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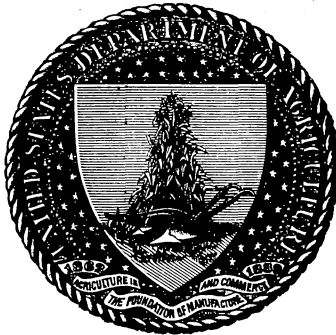
SORGHUM AS A FORAGE CROP.

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SORGHUM AS A FORAGE CROP.

GENERAL CHARACTERISTICS AND ORIGIN.

There are comparatively few plants that will flourish under such widely different conditions of soil and climate as sorghum. The tendency to vary, which enables it to adapt itself so readily to different conditions of environment, has produced an almost endless number of varieties, differing chiefly in habit of growth, character of the seed, degree of sweetness, and length of season required in which to reach maturity. There are two main groups of these varieties, separated largely in common practice according to the character of the juice or sap. One group, the sweet or saccharine sorghums, containing a considerable amount of sugar, the other, the nonsaccharine sorghums, containing comparatively little of this substance. The varieties of the first group are cultivated chiefly for the manufacture of sugar and molasses, while those of the second group are cultivated principally for forage and grain. One variety, broom corn, is grown for the manufacture of brooms and brushes. The varieties of the first group form the subject of this paper.

Sorghum is supposed to have come originally from equatorial Africa. At the present time some of its many varieties and forms are cultivated more or less extensively in all the warmer regions of the earth. In some countries, notably parts of Asia and Africa, it is one of the principal sources of the food supply for both man and beast.

Sorghum was first grown in the United States in 1855 from seed obtained in China. Two years later Mr. L. Wray introduced fifteen varieties, which he had collected in southern Africa. Since then many new varieties have been introduced from various foreign countries, and many more have been originated by growers here in the United States, until at the present time they are so numerous and the names are so much confused that it would be useless to attempt anything like a complete enumeration of them here.

EXTENT OF CULTIVATION IN THE UNITED STATES.

Since its introduction into this country some forty years ago, the cultivation of sorghum has spread very rapidly. At first it was grown almost entirely for the manufacture of sugar and molasses, but its value as a forage crop was soon recognized by many farmers, and for the past fifteen years or more it has been extensively grown for that

purpose in many parts of the country. It is regarded as one of the most valuable forage crops for the South, particularly the drier portions, and for a large part of the semi-arid West and Southwest. In 1895, 283,137 acres of the sweet sorghums and 232,498 acres of the nonsaccharine varieties were grown in Kansas alone for grain and forage. The total value of the product was nearly \$4,000,000.

The sweet sorghums are successfully grown in nearly every State and Territory in the Union, the only exceptions being some of the colder New England States and those in the Northwest which include the higher altitudes of the Rocky Mountains and other ranges. In most localities south of Pennsylvania, Minnesota, and Oregon, two or more crops may be harvested in a single season.

While the acreage of sorghum annually sown for forage has increased very materially during the past ten or fifteen years, there has been a decrease in that grown for the manufacture of sugar and molasses. During the ten years from 1878 to 1888 an extended series of experiments in making sugar from sorghum was carried on under the direction of the United States Department of Agriculture. The great interest taken by farmers in this industry led them to plant many more acres of sorghum than could be successfully handled with the means at command, and in many cases serious financial loss resulted. This caused a falling off of the acreage, until at the present time few farmers grow more cane than is wanted for home consumption, either for forage or for molasses, unless in the immediate vicinity of a successfully operated mill. In this case the cane is readily marketed and reasonable returns are assured.

VARIETIES.

Although there have been so many varieties of sorghum introduced into cultivation, not more than ten or twelve of these are in general use at the present time. Those which give best returns in sugar and molasses are not always the best to grow for forage. For this purpose they should be hardy, rapid growing, not too coarse, quick maturing, well seeded with soft seed free from astringency, and they should stand up well. While a high sugar content is desirable, that quality is not so necessary as are the others named.

Early or late varieties may be used, according to the time at which the forage will be most needed. As a general rule, the earlier varieties are the best for forage purposes. Seed may be planted at various times during the spring, and thus almost any desired succession of forage obtained.

The Amber canes are the most widely used for forage purposes, especially the earlier sorts. In the North and West, Early Amber and Minnesota Early Amber are grown almost exclusively. The former originated in Indiana as an early form of one of the Chinese sorghums, and from it the latter originated, as the name indicates, in Minnesota.

The Amber canes have a high sugar content, and come nearest to combining all the other qualities of a general-purpose cane. Next to these in value and extent of cultivation come the Orange varieties, especially those known as Early Orange and Kansas Orange. These are extensively grown in the South and Southwest, and are preferred by some to the Amber canes. The Orange canes are generally coarser growing and later than the Amber, and hence are less desirable for early feed or for hay, although as good or even better, perhaps, for late soiling or for the silo.

