery.

Yields: Time, rate and manner of seeding greatly influences the quality and yield of forage per acre. Medium early plantings, sufficiently thick and regular in the drill to allow the crop to utilize all available moisture, are most favorable to the maximum yield of forage per acre. The yields under such conditions during the season of 1907, which was not at all favorable to a heavy production of forage were as follows: Sumac 5 tons, Orange 5 tons, Blackhull kaffir 4½ tons, Red Amber 4½ tons, Minnesota Amber 4¼ tons, Planter 4¼ tons, Red kaffir 4 tons, and Milo 3 tons. These crops were all

allowed to cure in the shock for about five weeks before weights were taken and were thoroughly dried out.

Beginning on April 15th, 1907, plantings were made of Blackhull, Kafir, Red Kafir and milo ever 15 days through the season up to July 15th. These different plantings were at the same rates, and were given as nearly as possible the same cultivation. The results obtained showed the heaviest yield of forage from the early plantings.

The kafirs and milo, as well as the sorgos can be grown profitably as a hay crop in drill rows from 8 to 24 inches apart. However, as a rule, they are planted in rows three to three and a half feet apart and cultivated. In this case they are most often planted too thinly in the drill to give the maximum yields of forage of the best quality. From the plantings made April 25, 1907, at different rates from one to sixteen inches in the drill it was found that the heaviest yields of forage were secured from the kafirs, and the sorgos when planted in drill rows 21 inches apart and with stalks every inch. All the plantings were cultivated. Milo produced most forage when planted in rows 42 inches apart with stalks every inch. The best seed yields were given by the kafirs and the milo, when planted in rows 3 feet apart, with stalks every six inches. The maximum yield of seed from milo may probably be obtained by thicker planting, although this was not indicated in the above test. The sorgos have produced most seed when planted in rows 3 feet apart and with stalks every three inches.

Surface planted kafirs and milo at Chillicothe during the season of 1907 gave much larger yields of both forage and seed than did deep listed plantings. However, a much better stand was secured and retained on the surface planting.

Threshing: The average milo is too tall to thresh in the bundle. If grown for seed it is, therefore, headed by hand, an operation which necessitates considerable labor. These heads can be threshed quite satisfactorily with a small percentage of cracked grains, by removing the concaves from an ordinary threshing machine, and running the cylinder at a low rate of speed, at the same time feeding the machine as heavily as possible. Extra dwarf strains of milo can be threshed from the bundle like wheat or oats. The kafirs, on account of the stoutness of the stalks, must ordinarily be headed before threshing.

Seeds Selection: In the selection of seed, every farmer should aim to increase the quality as well as the yield of the crop. This can be done by the selecting for a higher percentage, by weight, of leaves and seed to the amount of stalk. Since the stems of the sorgos have considerable sugar, a large percentage of stalk is not so undesirable as in the kafirs and milo. The most desirable selection is one that will give the maximum yield of combined forage and seed of the best quality. The stems of such a strain must necessarily contain as much sugar as possible and bear as many leaves as the variety will carry. Its head must be well shaped and well filled both at the tip and butt. (Figure 4 shows selected field of kafir). Time or rate of planting, or climatic conditions will cause a variation in the rate of growth, and consequently in the uniformity and yield of the crop. Therefore, in making selections in the field care must be taken to note the relative conditions under which each individual plant grows, so as to choose plants

which have had unusually favorable conditions. These selections should be made as soon as the heads are filled, and near the center of the field, preferably at least 100 feet from any other variety of sorghum. Care must be taken to remove from the patch before blooming time all other sorts, as the sorghums cross rather freely. The results of the past work have shown that selections thus made will give in three years a perfectly uniform strain. The sorghums have heretofore, had little or no selections and for this reason respond remarkably to careful work along this line.

Blackhull kafir: In selecting Blackhull kafir, only medium early plants without branches should be considered, and these must have sweet and juicy stems. These should bear not less than 14 leaves, and rather club-shaped heads entirely free from the boot. The heads should not be too loose or open at the tip, and must be well filled at the butt. The type of the head is easily controlled by selection.

Red kafir: In selecting Red kafir the same type of plant as for the



Figure 4.—A field of selected kafir planted thickly for forage.

