The Production of Maple Sirup and Sugar in New York State
G. H. Collingwood, J. A. Cope, and M. P. Rasmussen

Gathering sap in a New York sugar bush

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Figure 1. Number of maple trees tapped, by counties, in the principal sugar-producing states

From the report of the United States Census, 1919

LEGEND

1 - 10,000
10,001 - 100,000
100,001 - 250,000
250,001 - 500,000
500,001 - 750,000
750,001 - UP
THE PRODUCTION OF MAPLE SYRUP AND SUGAR IN NEW YORK STATE

G. H. COLLINGWOOD, J. A. COPE, AND M. P. RASMUSSEN

Maple syrup and maple sugar are American foods—distinctly in the luxury group. As such they present increasingly attractive opportunities for the owner of a sugar grove, or "bush," to obtain, at a time of year when other farm work is not pressing, a substantial cash return for labor and investment.

Within New York State, with the exception of Long Island, the sugar maple is generally distributed. So common, in fact, is this tree that many splendid groves of sugar maples are never tapped. Also, many farmers make syrup or sugar that is not the high-grade and high-priced product which their efforts deserve.

It is the purpose of this bulletin to help New York State farmers to decide whether the manufacture of maple syrup and sugar will give a profitable return on their land, time, and investment. Furthermore, the bulletin presents information concerning the various steps in the manufacture and the distribution of maple syrup and maple sugar for those farmers who regularly tap their sugar groves or who are contemplating this enterprise for the first time.

ECONOMIC IMPORTANCE OF THE INDUSTRY

MAPLE-SUGAR PRODUCTION IN THE UNITED STATES

Maple syrup and sugar is a commercial crop in the northeastern parts of the United States (figure 1) and the adjoining regions of Canada. Only a little is made south of the Ohio River and that is largely in the higher slopes of the Appalachian Mountains. That which is produced west of the Mississippi River is largely limited to part of Minnesota and the Ozarks of Missouri. More than 70 per cent of the total production of the United States comes from New York and New England, and at least 33 per cent of the total comes from New York.

In the United States a record crop of 52,900,017 pounds\(^1\) of maple sugar was reported in 1860. Since then the amount has fluctuated from 1,000,000 to 15,000,000 pounds below this, but in 1900 it fell to 28,381,658 pounds. Stimulated by patriotism and the high price of white sugar which accompanied the World War, the production rose in 1918 to 52,512,977 pounds. Since 1918, owing to the decline in price of white sugar, the production of

\(^1\) Sirup has been reduced to sugar at the rate of 8 pounds to 1 gallon.
maple sugar has been comparable with that established before the War. The last record available is for 1930 when the United States production was 20,070,000 pounds of sugar.

The relative position of the principal sugar-producing States since 1850 is shown in figure 2. In 1850 the three leading States were New York, Vermont, and Ohio. During the succeeding decades these States shifted their relative positions, but always the three held the lead.

MAPLE-SUGAR PRODUCTION IN NEW YORK

The principal sirup-producing counties of New York in the order of their volume production are (1) St. Lawrence, (2) Lewis, (3) Chautauqua, (4) Cattaraugus, (5) Delaware, (6) Allegany, (7) Franklin, (8) Wyoming, (9) Cortland, (10) Jefferson. In 1930, more than 30,000 gallons of sirup was produced in each of these counties, as shown in figure 3, and the total production for the ten counties was in round numbers the equivalent of 450,000 gallons, which is approximately 70 per cent of the total production (650,000 gallons) of the State in that year.

These figures, from the 1930 Census of Agriculture, are in sharp contrast to those for the preceding decade, when practically double this amount, or 1,332,125 gallons, was produced.

This sharp decline in volume production over a ten-year period may be directly laid to low prices for maple sirup. During the closing years of the World War very high prices were received, and the production reported in the 1920 census for the crop year 1919 is probably an all-time high for New York State. In the early twenties, prices for maple sirup dropped to an
excessive low, so that many farmers refused to tap, and others actually sold the sugar bush to the lumberman for "last block" stock, basket veneers, or flooring. Prices were on the up grade by the time of the mid-decade census, so that production for 1925 was reported as 1,274,000 gallons. The closing years of the decade, bringing with it the depression, were directly reflected in the maple-sirup production. Never since 1850 has the volume production been as low. The forth-coming census (1935) should show a decided increase in the quantity of sirup produced.

**Maple-Sirup and Sugar as By-Products on the Farm**

Maple sirup and sugar are produced during a period of from four to six weeks in the early spring and interfere but little with the other farm crops. The sugar season usually forms a welcome break between the comparative

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**Legend**

- **0 - 1,000** gallons
- **1,001 - 10,000** gallons
- **10,001 - 20,000** gallons
- **20,001 - 50,000** gallons
- **50,001 - 40,000** gallons
- **40,001 gallons and over**

**Figure 3. Sirup Produced in New York, by Counties, 1929**
idleness of winter and the early spring plowing. It comes at a time when little else can be done. But after considering the long hours of tending the evaporator and the work of gathering the sap, many a man has asked himself if the results are worth the effort.

Most of the producers of maple sirup and sugar tap less than 500 trees. Considered from the point of view of the bookkeeper who figures overhead, depreciation, labor costs, and interest, very few of these small groves can show a profit. But is there anything that can be done to better advantage at that season of the year? Faced with such a question, nearly every farmer who owns a maple grove will decide that sugar and sirup making is worth while.

The producer who hangs less than 500 buckets will not find sugar-making an especially profitable undertaking. For the large producer, however, an efficiently managed maple grove may return an attractive profit. This is especially true of those producers who operate the grove as a definite part of their farm.

A few characteristics of the smaller groves make the cost of production comparatively high. These should be recognized at the outset.

There are usually fewer trees per acre, so that more time is required to gather the sap.

The equipment is usually less efficient so that more time is required to boil down the sap.

In nearly every case the amount of sugar obtained from each tree tapped is less, owing to inefficient methods of gathering, boiling, and packing.

An operation should show a reasonable profit to the producer after all of the so-called business costs have been accounted for. These include interest upon the value of the grove and the equipment, repairs, depreciation, and taxes, together with costs of labor for men and teams, and the market value of the fuel used.

The operator should bear in mind, however, that if the woodlot remains idle, no extra return can be expected. Interest must be carried until the periodic or final return from the sale of trees is made. In many cases the maple sirup or sugar crops can relieve this long wait by providing a profitable by-product to the main crop of lumber and firewood.

Low-grade cordwood is used for fuel with which to boil the sap. Thinnings, improvement cuttings, and even windfalls may be used for such fuel. This should be an incentive for careful management within the grove.

The cash returns usually follow a few weeks after the harvest. If the crop is well made, it need not be sold immediately but may be stored and, under satisfactory conditions, may be collateral for a short-time loan.

The owner of a small maple grove who is without the necessary equipment should consider the proposition from every angle before investing in
an evaporator, buckets, and so forth. The following questions should be answered:

Are there sufficient trees to warrant the effort?

Can the land now occupied by maple trees be economically put to a more profitable use?

What other early spring work offers high wages to himself or his hired men?

Is there work for his team at that time which will bring in a better return?

Much of the land now occupied by sugar maples would be producing nothing if the trees were cut off. With some rearrangements of work on the farm, the time of men and teams in the sugar woods can be used with little loss to the other demands of the farm.

Like any other woodlot the maple grove will largely take care of itself. If properly tapped, it will produce an annual income, furnish the finest table sirup in the world, and under favorable circumstances will even supply the fuel to evaporate its own sugar-laden sap.

THE TREE^2

VARIETY

The sweet sap from which sirup and sugar can be made is common to all the native varieties of maple, but the hard, or sugar, maple, _Acer saccharum_, (figure 4) furnishes 75 per cent of the commercial sirup and sugar. This splendid forest tree grows in a commercial quantity from North Carolina and Missouri northward into the valley of the St. Lawrence River in Canada. It is a strong and vigorous grower adapted to a wide variety of soils, and has pronounced shade-enduring qualities. Among its common woodlot associates, only beech and hemlock exceed it in this respect. It is for that reason that it is able to maintain itself for many years against the competition of most other species. Leaf, one-third natural size; fruit and twig, one-half natural size.

Nearly every year the sugar maple bears large quantities of highly fertile seeds whose wings assure their wide

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^2 For a more detailed description of the several maple trees refer to _Manual of the Trees of North America_, by Charles Sprague Sargent, or to one of the many other books on tree identification.

Cuts for figures 4, 5, 6 were furnished thru the courtesy of the United States Forest Service.
distribution. Many practically pure stands of sugar maple in New York State are to be found as a result of the favorable combination of these aggressive characteristics of the species.

The hard, or sugar, maple prefers a well-drained site, but is found growing on practically all types of soil, except swamps and bare sand areas. It appears to grow especially well on glacial drifts or on rocky hillsides and benches. Climate seems to have more to do with the yield and the quality of the sap than has the soil. Sirup from the northern part of the range of the sugar maple is considered best.

Black maple, *Acer nigrum*, is a form of sugar maple that covers much the same territory as that already outlined. It resembles sugar maple so closely that it is usually reported under the same name. The best maple sirup and sugar is obtained from the hard maple and the black maple.

Red maple, *Acer rubrum* (figure 5) grows from Canada to Florida and as far west as Texas. The name refers to the color of the winter buds, the flower, and the leaf in autumn, perhaps also to the reddish or light chocolate color of the wood.

Silver maple, *Acer saccharinum* (figure 6) is usually called *soft maple* among lumbermen and sugar makers. Nurseriesmen, park keepers, and others planting or selling the tree call it *silver maple*, because of the whiteness of the underside of the leaf, which, when blown by the wind, gives the tree a silvery appearance. It grows faster than sugar maple and is, therefore, perhaps more frequently planted, but the wood is weak and the tree is shorter lived. The silver maple occurs frequently in maple groves, or sugar bushes, in New York, but can be distinguished from the hard maple by marked differences in bark, leaf, and bud.

The winter buds of the silver maple in common with the red maple are
reddish, blunt, and rounding, while the sugar-maple buds are brown in color, narrowly conical, and sharp pointed. On mature trees, the sugar-maple bark forms long thick irregular plates, frequently curling along one edge, while the bark of the silver maple separates in long, thin flakes often turning up at both ends so that they are easily scaled off. The leaf differences of the three maples, as shown in figures 4, 5, and 6, are pronounced and provide a sure means of distinguishing one from another.

While both the red maple and the silver maple are associated with the sugar maple in the sugar bushes of New York State, they are seldom if ever tapped because of the much lower sugar content of their sap. It is advisable on this account to treat these two species as weed trees in the sugar bush and to remove them.

Studies in Pennsylvania3 indicate that red and silver maples produce on the average only two-thirds as much sap as do sugar maples, and the sap is only two-thirds as sweet, hence the sugar maple is twice as valuable as the red or silver maple for sap production.

WHERE THE MAPLE TREE GETS ITS SUGAR

Food materials for plants are fundamentally the same as those for animals. Trees are large plants and obtain certain nutrient salts from soil and water. These raw materials are absorbed by the roots and are moved to all parts of the plant. From the air a gas, carbon dioxide, (the same that causes fizzing of soda water and other beverages) diffuses into the leaves thru minute openings. Likewise in the cells of the leaf tiny structures, called plastids, contain the green pigment known as chlorophyll. Within these plastids the carbon dioxide and water undergo chemical changes, and sugar results. To accomplish this the energy supplied by sunlight is necessary.

Some of this sugar may be immediately used in the leaf, but constantly there is a movement of sugar in the direction of the growing points and to the trunk and the roots. Some is transformed in the leaf to starch and is temporarily stored there. Later, when food materials are needed in another part of the tree, this starch is again transformed to sugar and it moves out of the leaf. When the leaves fall in the autumn, there remains in the leaf relatively little sugar or starch.

This manufacture of sugar in the leaf from carbon dioxide and water is one of the mysteries of nature. Each leaf may be considered as a factory for the production of sugar. The more leaves there are and the larger the

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4Contributed by Dr. Lewis Knudson of the Department of Botany, New York State College of Agriculture, Cornell University.
leaves, the greater will be the production of sugar. It is obviously important, therefore, to maintain a large leaf area. But, with a large leaf area, there is a corresponding evaporation of water. A maple tree with a trunk diameter of 15 inches is said to have a leaf area equal to one-third acre, and from such a leaf area more than 100 tons of water may evaporate during an entire season. It is, therefore, necessary that the tree have an adequate supply of water.

