COOPERATIVE CANE-SIRUP CANNING: PRODUCING SIRUP OF UNIFORM QUALITY

By

J. K. DALE

UNITED STATES DEPARTMENT OF AGRICULTURE
DEPARTMENT CIRCULAR 149

Contribution from the Bureau of Chemistry
CARL L. ALSBERG, Chief

Washington, D. C. November, 1920

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920

COOPERATIVE CANE-SIRUP CANNING: PRODUCING SIRUP OF UNIFORM QUALITY.

INTRODUCTION.

Among the crops that can be grown profitably in the southernmost section of the United States sugar cane is one of the best known. It has long been a favorite. In only one State is it cultivated extensively for the purpose of manufacturing sugar, but in all that section of this country where the climate is suitable it has been cultivated for years for one purpose—to produce a sirup, which, when properly made, is both wholesome and delicious.

Two distinctly different types of sugar-cane sirup are made in this country. Nearly all of one, from the district where sugar is also manufactured, is made by comparatively large, well-equipped factories. For purposes of clarification lime and the fumes of burning sulphur (sulphur dioxid) are added to the juice during the process of manufacture. The resulting sirup has a somewhat different taste and the color is much lighter (having a rather greenish tinge) than the other type of sirup. As this first type of sirup is manufactured in large units and is sold, as a rule, to a few large packers, a discussion of the problems involved in its manufacture and sale do not come within the scope of this circular.

The second type of sirup is that made by the farmers in all the sections of the cane-growing regions outside the sugar-producing area. It is produced mostly by the individual farmer with a simple, inexpensive equipment, though there are a few small factories in the regions where the industry is developed more fully. Generally in the manufacture of cane sirup of this type no chemicals are used in clarification. The impurities and scums that rise to the surface as the juice is heated are skimmed off with care, this process constituting all the cleaning and clarification that is attempted. This sirup is of a reddish color and darker than that which has been treated with sulphur fumes. The taste also differs somewhat from that of the other type, being, when the sirup is well made, milder and smoother.

INCREASE IN PRODUCTION.

Although the first type of sirup, which may be called the "Louisiana type," is made almost wholly in large factories, the quantity of it produced during the past few years has not been as great as that of the

other type, made as it is by hundreds of farmers and planters scattered throughout the whole of the region where sugar cane can be grown. Although each farmer may produce a comparatively small amount of sirup, the total number of gallons made by those who include sirup among the products of their farms reaches pretentious figures. The census of 1910 gives the following statistics for sirup production, showing approximately the amounts of these two types of sirup manufactured in 1909:

	Gallons.
Factory-made sirup (Louisiana type)	[1] 5,574,943
Farm-made sirup	17,508,496
Total	23,083,439

The production of both of these types of sirup has materially increased since 1909. The Bureau of Crop Estimates has estimated the total cane-sirup production of the United States for the year 1918–19 as 36,730,000 gallons, of which 12,367,000 gallons were produced in Louisiana. Using the figures given, it may be seen that the production of sirup in Louisiana has increased about 43 per cent, while that of farm-made sirup outside of Louisiana has increased but 28 per cent. There are two reasons why the percentage increase in the amount of farm-made sirup is smaller than that of the Louisiana type of sirup. Since in the southern parishes of Louisiana cane is the principal crop and sugar the chief product, to increase sirup production it is necessary only to manufacture sirup from cane that otherwise would be given over to sugar production. In the other sections of the South, where sirup is the only product manufactured from the sugar cane, an increased sirup production means necessarily an increased acreage planted in cane. In the second place, peculiar conditions and difficulties involved in the handling and marketing of cane sirup exist in many regions, decreasing the amount of sirup that is produced.

CLASSES OF SIRUP PRODUCERS.

The farmers who make sirup may be divided into three classes: First, those who raise as much cane as is practicable in their general scheme of crop rotation and find a ready cash market for any amount of sirup that they make; second, those who, on account of climate, soil conditions, or other reasons, can raise a very small amount of cane each season, the small quantity of sirup made being consumed by their families and their neighbors; third, those who could increase the

[1] This figure includes the sirup made in Louisiana as given in both the manufacturers' census and the agricultural census and also the amount of sirup made in Texas as shown by the manufacturers' census. It does not include the returns from 22 mills in Louisiana that failed to send in a report. The author estimates that these 22 mills made not less than 1,500,000 gallons, thus giving a total of over 7,000,000 gallons as the production of the Louisiana type of sirup.

cane acreage of their farms but who find that they are unable to market more than a limited amount of sirup, any surplus being left on their hands or disposed of with difficulty.

