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Production of Maple Sirup and Other Maple Products

by F. E. Winch, Jr., and R. R. Morrow

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Contents

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A variety of maple products, attractively displayed and marketed year round, enables the producer to profit from the maple enterprise.

Success in Maple Enterprises

Successful maple operations feature some or all of the following characteristics:

- *Good markets with a variety of products packaged throughout the year.* Good markets are the result of nearness to people, good transportation and parking facilities, attractive packaging, fair and adequate pricing for a high quality product, and effective promotion. Year-round packaging and sales distribute work loads, permit better quality control, and provide customers with fresh, clean packages. Light sirup can be blended with some of the darker sirup to provide a more-uniform medium-amber table grade to satisfy more people.
- *High-yielding trees and bushes.* Trees that yield lots of sap with a high sugar content greatly reduce the high fixed costs of tubing. High sugar content also reduces the fuel and labor needed for boiling. Tree yield depends on heredity, thinning for open crowns, region, and exposure. Southern New York bushes often flow better than Adirondack or more northern bushes. Southerly facing, especially southeast, slopes are good. Concentration (up to 100 taps per acre) and volume of taps are also important.
- *Suitable topography and location of physical facilities.* Land with suitable slope, facing generally south toward a few central collecting points, is best for maximum sap flow and ease of collection with a tubing system. The sugar house, with electricity and water, and the access road should be located near collection points.
- *Combination with complementary income activities.* Enterprises that require work primarily in other seasons of the year and that may also attract customers and enhance maple sales are complementary. Christmas tree farming, outdoor recreation such as camping or lease of hunting rights, and dairy or orchard farming activities complement maple enterprises. On the other hand, maple may provide a valuable complement to other income activities for rounding out a total enterprise.

Of all the foods produced in New York, maple sugar, maple sirup, and maple cream are most typically American. About 33 percent of the total United States production comes from New York. These foods, definitely luxuries, are attractive products from which the sugar bush or grove operator can obtain substantial cash return for his labor and investment. A few producers devote full time to sirup manufacture and marketing.

Areas of maple sirup production

Maple sirup and sugar are commercial crops from Maine to Minnesota and in adjacent areas of Canada. More than two-thirds of the United States production comes from New York and New England.

In the United States, a record crop of 6,612,500 gallons of maple sirup was reported in 1860. Since then production has dropped because of high labor and equipment costs and the gradual loss of small farm enterprises. Production in the 9 leading states was 1,076,000 gallons of sirup in 1974. Canadian production has followed somewhat the same trend.

The leading sirup-producing counties in New York are Lewis, Chautauqua, Wyoming, Cattaraugus, Allegany, Delaware, Clinton, Franklin, Chenango, and St. Lawrence. Since 1952, interest in maple production has increased. New bushes have been tapped, new producers have started business, and new marketing techniques have resulted in better income, with an annual crop of maple products valued in excess of $4,850,000 in 1974. Most of the New York crop is sold retail within the state as sirup or sugar products.

Sugar maple trees are so numerous in most parts of New York State (except Long Island) that many good stands are never tapped. Many owners do not tap their maples, and others make maple products of lower grade than this crop deserves. This publication suggests ways in which New York producers may improve their product, *increase* the yield, *decrease* the cost, and consequently *receive a better income from the enterprise.*

The tree

The sweet sap or sweet water from which sirup and sugar are made is common to all the native maples. However hard, rock, or sugar maple, *Acer saccharum* (fig. 1), yields sweeter, more palatable sap and is used for most of the commercial sirup and sugar produced. This vigorous and splendid tree is found in commercial timber quantities from the mountains of the Carolinas to north of the St. Lawrence in Canada. The tree seeds vigorously, is a strong and vigorous grower, and is tolerant of shade during most of its life. It maintains and renews itself for years against competition of other species. As a result of the aggressive characteristics of the species, there are many pure stands of sugar maple in New York.

The tree thrives best on a well-drained site, but it grows under nearly all conditions and on all soils except swamps and bare sandy areas. It grows well on glacial till or rocky hillsides and benches. Climate, crown size, and vigor have more influence on the yield and quality of the sap than has soil.

Black maple, *Acer nigrum,* a form of sugar maple, is found in many parts of New York. It so closely resembles sugar maple that it is usually reported as that species.

Red maple, *Acer rubrum* (fig. 2), ranges from Canada to Florida and Texas. The name refers to the prominent red winter buds and flowers and to the leaf in autumn. The sap usually is lower in sugar content than that of sugar maple, and the tree buds earlier than sugar maple.

Silver maple, *Acer saccharinum* (fig. 3), is usually called soft maple when growing in the woods; in parks and in ornamental work, it is called silver maple because of the white underside of the leaf. The sap characteristics are similar to those of red maple.

Research in many areas has shown that red and silver maple produce only two-thirds as much sap as does sugar maple, and the sap is not ordinarily as sweet. Moreover, there is often more sugar sand, and its early budding may spoil the sap from other trees. Both red and silver maple are found in many sugar bushes with sugar maple; it is advisable to remove these trees from the bush.

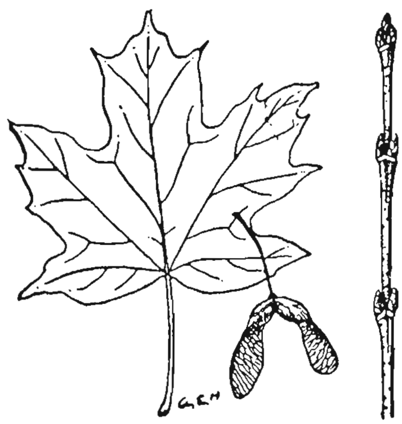

Figure 1. Sugar maple leaf, one-third natural size; fruit and twig, one-half natural size.

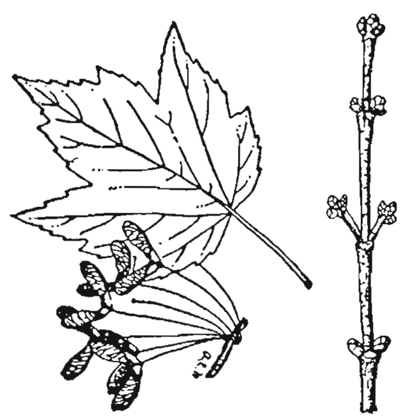

Figure 2. Red maple twig, one-half natural size; leaf and fruit, one-third natural size.

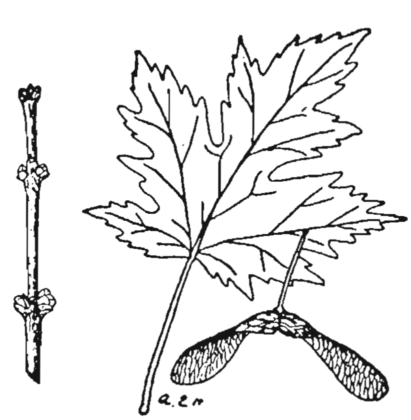

Figure 3. Silver maple twig, one-half natural size; leaf and fruit, one-third natural size.

Where the maple tree gets its sugar

Each green leaf on a maple tree is a factory where water and carbon dioxide are chemically changed into sugar by the energy of sunlight.

A large leaf area exposed to sunlight creates a large amount of sugar. This means, however, that more water is evaporated (as much as 100 tons of water in 1 year from a large tree), and a good soil with an adequate supply of water is necessary. The sugar made by the leaves is used for tree growth and respiration. A little of the newly made sugar is used immediately in the leaf, but most moves out to the branches, stem, and roots. Here part of the sugar is used in the growing points of the twigs and roots, for seed production, and in the cambium for diameter growth. Much of the sugar, however, is changed to starch to be stored for use in tree growth the following spring.

With the coming of cold weather, the starch, which is not soluble in water and cannot move in the sap stream as can sugar, is gradually changed back to sugar. The sugar reaches its highest concentration in late winter and early spring, coinciding with the sap season. When the tree is tapped, some of the sap is taken from the tree. Obviously, only a small proportion of the sugar can be taken without noticeable change in the tree's general health and vigor. About 10 percent of the sugar is normally taken by tapping.

Also present in the tree are certain organic compounds, apparently in the lignin, that contribute to the characteristic maple flavor. In many years, the late-season sap flow decreases notably in sugar content in correspondence with the coming of warm weather and the beginning of tree growth.