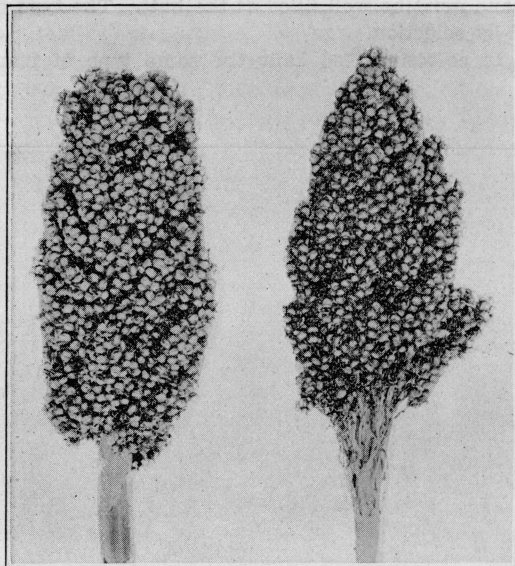
Blackhulled variety is desired, differing only in that the head should be broad and fairly long, with red seeds, and should not be pointed at the butt or tip. Reference should be given to the form, rather than to the size of the head.

Milo. In making milo selections only medium dwarf early plants that have no tendency to put out branches should be considered, and the stems of these should be somewhat juicy and as sweet as possible. The stalk should bear at least 12 leaves, and should have preferably an erect head well out at the boot or sheath. The head need not necessarily be large, but should be well-shaped, (see Fig. 5), rather oblong, and well filled both at the tip and butt. The tip of the head should not be pointed, but rather blunt.

Sorgos: Seed selections in the sweet sorghums is very desirable. This must be done also as soon as the heads are mature, and only from medium

early plants without branches. The stem should be very sweet and juicy, and very leafy. The head must be fairly large, and characteristic in shape of the variety.

Thrashing Selected Seed: Seed for planting should not be thrashed with a machine, as many grains are cracked and this destroys their vitality. The heads saved for seed when thoroughly dry can be flailed out easily by hand and winnowed. Where a fanning mill is not available the seed may be cleaned by placing in water. All chaff and light seeds can thus be removed, leaving only the clean, heavy grain. In this manner, one man can in a half day thrash and clean sufficient seed to plant 150 acres.



ALFALFA.

Alfalfa promises to be a valuable crop throughout this section. Its acreage about Chillicothe has increased from 11 acres in January 1904 to 1415 acres in 1907. With great care in preparing and seeding the land an excellent stand can be secured and unless the first two seasons are extreme-

Figure 5.—Desirable and undesirable types of Milo heads.

ly dry ones, the crop will have an excellent opportunity to root deeply. After the roots are well established alfalfa should withstand the drouth and make fairly profitable yields.

Preparation of the land: Alfalfa should not be planted on newly broken land. Thoroughly tilled land which has been in cultivation for some time is most desirable. It should be plowed early and deeply, and preferably cultivated through the season without a crop. However, land from which a crop of winter wheat has been taken can be prepared by plowing

the stubble deeply not later than July 1st. This can be thoroughly disked and harrowed and will have ample time to settle a firm seed-bed and catch the necessary rainfall to insure a stand. If a cultivated crop is grown it should be a hay crop of cowpeas well tilled. This crop must necessarily be planted before April 1st. The cowpeas should not be plowed under as the vines will not decay in time for planting alfalfa. As soon as the hay is taken off, the land should be plowed shallow and harrowed thoroughly so as to crush all clods and put the soils in perfect tilth. This early preparation will give at least a month and a half for the seed-bed to become settled, and to absorb any rain which may fall. Harrowing or dragging before planting will smooth the land and put it in a more satisfactory condition for drilling.

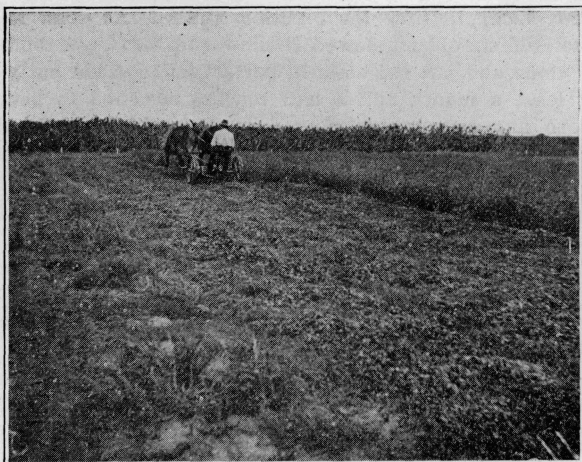
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Seeding: Alfalfa should be seeded in the fall, preferably between August 15th and September 1st. It can be seeded, however, as late as November 1st if conditions are favorable. Seeding in spring is not advisable on account of weeds and the prevailing high winds. The seed should be drilled rather than sown broadcast, as it will be distributed more evenly and at a more uniform depth. Alfalfa can be planted with an ordinary wheat drill by inserting pieces of leather in the feeds, or by ordinary wheat half and half with corn meal and setting the drill as for planting 3 pecks of wheat per acre. As a rule the seed should be planted somewhat more deeply on sandy soils than on the darker loams. However, with a drill it is easy to put the seed too deep and care should be taken to avoid this, especially on very sandy soils. If a hoe drill is used, a light drag or smoothing harrow following will fill the small furrows and lessen the danger of losing the stand by heavy rains. Broadcast seeding is not recommended because the seed cannot be put in at an even depth. In such event this often results in an uneven stand due to the high winds drying out the surface soil to such an extent that many seed do not germinate. If the soil is in the proper tilth, twenty pounds will be sufficient seed to plant an acre. With care good results are obtained with 12 or 15 pounds.