The class into which a producer falls is usually dependent upon his environment. In one district all the sirup produced, though it amounts in the aggregate to a large quantity, can be sold readily. In the second district the local demand takes care of all that the farmers care to produce in rotation with their other crops. Finally, there are numerous districts in the cane-growing area where the farmers could and would gladly increase their cane acreage if they could find a ready market for an increased output of sirup, a market which would expand as their production increased. These districts have reached a stage where their production has grown beyond the local demand, but, on the other hand, has not become large enough to attract the attention of the larger buyers of sirup, the packers, and blenders. It is for the farmers and merchants of the last class, living in districts where a more elastic market for sirup would be welcomed, that this circular is primarily written.

MARKETING THE SIRUP.

Sugar-cane sirup is sold by the farmer either in barrels or in No. 10 cans.[2] Most of the sirup that is marketed in barrels goes to packers, who can it under sterile conditions and sell it either pure or blended under their special brands or labels. This method of marketing sirup is the customary one in the regions where the farmers consider sugar cane one of their principal crops, raising all of it that the conditions of their farms permit. The sirup is barreled as it comes from the evaporator, then hauled to the nearest town, where it is disposed of immediately to representatives or agents of the packing establishments. No criticism is to be made of this method of marketing sirup. The competition between the different buyers is lively enough to assure, as a rule, a fair price to the producer.

In the districts where the local demand equals the output, the farmers market their sirup in cans, which are filled directly from the evaporator as the sirup is made. The farmers in the districts where the amount of sirup manufactured has outgrown the local consumption continue to use this same method to market their sirup. When they make more sirup than they can dispose of to neighbors and to the merchants of the near-by towns, the surplus is left on their hands. They can not sell this sirup, already packed in cans, to the large dealers, for these buyers wish to buy their sirup in bulk,

[2] These cans are usually spoken of and sold as holding 1 gallon. However, their actual contents are considerably less.

so that they can pack it in their own type of can and sell it under their own labels and trade-marks.

Practically all individuals, firms, or corporations manufacturing or selling material for direct consumption or utilization by the general public find it necessary to employ salesmen to travel throughout the territory they supply to sell their product. This is no less true in the sirup trade than in any other. For instance, when a farmer produces more sirup than his usual clientele will buy, it is necessary for him to find new fields where the supply of sirup has not exceeded the demand. Obviously, this is, as a rule, difficult for him to do. His farm demands his attention and if he starts out to find a market for his sirup his other activities are likely to suffer. Some farmers have built up gradually a rather extensive market for their product, shipping it in small lots to various places, some of which are quite a distance from home. These men are, to a certain extent, independent of local trade conditions, but even their production of sirup is limited by the ability of their usual customers to consume it. Occasionally a farmer who is situated more fortunately than his neighbors, and who is able to leave his farm without detriment, can go out and seek a market for his sirup. Such men have little difficulty in disposing of all the sirup they can make, for there is no doubt that there is an active demand for a good grade of cane sirup; the great difficulty is getting the farmer in touch with this market. Shipping a few cans of sirup here and there by express is both expensive and unsatisfactory.

The question is often asked, "Why is it not feasible and satisfactory for the farmers of a locality to pool their surplus sirup until one or more carloads are obtained, then ship it to a near-by city or other place where there is a good demand for high-grade sirup?" The answer to this question can be summed up in one phrase, "the nonuniformity of the ordinary farm-made cane sirup." Sirup shipped to distributing centers in large quantities must be handled by commission houses or wholesale grocers, thereby coming into competition with standard, uniform, advertised sirups. A nonuniform, uncertain product always suffers in competition with a product which can be bought with the knowledge that the contents of each package will be the same.

A housewife may purchase a can of sirup, and her family may be so well pleased with it that when it is consumed she may wish to obtain another can of the same brand. If her first purchase was a can of farm-made cane sirup, the probability is that the second can will differ markedly from the first can. Her disappointment in not obtaining the product she had enjoyed and wished to obtain again may end her interest in this class of sirup, and she will turn to

brands of sirup put out by the packers which she knows will be uniform.

