SUGAR CANE FOR SYRUP MAKING

By

E. B. FERRIS

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MISSISSIPPI AGRICULTURAL EXPERIMENT STATION
Agricultural College, Mississippi

J. R. RICKS, Director
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Introduction.—For about seven years after this station was located at McNeill a lot of work was done with sugar cane and considerable money was spent in building and equipping a syrup plant in which to manufacture the cane grown on the station, together with that grown in the neighborhood, into a first class syrup, with the hope that the industry might be stimulated and information obtained not only on the growing of the cane but on the making and marketing of the syrup. To carry on this work required a considerable outlay of money, for in order to run the plant most economically some fifty acres of cane would have been required. To grow so much cane ourselves or to have manufactured it into syrup if grown largely by others would have required a considerable outlay of money, for it is an expensive crop both to grow and put into marketable condition.

At the time the work was started and for several years thereafter our station retained its sales fund and so long as any crop paid its own way we could afford to grow it in any quantity. While this work was at its best, the Legislature passed a law requiring money derived from the sale of farm products returned into the State treasury and this made it impossible to continue work of this kind without a considerably larger appropriation for maintenance than this or succeeding Legislatures would give and so our work with sugar cane had to be abandoned.

This was not done, however, until after a lot of information was obtained about the growing of the cane and the making and marketing of the syrup and this information was embodied in a bulletin on the subject issued in 1909 which has since become exhausted. As there continues to be considerable demand for such information as it contained it has been thought best to rewrite it, bringing it as nearly up to date as possible and embodying in the new edition any information of value obtained since it was written.

Soils suited to sugar cane.—Sugar cane is a gross feeder and requires a soil not only well filled with available plant food, but also one with sufficient humus to hold a large supply of water to tide it over any droughts that may occur. Dr. W. C. Stubbs, the well known authority on sugar cane, figures that a yield of 45 tons of cane to the acre will require a 56 inch rainfall and it would be a very exceptional season when water for a crop even one-third as large would be so well distributed by rains as to meet
the requirement without the aid of vegetable matter in the soil to hold some of this rainfall in reserve for periods when it would not be supplied by rain.

Cane, therefore, should be planted only on the best lands, well filled with decaying vegetable matter, preferably well drained bottom lands. In this latitude two crops are nearly always grown from one planting, often three, and it is only the best soils that will give economical yields under such a strain. The man who would attempt here to grow sugar cane on all his land, or so large a part of it as is so frequently planted to corn or cotton would soon be growing it at a loss. It is for this reason that it should continue to be grown as it has been grown in the past, in small quantities to each farm by a large number of small farmers. In this way it is doubtless the best paying crop that can be planted here and only one thing prevents its being developed in far greater proportions than it is and this is a lack of uniformity in the syrup made from it and the effect this has on the sale of the syrup. The sandy loam soils of the Coastal Plains region of this state are ideal for growing a superior quality of sugar cane syrup, better in color, clearness and flavor than that grown on the heavier lands of this and other states. This is doubtless due to the fact that cane on our light lands comes nearer reaching maturity in a growing season and there are consequently fewer immature joints on each stalk to be ground and made into syrup.

History.—Sugar cane belongs to the large family of grasses and is said first to have been grown in China and India. It was introduced into this country by the planters around New Orleans and is now extensively grown in Louisiana for making both syrup and sugar. It does not form seed in this climate but in countries further south, even in middle and southern Florida, some varieties throw out seed stems when from twelve to thirteen months old and reach maturity some three months later. However, the seeds from sugar cane germinate very poorly and it has been only in recent years that they have been used at all as a means of propagation and even now they are only used for introducing new varieties. In this and in all tropical countries, even, cane is propagated commercially by planting the stalks. A sugar cane stalk is made up of a series of nodes and internodes and at each node or joint is a bud which sprouts and forms a stalk. These stalks sucker or tiller freely so that from every original plant from three to ten stalks should be found at the harvest and in tropical countries many more than this.

Saving seed cane.—Seed cane should be allowed to grow as late as possible in the fall consistent with danger from frost. It matures faster and better as the season advances and if cut and banded while the weather is yet warm is more apt to heat and spoil as a consequence. If cut and not covered at once with soil, it is apt to dry out and become injured in this way. Too, if cut early the stubbles are apt to sprout and the young plants be killed by the first frost. In the latitude of Poplarville we seldom have
a frost that will injure the buds before the tenth of November and often not until later. While many reasons may be advanced for saving seed from the immature parts of the cane stalk, that is, the upper part, our experience has been that best results are to be had from planting the whole stalk. As the joints are shorter in cane grown from stubble than in plant cane, more plants are to be had from a given length as well as less juice, if used for syrup. Therefore it is well to save seed cane from the oldest stubble and in saving this seed cane, if ground is not to be used for a succeeding crop of cane, it is best to take up these seed canes by the roots as by so doing the canes keep better thru the winter while the buds near or beneath the surface of the ground are much closer than they are higher on the stalk. Seed cane is saved by windrowing near where it is cut, by putting in a regular seed bed, or by planting at once where it is to be grown the succeeding year. Where it can be done we very much prefer fall planting of cane for it saves a lot of work and if cane is bedded and planting done in the spring it frequently sprouts thru the winter and these sprouts are broken in rehandling. Whether planted when cut in the fall or bedded for planting in the spring much care should be taken against letting the stalks dry and by either method the canes should be quickly covered with moist earth so as to prevent evaporation.

