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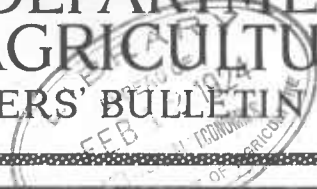
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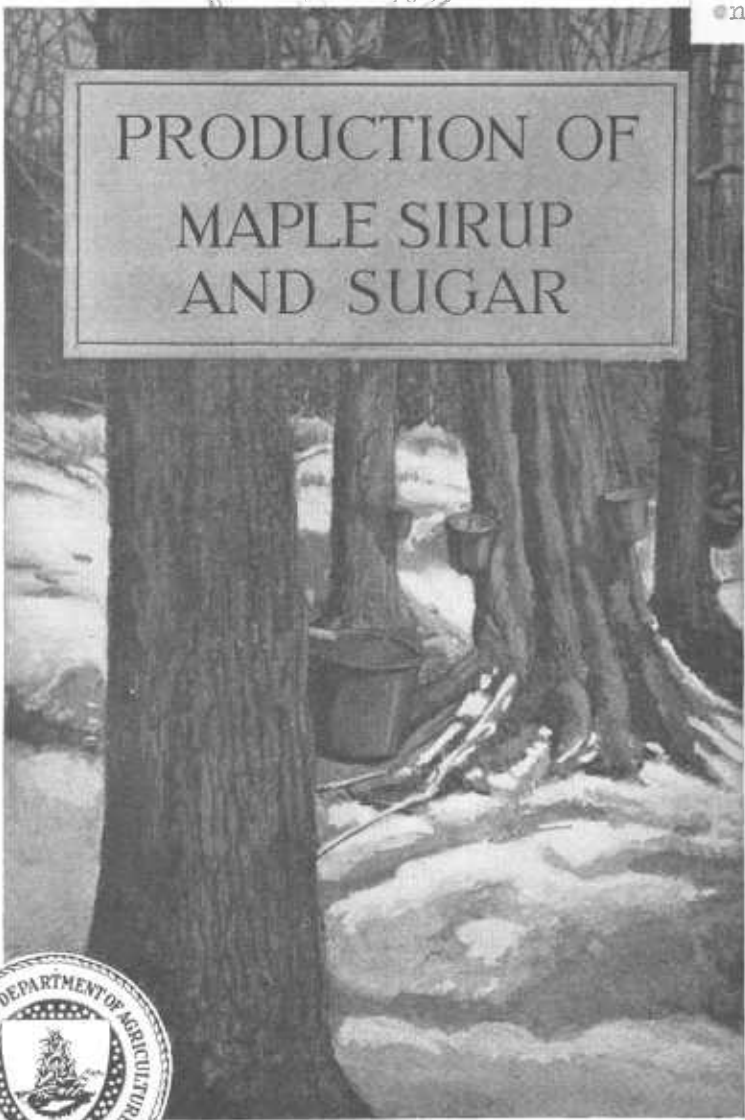
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1366



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PRODUCTION OF MAPLE SIRUP AND SUGAR



THE MAKING of maple sugar on a commercial scale is confined to a small part of the territory in which the sugar maple is found, the gradual spring of the North being necessary for a profitable sap flow.

This bulletin gives directions for collecting and handling the sap, for making maple sirup and sugar, and for handling and storing the finished products. It also contains directions for caring for maple trees and for planting new maple groves.

This bulletin is a revision of and supersedes Farmers' Bulletin 516.

PRODUCTION OF MAPLE SIRUP AND SUGAR.

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The production of maple sirup and maple sugar is purely an American industry, the United States and Canada being the only countries where these products are made.

The earliest explorers in this country found the Indians making sugar from the sap from maple trees, and in some sections, especially along the St. Lawrence River, producing it in quantity for trade. The crude methods of the Indians were soon improved upon by the white people, but beyond the tapping and boiling the general process is still the same as it was at that time.

For many years, especially among the early settlers of the northern part of the United States, and even in Kentucky and Virginia, maple sugar was the only sugar used. Some makers attempted to secure an article equal to the imported cane sugar, or muscovado, of the West Indies, with varying degrees of success. A few refineries for producing white sugar were operated with maple sugar as their raw supply. The iron kettle, birch-bark tank, wooden spiles, and old way of tapping yielded a dark, ill-tasting product, but with care and changes in methods and apparatus the products were improved.

SUGAR MAPLES.

All maples have sweet sap, but from only a few species have sirup and sugar been produced in paying quantities. The sugar maple (*Acer saccharum*) and the black maple (*A. saccharum nigrum*) are practically the only trees used for this purpose, the quantities of sirup and sugar produced from the red maple (*A. rubrum*), the silver maple (*A. saccharinum*), the Oregon maple (*A. macrophyllum*), and the box elder (*A. negundo*) being so small that they are of no importance.

As a tree for the production of sirup and sugar in commercial quantities, the maple tree is confined in its range to the eastern and northern United States and the neighboring southeastern parts of Canada. Tables 3 and 4 (page 34) list the States in which maple sugar and sirup are produced and show the quantities made.

The sugar maple is a stately and vigorous forest tree, capable of growing in dense stands. It bears a plentiful crop of seeds, which in most places ripen in the early fall. These seeds germinate readily, and under favorable conditions the entire forest floor is heavily carpeted with seedlings, the foliage of which is eagerly eaten by stock. The young seedlings are very thrifty and can stand the shade of a complete forest cover. This tolerance of shade is one of the distinguishing features of the sugar maple, and, although it is less pronounced in later years, the mature tree has one of the most persistently heavy crowns in the forest.

In this bulletin, the sugar maple is not considered as a lumber tree, for which a long stem free of branches is desired, but rather as a paying producer of sap. This is a silvicultural problem radically different from that which ordinarily confronts the forester. The full and heavy crown with a large leaf surface must be developed in place of the long, clear stem. The sap flow must be continuous and plentiful. The best sap flow is where the change from winter to spring is slow, where the days are warm and sunny and the nights frosty. These conditions do not occur throughout the entire range of the species. A region where the ground thaws quickly and where the temperature does not vary greatly from day to night is not suitable for sap production. The "season" must be long enough, also, to insure sap in merchantable quantities. Such conditions are characteristic only in the Northern States, and as sugar making extends farther south it can be profitable only at altitudes which reproduce the climatic conditions of the North.

The black maple is generally considered superior to all others as a producer of sap. How far this is true is uncertain. In its general silvical characteristics it is similar to the sugar maple, save in the fact that it seems to prefer lower land, such as the banks of streams and rich alluvial river bottoms. It is found in Vermont, on the shores of Lake Champlain, and ranges southward, west of the Alleghenies, from Minnesota to Arkansas and eastern Kansas.

SUGAR GROVES.

GENERAL CONSIDERATIONS.

The quantity of sap that a tree yields stands in direct relation to the size of its crown. Many sugar makers, however, believe that trees in a forest produce more sap than those in a grove. The explanation is found in the fact that the forest floor with its covering of litter and humus contributes to the vitality of the trees more than the grass carpet of a grove. To obtain a heavy sap production a complete crown cover and a rich deposit of humus are of vital importance in the management of a sugar grove (fig. 1).

The model grove should satisfy the following requirements as far as possible:

It should contain the greatest number of trees per acre consistent with fully developed crowns.

The forest cover should be unbroken, so that in summer little sunlight falls upon the ground.

There should be a complete litter of humus and leaves, to the exclusion of grass and light-demanding weeds.

Young trees should be kept in reserve to take the place of those that fail, and to fill other openings in the cover.

No grazing should be allowed in the grove, except in special cases where the cover is perfect and no reproduction is needed. Cattle not only keep back all reproduction, but also do harm by trampling and breaking the ground, so that it dries out.

The grove should be made accessible by a system of roadways to facilitate the collecting of sap. If the network is complete no difficulty will be found with the underbrush, which hinders sap gathering little in the early spring when the woods are devoid of foliage.

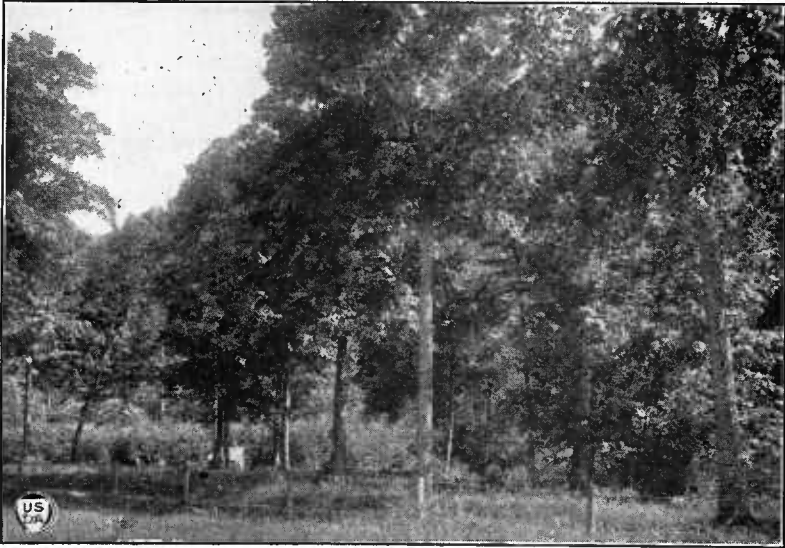


FIG. 1.—A sugar maple grove of old forest-grown trees. The large crowns of the trees and the shady forest floor, covered with litter and humus, help the flow of sap.

IMPROVING A DENSE MATURE GROVE.

Many groves are merely parts of an old hardwood forest, having a large number of sugar maples in the mixture. These trees have their normal forest form—a long, smooth stem and compact crown. There is little to be gained in actual sap production by thinning such a stand, as it has generally passed the period of vigorous growth and would not develop larger crowns, although the sap season may be brought on earlier by opening up the grove to the sunshine. The mixture can be regulated, however, and provision made for a pure growth of maple to succeed the old forest as it passes away. The usual mixture of birch, beech, elm, basswood, and ash may be gradually removed and the reproduction of maple thereby assured. This thinning should pay for itself in most localities from the resulting fuel and saw timber. In making such a thinning the following precautions should be observed:

When the trees to be removed are in groups, all should not be cut out immediately, leaving large gaps in the forest cover, since forest-grown sugar maples have a broad, shallow root system, and are subject to windfall when suddenly exposed. The trees which crowd the best maples should be taken out first; the rest should be removed later, when the sugar trees have become more wind firm.

Where several maples crowd one another and form a dense cover, those with the smallest crowns, those which are unsound, and those which show signs of bad health or decline should be removed.