The sugar manufactured in the leaves gradually, but constantly, moves out of the leaves to the branches, the trunk, and the roots. Some may be used in growth and seed production, but a large part is transformed into starch and cells. There is relatively little sugar of any kind in the trunk or the roots during the winter, but toward spring the starch is gradually changed again to a simple sugar. In these living cells two simple sugars are evident, glucose and fructose (sometimes termed fruit sugar). A mixture of equal parts of glucose and fructose is termed invert sugar. Each of the sugars has the empirical formula of $C_6 H_{12} O_6$, which means that it is composed of carbon, hydrogen, and oxygen in the proportions of 6, 12, and 6. When these two sugars are combined with the loss of one molecule of water for each two molecules of sugars combining, a new sugar, termed sucrose or sucrarose, is formed, more commonly called cane sugar. Incidentally, cane sugar and beet sugar are the same. The formula for the reaction may be written.

$$C_6 H_{12} O_6 + C_6 H_{12} O_6 = C_{12} H_{22} O_{11} + H_2 O$$

glucose fructose sucrose water

The sugar present in the conducting cells of the wood is sucrose, or cane sugar, and the sap which flows from the tap hole contains this particular sugar along with certain other organic compounds and inorganic salts. It is the presence of additional organic compounds that give the characteristic flavor to maple sirup.

**YIELD OF SAP PER TREE**

Some of the factors which determine the amount of sap produced by a tree in one season are the size of the trees, the crown area, the condition of the forest floor, and the weather which characterizes the season. Authentic records are available of large sugar-maple trees that have produced as much as 40 gallons of sap in one season. On the other hand, in a season of unfavorable weather, it is not infrequent to get as low as 5 gallons of sap from a single tree. Perhaps a yield of 15 gallons of sap for each tree may be considered as average for the general run of sugar groves in New York.
RELATION OF SAP TO SIRUP AND SUGAR

The sugar content of the sap from sugar maples fluctuates. Even in the same tree it may vary with the season, depending on past growing conditions. Normal sap in an average year contains about 2 per cent of sugar. For purposes of calculating it is usually considered that 1 gallon of sirup of standard density will yield 8 pounds of sugar. Accordingly it will take from 45 to 50 gallons of sap to make 1 gallon of sirup. An average yield per tree of 15 gallons of sap with a 2-per-cent sugar content would be approximately 2½ pounds of maple sugar or 1¼ quarts of maple sirup of standard density.

THE IDEAL SUGAR TREE

An ideal sugar tree is well rooted, is surrounded by conditions which promote vigorous growth, and has trunk and limbs free from decay in order to support a heavy crown of foliage (figure 7). As the maple-sugar industry is usually associated with the production of timber, an ideal sugar tree might well have a long, clear trunk that lifts the crown and that ultimately could be sawed into high-grade lumber.

THE GROVE OR SUGAR BUSH

LOCATION AND NUMBER OF TREES

Any one who has boiled sap on the kitchen stove knows that a single tree will produce enough sap for a cup or more of table sirup, but a grove from which the operator expects to get considerable financial returns should have at least 500 trees, the smallest with a diameter at breast height of 12 inches. It is an advantage to have the grove close to the farmstead so that the work may fit in with the other farm operations. Sugar bushes which are far removed can seldom be economically operated unless there is a camp for housing the men and the horses, so that the men may spend all their time making sirup or sugar. These greater overhead charges require many trees in the grove and a large, well-equipped, evaporating plant. Camps of this type are comparatively common in the Adirondack Mountains and the adjoining foothills, but are not found in any number in the remainder of the State.

Groves with less than 20 trees to the acre seldom show a profit, and an ideal grove might have from 60 to 75 trees to an acre, each capable of being tapped. Thus, in developing a grove one must think of the possible yield per acre as well as the yield per tree. Trees should be encouraged to develop large crowns, but this must be done gradually to avoid serious openings in the crown cover.
Figure 7. An ideal "sugar tree"
THE FOREST FLOOR

As already brought out, the quantity and sugar content of sap produced by a sugar maple is in direct relation to the area of the crown. Another important consideration is the forest floor, for beneath it are the roots which support the trees and search for moisture. Maple sap is so largely water that a heavy flow is dependent upon a soil well supplied with available moisture. The leaves and humus of a good forest floor, together with the crown canopy, protect the ground against the sun and the drying winds. This is characteristic of natural forest soils. Excessive sunlight encourages briars and weeds, and helps to dry out the upper soil layers. Heavy seasonal demands upon the trees in the sugar bush make such a soil condition especially important. This can be maintained when the crowns are close enough to keep the direct sunlight from reaching the forest floor.

Most important of all is the exclusion of stock. Both cows and horses trample the ground and destroy the layers of leaf mold and valuable humus. Also, they browse and prevent young maples from getting established to take the place of the veteran trees as they give way to cutting or to decay. Excessive grazing, like fire and too heavy cutting, robs moisture
from the soil, reduces the vitality of the trees, and decreases the flow of sap (figures 9 and 10).

**THE IDEAL MAPLE GROVE**

The ideal maple grove should satisfy the following requirements:

(1) The area should be completely filled with sugar-maple trees having fully developed crowns.

(In a mature sugar grove a spacing of 30 by 30 feet, or 900 square feet, per tree allows 50 trees to the acre.)

(2) The canopy of leafy crowns should allow little sunlight to fall upon the ground, so that scarcely any grass or weeds will grow among the litter of humus and leaves.

**FIGURE 9. A GRAZED BUSH WHICH IS ON THE DOWN GRADE**

Note the exposed roots due to grazing and the stumps of trees with none to take their places
(3) There should be maple trees of all ages, with many young ones over the entire area (figure 11). As the old trees mature and are cut out, the younger ones will take their places.

(4) Roadways thru the grove help in the collection of sap, and reduce the usual difficulties with underbrush.

(5) Stock should not be allowed in the sugar bush. Cattle nip the tips and leaves of young trees, pack the ground around the tree roots, and destroy the protecting blanket of leaf mulch.

FIGURE 10. A STEP FURTHER IN THE DETERIORATION OF A GRAZED SUGAR BUSH
Note the stag-headed trees, large openings, and a heavy sod thrumut instead of a water-conserving forest floor.
EXPOSURE AND SLOPE

Southern exposures are preferred by many producers, because there the sap runs earlier. Sirup from the first run is generally supposed to be better and brings a higher price. There should, however, be no difficulty in disposing of good sirup from any run. On northern exposures and in very dense groves the sap flow begins later and continues somewhat longer than on southern exposures. After all, the advantages of one slope over another depend upon local conditions and the point of view of the operator. Any large maple grove will probably include both north and south slopes.
IMPROVING THE GROVE

Many sugar-maple groves are the remnants of the original forest and have been used for sugar making because they contain a number of maple trees. Often the trees are overmature, while heavy grazing or fire has destroyed the young growth. Old age, neglect, and in many cases absolute abuse have combined to make hollow-butted, stag-headed trees. In addition, they have suffered from the sugar-maple borer, the maple leaf miner, or other insects.

If grazing animals are kept out, seedlings will be encouraged and a mulch of leaf litter and humus will accumulate. Within a few years the ground will become loose and capable of holding more moisture. This protection will stimulate dense growth of seedlings and saplings. The objection is raised that in dense growth the seedlings whip the face and tear the clothes of the man who gathers the sap, and otherwise impede the collection of sap. Sap-collecting driveways and lanes to each sap-producing tree will partially correct this objection (figure 12). Any additional inconvenience should be considered as unavoidable, because these seedlings and saplings are the potential "sap producers" of the future.

Two of the largest operators in St. Lawrence County, New York, each of whom hangs a thousand buckets a year, believe that grazing should be excluded from the sugar bush. They believe also that the slight added cost of collecting sap, due to the presence of young growth, is more than offset by the advantage of a completely shaded forest floor and young maples to take the place of the veterans.

Continued management and protection will accumulate a mass of young growth. In eight or ten years these trees will be from 6 to 8 feet high, and the struggle for supremacy will be keen. At least two-thirds of them should be removed. While they are small, the less desirable ones can be lopped off with a hatchet or a corn knife, leaving well-spaced, thrifty maple saplings.

All other trees, such as beech, basswood, and hemlock, as well as stag-headed or deformed maples, should be cut out. Occasionally a promising white ash, red oak, basswood, or similar rapidly growing tree may be kept for lumber, but only when no satisfactory maples are present to fill the space. All trees in which the maple borer is working should be cut and burned or used before the following May.

CARE OF A WELL-STOCKED GROVE

Culture operation in a dense stand of healthy mature trees presents a different problem from the improvements to be carried on in an old grove. There may be little immediate need of thinning because the trees have already developed their form. It is desirable, however, to make openings
to encourage the growth of promising trees. The fuel and saw timber resulting from such cuttings should pay for the labor and, if the area is large enough, should be produced year after year.

A yearly cutting program should be carried on with the following points in mind:

**Figure 12. A thousand-bucket sugar bush in St. Lawrence County, New York, whose owner firmly believes in the exclusion of stock**

Note the splendid reproduction of young maple
Production of Maple Sirup and Sugar in New York State

(1) Forest trees grow slowly and forest development takes time. For that reason the work must be continued indefinitely.

(2) Encourage worth-while trees.

(3) Take out trees which crowd the desirable maples; others may be removed from year to year after young growth is established. Forest-grown sugar maples usually have a broad, shallow root system, and wind-fall may result if they are suddenly required to stand alone.

Figure 13. A splendid stand of second-growth maple now in need of thinning to bring about greater crown development.
(4) Cut out maples with small, narrow crowns, and those which are unsound or show signs of decline (figure 13).
(5) Remove most of the young growth of trees which are not hard maples.
(6) Avoid heavy cuttings which will expose a large part of the forest floor to the sun and the wind.
(7) Leave an unthinned border at least 25 feet wide around all sides of the grove. Branchy trees and shrubs develop a "wind mantle" which serves as a safeguard against storms.

ESTABLISHING A GROVE FROM A THICKET OF YOUNG TREES

Some groves in New York have been tapped continuously for fifty years. With all their sturdiness, these veterans cannot live forever, and, if maple sirup and sugar is to continue as a forest crop, some thought must be given to establishing new groves. In fact, many of these old groves are deteriorating, owing to excessive grazing which slowly, but effectually, helps to bring about the ultimate destruction of the trees. As if heavy grazing

Figure 14. A twenty-year-old maple thicket with several thousand trees to the acre and very much in need of a thinning.
were not enough of a handicap, many of the splendid veterans have as many as seven buckets hung on them in one season, as shown in figure 24 (page 41).

It has been suggested that the groves be perpetuated by encouraging the growth of young maple trees. The exclusion of livestock is often all that is necessary, but fire and insect pests must also be guarded against.

To start a new grove, one can usually take advantage of the dense sapling stands which frequently come up near seed trees after grazing has been excluded (figure 14). Such stands may contain thousands of maple trees.

When the saplings are from 6 to 8 feet high, they can be thinned so as to leave the largest and healthiest trees about 12 feet apart (figure 15).\(^6\) The tops of the undesirable trees may be cut back with a sharp hatchet or a corn knife and left on the ground to decay. Three men can cut back trees in this manner at the rate of an acre a day. Such an operation is comparable to transplanting saplings or sowing seeds. It offers no immediate profits, but is cheaper and the returns are quicker.

\(^6\) This means approximately 300 trees to the acre.
Some points to keep in mind while thinning a young stand are:

1. Choose thrifty trees capable of symmetrical crown development. They should be sound and free from forks.
2. Remove all long, spindling trees likely to bend over.
3. Preserve small trees of desirable species.
4. Remove all competing trees other than maple. Suppressed ones may be left.
5. Do not disturb the borders. Develop a “wind mantle” along all borders to exclude sun and wind.
6. Thinnings in dense young stands may allow crowns of selected trees free space of 10 or 12 feet. If growing conditions are favorable, the crowns will touch in five or six years, requiring further thinnings to follow in ten years or less.