Cutting and Curing: Alfalfa should be cut two or three days after the first blossoms appear. A delay of four days on each of three or more cuttings during a favorable season will lose, in addition to the leaves dropped, a full cutting of hay. Delay in cutting young fields is very injurious to the crop, and in no case should they be allowed to produce seed. During the first summer the cuttings should be made with the cutter bar of the mower set high. Alfalfa will not as a rule thicken its stand by its own seed, and no field should be allowed to seed for this purpose. Alfalfa is always cut with a mower and put in windrows or cocks to cure. Figure 6 shows the fourth cutting of alfalfa sown the preceeding fall. If cut in the morning the crop should be raked into windrows the same day, and put into cocks the day following. The hay will cure sufficiently in three or four days to be stacked or stored under cover. Cocks small enough to handle with pitchforks without tearing apart are most desirable, for the reason that they can be handled with the least loss of leaves.

Treatment of the Field: Young alfalfa may be harrowed the first season after each cutting and in case the field has made good growth may be lightly disked and harrowed after the last cutting. After the first year the

field should be disked at least twice during each season. This can be done once early in the spring before growth begins, and later in the season after one of the cuttings. The disk should always be followed with a smoothing



Fourth Cutting Alfalfa on Testing Station Field August 17, 1906.

harrow. Disking gives the field thorough cultivation and tends to thicken the stand by splitting the crowns. It is therefore very helpful to the crop.

Yields: In comparative tests on both small and large plots Kansas, Texas and Wyoming grown seed produced the heaviest yields of hay in the order mentioned. Turkestan alfalfa gave the poorest yield of seventeen lots tested for a period of three years. The average yield per acre at Chillicothe for each of the past three seasons has ranged from $2\frac{1}{2}$ to $3\frac{1}{2}$ tons. This yield at the average price makes the crop compare favorably with wheat.

COWPEAS.

Value as a Crop: The cowpeas as a crop throughout this section will produce from one to two tons of cured hay per acre. Figure 7 shows a field of cowpeas. It is a legume and, therefore, may add to the fertility of the soil by fixing nitrogen from the air by means of the tubercles on the roots. The roots also tend to make the soil more porous and to put it in much better physical condition. For these reasons the cowpea is a very profitable and valuable crop to grow in rotation with the sorghums to precede alfalfa. It is a valuable crop to plant in corn at the last cultivation and is also frequently grown as a second crop on wheat stubble. The vines when turned under green add much humus, which produces a loose friable condition of the soil.

Best Varieties: . . . Of a number of varieties grown during the past three seasons, New Era, Clay, Iron, Unknown, Holstein, Red Ripper, and large Blackeye are the most promising commercial varieties in the order mentioned. The New Era and a selected Clay are both fairly erect early varieties

and make a large growth of vines. They are heavy seeders, and excellent forage varieties. The Iron and Whippoorwill are both large growers, and heavy seeders. The Iron is fairly erect; the Whippoorwill has a tendency to trail more than either the New Era or the Clay and is, therefore, less de-



A field of Clay Cowpeas.

sirable. The four remaining varieties make an excellent growth of fairly erect vines, but are light seeders, and consequently do not make cowpea forage of the best quality.

Preparation of the Soil and Seeding: The land should be plowed early and harrowed as in preparing land for any other crop. If the crop is to be planted on wheat stubble or any other land which has been cropped the same season, it may be plowed, listed, or furrowed and planted without plowing. However, plowing the land is most desirable. Cowpeas may be planted at any time between May 15 and August 1st. Early plantings usually seed heavily in this section, and, therefore, make forage of the first quality. Late seedings usually produce heavy crops of forage, but ripen few seeds. Cowpeas should be planted preferably in rows three feet apart so that the crop can be cultivated. If sown broadcast or planted in close drill rows without cultivation the crop does not yield as heavily throughout this region either in hay or seed. In rows three feet apart from 8 to 10 pounds per acre will give an excellent stand. If in close drill rows or sown broadcast from 30 to 60 pounds is required.

