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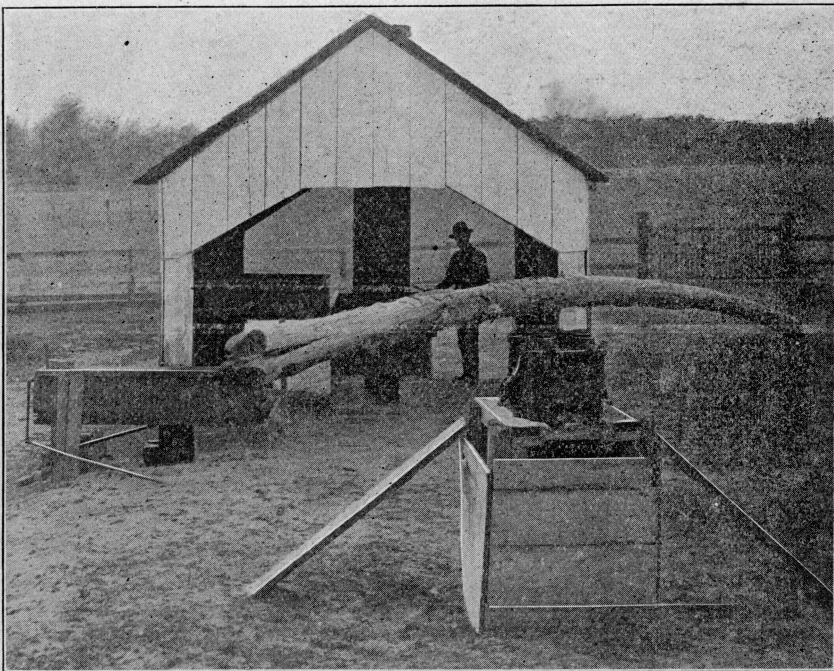


FIG. 4.

A common type of syrup factory, consisting of mill, sulfur box, and evaporator. (Courtesy Louisiana Experiment Station.)

THE MANUFACTURE OF CANE SYRUP.

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THE MANUFACTURE OF CANE SYRUP.

By H. H. HARRINGTON.

The main object of this bulletin is to encourage the small farmer to engage in the growth of sugar cane with a view of manufacturing syrup for his own use, and in a limited way supplying the local market. In the preparation of the bulletin considerable attention has been given to the composition of glucose and mixing syrups. The preparation and use of these will therefore be considered. Sorghum syrup is still manufactured in the South to some extent, and Kansas farmers have in some cases given its production special attention, under scientific direction. But sorghum syrup as ordinarily manufactured on the farm is wanting in flavor, and has a peculiar, strong taste that to many people is not agreeable or pleasant. It hence has little demand in even a local market, and none as a regular commercial product. When made at all it is usually consumed on the farm where produced. It may not be out of place, to here refer to a paper read before the Interstate Cane Growers' Convention on May 6, 1903, by Mr. D. G. Purse, President of the Savannah Board of Trade. Mr. Purse says: "About a year or more ago your speaker had his attention directed to a telegram from Topeka, Kansas, in which it was claimed that Hon. A. A. Denton, Medicine Lodge, Kansas, had discovered a process which produced a syrup from sorghum, by which he would be able to drive Louisiana syrup from the market in Kansas. Correspondence was at once opened with Mr. Denton, and Hon. F. D. Coburn, Secretary Kansas State Board of Agriculture. From the former we received a sample of sorghum syrup, which was reciprocated by sending both Mr. Denton and Mr. Coburn samples of pure cane syrup. Mr. Denton, in acknowledging his, said he was not competing with that kind of syrup. Secretary Coburn, after subjecting to tests samples sent him, said, 'The sample looks well and tastes well, and it is a remarkable fact that we *can not get this syrup here for love or money.*'" In former years it was easy to get what is known as "open kettle syrup." This is really not a syrup, but a molasses. The juice of the cane properly defecated is boiled down until some of the sugar is ready to crystallize out, when the magma or masse-cuite cools. The molasses is then allowed to drain away from the brown crystallized mass of sugar and is sold as open kettle molasses. It has the flavor of the cane, contains still a large amount of sugar and is a most excellent table article. But it is being rapidly superseded by glucose and mixing syrups, and when sold at all, usually commands a fancy price. The reason for this displacement is due to the fact that the constant aim of the modern sugar planter is to extract as much sugar as possible, and to treat the resultant molasses entirely as a by-product. The "first molasses" from the centrifugals may find its way to the market, for table use. But such is not usually the case. It should be regarded as the real "sugar-house molasses," so much spoken of by the trade, and so difficult to find; although so-called "sugar-house molasses" can be obtained of almost any grocer. *Cane Syrup* is better than "open kettle molasses," for the reason that no sugar whatever has been separated; and it carries a distinctive cane flavor. The purified juice of the cane has simply been boiled to the consistency of molasses.

PURE FOOD LAWS.

It is only a question of a short time until the State will be compelled to pass an effective pure food law, for the protection of the public. Several bills of the kind have been before the national Congress, but none of them finally considered. In England, and European countries, the consumer is protected by adequate laws; and some of the older States in this country have adopted measures somewhat similar; though, as a rule, not so complete in the number of articles controlled by the law. In the operations of a pure food law it is not necessary to impose a tax on any particular article. The aim should be to prevent adulteration, and

to fix a penalty that could be enforced for a violation of the law. To do this the law should provide that each article should be labeled plainly and distinctly in such a manner as to give a true idea of its character; and unless this can be done its sale should be prohibited entirely. Chicory and beans, for example, should not be sold as coffee. Candy made of glucose, of gum, or of paraffine wax coated with sugar, should show it by the label. If wheat flour is to be blended with starch made from corn flour; if the product of other cereals, pea flour, or sorghum seed flour, are mixed with the wheat flour, the label on the sack should plainly state it. There are now very few classes of articles coming to the dining table which are not commonly adulterated. In many cases the practice works a direct injury or hardship on the honest manufacturer of the State. Take the case of flour. There is probably not a mill in the State which adulterates its products with *Flourine*, a starch product made from corn. But in the trade they must compete with the Northwestern mills that add this *Flourine*, and thereby secure a whiter and cheaper product. It is said that a "flour" from sorghum seed is now commonly used to adulterate buckwheat flour.

Saccharin is used by canners as a substitute for sugar; not in this State, perhaps, but the home manufacturer must come in competition with the outside markets. In the same way preservatives—salicylic acid, boracic acid, benzoic acid, etc.—are used to insure the keeping quality of canned or preserved goods. I do not mean to say that pure goods can not be obtained in the market; but in the absence of any law, it is difficult to know just when we are getting the unadulterated products. Besides the articles referred to above, tea, cocoa, baking powders, jellies, fruit extracts, spices and condiments, are commonly adulterated. It may be that some of the articles used for adulteration are not unhealthful. But that question should be left to the judgment or discretion of the consumer. In Iowa, the greatest corn producing State of the Union, the statute provides that "no person shall mix any *glucose* or grape sugar with syrup or sugar intended for human food."

GLUCOSE SYRUP.