Evidently before a farmer can sell an unlimited surplus of sirup otherwise than in barrels to the packers, and this has been shown to be unfeasible in some districts, some method must be devised by which his sirup can be standardized; the contents of all cans must be guaranteed to be of uniform quality. A method for accomplishing this (p. 12) is the establishment by the farmers themselves of cooperative sirup-mixing and canning plants capable of handling the surplus sirup of their community.

SECURING A UNIFORM PRODUCT.

Besides the growing of the cane, the production of sirup involves the evaporation of the cane juice, not a difficult process, but one which requires skill, care, and constant attention. Many factors influence the final quality or grade of cane sirup, causing many variations, though made by the same man, with the same equipment, and from the same field of cane, during the same season. New sirup varies in flavor or taste, color, density, and cleanness. To the same qualities in older sirup may be added the factors of whether or not it has fermented and whether or not it has crystallized.

The quality of sirup does not depend so much upon the equipment which the farmer has at his disposal as it does upon the man who manufactures the sirup. The writer has seen excellent sirup made with the crudest kind of evaporators, while, again, he has seen sirup of very poor quality made with up-to-date, expensive equipment. As long as the kind of sirup made depends upon the ability, taste, and experience of the man who makes it, the quality will vary from farm to farm, and there will be as many different grades of sirup as there are producers. Some sirup makers think sirup should be cooked thick; others prefer to make it thinner. Some are careful and skim the juice well, obtaining a clear, clean sirup, while others, more careless, produce a sirup full of dirt and dregs. The standards set by a sirup producer for himself are not always attained, for it is difficult to skim the juice properly, and it is even more difficult to cook it to just the density desired, unless the evaporation is done by steam. The danger of scorching the sirup or otherwise injuring its flavor must be guarded against particularly.

The natural characteristics of cane sirup render it difficult to produce a uniform product on the farm under present conditions. Sirup that is cooked too thick will sugar, and often a can will be found half full of sugar or filled with a mushy mixture of sugar and sirup. For the local market this does not constitute an objection, since it is known that this sugar can be melted up with or without

the addition of a little water to make an exceptionally delicious sirup. However, this does decrease the sales of cane sirup in the cities and in the regions where cane is not grown and cane sirup is not a well-known product. The people in general throughout this country do not want a mixture of sirup and sugar; if they want sirup they want sirup alone, and if they want sugar they want white granulated sugar, never a mixture of the two.

The other objectionable characteristic, especially of thin sirup, is its tendency to ferment as soon as the weather turns warm, unless it is sterilized and sealed air-tight. As it is difficult for a farmer to can his sirup under sterile conditions, it often ferments if kept until summer and the cans swell and even burst. This naturally constitutes a serious objection to a widespread, unlimited marketing of this type of cane sirup, for no grocer wants to have on his shelves cans of a product in this condition. All of these factors interfere seriously with the successful marketing of an increased and unlimited supply of sirup made and canned by the methods at present prevailing on the farms.

In making a study of cane-sirup manufacture, canning, marketing, etc., at one time nearly 3,000 cans (a carload) of sirup gathered from various localities in a few neighboring counties were opened. The lack of uniformity in this shipment was apparent. More than one-third of the cans had sugared partially, a few had sugared solid, many were half full of sugar, while some were too thin to be classed as sirup. Fifty-odd cans contained sirup that had been made from frozen cane, having an extremely disagreeable taste; in 1 can out of every 10 a bee or a wasp was found, while many of the cans contained smaller insects. It is highly probable that if this carload of sirup had been marketed the buyer would not have purchased another the next season; farm-canned sirup would have lost another friend and received one more "black eye." In fact, it has been the experience of a number of men who have collected as much as a carload of sirup from various farmers and shipped it to a distributing point that it was difficult or impossible to sell another carload to the same customer the next year. Both past experience and the increasing desire among the general public for clean, reliable food products make it evident that cane sirup must be well made, standardized, and packed under sterile, cleanly conditions before it can be marketed successfully on a large scale.

When sirup is marketed in bulk, the principal qualities by which it is graded and sold are taste, color, and density. When marketed in cans, in addition to these qualities, the manner in which it has been packed as judged by its keeping qualities, together with the neatness of the package, must be taken into consideration. All these factors,

in making a uniform, marketable sirup, except color and flavor, can be regulated accurately in a small mixing and canning plant, and even sufficient uniformity of color and flavor can be obtained. Concerning the standardization of color and flavor of farm-made cane sirup, a situation exists that goes a long way toward the solution of this problem—that is, the pride which practically every sirup producer takes in making a good product.