Young maples which show possibilities of good crown development should be freed from interference on every side.

If the grove borders on open land, it should not be thinned for a distance of at least 25 feet from its edge. This is a safeguard against damage by storms and is particularly important in borders exposed to heavy winds.

When practicable, the young growth of species other than maple should be removed.

It is well to accomplish the thinning in a series of years, rather than at once and radically, thus avoiding violent changes.

It is important to maintain the humus and ground moisture in every maple grove. Where natural forests of sugar maple are common the danger of destroying the proper soil conditions by letting in the sunlight is not great, but if a grove of this type lies where the summers are hot the cover must be broken very gradually.

IMPROVING AN OPEN MATURE GROVE.

In the more settled and less wooded portions of the maple sugar producing district a large proportion of the groves are old and very often overmature. They have evidently been left on favorable situations from the original forest, and as a rule no attempt has been made to renew them or keep up their vigor since the adjoining land was first cleared. Among the great number of old, open, and grass-grown groves, a young and thrifty set of trees is rare.

As a rule, these groves are on small farms, where they are used as much for pasture as for sugar making. Where the pasturage can not be spared and where sugar is only a small item in the farm production, there is little to be done for their improvement. When the grazing can be spared, however, and the owner desires to increase the sugar-producing capacity of his trees, it is better to bring about a reproduction from the old trees than to plant a new stand.

In an open and grass-grown grove the first step is to exclude stock. After laying out driveways for sap gathering, the seedlings should be allowed to come up everywhere else. All unsound and dying trees should be cut out and young growth of all species other than maple removed. In a very short time the young maple seedlings will take possession of the open ground and grow vigorously where they get enough light.

When they are 8 or 10 years old and 6 to 8 feet high, or more, the struggle for supremacy among them begins. In each opening large enough to permit the development of a tree with a full crown, the strongest and most thrifty seedling which has a favorable position should be selected, and the heads of those within a radius of 12 feet or more about it should be lopped off with a corn knife. The crowns of at least two-thirds of these trees must be removed; the remaining crowns will insure a good ground protection and leaf fall until the favored tree has filled the opening. In small openings the thicket should remain unthinned. The struggle between the trees will keep them all suppressed, and they will supply the necessary ground cover. The seedlings which come up under the direct shade of the old trees will never grow to any size, unless some of the large trees are removed by age or accident.

Cattle may be let in the grove when it has become too tangled for convenient sap collecting and when the young growth desired for open places has reached a height of 8 or 10 feet. They will soon open up the smaller and undesirable growth. At the same time roadways should be opened and the ground kept free of fallen limbs and trees. The tall, slender seedlings will be a small obstruction in sap gathering, but a little discomfort can be borne for the sake of the undoubted advantages obtained by a ground cover.

IMPROVING A DENSE YOUNG GROVE.

In many parts of the maple-producing section a second-growth forest similar in composition to the original stand has come up. When, as often happens, the sugar maple forms the greater part of such a wood, all that is needed to turn it into a sugar grove is to remove a number of interfering trees, thus giving the proper number of maples a chance to develop the full crowns necessary to a maximum yield of sap per acre. Preference should be given to the younger and more thrifty stands, where the trees are just entering the period of most vigorous development.

In thinning a young stand provision must be made for growing a set of full-crowned sugar trees from the more thrifty of the young maples. In a stand from 40 to 60 years old it is easy to pick the largest and best-developed specimens and favor them for the future. Some of the directions for treating a dense young grove are the same as those for treating the mature grove.

Select the sound, dominant trees which show a natural tendency to a well-branched, compact crown of large size, and remove from all sides everything which tends to crowd them. If the stand is between 40 and 60 years old, leave about 100 trees to the acre; if older, leave about 75 trees. The average healthy young maple can be freed for 10 to 12 feet on all sides of its crown without the slightest danger, except in the most exposed positions.

In the choice of sugar trees the position and influence of each on its neighbors must be considered. If two dominant trees crowd each other seriously, remove the less promising one.

In case the beech, birch, or other species are so grouped that their removal would make a serious gap in the forest, it will be well to let several of them stand. They should be so treated, however, that maple seedlings, which nearly always gain possession of the soil, even under beech, will have light enough to come in under them. When these seedlings become established the beech or birch can be removed and young maples favored. When practicable, always cut out seedlings other than maple.

Successive thinnings are better than a radical opening up of the stand, because in this way danger of windfall and drying out of the soil are avoided. This method also leaves room to overcome the damage done by porcupines, which probably are the worst enemies of the young maple. One porcupine in a single night can strip the bark off many saplings, and to such an extent that they are permanently ruined. The sugar trees should not have more than 10 or 12 feet of free space on any side of their crowns. A thrifty maple can fill such a gap in eight or ten years, after which a final thinning may be made and the remaining weed trees removed.

The edges of the grove which border upon open land should not be thinned enough to leave the stand unprotected from strong winds

and sunlight. If other species are crowding the dominant maples, they should be removed. As a rule, however, the borders should remain dense and the trees should be covered to the ground with foliage.

In cool or elevated regions, the thinning may be more extensive than farther south or in lower lands, where more care is necessary to preserve a proper ground cover. Firewood and other timber secured by thinning should pay for the cost of the operation. The necessity for well-placed roadways to take out the sap should not be forgotten.

MANAGEMENT OF A SAPLING THICKET.

Throughout the maple region dense thickets of young saplings are common in abandoned fields and pastures. Where a sugar grove is desired, it will pay to take such young growth in hand if old trees are not available in sufficient numbers. Left to themselves, the



FIG. 2.—Stand of maple seedlings in need of thinning. Many suppressed and undesirable trees take up the food and light needed for the growth of the better trees.

young trees usually become so densely crowded that even when 20 feet high they number from 2,000 to 3,000 to the acre. Under such conditions growth almost ceases, even in the dominant trees, and at a time which in normal stands is the period of most vigorous growth.

The first thinning should be made when the saplings are about 6 or 8 feet high, if the owner feels justified in helping them at this time. The largest and healthiest trees, on an average about 12 feet apart, should be selected, and the tops of the others cut back with a hatchet or a corn knife in such a way that they can not overtake the favored individuals.

Cutting back trees in this manner can be done very rapidly. Three men should cut over an acre a day. Although there is no return in

firewood or other material from such early thinnings, the young trees will receive a favorable start at the most critical period of growth. At the same time the ground cover will be kept intact by the sprouts, until the selected trees fill out and close up the space with their crowns. When they are about 25 years old the dominant trees, which are about 12 feet apart, begin to crowd one another, so that another thinning must be made to give the best ones room. All general forest practice shows that the gain over the unthinned thicket should be at least 25 per cent.

If the thicket to be turned into a sugar grove contains older and larger trees than those here considered, a regular course of thinning is necessary. The main points in this case are as follows:

Choose the thrifty trees which show a tendency to good, symmetrical crown development, and set their crowns free on all sides to a distance of about 12 feet. See that the selected trees are sound and free from forks which may develop badly.



FIG. 3.—The stand shown in Figure 2 after being thinned. Twelve cords to the acre of fair firewood were removed, and the remaining trees were given a chance to grow. Care must be taken not to thin too much. It is better to leave an opportunity for a later thinning.

Remove all long, spindling trees which are likely to bend over.

For ground cover, leave all specimens which do not threaten the crowns of the chosen trees and which are capable of casting a little shade.

Remove all species but maple, except when they are very much suppressed. Low, broad-crowned trees of any kind help to shade the ground.

Do not disturb the borders of a dense thicket. Sun and wind must be excluded from a stand which has been suddenly opened up within, and which is not used to the new conditions.

Figures 2 and 3 show a tract before and after thinning. Twelve cords to the acre of fair firewood were cut, which ordinarily should

pay for the thinning. The large number of small trees left after thinning should not be overlooked. All trees that in no way interfered with the dominant stand and had a fairly full crown were allowed to remain as cover. There is no chance of their overtaking the favored trees, and they furnish the needful shade whereby a greater opening of the crowns in the dominant stand is permitted. The final trees of the grove are to be selected from the trees which are 4 to 7 inches in diameter, the remainder acting as a reserve in case the selected trees should meet with accident. The heaviest cutting was made in the part of the stand which ran from 2 to 4 inches in diameter, the class which interfered most with the future sugar trees. The trees which gave promise of becoming members of the final stand were given more room than the others. Although the cutting took away a large proportion of the stand, the trees are still in close order. This necessitates a later thinning, probably after about six years, but at present further thinning would subject the long, slender saplings to danger of overthrow and the ground to drying.

SITUATION OF A SUGAR GROVE.

The best location for a sugar grove is where the maple thrives best under natural conditions. In the Appalachian region this is in the north coves, and in Ohio, Indiana, and neighboring States on rich, moist, gravelly soils. In the Northern States, where the maple flourishes on all exposures, the exposures to the south are generally to be preferred, because there the sap runs earlier, and the first sirup and sugar to reach the market bring the best prices. On northern exposures and in very dense forests the sap season begins later. If the sugar grove is to be on a large scale, however, it will be well to have it include both southern and northern exposures, so that the run of sap may be continued longer and not come at once in a quantity too great to be easily cared for. In the Northern States the best sugar groves are usually on rocky slopes with soils rich in humus. at an altitude of about 1,000 feet.

PLANTING A SUGAR GROVE.

The advisability of planting a sugar grove depends partly on the locality. The problem presented is notably different in the Middle West than in the Lake States and the Northeast. In the West maple-sugar production has steadily declined and shows no sign of a revival. The planting of sugar groves in this region is, therefore, not generally advisable.

In the region of commercial production it is usually easy to find old groves, young stands of second growth, or sapling thickets which can be made productive more quickly than a plantation of seedlings. Where no such beginning is possible, and a plantation has been determined upon, the following suggestions may be useful:

Avoid planting the trees too far apart. This is the mistake most commonly made. Wide spacing deprives the soil of its needful protection, reduces the yield of sap per acre, and gives a poor return for the expense of planting and for the amount of land used. Planting should always be done in early spring, and as the regions in which it is likely to be necessary are usually at low altitudes, it is good policy to plant the trees close enough to insure a proper ground condition from the first. This is best done by setting the trees 6 by 6 feet

apart, giving 1,210 trees to the acre. The small seedlings may be bought, or they may be gathered from the woods, preferably in wet weather. When this is done, care should be taken to select thrifty specimens, not more than 2 feet high, and to plant them immediately.

When the young trees reach a height of about 10 feet and begin to crowd one another, the grove should be treated in the same manner as that recommended for the wild sapling thicket. This will give a maximum number of full-crowned trees to the acre, and the proper ground conditions will be maintained.