For fall planting the ground should be thoroughly prepared and rows opened 4 1/2 or 5 feet apart with middle burster or with two furrows from an ordinary turn plow, the seed cane should be dropped in this furrow and covered immediately with three or four inches of soil. If the weather is dry a heavy roller should follow the covering of the cane to bring moisture to it and prevent "dry rot." Where the natural drainage is good as is the case on the hill lands of this section flat preparation and planting is to be preferred. On poorly drained soils it is best in the case of fall planting to throw up beds wide enough for two rows of cane so as to give better drainage, for if the land becomes water sogged "wet rot" will prove equally as bad on the seed cane as is the "dry rot" caused by a lack of moisture.

Where planting is to be done in the spring the seed cane should be cut in the fall if the same ground is to be used the following year to grow cane from the stubbles, if not, it should be dug or plowed up, and in either case should at once be piled shingle fashion between the old cane rows or hauled to the seed bed and covered promptly with soil using turn plows to do the covering and following these with shovels to complete the job. It is best to do this while the weather is damp or else to pour water over the windrowed cane. Prompt covering with dirt keeps out the air, prevents the drying of the cane, and will save much loss from dry rot.

Quantity of seed required to plant an acre.—A question frequently asked is the quantity of seed required to plant an acre. We will assume that standard rows will be five feet apart as this is a good distance for placing them. This would give 42 rows each 210 feet long to the acre and would require 8820 feet of cane. Assuming that each stalk would be four feet long, it would require 2205 stalks, or if we doubled them in the drill
4410 stalks. Each of these stalks will weigh about two pounds giving a total of about four and one-half tons to plant an acre. On land thoroughly prepared and carefully planted in the fall we feel sure that a good stand could be obtained by half lapping the cane in the drills, tops over butts, and using about 3500 stalks to the acre. This is especially true if care is taken in the spring to remove surplus dirt from the cane drill by barring off with turn plows and allowing the sprouts every opportunity to come through promptly.

**Should the stalks be cut?**—In planting these seed stalks it is generally thought that they should be cut in small pieces, the popular impression being that if not cut the buds that sprout first will draw the strength from those that sprout later and prevent them coming out at all. This is not true according to the results of the Louisiana Experiment Station which results seem to have been borne out by our experience at McNeill. Each eye or bud on the stalk is independent of the other and the cutting of the cane, especially in fall planting, only serves to induce fermentation and consequent decay. If the seed stalks are straight (which is seldom the case) it is best not to cut them at all, but if they are crooked they should be cut in two or more pieces so as to make them lie flat in the furrow and lessen the danger of pulling them up in cultivation or of covering a part of the stalk too deep and another part too shallow.

**What part of the stalk to plant.**—In ordinary farm practice the entire stalk of cane is planted and in a recent interview with one of our best growers he stressed the point that the best and heaviest stalks for seed gave most satisfactory results in the subsequent crop. The young plant draws its subsistence from the mother cane until an independent root system can be developed to where it can draw its support from the soil. It would appear, therefore, that large stalks for cane would be as necessary as large seed pieces in planting Irish potatoes with this difference that the cane has a much longer growing season and could better overcome a handicap in its very early life.

Some people advocate the planting of the upper part of the cane for seed and the use of the lower part for syrup. This would undoubtedly effect a considerable saving if the cane obtained therefrom were as good as that from the whole stalk and the labor of thus handling were not too great. The upper part of the stalk has much less sugar than the lower and is therefore less valuable for syrup and if as many as five or six joints of mature cane are left with the tops these may be used successfully in getting stands of cane. If only two joints of mature cane are left with the tops, as was advocated for a time by some agriculturists, our experience has been that poor results will follow and taking every thing into consideration we doubt the advisability of trying to use the less mature parts of the cane for seed. We would advise always the use of cane from stubble fields which is less valuable for juice and more valuable for seed by reason of the joints being closer.
Varieties.—In recent years a number of varieties of cane have been brought to Louisiana from all over the sugar growing world by the Louisiana Sugar Experiment Station located at New Orleans. They were kind enough at one time to send us a number of these varieties in small quantities which we planted and grew with poor success. Only two of the many sent sprouted or gave any promise of success with us. These two were D74 and D95 from which we grew sufficient cane to plant in fairly large quantities. At the end of a period of years, however, neither seemed so well adapted to the section as the common kinds already in the country and these finally disappeared. The red or purple cane is the one most commonly grown here with ribbon and white following in the order named. This red cane being harder than either of the other kinds will withstand more hardships and is the one that will finally predominate under average conditions. Tests here comparing this purple cane with the ribbon cane have not shown any material difference in yields. The ribbon and white canes, being softer, are more desirable for chewing and there being less coloring matter in the outer covering they give a brighter syrup. Japanese cane is the hardiest of all the varieties tried and can be grown much farther north than the other kinds, but it is not so good for syrup, the stalks being smaller and more woody, making it more expensive to handle from field to mill, harder to grind, with a smaller percentage of juice and this containing less saccharine matter. In tests made at our syrup plant comparing Japanese and purple cane, we got a 72% extraction from the purple cane, only 60% from the Japanese while the juice from the latter had from 15% to 25% less saccharine matter than the former.