Sap flow

Freezing nights and warm, sunny days have long been associated with good sap runs. After a freeze, rising temperatures in living cells initiate and sustain sap pressure. Expecially heavy flows occur when twigs, stems, and root tissues are all warmed. Falling temperatures decrease pressure. During freezing, a vacuum develops to help draw more sap from the roots and ready the next flow.

Sap flow can occur in the fall, but deficient soil moisture may greatly reduce the amount of sap, and sugar content is low. Therefore, tapping is usually limited to late winter and spring.

Relation of sap to sirup

The boiling process develops the characteristic maple flavor and color. Good clear sap, boiled quickly, makes light-colored, delicately flavored, high-grade maple sirup. The same sap boiled slowly for a long period of time makes dark-colored sirup of lower quality. Long boiling of sap at high sugar concentrations (more than 40%) causes a browning, or caramelization, of the sirup. Often this caramel flavor predominates over the true maple flavor. Therefore, it is important to have an efficient evaporating system for both fuel economy and speed of evaporation.

The sugar content of the sap influences the grade of sirup since sweet sap can be boiled down more quickly than can sap with less sugar and a higher proportion of water. The more sugar in the sap, the more and better sirup can be made with the same amount of sap, labor, and equipment. The sugar content of the sap varies from tree to tree, from day to day, and from season to season. A sap hydrometer (preferably a large model that can be read to 0.1%) can be placed in stirred sap to give the sugar percentage after the reading is corrected for temperature. The sirup yield for sap of varying sugar concentrations can be determined from this formula:

$$\text{Gallons of sap per gallon of sirup} = \frac{86}{\text{sap sugar percent}}$$

Two percent sap requires approximately 43 gallons of sap for 1 gallon of standard density sirup; 3 percent sap requires approximately 29 gallons. Average sugar concentration of sugar-bush sap is about 2 percent, and average sap flow is from 10 to 15 gallons per tap hole. Therefore, each tap hole yields approximately 1 quart of sirup in an average year. In years when sap is sweeter and sap flow above average, some producers make more than 2 quarts per tap hole. Efficient boiling methods usually counteract much of the effect of low sugar concentration in making quality sirup.

Good quality sirup depends also on sap that is relatively free of microorganisms (bacteria and yeasts). It is possible to make high-grade sirup until the advent of buddy sap if the microorganism count can be kept low.

Normally, there is little bacterial activity in the cool, early season. With the warm spells of late season, however, the sap spoils quickly unless it is gathered promptly and boiled down the same day. Microbial action helps to break down the normal sap sugar, called *sucrose,* into invert sugar. Sirup made from sap with much invert sugar may be dark in color, low in grade, poor in flavor, and cannot be made into maple cream. Microbial activity, not buddy sap, is the principal reason why low-grade sirup is made by most producers late in the season. It is also the reason sap stops flowing from the tap hole. Bacteria can be controlled by use of chlorine compounds to sterilize all maple production equipment from spile to storage tanks. A sanitizing pellet (paraformaldehyde) can be placed in the tap hole to help control microorganisms. The best remedy is clean equipment, fast handling, and fast evaporation of the sap before the bacteria can take full effect.

THE SUGAR BUSH

The ideal sugar tree

The ideal sugar tree produces a large amount of especially sweet sap which can be gathered and evaporated efficiently. Some trees are inherently sweeter than others. Since sugar is made in leaves exposed to sunlight, the amount of branching is important. Trees with wide and deep crowns, especially when open-grown, have high sugar concentrations (fig. 4).

The amount of sap per tap hole varies more than does sweetness. Sap flow is also affected by heredity and increased by large crowns and open conditions. In addition, large stem diameters and southerly facing slopes favor more sap flow. Daily weather, location of tap holes, wind protection, and elevation are other important factors influencing the amount of sap.

Sugar concentration and sap flow may change from day to day and year to year. However heredity, crown size, and openness change little with time; thus a tree that is sweet one year can be expected to be sweet in other years. A sweet tree tends to remain sweet when compared with its neighbors. The same is true for sap flow. There is also a tendency for sweet trees to flow well.

The ideal sugar bush

Sirup production per acre varies little with tree or crown size (table 1). The ideal sugar tree is efficient mainly because of savings in time, fuel, and equipment needed for collecting sap and processing it to sirup. But with its many branches, it is virtually useless for lumber. Since sugar maple is a valuable lumber tree, to define the ideal sugar bush is difficult. Should it contain the open-grown trees best for sirup production or should it consist of less-efficient forest-grown trees which will yield both sirup and lumber? Probably those trees in accessible locations near the sugar house should be thinned early and often to develop good sugar trees, whereas more remote trees should be managed for timber growth.

In normal years a single tap hole produces 1 quart or more of sirup. The ordinary sugar bush should be capable of producing at least 200 gallons of sirup. This will require 400 to 800 tap holes, the number depending on the size and productivity of the trees. Operators of 1500 to 2500 or more taps are more efficient largely because of savings in time from larger or multiple evaporators and a lower per gallon cost for sugar house and evaporators. Sugar bushes with fewer than 25 taps per acre seldom show profits.

Table 1. Relation of Sirup Production to Tree Crowns
(Mature Trees — fully stocked with sugar maple only)

Crown diameter in feet	18	25	32	40
Crown depth in feet	20	35	45	55
Diameter breast height in inches	13	18	23	28
Sugar percentage	2.0	2.2	2.5	2.8
Gallons of sap per tap hole	10	12	13	15
Gallons of sirup per tap hole	0.23	0.31	0.38	0.49
Number of trees per acre	135	70	40	25
Number of tap holes per acre	135	115	95	75
Gallons of sirup per acre	31	36	36	37

Natural enemies of sugar maple

Sugar maple has few natural enemies. This is borne out by the presence of trees more than 200 years old that have been tapped by axe gashes, hand augers, breast drills, and machines. The following pests warrant consideration, however.

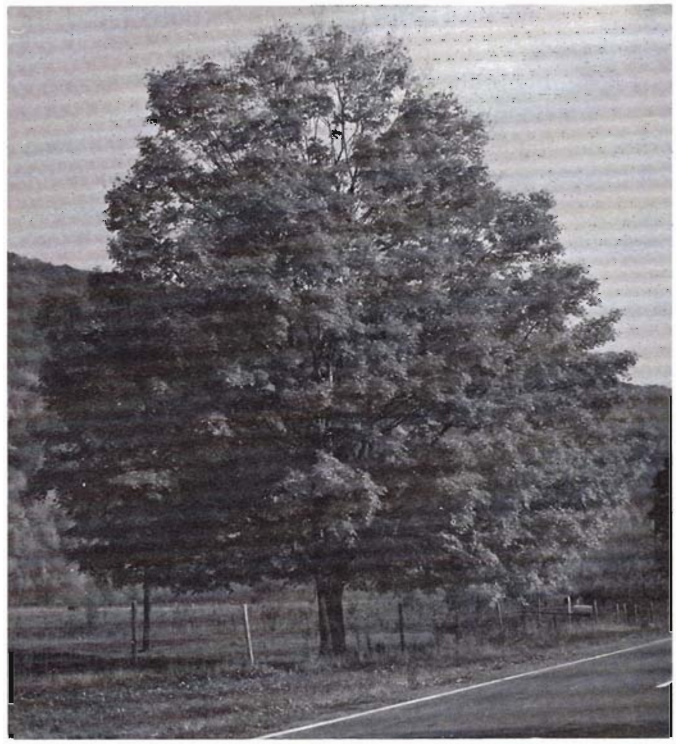

Figure 4. An ideal sugar tree has a wide, deep crown, open to full sunlight for high sugar production.

Forest tent caterpillars are present yearly in nearly all forest stands. In small numbers they cause little damage and are usually overlooked. Occasionally, however, their numbers are of epidemic proportions, and they heavily defoliate the sugar maple. Defoliation reduces the growth and vigor of the tree and causes a drop in sweetness of the sap. If defoliation is severe for 3 years in succession, other insects attack the weakened trees which may die.

Control is essential in such valuable properties as sugar bushes. Local foresters employed by New York State Department of Environmental Conservation can give specific recommendations for control of all insects in the sugar bush. Sap production can be reduced from 50 to 70 percent and quality lowered by defoliation. Outbreaks of forest tent caterpillars should be controlled during the first year of their epidemic.

The sugar maple borer is present in many maple stands in small numbers. Its work is easily noticeable. There are dead areas on the trunks where the bark has fallen off showing a small channel cut into the wood. If this channel completely circles the main stem of the tree, the crown above it dies. This insect prefers sunny warm trunks of the sugar maple and usually appears after outbreaks of the forest tent caterpillar or heavy cutting. It can be controlled by making frequent, light cuts and by maintaining a vigorous crown on the desired trees.