Other varieties used more or less extensively for forage purposes are Folger's Early, Coleman, and Gooseneck. The first is said to be an excellent variety to use for summer pasturage.

CONDITIONS OF GROWTH.

Sorghum, like corn, does best on rich, sandy loams. It is a stronger feeder than corn, and gives better results on thin lands. It is maintained that when land has become too poor and thin to raise corn or small grain two or three good crops of sorghum may be obtained from it, and the land will be left in better condition for corn, cotton, and other surface-feeding crops. In California and elsewhere good yields are obtained on soils containing a high percentage of alkali, and hence it is regarded as a good crop to use in rotations for such lands.

Sorghum is generally regarded as harder on land than corn, and this is undoubtedly true to a great extent, since it is a deeper feeder and two or more crops are often harvested in a single season. Still there are many instances of sorghum being grown on the same field for many years without any apparent lessening of the quantity or quality of the crop from the impoverishing of the land, and there are many soils that are undoubtedly benefited by the deep-growing roots of the plant. Sorghum, like corn and other related plants, draws a large proportion of its food elements from the atmosphere. The principal materials taken from the soil are potash, phosphoric acid, and nitrogen. Comparatively little of the last substance is used.

As sorghum is grown in many places it is certainly not as hard on the land as most other crops. When planted late, sown with cowpeas or field peas and cut before the seeds ripen, the land is left in excellent condition, especially if it is plowed soon after the crop is taken off.

A native of the tropics, sorghum naturally reaches its best development where high temperatures prevail. Because of its wonderful adaptability, however, varieties have been developed which are perfectly hardy throughout the greater part of the United States and in many portions of Canada. As a general thing, sorghum will do well in the North wherever corn can be successfully grown, while it is a standard crop in many places in the South where corn is grown in limited quantities. Both the saccharine and the nonsaccharine varieties of sorghum endure drought much better than corn, and hence are extensively grown

in many of the drier regions of the country. In parts of the South and West where severe droughts sometimes occur sorghum is regarded as a sure crop, though corn and other grain and forage crops may fail to reach maturity. It will remain fresh and green through a dry spell that would ruin corn. Even when drought has been so severe as to check its growth it will recover immediately on the renewal of the supply of moisture.



FIG. 1.—Sorghum grown at the Tennessee Agricultural Experiment Station.

The seeds germinate best when the soil is quite warm and should not be planted until after danger from damp, chilly weather is past. At first the young plants make a large root growth as compared with the growth of the stem, and hence seem to develop slowly. But as soon as the roots are well established the stem growth is very rapid and is not easily checked by dry weather.

METHODS OF CULTURE.

PREPARATION OF THE SOIL.

Many different methods of preparing the soil for sorghum are practiced in the various parts of the country. In general it may be said that the land should receive essentially the same treatment as if it were to be planted to corn or cotton. The time and depth of plowing will necessarily vary according to the season and the character of the soil and climate. In any case the soil should be in fine tilth to a good depth, so as to afford a good seed bed.

In the West and Southwest good results are obtained by plowing shallow the fall before planting, or in early spring, and then a second time to a greater depth after the weeds have started well and just before the time to plant. This gets rid of the early weeds and allows the sorghum to get well established before another lot can spring up. If the land is at all rough or cloddy, it should be gone over with a harrow or pulverizer and reduced to a smooth, mellow condition. In the South the land is usually bedded as for cotton.

When sorghum is grown for forage and in ordinary farm rotations, there is seldom need of much of an application of fertilizers. Many soils have been known to produce successive crops for eight or ten years without any apparent decrease in fertility. Well-rotted barnyard manure is perhaps the best fertilizer, should any be needed. The commercial sorts containing potash, phosphoric acid, and nitrogen may also be used, though as a rule but little of the last substance will be necessary. In the South it is a common practice to use 150 to 200 pounds of cotton-seed meal on land to be sown to sorghum.

TIME AND METHODS OF PLANTING.

The best time for planting this crop for forage varies from about the middle of April in the South to the middle of May or the first of June in the North. As a rule, it should be planted soon after the corn is in. The seed should not be put into the soil until the latter has become well warmed, so that germination may take place at once. Moreover, the young sorghum plants grow slowly if the weather is cold and weeds are likely to become troublesome. On the other hand, if the soil is warm and free from weeds to start with, the sorghum will keep ahead of the weeds and cultivation will be much easier.

As a rule, the best forage is obtained by sowing the seed broadcast or with a press drill, such as is used in planting small grain. In the West and Southwest the latter method is to be preferred, as the cane stands up better and is not so likely to suffer from drought. On some soils, particularly in parts of the East and South, better results are obtained by dropping or drilling the seed in rows far enough apart to allow an occasional stirring with one or two horse cultivators. This is also a good method to follow for cane to be fed early in preparing hogs for market or as a soiling crop for stock in the pasture. The plants

grow too coarse for dry forage, however, and for general purposes broadcasting and seeding with press drills will give better satisfaction.