Japanese cane is valuable as a forage crop and may be cut before and after frost falls and fed from wagon or ricks to all kinds of livestock, all devouring it greedily. It may also be taken from the field without stripping or topping, run thru a cane mill and the greater part of the juice expressed, then the bagasse may be put in ricks to which animals have access thru the winter. Mr. H. M. Holcomb, recently from North Alabama but now of Carrierre, Miss. has had some interesting experience with Japanese cane as a combination syrup and forage producer. In 1919 he run this cane before frost thru a mill without stripping or topping, making syrup of the juice and piling the bagasse in a rick made of pine poles and so constructed as to allow cattle or horses to go under it for shelter and at the same time eat it from the under or outer side. He found that in cutting before frost it did not make as good syrup and that the bagasse with the green leaves and tops fermented quickly and did not keep well in the rick. The 1920 crop he allowed to stand in the field until after Christmas when the cold had killed the tops and leaves, then run it thru the mill and put bagasse in rick. The syrup was much better and there was no tendency for the bagasse to sour while animals ate it well and dry cattle were wintering on it with what additional feed they got on the range.
Fertilizers.—Seed cane should have a light application of fertilizer at the time it is planted for the reason that around the joints the mother cane puts forth roots long before the plants appear above ground and if these roots are promptly fed the young plants will grow off much more vigorously. Aside from this, it is best to apply the bulk of the fertilizer to both plant and stubble cane in the spring after the stand is about completed and the dirt ready to be thrown back to the cane rows. This fertilizer should be applied on both sides and also scattered across the cane rows. A number of tests have been conducted at this station to show the effects of different plant food materials on the yields of cane, also to show the effect of one or more applications of a given fertilizer. These tests while not altogether conclusive lead us to advise under average conditions making a single application of the fertilizer in the spring and not a part then and the balance later. This does not have reference to the small quantity that should be put under the cane before planting to give it a more vigorous start.

On the whole our results have shown no material increase in yield due to the addition of potash to a mixture of nitrogen and phosphorus. At least this is true where cotton seed or cotton seed meal have been used as a source of this nitrogen. In fact, except in regular test plats, we used no potash under cane grown under field cultivation and one year averaged twenty tons of cane per acre from a field of twelve acres, while on a small part of this field, fertilized the year before with cotton seed and acid phosphate and grown to cabbage, we made over fifty tons of cane per acre. In cases where potash is known to increase the yields of sugar cane it should, of course, be used but where growers are not convinced of its need we believe it safe to leave it off until actual results show the want of it.

On good land well filled with vegetable matter sugar cane will ordinarily give profitable returns from the use of one thousand pounds or more of commercial fertilizer and this under prevailing prices of cotton seed meal may conveniently be made at home by mixing equal parts of cotton seed meal and acid phosphate. Sugar cane belongs to the family of grasses and all such crops require fertilizers rich in nitrogen. Many practical growers consider cotton seed meal alone as one of the best fertilizers for cane and with this commodity selling so low as at present we would be inclined to use it in preference to other carriers of nitrogen even to using two parts of the meal to one part of acid phosphate. Sugar cane is an extremely hard crop on the land and should always be planted on the best soils following a leguminous crop of some kind. On such soils, if nitrogen as compared to phosphorus, is relatively high, a mixture of two parts acid phosphate to one of cotton seed meal will give good results the first year, but if the land is kept to cane more than one year the proportion of nitrogen to phosphorus should be gradually increased.
Cotton seed meal is so valuable as a feed that economic conditions ought to place such a premium on it that it could not be used as a fertilizer except indirectly but such is not the case at present and so long as these conditions remain unchanged we regard cotton seed meal as the best nitrogen carrier for any crop, more especially sugar cane for many of the best growers think it has a decided influence on the quality of syrup made from such cane and we are much of this opinion ourselves, though with no proof with which to base the statement. If the nitrogen in cotton seed meal goes very much higher than in its other carriers these may be substituted for the meal, but few of them make mechanical mixtures with acid phosphate that can so easily be distributed or handled with as little discomfort to the ones applying it.

The following table gives the results of two years work with fertilizers under sugar cane as conducted at McNeill:

<table>
<thead>
<tr>
<th>Plat No.</th>
<th>Area</th>
<th>Cot. Seed Meal per A.</th>
<th>Acid Phosphate per A.</th>
<th>Kainit, per A.</th>
<th>Yld. per Plat Lbs.</th>
<th>Yield per A. Lbs.</th>
<th>Yld. per A. Tons.</th>
<th>Yld. per A., in this Style cane</th>
<th>Notes</th>
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<tbody>
<tr>
<td>1</td>
<td>.062A</td>
<td>210</td>
<td>208</td>
<td>90</td>
<td>3660</td>
<td>58,560</td>
<td>29.3</td>
<td>16.9</td>
<td>Purple Cane</td>
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<tr>
<td>2</td>
<td>.062A</td>
<td>210</td>
<td>208</td>
<td>90</td>
<td>3570</td>
<td>57,120</td>
<td>28.6</td>
<td>16.7</td>
<td>Ribbon Cane</td>
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<td>210</td>
<td>454</td>
<td>90</td>
<td>4340</td>
<td>69,440</td>
<td>34.7</td>
<td>20.8</td>
<td></td>
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<tr>
<td>4</td>
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<td>420</td>
<td>416</td>
<td>180</td>
<td>4280</td>
<td>68,480</td>
<td>3.42</td>
<td>21.0</td>
<td>1/2 Applied in Spring &amp; 1/4 in July</td>
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<tr>
<td>5</td>
<td>.062A</td>
<td>420</td>
<td>416</td>
<td>180</td>
<td>4400</td>
<td>70,400</td>
<td>35.2</td>
<td>20.4</td>
<td></td>
</tr>
<tr>
<td>6</td>
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<td>210</td>
<td>208</td>
<td>358</td>
<td>3850</td>
<td>61,600</td>
<td>30.8</td>
<td>17.0</td>
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<tr>
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<td>.062A</td>
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<td>104</td>
<td>49</td>
<td>4110</td>
<td>65,760</td>
<td>32.9</td>
<td>16.9</td>
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<tr>
<td>8</td>
<td>.062A</td>
<td>838</td>
<td>832</td>
<td>358</td>
<td>4900</td>
<td>78,400</td>
<td>39.2</td>
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<td>61,280</td>
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<td>162</td>
<td>61</td>
<td>4050</td>
<td>64,800</td>
<td>32.4</td>
<td>18.0</td>
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</table>
Cultivation.—After the cane has been planted and is ready to sprout in
the spring it is very important to remove all surplus dirt from above it so
as to allow the young sprouts to come through. This is done by barring
off the rows with turn plows and sometimes removing soil above the cane
with hoes. The stubble cane should be treated pretty much the same way
and the dirt removed from around the stubbles with hoes or pronged forks,
or better by a stubble digger. Experience here has been that the stubbles
will keep through the winter as well and possibly better by simply leaving
them alone with no more dirt above them than would naturally accumulate
in cultivation.