Maple dieback. Reports of maple decline or dieback have become commonplace in recent years. Symptoms include leaf discoloration, early leaf fall, dead twigs, slowed growth, and less sap. They may be associated with earlier defoliations, droughts, or, in the case of old trees, post-logging decadence. A maple canker, prevalent on thin bark in exposed situations, has been linked to late spring frosts, resulting in tissue breaks, through which disease organisms can enter. Roadside trees often suffer from cutting of roots to widen roads or too much salt. In general, the sugar maple is vigorous and, if properly thinned and cared for, long-lived and productive.

Effect of tapping on the tree

A properly tapped maple tree is not seriously injured. The small amount of sugar taken is about 10 percent of the tree's annual production. A hole made with a 7/16-inch bit heals in 2 to 3 years if the trees are fairly vigorous. Large-crowned, fast-growing trees sometimes heal in 1 year. Plugging the tap hole is unnecessary and may delay healing. Large bits make wounds that take much longer to heal and are subject to decay.

A tap hole affects adjacent wood. The sapwood dries out and is killed in a strip equal to the depth of the hole and a little wider than its diameter. The dead wood normally extends 1 to 2 feet above the hole and a shorter distance below the hole. This dead area cannot be tapped until new wood grows over it (fig. 5). For this reason, *only 1 spile should be used per bucket.* The practice of tapping a fresh hole or reaming to renew sap flow after a period of warm weather is not recommended since larger areas of dead wood are produced.

The sanitizing pellet, containing paraformaldehyde, was developed for placement in the tap hole. It reduces microbial growth, lengthens the period of sap flow in warm seasons, and helps upgrade sirup quality. Unfortunately the pellet sometimes damages more wood tissue surrounding the tap hole and delays healing. For this reason, some people prefer less-effective chlorine solutions for sanitizing the tap hole.

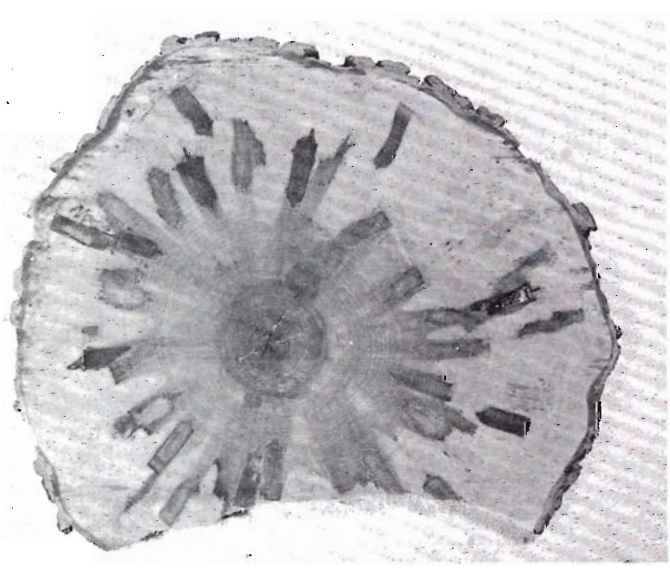

Figure 5. Cross section of dead wood caused by tap holes. Excessive tapping must be avoided; new wood should be allowed to grow over the old wounds before the tree is tapped again in that region.

Size of trees and number of tap holes

Trees less than 9 to 10 inches in diameter at breast height should not be tapped. As trees increase in diameter, more buckets can be hung without serious injury to the tree. However, sap flow may not be greatly increased by adding tap holes. In a test of trees, 14 to 22 inches in diameter, for example, 1 tap hole yielded over 60 percent as much as 3 tap holes per tree.

The following tapping rates are suggested for closed stands and older trees where growth of new wood is typically slow. Heavier tapping is appropriate for fast-growing trees in the open.

Tree diameter at breast height	*Number of tap holes*
10 to 17 inches	1
17 to 24 inches	2
24 to 30 inches	3
30 and over	4

SAP PRODUCTION

Tapping

The best sugar-making months usually are late February, March, and April before the buds begin to swell. Tapping should be done early enough to catch the first real run of sap for the following reasons:

1. Yearly costs of sirup making are influenced most by the total yield of sirup per tap hole. Catching early runs increases the yearly total at little extra cost.
2. The best-quality sap flows early and produces more high-grade sirup. At this time the sugar content is usually higher than in late season, microbial action is very low, there is usually less sugar sand, the sirup made is more suitable for creaming, and flavor and quality are at their peak.

To catch the first good run, a representative test tree in each sugar bush should be tapped early in the season. Start of the sap flow depends on the weather and varies with openness, elevation, exposure, and size of tree crown. Large-crowned trees in the open at low elevations often flow first. All equipment should be ready ahead of time and special attention paid to daily and 5-day weather forecasts as the season approaches.

Tap holes should be made about 6 inches from the nearest visible tapping scar. With a 3/8-inch or 7/16-inch bit, bore a hole slightly upward to allow drainage. Most producers squirt a few drops of chlorine solution or insert a sanitizing pellet into the tap hole to reduce infection by microorganisms. Spiles should be transported in a chlorine solution. Insert the spile at once and tap it in snugly. If driven too hard, the bark may split, and a leaky tap hole results. At the time of the first sap gathering, tap hole leaks can be stopped by lightly tapping leaky spiles again.

Because of the dead wood made by each tap hole, the trees should be tapped on all sides and at different levels from 2 to 6 feet up and down the trunk. Concentrated tapping on the south side year after year produces dead wood faster than the tree can grow new wood over it. In most years, total sap flow is about the same regardless of the side of the tree. In some years, north tap holes yield a little less, but the decrease seldom exceeds 25 percent. South taps usually yield better early in the season, and north taps continue to flow after the south taps cease. For this reason, it may be wise to tap the north sides of all trees in the same year. If tapping has been delayed until the season is well started, it is wise to tap on the north side to get a greater flow.

The use of plastic tubing to collect sap makes tapping more flexible. The stringing of tubing can be done ahead of the expected season though tapping and installation of the spiles should be done just ahead of the expected flow. With plastic equipment there is more flexibility in placing taps on the trunk of the tree.

Drill tap holes to a depth of 2 to 3 inches. There is about 10 percent more sap flow from the deeper tap holes, but more dead wood is made. The producer who bores tap holes by hand will seldom tap more than 2 inches deep. In old trees with little sapwood, care must be taken to prevent boring into the brown heartwood. Heartwood yields no sap, is very susceptible to decay, and may darken the sap.

Gathering the sap — buckets

Microorganisms begin to grow in maple sap at nearly freezing temperatures. Bacterial growth is fairly limited at temperatures below 40°F for a short time, but warmer temperatures increase the growth many times. Therefore, sap from each bucket should be gathered once a day, especially on warm days late in the season. Early in the season, buckets should be emptied near the end of the daily flow to prevent freezing damage to them during the night.

Buckets are emptied, by spinning on the spile, into gathering pails which are carried to the gathering tank. Use a fine-meshed strainer or cloth over the mouth of the gathering tank to keep out leaves, twigs, and dirt. All sap should be hauled to a storage tank outside the sugar house, strained, and evaporated as rapidly as possible. Efficiency should be stressed; 40 percent of the labor of sirup making is charged to gatherings (table 2) when buckets are used.

Rayon filter paper is used as the sap comes from the gathering tank to the storage tank to remove very small bits of debris which may wash in from the bark with rain water. It does not remove the material known as sugar sand. Producers report greatly increased amounts of higher-grade sirup with this preboiling filter.

Ice that forms in a bucket of sap is usually thrown away because it has a much lower sugar content than the sap. Some producers, however, keep the ice to hold down temperatures and prevent bacteria growth when they cannot collect sap every day.

The sap flow is never continuous but is broken into several runs during the season. Between runs, storage tanks should be washed. Several producers have made a practice of washing metal buckets at the time the sap shows bacterial action. Any good chlorine bleach free of detergents can be used.