The following table is suggested as a guide in thinning a pure even-aged stand of sugar maple for the purpose of developing a sugar grove:

<table>
<thead>
<tr>
<th>Diameter breast height</th>
<th>Space per tree</th>
<th>Trees per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inches</strong></td>
<td><strong>Feet</strong></td>
<td><strong>Number</strong></td>
</tr>
<tr>
<td>4-5</td>
<td>12 x 12</td>
<td>300</td>
</tr>
<tr>
<td>7-8</td>
<td>15 x 15</td>
<td>200</td>
</tr>
<tr>
<td>10-12</td>
<td>20 x 20</td>
<td>100</td>
</tr>
<tr>
<td>14-16</td>
<td>24 x 24</td>
<td>75</td>
</tr>
<tr>
<td>18 and up</td>
<td>30 x 30</td>
<td>50</td>
</tr>
</tbody>
</table>

One farmer in Cattaraugus County is establishing a maple grove in this manner. The thinning was first begun when the trees were seven years old, and has been continued up to the present time. The stand is now about twenty-five years old. More than three standard cords of wood to the acre have been cut, which were used for fuel. There remain 200 well-developed, thrifty maple trees to the acre, averaging more than 25 feet in height and 4 inches in diameter. Some of the more-favored trees with plenty of light have a diameter of 7 inches and will be ready to tap in fifteen years. It will be necessary for the owner to continue thinnings to insure proper crown development. Within the next twenty years, the number of trees per acre will be reduced by one-half.

**ESTABLISHING A GROVE BY PLANTING**

The wide distribution of maple throughout the State and the readiness with which saplings develop under natural conditions has made hand planting generally unnecessary. There are, however, some hand-planted groves in the State that have been yielding sap for several years. The ease of transplanting has made the maple-bordered highways of New York famous
Production of Maple Sirup and Sugar in New York State

thruout the east, and similar methods can be applied equally well in the
grove. Cultivation is desirable, however, and it is doubtful whether a
maple plantation will prosper if given as little care as is ordinarily given to
a pine plantation.

Small trees not more than from 2 to 3 feet high can be lifted from the
near-by woods and set out early in the spring. Five- and six-foot trees
were generally planted by the early settlers along the highways, and if there
is no objection to the extra time and expense required to handle large stock,
such trees can be used in establishing a grove.

Cultivation for the first year or two after planting will relieve the trees
from the competition of grass and weeds. Since a well-developed crown
is essential to good sap production, it follows that the trees may be planted
as in an orchard. A spacing of about 20 feet apart each way, or approxi-
mately 100 trees to the acre, has been used. The space in between may be
temporarily used for other crops. Hundreds of roadside maples thruout
the State spaced similarly are being tapped and give a good yield of sap.

It should be borne in mind, however, that an essential of high-quantity
production is a moisture-conserving forest floor within the grove. This
can scarcely be obtained with the wide spacing. As soon as cultivation
ceases, grass, weeds, and competing growth will spring up to exhaust,
rather than conserve, the soil moisture. Therefore, closer spacing, 6 by 6
feet, or 1200 trees to the acre, more nearly approximating natural seeding
is to be preferred. As the grove develops, thinnings, such as have been
described for natural stands, are in order.

There is no reason why another species might not be interplanted with
the maple to be cut at the end of twenty or twenty-five years for use as
posts or Christmas trees. European larch, black locust, or spruce, depend-
ing on the soil, site, and ultimate purpose of the crop, might be used to
advantage, altho the writers have no records of such experiments in New
York State.

Yield of Sirup Per Acre of Grove

It has already been brought out that few groves in New York average
more than 35 trees per acre of a size suitable for tapping, tho under proper
forest management this number might well be increased to 50.

On the basis of 35 trees per acre, using the average yield per tree of
23/4 pounds of sugar, the sugar bush will produce from 85 to 90 pounds
of sugar per acre, or 11 gallons of sirup a year.

It is usual, however, to consider the yield per tree rather than per acre.
A 100-tree sugar bush would yield 250 pounds of sugar or 30 gallons of
sirup.
MANUFACTURE OF MAPLE SIRUP AND SUGAR

EQUIPMENT*

The following is a list of the more important articles of a complete sugar-making equipment, with a few notes on the size of the operation for which each is adapted:

- Tapping bit, ¾ inch in diameter.
- Reamer, 7/16 inch in diameter.
- Brace or auger with which to operate the bit and reamer.
- Light axe or hatchet.
- Claw hammer, or a similar tool for removing spouts.
- Spouts or spiles.
- Buckets, 12-, 13-, or 16-quart capacity.
- Bucket covers.
- Gathering pails (in pairs), 16- or 18-quart capacity.
- Gathering tank, 3-, 4-, and 5-barrel capacity.
- Storage tank, from 8- to 20-barrel capacity and more.
- Evaporator house.
- Evaporator and arch.
- Thermometer.
- 3 or 4 felt strainers.
- Skimmer.
- Sugaring-off arch, and pan.
- Settling can, from 15- to 100-gallon capacity.
- Cans, pails, boxes, sugar molds, or barrels, in which to care for and dispose of the finished product.

It is probably impossible to present a complete list of all manufacturers of sugar-making equipment. Following is a list of manufacturers, several of whom have furnished catalogs which have been helpful in the preparation of this bulletin: G. H. Grimm, Rutland, Vermont; Leader Evaporator Co., Burlington, Vermont; George H. Soule, Fairfield, Vermont; True and Blanchard, Newport, Vermont; Vermont Farm Machine Co., Bellows Falls, Vermont; Vermont Evaporator Co., St. Regis Falls, New York; Sproul Manufacturing Co., Delavan, New York.

Such equipment as is listed and described in the following pages will cost about $2 for each bucket to be hung. This is on the basis of new materials, and it does not include the cost of erecting an evaporator house.

*Maple sirup and sugar production. By R. A. Chandler. This publication is a war-time conservation bulletin of the Department of Forestry, New York State College of Agriculture, Cornell University.
Tapping bit

A short, stout, oval-lipped bit with a short, coarse-threaded, sharp screw which will cut rapidly and smoothly is recommended. Such a bit need not be more than \(\frac{3}{8}\) inch in diameter, which will permit the use of a 7/16 inch reamer. Any strong brace will serve, provided it holds the bit straight in the socket and firm.

Reamer

When the run is interrupted by a period of warm weather, the sap flow is slow and bacterial growth develops in the tap hole, resulting in sour sap and dark-colored sirup. Often this may be corrected by cleaning out the tap holes with a reamer, a special auger which bores a hole slightly larger than the previous one. By using a \(\frac{3}{8}\)-inch auger to bore the original hole, the reamer need not be more than 7/16 inch. Hold the reamer firm and true so that it will make a round hole, otherwise leakage will result.

Sap spouts

The day of the wooden sap spout, made from a stem of elder with the pith pushed out, is past. The modern sugar maker demands a metal spout which is easily cleaned and will not corrode or rust. If it is made of iron, it should be galvanized or tinned. The part that goes into the tree should be round, smooth, and tapering so that it may fit bores of varying size. This will permit the same spout to be used after reaming. It should be strong enough to be driven with a mallet, yet capable of being easily pulled out at the end of the season. It should fit snugly into the hole without being driven so hard as to crush the wood cells or crack the bark. A snug fit at the collar of the spout is essential to prevent air from drying the walls of the hole and stopping the sap flow. A hook or notch should be provided on which to hang the bucket, for nails or spouts left in trees become overgrown and hidden in the wood, forming a source of annoyance and danger when the log is sawed into lumber.

Two types of spout seem to fill these needs. One is of cast iron coated to prevent rusting, with its shank deeply indented on four sides so that it touches few wood cells as it goes into the tree. Holes in the interior of the spout allow the sap to enter. A smooth collar fits firm against the wood, and a dam across the opening maintains a little reservoir of sap and keeps the air from reaching the wood. A hook provides a place to hang the sap bucket.

Another type of spout is made of sheet steel rolled to form an elongated funnel and coated to prevent rusting. The small end is closed except for a hole on the rear of the bore. A long, downward-curving under lip delivers the sap into the bucket without allowing any to flow backward on the
underside of the spout. The makers of this spout claim that, because of the long taper, it is not necessary to smooth the bark before boring the hole.

**Buckets**

Wooden buckets (figure 16) are fairly satisfactory, provided they are kept clean and painted each year, but metal buckets have largely taken their place. They are readily available, light, easy to clean, and will nest one into the other, occupying comparatively little space during storage. The 12- or 13-quart size is satisfactory, and usually more convenient than the ones holding 16 quarts. Heavy tin plate is preferred to galvanized iron.

**Bucket covers**

Bucket covers are essential in the production of high-quality sirup and sugar. They keep out sticks and dirt, prevent snow or rain from dropping in, and keep the sap cool and sweet by shading it from the sun (figure 17).

![Figure 16. Wooden buckets are satisfactory if kept painted but are difficult to cover](image)

Experience of many operators indicates that the type of cover which is ridged or arched in the middle and thus permits of air circulation is preferable to the close-fitting type.

**Gathering pails**

Gathering pails need to be larger than the sap buckets. The 18-quart size of galvanized iron or heavy tin plate is satisfactory. Special gathering pails are made large at the bottom to prevent tipping and spilling. Two for each man who expects to gath-
er sap are needed. Occasionally these are carried on a yoke (figure 17), but with a large gathering tank on runners this is seldom necessary.

**Gathering tank**

Gathering tanks are made in 3-, 4- and 5-barrel sizes. A 4-barrel tank is satisfactory for operation of from 500 to 1500 buckets. It may be mounted on a low sled or a stone boat (figure 18) and is equipped with a splash cover, a top strainer, and an outlet pipe.

Careful makers often supplement the metal strainer in the top of the gathering tank with a piece of cheesecloth, and let the sap flow thru another piece of cheesecloth when it is poured into the storage tank.

**Storage tank**

Metal storage tanks are made with a capacity of 8, 10, 15, and 20 barrels and over. The capacity of the tank should depend upon the extent to which the evaporator is capable of taking care of the sap flow. Allow at least one barrel of storage for each 50 buckets hung (figure 18). This will take care of delays in evaporation and occasional heavy runs. The tank should be set on a strong frame and provided with a roof. It should not be in the evaporator house because the heat will encourage fermentation of
the sap. The ideal place is on the north or east side of the house above the level of the evaporator, but no higher than the road so that sap from the gathering tank may flow directly into the storage tank and then on into the evaporator (figure 18).

**Piping systems**

Labor difficulties have encouraged an increasing interest in schemes for piping the sap directly from the trees to the storage tank and thence to the evaporator. There is available a patented system of sectional metal pipes, each supported on wires and connected by a “goose neck” pipe to the sap spout. The sections of metal pipes are available in different sizes so that the diameter may be increased according to the number of trees which feed into it. The plan has some real merit for groves standing on a slope with the evaporator house conveniently located near the base.

Two outstanding difficulties prevent its general acceptance, (1) the time required to erect the pipes and (2) the difficulty of thoroly cleaning them.

The advantages are chiefly the saving of labor and the direct delivery of the sap from the tree to the evaporator.

**Evaporator house**

The evaporator house should be near the trees that are to be tapped, and near a supply of pure cold water. Comparatively short hauls from the

![Figure 18. Taking advantage of the slope to have a gravity system](https://example.com/figure18.jpg)

*The sap flows from the gathering tank to the storage tank and into the evaporator.*
trees to the evaporator house will help to hold down the cost of man and team labor. A house on a slope will make possible a raised driveway on the uphill side. This will permit the gathering tank to be emptied thru the outlet pipe directly into the storage tank, which should be above the level of the evaporator and outside the house (figure 18), but under cover to keep the sap cool. The sap should flow directly into the evaporator. By taking advantage of the slope, the finished products can be loaded from the downhill side of the house. An ample supply of pure water is essential if the evaporator, the pails, and the other utensils are to be kept clean. Cleanliness in the entire operation cannot be too strongly stressed.

Sugar makers spend many hours over the evaporator, often working late into the night. In spite of long hours and harsh weather, many producers think that any shack will do. Sometimes they seem to take pride in having it as rough as possible. Even tho the man cares little for his own comfort, if evaporation is to be done efficiently and if he is to protect the apparatus during the long idle months between seasons, the house should be well built, with tight sides, and should stand on a good foundation. The floor may be of concrete or wood, but the part in front of the fire box should be of concrete or brick to prevent any possibility of fire from falling embers. A wooden floor or platform, 8 or 10 inches high, along the working side of the evaporator is helpful. There should be several windows, for no one can work well in the dark. Doors should be at least 40 inches wide, so that one may carry an armful of wood thru them. There should be room to work around the evaporator, space for a work bench, and possibly for a sugaring-off arch.