The Louisiana Experiment Station recommends the burning of all fod-
der and other trash accumulating from the harvest of sugar cane as early in
the winter as possible so as to destroy insects likely to attack the cane the
following year, but since this fodder and tops afford considerable protection
for the stubbles against cold, and insect pests and diseases have been neg-
ligible here so far, we have preferred to leave this covering alone throught
the winter, burning it just before the cane is barred off in the spring.

If any considerable area of stubble cane is to be cultivated it will pay
to buy a stubble digger, a two-horse implement made by B. F. Avery &
Sons, which should be run over the stubble rows after they are barred off
in the spring, loosening the dirt around them and reducing the cost over
such work done with hoes in the same proportion that the mowing machine
does over the scythe.

With proper care in early spring the sprouts from both stubble and
plant cane will quickly show above the ground and the dirt should not be
thrown back to them until sprouting has been about completed. It is then
that the fertilizer is applied and the dirt returned to the row, after
which cultivation should proceed as with other farm crops such as cot-
ton or corn. Shallow cultivation is to be greatly preferred and for single
horse work we have found nothing superior to the spring tooth cultivator
which will drag over litter and trash buried in the middles where this has
never been burned. Cultivation should be frequent enough to keep all weeds
and grass killed as they appear above the ground and to conserve moisture
to the extent that such conservation is necessary.

Harvesting.—In the fall or early winter, preferably after the first light
frost has fallen, the blades must be stripped from the cane, the tops re-
moved, and the stalk severed at the surface of the ground. It requires
considerable cold to injure cane standing in the field, especially for syrup
and in 1907 the thermometer went to 28 degrees on November 13 with a
large part of our cane standing in the field. The buds on this cane black-
ened, the juice became a little frost bitten and we had great fear that it
had been ruined. The temperature went to 32 degrees, and below, for three
successive nights, the cane tops and leaves were largely killed, but when
left standing all effects of the frost on the taste of the juice grew out of
the cane and an excellent quality of syrup was made from it. Some of our
best growers here leave a part of their cane in the fields until after Christ-
mas each year, beginning the making of syrup after the first frost and continuing it for weeks with practically no loss from cold.

The implement used almost universally for stripping cane is the ordinary cane or corn knife which is a piece of flat steel on a suitable handle and with a slight hook on the back end of the knife opposite the handle for stripping. In the Louisiana cane fields the cane is stripped by the downward strokes with the back of the knife, the third lick removes the top, and the fourth severs the stalk at the ground, the entire operation being completed as the workman proceeds.

Mr. Wm. Howse, a farmer of Cairo, Ga., has invented a simple cane stripper made of two pieces of thin steel about fifteen inches long by one inch wide and 1-16 inch thick, bent and flared at one end so as to slip over and fit around the stalk of cane, and at the opposite end securely bradded to a handle about three feet long. This stripper removes the blades with a single downward stroke and has been found to be a very useful implement. With this stripper the blades are removed by one set of laborers while others follow with knives and top and cut the cane. Much work has been done on the perfection of a cane harvester but with poor success on account of the extreme difficulty of handling crooked cane by machinery. It is seldom that a crop of cane can be grown to harvest without being blown and twisted by the wind into all sorts of shapes.

Yields of cane.—The yields of cane vary widely, of course, with the fertility of the land, cultivation, seasons, etc., but on reasonably good land here, properly fertilized, a yield of twenty tons of plant cane and fifteen tons of stubble cane may reasonably be expected, a ton of cane corresponding roughly to twenty gallons of syrup. In 1907 our station had at McNeill about twelve acres planted to sugar cane, a good portion of which was on hill land that was very rolling. On this entire acreage there was 1.1 acres of the Japanese cane which yielded 34.7 tons and made 537 gallons of syrup, or 15.5 gallons to the ton. The remaining 10.9 acres of purple cane made 224 tons which gave 4,236 gallons of syrup, or 1899 gallons per ton. In 1908 Japanese cane made only 13.7 gallons to the ton while purple cane made twenty two. In 1907 when we used sulphur, lime and "Clariphos" for bleaching and cleaning cane juices the syrup from Japanese cane was of good quality, but in 1908 when the use of these materials was discontinued the syrup from this Japanese cane had an extremely biting taste and would not sell in competition with that made from the purple cane made at the same time and in the same way.

On the choicest spots in the cane field above mentioned the yields ran up to above 800 gallons of syrup to the acre and on one plat of .43 of an acre we weighed 49,735 pounds of cane which made 470 gallons of syrup, or at the rate of 1092 gallons to the acre. This was on level hill land that had been fertilized with raw cotton seed, animal manures and acid phosphate in 1905, planted to cabbage and again fertilized in 1906 rather heavily. In the fall of 1906 purple cane was planted on this land in rows 4½ feet apart and in the spring of 1907 this cane was fertilized with equal parts
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of cotton seed meal and acid phosphate at the rate of 500 pounds of each per acre. It is well to say that while this cane began sprouting soon after Christmas, these sprouts were never killed, a perfect stand was obtained very early in the spring and all conditions thruout the growing season were very favorable to the development of cane.