The fact that every community thinks the sirup it produces a little superior to that produced anywhere else is as noticeable as the fact that each farmer likes to have a reputation for turning out a high-grade sirup. The farmers in the sirup-producing regions seem to take more interest and pride in the quality of sirup they make than in any other product of their farms. This commendable spirit has resulted in the production, with the crudest equipment, of very little sirup which is not high grade in flavor and color. Unfortunately, however, even the greatest care in making sirup will not prevent its crystallizing if too thick or fermenting if it is too thin or canned carelessly. In the present stage of sirup making the principal step necessary to secure a uniform brand of sirup in one locality would be the establishment of a sirup-mixing and canning plant the chief function of which would be to bring the sirup to a standard density and to can it under absolutely sterile and cleanly conditions.

It is the author's opinion that density in a canned sirup, together with the absence or presence of sugaring or fermentation, are, within certain limits, the principal factors that are noticed by the consumer in connection with the uniformity of a sirup. As a rule the consumer does not notice slight differences in the color and flavor of the sirup he buys, but changes involving density, sugaring, and fermentation are noticed readily. Excluding scorched and low-grade products, the sirup of a community will generally be sufficiently acceptable as far as color and taste are concerned to make uniformity in these respects possible. The operation of a plant for turning out a uniform grade of sirup would be essentially one of reheating the farm-made sirup and canning it properly. The establishment of such a plant would mean that the farmers making use of it would no longer can their sirup themselves but would bring it to the canning plant in barrels where it would be canned under the proper conditions and standardized during the process.

ORGANIZATION OF SIRUP-CANNING ASSOCIATIONS.

It is desirable that sirup-mixing plants located in areas of production should be owned and operated cooperatively. Such ownership and operation would have a tendency to increase the returns

to the producers and at the same time stimulate production. The absence of a dependable market for farm-made sirup at present and the possibility of better returns per acre from sugar cane if a satisfactory market can be obtained are inducements which should incline farmers to cooperate. If there is a desire to organize cooperative mixing plants such organizations should be incorporated, as it gives the organization a distinct legal status.

More than two-thirds of the States have special laws for the incorporation of cooperative associations.[3] Some of these laws provide for organizations formed with capital stock, while others provide for the nonstock form, both of which forms specify that each member shall have but one vote, regardless of his financial interest in the organization, and that dividends shall be paid on the basis of patronage after a certain percentage of the savings have been set aside to create a reserve fund and an educational fund, and in case of a capital stock organization to pay a reasonable rate of interest upon capital invested.

By-laws[4] should be adopted in which definite working plans are outlined. The initial amount of money required to finance a cooperative organization would not be large. It is estimated that an investment of approximately $3,000 to $4,000 in a sirup-mixing plant and $1,000 or $2,000 for operating capital would answer immediate requirements. By judicious use of this amount and the employment of bank credit a stock of cans could be purchased and expenses of operation met until the turnover of trade begins.

While the farmers have been accustomed to selling their sirup for cash, in order to protect the individual member from possible loss because of unfavorable market conditions, it is desirable that a system of pooling returns for the products sold should be established. By pooling is meant averaging the returns for products sold during a given period, or for certain shipments, so that if growers have products of the same quality and grade they will receive the same price. In order to make pooling systems successful, strict observance should be given to uniform and effective grading.

---

[3] Among States having cooperative laws may be mentioned: Alabama, California, Colorado, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Louisiana, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Vermont, Virginia, Washington, Wisconsin, Wyoming.

[4] A suggested form of by-laws with suggested financing plans may be obtained from the Bureau of Markets, U. S. Department of Agriculture, Washington, D. C.

ARRANGEMENT AND EQUIPMENT OF PLANT.

Any outline that can be given for the arrangement of a sirup-canning plant must be necessarily only suggestive. The actual space required for the equipment is small, but ample room must be provided for storage. First, there must be room to store the cans, of which a sufficient number must be on hand before the operation of the plant is started. Then, too, space must be provided for storage of the barrels of sirup as they are brought in, for the empty barrels, and for the finished product. This last provision is not necessary always, as in a well-managed cannery the sirup is shipped out nearly as fast as it is canned, labeled, and crated. If possible a sirup-canning plant should be on a railroad siding so as to save all the labor possible in handling the finished product from the factory to the cars.