In most cases it will be well to cultivate the ground for one season, or possibly two, but the soil should acquire the forest character as soon as possible. Where that is not readily attainable, a maple grove is not likely to pay.

In some places it may be advisable to mix with the maple a number of quick-growing trees valuable for posts or farm lumber, in order to secure early returns on the investment. The best species to use in this way can be determined only for definite localities. Advice in such cases will be furnished willingly by the U. S. Forest Service, by State foresters, or by local county agricultural agents.

OPENING THE SUGAR GROVE.

In the spring, when preparing for the opening of the sugar season, or during the fall of the year before, roads should be cut through the bush. Any brush that is in the way should be cut down, and any holes that might overturn the cart of sap should be filled. In laying out the roads through the woods some plan that will make every portion of the bush accessible should be followed, so that when the sap is running fast and many sap buckets quickly fill the gathering pail, it will not be necessary to carry the pail far to empty it into the hauling tank. Roads accessible to all parts of the bush give more assurance that all the sap buckets will be visited each day during the sugar season.

TAPPING THE TREES.

LOCATION AND CHARACTER OF TAP HOLES.

Before tapping, the side of the tree should be brushed with a stiff broom to remove all loose bark and dirt and a spot where the bark looks healthy, some distance from the scar of a previous tapping, should be selected. Care should also be taken to tap where a bucket attached to the spout inserted in the hole will hang level and be partly supported by the tree. For convenience, the hole should be about waist high. It is usually best to tap on the side of the tree where other trees do not shade the spot. In general, the south side of a tree is best for earliest runs, as the sun shines on this side first. The east side is next best. Some makers believe that holes on the north side flow longest.

In tapping a tree, a sharp bit with which a clean-cut hole can be made is necessary. If rusty and dull, the bit cuts a rough, feathered hole, which soon becomes foul, stopping the flow. After the tapping all shavings should be removed to make the hole clean. The bark should never be cut away before boring the hole, as this shortens the life of the tree.

SIZE OF TAP HOLES.

Among sugar makers the size of the hole is a much mooted question. All agree that it should be of such size that it will heal over in one season, or at the longest in two years. General practice seems to indicate that three-eighths to half an inch is the best diameter. If the season is long and a warm spell stops the flow, the holes can be reamed out to one-half to five-eighths of an inch, thereby giving an increased run. A thirteen thirty-seconds of an inch bit is often used. The bit should be very sharp and should



FIG. 4.—In tapping the tree a sharp bit three-eighths to half an inch in diameter is desirable. A deep hole is unnecessary; ordinarily one $1\frac{1}{2}$ to 2 inches deep is best.

bring the shavings to the surface. Its direction is slightly upward into the tree (fig. 4). The slant allows the hole to drain readily.

The depth of the hole is an important point on which makers disagree. It should, however, be regulated by the size of the tree, as only the layers next to the bark are alive and contain enough sap to flow freely. Toward the interior the flow diminishes. With the ordinary tree a hole not over $1\frac{1}{2}$ to 2 inches deep seems to be best. In small second-growth trees a short incision, or just through the sapwood, is best. Dark-colored shavings show dead wood, indicating that the sapwood has been passed through, and boring should be stopped when they appear.

NUMBER OF TAP HOLES TO A TREE.

Tapping only one place on a tree prolongs the life of the tree. Large first-growth trees may be tapped in two and sometimes three places without injury, but it is disastrous to tap in two places near together, in order to collect the sap from the two in one bucket.

TIME FOR TAPPING.

It is good policy to tap early in the season in order to obtain the earlier runs of sap, which are generally the sweetest and therefore the best sugar producers. Makers have lost half and even more of their crops many seasons by not being prepared for the first runs. All sugar makers are familiar with "sugar weather." In general, the

season is ready to open during the middle or last part of February in the southern sections and later in the northern ones, when the days are becoming warm, the temperature going above 32° F., and the nights are still frosty. If the days are very bright, warm, and sunny, the sap starts with a rush, but soon slackens. A high wind, warm spell, or a heavy freeze checks the flow, but the return of seasonable weather causes it to start again.

The variations in the opening and closing dates from season to season are shown in Table 1.

TABLE 1.—Dates of opening and closing an Ohio sugar camp from 1880 to 1912.

Year.	Opening date.	Closing date.	Days.	Year.	Opening date.	Closing date.	Days.
1880.....	Feb. 24	Apr. 1	37	1897.....	Mar. 8	Mar. 31	23
1881.....	Mar. 9	Apr. 16	38	1898.....	Mar. 3	Apr. 11	39
1882.....	Mar. 2	Apr. 1	30	1899.....	Feb. 20	Apr. 11	50
1883.....	Mar. 1	Apr. 10	41	1900.....	Mar. 8	Apr. 14	37
1884.....	Mar 12	Apr. 14	33	1901.....	.....	.....	.....
1885.....	Mar. 27	Apr 18	22	1902.....	Mar. 7	Apr. 6	30
1886.....	Mar. 15	Apr. 11	27	1903.....	Feb. 26	Mar. 15	17
1887.....	Mar. 2	A pr. 9	38	1904.....	Mar. 2	Apr. 6	34
1888.....	Feb. 21	A pr. 10	50	1905.....	Mar. 16	Mar. 29	13
1889.....	Mar. 11	A pr. 9	29	1906.....	Feb. 13	Apr. 2	48
1890.....	Feb. 17	A pr. 7	49	1907.....	Mar. 14	Mar. 23	9
1891.....	Feb. 13	A pr. 11	57	1908.....	Mar. 5	Mar. 26	21
1892.....	Feb. 22	Mar. 30	37	1909.....	.....	.....	.....
1893.....	Mar. 7	A pr. 3	27	1910.....	.....	.....	.....
1894.....	Feb. 27	A pr. 7	39	1911.....	Feb. 16	Apr. 4	47
1895.....	Mar. 23	A pr. 12	20	1912.....	Mar. 17	Apr. 9	24
1896.....	Feb. 27	A pr. 10	43				

APPARATUS.

SPOUTS.

The spout, or spile, the tube through which the sap flows into the bucket, is usually of metal, although often hollow reeds or elder with the pith removed are used. The best forms are perfectly cylindrical, smooth, and of an even taper, making them easy to insert and to remove without interfering with the wood tissue. The perfect spout should be strong enough to support the bucket of sap safely, and should bring the whole weight on the bark of the tree, not on the inner tissue or sapwood. Spouts with spurs or anchors tend to split the bark and crush the sapwood, thereby decreasing the flow and allowing the sap to leak. A spout having a small hole is best, because one with a large hole allows the bore to dry out faster when there are strong winds. Various forms of spouts on the market (Fig. 5) meet these requirements, and others that will serve the purpose can be made at home. A spout should have a hook or stop on which the bucket is to hang, unless the bucket may hang on the spout itself. It is bad policy to drive a nail in the tree for this purpose.

As a rule wooden spouts are not strong enough to hold the bucket; also they soon become foul from bacteria and souring of sap. Their use generally leads to a decreased yield and to the production of a poor-grade sirup.

In driving spouts into the tree great care must be taken not to compress the sapwood or split the bark. Both prevent a good yield of sap and splitting the bark tends to cause decay of the tree or a bad healing of the hole. The same care should be used at the end of the

season in removing them. Perfectly round spouts with the proper taper should be easily removed by turning.

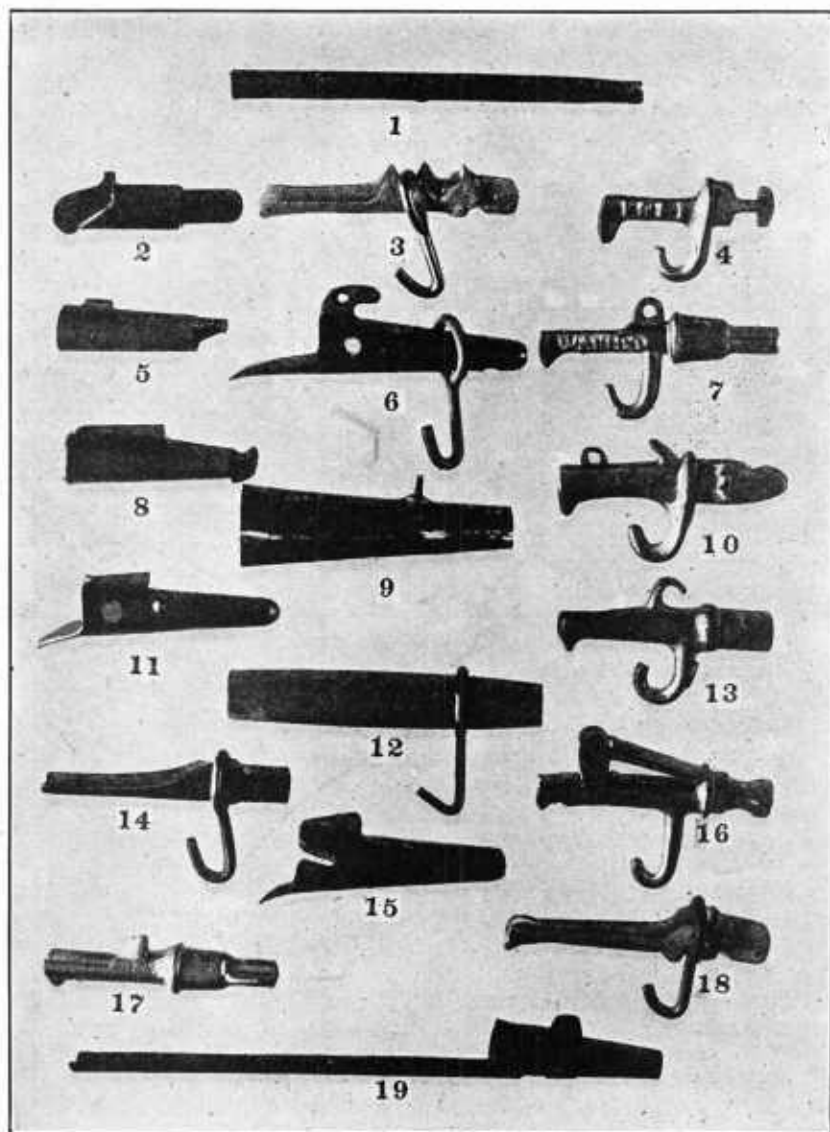


FIG. : —Common forms of sap spouts. (Nos. 1 and 12 are wooden; nos. 3, 4, 7, 10, 13, 16, 17, and 18 are molded metal; the others are metal bent into shape, usually over forms.)