The lister has been used with good results in some instances in the West, but the practice is hardly to be recommended because of the often slow growth of the young cane already mentioned and because of a liability of the plants being washed out of the furrow by heavy rains.

Some farmers report good results by sowing the seed broadcast on unprepared land and plowing it under, while others condemn this method of seeding. Covering the seed with a disk harrow seems to be more successful, especially in loose, sandy soils.

Many farmers mix corn, millet, and various kinds of peas or beans with the sorghum, and in this way secure a better quality of forage. The sowing of legumes with sorghum is an excellent practice. The large amount of muscle-making substances in the legumes, together with the sugar and other fat-forming elements in the cane, affords a much more evenly balanced ration than either of the plants would make alone. Moreover, the legumes will do much to replace whatever nitrogen the sorghum may take from the soil.

QUANTITY OF SEED PER ACRE.

Sorghum should always be sown much thicker when grown for forage than when it is to be used in the manufacture of sugar or molasses. The amount of seed needed per acre will vary somewhat according to the kind of forage desired, the method of planting to be followed, and the character of the soil. The practice varies greatly in different parts of the country, ranging from one-half bushel to 3 bushels per acre, broadcasted or drilled. Under ordinary conditions $1\frac{1}{2}$ to 2 bushels (45 to 60 pounds) will be sufficient when sown broadcast, and a somewhat less amount will suffice when planted with the press drill. If the cane is intended for a summer pasture, a little more seed may be used. If peas or like crops are sown with sorghum, 3 pecks to 1 bushel of each will be ample. When planted in hills or drills for cultivation with hoe and plow, the seed should also be planted more thickly than when grown for the manufacture of sugar or molasses, otherwise the cane is likely to be too large to be easily handled, and stock will not eat it up clean. In many places in the South one seeding is sufficient for several years, as the cane sprouts up each season from the old stubble.

CULTIVATION.

If the cane has been sown broadcast or put in with a press drill and the ground is clean, very little cultivation is necessary. One of the advantages in using the press drill is that the field would be in better condition for cultivation with the harrow should weeds become troublesome or the ground packed or baked. In such cases the sorghum may be given a light harrowing as soon as it becomes well established. After the first crop has been harvested the field may be again cultivated, and if irrigation is practiced the water may be turned on to good

advantage. The same method of procedure may be followed where three or four crops can be obtained.

When sorghum is planted in hills or drilled in rows, it should be given about the same cultivation as corn. As a rule, however, the harrow may be used more and the plow and hoe less than with that crop. One of the greatest difficulties in the growing of sorghum in the North is that, if the weather is cold, the growth of the young plants is likely to be so slow that the weeds may spring up and choke them out. In such cases cultivation with the harrow should begin while the weeds are small. In the West and Southwest cultivation should be shallow and often. Two or three harrowings and one or two shallow plowings will keep the ground in good condition. In the East and parts of the South where the soil is heavier it may be necessary to do more plowing. It is not necessary to thin out the cane when growing it for forage. Six or seven small stalks in a hill are of more value for this purpose than three or four large ones.

As soon as each crop has been harvested the field should be stirred with plow or harrow, and in this way the cane can be kept growing until frost stops it.

HARVESTING.

Much of the sorghum grown for forage is cut and fed green as a soiling crop. This is especially true in the East and South. This method of feeding the crop is also coming rapidly into favor in the West and Southwest, where pasturage is often short during the drier months of summer and autumn.

In moist climates there is often some difficulty in getting the cane properly cured. The stalks dry slowly and are liable to become sour and blackened if stored in large quantities. Under such circumstances sorghum which has been sown thickly may be cut with a mower or scythe and allowed to lie several days, when it may be put up into good-sized cocks and left until thoroughly cured. It may then be stacked in sheds or stored in the barn. That planted in rows may be cut with the corn knife or corn harvester and put up in small shocks or leaned up against poles supported on forked posts. It may be fed directly from the field or, when thoroughly dry, stacked or housed as desired.

In the West and Southwest, or where there is not a great deal of moisture during the late summer and early fall months, there is seldom any difficulty in curing the crop satisfactorily. The cane may be cut with the mower, corn knife, or corn harvester, and shocked like corn, or, if not too heavy, it may be cut with an ordinary self-binder. In the latter case the bundles should be put into shocks loosely, two and two.

Probably the commonest way of harvesting is to cut with a mower, and after the sorghum has become thoroughly dried, which takes from four days to a week or more, according to the weather and the heaviness of the crop, to rake and gather into large piles. It is then usually fed directly from the field as wanted. There is less loss, however, when it is drawn to the barn or put into stacks topped with rye or coarse grass.

It is a good practice in storing to alternate the layers of cane with straw, particularly if the cane is not well cured.