Before considering the manufacture of cane syrup, it will be well to make an inquiry into the nature of glucose syrup. Glucose, or Dextrose, itself, is one of the sugars, commonly known as grape sugar. It occurs in sweet fruits and in honey. When pure it is perfectly white, and is somewhat less sweet than cane sugar, the ratio of sweetness being probably as 3 to 5. It is manufactured on a very large scale in this country, from starch; the starch being manufactured from corn. The number of commercial products which can be made from corn is quite surprising, and the daily quantity of grain consumed is something over 100,000 bushels. There are four primary products obtained from the grain of the corn. The hull or outside covering of the corn is taken off and is known as *corn bran*, sold for cattle feed. The *corn germ* is then separated from the starchy matter of the grain, the oil is pressed out, known as *corn oil*, and the residue constitutes *corn oil cake*, which is sold for cattle feed. The *glutenous part*, which occurs mainly immediately under the hull or outside covering, is also separated and sold as *gluten meal* for cattle feed. It is sometimes mixed with the hull or bran and sold as *Maize Feed* or *Gluten Feed*. This leaves the *starchy* part of the corn, which is repeatedly washed and settled until purified, and is then sold as commercial starch, or it may be sold as Starch Flour to be added to wheat flour. Besides these four primary products from corn, there are many additional ones derived from these. Six grades of starch, one of which is supplied as "refined grits" to replace corn grits or rice for table use. Seven or eight different grades of *glucose syrup*, to be used as such on the table or for other purposes, or to be sold as a "mixing syrup." Two grades each of dextrin and gum.

How Is the Corn Starch Converted Into Glucose Syrup?

After the starch is purified in its manufacture from the corn, it is taken without drying and treated with muriatic acid, or with sulphuric acid. Heat is employed, and either open or closed vessels are used. This converts the starch into a mixture of dextrose, maltose and dextrin; and the process is called "hydrolysis." The acid does not enter into the re-action and its behavior is not understood. After the starch is converted into the compounds above named, constituting the glucose syrup of commerce, the acid is removed; in the case of muriatic,

by soda ash, or in case of sulphuric, by limestone. The syrup is then run through bag filters to remove suspended matter, and then through bone-black to bleach or decolorize it. It has then a small amount of sodium bisulphide added to it to bleach it and to prevent fermentation, and boiled down in a vacuum pan to the right degree of concentration for syrup. But this syrup is not usually sold direct to the trade for table use. It is too expensive, although its wholesale price is about 13 cents a gallon. It is sold to the "mixer." He buys the last centrifugal molasses from the cane mill or the refinery—a black, tarry product, full of all the impurities, except the scums, which it has been possible to separate from sugar, and mixes this product in with the glucose syrup. This gives a mixture carrying some cane sugar, with a slight—very slight—flavor of the cane, and is sometimes put on the market as "sugar-house molasses." This centrifugal product from the refineries can be had at from 3 to 7 cents a gallon. It will be seen what a profit there is in this artificial preparation of a table syrup or molasses. It is a good thing for the Northwestern corn planter, for the glucose sugar refiner, and for the "syrup mixer," but not for the Southern planter. It is not probable that glucose syrup when properly made is unhealthy, but if it should contain sodium bisulphide this would be objectionable to the same degree as its presence, or that of other antiseptics, in other foodstuffs is objectionable. An objection based mainly on the assumption that if an antiseptic can arrest fermentation in a food-stuff, it can at least delay digestion in the stomach. A conclusion that seems reasonable. What, then, are the objections to glucose syrup as a commercial product for the table? (1) Besides glucose, it may contain dextrin or gums. (2) It may contain an antiseptic to prevent fermentation, which might also interfere with digestion. (3) Mainly, its sale is to some extent at least a deception and a fraud. From an economic standpoint, it takes away from the farm and from the South a large amount of money that should be kept at home.

Aside from the above considerations, the main advantage which cane syrup has over glucose syrup is one of flavor. The delicate flavor imparted by the cane is considered by many consumers to make this syrup to equal or excel maple syrup, and becomes therefore quite as desirable. Glucose is entirely without flavor. When any article is extensively adulterated, the effect is to cast suspicion and doubt on even the pure goods, lessening demand, and depressing the market value, to the detriment of the farmer or producer. I believe that the sale of "mixed syrups" in this State should be prohibited absolutely; while all unmixed syrups should be labeled plainly, to show their character.

SUGAR CANE.

Sugar cane belongs to the family of grasses; and most authorities are inclined to trace all the different kinds of sugar cane now grown to a single species, *saccharum officinarum*. According to this, all the different sorts of cane now met with are induced by the effects of cultivation. But there is no absolute unanimity of opinion upon this subject. For practical purposes we may divide the canes grown in this State into three principal varieties—the red or purple cane, the ribbon cane, and the green cane. The red cane is the hardiest variety; will resist cold and drouth better, and is perhaps a little richer in saccharine matter at early cutting; although there is little difference between it and ribbon cane in this respect. The green cane appears to be rich in juice, but is later maturing, and is, therefore, liable not to be so sweet as the other varieties. It is, however, a softer cane—easier to crush—and this is a property worth considering when horse-power mills are used. But I should recommend the red cane, on account of its power to withstand drouth and cold.

Improvements of Varieties.

According to Deerr, some of the methods for improving cane may be classified as follows:

- (a) By importing new varieties.
- (b) By selection of tops for planting from canes of high saccharine strength.
- (c) By raising new varieties by means of the seeds of the cane.

With regard to the first method, it must be remembered that the cane plant adapts itself very slowly to new surroundings. A variety that is good in one

locality may not prove itself of value in another; but like other plants, the cane can be improved by "continuous careful cultivation." The importation of new varieties by the Louisiana Experiment Station has not generally given gratifying results. In regard to the second method of improvement, there seems to be no uniformity of opinion among authorities as to its definite value. The third method in the hands of Dr. Stubbs has given most satisfactory results, after many disappointments.

Of course this improvement of varieties is not so important to the syrup maker as it is to the sugar manufacturer. But even in syrup making, it is not to be overlooked or neglected, since varieties may influence the ease with which the juice is subsequently handled.

SOIL.

There are three conditions which a good cane soil should possess—good drainage; fertility; the capacity to retain moisture. These conditions are found mainly in our alluvial soils when properly drained. They vary from a sandy loam to a stiff clay. The clays, when well drained and properly cultivated, usually give a heavier tonnage to the acre, while the lighter lands yield a cane richer in sugar. In this State a clay loam is perhaps the best cane land. It is comparatively easy to work, fertile, retentive of moisture, and yields a cane rich in sugar. In the manufacture of syrup, however, it is more important to have a heavy yield of cane than that the cane be especially rich in sugar. Of course, under irrigation, the question of the retentive power of the soil for moisture is not so important.

PREPARATION OF THE SOIL.

It can not be too strongly impressed upon the mind of the cane planter, however small or large the acreage put in, that his land must be thoroughly drained. Plant-cane, stubble-cane, nor cane in windrow, will not permit continued contact with sub-soil water. Once get the land thoroughly drained, and the next important consideration is to get it thoroughly pulverized to as great depth as practicable. The land should be broken up in the fall and go through the winter in good condition; at least come out so in the spring. If the land is poor, it must be fertilized if good crops are expected.

PLANTING.

The very best farmers in Louisiana are not yet agreed as to whether it is best to plant in the fall or in the spring. I think the fall is preferable in localities so far north that the cane does not have full time for maturity. Planted in fall, the cane comes up earlier in the spring, and, of course, permits of earlier grinding. At the same time, more care is necessary to protect the cane from frost during the winter months. "Plant-cane" is not so easily protected from the cold, as when in windrow or bed. The ground should first be broken broadcast—preferably with a disc plow; on account of its giving a more perfect pulverization, and the burial of any trash or vegetation. Then take a two-horse turning plow and put up the best beds possible, cleaning out the middles so as to leave unobstructed drainage to the ditch or quarter drains. When ready to plant, from the last of September to the middle of October, take a turning plow and open up the top of the bed, throwing the dirt both ways, going to a depth of about 6 inches. In this trench—the bottom of which should be above the level of the middles between the rows—plant the cane, and cover to a depth of at least six inches to keep out the cold of winter; the eye of the cane being very sensitive. The cane should only be cut in pieces short enough to admit of a straight row. If the cane is very crooked, of course it must be cut in shorter lengths to give this straight drill. But it is a mistake to cut straight cane in short pieces; or to cut it at all, if it can be avoided. The cane can be planted stripped or unstripped, and it is safer to put two running stalks together; although a good stand may sometimes be had from one running stalk, by allowing the ends to lap at least 6 inches. It should be remembered that the tops of the cane will do for planting; and at time of grinding, these may be kept for that purpose.