The reheating vats should be placed so as to allow the hot sirup to be drawn from them into the cans at a convenient working height from the floor. This arrangement is important, as the capacity of the plant is in a large measure dependent upon the efficiency with which this part of the work is handled.

There are two arrangements possible for the relative positions of the mixing and reheating vats. Either the mixing vat can be placed at or near the level of the floor, in which case it would be necessary to pump the sirup from this tank into the reheating vats, or it can be elevated above the floor level sufficiently high to enable the sirup to flow by gravity from it into the reheating vats. In the latter case it probably would be necessary to install a small derrick to lift the barrels of sirup from the floor to the top of this vat. If the former scheme is preferred and the mixing vat is built near the floor level, the barrels can be emptied into it by rolling them up to the top of this tank on inclined skids. Here the beams should be strong enough to support one or more barrels while the sirup runs out of the bunghole. It is well to allow the sirup from the barrels to empty into this mixing vat through a wire screen, thus removing large insects, trash, large crystals of sugar, and other objectionable material.

The reheating vat or vats should be situated so that the least effort is expended in bringing up the empty cans and taking away the filled ones. The number of reheating vats will depend upon the desired capacity of the plant; the more heating vats in use the more sirup can be reheated and canned in a unit of time. Efficient work requires at least two of these vats, so that one can be filled and heated while the other is delivering its hot sirup into the cans. A bench built in front of the mixing vats just high enough to allow the cans resting on it to be filled without spattering is very convenient. After being filled the cans can be pushed along this bench to the man who caps or seals them as soon as they are filled.

The size and kind of a boiler necessary to furnish steam for the mixing tank and reheating vats must be considered. The amount of steam necessary, regulating the size of the boiler, is, of course, dependent upon the amount of sirup it is desired to can each day. A very large boiler is not necessary as a rule, for the consumption of steam in a sirup-canning plant is not large. For a small plant, canning from 1,000 to 2,000 gallons of sirup a day, a 25- to 30-horsepower boiler should furnish an abundance of steam.

Cans.—The several types of cans on the market and in general use as sirup containers are known as the sanitary can, the solder-top can, the large friction-top, and the small friction-top can. The first two, probably the best general types for material which ferments or decomposes easily, have one disadvantage—they must be sealed by machinery or with special sealers if the work is done by hand. The latter process is slow and unsatisfactory when a large number of cans must be handled. The third class, the large friction-top cans, are the least satisfactory if the sirup is to be shipped or handled to any extent, because the tops are easily sprung loose, allowing some of the sirup to leak out. Often they are not air-tight, and hence not proof against fermentation. Any rough handling loosens the top or makes it come off entirely, with the result that the entire can of sirup will be lost. The last type, the small friction-top can, is considered the most satisfactory by canners who operate mostly by hand labor. These cans have a hole in the top 2 inches in diameter, large enough to enable them to be filled quickly; at the same time they are easily capped with a small, tight seal, giving less chance for leakage. Since the friction cap is much smaller than that of the other type of friction-top can it is much more difficult to loosen; hence the danger of being jarred loose in handling is much lessened. This type of can makes a good, strong, air-tight package, and has the advantage, for the small-sirup packer, of being sealed easily and rapidly.

OPERATION OF PLANT.

The work of a sirup-canning plant would include the following operations: (1) Grading the sirup as received, (2) mixing, (3) reheating and bringing to the proper density, (4) canning, (5) labeling and crating the cans ready for shipment.

1. *Grading.*—Since the sirup made by the farmers is of good quality, usually, the grading is simplified. In some cases it might be necessary to divide the sirup brought to the canning plant into three classes, but as long as the original makers of the sirup keep up their present standard two classes only would be necessary. In the first case the sirup would be divided into three grades—the first or good sirup (and this class it is believed will contain by far the larger por-

tion of the sirup brought in); a second or lower grade of sirup; and finally, a third or very poor sirup, including all scorched sirup, all sirup made from frozen cane, sirup that is too thin, and all sirup that for any other cause could not be mixed with good sirup without lowering the quality of the product too much. This last class of sirup should not be received or accepted by a sirup-mixing and canning plant.