The following method of curing sorghum for hay is recommended by Professor Connell,¹ of Texas:

After mowing, allow the sorghum to lie upon the ground sufficiently long to dry out at the ends of the blades. If the crop is thick, it should be turned over upon the ground to expose the bottom portion of the crop to the sun for a short time; usually one full day's sun is required to dry it sufficiently to be put into the "cock." These haycocks may be 5 feet high and 4 in diameter, of the shape of an old-fashioned beehive. All of the hay that is put up in this manner should be well settled as it is laid on the pile. After having constructed it to the proper height, rake the loose sorghum away from the sides, leaving a neat pile of hay that will turn water in case it should rain. Allow it to remain in this shape for two or three days for fermentation to take place, which is evidenced by the "heating" and the deposit of dew upon the interior parts of the cock. When thoroughly warm and before the hay loses its natural color, open the cocks and expose the hay to four or six hours' sun, according to the weight of the crop per acre and the size of stacks; then the hay is ready to haul to the barn or be placed in stacks, where it may safely be expected to remain without molding or heating further. If the hay is allowed to remain in the cocks too long, the fermentation proceeds too far and the hay sours and then rots in the field. It will remain longer in the cocks without damage the less of water or sap it contains when put up. * * * Use no salt or other applications to preserve the hay. The hay may be baled safely if given six to ten hours' sun from the cock, depending on the size of stalks.

When used for soiling, the cutting of sorghum may begin as soon as the "heads" are well formed, or even before if necessary, but it is at its best from the time of coming into bloom until the seed is about half ripe. After this time the stalks become hard and woody, and there is more waste, although the total weight of the forage obtained may be greater.

Chemical analyses of sorghum made at the Texas Station² show a gradual increase in the percentages of fats and protein as it approaches maturity. But according to the few experiments which have been made on the digestibility of sorghum a greater percentage of these elements is digested when the forage is cut while the plants are in bloom. Hence much, if not all, that may be gained in quantity by late cutting is lost so far as its feeding value is concerned, and the drain on the land is heavier. The sugar content is greater and the crude cellulose less in the more matured cane, but the digestion experiments also show a much greater digestibility for these carbohydrates in the cane cut in bloom. Analyses made at some of the other stations do not agree very well with those obtained at the Texas station, and give higher percentages of fat and protein in sorghum cut during the blooming period.³ It is therefore safe to say that, considering the quality of the forage and the ease with which it may be handled, as well as the quantity, the best time to cut this crop for either green or dry forage is when it is in bloom, or very soon afterwards. When more than one crop is to be harvested, it is the usual practice to cut the first one about the time the "heads" are well formed, but it may sometimes be necessary to cut sooner in

¹ Bull. 37, Tex. Exp. Sta., p. 674 (1895).

² Bull. 13, Tex. Exp. Sta., 1890.

³ Bull. 13, Cal. Exp. Sta., 1891.

order to give the second growth an opportunity to make sufficient development.

There is still considerable doubt as to the best time to cut sorghum for the silo. The common practice seems to be to allow it to stand until the seed is in the "dough," and some farmers wait until it is almost ripe. It would certainly seem best to cut at the first-mentioned stage, since the hard, woody canes of the older stages are not easily masticated by stock. It is probable that the time of cutting may have much to do with the keeping qualities of the silage.¹ Careful experimentation is needed to settle this question.

YIELD.

The amount of forage per acre which may be obtained from sorghum varies according to the soil, climate, and methods of cultivation employed. Yields of from 3 to 15 or more tons of cured fodder are reported from different parts of the country. When but a single crop is harvested, from 5 to 10 tons per acre are usually obtained, while if several crops are cut the total yield may often exceed 15 tons. One correspondent in Ohio reports a yield of over 7 tons and a ready sale at \$6 per ton, which, considering the cost of production, made it a very paying crop.

In Nebraska 3 to 5 tons or more per acre are often raised on land which has already produced a crop of winter rye the same season. Considering the value of the rye for fall, winter, and spring pasturing in addition to the grain obtained, it will be seen that this makes the land very productive.

At the Fashion Stock Farm, near Trenton, N. J., three cuttings and yields of 15 or more tons per acre are reported. In Kansas and elsewhere in the West and Southwest the yield usually ranges from 5 to 12 or 15 tons, with from one to three cuttings. In the South, generally, two or three crops are obtained each year, and the yield varies accordingly.

As a rule, except in the best of the corn-growing States, sorghum affords at least one-third more forage than corn under similar conditions, at about the same cost, and it can be fed with much less waste.

VALUE FOR FORAGE.

AS A SOILING CROP.

Stockmen are unanimous in placing a high value upon sorghum for soiling purposes. It is not only an excellent forage for growing animals and those which are being prepared for market, but is one of the best feeds that can be used during the summer and early autumn for dairy cattle, on account of the large flow of excellent milk which it induces.