In this connection we would caution growers about the use of fresh animal manures under sugar cane. They will give an immense yield but have a tendency to give a salty, disagreeable flavor to the syrup. It is well to use manures on all land where they may be had, but these should be applied to cane lands at least a year before the cane is grown and this should follow a crop like peas or velvet beans at least partially turned into the soil so as to give it a better water holding capacity.

Handling cane.—Sugar cane is an extremely heavy crop and difficult to handle. It seldom remains erect until harvested, being nearly always blown by winds in summer, after which it grows in all sorts of shapes. When cut it is usually piled in heaps in every third row so that wagons may be driven through to pick it up. If loaded in an ordinary wagon body it is difficult to get to and troublesome to unload and in our section it is seldom grown in sufficient quantities to warrant the use of machinery for unloading, though if placed on ropes as it is loaded into the wagon body, simple hoisters may be improvised for lifting it out. In the absence of such a device or of carts or wagons that will dump the cane, the station has found a frame specially made for hauling silage corn or sorghum a most convenient method. This frame is recommended by the U. S. Department of Agriculture for use in hauling to silos and is made so as to be easily attached to the ordinary farm wagon.

Such a frame is made from 2 pieces of 2x6 18 feet long. With two U. bolts fasten the ends of these under the hind axles so as to clear the wheels. Bring the opposite ends together, bevel, and bend or nail securely to a short piece of material sufficiently thick for boring a one inch auger hole and fasten under front axle with long king bolt. Four feet back of front axle nail or bolt a piece of 2x6 6 feet long across this main frame. Take two other pieces of 2x6 about ten feet long and bolt the ends of these to cross piece above mentioned so as to leave them about five feet apart, bevel the opposite ends of these two pieces and nail to outside of main frame about four feet from hind wheels. At a distance sufficiently great from both front and hind wheels to give them clearance nail pieces of 1x6 slanting over these wheels and cover space between wheels with boards one inch thick and about five feet long. The accompanying illustration will give a fair idea of the construction of this frame which any novice can build out of material that is easily obtained on any South Mississippi farm.

Such a frame has been used here for years with perfect satisfaction. It will hold a maximum load, the cane can be put on it with a minimum effort on the part of the laborer, it is easily got to for unloading and at least on short hauls will prove very valuable.
Syrup making.—The most of the cane made into syrup in this state is ground on three-roller horse mills that are seldom screwed up as closely as they should be and the percentage of juice extracted is usually far below the actual content of the cane. In examining several mills around the neighborhood the extraction was found to average below 60%, but the same mills by screwing up as closely as possible would give an extraction of 65% or more. The Experiment Station had a 3-roller mill of 6 h.p. capacity run by a steam engine and this gave an extraction of 72% or more. A 5-roller mill should give an extraction of more than 75%, so, as at present handled, a large part of the juice in the cane grown by the average small farmer is left in the bagasse and goes to waste.

The common method of making syrup by the average grower of cane is about as follows: the juice runs from the mill through the burlap bag into a barrel; from this it is usually removed in buckets or thru a pipe into another barrel elevated above one end of the evaporator; from this barrel it runs thru a faucet into the evaporator and as nearly as possible, the flow is so regulated as to have a constant stream of juice running in with a constant stream of syrup running out at the opposite end, in the proportion of about six parts of juice to one of syrup; while the juice is going the circuit of the evaporator it is being skimmed and cleaned and by the time it reaches the syrup stage, it is possible to have it fairly pure. An expert manipulator may make a fair quality of syrup in this way, but the average man will not clean the juice well and will either cook it too much when the syrup will go to sugar or too little when it will ferment. On such an outfit it is impossible even for an expert with a saccharometer to cook all the syrup to the same gravity and this ought to be the first and most important object in view.

A better quality of syrup may be made on just as simple an outfit as the one described by substituting a pan or kettle for the evaporator and by cooking a definite quantity of juice down to syrup, skimming thoroly, and finally testing the density of this syrup with a saccharometer that may be bought very cheaply or improvised at home. One of the most successful syrup makers in this county uses a pan that he made himself out of galvanized iron for the bottom and poplar boards for sides. This pan is three feet wide, fifteen inches deep and 7½ feet long, with a trough at one end for catching the skimmings. He cooks about 150 gallons of juice at the time and gets from 22 to 30 gallons of syrup from it. The cooking is done with wood and towards the end of the operation the fire is allowed to go down so that when the proper density is reached the syrup may be removed before its density can be materially increased. This party makes from 50 to 60 gallons of syrup a day on the one pan which is about the capacity of the ordinary evaporator. On the evaporator there is about an hour between the time the juice enters and comes out as syrup and on the pan described about five hours. In the one the evaporation takes place in shal-
low depths and in the other a large part of the boiling is done at depths of from 5 to 12 inches. Naturally less of the crystallizable sugar is converted into non-crystallizable in the first process than in the second so that syrup of the same gravity made on an evaporator is more likely to go to sugar than if cooked in a kettle or pan.