A plant adopting the first of these schemes of grading sirup would turn out two brands of canned sirup, a high-class product made by mixing barrels of grade 1, and a brand of lower quality and cheaper, made by mixing barrels of the second-grade sirup. A plant which adopted the second scheme of classifying all sirup into two classes, good sirup and very poor sirup, the latter being rejected, would turn out one grade of sirup, that made by mixing convenient amounts of all the sirup accepted.

In grading, the color and flavor of a sirup, and to a large extent the density also, can be determined by driving a nail into the barrel, withdrawing it, and observing the appearance and taste of the sirup that oozes from the hole. The density may be determined more accurately by knocking out the bung of the barrel and floating in the sirup a Baumé spindle, an instrument well known to sirup makers as a "saccharometer." It consists of a glass spindle with lead shot in a bulb at the bottom, and the stem contains a scale which reads zero in pure water and runs up to 50°. The thicker a solution or sirup, the higher this spindle will stand in the liquor and the larger will be the scale reading.

The density of a sirup in terms of this scale can be determined easily by allowing the spindle to float in the sirup until it becomes steady and then reading the division of the scale that is just at the surface of the liquid. One very necessary precaution must be taken in the use of this instrument. The same sirup will have a density, as determined by a saccharometer, 4° to 5° lower if it is tested near the boiling temperature than if it is tested while the sirup is at the temperature of the atmosphere. However, as the sirup almost invariably would be tested at the canning plant after it had cooled to the temperature of the air, this variation of the scale reading with the temperature will not play a large rôle in testing the density of the sirup as brought to the canning plant. The difference in the density of the sirup as shown on the saccharometer scale on a cool day and on a warm one will be about one-half degree. Table 1 gives the variation in saccharometer scale readings for different temperatures. This table was determined by allowing a Baumé spindle to float in a cylinder containing hot sirup and reading the temperature and the corresponding degree Baumé at different intervals as the sirup cooled.

TABLE 1.—*Density of sirup at different temperatures.*

Sirup.	210° F.	200° F.	150° F.	90° F.	75° F.	60° F.
	° *Bé.*	° *Bé.*	° *Bé.*	° *Bé.*	° *Bé.*	° *Bé.*
I	14.7	15.1	17.2	19.0	19.3	19.5
II	32.5	32.9	34.6	36.6	37.1	37.4
III	34.7	35.1	37.4	39.1	39.4	39.7
IV	36.1	36.4	37.7	39.5	39.9	40.3

The farmers should endeavor to cook their sirup to a water content of 28 per cent. A sirup of this density will measure 39° on the saccharometer scale at a temperature of 60° F. (15.5° C.). This density is a good standard for a sirup-canning plant to adopt as a basis for the price paid or allowed for sirup. More should be paid or allowed for a thicker sirup and less accordingly for a thinner sirup.

Table 2 shows the percentage of water in a sirup corresponding to the degrees Baumé at 60° F.

TABLE 2.—*Percentage of water in sirup.*

Density.	Water.	Density.	Water.
° *Bé.*	*Per cent.*	° *Bé.*	*Per cent.*
35	36.1	40	26.3
36	34.2	41	24.3
37	32.2	42	22.3
38	30.3	43	20.3
39	28.3	44	18.2

A good basis for determining the comparative value of sirups of different densities is to consider the actual amount of sirup that can be obtained from unit quantities of juice of the same initial density. The amounts of sirup, of the density indicated, shown in Table 3, have been obtained from 1,000-gallon lots of cane juice measuring 13° Brix or 7.4° Baumé.

TABLE 3.—*Amount of sirup obtained from cane juice.*

Water in sirup.	Density.	Amount of sirup obtained.
Per cent.	° *Bé.*	*Gallons.*
30	38.1	145
28	39.1	139
26	40.1	134
24	41.1	129

Working from Table 3, and assuming that sirup of 38.1° Bé. is priced at 50 cents per gallon, the value obtained from 1,000 gallons of 7.4° Bé. juice would be 145×$0.50, or $72.50. If the sirup were cooked 1° higher, only 139 gallons would be obtained, but the

value of this smaller amount of sirup should be at least the same as that of the thinner sirup, as it was made from the same amount of juice. Hence the value of each gallon should be $72.50÷139, or 52 cents. Figured on a percentage basis, this gives $\frac{(52.1-50)}{50}\times 100$, or 4.2 per cent increase in value for a 1° increase in the density as measured on the Baumé scale. Thus, from the producer's point of view, if the standard 39° Bé. is taken and a fixed price is allowed for sirup of this density, an increase or decrease of approximately 4 per cent of this standard price should be allowed for every degree of variation from this standard.