A brick chimney is more economical than a metal one because it does not rust. The chimney should extend well above the building to insure a good draft, but not so high that the fire will roar and waste fuel. Some makers of equipment recommend that the chimney be as high as the evaporator arch is long. A good fire, a cool chimney, and the use of a boiling pan indicate effective use of fuel.

Overhead, in the peak of the roof, extending the full length of the evaporator, may be a ventilator with either side capable of being opened or closed from below (figure 19). Driving winds can be kept out by closing the windward side. Cross drafts cool the sap and lengthen the boiling time, while good ventilation hastens evaporation.

One operator in St. Lawrence County, New York, has developed a wooden hood which spreads out to cover the evaporator and carries the steam up thru a funnel in the roof (figure 20). This does away with the need of ventilators in the roof. The edge of the hood is about 2 feet above the top of the evaporator. A sectional canvas curtain hangs down from the hood to the outside of the evaporator, thus precluding any steam escaping into the room.
Adjoining the house should be space for storing a standard cord of fuel wood for every 60 to 70 trees tapped. This space should be roofed, but need not be sided (figure 19). In smaller operations it is often found convenient to store wood in the evaporator house itself. If the steam is properly taken care of as described, there will be no excessive dampness in the wood so stored.

![Figure 19. An excellent storage shed for fuel wood](image)

A covering protects the wood from rain but open sides permit free circulation of air. Note the open ventilator in the adjoining evaporator house.

**Sugaring-off room**

It is more convenient to boil sirup to sugar over a separate fire, and preferably in a room separate from the sap evaporator. The higher temperatures require constant watching to prevent the sugar from burning on the bottom of the pan and to keep the sirup from boiling over the top of the pan. An ideal arrangement is to have the sugaring-off room adjoining the evaporation room. The inside dimensions of such a room should be at least 10 by 12 feet, which will accommodate the sugaring-off arch and pan, a work bench, and some storage space.

*A standard cord is 4' x 4' x 8'.*
There are those who find difficulty in always boiling the sap to finished sirup on the evaporator. Frequently they carry the semi-sirup into the kitchen to finish the boiling on the kitchen range (figure 27, page 49). This is usually inconvenient as well as wasteful. The sugaring-off outfit in the adjoining room serves equally well, and keeps the entire operation under one roof.

The sugaring-off arch is more simple than the evaporator and has pans which are shorter and deeper. They are usually from 2 to 2½ feet wide, from 3 to 6 feet long, and from 12 to 14 inches deep. A practical size for most farm operations is approximately 2 feet wide, 4 feet long, and 12 inches deep. The pan has a faucet for drawing off the thickened sirup and is set on an arch similar to that of the evaporator.

The sugaring-off room might be so arranged that the same brick chimney may be used for both the sugaring-off arch and the evaporator. If the pan is placed directly beneath two rafters or stringers, one man with the aid of a block and tackle can lift it from the arch and swing it to the work bench or to another part of the room where it is to be emptied.

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Summary of the points of a good sugar house

1. Tight walls which will exclude side draughts.
2. Windows enough to insure plenty of light.
3. Sufficient room for the evaporator and for operating it.
4. A brick or concrete floor in front of the fire box.
5. A raised plank floor by the working side of the evaporator.
6. A woodshed at one end of the house large enough to store one full cord of wood for every 60 or 70 buckets hung.
7. A ventilator in the roof, directly over and as long as the evaporator, adjustable from the floor.
8. A room for sugaring-off.
9. A work bench at one side of each room.
10. A storage tank, outside of the building, on the shady side, easily accessible, and above the level of the evaporator.

Evaporator

The earliest evaporators are said to have been bark vessels, which held the sap and into which Indians dropped hot stones. These gave way to open kettles, and then to flat pans. Each is slow and produces an inferior product, for long boiling caramelizes the sugar and darkens the sirup. Modern evaporators are designed to reduce the sap to sirup or sugar with the least possible loss of time or wastage of fuel. Corrugations in the bottom of the pan give increased boiling surface and cleverly arranged partitions conduct the sap from one end of the evaporator to the other, keeping the thickening sirup separate from the sap. The flues and firebox have been perfected to a point comparable with the modern kitchen range or furnace.

Nearly all of the evaporators in use by New York State farmers are made of sheet iron heavily coated with tin (figure 21). No doubt some are of galvanized iron. One who wishes to make light-colored sirup should not boil sap in an uncoated iron pan, for the action of the iron on the sugar produces a dark sirup. The likelihood that the tin coating may wear off or the galvanized iron be corroded prompts the Bureau of Chemistry of the United States Department of Agriculture to recommend the use of copper.9

Although a copper evaporator costs nearly twice as much as one of the galvanized iron, the extra expense is more than counterbalanced by the advantages gained. Copper lasts much longer than galvanized iron; it can be easily cleaned without injury by the use of acid; it conducts heat better than does galvanized iron; and the use of a copper evaporator results in lighter-colored sirup. The first costs of a good evaporator is only a small item in the total cost of making sirup, so that the use of copper is no sense of the word an extravagance.

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The advantages of evaporators are: 10 (1) rapid evaporation, which is essential in making light-colored sirup; (2) the sirup is concentrated in a thin layer, thus increasing the rate of boiling and foaming and affording better opportunity for thorough skimming; (3) heat is applied to the bottom of the evaporator, thus imparting an upward motion to the coagulated material, whereby skimming is facilitated.

Evaporating pans may be bought with the arch or furnace upon which they are intended to set. The fire box should be large enough to take 4-foot wood, or about 2½ inches longer than the wood used. A well-distributed air supply is usually assured when there are numerous small grate flues. Dampers in the chimney regulate the draft. A well-constructed arch will allow the blaze to rise vertically, strike the evaporator close to the front end, and hug the bottom of the pan slightly beyond the arch of the chimney. To insure this the throat of the arch should be shallow, and fitted with dampers. The distribution of heat over the bottom of the pan may be further controlled by filling the base of the furnace with earth between the end of the grates and the chimney. 11

The ash pit should also be large, with doors which open wide to allow ample draft from below. Ashes should never be allowed to pile up close to the grates.

The arch may be supplemented by a casing of brick, but this is not necessary. In any case all exposed metal parts of the arch should be kept painted.

11 Further discussion of this may be found on page 23, of Bulletin 1370 (see preceding footnote).
Manufacturers of sap-evaporating equipment are sometimes unduly optimistic regarding the evaporator capacity of their outfits. The estimates stated in most catalogs are high, so that the number of buckets that can be cared for may usually be cut in two if the producer desires to limit his boiling to the hours of daylight. In general, 1 square foot of corrugated 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 from 40 to 50 gallons of sap an hour. Following are suggestions for selecting any well-made modern evaporator in relation to the number of buckets hung. These figures will be found to exceed the rule of 10 square feet of boiling surface for every 100 buckets hung when applied to the smaller operations, but to follow this fairly closely in numbers from 300 and more.

These suggestions may cause a greater initial investment, but the cost of labor and fuel should be materially less. Only an unusually heavy run need keep the producer in the sugar house after sundown. This will help to adjust sugar making to the other farm operations. Furthermore, the

<table>
<thead>
<tr>
<th>SIZE OF EVAPORATOR</th>
<th>CAPACITY BASED ON 10 HOURS' CONTINUOUS BOILING (buckets)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30&quot; x 8'</td>
<td>50 to 150</td>
</tr>
<tr>
<td>30&quot; x 10'</td>
<td>100 to 200</td>
</tr>
<tr>
<td>30&quot; x 6'</td>
<td>50 to 150</td>
</tr>
<tr>
<td>36&quot; x 8'</td>
<td>100 to 200</td>
</tr>
<tr>
<td>36&quot; x 10'</td>
<td>200 to 300</td>
</tr>
<tr>
<td>36&quot; x 12'</td>
<td>300 to 400</td>
</tr>
<tr>
<td>40&quot; x 8'</td>
<td>150 to 250</td>
</tr>
<tr>
<td>40&quot; x 10'</td>
<td>200 to 400</td>
</tr>
<tr>
<td>40&quot; x 12'</td>
<td>300 to 500</td>
</tr>
<tr>
<td>40&quot; x 14'</td>
<td>400 to 600</td>
</tr>
<tr>
<td>40&quot; x 16'</td>
<td>500 to 700</td>
</tr>
<tr>
<td>48&quot; x 12'</td>
<td>400 to 550</td>
</tr>
<tr>
<td>48&quot; x 14'</td>
<td>500 to 600</td>
</tr>
<tr>
<td>48&quot; x 16'</td>
<td>550 to 700</td>
</tr>
<tr>
<td>60&quot; x 14'</td>
<td>600 to 800</td>
</tr>
<tr>
<td>60&quot; x 16'</td>
<td>800 to 1,000</td>
</tr>
<tr>
<td>72&quot; x 16'</td>
<td>1,200 to 1,500</td>
</tr>
</tbody>
</table>

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quality of the sirup or sugar will be better because no sap will be left over from one day to the next. If more than 1000 trees are tapped, it is desirable to use two or more evaporators. It is then convenient to clean one every day and to use the other for evaporating the first supply of sap in the
morning. In case of an irregular run, labor troubles, or accidents to the equipment, such a plant is more flexible than one using a single large evaporator.

Fuel

The evaporator and arch already described is designed for fuel that may be burned in the fire box with the heat applied directly to the bottom of the evaporator pans. The most common fuel is wood, altho some farmers use soft coal. A few farmers in the southwestern counties use natural gas.

Wood

Wood is the most practical fuel to use in New York because transportation is eliminated. The material would often otherwise go to waste, and the odd time, always present during the season, can be used to advantage in cutting and storing the next year's fuel supply (figure 23).

For every 60 or 70 buckets hung there should be available, at the start of the season, one standard cord of well-seasoned wood. Green or wet wood is never satisfactory. To wait until the beginning of the season to collect wood, and to have to fall back on trash and green wood, is to cut down effective operation of the evaporator.

Figure 23. Using spare time to collect fuel for next year's run
During a normal season one cord of fuel wood is burned in the making of from 100 to 120 pounds of sugar, or from 12½ to 15 gallons of sirup. No better use can be made of thinnings from the young grove or weed trees removed from the matured grove than for next season's fuel supply. By doing this work at odd times, the cost is insignificant. An ungrazed properly managed sugar bush will supply sufficient fuel year after year to evaporate all the sap the grove will produce without decreasing its sap-producing power.

Steam

Theoretically steam is an ideal means of applying heat, because the danger of burning the sirup is eliminated. If one has available an adequate boiler, the problem is comparatively simple, though it is doubtful if a producer would be justified in buying a boiler just for the reduction of sap to sirup.

One operator in Allegany County using 5 coils of ¾-inch pipe in the bottom of a tank 12½ feet long by 3 feet wide by 2 feet high reduces sap from a 1600-bucket bush very effectively with steam at 120 pounds pressure.

Other evaporator equipment

Other equipment which is helpful in the manufacture of good sirup and sugar includes a thermometer, (supplemented if possible by a Baumé saccharimeter), a skimmer, at least four felt strainers, a settling tank, and possibly a set of sugar molds.

The standard thermometer for testing maple sirup and sugar reads to 260° F., and is usually marked off as follows: 219° F., sirup; 238° F., tub sugar; 245° F., cake sugar.

If much sugar is to be made, a sugaring-off arch to supplement the evaporator will be found economical. As previously suggested, this should be in an adjoining room of the evaporator house. Some, who make only a small amount of sirup, often use a sugaring-off pan in which to finish their sirup.

PRELIMINARY PREPARATIONS

Cleanliness, speed, and regularity are three requisites to the manufacture of high-grade sirup or sugar. These must be applied to the entire operation if a light-colored, mild-flavored product is to be obtained.

Before the season, every utensil of the sugaring outfit, from spouts to evaporator pans, should be scrubbed and scalded. Roads should be broken thru the sugar bush so that the trees can be reached with the least walking between sled and bucket. The wood supply should be stored conveniently and ready for the rush. Containers for the expected crop should have been
ordered during the winter and should be in readiness. An estimate of the number required can be made on the basis of about 2 pounds of sugar for each bucket hung.

**TAPPING TREES AND GATHERING SAP**

**Size of trees and number of buckets**

Trees less than 9 or 10 inches in diameter at breast height are not worth tapping. Such small trees do not have enough leaves to provide a satisfactory amount of sugar in the sap.

Trees less than 9 or 10 inches in diameter at breast height are not worth tapping. Additional buckets hung as the trees get larger in diameter increase the yield without serious injury to the trees. The general practice followed by many of the best syrup producers in the State is to be recommended as giving a maximum yield of sap from year to year without at the same time seriously limiting the health and vigor of the trees.