In many dairying and stock-raising communities one of the most critical periods of the year is that of the dry season during July, August, and September. At this time the pasturage is often insufficient for the

¹ See note, p. 19.

stock, and great difficulty is experienced in growing enough early fodder to keep the animals in a thrifty condition. Sorghum, on account of its drought-enduring qualities and ready adaptability to varying conditions of soil and climate, as well as because of its feeding value, is one of the best crops that can be grown for this purpose. By a judicious selection of early and late varieties or by planting several fields at different times a succession of crops can be had, each of which will be in its prime when wanted. Whatever surplus there may be can be cured for winter feed.

Sorghum may be fed green to all kinds of stock, even to poultry, with very profitable results. A full feed should not be given at first, particularly if the animals are hungry. It is a good practice to give first a light feed of grain or other food and then a small amount of the sorghum. The latter may be increased day by day until a full feed is reached. Fresh sorghum is a very succulent forage and, like clover, is liable to cause bloating when fed in too large quantities at first. With ordinary precautions no trouble from this source need be feared.

AS A PASTURE PLANT.

Sorghum may be used to advantage as summer pasturage for all kinds of stock, and it is especially satisfactory for sheep and hogs. It is claimed that it makes a better pasture than alfalfa for fattening hogs. Many correspondents recommend it highly for pasturage for lambs. At the Arkansas Station¹ it gave excellent results in hog pastures, used in connection with clover and Spanish peanuts to give a succession of fresh feed for the season.

For this purpose sorghum should be sown or drilled thickly and the land left as smooth as possible. Several fields should be sown at different times, so that a succession of forage may be had, and as soon as one field is pastured off the stock may be turned on the next, and so on through the whole series. By the time the last has been fed down the first will be ready again. In California the first crop is often cut for hay or soiling. Stock are then turned on the field and the subsequent growth is pastured off. This is done on ground that is fallowing for wheat the coming season, and the farmers maintain that the land is left in better condition than if nothing had been grown upon it. The plowing and harrowing necessary in putting in the crop give the required cultivation, while the droppings from the stock fertilize the soil.

Care should be taken not to allow the stock to have too much of the sorghum at first. After the animals have been fed in the morning they may be turned on the sorghum for a short time and this practice kept up until they have become used to the forage. It is thought by many farmers that serious trouble is more likely to result when the animals are allowed to feed on the sorghum early in the morning while it is wet with dew, and accordingly, when beginning to pasture it, they do not turn their stock on the field until toward the middle of the day.

¹ Bull. 41, Ark. Exp. Sta., Aug., 1896.

AS A DRY FORAGE.

When fed in the dried condition, sorghum is handled in about the same way as fodder corn. It is fed in racks or on the ground, or, if the stalks are coarse, cut up with a feed cutter and fed in close troughs or mangers. An excellent practice is to cut it quite fine and mix with grain, chop, bran, and other feed stuffs. This plan is especially adapted to the dairy, where it has given very good results indeed.

Cured sorghum is most extensively used as a forage during the late fall and early winter months, as it is often more difficult to keep than corn fodder and other of the commoner kinds of roughness. However, when well cured and stored in a dry place, it may be kept in good condition for a year or more, and hence often constitutes the entire hay supply of many farmers. Even in the great corn-growing States it is widely grown and fed to stock as a change and appetizer. All kinds of stock will eat sorghum fodder more readily than they will corn fodder, and there is much less waste in feeding.

AS SILAGE.

Opinions vary widely as to the value of sorghum for ensilage. On account of a greater tendency to develop acidity it is more difficult to keep in good condition than corn. Well-kept sorghum ensilage is an excellent feed, and is highly prized by stock-raisers and dairymen in many sections of the country.

Prof. C. S. Plumb¹ regards sorghum as less satisfactory for ensilage than either corn or red clover, though he would recommend it for sections in which there is difficulty in getting good crops of the other two plants. At the Texas Station, Director Connell reports that sorghum has given very satisfactory results in both field and barn silos. Chemical analyses of silage at this station² show sorghum to be but little behind corn and Kafir corn in feeding value. Director Redding, of the Georgia Experiment Station, says: "My experience with sorghum ensilage is quite satisfactory. For the silo I consider the three most valuable plants, in order, are Indian corn, cowpeas, and sorghum."

Among other stations which report more or less satisfactory results in the use of sorghum for ensilage are New York (State), Kansas, and Mississippi. Many farmers also report good results.

There is no doubt but that corn silage can be more easily kept. On the other hand, a larger yield is usually obtained from sorghum, especially on thin soils, and, at least in the drier sections of the country and throughout the South generally, it is a surer crop. Prof. E. M. Shelton,³ at the Kansas Station, found that while 16 tons per acre was the heaviest yield for corn, sorghum frequently reached 20 tons.

All things considered, sorghum is not as valuable a crop for the silo as corn in regions where the latter can be successfully grown, but there

¹ Bull. 40, Ind. Exp. Sta., p. 70 (1892).

² Bull. 13, Tex. Exp. Sta., p. 33 (1890).

³ Bull. 6, Kans. Exp. Sta. (1889).

is no doubt that for a large portion of the South and West the former is the more profitable crop to grow for this purpose, taking one year with another.