SAP BUCKETS.

Buckets are hung on the tree to catch the sap.

Wooden buckets, formerly used almost universally, are still common. As a rule they are heavy and do not hang well on spouts, often making it necessary to drive a nail in the tree below the spout. Great care is required to keep the hoops tight to prevent their

falling to pieces or causing loss of the sap from leaking. Other points against their use are the large space they occupy in storage between seasons and the difficulty of keeping them clean. Sap enters the wood which extracts coloring matters and flavors. Wooden buckets soon become sour when the warm days come. To prevent these conditions makers who use this form of buckets paint them on the outside, and in many cases on the inside, during the summer or fall. By this means the pores of the wood are filled and the wood is preserved from decay. Ordinary iron oxide red paint is most commonly used for this purpose. Lead paint should not be used for painting the inside of buckets. Most makers are replacing their wooden buckets as they become useless with some form of metal buckets.

The most satisfactory buckets are of metal, practically free from corrosion or rust, and fitting well to the tree (fig. 6). They are light, yet strong, and not easily dented. They are readily cleaned and easily stacked away in a small space after the season closes. No doubt the



FIG. 6.—Clean metal buckets are used by careful sugar makers. This large tree can easily carry two buckets but should not be made to carry more. Each bucket has a cover.

best metal for this purpose would be aluminum, but it is too expensive. Heavy tin plate is next best, followed by lighter tin plate, then galvanized iron. "Terne plate" is iron coated with a mixture of tin and lead in about equal parts. Because of the poisonous nature of lead, buckets made of this material should not be used. For the same reason there is objection to a bucket that is soldered on the inside. The seams should be turned, and, if soldered, this should be on the outside, so that the sap does not come in contact with the solder. Objection has also been raised to galvanized buckets in that they soon begin to peel, leaving the iron surface to rust.

The widely flaring bucket, such as the ordinary tin water bucket, is not a good form. One with a gentle slope is better, as it gives greater surface in contact with the tree, but still has enough slope to allow stacking. A stout wire should be turned under the metal forming the rim, to give strength. Such buckets come in sizes of 8, 10, and 12 quarts. Some makers prefer the straight-sided buckets, of which three sizes that easily nest should be bought.

Buckets without handles may be obtained. A round hole of an inch or less is made in the side just under the rim, and by means of



Fig. 7.—A hauling tank is necessary for a tapping operation of any size. Wooden tanks are gradually giving way to the steel or galvanized-iron tanks.

this hole or a wire loop through it the bucket is suspended from the spout. If care has been taken in the selection of the place of tapping, a nail to keep the bucket in position will not be needed.

One great advantage of the metal bucket is the ease with which it may be cleaned. All parts are readily reached and there is no danger of sap remaining to sour later.

Painting the outside of new metal buckets lengthens their time of usefulness. Painting them on the inside is not a good practice, as the paint film soon comes off, especially if the buckets are scalded or washed with hot water. If they are rusted on the inside to any extent, it is best to discard them. Iron buckets or iron surfaces always change the sap, producing a dark-colored product.

COVERS.

The use of bucket covers is a disputed question. During the sap season rain and snow alternate with sunshine. Uncovered buckets hung on the trees are in a position to catch all this, as well as leaves, twigs, bark, insects, and dirt that may be swept through the air by the wind. The rain water dilutes the sap and often carries with it dirt from the trees as tree washings, which can not be removed from the sap. Twigs, leaves, insects, etc., can be removed by straining the sap, but they leave part of their soluble matter, which can never be removed. Objections made to the use of covers are that more time is consumed in removing them when emptying the buckets and that the sap sours more quickly in covered than in uncovered buckets.

Makers who always use covers say that with a hinge arrangement fastened to the spout no extra time is necessary to empty buckets, and that if any extra time is used less time is needed in boiling the sirup and a better-flavored product is obtained, resulting in an actual saving of time. By fastening the cover so that the back edge is raised a little above the front, free access of air is possible. Many of the

covers on the market are arranged in that way. Makers who use covers deny the statement that sap sours more easily when covered, stating that it sours rather from uncleanly methods. When little or no rain or snow falls during the sap season, there is less need for covers. It is true, however, that when uncovered buckets are used, the sirup is darker.

Covers may show how often buckets are emptied. This is accomplished by having the two sides painted different colors and turning each cover as the sap is gathered.

GATHERING PAILS.

Large buckets fitted with handles (fig. 8) may serve the purpose of collecting sap from the buckets on the trees and carrying it to the tanks. The usual form is a metal pail with a larger diameter at the bottom than at the top, which gives it stability and makes it less likely to turn over when resting on its edge to be emptied. Many have flaring funnel tops. As in the case of sap buckets, wooden pails are unwieldy on account of their weight. They should be cleaned often; in fact, after each time of using. The inside bottom edge, forming an acute angle, gives opportunity for dirt to collect and may soon become foul from bacterial growth. The gathering pails hold from 15 to 20 quarts.

HAULING TANKS.

Where only a few trees are tapped and the boiling is done close by, the sap may be carried in the gathering pails to the supply tank for evaporation. Where the sugar bush covers many acres, however, some means of transporting the sap is needed. Usually sap is trans-



FIG. 8.—Metal hauling tanks are taking the place of wooden tanks. The rivet holes on the side outline the metal apron which helps to keep the sap from slopping out.

ported in a large receptacle on a sledge or stone boat drawn by horses or cattle. Many small camps set a barrel on end, knocking the head in and fixing a faucet at the other end for the sap to run out. Others use large wooden tanks, either round or square, fitted with an opening at the bottom and a standpipe (fig. 7).

There is the same objection to the use of these wooden tanks for collection as to the wooden sap buckets. As the sap does not stay in them very long, however, the objection is not so strong. They should be painted on the inside before the beginning of the season and cleaned often when in use.

The many forms of metal tanks made for this purpose are desirable on account of ease of filling and emptying. The iron pipe at one end is loosely screwed onto the nipple at the bottom of the tank and is held upright by the lock at the top of the tank. To empty, the lock is taken out of the socket and the pipe is turned downward (fig. 9). These tanks may be obtained in sizes holding from 2 to 6 barrels of 32 gallons each.

Flannel or cheescloth may be stretched over the top of the tanks and the sap poured through this to remove any twigs, leaves, or pieces of dirt. This is of great importance in the production of a good grade of maple product.

Where the slope of the ground is suitable, pipe lines are frequently used to carry sap to the boiling house storage tanks. These lines



FIG. 9.—Gravity is a big help in emptying hauling tanks and in carrying sap from the storage tank to the evaporator. Storage tanks should stand in a cool, shady place, so that the sap will not spoil.

are made of galvanized pipe or galvanized or iron down spouting of small diameter. They are carried on stakes driven into the ground, the sections being fastened together in such a way that they may be uncoupled and cleaned. Ordinarily the main line extends to suitably elevated points throughout the grove. The ends of the lines are provided with funnel-shaped tanks of small capacity into which the gathering pails are emptied, the sap flowing by gravity to the boiling house. Time and labor are saved by this arrangement. (Fig. 9.)

BOILING HOUSES.

If the sugar bush is small and near the house or farm buildings, the boiling can be done in the summer kitchen, over the cookstove, or in a shed. If 200 or more trees are tapped, some kind of a boiling house should be used and some attention paid to its location. It should be in the bush or near by and on a level spot where good drainage can be secured, close to higher ground, to allow a drive where the gathering tank may be drawn up and its contents emptied by gravity. It is not a good plan, however, to have a house close up against a high bank or cliff which would interfere with the draft for the chimney. If no low spot with a slight elevation is available, dirt can be piled up for the driveway. (Fig. 10.)

Although not necessary, a roof serves to house the sleds and apparatus, and in bad weather to keep snow and rain from the tank. After season this space is also available for the storage of the sap buckets.

The size and kind of sugar house must be regulated by the size of the camp or number of trees to be tapped. A convenient size is one in which there are at least 3 feet of space on both sides of the evaporator and 5 feet in front. The house should be at least 7 feet—and, better, 8 feet—high at the sides and covered with a well-slanting gable roof. A quarter pitch for the roof is often recommended. A ventilator as long as the evaporator should be placed immediately over the evaporator in the ridge of the roof. A wooden roof causes less condensation and dropping into the pan than a metal one. Moreover, a metal roof without paint soon rusts and allows dirt to drop into the pan. In connection with the house there should be a shed for the storage of wood to be burned in the evaporator.



Fig. 10.—This boiling house stands on high ground, but the gathering tank may be emptied by gravity. The sides of the house are tight and a ventilator on the roof allows the steam to escape.

It is not good policy to throw up a cheap, makeshift house. The sides of the house should be battened and all cracks covered over; the doors and windows should fit tight. Without these precautions the house soon becomes filled with partially condensed vapor or steam, and a cold, chilly dampness, which greatly hinders evapora-

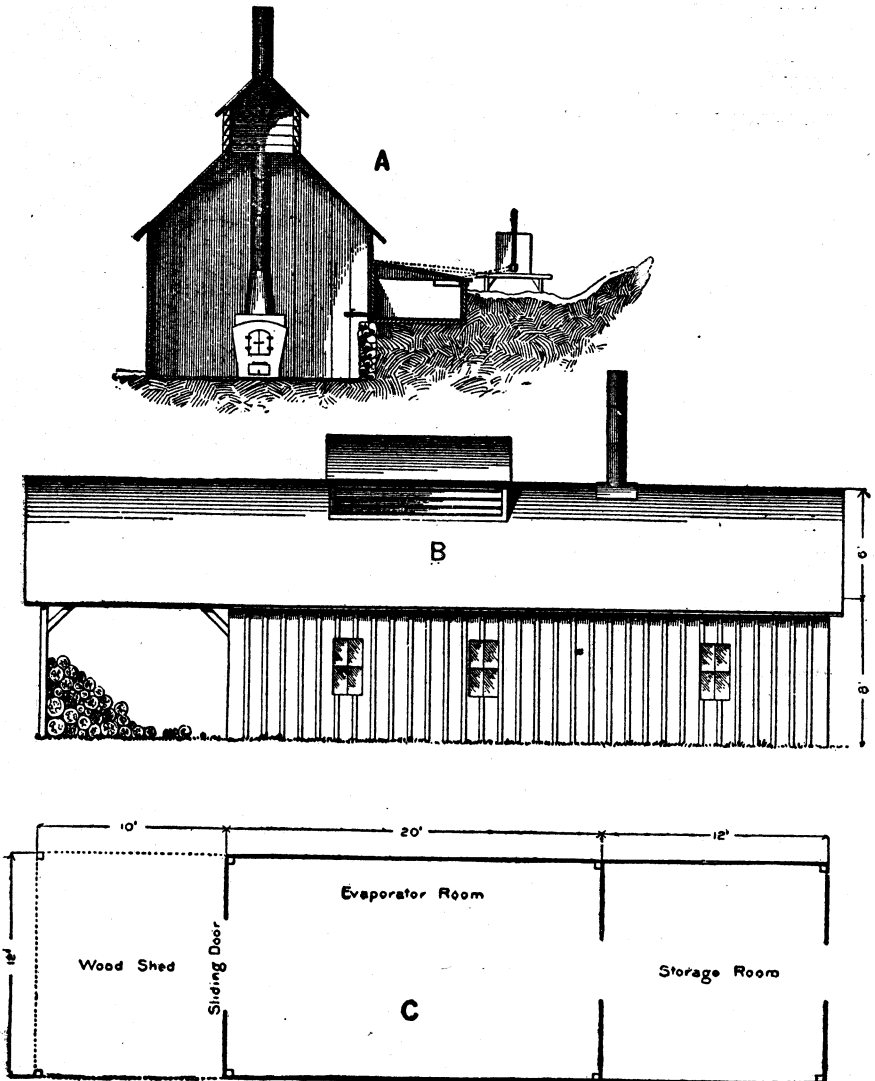


FIG. 11.—Plan of a model evaporation house: A, sectional view, showing evaporator, storage tank, and gathering tank (on shed); B, elevation; C, ground plan.