Table 2. Costs of Producing Sap and Sirup from 64 New York Farms, 1969

SAP COSTS	*Per 100 Taps*	*Per Gallon Sirup*
Sugar bush	$10	
Equipment	32	
Labor	34	
Transport	7	
Other	5	
	$88	$3.50
SIRUP COSTS		
Buildings		$ .43
Equipment		.73
Labor		1.08
Fuel		.35
Containers		.57
Other		.44
		$3.60
	Total Costs	$7.10

MINUTES SPENT PER GALLON	*Minutes* *Buckets*	*Tubing*
Sap		
Opening bush, hanging buckets	8	–
Opening bush, hanging tubing	–	14
Gathering and hauling sap	30	7
Remove, clean, and store equipment	6	6
	44	27
Sirup		
Obtaining fuel	4	4
Evaporating	13	13
Packaging	3	3
Selling	2	2
Preparation and cleanup	2	2
	24	24
Total	68	51

SOURCE: Summarized from *An Economic Study of Maple Sap and Syrup Production in New York State, 1969* by C. D. Kearl, Cornell Agric. Econ. Dept., A. E. Res. 314, 1970. Prices of fuel and metal materials more than doubled in the following 6 years.

Plastic tubing for sap collection

Plastic tubing, introduced in the 1950s, is now commonly used for sap collection in cold as well as warm bushes (fig. 6). Sap from numerous trees flows through tube networks to a common collecting tank. One or more large plastic pipelines can receive sap from numerous tube networks and deliver it to a central location at the bottom of a hill.

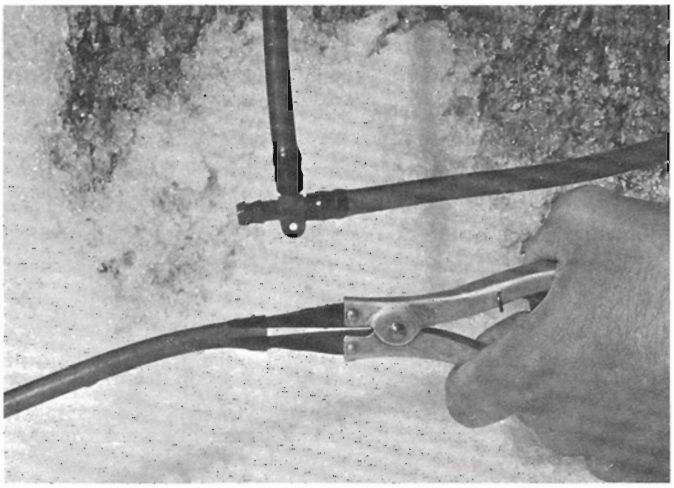

Figure 6a. Special tools have been developed to enable the tubing user to put tubing in place in cold weather.

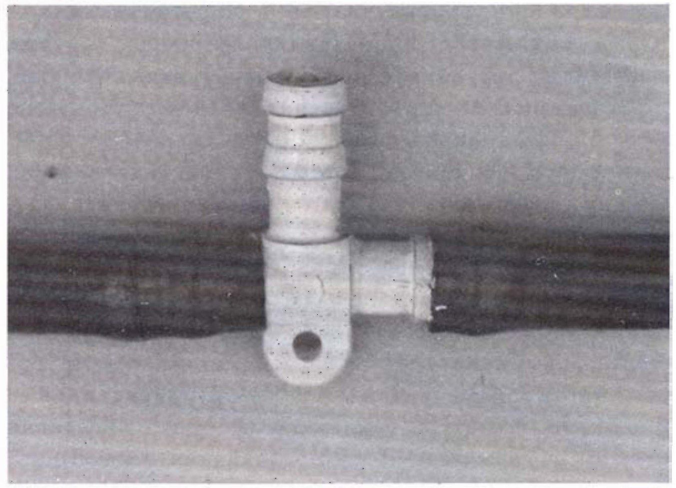

Figure 6b. Tubing must be fitted completely onto the tee; the joint on the *right* may not hold.

Plastic tubing, spiles, tees, and other fittings have been specially designed for the maple industry. Plastic tubes are translucent but have dark coloration to help thaw frozen sap. Black water pipe, which lasts longer than lighter-colored pipe in sunlight, is useful for the larger main pipelines.

Tubing, commonly 5/16-inch inside diameter, saves the hard labor of collecting sap from individual trees. On the other hand, much care and time is needed for proper installation and maintenance. Thus, tubing lengthens the maple work season but eases and distributes the total workload. Other advantages of using tubing include cleaner sap, easy sap collection from steep or rocky areas, reduced need for roads and road maintenance, and less trail breaking in unusually deep snows.

For best sap flows with tubing, observe these guidelines: determine main pipeline sizes according to expected sap flow and slope; permanently install main pipeline on wire, graded and vented; use 15-inch or longer drop lines from spile to tee; run fairly straight tube lines (lateral lines teed in are better than sharp zig-zags); run tubing and pipeline on warm side of large trees or rocks; remove conifers that shade tubing excessively; keep flow records to indicate reduced flows caused by leaks; plan to control squirrels or other rodents which chew tubing, especially in peak population years; use separate vacuum transfer lines, rather than main pipelines, to get pumped vacuum to trees.

To obtain the most sap, you should minimize tube friction and, if possible, use vacuum. Friction between the sap and tube wall can slow sap flow, trap gas bubbles, and cause back pressure. It can reduce sap flow to less than half in 500 feet of tubing on the level but is negligible on a downhill slope of 10 percent. On a 5 percent slope, careful installation to maintain a constant grade greatly reduces friction. On the other hand, the weight of sap in closed, leak-free tube lines on hillsides creates a natural vacuum in the upper tubing. This vacuum, as well as pumped vacuum, causes more sap to flow from the tap hole.

Reducing friction and enhancing vacuum are both aided by nearly constant slopes. It is especially important to avoid too shallow slopes at the bottom of tube lines. Tubes drawn tight in the air between trees are preferable to tubes on undulating ground (the latter must usually be lifted from new snow to thaw) (fig. 7). Trees in depressions are seldom worth tapping. These principles apply to natural vacuum, pumped vacuum, or vented tube lines.

Natural vacuum can increase sap flow about a quart per tap hole for each inch of mean vacuum. This can increase production by as much as 50 percent without noticeable change in quality and with no added equipment. Optimum results occur on 10 percent slopes, during good flow conditions, and with correctly installed tubing. Tests give these guidelines:

15% slope — 100 or more taps per tube line needed for high vacuums (may be difficult to find enough taps)
10% slope — 50 to 80 taps; highest vacuums were found on this slope
5% slope — 40 to 50 taps; more taps may overload line
3-4% slope — probably 20 to 40 taps; difficult to install and maintain even slopes; only limited vacuum possible
1-3% slope — may be impractical to try to obtain natural vacuum

Pumped vacuum can increase sap flow in a variety of circumstances, including adverse slopes and low flow situations (fig. 8). Pumped vacuum can overcome friction on low slopes, suck uphill for short distances, eliminate air locks, and reduce possible sap losses from freezing or reabsorption. However, vacuum used to overcome friction is quickly dissipated and does not increase the flow at the tap hole. Thus few taps and nearly empty tubes are best for pumped vacuum in the absence of good slopes.

Yields of sap from pumped vacuum can be doubled

Figure 7. Tubing drawn tightly between trees eliminates problems with air lock and freezing. Photograph courtesy of U.S. Forest Service, Burlington, Vermont.

Figure 8. Vacuum pump and dumping unit which has proved successful in overcoming friction in tubing lines.

under some conditions, but average gains are usually less. You must determine the point where the cost for added vacuum equipment is not compensated by the value of added sap gains.

Use of *vented tubing* is an alternative to pumping on nearly level land. Figure 9 shows a method developed by Mr. Lloyd Sipple. It is limited to some 30-50 taps per line, requires careful adjustment of tap heights, and can be used with either aerial or ground tubing.

Clean and store tubing immediately at the end of each season. The following procedure is commonly used:

- Disconnect drop lines, with spiles attached, from tees. Tie in bundles and soak in cleaning solution.
- Cap tees, roll 300 to 500 feet of tubing, tag for reinstallation on same trees.
- Pump a weak chlorine solution (5–10% chlorine bleach in water) through tubing, or build a washer that rotates rolls of tubing in cleaning solution.
- When clean, drain and store in collecting tanks (or other dark, rodent-free storage).
- Pump cleaning solution into main pipelines until filled. Drain and plug end openings.

Drying of tap holes

Research shows that tap holes dry up because of microorganisms that infect the spile and the tap hole. As weather conditions favor the growth of microorganisms, they penetrate the cells of the wood and effectively seal off the holes. Reaming does little or no good because the bacteria may reinfect tap holes within 24 hours. Pulling and washing buckets in chlorine compounds and flushing out tap holes with these compounds help to keep bacteria count down.