THE SEED AS A GRAIN RATION.

In chemical composition sorghum seed is very similar to shelled corn, but contains rather more crude fiber or cellulose and less fat and crude protein. As a consequence it is not so valuable for general feeding purposes. The following table¹ shows the averages of a number of analyses of corn and sorghum. These, it will be observed, are somewhat in favor of the corn:

	Number of analyses.	Air-dry substance.						Water-free substance.				
		Water.	Ash.	Fiber.	Fat.	Protein.	Nitrogen-free extract.	Ash.	Fiber.	Fat.	Protein.	Nitrogen-free extract.
Corn (shelled, all varieties)	208	10.9	1.5	2.1	5.4	10.5	69.6	1.7	2.4	6.1	11.7	78.1
Sorghum seed	10	12.8	2.1	2.6	3.6	9.1	70.0	2.4	3.0	4.1	10.4	80.1

Many stockmen who have had experience in feeding the seed claim that it is worth about 90 per cent as much as corn. There are others, however, who give it a somewhat lower value. It is rather seldom that any large amount of seed is saved when the sorghum is grown for forage. It is usually fed on the stalk, or is cut up with it and fed as silage. When cane is grown for sugar or molasses, the "heads" are often stored and fed whole, or thrashed and the seed fed or kept for planting.

Though the thrashed seed is often fed whole, either dry or soaked, it can be used to best advantage when crushed or coarsely ground. Mixed with equal quantities of oats, peas, or soja beans, it makes an excellent food, and for most purposes is a very good substitute for corn.

Professor Hunt says² that "to be most economically used the seed should be siloed," which is certainly true if the "heads" are to be fed whole. It is probable, however, that more of the seed is digested by the animal when ground and fed in connection with foods richer in nitrogenous substances as above described, and for certain kinds of stock, at least, this is the preferable way of feeding it.

One of the most common uses of sorghum seed is as a feed for poultry. For this purpose it is very highly prized by all who have tried it. It is especially recommended for laying hens.

CHEMICAL COMPOSITION AND DIGESTIBILITY.

Though many chemical analyses have been made of sorghum at various stages of growth, very few feeding experiments have been conducted to determine the digestibility of the various food elements

¹ Bull. 15, U. S. Dept. Agric., Office of Experiment Stations, p. 390 (1893).

² Soils and Crops, p. 263.

contained in it. At several stations attempts have been made to learn the general feeding value of cane as compared with other forage crops, and the results obtained show its great value for conditions which exist in many parts of the United States.

CHEMICAL COMPOSITION.

The following table shows the composition of various parts of the sorghum plant, of the same varieties cut at different stages of growth, and of the different forms of forage in which the sorghum is usually fed. For comparison, analyses of the silage from Kafir corn and Indian corn are also given.

Composition of various parts of the sorghum plant, also of Kafir and Indian corn.

	Air-dry material.						Water free substance.				
	Water	Protein.	Fat.	Nitrogen-free extract.	Cellulose.	Ash.	Protein.	Fat.	Nitrogen-free extract.	Cellulose.	Ash.
<i>Whole plant.</i>											
Amber cane (in bloom) <i>a</i>	43.62	3.91	3.34	25.74	20.21	3.18	6.94	5.92	45.65	35.85	5.64
Link's hybrid (in bloom) <i>a</i>	47.20	4.41	3.01	22.81	19.20	3.37	8.35	5.70	43.21	36.36	6.38
Amber cane (seed in dough) <i>a</i>	41.70	3.17	2.93	32.22	17.03	2.95	5.44	5.03	55.26	29.21	5.06
Link's hybrid (seed in dough) <i>a</i>	38.60	2.41	2.82	32.45	20.39	3.33	3.93	4.60	52.84	33.20	5.43
<i>Seed heads.</i>											
Amber cane (seeds ripe) <i>a</i>	20.15	7.04	3.08	58.42	8.82	2.49	8.81	3.86	73.16	11.05	3.12
Link's hybrid (seeds ripe) <i>a</i>	19.90	9.11	3.46	52.25	12.34	2.94	11.38	4.32	65.23	15.40	3.67
<i>Stalk.</i>											
Amber cane (final cutting) <i>a</i>	35.72	2.93	3.29	35.96	19.36	2.74	4.56	5.12	55.95	30.11	4.26
Link's hybrid (final cutting) <i>a</i>	35.40	1.86	1.39	40.05	17.73	3.57	2.88	2.15	62.00	27.45	5.52
<i>Leaves.</i>											
Varieties not stated <i>b</i>	12.43	9.60	4.55	44.93	23.93	4.56	10.96	5.19	51.31	27.33	5.21
<i>Silage.</i>											
Orange cane (average of 3 analyses) <i>c</i>	80.94	.97	1.13	8.72	6.93	1.30	5.14	5.87	45.82	36.35	6.83
Kafir corn (average of 3 analyses) <i>c</i>	67.20	2.10	1.40	15.17	11.20	2.88	6.39	4.31	46.18	34.32	8.79
Mixed sorghum (average of 17 analyses) <i>d</i>	75.50	1.55	1.19	11.85	8.04	1.87	6.37	4.77	48.42	32.80	7.64
Corn silage (average of 99 analyses) <i>e</i>	79.10	1.70	.80	11.10	6.00	1.40	8.00	3.80	53.00	28.70	6.60
<i>Fresh material.</i>											
Sweet sorghums (average of 31 analyses) <i>f</i>	72.66	1.44	1.66	15.20	7.40	1.62	5.30	6.05	55.52	27.18	5.94
<i>Waste.</i>											
Sorghum bagasse (dry) <i>g</i>	11.25	3.44	1.44	50.47	30.52	2.88	3.87	1.62	56.87	34.40	3.24