tion, is noted. The ventilator should be capable of being opened or closed easily. The floor should be of brick, cement, or wood, and should have a slope for ease of cleaning. Brick or cement is preferable to wood, because it offers less chance of fire.

Although not necessary, a small storage room (fig. 11) is a good place for setting up the "sugaring-off" pan (p. 23). It is of special benefit

to have the woodshed boarded up, but this is of less importance than the other portions of the house. The dimensions given for the sugar house shown in Figure 11 allow for the ordinary sized evaporator, but for larger ones it may be well to increase the width and length of the whole structure.

The storage tank should be large, capable of holding about a half day's run of sap. It can be made of wood, but it is better when of metal. Wooden tanks soon fall to pieces and are a constant source of loss through leaking. The tank should be outside the house and immediately against it. The bottom of the tank should be at least a foot above the top of the evaporator, to allow an easy grade for the tank to drain into the evaporator. This tank, which should be closely covered to keep out rain and dirt, must be on the side of the house next to the roadway, so that it is easily accessible to the gathering sled.

By partially burying the tank or boxing it in with wood and filling the space with leaves, the sap will not freeze so easily in cold weather or heat so soon in hot weather.

EVAPORATION APPARATUS.

Evaporation apparatus in general use may be divided into three general classes: Iron kettles, arch evaporators, and patent evaporators.



FIG. 12.—Crude iron kettles are still used for boiling maple sap in many parts of the country. The cheapness of this equipment, however, is more than offset by the longer hours of labor and the greater quantity of fuel necessary to make sirup which is inferior to that made in modern evaporators.

The iron kettles, usually from 2 to 4 feet in diameter, are seldom housed. They are set on stones or suspended from a support (fig. 12). In some cases two or more are set in brickwork, with a place for the fire beneath. This crude form of evaporation apparatus seldom, if ever, yields a pleasant-tasting product. The danger of burning or scorching the sirup by the flames playing around the metal near the edge of the liquid is ever present.

Another crude method of boiling is with sheet-iron pans, usually from 2 to 3 feet wide and 3 to 6 feet long. They are raised above the ground by brick or stone work and the fire is built under them. While their use is attended by the danger of scorching the sirup, they are a step toward a better product. Pans made of sheet tin, with care in boiling, will produce a well-flavored product. Galvanized-iron pans can not be recommended. Two home-made pans, one in back of the other, may be used for evaporating sirup. The sap is placed in the front pan and when partially concentrated transferred to the back one, or vice versa, by means of a ladle. This form of concentrating apparatus is generally known as an arch evaporator. In most cases the arch on which the pans rest is made of brick, but often stone is used. It may be 3 or 4 feet wide and from 8 to 15 feet long, inside measurements. The sides are usually from 2½ to 3 feet high. Between these two walls the bottom is bricked or cemented and the walls are held together and in place by iron stays, which also support the pans. At the back the arch ends in a flue and a brick or metal chimney extending through the roof. In the front grate bars may be provided and an excavation made for an ash pit.

It is well to build the arch during good weather and allow it to set. When built hurriedly before the season or in bad weather it is likely to crumble and break away. The top layers of the two sides must be of equal height so that the pan will be level. A slight slant of an inch in 16 feet in the level of the length of the arch is of value, as it gives the sirup a tendency to run toward the back where the final concentration takes place.

The pans are made to fit the arch and are not over 6 inches deep. The edges may be turned over a stout wire to give rigidity and strength, and should be fitted with handles so that they can be readily removed from the fire. The arch can be supplied with a regular stove front containing a fire door and ash door or it may be fitted with a piece of sheet metal. The stove front fits better and more closely and allows a better control of draft.

Patent evaporators are simply improvements over the arch evaporators (fig. 13). The arch is generally metal, lined with fire brick. The pans fit the form much more closely to allow a better play of heat without loss, and often have corrugated bottoms to present a greater surface to the fire for quicker evaporation. The pans are also partitioned off to give a zigzag course to the sap.

Some forms have at the side an apparatus which automatically keeps a constant level of sap in the boiling parts and can be set and regulated to keep an even depth of boiling sap. The finished sirup can then be drawn off continuously.

The iron arch, with its dampers, makes possible the best results from the fire, which are hard to obtain in an ordinary arch built of masonry. Such patent evaporators can be obtained in sizes from 2 by 7 feet up to 6 by 24 feet. In general, with this style of evaporator with corrugated bottom, 1 square foot of bottom is capable of concentrating about 2 gallons of sap an hour—that is, a pan 3 by 8 feet, or 24 square feet, will evaporate about 40 to 50 gallons of sap an hour, and one 4 by 16 feet, or 64 square feet, will evaporate about 115 to 130 gallons an hour. Some makers have found that about 10 square feet of boiling surface are necessary for every 100 buckets set. That is, a camp of 500 trees would need an evaporator of 50

square feet. In figuring capacity, it is well to take the minimum figures rather than the average or maximum figures.

SUGARING-OFF APPARATUS.

Where maple sugar is made as a side issue or in very small quantities, it is customary to boil the sirup in pots over the kitchen stove, but where it is made on a larger scale, special apparatus is used. Sugaring-off outfits may be homemade. The pans used are much shorter than the evaporators and very much deeper, generally from

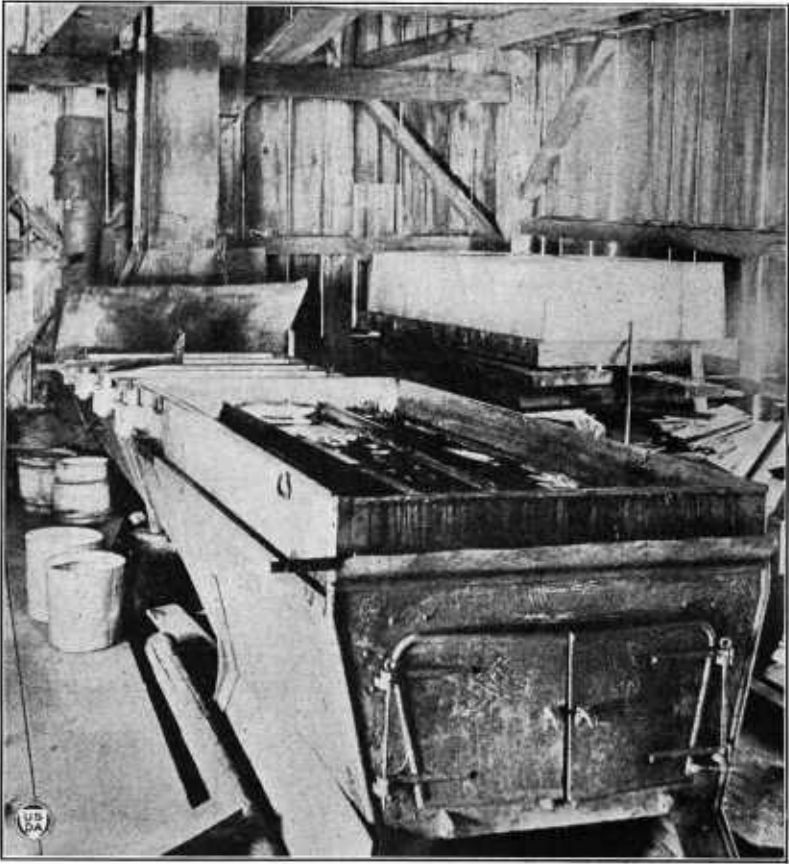


FIG. 13.—Interior of a boiling house equipped with a modern evaporator, of which there are several types. Partitions in the pans give the liquid a zigzag course and divide that which has reached a sirup stage from the raw material. Floats and siphons help to keep the sirup in the pans at a constant level.

2 to 2½ feet wide by 3 to 6 feet long and from 12 to 14 inches deep. The metal is usually heavy tin or sometimes galvanized iron, but never sheet iron. The sides slant toward the bottom and the edges are reinforced well with heavy wire. The pan has a faucet for drawing off the thickened sirup. The arch is made of brick with a fire box and ash pit. Where there is no means of drawing off the sirup the pan should be easily removed from the fire, so that when the proper concentration has been reached the contents can be immediately poured into molds.

It is well to have the sugaring-off pan in a separate room in the sugar house and directly beneath at least two rafters or stringers

holding the sides of the house. By attaching to these block and tackle fitted with a ring having four hooks which can be inserted in the handles of the pan, one man can easily lift the pan from the arch, and swing it to the part of the room where it is to be emptied.

Sugaring-off pans with metal arches have many points of advantage over the homemade arches, the main one being the absolute control of the heat by means of dampers.

MAPLE SAP.

The flow of sap is not continuous; that is, when the tree is tapped the sap does not start to run and continue until the season closes. It runs only when atmospheric conditions are favorable. As a rule the run is stronger during the day than at night and often stronger in the middle of the day than in morning or evening. With changes in the weather the sap stops, to start again when the right conditions are present, so that there may be a run of sap for a day or two and a lapse of a few days before another. During a season there may be as few as 2 or 3 runs or as many as 10 or 12. Freezing weather, excessive wind, too bright sun, or a warm snap will stop the run.