Mr. D. R. Johnson of McNeill is one of the largest as well as the most successful syrup makes in this section of the state. He grows considerable cane of his own and makes syrup for the public. He has a 3-roller mill weighing about 3500 pounds and made by the Mobile Pulley and Machine Works at Mobile, Ala. This mill is run by a 6 h.p. gasoline engine and is driven by a 6 inch belt. This mill has a capacity of 200 gallons of juice per hour. This juice runs from mill into a 200 gallon juice tank and from this tank is run by pipes and troughs into one or the other of two evaporators set on furnaces just below the mill so that it runs by gravity. These evaporators hold about 200 gallons of juice and are so arranged that when cooking is completed they may be lifted clear of the furnaces, tilted at the same time and the syrup drawn off from one end. When the cooking is completed and the syrup ready to draw a lever is pulled down and fastened and a sheet of iron placed over the furnace so as to cut off all heat. The 200 gallons of juice in each evaporator is cooked down to a density of 34 degrees as taken from the boiling syrup and usually makes 30 gallons of the finished product. From the evaporators this syrup is run thru cypress troughs and strained into a cypress tank from which it is drawn into cans or barrels. It requires about five hours to cook off a charge so that the capacity of the present plant is about 120 gallons per day and Mr. Johnson contemplates putting in two other evaporators in order to equalize his capacity for making juice.

Everything about the plant except the mill, engine and belt was made at home. The furnaces and chimneys to same are built of brick; the evaporators are made of 2x12 cypress boards nailed together and the bottoms are of sheet copper sufficiently wide and long to be turned up and nailed with copper nails to the sides of the evaporators. These evaporators are 38 inches wide, nine feet long and one foot high with 2x6 cypress boards beveled and flared and nailed to the top part of the sides so as to hold the juice when it boils and foams. The 1x6 boards are nailed to the sides of these evaporators, extending beyond the ends for about a foot and are notched so as to hold V shaped gutters into which the skimmings are drawn by means of a wide board nailed to the end of a handle of convenient length. From this trough the skimmings run into a barrel and thence to troughs in a nearby lot where they are fed to hogs. This operation gets rid of the bulk of the impurities in short order, subsequent cleaning being done with hand skimmers in the regular way. The one outstanding feature of this outfit is its simplicity and efficiency. It is built on the side of a hill, gravity moves all juice and syrup. It is largely home made and simple levers enable one man to lift the evaporator and contents clear of the furnace with little effort and the syrup made will neither sugar nor sour and has that quality which holds a customer once he is obtained.
Cooking by steam.—Really the best means of evaporating cane juice is by steam and if any considerable acreage is ever devoted to sugar cane in a given community, it will pay to have a community syrup factory or mixing plant just as we now have cotton gins and grist mills. These could be run in combination using the same boiler and engine to gin the cotton, grind the corn or cane, and evaporate the juice or mix the syrup. One of the bad features about the use of so much machinery for grinding and cooking syrup is that this machinery is idle the most of the year and pays nothing on the investment. In the boil weevil territory cotton ginning may always be completed before cane is ready to grind or syrup available for mixing and so the two might be run in conjunction. In many of the small towns in South Mississippi ice factories, cold storage plants for meat and dairy products, canneries for fruits and vegetables and at least mixing plants for syrup might easily be run as a single organization so as to keep most of the machinery and at least the expert labor busy through the year. Such a plant, run cooperatively, could cure the farmers’ meat, cool his milk or cream for shipment to market, furnish ice for the towns and country, can the surplus fruits and vegetables and if not best suited for grinding the cane, could at least take the syrup as it comes from the many farms, mix, standardize, can and market this syrup.

The greatest trouble in extending the acreage of cane in South Mississippi is the lack of reliable markets. The home markets are already supplied and the individual growers have no time and little ability to open up new markets. If some dealer undertakes to buy up this syrup, he soon finds that he has about as many grades, possibly more grades, than he has farmers furnishing syrup and if by chance he should find a market he could never hold it for the reason that he could never guarantee to sell the same grade of syrup twice in succession. A better grade of syrup can be made by uniform handling from grinding the cane to canning the finished product, but experience has shown that the average farmer takes a pride in the quality of the syrup that he makes, cleans it fairly well, but falls down in standardizing his product. If all, or a part of the syrup made by the many individual growers could be brought to a central plant, mixed, re-boiled and canned, it could be sold in competition with other standardized products under brand names. The trade will consume all the cane syrup we are likely able to furnish if it can be put up in the way the buyers demand.

Arrangement of syrup house.—While at McNeill this station built and equipped a complete syrup making plant designed and equipped by the Blymyer Iron Works Co. of Cincinnati, Ohio. The machinery in this plant cost in 1905 about $2200.00 and consisted of a 40 h.p. boiler; 8 h.p. engine; 6 h.p. mill with cane and bagasse carriers; two 200-gallon juice tanks; two 300-gallon defecators; three 300-gallon settling tanks; one 400-gallon evaporator; one boiler feed pump; one juice pump; one sulphur apparatus consisting of stove, cooling tank and sulphur box; together with all necessary pipe, copper steam coils, valves and other fittings for connecting all into
a working unit. This machinery was housed in a building 26 feet wide and 72 feet long, with 22 feet side walls and an extreme height of 30 feet. This apparatus was so arranged that the boiler, engine and cane mill set on the ground floor; the juice tank was sunk into the ground so that the top of it was on a level with the ground floor. The juice was picked up from this tank by a rotary pump run by the same shaft which turned the cane mill and was pushed to the extreme height of the building where it entered the top of the sulphur box and flowed back and forth over a series of super-imposed copper shelves where it came intimately in contact with fumes from burning sulphur which entered this box from below and passed out at the top. This sulphur was burned in a small stove also set on the ground floor and the fumes were conducted through a two-inch pipe (surrounded by running water) into the sulphur box, the quantity of fumes being regulated by a steam jet which entered the escape pipe at the top of the sulphur box. After the juice was bleached it entered a second juice tank from which it was directed into one or the other of two evaporators or defecators placed on what might be called the third floor of the building (the sulphur box being set on the joists). These defecators were provided with copper steam coils and it was here that the juice was first heated and the blanket of impurities which rose to the top brushed off into troughs extending entirely around each defecator. Milk of lime was then added to the point of neutrality as measured or determined by the use of litmus paper or by the eye when properly trained, and the cleaning was continued here for some time. After the juice in the defecators was so clean that no particles were to be seen coming to the surface as the boiling continued, a small amount of "Clariphos," a preparation of phosphoric acid, was added at the rate of about three quarts diluted with several times this volume of water, for every one thousand gallons of juice. The juice was then drawn off into settling tanks placed to one side of the building and just a little lower than the defecators. The "Clariphos" precipitated any excess of lime that may have been added and carried down with it a quantity of other impurities. After settling for at least two hours the juice was drawn into the evaporator placed on a still lower level, where the cleaning process was continued and it was finally brought under vigorous boiling to the consistency of syrup as determined by the Beaume hydrometer or saccharometer which should indicate a gravity of about 34 degrees. At this point the steam was quickly turned off and the syrup turned by means of a large gate valve into a cypress tank still lower down from which it was drawn while still hot into bottles, jugs, barrels, cans, etc.