a Bull. 13, Ga. Exp. Sta., 1891.
b Bull. 97, N. C. Exp. Sta., 1894.
c Bull. 13, Tex. Exp. Sta., 1890.
d Bull. 3, Vol. IX, Tenn. Exp. Sta., 1896.
e Bull. 11, Office Exp. Sta., U. S. Dept. Agric., 1893.
f Average made up from analyses given in Bull. 13, Tex. Exp. Sta., 1890, and Ann. Rep. S. C. Exp. Sta., 1892.
g Bull. 97, N. C. Exp. Sta., 1894.

From this table it will be noticed that cured fodder from sorghum cut when in bloom contains higher percentages of fat and protein than that cut when in the "dough," and also that the cured leaves contain better percentages of these elements than any other part of the plant. The value of the leaves for forage is very apparent.

The bagasse contains a very small amount of either fat or protein, and hence is by itself a very poor food. It can, however, be fed with oil cake, cotton-seed meal, peas, and other foods rich in these substances. Many farmers store the bagasse in silos and feed it in connection with grain with very good results. This is an excellent way to utilize what would otherwise be largely wasted.

DIGESTIBILITY OF SORGHUM AND CORN FODDER.

From the table of digestibility it will be seen that, on the whole, sorghum compares quite favorably with corn. In the fresh state it is ahead of corn in the digestibility of crude cellulose and extract matter, while that crop shows a higher percentage for the crude protein, and there is very little difference as far as the fat is concerned.

The dried leaves of sorghum show better percentages of digestibility than those of corn in every respect except in that of the crude fat, and here the corn leads.

No reliable data are at hand from which to draw a comparison of the digestibility of corn and sorghum silage, but judging from the experience of cattle feeders generally it is quite certain that the figures would show to the advantage of the corn.

It will be noticed that sorghum cut while in bloom shows higher percentages of digestibility, especially for the crude fat, crude protein, and crude cellulose, and this fact should be taken into consideration when deciding upon the proper time to cut the cane for forage.

Below are given the percents of digestibility of the crude cellulose, crude fat, crude protein, and extract matter in various parts of corn and sorghum that are used for forage:

	Crude cellulose.	Crude fat.	Crude protein.	Extract matter.
<i>Whole plant.</i>				
Early Amber cane (average of 2 trials of fresh material, cut just after bloom).....	42	67	40	71
Sorghum, variety not stated (average of 2 trials of fresh material, cut while in blossom).....	75	81	53	78
Dent corn (average of 9 trials of fresh material, cut when kernels were glazing).....	51	78	54	75
<i>Leaves.</i>				
Sorghum leaves (average of 2 trials of dry material).....	70	47	61	65
Corn leaves (average of 4 trials of partially dry material).....	69	59	45	63
<i>Waste.</i>				
Sorghum bagasse (1 trial of dry material).....	64	46	14	65

From the preceding tables of chemical composition and digestibility it may be estimated that, in round numbers, fresh sorghum, cut from

blooming time to the "dough" stage, will contain to each ton of forage about 87 pounds of digestible cellulose, 226 pounds of digestible extract matter, 24 pounds of digestible fat, 14 pounds of digestible protein, and 1,453 pounds of water. This compares very favorably with similar estimates for fodder corn, and shows that, while sorghum may be somewhat below corn in the muscle-making elements, it is richer in the fat-forming ones, and hence is an excellent food for preparing animals for the market.

This, taken together with the fact of the heavy yields of forage obtained from the sorghum, certainly shows it to be a profitable crop to grow for feeding purposes.

OBJECTIONS SOMETIMES URGED AGAINST SORGHUM AS A FORAGE CROP.

EFFECTS UPON THE LAND.

The often-repeated statement that sorghum is a hard crop on the land is undoubtedly true for many soils. Those poor in potash and phosphoric acid are likely to suffer more from sorghum than from wheat and corn, since it uses more of these substances than do those crops. On the other hand, its deep-rooting habit enables it to draw many elements from the subsoil which the shallower-rooting plants would not reach, but which they need in their growth. Hence sorghum can be used advantageously in rotations with such crops. Farmers generally maintain that cotton, wheat and other small grain, sweet potatoes, and like crops do well after sorghum. The stubble is quite persistent, and when the cane grows large and coarse may interfere somewhat in working the land the next season. Plowing deep and thoroughly as soon as the crop is harvested will usually get around this difficulty. In case the cane is sown or drilled thickly little trouble is experienced, as the stubble is not coarse enough to bother much. It is always a good plan, however, to plow as soon as the crop is harvested.