At the beginning of the season the sap is water white, clear, and transparent and has a sweet taste, but as the season advances it usually becomes cloudy and yellowish, with a peculiar odor. The composition of the sap varies, depending upon the season and the tree. There is anywhere from 1 to 5 per cent of solids in the sap, of which about 95 to 97 per cent is ordinary sugar. Thus the sugar content varies from 1 to 4 per cent, with an average of 2 per cent or possibly more. Some nitrogenous matter and some mineral matter are also present.

The sap is very susceptible to the growth of bacteria, which are believed to cause the souring of sap and the change in its physical condition toward the end of the season. When the sap is running well the danger from them is not great, but when warm weather starts and the flow is intermittent they become very active. Therefore the sap should be collected each day and not allowed to accumulate. It is necessary also to keep the buckets and containers clean. After each run they should be washed with warm water. This is of great importance in obtaining a fine grade of sirup from the later runs. One of the visible signs of sour sap is the mucous formation in the buckets. When this is noted the buckets should be cleaned thoroughly and scalded.

The tap holes also become infected. This infection increases more slowly in spouts with small openings than in hollow tubes with large bores. The latter allow a drying out of the wood tissue, which, together with the growth of bacteria, slackens the flow of sap and causes what does flow to be inferior. Under these circumstances reaming of the tap holes is recommended, as this removes the dry contaminated tissue. At the same time the spouts should be steamed out or fresh ones inserted.

"Buddy sap" is the name applied to late runs of sap, especially that running at about the time the buds in the trees start to open. It is usually green or yellowish and has a peculiar odor easily recognized. Sirup produced from this sap does not have a good flavor and when this peculiar odor or flavor is noted in the sap no more sugar or sirup is made.

Stringy sap is ropy or stringy and generally milky in color; "green sap" has a greenish to greenish-brown color; "red sap" shows a reddish sediment; and "milky sap" has a peculiar milky appearance. None of these saps produces a good sirup. Although they are spoken of as "sour saps," in reality they are not sour in the strict sense of the word, as the acidity is seldom much above the normal acidity of the sap; they are simply changed by bacteria. Reboring the tree some distance from the old hole when holes are running this peculiar sap, and putting in new sterile or clean spouts, usually will result in normal sap. The season may be prolonged to some extent in this way, but tapping more than a second time in one season is not recommended.

MAPLE SIRUP.

CONCENTRATION OF SAP.

On frosty mornings ice is often found in sap buckets and sometimes the whole mass of sap is frozen. Makers differ as to whether this ice should be thrown away. When all of the sap is frozen it should not be thrown away. Floating ice, however, includes very little sugar and should be thrown away. The sap is concentrated to some extent in this way, a method of concentration said to have been used by the Indians.

When the sap is heated a scum forms on the surface. Should there be fine sediment in the sap as it runs to the evaporator this will be caught in the scum and brought to the surface, when it should be carefully skimmed off. For this a form of metal skimmer, which resembles an ordinary dust pan with the bottom perforated (fig. 14), may be used. It may have a short handle, or a long wooden pole may be attached. With it the scum can be raked to the near edge of the pan or kettle and then lifted off. As the concentration goes on mineral matter floats around in the thickening sap or settles out

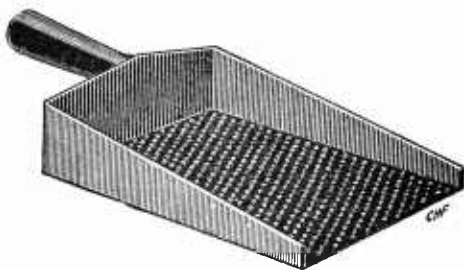


FIG. 14.—Sirup skimmer.

on the bottoms or sides of the pans. The removal of this mineral matter, commonly known as "sugar sand," "niter," or "silica," is discussed under "Cleansing the sirup," on page 26. Sugar in solution is easily broken up by long boiling. As the solution becomes more concentrated the temperature of boiling is raised and more decomposition takes place. Then to keep the flavor of the thin juice in the final sirup evaporation must be done as quickly and at as low a temperature as possible.

When using iron kettles, they should be charged and this charge concentrated, the kettles being filled once or twice with fresh sap. A light-colored, well-flavored sirup will not be obtained by keeping up the addition of fresh sap to the boiling kettle and only "siruping off" once or twice during the day. This concentrating, then diluting, and then concentrating causes decomposition of the sugar and organic matter and therefore blackens the sirup. It is difficult to obtain a fine, mild-flavored maple product by concentrating in iron kettles.

Iron pans may produce dark-colored sirup, as also may patent evaporators if they are used to concentrate sap in the way the iron kettles are used. The way to obtain good products with them, provided the sap is not sour, is to concentrate in as thin a layer as possible, drawing off the sirup as quickly as made. When a large single pan is used this is hardly possible. However, an inch or two of sap can be put in the pan and boiled and more added, a little at a time, so as not to stop boiling or materially change the density of the boiling liquid. When this charge is concentrated, the sirup should be drawn off. Care must be taken not to allow the remaining sirup in the pan to be burned. When more than one pan is used the sap can be placed in the one over the fire, skimmed, and partially concentrated, then transferred to the next and further boiled, then ladled to the others, the last one being the finishing pan. As one pan is emptied, the sap from the one in front is brought to it. This permits better skimming. In patent evaporators the sap and partly concentrated sirup flow through siphons from one compartment to the other, thus doing away with the use of a ladle.

To produce the best-flavored sirup of highest quality the liquid should not be deeper than 1 to 1½ inches in the evaporator at any one time.

CLEANSING THE SIRUP.

During concentration the mineral matter of the sap separates out, a large portion forming a crust on the pan, and some floating in the partly concentrated solution and also in the finished sirup. This makes the sirup murky and unattractive. Settling removes a large part of this matter, and filtering through flannel a greater portion.

Another means for removing this sediment is the addition of white of egg, whole milk, or baking soda to the sirup in the last pan. They collect around the suspended matter and bring it to the top or liberate a gas, causing foam to appear. By careful skimming, this is removed. When used in quantities, these settlers change the flavor of sirup and, contrary to the general belief, do not make it lighter in color. Baking soda, added to the finishing sirup to make it foam and bring the foreign material to the top, also tends to neutralize any acidity. Its use is very questionable, for if added in quantity it darkens the sirup, besides greatly changing the flavor.

Cleansing can be accomplished by allowing the finished sirup to settle or by pouring it from the evaporator through felt or flannel into the cooling cans. As a rule, this will give as light-colored sirup as when clarifiers are used. Hot sirup is easily filtered through a felt strainer, shaped like a cap, 10 inches in diameter at the top and 14 inches deep, or through a double thickness of heavy flannel, suspended in the neck of a large milk can, with the edges turned. Cocks in the settling can make it possible to draw off the clear sirup from the top after the sirup has been allowed to stand and from lower down in turn, stopping when the sediment is reached. The sirup should be filtered hot.

FINISHING POINT.

According to the regulations of the Federal food and drugs act, maple sirup contains not less than 65 per cent total solids, and weighs not less than 11 pounds to the standard United States gallon. In commercial practice it is generally recognized that maple sirup should

weigh not less than 11 pounds to the United States gallon. Such a sirup will have 65 per cent solids or 35 per cent water. A sirup made thinner than this—that is, containing more water—will sour, and one made much thicker—near 12 pounds to the gallon—will tend to crystallize. The maker must determine the density of his product. This is often accomplished in a crude way by noting the bubbles as they break on the surface of the boiling sirup or by removing some in a spoon and watching how it pours. A more satisfactory way is by means of a thermometer to determine the boiling point or a Baumé hydrometer spindle to determine its density.

By thermometer.—The boiling point of a liquid is affected by its concentration and also by altitude. Water at sea level boils at 212° F., but for every 500 feet above sea level, roughly speaking, the boiling point is lowered 1 degree. Therefore, at an altitude of 2,000 feet the boiling point of water is 208°. The Vermont Agricultural Experiment Station has found that a maple sirup boiling at 219° F. weighs 11 pounds to the gallon, or is at standard density. This figure, however, changes a little, depending on the run of the sap. A first run often boils at 217° or 218° F. when having a concentration equal to 11 pounds to the gallon. It is necessary, then, to note the boiling point of the sirup only in the last pan to decide whether it is concentrated sufficiently. The thermometer must be correct and must not touch the bottom or sides of the evaporator, but measure the temperature of the liquid only.

The temperature which the thermometer registers when placed in boiling water plus 7° is the point at which the sirup will boil when it is properly concentrated. It is extremely important, however, to test the sirup again by weighing a quart or a gallon after it has cooled to make sure that it has a proper density.

By Baumé hydrometer.—A hydrometer or spindle is an instrument for showing the density of a liquid. Hydrometers are graduated to various scales and for various purposes. The one generally used for rough sugar work is the Baumé. The standard of graduation varies somewhat with different makes. The usual Baumé hydrometer is made of glass and shows a graduation from zero to 50, divided into degrees (fig. 15). The density is measured by floating the hydrometer freely in the liquid, which is generally held in a tall cylinder. The point on the scale where the instrument comes to rest is considered the density. The surface of the liquid is curved up at the points of contact with the metal cylinder, and also with the hydrometer. The correct reading of the instrument is on a line with the surface of the liquid, not at the upper edge of the curved portion. The temperature at which Baumé hydrometers are standardized is 60° F., unless it is otherwise marked on the stem of the hydrometer, so for correct readings the sirup should be cooled to that temperature. At 60° F., sirup of standard density has an ordinary Baumé reading of 35.6°. The zero mark of the hydrometer is at the upper end and the 50-degree mark is at the lower end. If the sirup is hotter than 60°, it will be lighter, or less dense, and the hydrometer will sink lower, giving a lower reading. If it is cooler than 60°, the sirup will be heavier, or denser, and the hydrometer will not sink as low, giving a higher reading.

As the accuracy of glass hydrometers is very much affected by being placed in hot liquids, it is not good practice to use the accurate instruments in hot sirup.

TABLE 2.—Dry substance and water corresponding to each degree Baumé.