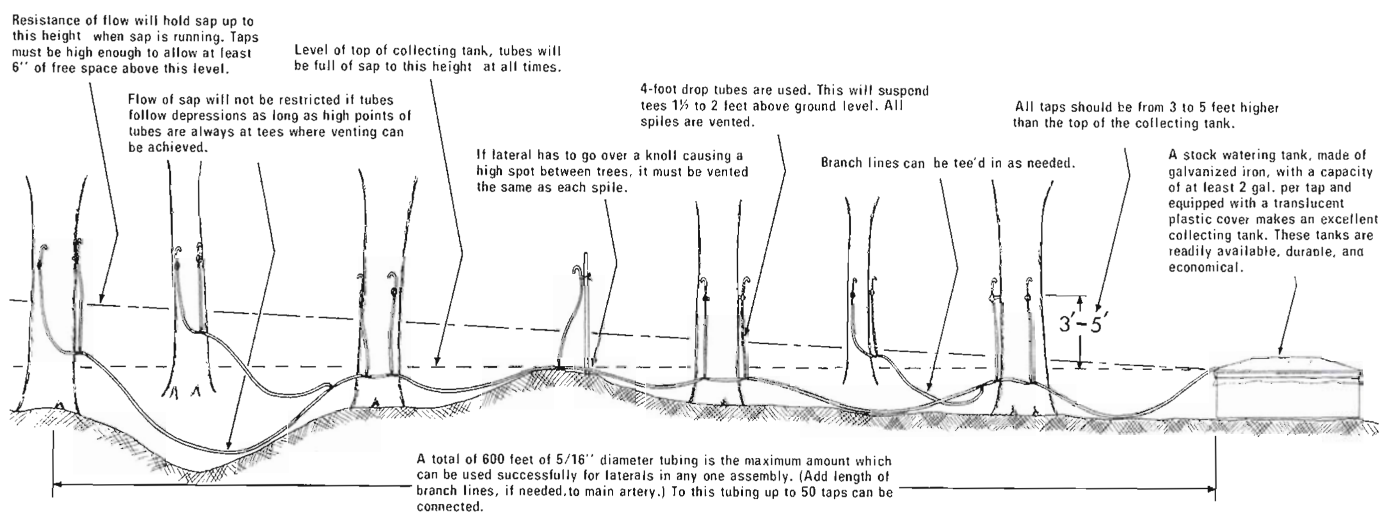

Figure 9. A method of using vented tubing on flat land by building in a gradient. (After system devised by Lloyd Sipple, Bainbridge, New York.)

Sour sap — buddy sap

At the beginning of the season the sap is water white, clear, and transparent. It has a sweet taste and practically no odor. In strong early runs, the danger of microbial action and souring is not great; but when warm weather comes and the flow is intermittent, the bacteria become active. Microorganisms in the sap cause formation of invert sugar, resulting in darker and lower grade sirup. Mucous formation in spiles and buckets is a visible sign of sour sap. When found, clean and scald (or wash with chlorine solutions) the buckets and spiles.

True buddy sap comes during bud swelling and indicates the end of the season. The sap has a very unpleasant odor. Buddy sap is caused by physiological changes in the tree as it starts its spring growth and has nothing to do with the microorganisms of maple sap. Producers who specialize in high quality sirup pull their buckets and spiles before the buds swell.

EQUIPMENT

Below is a list of the more important equipment for sugar making:

- Tapping bits, 7/16 inch in diameter (at least 1/4 dozen)
- Brace, breast drill, or power tapping machine
- Claw hammer or spile tool
- Hand axe
- Spiles or spouts
- Buckets, 14- to 16-quart capacity, and covers
- Plastic tubing
- Gathering pails (in pairs)
- Gathering tank (3- to 10-barrel capacity)
- Plastic pipe (if used)
- Storage tanks (8- to 50-barrel capacity)
- Sap pumps (optional)
- Sugar house
- Evaporator and arch (1 or more)
- Hydrometers (sap and sirup on Brix scale)
- Dial or target thermometers
- Standard maple sirup grading set
- Large flat felt (orlon) filters and filter box
- Rayon prefilters
- Bucket washer or tubing washer
- Finishing pan with gas heater (optional)
- Skimmer
- Tin, glass, or plastic containers for packaging sirup
- Molds, boxes, and glass for maple sugar and maple cream

The equipment described in the following pages costs for new materials from $4.00 to $6.00 for each taphole, but does not include the cost of a sugar house. Most of the investment on most New York farms is in the sugar house, gathering equipment, and evaporator.

A partial list of manufacturers of maple sirup making equipment can be obtained from the Department of Natural Resources, New York State College of Agriculture and Life Sciences, Ithaca, New York 14853.

Hand tapping bit

For a brace, use a coarse-threaded screw-type bit with oval lips. For a breast drill, use the same type of bit with fine threads or a fast cutting type without screw threads. The latter, often called the *bobbin bit* or *wood drill,* is preferred for use in the tapping machine. A 7/16-inch-diameter bit is standard. Two men can hand tap and hang from 500 to 600 buckets per day.

Power tapping machines

Several commercial gasoline tappers are available. Most have a direct drive and are carried in front of the operator (fig. 10). Battery-powered drills are available also, safe, and somewhat slower. Several operators have used adapters on light chain saws to power tapping bits. With any of these machines, a 2- to 3-inch hole, 7/16 inches in diameter, can be bored in a few seconds. Care must be used to drill straight and avoid oval holes. Crews can tap and hang 500 buckets per man per day.

Spiles or spouts

Spiles are made from malleable iron, sheet steel, aluminum, or plastic.

Metal spiles have horizontal or vertical flanges to hold the bucket in place and still close off a minimum number of openings in the conducting vessels cut by the bit. These spiles are made both with and without a hook for hanging the bucket. With the hookless spile, the bucket is supported by the spile itself. Plastic spiles have been developed for either closed or vented tubing.

Buckets

Zinc-coated metal buckets, aluminum, and plastic buckets have largely replaced the old wooden bucket. The 14- to 16-quart sizes are most common. For ease in nesting and separating, it is important that the buckets be humped near the top. Most buckets are slipped onto the spile through a hole near the top; they are easily emptied by spinning on the spile.

Occasionally, operators have used larger (10-gal.) utility cans on free-running trees or in back-lot bushes. Usually such cans, hung very early in the season in remote parts of the bush, are gathered less frequently than normal.

Bucket covers

Bucket covers help make high quality sirup. They help keep out sticks, insects, and dirt; prevent rain, snow, or ice from dropping in; and keep the sap cool and sweet by shading it from the warming rays of the sun. When sap diluted with rain or snow freezes, buckets burst more frequently.

Gathering pails

Gathering pails of galvanized iron, aluminum, or plastic usually have an 18- to 20-quart capacity. Most pails are made with broad bases to prevent tipping and spilling. The new aluminum pails are made with short coupled handles and a recessed base to facilitate dumping. Two buckets are used by each gatherer.

Gathering tank

Gathering tanks are of many sizes, depending on the power used, the distance of the haul, and the number of buckets to be served. For horse-drawn tanks, 3-, 4-, and 5-barrel sizes are most common; on downhill runs and for roadside use with tractor or truck power, 10-barrel tanks can be used. The tanks can be mounted on low skids, wheeled trailers, tractor drawbars, or pick-up trucks. They are equipped with a splash cover; a top strainer for removal of bark, leaves, and other debris; and an outlet pipe.

It is important to augment the built-in metal strainer with several thicknesses of flannel, closely woven burlap, or cotton sacking and to filter sap through rayon filter paper as it is emptied into the storage tank.

Storage tanks

Metal storage tanks are made with a capacity of 8, 10, 15, 20, or more barrels. Size and number are determined by the capacity of the evaporator used and the number of tap holes. The usual requirement is 1 barrel of storage space for every 50 tap holes, which will take care of the usual flow of sap if the evaporator is kept going. Tanks should be adequately supported on the cold side of the sugar house above the evaporator and covered with a tight roof or with clear plastic. Rapid multiplication of bacteria and fermentation of sap may occur in tanks in warm locations. Ideally, the storage should be on the north or east side, above the level of the evaporator but below the road to permit the sap to flow directly into the storage tank and on to the evaporator.

Sometimes sap must be held over for short periods. Many bush operators use insulated glass-lined milk tanks, iron tanks sunk into the ground, or underground reinforced-concrete tanks lined with sheet plastic to hold sap. Provision must be made for access into these tanks and for water to scrub and flush them between runs. Added control of bacteria can be obtained by the use of ultraviolet lights over the sap storage. Care must be taken to shield workers' eyes from such lights or arc burn may result.