Cultivation. The cowpea as a crop is generally regarded as one that needs little cultivation. Like most other crops, it will make more profitable yields when cultivated. While the plants are small the field should be harrowed and later given at least two cultivations with small shovels. This saves moisture and gives more ideal conditions for the formation of tubercles on the roots.

Harvesting: Cowpeas should be cut as soon as the crop is heavily seeded and half the pods begin to ripen. Delay after this means loss by the dropping of leaves and the shattering of seeds. If, however, the crop is grown solely for seed it should not be harvested until a full crop has matured. Cowpeas are always cut with a mower and put in small cocks with rake or fork. These cocks will cure sufficiently to stack in 7 or 10 days. The hay should be handled as little as possible so as not to shatter the leaves and seed. If grown for a seed crop, the vines can be thrashed quite satisfactorily with a machine.

MOTH BEAN (*P. aconitifolius*): MUNG BEAN (*P. max*; *P. radiatus*).

These beans are native of India where the seeds are used as human food. The Moth bean in this country produces very little seed but makes a tremendous growth of fine-stemmed leafy vines which cure more easily than cowpeas, and make a hay of about the same quality. The plant is a legume and becomes inoculated very readily. It is apparently more resistant to drought than cowpeas, and promises to be valuable to grow in rotation with sorghum and as a second crop on wheat land.

The Mung beans make an erect growth and seed fairly well. They are not as easily cured as cowpeas nor do they make a hay of the same quality. They are perhaps somewhat less resistant to drought than the Moth bean.

Preparing, Seeding and Cultivating the Land. The land should be prepared the same as for cowpeas. Thorough preparation is always advisable. These beans are preferably planted in rows two and one-half or three feet apart, and with plants every 2 or 3 inches in the row. This requires from 5 to 6 pounds of seed per acre. If seeded broadcast or in close drills from 2 to 3 times as much seed is required. This crop should be given at least two cultivations, and the surface soil should be left as smooth as possible so as to facilitate harvesting.

Harvesting the Crop; Yield per Acre. The Moth bean should not be harvested until it has made the maximum growth. Cutting can be delayed until just before frost without a serious loss of leaves. In rows three feet apart it produces a dense tangled mass of fine-stemmed leafy vines, which, on account of the thickness and evenness of the growth can be harvested with a mower. These vines can be put in windrows with a rake and left to cure.

In 1906 the Moth bean planted in rows 3 feet apart and cultivated twice gave a field yield of 3892 pounds per acre. In 1907 it gave on wheat stubble an estimated yield of one ton per acre. This bean has so far failed to produce enough seed to replant the crop another season. However, this is not a serious drawback as seed can be imported very cheaply. Results thus far indicate that the Moth bean planted late in the season gives better growth than cowpeas planted at the same time, and it may prove a more profitable crop for late plantings.

The Mung beans must be harvested as soon as the first pods are ripe, so as to avoid the loss of leaves and seeds. This forage can then be put in small cocks to cure. The Mungs do not compare with either the Moth bean or the cowpeas, and have little promise as a forage crop.

FORAGE CROPS AT AMARILLA.

The forage crops tested at the Amarilla Experiment Farm were planted

at about the same rate and given a similar tillage to those at Chillicothe. Among these were ten varieties of sorghum, sixteen lots of alfalfa, twenty lots of cowpeas, four soybeans, two millets, eight grasses and fifteen lots of Mung beans. Although the rainfall has been near the average each season, both the sorghums and the cowpeas have been favored by late rains at the time when most needed, especially during the season of 1907. This has had a tendency to increase their yields but not abnormally. The soil is somewhat stronger than at Chillicothe, and this also should be taken into consideration.

SORGHUM.