- Trees 10 to 15 inches in diameter at breast height, 1 bucket
- Trees 16 to 20 inches in diameter at breast height, 2 buckets
- Trees 21 to 30 inches in diameter at breast height, 3 buckets
- Trees 31 inches and over in diameter at breast height, 4 buckets

Additional buckets hung above the numbers indicated do not materially increase the yield and at the same time the increased number of tap holes means a greater area of dead sap wood. The practice of tapping the tree in two places close together in order to collect the sap from the two in one bucket is not recommended.

**Effect of tapping upon the tree**

A maple tree which has been properly tapped is not seriously injured. The small amount of sap taken is scarcely more than from 4 to 9 per cent\(^{13}\) and can be easily spared. The chief danger to guard against is infection by wood-destroying fungi from which decay develops. A fair degree of protection is possible if the trees are growing vigorously so that the healing process is relatively rapid. Occasionally producers express a desire to plug up the old hole. This is possible, but, if a plug is used, it should not protrude beyond the growing tissues of the tree or it will obstruct healing. A hole made with a \(\frac{3}{4}\)-inch bit usually heals in two or three years. For this reason, the use of plugs is discouraged.

Years ago when holes 1 inch in diameter were made, it was advisable to plug them to hasten healing. A healed-over plugged hole is shown in figure 25.

The healed-over holes in a sugar maple ruin the "butt cut" for lumber production, but, unless decay has entered, the bole 5 feet above the ground is unharmed. Sawmill men usually avoid maple butts because of the danger of sawing into metal spiles which may have been left in the tree.

It should be remembered that when a tap hole is made, adjacent wood is affected. The area of dead sapwood extends for a distance of at least 2 feet immediately above and below the tap hole. It is for this reason that small tap holes are recommended (less than \( \frac{1}{2} \) inch in diameter) and the practice of having more than one spout per bucket is strongly discouraged.

**Figure 24. Seven buckets on this tree—hastening decay without increasing the sap yield**
When a period of warm weather interrupts the sap flow in mid-season, some operators make the practice of tapping a fresh hole. From the standpoint of the accumulation of dead sapwood areas (dry holes) around the trunk, this practice is as bad as hanging an excessive number of buckets. Reaming out old holes in mid-season is to be preferred to boring new ones.

The flow of sap\textsuperscript{14}

Why does the sap of maple flow from places where the tree is wounded? It is scarcely necessary to go into all of the reasons which may be back of this, but certainly pressure is exerted which forces out the sap. During a few hours the pressure will rise, then gradually fall, and finally change

\textbf{Figure 25: WHEN THIS MAPLE TREE WAS 10 INCHES IN DIAMETER (PORTION B) IT WAS TAPPED AND SUBSEQUENTLY THE HOLES WAS PLUGGED. PORTION A REPRESENTS THE SUBSEQUENT SEVENTY-YEARS OF GROWTH}

into suction. For example, careful experiments have shown at eight o'clock in the morning a suction of 2 pounds to the square inch at the tap hole. At ten o'clock this may be a pressure of 20 pounds, and by noon a state of equilibrium, displaying neither pressure nor suction, may be established. This slow pump-like action or alternate pressure and suction is repeated day after day.

The daily range of temperatures during the sugar-making season has much to do with the yield of sap. Alternate freezing and thawing caused by cold nights and warm bright days, usually brings about a big yield of sap. If this condition continues for a total of four weeks during the sugar season, the year will be a good one for sugar makers. Continued warm weather will stop the flow of sap. This is also true of a high, drying wind. Sometimes a snowstorm will bring back the proper conditions and restore the interrupted sap flow. Each period of sap flow is known as a “run.”

The thin walls of the tiny wood cells permit the passage of sap, but exclude the air. The tapping bit penetrates the cells, exposes a number of cell walls, and the hole serves as a reservoir to catch the sap passing into the surrounding cells. Nearly all of the sap is carried in the layers of sap wood immediately under the bark, so that little, if any, sap is obtained from the deeper layers of heart wood.

The greatest flow of sap is during the early mornings. Records show that 60 per cent of the flow is during this period and ordinarily it slackens considerably by noon.

**Tapping and bucket hanging**

Sap will flow any time after the first thaw following the fall of leaves in the autumn. Tapping may continue from then on until the buds begin to swell in the spring. Usually March and April are the best sugar-making months, but occasionally a good run is obtained in February. The tapping should be done early enough to catch the first real run of sap, but not a day earlier as every hour tends to dry up the tap hole and to decrease the amount and the quality of the sap flow. The judgment of old sugar makers in the neighborhood will help the inexperienced man to decide when to tap his trees.

Select a spot for the new tap hole about 4 feet from the ground, at least 10 inches away from the nearest visible tapping scar, and where the bucket may hang plumb from the spout (figure 26). Trees tapped approximately 4 feet from the ground yield a larger quantity of good-quality sap than do those tapped at the ground level or high up in the trees.15 If the bark is very rough, smooth it with a sharp axe, but ordinarily this is not necessary or desirable. With a sharp 3/4-inch bit bore a smooth hole slightly upward

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to allow draining and not more than from $1\frac{1}{2}$ to 2 inches deep. Blow out the shavings and drive the spout in at once. Use a wooden mallet and do not drive hard enough to split the bark, for this allows the sap to leak, and permits the air to enter and dry out the hole. If not driven hard enough, the spout may pull out under the strain of a full pail.

Hang the buckets at once so as to catch the first run of the season. Many makers think the first sap is the best. This is probably because the

Figure 26. making a tap hole
utensils are clean and cool weather holds back the growth of bacteria so that a good product is more easily made.

**Gathering the sap**

Every bucket in the orchard should be emptied at least once a day. A single quart of stale sap mixed with a gathering tank full of perfectly fresh sap will contaminate the whole lot. When the trees are running freely, collect the sap twice a day. This is especially important during warm weather, for then the sap will sour quickly.

The buckets should never be carried away from the trees, but they should be emptied directly into the gathering pails (figure 17). These in turn are carried to the gathering tank. A fine-meshed strainer over the mouth of the gathering tank will keep out leaves, twigs, and dirt. All sap should be hauled to the storage tank, outside the boiling house, and allowed to run thru the evaporator as rapidly as possible.

Ice that forms in a bucket of sap should not be thrown away as it contains enough sugar to make it worth while. It may be left in the buckets until it melts or it may be carried to the gathering tank. In either case it helps to keep the sap cool. Ice seldom forms when the buckets are emptied in the afternoon, as more than 60 per cent of the sap flow is during the morning. For that reason early afternoon is an efficient time to take it to the evaporator. If the run continues, another collecting tour may be made in the early morning, or, in case of extremely cold weather, just before night.

The sap flow is never continuous, but is broken into several runs during the season. Between every run the buckets, gathering tank, and storage tank should all be washed, scalded, and, if possible, exposed to the sun. At least once during the season, and oftener if the sugaring time is prolonged, the tap hole should be reamed and each spout washed and scalded.

**“Buddy sap”**

The term “buddy sap” is usually applied to late runs, especially those occurring about the time the buds begin to burst. It may be green or yellowish, and has a peculiar odor. In contrast to this the sap at the beginning of the season is water white, clear, and transparent. It has a sweet taste and practically no odor.

Sap is very susceptible to the growth of bacteria. Their action is largely the cause for the souring of sap and the physical change which takes place toward the end of the season. When sap is running strong, the danger of souring is not great, but, when warm weather comes and the flow is inter-

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mittent, the bacteria become active. One of the first visible signs of sour sap is a mucous formation in the buckets. When this appears, the buckets and spouts should be cleaned thoroughly and scalded. If another run follows, the tap hole should be reamed out.

Much so called “buddy sap” results from lack of cleanliness, and does not always accompany the swelling of the buds. In fact, it may occur some time before the buds swell. It is largely caused by bacterial growth in the sap after it leaves the trees. Bacteria develop more rapidly during warm weather so that additional care is needed as the season advances. If all the utensils are frequently washed, scraped, and scalded, if the tap holes are reamed out or changed with each new run, and if each day’s sap is evaporated before the close of the day, “buddy sap” can be avoided until late in the season.

MAKING SIRUP

Starting the evaporator

Like the spouts and buckets, the evaporator must be thoroly clean before the operation is started. This may be done by boiling water in the evaporator and scrubbing. Heavily tinned or copper evaporators may be cleaned by filling with a weak solution of hydrochloric (muriatic) acid18 and allowing it to stand for an hour or two. Galvanized iron is badly corroded by the acid and should not be treated in this way. The weak acid partially dissolves the sediment so that it may be scrubbed off while running water thru the pan. The pan must be well rinsed before filling it with sap.

Before starting the fire see that the intake from the storage tank is in adjustment, and flowing freely. If the pans are connected by siphons, they must be working and the bottoms of the pans must be covered with sap from 1 to 1½ inches deep. More than this prolongs the period of concentration and makes the product dark. As it boils, the sap in the sirup end of the pan should be dipped back to the inflow end until sirup of the desired density is flowing into the outlet. In the meantime, the scum which will constantly rise should be removed with a skimmer. This may be saved as a basis for cider vinegar. It should never be thrown carelessly about the place. Every effort should be made to keep the house and the surroundings clean and free from foul smells.

As the sap boils down to sirup, keep it flowing as steadily as possible from one compartment to another. After the operation is well started dipping should be avoided, for mixing high- and low-density sirup causes the finished product to be cloudy.

18 The authors have freely used material for this section of the bulletin which may be found in greater detail in Bulletin 1370, pages 24 to 28, of the United States Department of Agriculture, “Sugar-cane sirup manufacture,” by H. S. Paine and C. L. Walton, jr.
At the end of each day the evaporator should be cooled and held partly full of juice or water overnight. This can be done by flooding the pan with sap while the fire is hot, taking care that the pans do not boil dry. Skim the surface of the sirup before leaving it overnight. In the morning the bottom of the pan will be covered with a deposit. Unless this is scraped and the sap is stirred before building the fire, the heat will cause the deposit to stick to the bottom of the evaporator and a dark, poor-flavored sirup will result. Part of the sediment may be skimmed as it rises during boiling and the remainder will run out with the first few gallons of sirup.

Each morning the evaporator will have to be started with care to keep the pan from burning dry and to insure a constant flow from the sap intake to the outlet where the finished sirup is drawn off. To produce a clean bright sirup, the evaporator should be cleaned every two or three days, depending upon the quantity of sediment. Care must be taken to keep the pans clean, for dirty pans are responsible for much low-grade sirup.

**Testing the density of the sirup**

Sirup should be as thick as possible without crystallizing or granulating. To meet these requirements the weight should be about 11 pounds to the gallon, altho it is better for table use if boiled down to 11½ or even 11¾ pounds to the gallon. Such sirup contains about 35 per cent water.

Experienced operators are able to judge the density of the sirup fairly accurately while it is still boiling. Some do this by dipping the skimmer into the boiling sirup, holding it up, and noting how the cooling sirup “aprons off.” No amount of experience can take the place of accurate knowledge, and the uncertainties of guessing can be eliminated by using a thermometer.

It is well to check the accuracy of the thermometer by placing it in boiling water or in boiling sap in the sap house and noting the boiling point. An accurate thermometer should register 212° F. for water boiling at sea level. Roughly speaking, the temperature is lowered 1° F. for each 500 feet above sea level. Finished sirup weighing 11 pounds to the gallon boils at 219° F., or 7 degrees above that of boiling water. Sirup weighing 11 pounds 2½ ounces (11.15 pounds) will boil at 219.2° F. At 500 feet above sea level sirup will boil at 218° F., and at 1000 feet above sea level the boiling temperature will be about 217° F.

Thermometers should be kept clean because a coating of scum or “sugar sand” makes the reading inaccurate. Furthermore the thermometer must not touch the bottom or the sides of the pan, but should measure the temperature of the liquid only.

The hydrometer, or Baumé saccharimeter, is often recommended, but is more troublesome than a thermometer. It is necessary to draw off a
cylinder full of sirup from the evaporator and float the hydrometer in it. The Baumé reading for 11-pound sirup is 35.6°, and for a sirup weighing 11.15 pounds the reading is 37.1° (table 1). Baumé test should be used in sirup of approximately 60° F., as higher temperatures destroy its accuracy.