If gravity cannot be used to move sap in and out of storage, small electric- or gasoline-powered motors pump the sap to the right level.

Sugar house

The sugar house is used as a promotion and sales center as well as a processing plant. As such, it must be near the road, with electricity and running water available, yet as near the sugar bush as possible. With the use of pipe lines or tractor-drawn tanks or trucks to collect sap, an increasing number of producers are bringing the sugar house out of the woods.

For efficient production and for protection of equipment during idle months, the house should be well built with tight sides and be placed on an adequate foundation. Pole-type houses may save construction costs. Adequate drainage, concrete floors, and water for flushing are important. Light from both windows and electricity should be available. Allow plenty of working space around the evaporator and space for work benches, filters, packaging, and storage. Adjust the height of the evaporator and work benches to make the job easier (fig. 11). Space should be allowed for expansion.

A permanent stack or chimney of brick, cinder, or concrete blocks is more economical than a metal one because it neither rusts nor has to be put up and dismantled yearly. The stack should extend well above the building to insure a good draft. Most users report that permanent stacks are shorter than metal ones. Manufacturers recommend that the metal stack be twice as tall as the evaporator is long.

Many producers add a sugar room or sales room to the sugar house to save time and labor in the manufacture and sale of products. These rooms need not be elaborate; but water, electricity, and cleanliness are essential.

Figure 10. The light chainsaw can be adapted to tapping. It is fast and durable.

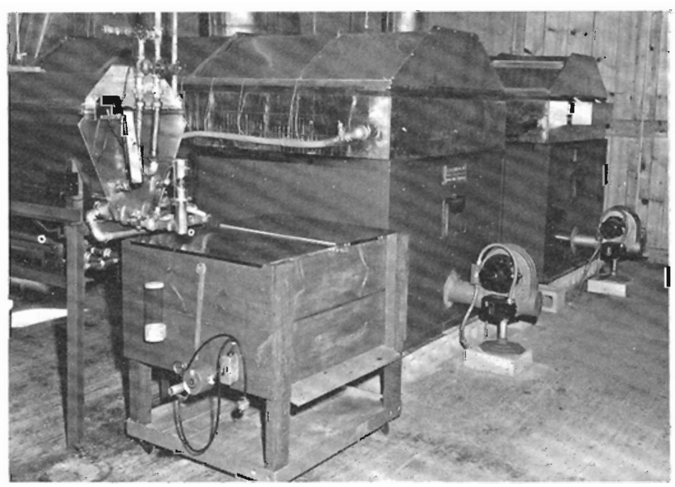

Figure 11. This modern sugar house has been planned for a progressive evaporation system with automatic draw-off in a steam finishing pan and good filter arrangement. Sirup is handled by pumps from the filter.

If wood is to be the fuel, there should be adequate space adjoining the sugar house to store a standard cord (4 ft by 4 ft by 8 ft) of fuel wood for every 60 to 80 tap holes. The space should be roofed but need not be tightly sided. Store wood under cover for at least 9 months to dry it enough for a hot, fast fire (fig. 12).

Evaporators

The earliest evaporators were bark vessels into which the Indians dropped hot stones. These gave way to open kettles, which were supplanted by flat pans. Each method is slow and, under most conditions, produces an inferior product because the long boiling of the half-concentrated sap caramelizes and darkens the sirup. Many old-timers can truthfully say that modern sirup is different from most sirups they knew as boys. From this, too, arises the request for first-run sirup; under the flat-pan technique, the pans were clean, the sugar unscorched, and the early-season sirup more truly maple flavored.

Modern evaporators, still undergoing change, are designed to reduce sap to sirup with the least possible loss of time or waste of fuel. Flues in the bottom of the pan give more boiling surface and cleverly arranged, narrow partitions conduct the sap from one end of the evaporator to the other in a gradually thickening flow. Fireboxes and flues have been improved and are adapted for modern oil fuels.

Nearly all evaporators now used in New York State are of English tin plate. Folds and bends in galvanized iron do not stand up well when subjected to high temperatures. Copper and stainless steel are sometimes used for the flat-bottomed sirup or finishing pan.

In estimating the capacity of the modern large flue-type evaporators, use the following formulas: 1 square foot of flue-type bottom is capable of evaporating sap of average concentration (2%) at the rate of 2 gallons per hour when proper fuel, draft, and ventilating conditions are met. Also 1 square foot will accommodate about 15–20 tap holes. An evaporator, 3 by 8 feet, with 24 square feet of heating area, evaporates about 50 gallons of sap per hour and can handle the sap from about 400 taps. Faster evaporation is possible with more fuel input, but the pans have a shorter lifetime.

With many fuels, efficiency tends to drop with larger evaporators. Evaporators exceeding 14 feet in length are not recommended. In larger operations of 2000 to 10,000 taps, added flue-type sap pans are most efficient. One operator runs sap through a series of four 5- by 10-foot sap pans before it gets to the sirup pan, quickly eliminating most of the water. In the sirup pan, the condensed concentrate is rapidly made into sirup of high quality. The extra sap pans can be automatically controlled and need little supervision. One man can run the operation, devoting most of his attention to the sirup pan.

Tight covers for the evaporator are used for steam elimination from the sugar house. Aluminum covers, with a steam stack, conduct the vapor through the roof. Steam is eliminated, the sugar house is kept warmer, boiling is faster, and skimming of the pans is nearly eliminated.[1]

A preheater, which makes use of exhaust steam to heat incoming sap, can be built as an integral part of the evaporator cover. Essential features include several lengths of copper tubing (usually 50 ft. or more of 1-in. pipe), cover or hood designed to *concentrate* the steam as it passes the copper tubing, a drip ledge to collect and discharge condensed liquid outside the evaporator, and a stack damper to control steam discharge. The diameter and length of tubing depend on evaporation rates and elevation of the sap storage tank. A properly designed preheater can save some 15 to 18 percent on fuel and evaporating time.

Other evaporator equipment

Other equipment is essential for the manufacture of good sirup. A thermometer is most useful to check the sirup for standard density in the evaporator. The boiling point of standard sirup (a 66% sugar solution) is 7¼° F above the boiling point of water. Although 212° F is considered the boiling point of water, it varies with the elevation above sea level and the barometric pressure at the time. Thermometers must be calibrated several times a day to allow for barometric change. Two general types of thermometers allow for calibration: one is the target thermometer which is used inside the pan and is difficult to read when steam is rising. The more accurate dial type is easier for the operator to read because it is mounted through the pan and can be read outside the steam. A typical installation is shown in figure 13. Newer, mercury-column, right-angle thermometers, used like the dial thermometers, are preferred. With these it is well to calibrate for the boiling point of water, record it, and add the desired boiling point to obtain the drawoff temperature. Because these thermometers read to ¼ degree, accurate density can be obtained.

Automatic draw-offs also are available commercially. These are best used when sirup is held for later finishing in gas-fired batch pans. The use of a finishing pan allows the work load to be spread out, more careful density control, and mixing of early- and late-season sirup for a more uniform product.

Hydrometers can be used, preferably the Brix scale which reads density directly. When cold sirup (68° F) reads 66° Brix, it is 66 percent sugar. Slender-necked hydrometers read more accurately than thick-necked ones. Hydrometers must be corrected for temperature when testing hot sirup.

Other evaporator equipment includes a skimmer for removing impurities and a dipper to add sap to the pan if the level gets too low.

1. Plans for covers for evaporators can be obtained from the Extension Forester, Department of Natural Resources, New York State College of Agriculture and Life Sciences, Cornell University, Ithaca, NY 14853.

Figure 12. The best sirup is made when evaporated rapidly. Dry wood stored under cover for at least 9 months enables the operator to process rapidly.

Figure 13. The dial thermometer is easily read as is the right angle thermometer. This operator is drawing off at 5½°F above the boiling point of water to filter and finish in a gas-fired finishing pan.

Filters are essential if the product is to be of table grade. In most large operations, flat felt squares on a flat hardware cloth support enable rapid filtering. Within the last few years, new orlon felts that are superior to the wool felts have become available; these cannot impart off-flavors to sirup. Rayon prefilters, used above the felts, remove most of the sediment and hasten filtering by prolonging the period between washing the felts. Boot- or hat-type felts also can be used but are slower and require a larger investment to filter the same quantity of sirup. Filter cans should be arranged so that hot sirup (180°F or more) can be packaged direct from the filter.

Standard permanent grading sets permit sirup to be classified at official New York table grades, light amber, medium amber, and dark amber.