The greater value of a thick sirup over a thin sirup from the consumer's point of view can be calculated from Table 4.

TABLE 4.—*Weight per gallon of sirups of different densities.*

Water.	Density.	Weight of 1 gallon.
Per cent.	*° Bé.*	*Pounds.*
30.3	38	11.2
28.3	39	11.4
26.3	40	11.5
24.3	41	11.6
22.2	42	11.7

The valuable part of a sirup is the solid material which is nearly all a mixture of cane sugar and invert sugar. A sirup of 38° Bé. contains 69.7 per cent solid material and weighs 11.2 pounds. Hence, the actual weight of the solid material is 0.697×11.2 pounds, or 7.80 pounds.

In a sirup of 42° Bé. the amount of solid material is 0.778×11.7, or 9.10 pounds. Assuming that the solid or valuable part of a sirup of 38° Bé. is worth 50 cents, the value of the solid material of a gallon of sirup of 42° Bé. would be $\frac{91}{78}\times 50$, or 58.3 cents. Thus, from the consumer's point of view, a sirup of 42° Bé. is worth 8.3 cents more than one of 38° Bé., or for an increase of 1° Bé. in density the value of sirup is increased 8.3÷4, or 2.1 cents. This figured on a percentage basis gives $\frac{2.1}{50}\times 100$ or 4.2 per cent. It is seen, therefore, that the value of a sirup is increased 4.2 per cent from both the producer's and consumer's point of view for each Baumé degree of increase in density. On this basis a canning plant should allow a certain price for sirup measuring 39° Bé. and add or deduct 4 per cent of this amount for an increase or decrease of 1° Bé. in the density of the sirup.

2. *Mixing.*—The larger the quantity of sirup that can be mixed in one tank at one time, the more nearly uniform in color and taste the sirup in all the cans will be. Although there may be quite a noticeable difference in the color and flavor of the product in individual barrels that are brought to a canning plant, still, after the lower-grade sirup has been rejected, unit mixtures made from 5 or more barrels will be very similar to one another. Quantities of from 5 to 10 barrels of sirup can be mixed conveniently in a tank with an agitator or by hand with a paddle.

3. *Reheating and canning.*—This step is the most important one in canning sirup, for it is during this process that the sirup is brought to the desired density, and receives the sterilization that prevents subsequent fermentation. After the sirup from a convenient number of barrels has been mixed, a portion of it is run or pumped into the reboiling vat, which may be of any suitable shape or size—one holding about 100 gallons has been found to be efficient—and may be of copper, galvanized iron, or wood. For heating the sirup the vat would contain, necessarily, a steam-heating coil, preferably of copper. The operation of this part of the process is simple. After a convenient amount of sirup has been delivered to this vat from the mixing tank the steam is turned on, and it is heated to a point just below boiling. Usually canned sirup containing 28 per cent water is considered thick enough; its density will read 33½°–34½° Baumé when tested with a saccharometer at a temperature just below the boiling point. If the sirup, just before boiling, measures higher than this a little water may be added to thin it out; if it is too thin, and measures less than this, boiling a few minutes longer will bring it up to the desired density.

The sirup, ready at this point for canning, is drawn directly into the cans from the heating vat by some form of quick opening and closing valve. A thermometer should be kept in the sirup and watched closely to see that the temperature does not fall below 185° F. during the canning process. It may be necessary to turn on the steam occasionally to maintain this temperature. As the cans are filled with the hot sirup they should be sealed immediately.

Too much stress can not be laid upon the necessity of keeping the temperature of the sirup running into the cans about 185° F. Strict attention to this point will prevent subsequent fermentation. The density of the sirup in the vat is determined easily by means of the saccharometer by filling an elongated cylindrical cup with the hot sirup, in which the spindle floats until it becomes steady, then reading the scale division at the surface of the liquid.

4. *Labeling and crating.*—To promote the sale of the sirup the cans should be labeled neatly and attractively, for a well labeled can will sell more readily than an unlabeled one. A canning plant turning out a high-grade product should choose a brand for its sirup and stick to it. This is essential if any advertising is to be done or if a reputation is to be built up for the sirup of a locality, since the satisfied purchaser is enabled by the name or brand or design on the label to get another can of the same product.