INJURIOUS EFFECTS UPON STOCK.

Sorghum is sometimes objected to as a forage on the ground that it produces rough coats of hair on horses and cattle. This is only the case when the sorghum is used as the principal or only feed for a long period of time, and the difficulty is easily avoided by feeding it in connection with foods rich in albuminoid substances, such as clover, vetches, peas, and alfalfa.

There is considerable prejudice in some sections against second-growth sorghum on account of its reputed injuriousness to stock. Most of the trouble seems to have arisen from carelessness in turning hungry animals into the fields and allowing them to gorge themselves. Stockmen agree that the same difficulty is met with in feeding clover or any other succulent forage, and may happen with either first or second or any other growth.

Professor Connell,¹ in answering an inquiry regarding possible danger in turning cows upon second-growth cane, says: "In every case coming under my observation death has occurred when the cow's stomach was unaccustomed to such food. A small amount of this crop swallowed quickly into the paunch may produce a vast quantity of expansive gas, * * * causing death." He then gives his own practice of allowing the animals to run to the cane but a short time at first and gradually lengthening the period as they become accustomed to the food.

It is not advisable to allow stock to eat frost-bitten sorghum, especially while the frost is still on the plants. Many cases of loss of stock are reported from this cause.

There are a few cases on record where death has resulted in a very short time after eating sorghum (both saccharine and nonsaccharine varieties), and in some cases but little of the plant was swallowed by the animal. In most instances in this country, second-growth sorghum was eaten. It has been supposed that some poisonous substance developed in the plants under certain conditions was the cause of these sudden deaths. In India² it is known that under conditions of extreme drought, nitrate of potash may be formed in the canes of the closely related Johnson grass in sufficient quantity to cause the death of animals eating much of the forage. This seems more likely to take place when the drought is followed by a short period of excessive rainfall. Dr. Mayo³ records several instances occurring in Kansas where under similar conditions corn has developed this same substance, and cattle to which it was fed died, in some cases quite suddenly. It is quite possible that this substance may be developed in sorghum in this country and be the cause of the trouble mentioned. It is noticeable that the instances reported follow seasons of protracted drought as was the case with the corn in Kansas and the juar plant in India, and also that in these localities the soil was supposedly rich in nitrogen and potash.

However, cases of poisoning are so rare that little loss from this source is to be feared, although caution in feeding is always advisable, until the animals have become accustomed to the forage.

SUMMARY.

Sorghum stands drought better than corn. It is a stronger feeder and will do better on thin soils. It is a good crop to grow on "alkali" lands.

As a general thing, the earlier varieties are preferable for forage. Use plenty of seed. Sow when the ground becomes warm, in a well-prepared seed bed.

¹Bull. 37, Tex. Exp. Sta., p. 659 (1895).

²Poisoning of cattle by the juar plant (*Andropogon sorghum* Brot.), Dr. H. T. Pease in Agric. Ledger, No. 24, Calcutta, 1896.

³Bull. 40, Kans. Exp. Sta., May, 1895.

Keep the weeds down by shallow cultivation while the sorghum is small. Stir the ground as soon as each crop is taken off to start the new growth. Use water when it is accessible.

It is a good practice to plant cowpeas, field peas, or other legumes with sorghum. A better quality of forage is obtained and the land is left in better condition.

Sorghum may be used for soiling, pasturage, hay, and ensilage.¹ It is especially valuable as a pasturage for lambs and hogs and as a summer and autumn feed for dairy stock. Feed sparingly until the stock become accustomed to it.

The best quality of hay is obtained by cutting the sorghum shortly after it begins to bloom. When used for soiling, cutting may be profitably begun as soon as the "heads" are formed. The common practice is to cut for ensilage when the seed is in the "dough."

The forage contains an excess of fat-forming substances and should be fed in connection with foods rich in muscle-making materials. The seed is usually fed with the stem and leaves. Thrashed seed should be crushed or ground and mixed with wheat bran, oats, or other nitrogenous foods.

¹NOTE.—The practice of preserving this crop in the "stack silo" is followed by some farmers in the Southwest. The sorghum is drawn to the stack immediately after cutting, or it may be allowed to lie in the field until it has become somewhat wilted. The stacks are heavily weighted and left undisturbed until the process of curing has been completed; the sorghum is then cut down with the hay knife and fed to the stock as needed. The forage comes from the stack in fine condition, and the loss from rotting is usually small. This method of storing sorghum has much to recommend it for the Southwest, and the practice is growing rapidly there; but it would probably not do so well where the climate is very moist.

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