MAKING SIRUP[2]

Preliminary preparations

Cleanliness and speed are two requisites for the manufacture of table-grade sirup. These must be applied to the entire operation from gathering to canning or bottling if a light-colored, true-maple-flavored product is to be produced. It is desirable to boil the sap to sirup within 24 hours after the sap flow.

Before the season, every utensil of the sugaring outfit, from spiles to evaporator pan and filter tanks, should be scrubbed and sanitized. Many operators sterilize spiles, buckets, and gathering tanks with the chlorine compounds commonly used in the milk house. When buckets are used, roads should be broken through the bush along trails laid out to keep carrying distances to a minimum. Collection tanks for tubing systems should be located at roadsides for easy pickup. Glass, plastic, or tin containers for sirup products should be ordered long before tapping so that they will be at hand when the season opens.

2. The chemistry of maple sirup is complicated. Each producer should consult the *Maple Sirup Producers Manual,* by C. O. Willits, U.S. Department of Agriculture, Agriculture Handbook 134, reprinted March 1971.

Fuel

The evaporator previously described is designed for fuel that is burned in the fire box of the arch with heat applied to the bottom of the evaporator pans. Wood is a common fuel although a combination of wood and soft coal, used crankcase oil, and fuel oil is commonly used. Fuel oil is common where wood, labor, or a combination of the two is difficult to obtain. Research is now under way to use chipped wood for fuels in evaporators.

Wood

Wood is the most practical fuel to use in New York because supplies are ample, unlike those of oil. No better use can be made of thinnings from the young bush or of cull or weed trees in the mature bush than as next season's fuel supply. If the work is done at odd times during the sugar season or earlier, the cost is insignificant and the benefits are great.

For every 60 to 80 tap holes, 1 standard cord of well-seasoned wood should be available at the start of the season. Green or wet wood is unsatisfactory. During the average season, a standard cord of seasoned wood makes from 20 to 30 gallons of sirup in a modern flue evaporator. When green or wet wood is used, evaporation is slower, sirup will be of poorer quality, and more fuel will be used.

Crankcase oil

To use crankcase oil, drill holes in both sides of the evaporator arch just below the pans. Place a 1/2-inch pipe, with small holes bored at intervals along the lower side, in position and connect it with a drum of filtered oil set to provide gravity feed. Dripping oil from the holes onto the wood fire maintains a steady heat. Because the holes may become carbonized, have several sections of pipe as replacements. Recently, commercial oil burners that use old crankcase oil have proved successful; fuel of this type is low in cost and high in British thermal units. Several producers have also used pumps with oil burner nozzles to add such oil under pressure to wood fires.

Fuel-oil burners

Commercial oil burners have been installed in many sugar houses. These burners are most useful if large amounts of sap must be handled rapidly or if labor is unavailable or too expensive to cut fuel wood. The usual installation is made only where electricity is available and where oil trucks have access to the sugar house. Installation of oil burners is not always simple. The placing of the units, the arrangements of the fire brick within the arch, and the location of the draw-off valve for finished sirup must be considered.[3] Oil-fired evaporators have a constant uniform boiling with excellent control of heat which can produce better quality sirup. Oil is not cheaper than wood; the usual installation produces 1 gallon of sirup with 3 to 4 gallons of fuel, the amount depending on the sweetness of sap; as a rule of thumb, 1 gallon of number 2 fuel oil evaporates 10–12 gallons of sap. In larger operations, oil may be a cheaper fuel because the need for a stoker is eliminated.

Steam

Steam, an ideal heat because there is little danger of burning the sirup, is a rapid way to produce high quality sirup. If a stationary boiler of adequate size can be obtained, the cost of pans and evaporator is low. The partly evaporated sap in the large, deep pans is drawn off into a smaller, deep, finishing-off pan and brought to standard density. This procedure assures a uniform product. Steam finishing pans are fairly common and are a useful addition to an operation where steam can be used in the manufacture of sugars and other products.

Starting the evaporator

Like the spiles and buckets, the evaporator must be thoroughly clean before operation is started. To clean the evaporator, one can boil water in it and scrub it thoroughly. Tinned or copper evaporators can be cleaned by filling them with a weak, warm solution of sulfamic acid and allowing it to stand for an hour or two (galvanized iron is badly corroded by this acid and should not be treated in this way). The weak acid partially dissolves the sediment so that it can be scrubbed off while water is run through the pan. The pan must be well rinsed before it is filled with sap.[4] Less fuel is needed when soot has been removed from under the pans.

Before starting the fire, the intake from the storage tank must be adjusted to flow freely. The siphons must be working and the bottoms of the pans covered with sap from 1 to 2 inches deep. More depth prolongs the period of concentration and makes the product dark; too little depth may result in scorched sap, damaged pans, and a difficult cleaning job. As the sap boils, that in the sirup end of the pan should be dipped back to the inflow end of the sirup pan until sirup of the desired density is flowing into the outlet. In the meantime, impurities, which constantly rise in open-pan evaporators, should be removed with a skimmer. Every effort should be made to keep the house and the surroundings clean.

At the end of boiling, the evaporator should be cooled and held partly full of sap or water. First drain most of the partly boiled sirup from the sirup pan into pails or milk cans. Then flood the pans with sap while the fire is hot, taking care that the pans do not boil dry. Skim the surface of the sap before leaving it overnight. If freeze damage may occur, drain all sap after the evaporator is cooled. In the morning the bottom of the pan will be covered with a deposit. Unless this is scraped and the sap is stirred before the fire is built, heat will cause the deposit to stick to the bottom of the evaporator. Part of the sediment can be skimmed as it rises during boiling; the remainder will run out with the first few gallons of sirup. Most evaporators are constructed so that the flow is reversed daily; this reversal helps to clean the pans. Each morning, start the evaporator with care to keep the pan from burning dry and to insure a steady flow from the sap intake to the sirup drawoff. It cannot be emphasized too strongly that care must be taken to keep the pans clean. Dirty pans are the cause of much low-grade sirup.

Boiling sirup

During the evaporation of sap to sirup, the point at which standard sirup is reached can be measured by either a thermometer or a hydrometer.

In using a thermometer to determine the temperature of the boiling point of the sirup, one must read carefully and accurately the temperature at which water (sap) boils and add 7¼ degrees to this, because the sugar in standard sirup raises the boiling point of the sirup approximately 7¼ degrees above the boiling point of water (sap). It is necessary to test the temperature of boiling water (sap) at least twice a day in the sugar house since the boiling point of water changes with variations in barometric pressure. Measure sap temperature near the intake where rapid boiling occurs. The target and dial thermometers described on page 12 make it easy to adjust temperatures for the changes caused by variations in atmospheric conditions and differences in elevation.

For testing boiling sirup, the hydrometer is more troublesome than a thermometer. One must draw from the evaporator a cylinder full of sirup and float the hydrometer in it. If the drawn-off sirup has not cooled to less than 211° F, the hydrometer reading for standard sirup is 59.3° Brix. *Thermometers should be used in conjunction with hydrometers so that corrections can be made.*

Standard density sirup contains 66.0 percent solids as sugar. Sirup of less than 65 percent density is likely to

3. A pamphlet on oil-burner installation is available from Eastern Utilization Research Branch, U.S. Department of Agriculture, Philadelphia, PA 19118.

4. Refer to *Scale in Maple Sirup Evaporators,* by J. C. Underwood and C. O. Willits, U.S. Department of Agriculture, Agriculture Information Bulletin 203.

ferment and sour; that which contains more than 67 percent may crystallize. The best sirup contains 66 to 67 percent sugar. A gallon of sirup, 231 cubic inches of volume at 68° F, weighs approximately 11 pounds. Standard sirup cannot be guaranteed by weight measurements in the can since cans are not uniform in size and often hold more than 231 cubic inches. Below are boiling points and sugar percent comparisons.

Brix 65.5	boiling point +7°F	Baume 35.3
Brix 66.0	boiling point +7.1°F	Baume 35.6
Brix 66.5	boiling point +7.3°F	Baume 35.8
Brix 67.0	boiling point +7.5°F	Baume 36.0

For greatest accuracy in determining standard density sirup a gas-fired or steam finishing pan should be used. Sirup is drawn off at about 5°–7° F above the boiling point of water, filtered, and then finished, by the batch, to 7¼° F above the boiling point of water. When batches of 7 to 20 gallons are finished at one time, hydrometer and temperature readings are easily made for the batch as a whole.