A label bearing a registered name or trade-mark will prevent imitations and the substitution of goods of inferior quality. If a locality is proud of its quality of sirup, it should have its distinctive labels, so that all who use it may purchase it repeatedly and tell their friends. The process of labeling is simple and adds little to the cost of the sirup. For the larger plants machines may be obtained which rapidly and efficiently attach the labels to the cans. In smaller factories labeling by hand is not difficult, as an operator becomes surprisingly rapid after a little practice.

Before the sirup can be sold in large lots to wholesale grocers and other dealers it is necessary to crate it or put the cans in packages of convenient size. These crates or boxes, standard sizes holding 6 No. 10 cans, 12 No. 5 cans, or 24 of the No. 2½-size cans, are made of wood or fiber board. Those of wood come in the form of strips and must be nailed together, while the fiber-board boxes require a little gluing or pasting to make them ready for use. These packages furnish a neat, convenient, and safe means of handling sirup if large amounts of it are involved or it is to be shipped any distance.

COST OF CANNING SIRUP.

Only a general idea of the cost of canning sirup can be given. The men engaged in this business naturally do not want their cost data made public, so the only material at hand on which to figure this cost is that obtained in operating a small sirup-canning plant a short period, during which time all the troubles incidental to the first operation of a new plant developed. It is believed, however, from the experience thus gained that with the force as enumerated in Table 5, a plant can be operated with a capacity of 1,200 to 1,500 gallons per day. This rough estimate includes the process of receiving and canning the sirup, labeling, crating, and shipping not being considered. The figures given for hire of the operators are, necessarily, guesswork. They vary as labor conditions in the sirup-producing sections change.

TABLE 5.—*Cost per day of canning sirup.*

Superintendent	$5
Fireman (who can assist in other work)	3
Canner	3
Helpers, two at $2	4
Can sealer	3
Fuel	5
Total	23

Figuring that this force could handle 1,200 to 1,500 gallons per day, the cost of actual canning in round numbers would be between 1½ and 2 cents per gallon. As there is a difference of about 3 cents each in the price of empty cans when bought wholesale in carload lots and when purchased by individual farmers in small lots from retail stores, the saving in the price of cans will more than pay the expenses of the actual canning operations.

The price of labels as quoted recently by a large house handling canning equipment was $5 per thousand for No. 5 cans and $6.50 per thousand for No. 10 cans. Thus, the cost of labels would be slightly in excess of ½ cent per can. As wooden crates holding six No. 10 cans cost from 15 cents to 25 cents each under prevailing market conditions and corrugated paper boxes cost about the same, the cost of crates would be from 2½ cents to 4 cents per gallon of sirup.

It has been estimated that one girl is able to label 1,200 to 1,500 No. 10 cans per day; hence the cost of labeling should not be more than one-fourth cent per can. In a plant of this size three men should handle all the work of nailing crates, crating the cans, and stacking the crates ready for shipment. At an estimated cost of $2.50 each per day, the cost of this portion of the operation of a sirup-canning plant would amount to $7.50, or slightly more than ½ cent per can.

An estimate of the total cost of canning sirup per 100 gallons is summed up in Table 6.

TABLE 6.—*Cost of canning 100 gallons of sirup.*

Management, canning operations, and fuel	$2.00
Labeling	.25
Crating and stacking	.60
Labels	.65
Crates	2.00
Cans	12.50
Total	18.00

These estimates are made on the basis of canning sirup in No. 10 cans. The cost per gallon of canning sirup in the smaller-sized cans is appreciably more, but as these smaller sizes can be sold for a price that is relatively higher than that obtained for the larger sizes, the higher cost is thus absorbed.

SUMMARY.

At present the cane-sirup industry is handicapped by a lack of uniformity in the sirup offered for sale by the individual farmer. This condition may be remedied by the adoption of new and improved methods of manufacture and by cooperative canning. By means of a cooperative canning plant, the farmers in any sugar-cane-producing region will be able to secure uniformity in their sirup. It is also more economical for farmers to market their sirup collectively. This practice not only increases the sale of sirup, but also permits each farmer to devote more time to the production of other crops, thus deriving the maximum profit from his farm.

○