CULTIVATION.

When the cane first starts to coming up the planter may feel very much discouraged over the absence of a stand. But the disappointment is probably not justified. One shoot to every foot may be considered a good stand, since the stalk has great power for suckering, and will soon add to a stand that at first was very unpromising. There is likely to be an ultimate stand of three to six canes to the foot from planting two running stalks as above indicated. During the early season, the cane suckers freely, and many of these suckers are likely to die down later on. But if there remains three good canes to the linear foot, the crop may be considered a very satisfactory one. If the cane comes up thick from the start, it is likely to sucker excessively and become too thick, so it is well to aid the start of what suckers are wanted early in the season, and then cultivate to suppress additional ones. The experienced cane planter attempts to prevent excessive suckering by close cultivation; but, of course, this should not be close enough to cut the roots of the cane. Suckers appearing after the middle of June are not likely to mature in this climate, even when the rainfall happens to be pretty well distributed and the soil well adapted to cane. It is more than likely that the locality, north or south, from which the seed cane is obtained, will exert an influence upon the date of its maturity. Early in the spring—as soon as danger of frost is over—the cane should be barred off, and the top of the ridge removed with hoes to allow the young shoots to come out. Care should be exercised at this time in order that a good stand may be secured. When the cane is large enough, the middle may be broken out, throwing a good bed to the cane, and leaving a clean, clear middle furrow to facilitate drainage during the spring rains. While the cane needs a large amount of water for full development, it can not, as stated above, endure standing sub-soil water in actual contact with the roots. It is the practice with many farmers to use the turning plow for cultivation from this time on to laying by, or last working. Dr. Stubbs strongly condemns this practice, and believes that after the first bed is made with the turning plow, it should then be discarded, and cultivators used entirely; using the disc cultivator to throw dirt to the cane; and the middle, or diamond, cultivator for breaking out the middles. For small acreage, sweeps may be used to advantage when cultivators are not already on hand. Of course, the season will exert some influence on the manner of cultivation. It is necessary to keep in mind that in the cultivation of cane, a good bed should be maintained, up to the latter part of the season at least; and that frequent and shallow cultivation—here as elsewhere—greatly retards the escape of moisture from the ground. Be careful to see that the ground is in good mechanical condition, and not too dry, at the time of planting. From first to last, during the time of cultivation, the soil should be kept in good tith. Cane should not be planted in the fall when the ground is too dry, since “dry rot” is liable to occur; and it needs good drainage rather than rich land; but a large crop can not be obtained except on fertile land. About four tons of stripped cane will be required to plant one acre. The price in South Texas is from three to five dollars a ton.

WHEN SHALL THE CANE BE CUT.

It is desirable, of course, to allow the cane to stand as long as possible, in this climate, and still escape a killing frost. For syrup manufacture, cane which has had its tops killed by a light frost may still be used; although it will be more difficult to clarify. And if the cane is cut and moved under a shed, it will keep for weeks unless caught by a freeze. Plant-cane, which is cut too early in order to work off a late crop, leaves a stubble which is liable to sprout the same fall, and thus injure the stand of the next year's crop. It is, therefore, best to cut the oldest stubble first, leaving the plant-cane stubble until the last.

YIELD OF CANE AND SYRUP TO ACRE.

The richer the land, other things being equal, the heavier, of course, the yield of cane; but it is not so rich in sugar, and usually yields a juice which is more difficult to clarify. The tonnage in South Texas is anywhere from 20 to 40 per acre. The cane contains about 90 per cent. of juice; but only 78 to 85 per cent. of this is extracted by even the best and latest improved sugar mills. A small syrup mill would not extract more than 60 to 65 per cent. A ton of cane may be

expected to yield from 16 to 20 gallons of finished syrup; say an average of 18 gallons and 25 tons of cane, we may expect 450 gallons of syrup, which, at 25 cents a gallon, ought to yield a very handsome profit to the farmer.

THE MANUFACTURE OF THE SYRUP.

This may be done in the most primitive way (see Fig. 4). In fact nothing more is required than what is known as a "sorghum mill." This consists of three small iron rollers with a crank to which a wooden lever is attached, pulled by one or two horses; and in addition to the rollers, an evaporating pan, which can be mounted in a crude way on masonry over a furnace. This simple outfit is too well known to need description. But the best grade of syrup can not be made in this way for the following reasons: (1) The heat can not be properly controlled with an open or direct fire; steam heat should be used instead. (2) A product of even grade can not be obtained. The precise completion of the product for different runs from the evaporator can not be made by guess work. Some means must be provided for taking the specific gravity, or weight, of each "run." (3) This primitive method does not provide for the removal of the dirt, except that which collects in the scums and is removed with it. (4) Clarification is not complete. The skimming may be very carefully and patiently done, but without liming, the scums are not completely separated from the juice, and can not, therefore, be removed.

But fortunately most of these difficulties can be overcome with very little expense, or increased cost. Steam heat may be dispensed with, although a uniformly-cooked product is not likely to be obtained throughout the season, and certainly not from year to year. No matter how careful, some one "run" is sure to be more or less scorched. But the specific gravity can be easily taken with a simple and inexpensive hydrometer; and I know of no better or cheaper device than the one described by Professor Stockbridge.* "Take a straight, dry, thoroughly-seasoned hard wood stick, about one-quarter of an inch in diameter, and from 12 to 15 inches long. Roll a narrow piece of sheet lead around one end of the stick, or introduce a few shot into a hollow in the bottom of the same." A straight piece of "switch cane", with the upper joints punched out or burnt out, leaving one lower joint for holding the shot, makes a splendid hydrometer. The size of the cane may be as much as one-half inch in diameter. This gives the hydrometer—an instrument used for getting the weight or specific gravity of liquids as compared to water. But it must be graduated, or marked, in such a way that when dropped into a liquid it will show its comparative weight. For this purpose drop the stick or cane into a bottle filled with syrup which has been heated to the boiling point, and regulate the amount of lead on the stick in such a way that the stick stands upright, its lower end being about 2 inches from the bottom of the bottle, with about the same amount of stick projecting above the top of the liquid. Note carefully the surface contact of the stick with the top of the syrup in the bottle, and at this place make a little notch on the hydrometer, or "syrup tester." After the notch is made, verify its accuracy by dropping the "tester" back into the syrup, and see that the notch exactly cuts the surface of the liquid. A black thread may then be tied around the stick, or "tester," at the notch to make it more easily seen. It is well to keep on hand at least two of these "testers" at a time, so that if one is broken or mislaid the other will be ready for use. When making a run of syrup, and when in the judgment of the boiler it has reached the right density, or is "done," a sample should be withdrawn, and its specific gravity tested while hot. When the "tester" shows it of the right specific gravity it is immediately withdrawn. In this way, syrup of uniform density can not only be made during the season, but from year to year. Glass hydrometers, or "saccharometers," as they are called when used for sugar solutions, can be had of any chemical supply house, through your local druggist. They cost about 50 cents each. Ask for Beaume's hydrometer for liquids heavier than water, graduated from 0—40 degrees, divided into single degrees. Syrup of the proper density should register $33\frac{1}{2}$ to 34 degrees on this hydrometer, tested while near the boiling point. When the syrup has cooled to the ordinary temperature it should register 40 degrees Beaume. Having arranged for accurately gauging the specific gravity of the syrup, the next step is to decide whether or not the juice shall be limed and sulphured. In case it is not, it must be carefully strained or filtered through some material that will not only take out the sus-