Filtering the sirup

Heavy felt filters (page 13) have been largely adopted as the standard method of eliminating malate of lime, sometimes called nitre or sugar sand, which is present in all maple sirup. A filter is placed over a filter tank, and the hot sirup is run through directly from the evaporator. The amount of sirup that can be run through a filter depends upon the amount of sugar sand in the sirup, the density of the sirup, and its temperature. Some operators have to change the boot-type filters with every 3 to 4 gallons filtered; others filter as much as 10 gallons of sirup without a change. It is always best to have 3 or 4 filters on hand. Large flat felts are more efficient and cheaper. The same surface of the filter *must always be placed up.* Before the filter is placed on the filter stand, it must be thoroughly soaked in boiling sap if it is to function efficiently. Hot sirup filters best, and the filtering area should be protected from cool drafts. A cover fitted over the top of the filter tank helps to retain the heat necessary for a quick job of filtering and prevents further evaporation. New filters should be thoroughly boiled in water to remove any impurities. The new orlon felts have proved better than wool.

A prefilter of rayon pressed cloth or some similar material, supported over the felt filter, takes care of heavy sludge; the filters then do not require as frequent changes and washings.

When filters become clogged with sugar sand, they are removed – the boot type turned inside out – and washed thoroughly in a bucket of boiling water or sap. When thoroughly cleansed, the filter should be turned back to its normal position and the excess water squeezed out. For the best results, an old-fashioned hand wringer is recommended. *Wringing by hand tends to strain the fibers of the filter and shortens its period of usefulness.*

Canning

Canning sirup while hot is the logical sequence to the use of felt filters. A tap placed in the bottom of the filtering can permits canning while the temperature is still above 180° F; a sterile package is thus assured. The container is filled to contain the correct volume of sirup, and the cap is screwed on tightly. Contraction from cooling leaves a partial vacuum at the top of the container. The cans should be set apart so that they will cool rapidly and further coloration of sirup is not caused. Use of a finishing pan permits reheating and canning at any time.

Though sirup can be canned cold, such sirup is not a satisfactory commercial package and must always be stored at uniform temperatures. Sirup canned cold will undoubtedly keep if the container is properly filled with sirup of correct density and the caps are screwed on securely. In cold canning, the container should not be filled to the top since then no room is allowed for expansion should the sirup be stored in a warm place. In tin cans this expansion is often taken care of by bulging of the sides of the can; but glass containers have no possibility of such bulging, and the glass bursts. *Never can cold sirup for shipment or for sale in stores.*

Testing cold sirup

The hydrometer is the best instrument for measuring the density of cold sirup. *The best hydrometer now being used employs the Brix scale,* which tells the amount of sugar present in direct readings. Most hydrometers are standardized at 68° F. If the sirup tested is at some other temperature, either above or below 68° F, a correction must be made by adding to or subtracting from the observed reading (the point at which the hydrometer floats in the sirup). The correction is approximately 0.4° Brix for each 10° F above or below 68° F. Add the correction to the hydrometer reading when the temperature is above 68° F; subtract if below 68° F. For further discussion of measurement of sugar content in sirup, consult the publication *Measuring the Sugar in Maple Sap and Sirup* by Willits, Frank, and Underwood, Agricultural Research Service, U.S. Department of Agriculture, Philadelphia, Pennsylvania 19118. In any case, when testing sirup with a hydrometer *always* use a thermometer to enable you to make the proper corrections.

OTHER MAPLE PRODUCTS

Jack wax, soft sugar, maple cream

Delicious food products are provided when the temperature of sirup is raised from 18 to 24 degrees above the boiling point of water. If the sirup is poured at once over snow or cracked ice, a chewy sweet called *Jack wax* is the result. With pickles and a fork for twirling up a layer of wax, the makings of a jack-wax party are at hand.

If the sirup is stirred for a few minutes after it is removed from the stove, it soon crystallizes and can be poured into molds or containers. Each degree higher the sirup is allowed to boil, the stiffer the soft sugar becomes.

If the sirup is poured hot into a flat dish, allowed to cool rapidly to 60° to 70°F, and then stirred continuously for 10 to 20 minutes, maple cream will result. This product, a fondant-like product, is made up of microscopic-sized crystals covered with a thin coat of saturated liquid sirup. This gives a smooth, nongritty texture. The demand for this product is very great. Maple cream is made by using high-quality sirup, low in invert sugars, and boiling it to a temperature of 20° to 23°F above the boiling point of water. It is then poured into pans in which it will be stirred and rapidly cooled by setting the pans in a running cold water bath to 70°F or, better, 60°F. Then the sirup is stirred, preferably mechanically, in a room at 68°F or above. It will first become fluid, then begin to stiffen and tend to set, and later lose the shiny appearance on the surface. It is then ready to pour. The process can be hastened by seeding with a teaspoon of previously made cream for every gallon of cooled sirup used. This is added after stirring has begun. The product can be packaged in glass jars and plastic or waxed-paper tubs. It should be stored in cold rooms, refrigerators, or freezers.

Maple sugar cakes

After maple cream, soft maple sugar candies are most popular. The sugars are slightly stiffer than cream and about 8 pounds of cakes can be made from 1 gallon of maple sirup.

Cook the sirup to a temperature 25°F above the boiling point of water. Cool the cooked sirup slowly in pans to a temperature of 155°F; then stir the sirup with a wooden paddle by hand or mechanically. While it is still semi-liquid, the sugar can be poured into rubber molds of various shapes and sizes. Cakes formed by pouring are more attractive than those made by packing. The end of each batch can be placed in blocks for larger soft sugar cakes.

Package the sugar attractively in moistureproof coverings.

Hard sugars

There is still a demand for hard, crystalline, crunchy maple sugars which are usually sold in blocks. This sugar can be made by boiling the sirup from 26°F to 28°F above the boiling point of water, cooling to about 150°F, and then stirring to form large crystals. Afterwards it is poured into block molds. Block sugar is one of the most easily stored and shipped maple products.

Maple confections

Maple cream forms the base for the manufacture of a wide variety of confections. If one has attractive molds available, it is worthwhile to make pure maple cream or fudge in different shapes and to sell it in dainty packages. Nuts also can be added, either chopped or in halves, on the top of the molds. Many maple sugar producers have found it profitable to cater to the tourist trade by direct sales at roadside booths or to build a mail-order business through advertising. While sirup, as well as sugar, is often sold, such business rests essentially on high-grade maple sugar. When other products such as nuts or chocolate are added to maple sugar, it becomes a confection and as such is taxable under sales tax laws in New York.

Maple whip is a new product similar in many ways to maple cream. A proprietary additive is used to give the product lightness and volume. Standard density sirup is weighed and to it is added 1 percent by weight of Myverol. The sirup is boiled until it reaches 17°F above the boiling point of water. It is then cooled to 145°F and beaten at high speed for up to 15 minutes depending on the amount of inverts in the sirup. The volume is increased by the rapid beating. The product is then packaged for use as a topping or frosting.

In making these confections from maple sirup, an accurate large-scale thermometer is necessary. As soon as the sirup is put on the stove to boil, this thermometer is calibrated by placing it in a pan of boiling water.

Packages for sirup and sugar

Only the producer's ingenuity limits the type of package chosen for maple products. Lithographed or plain tins, glass jars or bottles, plastic containers, wooden or tin pails, paper cartons or confectionary boxes are all used.

The producer who prepares sirup for local trade or home use usually packs in the large, family-size package – the gallon tin. For more distant markets, for sale at the roadside stand or in stores, smaller packages of tin, plastic, or glass have increased the gross sales during recent years. Studies of marketing techniques show that these smaller packages have more buyer appeal. Pints, quarts, half gallons, and intermediate sizes all have their place depending on market demand.

The principal advantages of tin are its ease of packing for shipment and ready availability. Its disadvantage is that it rusts easily. Glass is in demand both by the buyer and the producer because it permits the buyer to see the product and the producer to use a distinctive, individual label. Plastic is reasonable in price and can be packed for shipment. Most sirup containers now come with inner seals to preserve the quality of hot-packed sirup. All containers have definite limitations on storage. This is especially true of some plastics. For keeping sirup for more than a year, glass containers stored in a cool, dark place have proved best.

Colorful, attractive labels for glass or tin sugar containers and plastic or paper cream boxes can now be obtained with the producer's name and address prominently displayed.

Consult the New York State Department of Agriculture and Markets, Albany, or the New York State Maple Producers Association, Bainbridge, New York, for information on grading and labeling requirements for maple sirup.

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