Degrees Baumé. ¹	Dry substance.	Water.	Degrees Baumé. ¹	Dry substance.	Water.
	<i>Per cent.</i>	<i>Per cent.</i>		<i>Per cent.</i>	<i>Per cent.</i>
1	1.7	98.3	26	46.8	53.2
2	3.5	96.5	27	48.6	51.4
3	5.3	94.7	28	50.5	49.5
4	7.0	93.0	29	52.4	47.6
5	8.8	91.2	30	54.3	45.7
6	10.6	89.4	31	56.2	43.8
7	12.3	87.7	32	58.1	41.9
8	14.1	85.9	33	60.0	40.0
9	16.0	84.0	34	61.9	38.1
10	17.7	82.3	35	63.9	36.1
11	19.5	80.5	36	65.8	34.2
12	21.3	78.7	37	67.8	32.2
13	23.0	77.0	38	69.7	30.3
14	24.8	75.2	39	71.7	28.3
15	26.6	73.4	40	73.7	26.3
16	28.4	71.6	41	75.7	24.3
17	30.3	69.7	42	77.7	22.3
18	32.1	67.9	43	79.7	20.3
19	33.9	66.1	44	81.8	18.2
20	35.7	64.3	45	83.8	16.2
21	37.5	62.5	46	85.9	14.1
22	39.4	60.6	47	88.0	12.0
23	41.2	58.8	48	90.1	9.9
24	43.1	56.9	49	92.2	7.0
25	44.9	55.1	50	94.4	5.68

¹ Taken at 60° F.

A degree Baumé does not correspond to 1.7 per cent of sugar, for the hydrometer measures other dissolved solids also.

In order to determine relatively the number of degrees Baumé of the cooled sirup when the reading is made with the hydrometer at a high temperature, it is necessary to take the temperature when the hydrometer is read. Subtract 60 from the number of degrees Fahrenheit of the heated sirup (this being the normal temperature) and multiply the difference by 0.0265. This figure (which is the temperature correction expressed in degrees Baumé) is added to the Baumé reading of the hot sirup and the result is the Baumé reading of the cooled sirup. For example, a heated sirup shows a reading of 30 at a temperature of 215° Fahrenheit. Then—

$$\begin{aligned} 215 - 60 &= 155 \\ 155 \times 0.0265 &= 4.1 \\ 30 + 4.1 &= 34.1 \end{aligned}$$

The cooled sirup would read 34.1 or, by Table 2, have about 38 per cent of water.

CANNING AND STORAGE.

After the sirup is strained or settled, it is ready for canning. Opinions vary as to whether it should be canned hot or cold. Some makers hold that canning hot tends to bring about crystallization. It is certain that there is no danger from fermentation when the sirup has been sterilized by boiling and is packed at once in sterile cans (steamed or washed in boiling water) which are immediately sealed in such a manner as to exclude air. This can not be said of canning cold.

When made on a large scale, maple sirup is often run directly from the evaporators into barrels and so shipped, but by far the greater number of sirup makers sell in quart, half-gallon, or gallon tin cans. These cans are generally square, with a screw cap. When being filled

they are tipped slightly and then lifted by the upper edges and filled even with the screw top, which is fastened tight with a wrench. This method applies to canning hot or warm sirup. When the cans are being filled in cold weather and with cold sirup, it is well to hold the can so that the sides are a little compressed and then fill to the top and screw on the lid. By this means no air enters and when the sides are released allowance is made for an increase in volume when the cans are placed in a warmer room. Fancy maple sirup is often put up in glass and when carefully canned it will keep from one season to another without souring or bursting the jar.

It is best to store sirup at an even, cold temperature. Temperatures around freezing, however, tend to make the sirup crystallize.

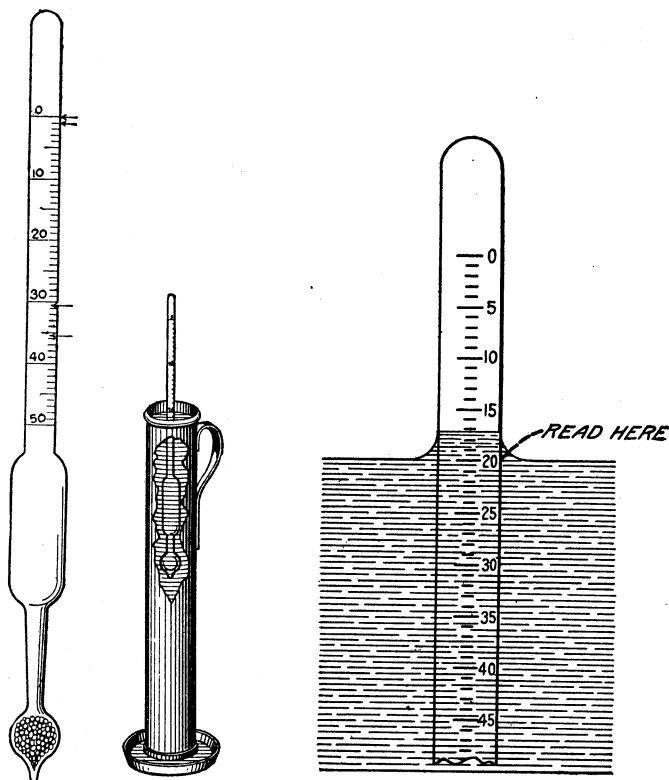


FIG. 15.—Hydrometer and its position in the liquid.

CRYSTALLIZATION.

Sometimes the sugar in sirup becomes concentrated to a point at which it is no longer soluble in the water present; hence it crystallizes out. Maple sap, being a dilute solution of sugar, when concentrated soon reaches a point where, on cooling, the sugar starts to crystallize out.

Pure water will hold in solution 66 per cent of pure sugar at ordinary temperatures. If there is a concentration by evaporating off the water to a point where there is 66 per cent of sugar in the resulting solution, the solution is holding all the sugar it can without depositing some as crystals. In practice, crystallization sometimes occurs

before this 66 per cent is obtained. The commercial standard gallon of sirup, weighing 11 pounds, contains at least 65 per cent solids, of which at best 95 per cent is sugar, and should not crystallize. If, however, the resulting sirup weighs 12 pounds to the gallon, there is much more chance of crystallization.

Makers differ on the question of the influence of hot and cold canning on crystallization. Some think that by canning hot crystallization is prevented; others think the opposite. It seems, however, to be a question of the density of the product rather than the heat of canning. Crystals may form in small patches or as large individual ones. Their presence in maple sirup is often considered an evidence of adulteration by addition of rock candy, which is not true. Once crystallization is started, the crystals grow until solution equilibrium is reached.

Crystallization is caused in many cases by changes in temperature, the solutions becoming cold and then warm. Hence it is well to store maple sirup in a place having as even a temperature as possible. The first runs are more likely to show crystallization than the later ones.

MAPLE SUGAR.

SUGARING-OFF.

"Sugaring-off" applies to the further treatment of the maple sirup by which it is made into a solid product. In the careful manufacture of sirup, even from sour sap, a solid product may be produced by concentrating to a higher degree. But if during manufacture cleanliness has been disregarded or sour sap has been used, a solid product can not be obtained by any amount of boiling.

The sugar, which forms about 95 per cent of the solids of the sap, and, after evaporation to sirup with care, forms from 90 to 96 per cent of the solids of the sirup, is easily broken down or split up into two sugars, one of which crystallizes easily, while the other does not. These sugars have a tendency to retard, and, when present in large enough quantities, to prevent the crystallization of the sugar originally present, and it is their formation that tends to prevent the making of sugar from certain sirups. This is the reason why late runs of sap or burned sirup or sour sirup will not yield sugar and why some sirups produce a hard sugar while others produce only a soft, mushy sugar.

Where maple-sugar making is conducted as a side line to sirup making, the ordinary iron pot of the kitchen is filled nearly half full with the sirup which is concentrated over the kitchen fire. On a larger scale, however, the sugaring-off pan (p. 23) is used. A small piece of butter or lard or some sweet oil or a piece of fat meat, as bacon or fresh pork, run over the surface, is used to stop the foaming which occurs when the sirup is boiled. Great care should be taken to select a neutral fat with little taste or flavor and to use it only in very small quantities, so that the flavor of the product will not be affected. If the sediment is heavy, white of egg or milk may be added and skimmed off during the boiling. Under all circumstances the boiling mass should be skimmed.

The hardness of the sugar produced is controlled to a large extent by its moisture content, and to some extent by the breaking up of the sugar during the heating. A charge should be "sugared-off" before adding any more sirup, as this concentration and dilution

and concentration again tends to blacken the product and decompose the sugar, making hard-sugar production difficult. The proper point of stopping the boiling is best determined by means of a thermometer. Another means of determining this point is to drop some of the liquid in cold water or on snow. Where a product of uniform hardness is to be prepared, the thermometer should be used.

Maple sugar for immediate use should be softer than that for storage and cake sugars are generally harder than tub sugar. In the first runs the boiling should be carried up to 238° or 240° F. (or 26° to 28° above the boiling point of water at that elevation) to make a medium hard sugar, while for a tub sugar (one that is sold in tubs) a temperature as low as 233° F. (21° above the boiling point) can be used. With later runs of sap the finishing temperature should be 240° to 250° F. (28° to 38° above the boiling point). These are not absolute in all cases. The maker can experiment with the proper temperature.

The quantity of sirup "sugared-off" at one time varies from 1 to 10 gallons, depending upon the size of the equipment, etc.

After the thick sirup has reached the proper boiling point, it should be taken from the fire and stirred until somewhat cooled. This gives it a uniform grain and color in the mold. The finishing temperature can be made a little lower if there is vigorous stirring during the cooling period. If it is not stirred the points of quickest cooling (the edges) become hard and coarse grained and the center or part last cooled is mushy.

FINISHING.

Large cakes of maple sugar are usually formed in wooden molds, while the smaller cakes are formed in tin molds. A convenient kind for large cakes is a wooden box with the sides clamped, so that when the sugar is molded the sides can be removed. By having the sides grooved, sheets of wood or metal can be inserted and smaller cakes made from the same mold.

The mold should be dry and warm. If it is wet, the cake of sugar will not be of uniform color; if cold, the cake is likely to stick at the sides, causing the sugar to harden there and be soft on the inside.

Grained or stirred maple sugar is concentrated to a high degree, then stirred continuously during cooling. A mold is not used. The finished product is, as a rule, dry and somewhat lumpy, resembling the ordinary commercial brown sugar in appearance, but, of course, retaining its maple taste. In color it varies from nearly white to dark brown.

Maple cream is produced by boiling the sirup to a density slightly heavier than that for a soft sugar and suddenly cooling the product, stirring all the time with a large spoon or paddle. This beating and cooling tends to produce very small crystals of sugar which give the product a creamy appearance and do not separate out on standing if the proper density is maintained. An early run of sirup is not the best for maple cream. This product, called maple butter in some sections, is frequently prepared by farmers.