<table>
<thead>
<tr>
<th>Weight of sirup per gallon (pounds)</th>
<th>Temperature of sirup (degrees Fahrenheit)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Baumé hydrometer readings (degrees)</td>
<td>35.6</td>
</tr>
<tr>
<td>11</td>
<td>37.1</td>
</tr>
</tbody>
</table>

Sirup which contains more than 35 per cent water is likely to ferment and sour, while that which contains less than 32 per cent may form crystals. For that reason sirup weighing between 11 and 11½ pounds to the gallon is the most satisfactory.

Cleasning

Some makers cleanse the sirup with white of egg, milk, cream, or even small quantities of cold sap. When these are thrown into the boiling sap, a violent bubbling follows which throws impurities to the surface where they may be skimmed off. There is a difference of opinion concerning the use of cleaning substances, but as similar results are accomplished by allowing the finished sirup to stand in a settling tank for twenty-four hours or by straining it direct thru felt filters, their introduction is not recommended. It is true, however, that good sirup can be made by either method.

Sediment includes malate of lime or “nitre” which is present in all sirup. The amount varies, depending upon the soil and the time of season. Sirup that has been allowed to stand and settle for from twelve to twenty-four hours is reasonably free from sediment. Special settling tanks with the outlet from 2 to 3 inches above the bottom are available. If these are used, it is not necessary to strain the sirup thru felt. Sirup which has settled overnight should be reheated before pouring it into cans.

In the making of sirup too much emphasis cannot be given to cleanliness. The evaporator, the tanks, the buckets, and the spouts must be free from sediment and scale. There should be plenty of pure water so that all equipment may be washed as often as necessary. Equipment that has stood idle for several days should be washed with strong lime water, which neutralizes acids and helps to prevent fermentation. After using lime, all the equipment should be carefully washed again.
Final boiling

Most careful makers boil the sirup to final density in the evaporator, while others take it off before it is complete and finish the boiling in the sugaring-off pan or on the kitchen range (figure 27). They claim that this increases the capacity of the evaporator and allows the hot sirup to be twice strained before it is poured directly into the cans. Modern evaporators are designed to complete the boiling from sap to sirup in one operation, for each reheating darkens the sirup. The labor and the muss of transferring
the unfinished sirup from the evaporator house to the kitchen, the unavoidable loss in transit, and the fact that rapid, continuous boiling gives the best product, all point to the advantages of finishing the boiling in the evaporator or in a sugaring-off pan near where the sap is received.

**Canning**

Sirup that has been reduced to the desired density is ready for canning after it has been strained or settled. Some sugar makers pour the sirup into cans while it is hot; others prefer to let it cool. Hot sirup poured into a can will shrink as it cools and will create a vacuum. If this vacuum is too great, “buckling” results. On the other hand, cold sirup may expand in the can and be forced out from under the stopper, or it may even burst the seams of the can. Cold-canned sirup is more likely to be attacked by mold-forming bacteria than that which is canned hot.

The Bureau of Chemistry recommends that sirup be 180° F. when poured into gallon cans (figure 28) while temperatures as low as 160° F. are satisfactory for the large drums or steel barrels. Higher temperatures darken the sirup. As it cools, a vacuum may be created sufficient to cause the cans to “buckle.”

Assuming that the cans or drums are clean and tight, at least three conditions are necessary to prevent loss:

1. Fill with sirup at the proper temperature (180° F. for gallon cans; 160° F. for drums).
2. Close the caps air-tight.
3. Do not keep the sirup hot longer than necessary, either before or after canning.

Tip the metal cans slightly as they are being filled, then lift by the upper edges and fill even with the screw top before it is screwed tight with a wrench.

When filling cans with cold sirup, compress the sides a little, fill to the top, and screw on the lid. This allows for an increase in volume when the cans become warm.

The method of canning cold sirup in use by the late C. B. Wieland of Virgil, New York, is as follows: Strain the sirup while

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**Figure 28. A gallon can contains 11 pounds of sirup**

Note the can weighs 1 pound

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hot and leave it in the settling can for twenty-four hours. Fill the can up to the neck and allow the sirup to stand thirty minutes. Then fill the can to the top of the screw. Place a piece of wax paper the size of the cork in the screw top. Screw the top on and tighten it with a wrench. If the top is air-tight, no mold will form. In case mold does form, it can be lifted out with a teaspoon handle when the can is opened for use. Sirup canned by this method has been kept for ten years.

Sirup should be stored in a dry, cool place. Whenever the cans are piled in stacks, place narrow strips of wood across every three or four rows to permit the circulation of air and encourage cooling. A cool, dry cellar is best for storing sirup. Well-made, properly canned sirup will keep from one season to another without souring or bursting the container.

MAKING SUGAR

A small evaporator or special pan may be used for sugaring-off, or boiling the sirup into sugar. The most convenient place for this is the evaporator house, and, if much sugar is to be made, a special room is recommended. Many farmers wish to avoid this extra investment and boil down the sirup on the kitchen stove. This is wasteful and inconvenient and should be discouraged.

To make soft or tub sugar, boil the sirup until the thermometer registers from 26 to 28 degrees above the temperature of boiling water (from 238°F to 240°F at sea level). Skim with the same care as when making sirup. Foaming can be partially controlled by running a small piece of butter, lard, fat meat, or even a little sweet oil over the surface. This fat must be without flavor, or it will spoil the sugar. In any case it should be used sparingly.

If the boiling continues until the thermometer registers from 30 to 33 degrees above the temperature of boiling water, the product will be hard or cake sugar. This contains less moisture than soft sugar, and is more subject to burning. Commercial plants reduce the sirup to sugar with steam and thus avoid the danger of burning.

Failure to sugar-off each charge before adding more sirup for concentration prolongs the boiling, and results in a dark product. Furthermore, it causes slight decomposition so that hard sugar is difficult to make. From 1 to 10 gallons can be sugared-off at one charge, depending upon the size of the equipment.

Both hard and soft sugars may be poured into moulds. The cakes may range in size from those made for the confectioner to big bricks of 10 or 20 pounds. Hard sugar that is stirred while it cools resembles ordinary brown sugar, but retains the maple flavor. This is usually made for home use or local sale.
Tub sugar need not be of inferior quality, but it often is. Poor sirup which will not harden is sometimes used so that a molasses-colored liquid rises to the top of the tub leaving the rest of the contents mushy.

**MAPLE CREAM**

So much interest has been shown in maple cream that the following directions from the Bureau of Chemistry, United States Department of Agriculture, are included.22

Maple cream is a high-quality product which appeals strongly to the palate of the public. The market for this article has great possibilities, if properly developed. Being a high-grade product, it is essential that quality be maintained and that the finest article attainable be produced.

Important marks of quality in maple cream are very smooth texture and consistency; in other words, it should not feel coarse or “sandy” to the tongue. Upon standing, no sirup should come out and separate at the surface. Maple cream consists of exceedingly small crystals of sugar which are too small to be seen by the naked eye, but can be observed easily under a microscope. These crystals are surrounded and separated from one another by thin films of sirup. The art of making fine maple cream depends primarily on keeping these crystals so small that they cannot be detected by the tongue; otherwise, the cream has a coarse or gritty feel. Also, if the crystals are small enough they will retain the sirup better, so that it will not come out readily and separate at the surface on standing.

The making of fine maple cream is really part of the candy maker’s art and is similar in practically all respects to the making of the cream or fondant used in the familiar chocolate-coated creams. If carefully observed the following directions, which have been adapted from the art of candy making, will insure the consistent production of smooth maple cream of high quality. It is strongly urged that a thermometer, preferably a home candy maker’s thermometer, be used.

**Directions**

Boil the batch of maple sirup briskly to about 232° Fahrenheit. Keep the sides of the kettle free from crystals by wiping with a wet cloth or brush. Pour the sirup into clean shallow pans (roasting or baking pans). The layer of sirup should not be over 3/4 inch deep. In order to avoid premature formation of sugar crystals, the cooked sirup should be cooled quickly with as little movement or agitation as possible.

The pans of sirup may be placed outdoors to cool or, if cooled indoors, they may be cooled quickly by placing in a larger pan containing snow or cold water. The sirup should cool to about 70° Fahrenheit (about room temperature) before “creaming” is commenced. This can easily be determined by testing with the hand after the sirup is brought indoors (in case it was placed outdoors to cool). These precautions make it possible to keep crystallization (creaming) under control and to produce the size of crystals and consistency desired.

Hard wooden paddles with a somewhat sharp edge and about two to three inches wide will be found very efficient for “creaming.” The pan is held or fastened on a table and the batch is scraped with the paddle to one side of the pan and then back again, thereby mixing the batch so that no portion is allowed to remain at rest. This thorough mixing causes crystallization to start and at the same time prevents the sugar crystals from growing too large. If the agitation of the batch is stopped or interrupted the crystals will grow rapidly, resulting in a “sandy” or coarse consistency, especially if the temperature is a little too high.

This stirring and scraping is continued until the batch becomes somewhat stiff and shows a distinct tendency to set; that is, the furrows made by the paddle do not close up rapidly. This stiffness is caused by the formation of great numbers of microscopic sugar crystals. The finished cream can be poured directly into the final packages if desired, but care should be taken to continue stirring and not to commence pouring until the batch is barely fluid enough to run. If the cream is too fluid when poured,

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more sugar crystals will be formed after pouring and these may be so large as to cause "sandiness." If desired stirring can be continued until the batch becomes stiff. The finished batch may be packed in glass or earthenware containers and tightly covered; it can then be "remelted" at leisure and poured into suitable packages. Remelting is done by heating the cream in a double boiler and stirring until it becomes just fluid enough to pour. Don't heat to any higher temperature than necessary. It can then be poured without much danger of forming air pockets which detract from its appearance in a glass container.

**How to shorten the time required for creaming**

The creaming operation can be considerably shortened, with the assurance of producing a smooth cream, by incorporating in the batch a small proportion of "inverted" maple sirup. The nature of "inverted" maple sirup and the manner of preparing it are described below.

Bring the maple sirup to a brisk boil and then add the required amount of "inverted" maple sirup. Cook to a temperature of 232° Fahrenheit. The usual proportion of "inverted" maple sirup is 1 pint to each 6 gallons of ordinary maple sirup in the batch. Pour the cooked sirup into pans as already described and start "creaming" as soon as the temperature drops to about 100° Fahrenheit (instead of 70° Fahrenheit as above). The temperature should be determined by a thermometer (preferably a candy maker's thermometer), tilting the pan, if necessary, until the sirup is deep enough at one end to cover the thermometer bulb. Don't stir the sirup more than absolutely necessary.

After "creaming" is commenced, if the stirring and scraping are continued without interruption, a smooth cream will be obtained in a shorter time than when the sirup is cooled at 70° Fahrenheit. However, if the "creaming" is started at 100° Fahrenheit without adding some "inverted" maple sirup, there is great danger that the cream will be coarse or "sandy" in texture.

**Preparation of "inverted" maple sirup**

The chemical name for the sugar in maple sirup is "sucrose." This sugar consists of two simpler sugars, dextrose and fructose, united together. A mixture of these two sugars in equal proportion is called "invert sugar." Invert sugar is the sugar present in honey. It has the property of preventing crystals of sucrose from becoming very large; hence the advantage of adding a little "inverted" maple sirup in preparing maple cream. In "inverted" maple sirup the sucrose has been split up into invert sugar. Sucrose can be converted into invert sugar through the action of a substance called invertase, which is used in a extremely small amount for this purpose. Two methods of preparing "inverted" maple sirup are described:

**Cold or slow method**—This is the best method. It requires more time, but is much simpler than the warm, or rapid, method described below. All that is necessary is to add 2½ fluid ounces of invertase to each gallon of maple sirup, stir thoroughly, and allow to stand at about room temperature (65 to 70° Fahrenheit) for 10 days (a somewhat higher temperature will do no harm). At the end of this time the sirup will be ready to use and should be added in the proportion mentioned above in making maple cream.

A small glass cylinder or bottle graduated in fluid ounces, which may be bought at any drug store, is convenient for measuring the invertase. Many medicine bottles are graduated in fluid ounces.

**Warm or rapid method**—Two and one-half fluid ounces of invertase, as above, is added to each gallon of maple sirup and is thoroughly mixed. The sirup is then placed in a well-tinned metal pail with a cover or in glass Mason jars. The containers are placed upon a rack fitted into an ordinary wash boiler, similar to the arrangement for cold-pack canning. Water is poured into the boiler until its level is just below the top of the pail or glass jar. The boiler is heated on the stove until the temperature of the water reaches 130° to 140° Fahrenheit. It is important that the temperature of the sirup never exceeds 140° Fahrenheit. The invertase loses its activity at a temperature much above this.