The sorghums during the seasons of 1906 and 1907 made on the whole better yields than those at Chillicothe. The average yields of different varieties for the two seasons range from $2\frac{1}{2}$ to 8 tons per acre. The following varieties gave average yields of forage per acre as follows: Sumac $8\frac{1}{2}$ tons, Planter $7\frac{1}{4}$ tons, Orange 6 tons, Blackhull kafir $6\frac{1}{2}$ tons, Red kafir $5\frac{3}{4}$ tons, Minnesota Amber $3\frac{1}{2}$ tons, Milo $2\frac{1}{2}$ tons. These crops were allowed to cure in the shock for about five weeks before weights were taken. Two plantings were made in 1907, in drill rows twenty-two and forty-two inches apart, with stands in the row about equal and averaging a stalk every three to five inches. A much heavier yield of forage was obtained from the planting made in twenty-two inch drills than those from the wider rows. This marked difference was due in part to the fact that the thicker planting did not reach the stage at which moisture is most needed before the late rains, and consequently did not suffer as much as did the thinner plots. The Milo in forty-two inch drills, contrary to the above, gave a heavier yield of forage than when planted in twenty-two inch drills. This can be explained, however, by the fact that the Milo in both cases, characteristic to the variety, put forth its energy to produce a crop on the available moisture, and consequently the thinner planting suffered least and gave a higher forage yield. The results of the two season's work indicate that five or six tons of cured forage per acre would not be an extraordinary yield for the average season.

ALFALFA.

In April, 1906, sixteen lots of alfalfa were planted on well prepared soil at Amarillo. In September of the same year eleven other lots were planted. Notwithstanding the fact that these were harrowed and kept in excellent growing condition, only one clipping was had during the season of 1906, and that not sufficiently large to get weights. During the following season only one clipping was had, and from this weights were taken which range from one to fifty-six pounds per plat (one-twentieth acre), averaging $12\frac{1}{2}$ pounds per plat, or 250 pounds per acre. Such a yield for a period of two years indicates that the crop cannot be profitably grown on the uplands. Some alfalfa is, however, quite profitably grown in depressions locally known as swales on beaches around lakes, and especially in canyons.

COWPEAS.

The growth made by cowpeas during the season of 1906 was only fair. during the following season (1907), a number of these peas made excellent forage yields. New Era, Early Black, Clay, 60 Day, Warren's Hybrid, War-

ren's Extra Early, Michigan Favorite, and Turney's Blackeye all made more than two tons of cured forage per acre. New Era gave a yield of 3 tons per acre. Cowpeas, thus far, have not become inoculated noticeably. Nevertheless this crop with careful treatment promises to be quite profitable, and one which in all probability will take the place of alfalfa on the uplands.

SOY AND MUNG, BEANS.

The soybean has proven an unsuccessful crop for this section, on account of the fact that all plantings are destroyed by rabbits.

The mung beans do not compare with the cowpeas in yield of forage or grain.

MILLETS.

Two varieties of millet, New Siberian and Hungarian, were grown during the seasons of 1906 and 1907. These averaged one ton of cured hay per acre, which is about a normal crop. Millet can best be grown as a catch crop.

GRASSES.

Orchard grass, slender wheat grass, and *Bromus inermis* made fair growth through the winter. Side oats grama made an excellent summer growth. These grasses, though quite promising, are not recommended except for planting in small enclosures for calf pastures, etc. The soil must be thoroughly prepared before planting.

SUMMARY.

Sorghum is by far, the most important forage crop throughout this section. It not only gives a heavy yield of forage per acre but is more dependable than any other feed crop that can be grown.

The best forage varieties are: Sumac, Orange, Planter, Blackhull Kafir, Red Kafir, Red Amber, Minnesota Amber, and Milo.

Careful seeding is of the greatest importance, as the stand controls largely the growth and yield of the crop. Hand thrashed seed germinate to an even stand and are found more satisfactory for seeding purposes than machine thrashed seed. The use of a planter that has a pack-wheel following will in most cases insure a perfect stand.

The heaviest yields of forage were had from the sorghos and kafirs when planted in drills 21 inches apart with stalks every inch. Milo gave the largest yield in rows three feet apart with stalks every inch. These yields ranged from 3 to 6 tons per acre at Chillicothe and from 3 to 8 tons at Amarillo.

Seed selection will greatly increase the quality and yield of forage per acre. This can be done by selecting for a higher percentage by weight of leaves and seeds to stalk; at the same time increasing the quality of the stem by decreasing its size and increasing the percentage of sugar.

Alfalfa promises to be a valuable crop in the southeastern part of the

section, but throughout the northwestern portion it has little promise except when grown in depressions between hills, locally known as swales, on beaches around lakes, and especially in canyons.

Kansas and Texas grown seed give best results. Turkestan alfalfa has proven so far to be a poor yielder.

The cowpea is a valuable crop to rotate with the sorghums and promises in the northern half to take the place of alfalfa on the uplands.

The moth bean compares favorably with cowpeas in yield of hay and is apparently more resistant to drouth. It is, therefore an excellent crop to grow in rotation with sorghum or to plant as a second crop on wheat land.

The End.