*Florida Bulletin, No. 44.

pended or mechanical impurities, but that will also improve the color of the juice, or partially bleach it, and remove from it some dissolved solids that are not sugar. In other words, it must in some degree at least take the place of sulphuring and liming the juice, which have for their object the bleaching and removal of dissolved impurities. Several substances have been tried for this: Excelsior, straw, hay, charcoal, sand, shavings, etc., but Spanish or gray moss, as first recommended by Professor Stockbridge, and the value of which I have myself verified, is by far the best material. In localities where this can be used, it can take the place of lime and sulphur, though it is not quite so effectual.

THE USE OF SPANISH OR GRAY MOSS.

The moss should be collected, hand-picked, to free it of foreign matter, and then thoroughly washed, and lightly scalded with water. It is then tightly packed in a half-barrel connected at the bottom with the supply pipe to the skimming pan. The barrel is placed so that it catches the juice as it runs from the mill, the juice filters through the moss and goes directly to the skimming pan. The second day, before beginning the run, the moss should be removed and put in a tub and well scalded, to correct any sourness or fermentation that may have set up during the night. The moss may be used in this way day after day until it begins to clog, and fails to remove the color from the fresh juice as it comes from the mill, which will usually be the second or third day, when fresh moss must be supplied. It is safer to collect fresh moss every other day.

THE USE OF SULPHUR AND LIME.

When gray moss can not be obtained, or when it is desirable to make syrup of a little higher grade, or on a larger scale, it becomes necessary to treat the juice with the fumes of sulphur, and subsequently with slaked lime. The object of this combined treatment is to remove dissolved impurities from the juice, and somewhat bleach it at the same time, giving a clearer, lighter colored syrup. The juice of the cane has a slight acid reaction or test, and this acid condition should never be entirely neutralized; if it should be, the keeping quality of the syrup is impaired, and the syrup darkened at the same time. Burning sulphur gives a gas which shows an *acid* test, and slaked lime shows an *alkali* test, such as that characteristic of wood ashes. The first step is the construction of the sulphur furnace, for which any kind of crude masonry enclosing three sides, with a wooden flue attached, will prove sufficient. A small fire is lighted in the furnace, and roll sulphur added as needed to keep up copious fumes, which are conducted to the sulphur box. This is a long narrow box with perforated wooden shelves through it, so placed that as the sulphur fumes come in at the bottom, they will meet the juice as it falls in a spray delivered at the top. From the sulphur box the juice goes to the storage tank, and from there is drawn directly to the first cooking pan, of which there may be only one, but should be three. In this pan, whether the first of three, or the only one used, the juice is limed. The quantity of lime added will vary somewhat, with the ripeness and condition of the cane. The lime is slaked to a paste, and if the cane is somewhat green, some 290 cubic inches of this paste is added. If the cane is fully ripe, 215 cubic inches will be sufficient. In the former case, when an excess of lime was added in order to secure clarification, the excess is corrected by the addition of a small amount of sulphurous acid or dilute phosphoric acid, known to the trade as "clariphos." This second acid treatment prevents the formation of dark-colored compounds in the syrup by the union of the lime with the glucose sugar of the juice. From one quart to one-half gallon of clariphos will be required for every 300 gallons of juice that has received the lime treatment. When most of the scum arises to the surface and is removed, the juice goes to the next or second pan, where it is still further heated, and any light scum removed. With steam heat, the juice in first and second pans can usually be freed of scum and ready for transferring to strike pan, in about one hour. The preliminary boiling and removal of scums is shown to be about complete, when a small bottle (two to four ounce) of syrup is removed, and the sediment in it settles quickly. The clarified syrup, if more than one pan is used, is then drawn off by gravity into settling tanks, where it is allowed to stand some time for the separation of sediment. From the settling tank it is carried back to the storage tank, and from there to the "strike" or "cooking pan." Here it slowly cooks and boils into a strong foam, and the experienced eye can tell whether or

not it has received the proper treatment in the previous pans. If the bubbles are large and high, they indicate that hardly enough lime has been used in the process of clarification. But if the bubbles are small and low it indicates an excess of lime remaining in the syrup. When the bubbles are bright and clear and of medium size, they indicate that the skimming has been good. As the foam rises to the surface in the "strike pan" it brings with it most of the scum remaining in the juice; this is swept off with a wooden paddle into the "catch all," which is a trough running around the rim of the pan. The scum rises as a dark covering or cloud on the surface of the bubbles. This foam and covering is swept off as explained above, rather than any attempt being made at skimming; it goes from the "catch all" by a pipe into a storage tank below, and finally back into the "clarifiers" to be reworked.

As the finished syrup leaves the strike pan it is usually passed into long cypress troughs, where it is allowed to cool and settle, before being barrelled. But this is not by any means the best practice.

The syrup, after being made, should be allowed to settle in long narrow boxes set upright. If this is done, it not only frees the syrup of any remaining dirt and sediment, but eliminates the necessity of filter press, which is expensive, and not so good as the settling process. Figure 5 shows a sample of syrup, which had been properly defecated with sulphur, lime and "clariphos," in which the sediment had been allowed to separate after clarification in the first two pans, and then carried to the "strike pan" for final cooking. Yet when this syrup was poured into a glass cylinder, as shown in the figure, almost one-seventh, or that part up to the rubber band, contained a large amount of sediment. All syrup which has not been filter pressed, an expensive process, will contain more or less sediment, which can easily be removed by narrow, upright settling tanks. These should be not less than 8 feet high, preferably 10 feet, and not more than 18 inches in diameter. Bibs can be supplied near the bottom for drawing off the syrup above the sediment, when a clear, uniform product can be obtained. The syrup containing the sediment can be drawn off from below, and either reworked in the "strike pan" or sold direct as a second grade product.

USE OF LITMUS PAPER.

There are two kinds of litmus paper, and they can both be obtained through any druggist. The blue paper is turned red by any acid solution, even when the acid solution is very weak. The red paper, on the other hand, is turned blue by any alkaline solution. It has previously been mentioned that the freshly expressed and untreated juice of the cane has an acid reaction; the effect of treating it with sulphur fumes is to still further increase this acidity. The treatment with lime not only precipitates or throws down, of itself, some of the dissolved solids in the juice, but unites with an excess of acid if present, and carries down impurities in a mechanical way. But in treating the juice with the lime paste, the litmus paper should be frequently used, in order that an excess of lime may not entirely neutralize the acid and render the juice alkaline. If this should occur, some sulphurous acid or phosphoric acid must be added immediately until the juice has a faint acidity.

USE OF THE LIME.

About one barrel of lime is slaked at one time in a box conveniently located with reference to the clarifying pan. Then a small box, about 6x6x6 inches, with 216 cubic inches capacity, will be found a very convenient measure for putting the lime into the clarifier.

THE EVAPORATING PANS.

The evaporating pans may be of any convenient size and shape. Pans 6 feet in diameter and 30 inches high will be found to be a very convenient size and form for steam heat. They should be of copper, but steel will answer quite well.