After the water reaches the proper temperature, the boiler should be moved to a cooler part of the stove in a position to keep the temperature at about 130° to 140° Fahrenheit (*but not above*). When the fire becomes low or is allowed to go out at night, the boiler should be well covered with blankets or similar wrapping so as to retain the heat during the night. Under these conditions the preparation of the
“inverted” maple sirup requires about 24 hours. It is best to start the batch in the morning; it will then be finished the next morning.

A fireless cooker is very convenient for preparing “inverted” maple sirup by this method. After adding the invertase, simply heat the maple sirup to 140° Fahrenheit (not above), place immediately in the fireless cooker, and allow it to remain for 24 hours. (Use no stones.)

In both the slow and rapid methods the addition of invertase may modify somewhat the flavor of the “inverted” maple sirup, but this will not be detectable in the maple cream on account of the very small proportion of “inverted” maple sirup added.

The stock supply of inverted maple sirup may be kept at any temperature below room temperature if desired.

Precautions and comments

A smaller proportion of “inverted” maple sirup should usually be added to maple sirup from the later runs of the season. In some cases when late run sirup is used no “inverted” maple sirup may be needed, even when “creaming” is started at 100° Fahrenheit. The proportion of 1 pint of “inverted” maple sirup to 6 gallons of ordinary maple sirup may be varied when necessary. The general rule to follow is that when the directions given in this circular are closely observed and the cream is “sandy” or coarse in consistency, the proportion of “inverted” maple sirup should be increased somewhat and when the time required for “creaming” is excessive the proportion of “inverted” maple sirup should be reduced.

The pans and paddles should be thoroughly washed between batches to remove all adhering portions of cream; otherwise, small particles of cream may start the formation of sugar crystals prematurely in the next batch, thus producing crystals that are too big and causing “sandy” consistency.

In order to produce smooth cream it is important, after “creaming” is commenced, that the batch be kept constantly stirred until crystallization is practically complete, as shown by the stiffness of the batch. Sugar crystals which are formed while the batch is at rest are considerably larger. Therefore, if many sugar crystals are formed after stirring is discontinued, they may be numerous and large enough to cause “sandyness.”

Precautions to avoid keeping the maple cream at too high a temperature after packing will reduce the separation of sirup at the surface on standing.

When maple cream is made on a sufficiently large scale, it may be advisable to use the smaller mechanical beaters rather than hand labor for “creaming.” Information regarding mechanical beaters can be obtained from the Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

Invertase may be purchased from The Nulomoline Company, 111 Wall St., New York. Home candy makers’ thermometers may be purchased from The Taylor Instrument Companies, Rochester, New York; Sears and Roebuck, Philadelphia, Pennsylvania; and Eimer and Amend, Third Ave., 18th & 19th Sts., New York City, New York.

These names have been taken from commercial directories for the convenience of readers. Articles sold by these concerns are not recommended over those of other concerns whose names and addresses are not at present available.

Invertase was not formerly available in commercial quantities and has only recently become a commercial article as a result of an investigation by the Bureau of Chemistry which demonstrated its value in preventing the sugaring (crystallization) of sugarcane and sorghum sirups. Its use has been extended to cream or fondant confectionery where it is valuable for improving consistency.

For further information regarding the making of maple cream address the Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

Maple candies

Maple cream forms the base for the manufacture of a wide variety of dainty confections, some of which are shown in figure 29.

If one has attractive molds available, it is well worth one’s time to make up pure maple cream or fudge in different shapes and to sell them in dainty
packages. Nuts may also be added, either chopped or in halves, on top of the molds. Many maple-sugar producers in New England have found it profitable to cater to the tourist trade by direct sales at roadside booths to those traveling by automobile, or to build up a mail-order business thru advertising. While sirup is often sold, as well as sugar, this business rests essentially on maple sugar in the form of high-grade confectionery.

PACKAGES FOR SIRUP AND SUGAR

Sirup and sugar are put up in packages as various as can be suggested by the minds of the makers. Pails, both wood and tin, boxes of all sizes, tins, glass (from gallon jugs to tiny glasses), waxed paper, brown paper cartons, dainty confectionery boxes, and so forth, all are used.

Farmers who prepare sirup for local trade or home consumption usually pack it in rectangular tin cans with a screw cap (figure 28). The one-gallon size is most popular with producers; a few use half-gallon tins, and others pack in quart jars.

The principle advantages of the rectangular tin can has been its comparative cheapness, ease of packing for shipment, and ready availability. These

Figure 29. An exhibit of New York maple products at the State Fair, 1927
advantages are offset by unattractive appearance, the fact that cans cannot
be held over to another year on account of rust, and finally because un-
scrupulous producers could put an inferior dark-colored product in them
and "get away with it" at least once. Glass\(^{22}\) is now coming widely into
use because it is cheaper, permits the customer to see the product pur-
chased, and is available in all sizes from a gallon down to a half pint.

Labels

An attractive label, 4 by 6 inches has been prepared.\(^{22}\) This label is suit-
able for both tin and glass containers, features New York State maple sirup,
and also provides a place for the individual producer's name and address.

The following recipe is recommended for a paste which will cause paper
labels to stick on tin or glass:

One-half ounce of silicate of soda (water glass), 1 ounce of cornstarch,
and 1½ pints of cold water. Add the starch and the silicate to the water
and stir the mixture until the whole is smooth, then place the vessel in a
double boiler and heat it until the starch is gelatinized. This paste should
be made often as it soon loses its sticking properties.

LEGAL REQUIREMENTS FOR SIRUP AND SUGAR

In the enforcement of the Federal Food and Drugs Act the Department
of Agriculture considers that maple sirup is a sirup made by the evapora-
tion of maple sap, containing not more than 35 per cent water, and weighing
not less than 11 pounds to the gallon, 231 cubic inches. This corres-
donds to the accepted commercial practice. The Act states that food in
package form is misbranded if the quantity of the contents be not plainly
and conspicuously marked on the outside of the package.

A recent survey of the industry in this State indicates that there is a
considerable amount of maple sirup on the market containing more than
35 per cent water, and also that there are some shipments of maple prod-
ucts which fail to bear plain and conspicuous statements of weight, on
maple sugar, and of volume on maple sirup.

Shipments into another State, of adulterated or misbranded products of
the character indicated above are liable to seizure and the shippers may be
subjected to criminal prosecution. In many cases the presence of exces-
sive water is due to faulty test methods. To attempt to determine the
density of sirup by the weight of a "gallon" of sirup is not sufficiently
accurate, because "gallon cans" vary in size. A determination of the boil-
ing point of the finished product is more satisfactory when proper allow-
ances are made for altitude, and so forth. The most satisfactory method

\(^{22}\) Detailed information will be furnished by writing directly to the Department of Forestry, New
York State College of Agriculture, at Ithaca, New York.
of ascertaining the water in sirup is by determination of specific gravity, either read directly as such, or as Baumé degrees. (See table 1, page 48, for Baumé hydrometer readings.) A 35-per-cent-water maple sirup has a specific gravity of 1.31989.

Under the laws of New York State a person who, with the intent that the same shall be sold as unadulterated or undiluted, shall adulterate maple sugar, maple sirup, or honey, with glucose, cane sugar or sirup, beet sugar or sirup, or any other substance for the purpose of sale, or who shall knowingly sell or offer for sale maple sugar, maple sirup, or honey that has been adulterated in any way, is guilty of misdemeanor.

Every farmer who has tapped a maple grove recognizes the desirability of such a law, but all do not know that it exists.

This does not affect maple blends, provided they conform with the Federal Food and Drugs Act by stating clearly the extent to which the maple product is adulterated with other materials.

Maple sirup or sugar for shipment to any place beyond the State boundaries is subject to the Federal Food and Drugs Act. This requires that it shall bear a statement written plainly upon the label giving the net weight at the time when it is offered for shipment. In the case of sugar, allowance should be made for any shrinkage or decrease in weight from evaporation, between the time of packing and the time when the package is offered for shipment. This will make sure that the declaration of net weight will be true at the time the article becomes subject to the law. 24

STANDARD GRADES OF MAPLE SIRUP AND SUGAR FOR NEW YORK STATE

After hearings held in all the large producing regions in January 1935, the following grades of maple sirup and sugar were established by law (article 12-A of the Agriculture and Markets Law).

Grades

I. Official standards for grading maple products packed or repacked within the State of New York.

FANCY: Fancy syrup shall be pure maple sap syrup free from foreign materials and of a density of 36 degrees Baumé Hydrometer reading, and weigh eleven pounds net to the gallon. It shall not have a sour, buddy or scorched flavor. It shall be of a color no darker than No. 5 according to the U. S. color standards.

If the syrup is cloudy, the grade shall be No. 1.

No. 1: Syrup shall be the same as above except in color. The color shall be darker than No. 5 and no darker than No. 7 according to the U. S. color standards.

No. 2: Grade No. 2 shall be the same as above except in color. The color shall be darker than No. 7 and no darker than No. 9 according to the U. S. color standards.

No. 3: Grade No. 3 syrup shall be the same as above except in color. The color shall be darker than No. 9 and no darker than No. 11 according to the U. S. color standards.

NOTE: All hydrometer readings shall be made at a temperature of 60 degrees Fahrenheit. Standard density syrup showing 36 degrees Baumé Reading at 60 degrees Fahrenheit will show the following readings at the stated temperatures:

<table>
<thead>
<tr>
<th>Temperature Reading</th>
<th>Correct Hydrometer Reading</th>
<th>Temperature Reading</th>
<th>Correct Hydrometer Reading</th>
<th>Temperature Reading</th>
<th>Correct Hydrometer Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>219°F</td>
<td>31.8</td>
<td>150°F</td>
<td>33.6</td>
<td>80°F</td>
<td>35.5</td>
</tr>
<tr>
<td>200</td>
<td>32.3</td>
<td>140</td>
<td>33.9</td>
<td>70</td>
<td>35.75</td>
</tr>
<tr>
<td>190</td>
<td>32.6</td>
<td>130</td>
<td>34.1</td>
<td>60</td>
<td>36.0</td>
</tr>
<tr>
<td>180</td>
<td>32.9</td>
<td>120</td>
<td>34.4</td>
<td>50</td>
<td>36.25</td>
</tr>
<tr>
<td>170</td>
<td>33.1</td>
<td>110</td>
<td>34.7</td>
<td>40</td>
<td>36.5</td>
</tr>
<tr>
<td>160</td>
<td>33.3</td>
<td>98</td>
<td>35.0</td>
<td>30</td>
<td>36.8</td>
</tr>
</tbody>
</table>

Tolerance:

In order to allow for unavoidable variations incident to proper grading and handling, a tolerance of one-half (½) degree above or below thirty-six (36) degrees, as determined by the Baumé scale hydrometer may be allowed.

The official State Grades for maple sugar shall be as follows:

FANCY: Fancy sugar shall be clean, pure maple sugar of good flavor made from fancy syrup.

No. 1: Grade “No. 1” sugar shall be clean, pure maple sugar made from Grade 1 Syrup.

No. 2: Grade “No. 2” sugar shall be clean, pure maple sugar made from Grade 2 Syrup.

No. 3: Grade “No. 3” sugar shall be clean, pure maple sugar made from Grade 3 Syrup.

Note: SCORCHED SUGAR: Any sugar that shall become scorched in its preparation shall not be considered as coming within the above grades. The use of these grades is optional, but when used must be used correctly.

Rules and Regulations

II. Rules and Regulations to supplement and give effect to Article 12-A of the Agriculture and Markets Law, in relation to maple products.

1. Statements such as “Fancy”, “No. 1”, “No. 2”, or “No. 3” when used in connection with the sale of and/or when branded on packages containing maple products packed or repacked within this State shall be deemed to mean “New York Fancy Grade”, “New York No. 1 Grade”, “New York No. 2 Grade” or “New York No. 3 Grade”, and maple products so represented and/or so marked shall be regarded as represented and/or graded according to the New York State Official Grades for Maple Products.

No. 2. All containers of maple products packed or repacked within this State, when sold or offered for sale on the basis of the New York State Official Grades for Maple Products, shall be plainly and legibly marked with one of the official grade designations as follows: “New York State Fancy Grade”, “New York State No. 1 Grade”, “New York State No. 2 Grade”, or “New York State No. 3 Grade”. In addition to the grade designation the container shall also be plainly and legibly marked to show the name and address of the packer or person or persons under whose authority the maple products were packed.