We found all the apparatus and processes above described by no means necessary to make a good quality of syrup that would meet the market requirement, though it did give a very bright syrup that had an excellent flavor and kept to perfection. Later we did away with the use of sulphur and clariphos with no bad results except the product was a little darker in color. One of the largest and most successful syrup makers in this state who cooks by steam uses a single evaporator without either defecators or
settling tanks. He made this evaporator at home out of cypress boards and the necessary steam coil out of 2-inch galvanized iron pipe cut in lengths to fit the evaporator and connected with return bond elbows. He uses an ordinary siphon jet for pumping the juice, wooden troughs wherever possible for conducting syrup and juice, and wooden tanks entirely for holding juice, skimmings and syrup. In fact, aside from the boiler and engine which he utilizes at times to saw lumber and a cane mill which was bought second hand, this party made every thing else about the factory at home. It is an easy matter to make defecators, evaporators and juice tanks out of wood and we believe they are superior to galvanized iron for the reason that they are less likely to color the syrup. A convenient evaporator may be made of 2x10 cypress lumber bored with a 11-16 inch ship auger and bolted together every three feet with 5-8 inch iron rods. The factory just mentioned belongs to the Allen Bros. of Emerald, Miss., and has an evaporator made of this material and in this manner. This evaporator is ten feet long, five feet wide, and three and one-half feet high, with flanged top on three sides and a trough to catch skimmings on the other end.

Containers for syrup.—The tin can is the best package for syrup that is to be sold to the consumer, the barrel where it is to be sold to the dealer who expects to work it over in any way. There are all kinds and sizes of these cans and we found that under average conditions the 10-pound or short gallon can was the most satisfactory. Smaller cans involved too much labor in handling where machinery for filling was not available. We also found friction top cans more satisfactory than those on which the tops had to be soldered. The wide mouth friction top can was satisfactory for syrup sold near home and where shipping on trains was not necessary, but such cans would not stand rough handling unless specially crated or partially soldered as the tops would come off and cause much loss. In fact, the railroads finally refused to accept such cans for shipment except under the conditions named. The small mouth friction top cans sold as the “Record Patent” was found to be the most satisfactory can for shipment, being easily filled, quickly covered, and an altogether satisfactory shipper. The screw top can was satisfactory in every way except the opening was too small to fill rapidly.

The cheapest cans are the ones that have to be soldered and these are quite satisfactory where syrup is canned in sufficient quantities to justify machines for filling and apparatus for soldering, but to the average farmer the labor in soldering these cans properly would more than offset the added cost of the friction top and besides the local trade prefers the wide mouth can because when the syrup is gone a useful vessel is left in the empty can. For certain fancy trade bottles are desirable, but the average farmer is in no position to pack them. Bottles and jugs are alright for home use, but unless well stoppered expansion in summer will cause much loss from being pushed out. It mattered not how carefully our syrup was made, if placed in kegs or barrels fermentation would set up in the summer unless
these containers were put in cold storage. It is needless to say that in any package neatness and attractiveness of appearance has much to do with the sale of the contents and that proper labeling of any container will pay handsomely.

Markets.—There is almost an unlimited market for first class cane syrup that has an established reputation. The syrup makers mentioned in this pamphlet can sell and do sell their syrup at remunerative prices largely on local markets and many other growers and makers of cane syrup in South Mississippi could, by adopting certain of their methods, greatly enhance the value of their product. But even these men could not greatly increase their production over supplying their present markets and possibly none of them are in a position to find other markets remote from their home towns in this and other states.

From an economic standpoint the bulk of the sugar cane in this section should continue to be grown by the numerous small farmers, the majority of whom will never standardize the syrup made from it nor be able of themselves to find markets for any greatly increased production. Community factories on the order of the one put in by the station at McNeill and patronized by the farmers within hauling distance would insure at least the best grade of syrup, but it is questionable if with the country so thinly populated sufficient cane would be grown in hauling distance of such a mill to make enough syrup to justify the expense required in maintaining the proper selling organization necessary in marketing this syrup. Sugar cane is so heavy and difficult to haul that at least in the case at McNeill we were never able to get any great quantity brought to the mill, nothing like enough to justify so large an investment in an outfit of the kind.