SIZE OF MILL.

A 100-ton mill will give about 2000 gallons of syrup a day, if the steam supply is sufficient for running the mill and heating the syrup at the same time. But this is larger than is necessary for any one farm; such a mill might be used as a central or co-operative one for several farms. A 50-ton mill is even larger than is ordinarily required. But according to a private letter received from Dr. Stubbs, the boiler capacity, when steam is used for evaporating the juice, should be at least double that required for running the mill alone.

THE MANUFACTURE OF CANE SYRUP AS A COMMERCIAL COMMODITY.

One great obstacle in the way of putting the manufacture of cane syrup upon a commercial basis has been the difficulty of getting the syrup to keep properly. Either the syrup would crystallize in winter, leaving a considerable deposit of brown sugar; or, failing to do this, it would ferment, "work," in summer, and finally sour, unless reboiled. It has, therefore, been difficult to sell the syrup to merchants, because of this trouble and loss incurred in handling it. But it is not necessary that either of these conditions should occur, if the syrup is made just right. The essential step toward avoiding them is to have some means of taking the specific gravity or density of the syrup, as already pointed out. Have this density $33\frac{1}{2}$ or 34 degrees Beaume, when just removed from the boiling pan, or 40 degrees Beaume, when the syrup is cold. The next important step is to see that the syrup retains a slight acidity—it need only barely turn blue litmus paper red after remaining in the syrup one minute—and this acidity should be due preferably to a trace of free sulphurous acid, which is made by simply passing sulphur fumes into water. An excess of lime must not remain in the syrup; it not only turns it dark, but injures its keeping qualities. It is by leaving a slight excess of a sulphide, or of sulphurous acid in glucose syrup, that the manufacturer protects it from fermentation.

Then again, when cane syrup is stored, whether in bottle, jug, keg or barrel, it should be exposed to the air as little as possible. If in keg or barrel, this should not be disturbed any more than is absolutely necessary. The best plan is to put up that which can be immediately disposed of, or which is to be immediately used, in small quantities, not to exceed five gallon kegs, preferably in one or two gallon cans or jugs. The barrels, when opened, should then be divided out in small quantities in the same way. I have kept one gallon kerosene cans of syrup for one year, and when opened, it showed no disposition to either ferment or crystallize, although kept for another year, and frequently exposed to the air. Those who make maple syrup, and sell it to us at fancy prices, understand perfectly well the art of putting it up in small packages—a gallon can is about the largest; never more than two gallons at a time; usually in quarts. In this way, the package is all used up or consumed before it has time to sour, which it would be certain to do if allowed to remain in a half-filled bottle for four or six weeks. Yet we frequently pay as much for a quart of maple syrup as we would pay for a gallon of cane syrup. There is little difference in the chemical character of the two, and the flavor of the cane is by many preferred to that of the maple. But this is assuming that we get in this State pure maple syrup, which is very rarely the case. Usually our "maple syrup" is made from cane sugar, water and the inner bark of the hickory.

THE CHEMICAL COMPOSITION OF SOME TABLE SYRUPS, AND OF GLUCOSE SYRUPS FROM
THE GLUCOSE REFINERY.

(Analyses by W. C. Martin and Dr. N. Fraenkel.)

	Degree Brix (Total Solids).	Water.	Sucrose.	Glucose.	Solids not Sucrose.	Solids not Sweet.	Apparent Co- efficient of Purity.	Number.
Georgia Cane Syrup.....	75.86	24.14	38.68	24.31	37.18	12.87	50.98	1
Table Syrup No. 1.....	80.68	19.32	24.97	28.05	55.71	27.66	30.95	2
Table Syrup No. 2.....	79.68	20.32	25.41	28.05	54.27	26.22	31.89	3
Wharton Table Syrup.....	71.03	28.97	52.24	10.28	18.79	8.51	73.54	4
Glucose Mixing Syrup.....	79.82	20.18	.....	35.53	.....	44.29	.....	5
Ribbon Cane Syrup, Mess Hall.....	75.76	24.24	25.99	26.74	49.77	23.03	34.30	6
Maple Syrup, Mess Hall.....	66.00	34.00	40.06	14.02	25.94	11.92	60.69	7
Sorghum Syrup, Mess Hall.....	79.38	20.62	8.80	36.65	70.58	33.93	11.08	8
Allenfarm Cane Syrup.....	72.63	27.37	53.02	11.40	19.61	8.21	73.00	9
Camperdown Cane Syrup.....	73.84	26.16	49.72	14.58	24.12	9.54	67.33	10
Maple Syrup No. 2 from Mess Hall.....	64.10	35.90	.....	48.75	.....	15.35	.....	11
Canada Maple Syrup.....	78.00	22.00	64.10	12.01	13.90	1.89	82.00	12
Pure Cane Juice Syrup, N. O. Coffee Co.....	64.00	36.00	48.79	12.58	15.21	2.63	76.20	13
Green Mountain Maple Syrup.....	65.00	36.78	48.90	14.32	16.10	1.78	75.20	14
Molasses from Mess Hall.....	79.80	20.20	.....	48.75	.....	31.05	.....	15
Sugar House Molasses.....	82.00	18.00	.....	61.74	.....	20.26	.....	16
Molasses No. 2.....	86.70	13.30	41.00	43.34	45.70	2.36	46.00	17
Molasses No. 3.....	81.00	19.00	37.00	16.79	43.90	27.21	45.60	18
Convict Molasses, Black Strap.....	82.00	18.00	26.00	40.00	56.00	16.00	31.70	19
Maple Syrup, Batavia.....	67.00	33.00	40.00	13.78	27.00	13.22	59.70	20
Brogdon's Cane Syrup.....	78.10	21.90	53.38	12.79	24.72	11.93	68.30	21
Howell Homemade Syrup (cane).....	78.50	.....	53.30	21.00	25.20	4.30	67.60	22
Glucose XX.....	80.80	19.20	.....	41.15	.....	39.65	.....	23
Glucose No. 8.....	80.80	19.20	.....	38.34	.....	42.46	.....	24
Glucose No. 50.....	80.10	19.20	.....	38.34	.....	41.76	.....	25
Glucose No. 80.....	81.10	18.90	.....	38.34	.....	42.76	.....	26

Numbers 4, 6, 9, 10, 13, 21 and 22 are cane syrups. Attention is called to the comparatively large amount of sucrose or cane sugar in them, and the small amount of "solids not sweet." The amount of glucose, or grape sugar, compared to the cane sugar is also small. It will be noticed that all the so-called "maple syrups" contain glucose, which they should not do if pure. "Maple syrup No. 2," bought from College Mess Hall, seems to be nothing more than glucose flavored. Sorghum syrup, No. 8, is remarkable for the small amount of cane sugar which it contains. "Sugar-house molasses," No. 16, was bought in the open market in Bryan at 50 cents a gallon; it is nothing but a glucose syrup. Molasses, Nos. 17 and 18, were bought in the same market; they cost the merchant 21 cents a gallon and were sold by retail at 35 cents a gallon. They are mixtures of glucose syrup and black strap molasses. Numbers 5, 23, 24, 25 and 26 are all pure, unmixed glucose syrups, from the Chicago Refinery. Numbers 5 and 23 are colorless, "water white"; used principally by syrup and jelly manufacturers. Number 24 has a brownish red color; No. 25 a yellowish color, and No. 26 is dark brown red. All of these glucose syrups show an appreciable amount of free acid.

CONCLUSIONS.