Maple honey is the name often given to a light-colored maple sirup which has been boiled to a density slightly greater than that of sap sirup, or similar to that of strained honey. The sirup could hardly be an early run. As this substance has no connection with bees and is never stored in combs, the fitness of its name may be questioned.

Maple wax is prepared by boiling sap sirup to a density nearly equal to that of hard sugar, but without stirring, and then pouring the product over snow or ice to secure an immediate cooling, thereby preventing crystallization of the sugar. This can be made only in small quantities and does not keep its waxy condition for any length of time.

STORAGE.

Maple sugar does not keep well in a moist atmosphere. It tends to absorb water, molds quickly, and if finished at too low a temperature becomes soft, the liquid portion draining out. Therefore sugar which is to be stored should always be boiled to a high temperature. After being taken from the molds it can be wrapped in paper, but should not be put in covered containers unless they are completely sealed. It is best to store the sugar in a warm room of even temperature. If the cakes are sealed without access to air, a cold place can be used, but in no case should the storage room be damp.

CARE OF APPARATUS.

When the buddy sap has started to run and no more high-grade maple products can be made it is time to close the season.

The buckets should be removed from the trees and placed upside down on the ground to dry in the sunshine. Some makers wash them, but many believe that the last sap should be left in the buckets, as it prevents rusting. When thoroughly dry they should be stacked in piles and put in the sugar house, barn, or other shelter away from the rain. In stacking, rope or straw should be placed between the buckets, so that they will not fit tight in one another. This is of great assistance when taking the stack down at the beginning of the next season. Some buckets have a bulged circle around them, which keeps them from becoming wedged together in stacking.

After the spouts have been removed, care being taken not to break the bark of the tree, they should be boiled in water once or twice, then allowed to dry thoroughly in a warm place, and stored in a box.

The collecting buckets, hauling tank, and storage tank should be painted on the outside and, if of wood, on the inside.

The evaporator should be cleaned, the ashes removed, and a coat of asphalt paint or red iron paint given to the exposed metal parts.

Scale in the pans, known as "sugar sand," "silica," or "malate," is best removed by boiling water in them and then using a fine wire brush. During the manufacturing season this scale, which has no particular economic use, should be removed from the pans after each boiling. Other methods of removing the scale are by scraping, by adding muriatic (hydrochloric) acid or vinegar, or by using butter-milk. Scraping weakens the pan and acids or vinegars should be used with the greatest care, as the metal of the pan may dissolve along with the scale. After removing the scale, the pans should be washed, thoroughly dried on the inside, and painted on the outside. They should be stored in a dry place, and turned over so as not to collect dirt or water during the summer.

If a metal smokestack is used, it should be taken down, freed from soot, painted, and, after drying, stored in a dry place.

If the arch shows cracking or sagging, repairs should be made during the following spring or summer rather than at the beginning of the next season.

YIELDS.

From 5 to 40 gallons of sap is obtained from a tree during a season, on an average between 10 and 20 gallons. Normal sap of an average year contains about 2 per cent of sugar, although it may vary from 0.5 per cent to as high as 7 or even 10 per cent. The sugar content varies greatly with the tree, its location, and its past growth. One tree can be counted on to give from 1 to 7 pounds of sugar per season, or, expressed in sirup of standard density, from 1 pint to 1 gallon, although the average from year to year and from tree to tree is about 3 pounds of sugar or 3 pints of sirup. In a normal year, then, 1 barrel of sap (32 gallons) should produce a gallon of sirup or $7\frac{1}{2}$ pounds of sugar. In many camps and for many years it takes sometimes as much as 50 gallons of sap to make 1 gallon of sirup. First runs of sap are generally richer in sugar, and hence take less for a gallon of sirup. From $6\frac{1}{2}$ to 9 pounds of sugar, according to the kind, can be made from 1 gallon of standard sirup, with an average of $7\frac{1}{2}$ to 8 pounds. A camp of 100 trees should produce about 40 gallons of sirup or 300 pounds of sugar.

MARKETING.

It is practically impossible to produce a grade of sirup of uniform flavor and color. The run of sap and manufacturing conditions are the principal factors influencing these qualities. A maker often finds it impossible to make the same grade on different days with practically the same run of sap. Therefore to have uniformity the various lots should be mixed into two or more standard grades. A buyer does not know why there are such differences in the product and wants two successive purchases of the same brand to be of the same grade. One may desire the mild, sweet, maple flavor, while another wants a stronger flavor. In order to satisfy these demands and at the same time build up a business, a number of makers could cooperate to ship their products to a certain point and then reship. After many years' trial in Vermont, and more recently in New York, this has been found to be of great advantage to makers.

Selling in large quantities on a sliding scale, depending on color and flavor, is becoming more common. Many organizations and buyers offer better prices for lighter-colored and milder-flavored products, thus stimulating producers to more cleanly methods of manufacture and bringing them more profit. Without this sliding-scale method there is no incentive for making the better grades of sirup and sugar.

There is a distinction between sap sirup and sugar sirup. Maple sap sirup results from the concentration of maple sap, with or without the usual clarifiers, to a standard density. Maple sugar sirup is the solution to a standard density of maple sugar which has come from a further concentration of sap sirup. It is then not correct to label as a sap sirup a product which has resulted from the solution of maple sugar or as a sugar sirup one made from sap. Both are maple sirups. As a rule sap sirups are sweeter, pleasanter to taste, and milder than sugar sirups, and possess a peculiar indescribable property of the sap which is lost when sugar is made and redissolved.

MAPLE SUGAR AND SIRUP PRODUCTION OF THE UNITED STATES.

TABLE 3.—*Maple sirup production of the United States (in gallons).*

[U. S. Census Reports.]

State.	1920	1910	1900	1890	1880	1870	1860
New York.....	1,080,505	993,242	413,159	457,658	266,390	46,048	131,843
Ohio.....	694,175	1,323,431	923,519	727,142	495,839	352,612	370,512
Vermont.....	631,924	409,953	160,918	218,252	128,091	12,023	16,253
Pennsylvania.....	273,762	391,242	160,297	154,650	140,667	39,385	114,310
Michigan.....	206,795	269,093	82,997	197,775	131,990	23,637	78,998
Indiana.....	167,360	273,728	179,576	180,702	242,084	227,880	292,908
Wisconsin.....	138,627	124,117	6,625	48,006	58,012	31,218	83,118
New Hampshire.....	112,824	111,500	41,588	81,997	79,712	16,884	43,833
Massachusetts.....	57,950	53,091	27,174	33,632	13,017	2,326	15,307
Maine.....	42,144	43,971	16,024	71,818	82,006	28,470	32,679
West Virginia.....	23,448	31,176	14,874	19,032	28,696	20,209	.....
Maryland.....	23,155	12,172	5,825	1,021	2,043	374	2,404
Minnesota.....	12,870	17,808	1,079	12,091	11,407	12,722	23,038
Illinois.....	12,114	18,492	9,357	13,978	40,077	10,378	20,048
Missouri.....	12,039	9,389	5,474	8,333	16,244	16,317	18,289
Virginia.....	8,137	6,046	1,677	3,468	7,518	11,400	99,605
Iowa.....	4,915	8,596	2,662	14,413	17,766	9,315	11,405
Connecticut.....	2,866	4,236	948	1,437	2,173	168	2,277
Kentucky.....	999	3,547	2,367	10,468	27,530	49,073	140,076
North Carolina.....	333	404	129	1,142	582	418	17,759
Tennessee.....	275	373	171	1,186	3,688	4,843	74,372
New Jersey.....	143	504	.....	134	334	5	8,088
Total ¹	3,507,745	4,106,418	2,056,611	2,258,376	1,796,048	921,057	1,597,589

¹ The totals include small quantities not reported under individual States.

TABLE 4.—*Maple sugar production of the United States (in pounds).*

[U. S. Census Reports.]

State.	1920	1910	1900	1890	1880	1870	1860	1850
Vermont.....	6,251,734	7,726,817	4,779,870	14,123,921	11,261,077	8,894,302	9,897,781	6,349,357
New York.....	2,012,932	3,160,300	3,623,540	10,485,623	10,693,619	6,692,040	10,816,419	10,357,484
Pennsylvania.....	535,954	1,188,049	1,429,540	1,651,163	2,866,010	1,545,917	2,767,335	2,326,525
New Hampshire.....	329,723	558,811	441,870	2,124,515	2,731,945	1,800,704	2,255,012	1,298,863
Maryland.....	150,957	351,908	284,160	156,284	176,076	70,464	63,281	47,740
Michigan.....	77,178	293,301	302,715	1,641,402	3,423,149	1,781,855	4,051,822	2,439,794
West Virginia.....	73,763	140,060	141,550	177,724	310,866	490,606	.....	.....
Massachusetts.....	73,198	156,952	192,990	558,674	878,793	399,800	1,006,078	795,525
Ohio.....	62,001	257,592	613,990	1,575,562	2,895,782	3,469,128	3,345,508	4,588,209
Virginia.....	38,362	44,976	19,310	26,991	85,693	245,093	938,103	1,227,665
Maine.....	24,934	15,388	5,500	84,537	153,334	160,805	306,742	93,542
Wisconsin.....	22,430	27,199	4,180	128,410	448,837	507,192	1,584,451	610,976
Indiana.....	14,487	33,419	51,900	67,329	235,117	1,332,332	1,541,761	2,921,192
Connecticut.....	5,173	10,207	4,930	8,617	44,092	14,266	44,259	50,796
Missouri.....	5,047	11,638	12,055	20,182	58,964	116,980	142,028	178,910
Minnesota.....	3,146	11,399	29,580	34,917	76,972	210,467	370,669	2,950
Iowa.....	3,130	6,173	2,320	45,120	50,710	146,490	315,436	78,407
Illinois.....	1,436	5,366	4,090	13,260	80,193	136,873	134,195	248,904
Kansas.....	20	40,016	.....	.....	.....	938	3,742	.....
Kentucky.....	2,393	10,697	2,340	11,259	66,535	269,416	380,941	437,405
Tennessee.....	1,872	4,326	1,160	9,167	31,296	134,968	115,620	158,557
North Carolina.....	1,560	3,305	1,180	7,713	4,403	21,574	30,845	27,932
New Jersey.....	29	1,195	.....	210	2,498	419	3,455	2,197
Total ¹	9,691,854	14,060,206	11,928,770	32,952,927	36,576,061	28,443,645	40,120,205	34,253,436

¹ The totals include small quantities not reported under individual States.

**ORGANIZATION OF
THE UNITED STATES DEPARTMENT OF AGRICULTURE.**

October 29, 1923.

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