We rather think the solution of the problem lies in a cooperative movement among the farmers of a much larger territory by which these individuals would continue to grow and handle their cane as at present, keeping so much of the syrup as was needed to supply their homes and local markets and pooling the surplus with some central cooperative organization that would take it, separate into the necessary grades, reboil to the extent required, standardize and can the resultant syrup, to which they would give brand names and let it enter the channels of trade just as other products of the kind are now marketed. With a cooperative organization, aside from the initial investment in the necessary factory equipment, no great amount of capital would be required, certainly no more than enough to buy cans and meet certain small current expenses and this could easily be obtained from local banks.

To just what point of concentration this syrup would have to be boiled before leaving the individual farms experience might have to determine. Certainly the more it was concentrated up to the point at which it might be taken by the central factory and worked into the best quality of syrup, the cheaper would be the cost of hauling or freighting to this factory. No
exact standard would be possible or necessary for with the saccharometer each barrel as it was received could be measured as to sugar content and credited to the individual producer. Our judgment would be that any syrup cooked to 30 degrees at or near the boiling point would keep sufficiently long without fermentation, especially at the time of year when it is made, to enable it to be handled at the factory without injury from souring. It might be necessary for the management of this central organization to give more or less supervision to the handling of this syrup on the individual farms, at least to the point of seeing that it was well cleaned during the process of boiling, but the establishment of grades under which it would be taken and finally paid for by the central plant would finally force the growers to the exercise of proper care in the handling of their product.

Sorghum.—There is very little sorghum grown for syrup making as far south as we are located and the writer has had no actual experience in growing the crop for this purpose. However, it is grown by this station for silage making almost to the exclusion of corn or any other crop. Under average conditions, considering droughts, injury from insects, unseasonable plantings, etc., we believe our tonnage from sorghum made into silage has easily approximated 75% greater than the same land planted to corn and by allowing this sorghum to ripen thoroughly before putting it in the silo we find it equally as nutritious and palatable. Sorghum has a decided advantage over sugar cane in the expense of seeding, fertilizing and cultivating as well as in the length of the growing season. We have planted certain of the early maturing varieties here after the first of August and have had them mature and be put into the silo before injured by frost. So, under many conditions, even so far south as we are, it may pay to grow sorghum as a syrup crop. This is especially true under the tenant system of handling plantation labor where such labor is too shiftless to look more than a few weeks ahead and entirely too careless to provide themselves with the sugar cane necessary to plant even a small acreage.

The cost of seeding an acre to sorghum amounts to little and if seed are saved at home might be disregarded. However, there is possibly more to be gained by careful seed selection in developing and maintaining strains of sorghum rich in sugar content than with any other plant in the entire list of field crops. In work done at the A. & M. College twenty odd years ago, the writer grew and determined the sugar content in a number of kinds of sorghum and found this to vary greatly, so it would appear that one of the stations with facilities for analyzing sorghum juices might do much good in developing, distributing and maintaining high producing strains of sorghum for syrup making, particularly if the crop is grown to any extent by the farmers of North Mississippi where sugar cane cannot be grown economically. Where sugar cane can be grown so successfully as with us in this latitude, particularly with a population of small white farmers who own their own farms so decidedly in the majority, we can see no need of growing sorghum to any extent, because, as we see it, the sugar cane syrup is so superior as to be incomparable.
Rotations. Cropping land in corn continuously is not a good practice. Insect and fungus diseases will be less troublesome, yields will be better, and the general fertility of the soil can be maintained more easily if a good system of rotation is followed. The crops put into the rotation are determined largely by the type of farming followed. For diversified farming, a three-year rotation consisting of corn with cowpeas sown in the middles at the last cultivation, oats and vetch followed by cowpeas, and cotton the third year gives good results. A dairy farmer will probably prefer to shorten rotation to two years, leaving out the cotton and growing corn every other year. A cotton farmer will prefer to lengthen the rotation to four years and grow cotton two years in succession.

Soils Adapted to Corn. The best soil for corn is well drained, rich, sandy loam which contains a fair amount of humus. Most of the valley soils in the area covered by this bulletin can be made to produce good corn and the black Houston clay soils of the Northeast Prairie as well. Growing corn for grain on the thin hill lands of Central Mississippi and in the Flat Woods belt is seldom profitable.

Source of Seed. Below is a list of the parties from whom the seed used in the variety tests in 1920 was obtained:

Champion Early White Dent Harpeth Valley Seed Co., Franklin, Tenn.
Cocke’s Prolific Mississippi Experiment Station
Florida Flint Mississippi Experiment Station
Goliad Mississippi Experiment Station
Gerrick Mississippi Experiment Station
Hastings Hastings Seed Co., Atlanta, Ga.
Johnson County White Mississippi Experiment Station
Laguna Mississippi Experiment Station
Mosby (Station) Mississippi Experiment Station
Mosby-553 Mississippi Experiment Station
Mosby (Ewing) E. C. Ewing, Scott, Miss.
Mosby (Wodruff) A. S. Woodruff, Batesville, Miss.
Marlboro (Wannamaker) W. W. Wannamaker Seed Co., St. Mathews, S. C.
Mexican June R. K. and F. L. Weir, Starkville, Miss.
Marlboro (Coker) Pedigreed Seed Co., Hartsville, S. C.
Pasamaster (Station) Mississippi Experiment Station
Paymaster (Harpeth) Harpeth Valley Seed Co., Franklin, Tenn.
Simmons’ Prolific Harlow Simmons, Warnerton, La.
Tennessee Red Cob (Station) Mississippi Experiment Station
Tennessee Red Cob-72 Mississippi Experiment Station
Vardaman Mississippi Experiment Station