1. That cane syrup, even when made only in small quantity, is a paying crop for the farmer.
2. A very simple and inexpensive outfit, consisting merely of a three-roller horse mill for grinding the cane, and one single horse evaporating pan, is all that is absolutely necessary for making a fair grade of syrup.
3. That this simple apparatus can be much improved, at very little increased cost, by the addition of the following:
 - (a) A simple hydrometer, as described for taking the specific gravity of the syrup, and thus getting it all of the proper density.

(b) Gray moss, when it can be obtained, for filtering the juice as it comes from the mill.

(c) Upright settling tanks, for the finished syrup. I regard this as very important.

4. That if moss can not be had, or if more than a few hundred gallons of syrup is to be made, a sulphur box, and lime, should be used.

5. That if the syrup is properly made, it can be kept for one year or more, even in barrels, if these are agitated very little, and the syrup exposed to the air as seldom as possible. But that if in small vessels that are tightly corked, not even sealed, the syrup will keep indefinitely.

6. That pure cane syrups, or even "open kettle syrups," are seldom found on the market; and that most of the table syrup which we use is only a mixture of glucose, starch, or corn syrup, with lowest grade of refuse cane molasses.

7. That we very rarely get pure maple syrup in the open market.

PLAN OF A SYRUP MILL.

In order that some idea may be had of the construction of a syrup mill where steam for power and for evaporation of the juice is used, I asked Professor Giesecke, of the Drawing Department of the College, to make the design given below. The design follows the general description given in the body of the bulletin, and is intended to be suggestive only. But the general arrangement is believed to be good; while the placing of the machinery, and the kind of structure wanted, would, of course, be determined independently in each case.

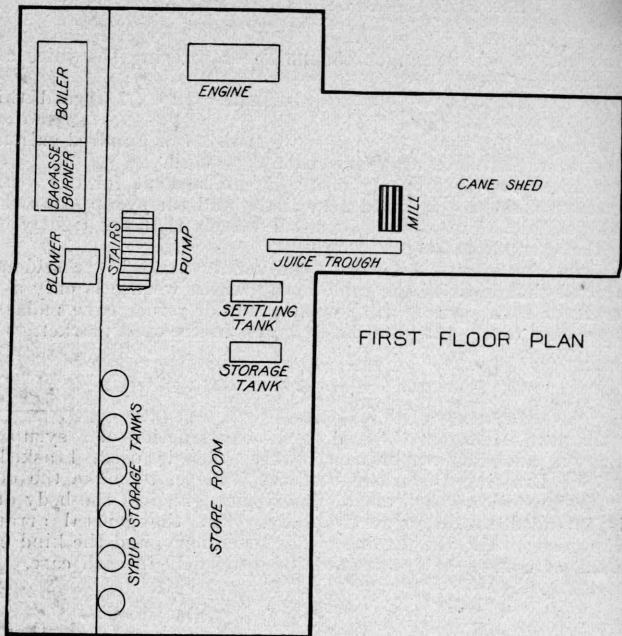


FIG. 1.

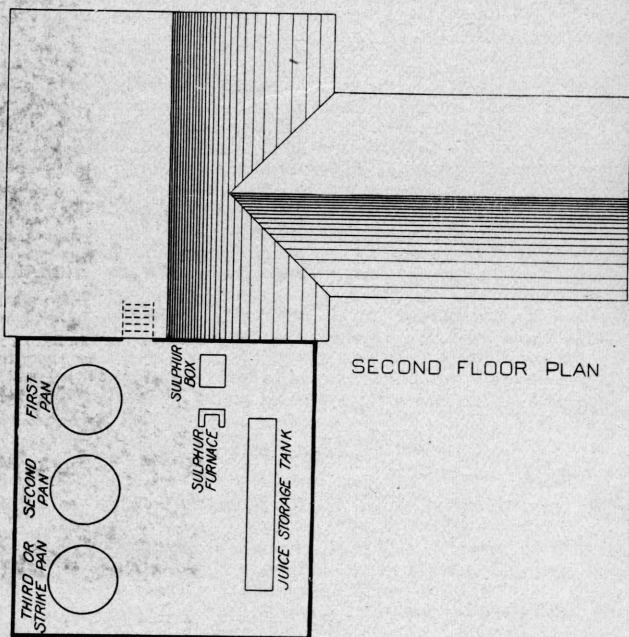


FIG. 2

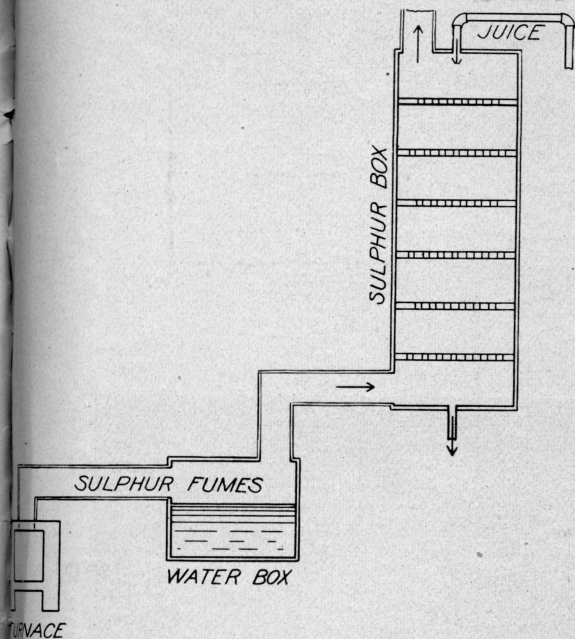


FIG. 3.

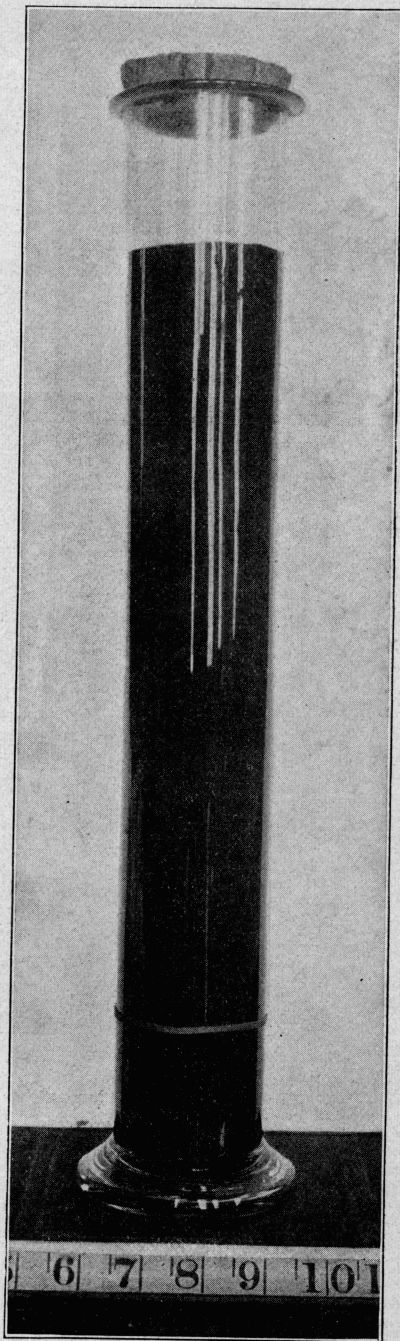


FIG. 5.

Sample of syrup with sediment at the bottom below rubber band. Kept one year in one gallon kerosene can; another year in jar as shown; without souring or crystallizing.

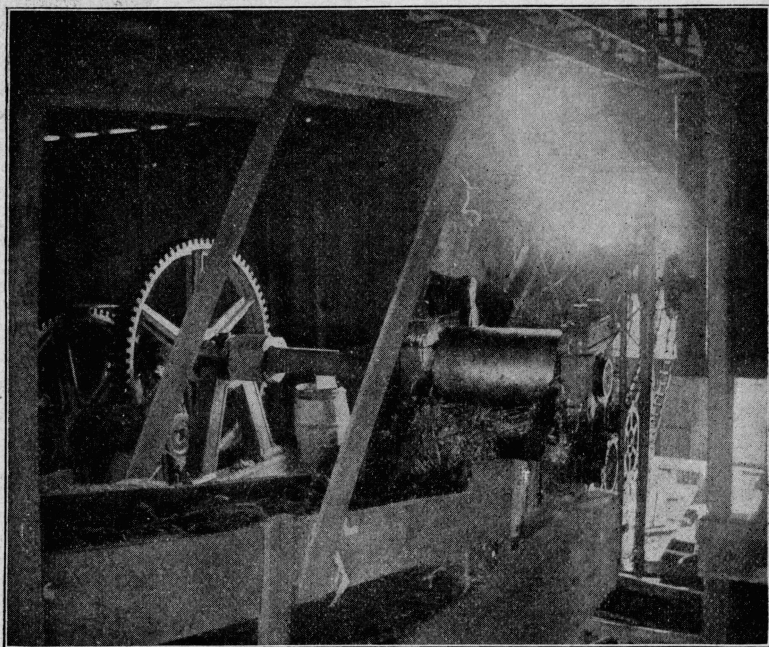


FIG. 6.
Mill as used at Camperdown Syrup Factory, Wharton, Texas. Cane carrier, mill and bagasse carrier.

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11-11-23

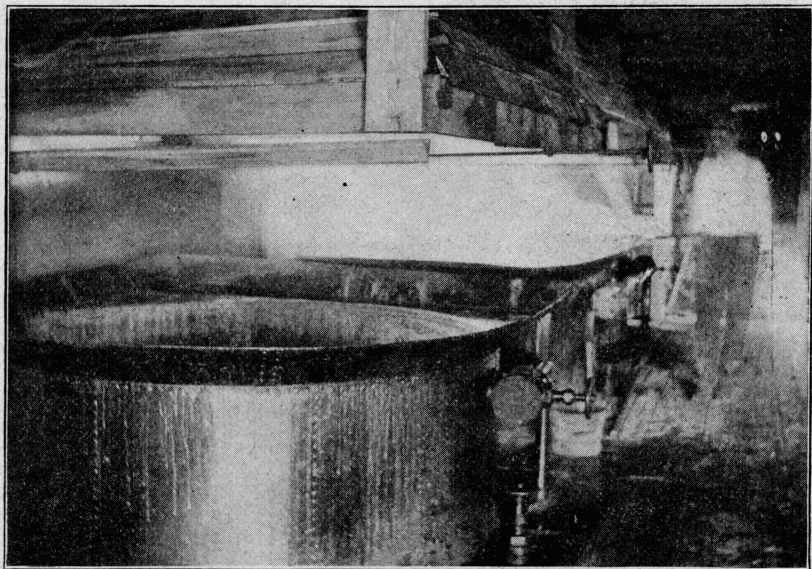


FIG. 7.

Evaporating pans (of steel) described in the bulletin. The first pan is being boiled, while (2) and (3) are empty. As soon as (1) is empty (2) will be filled. Juice will then go to the "settling tanks" on first floor. From the settling tanks, the clear juice will go to a barrel under the pump, and back to a tank on the second floor; from there, by a gravity to the pan (3)

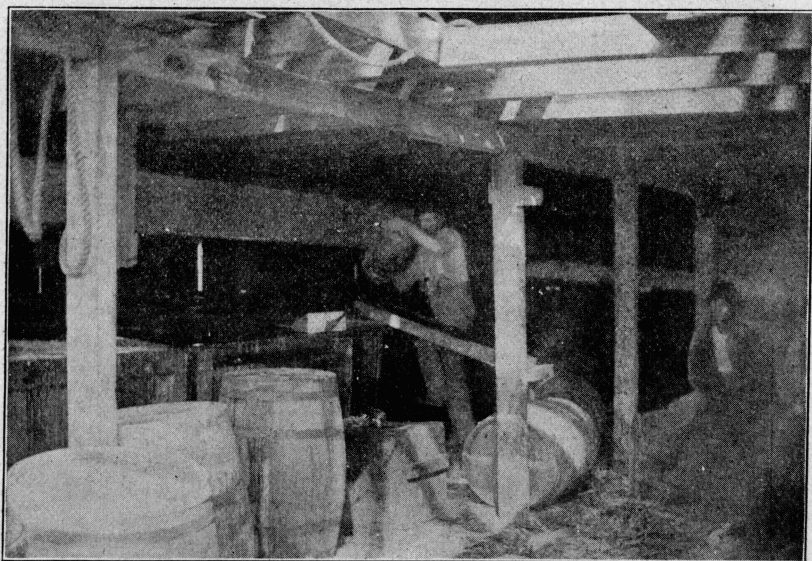


FIG. 8.

Shows syrup storage troughs under the strike pan. Barrels being filled from the troughs. These troughs should be narrow upright tanks; in order that the syrup might settle to a clear amber colored liquid.



FIG. 9.
Showing method of feeding cane in a mill. (Wiley, U. S. Dept. Agriculture.)

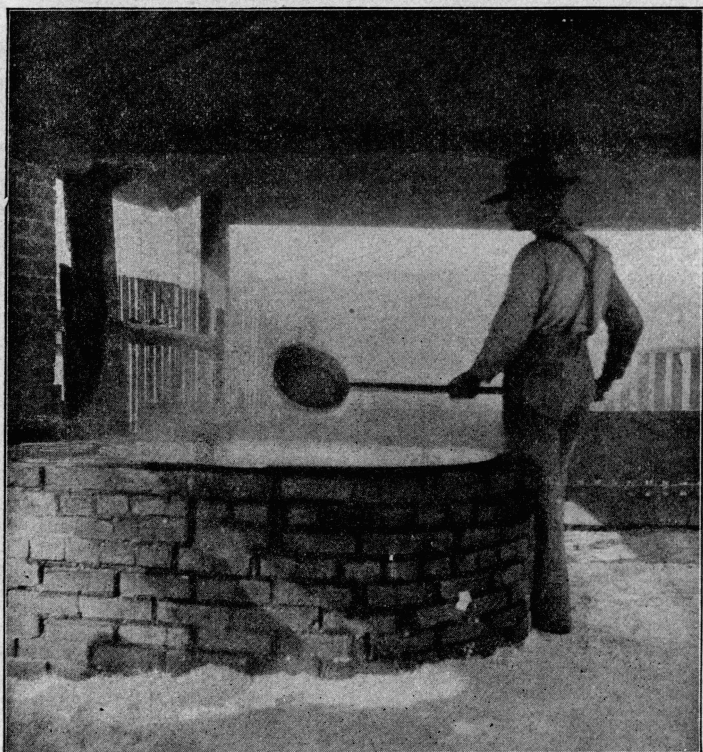


FIG. 10.
Showing single evaporator over direct fire, as used in Georgia. (Wiley, U. S. Dept. Agriculture.)

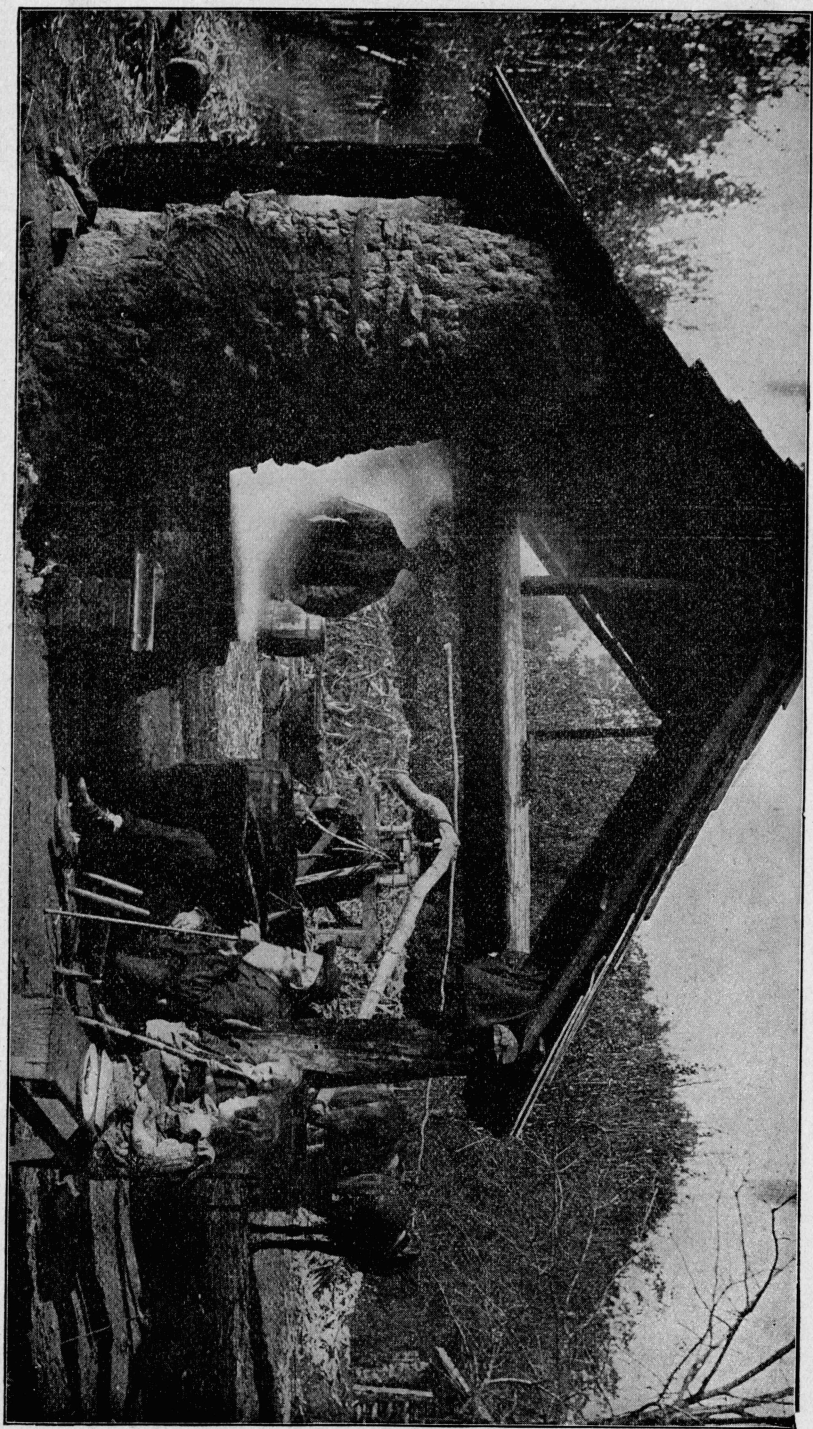


FIG. 11.
Showing mill and single evaporator as operated in Georgia. (Wiley, U. S. Dept. Agriculture.)

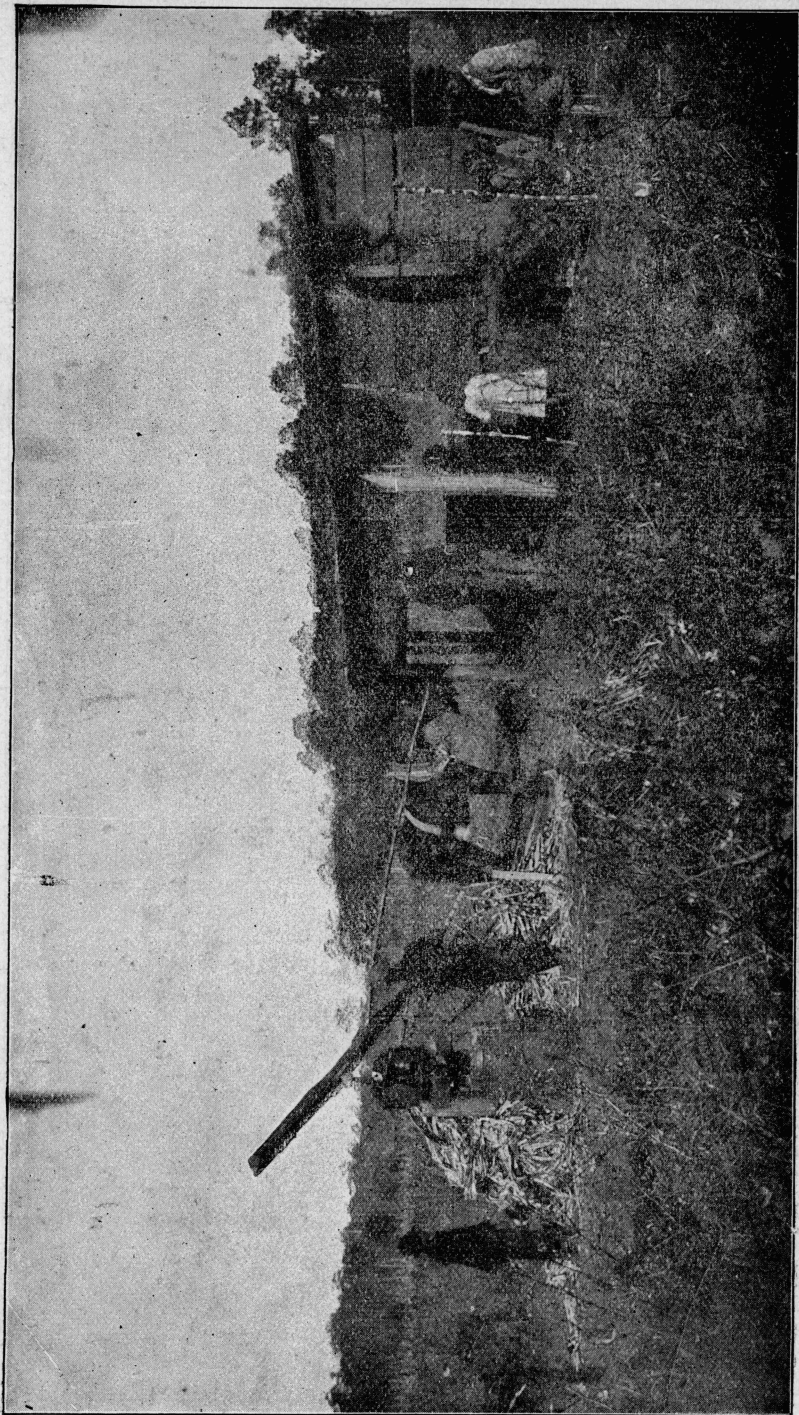


FIG. 12.
A very primitive form of mill and evaporator. (Wiley, U. S. Dept. Agriculture).