3. The foregoing grades and grade designations shall be used only on maple products made from maple sap produced within the State of New York.

MAPLE-SAP VINEGAR

Maple-sirup skimmings, dark or slightly scorched sirup, and maple sap or sirup which has begun to ferment can be made into excellent vinegar.

The following formula is suggested:25

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Maple sirup diluted with soft water to weigh 9 pounds to the gallon, 30 gallons.

Ammonium sulfate, 2 ounces
Sodium phosphate, 2 ounces
Dissolve the chemicals in the water before diluting the sirup to assure their complete solution in the sugary liquid. They are added because diluted maple sirup lacks sufficient nitrogen and phosphorus to provide food for the vinegar-making bacteria.

Maple sirup which has been diluted so that it weighs 9 pounds to the gallon will contain from 12 to 15 per cent sugar, as compared with 35 per cent sugar in sirup weighing 11 pounds to the gallon. This can be tested with the Baumé hydrometer.

If kept moderately cool26 (about 50° F.), alcoholic fermentation will probably take place spontaneously in the barrel. Fermentation can be made certain by putting in a cake or two of compressed yeast.

Alcoholic fermentation will be completed in about two weeks, after which the liquor should be carefully strained into a vinegar barrel. Add a small quantity of “mother of vinegar” or old vinegar to the extent of about one-tenth the volume of the alcoholic liquid. “Mother of vinegar” is the slimy skin which forms on the surface of vinegar. It is the growth of bacteria which convert alcohol into acetic acid, which is the characteristic acid of vinegar. Before pouring in the old vinegar, strain it thru cheesecloth, flannel, or felt to take out any vinegar eels or vinegar flies.

Warmth and air are necessary to produce vinegar. The room temperature should be about 70° F. and the half-full barrel may be laid on its side with both bung holes open. Vinegar flies may be excluded by covering the holes with muslin or cotton batting.

Between 25 and 30 gallons of vinegar can be made from materials that would ordinarily be thrown away in the course of operating a 1000-tree sugar bush.

**COST OF PRODUCING MAPLE SIRUP**

Of late years, the relatively low prices received for maple products, together with the high cost of everything that goes into producing them, have caused many a farmer to consider seriously whether he can afford to produce maple products at all. It is obvious that, to consider his problem intelligently, the farmer must know something of the cost of producing maple sirup and sugar.

Dissatisfaction on the part of the producers with the price received for maple sirup in Vermont in 1921 led to a study of the cost of producing

---

that commodity.\textsuperscript{27} These studies were continued in both Vermont and New York during the years 1922 and 1923. As a result, there are available today figures covering the cost of producing 40,952 gallons of maple sirup on 208 farms during the three sugaring seasons, 1921–1923, inclusive.\textsuperscript{28}

For the most part, these results do not represent production by the average farmer. These figures were obtained from producers in the leading sugar-producing counties of both States, who volunteered to keep records because they wished to know something about their production costs. These farmers were probably above the average. It is unlikely that cost-of-production figures could have been obtained from average farmers by the cost-account method.

Conditions under which maple sirup and sugar are produced in New York and Vermont are, in general, very similar, so that the results may be viewed as applying to the entire producing area in these two States.

**AVERAGE COSTS AND VARIATIONS IN COST**

As might be expected, the cost of producing a gallon of sirup on the individual farms in both States varied widely. On approximately 8 per cent of the farms, sirup was produced for less than $1 a gallon, while on 7 per cent of the farms the cost was more than $2.50 a gallon (table 2). Approximately 63 per cent of the farmers produced sirup for less than $1.75 a gallon. The lowest cost per gallon recorded was 54 cents; the highest, $4.24. The average cost of producing maple sirup in bulk was $1.45 a gallon. A summarization of the results of these studies and the items that make up the cost of production are given in table 3.

As is true in the production of almost any farm crop today, human labor accounted for the largest share of the cost, 46 cents per gallon, or 32 per cent of the total cost. Any farmer who has had to hire labor of recent years would expect labor to be a big item in making maple sirup. Some of the less obvious items of expense, however, are of equal or even greater importance than labor. It seems particularly worth while to point out that "fixed costs" amounted to more than 66 cents per gallon of sirup produced, or 46 per cent of the total cost. "Fixed costs" are those that run on whether sirup is made or not, such as interest on investment in equipment and sugar bush, depreciation of equipment, and taxes.

\textsuperscript{27}The writer (M. P. Rasmussen) while on the staff of the College of Agriculture at the University of Vermont, made the 1921 study in Vermont. The 1922 and 1923 studies in New York were made by the writer in cooperation with Professor G. H. Collingswood, of the Forestry Department, New York State College of Agriculture. Appreciation is due H. P. Young, College of Agriculture, University of Vermont, for the 1922 and 1923 Vermont data.

\textsuperscript{28}This study included 60 records in Vermont producing 11,700 gallons in 1921; 52 in Vermont producing 9,896 gallons, and 43 in New York producing 10,218.5 gallons in 1922; 34 in Vermont producing 4,389 gallons, and 19 in New York producing 4,189 gallons in 1923.
TABLE 2. VARIATIONS IN COST OF PRODUCING A GALLON OF MAPLE SYRUP IN NEW YORK AND VERMONT, 1921-1923

<table>
<thead>
<tr>
<th>Range in cost per gallon</th>
<th>Vermont</th>
<th>New York</th>
<th>Total, all records</th>
<th>Per cent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1921</td>
<td>1922</td>
<td>1923</td>
<td>1922</td>
</tr>
<tr>
<td>Less than $1.00</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>$1.00 to $1.25</td>
<td>13</td>
<td>9</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>1.26 to 1.50</td>
<td>14</td>
<td>6</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>1.51 to 1.75</td>
<td>9</td>
<td>10</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>1.76 to 2.00</td>
<td>7</td>
<td>10</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>2.01 to 2.50</td>
<td>10</td>
<td>4</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>More than $2.51</td>
<td>2</td>
<td>10</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Lowest cost per gallon</td>
<td>$0.87</td>
<td>$0.84</td>
<td>$0.88</td>
<td>$0.54</td>
</tr>
<tr>
<td>Highest cost per gallon</td>
<td>$2.75</td>
<td>$3.57</td>
<td>$4.24</td>
<td>$2.17</td>
</tr>
</tbody>
</table>

TABLE 3. AVERAGE COSTS OF PRODUCTION PER GALLON OF MAPLE SYRUP, IN BULK, NEW YORK AND VERMONT, 1921-1923
(This study covers a total of 40,952.5 gallons)

<table>
<thead>
<tr>
<th>Items of cost</th>
<th>Vermont</th>
<th>New York</th>
<th>Vermont and New York</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1921</td>
<td>1922</td>
<td>1923</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Average cost</td>
</tr>
</tbody>
</table>
| Human labor*              | $0.56   | $0.43   | $0.45          | $0.39 | $0.44 | $0.46      | 31.72%
| Horse labor               | 0.16    | 0.15    | 0.16          | 0.14  | 0.15  | 0.15      | 10.35%
| Fuel                      | 0.25    | 0.08    | 0.06           | 0.22  | 0.20  | 0.17      | 11.72%
| Repairs to equipment     | 0.01    |         |               | 0.01  | 0.02  | 0.01      | 0.69%
| Depreciation of equipment| 0.19    | 0.16    | 0.18           | 0.18  | 0.20  | 0.18      | 12.42%
| Interest on equipment    | 0.20    | 0.21    | 0.19           | 0.17  | 0.19  | 0.19      | 13.10%
| Interest on sugar bush   | 0.11    | 0.33    | 0.31           | 0.17  | 0.19  | 0.21      | 14.48%
| Taxes                     | 0.04    | 0.15    | 0.12           | 0.06  | 0.06  | 0.06      | 5.52%
| Total costs              | $1.52   | $1.51   | $1.47          | $1.34 | $1.46 | $1.45      | 100.00%
| Costs minus human labor   | $0.96   | $1.08   | $1.02          | $0.95 | $1.02 | $0.99      | 68.28%
| Fixed costs†             | $0.54   | $0.85   | $0.80          | $0.58 | $0.64 | $0.66      | 45.52%

* Man, woman, and child.
† Costs which must be met annually whether sugaring is engaged in or not include depreciation, interest, and taxes.
REASONS FOR VARIATIONS IN COST

So many factors must be considered that it is not easy to state definitely why the cost of producing maple sirup varied so widely on the farms studied. Some general conclusions seem justified, however, from an analysis of the 208 records. The factors which appeared most to affect the cost of production were (1) the size of the sugar bush, or orchard, (2) efficiency in use of labor, and (3) the yield of sugar per tree.

Influence of size of orchard on cost

Since a certain minimum amount of equipment and labor is necessary no matter how little or how much sugaring is to be done, it seems likely that the larger the number of units this cost can be spread over, the lower the cost per unit.

Analysis of the influence of size of orchard on cost of production showed the same results in both States for the three seasons studied. In Vermont in 1921, the larger the business done, as expressed in the number of trees in the sugar bush, the lower the cost per gallon (table 4). Where there

<table>
<thead>
<tr>
<th>Number of farms in each group</th>
<th>Range in number of trees in sugar bush</th>
<th>Average number of trees per sugar-bush in group</th>
<th>Cost per gallon of sirup</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>450 or less</td>
<td>327</td>
<td>$1.62</td>
</tr>
<tr>
<td>15</td>
<td>451 to 750</td>
<td>605</td>
<td>1.61</td>
</tr>
<tr>
<td>15</td>
<td>751 to 1,000</td>
<td>882</td>
<td>1.47</td>
</tr>
<tr>
<td>14</td>
<td>1,000 to 1,500</td>
<td>1,207</td>
<td>1.17</td>
</tr>
</tbody>
</table>

was an average of 1207 trees per sugar bush, the cost per gallon averaging $1.27; whereas with sugar bushes averaging 327 trees, the cost was $1.62 a gallon.

In New York, in 1922, the number of trees per sugar bush ranged from 200 to 3000, and again it will be seen (table 5) that the larger the business done, the smaller the cost per gallon. In the 3000-tree sugar bush, sirup was produced at 54 cents a gallon. Where there was an average of 1743 trees per sugar bush, the cost was around $1.09 a gallon, while in the smallest group, averaging 294 trees per sugar bush, the cost was $1.62 a gallon.

These results seem readily explained. It takes almost as much time to get the sugar house and the equipment ready for tapping 500 trees as for 1500. Many sirup makers have equipment capable of handling two or three
times the quantity of sirup made annually. Items of interest, depreciation, and taxes are almost as large for the small sugar bush as for the large one. The more nearly the maximum sirup capacity of the equipment is approached, the lower the cost is likely to be.

Efficiency in use of labor

The range in the hours of human labor used on the different farms in making 100 gallons of sirup was truly amazing. One Vermont farmer in 1921 produced 100 gallons of sirup with only 71 hours of human labor, while his neighbor, within hailing distance, used 416 hours for the same purpose. Farmers who used around 1.15 hours of human labor per gallon

produced sirup at approximately half as great a cost as those who used 3.76 hours for the same purpose (table 6). This indicates how extremely important it is to get efficiency in use of labor.

The results obtained in Vermont in 1921 were practically duplicated in New York in 1922 (table 7), altho the range in hours of human labor was somewhat less. One farmer produced sirup using only 1.03 hours of human labor per gallon, while another used 2.90 hours for the same purpose.

The number of hours necessary in sugaring will vary with the seasons, but it seems likely that from 150 to 200 hours per 100 gallons of sirup produced is about all profitable production will stand.
TABLE 7. Relation of Number of Hours of Human Labor per 100 Gallons of Sirup to Cost per Gallon, 43 New York Farms, 1922

<table>
<thead>
<tr>
<th>Number of records in group</th>
<th>Range in hours of human labor per 100 gallons of sirup</th>
<th>Average number of hours of human labor per 100 gallons of sirup</th>
<th>Average cost per gallon of sirup</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Less than 140</td>
<td>122</td>
<td>$0.96</td>
</tr>
<tr>
<td>13</td>
<td>141 to 175</td>
<td>148</td>
<td>1.43</td>
</tr>
<tr>
<td>18</td>
<td>More than 176</td>
<td>230</td>
<td>1.70</td>
</tr>
</tbody>
</table>

The accessibility of the sugar bush has an important influence on the labor required and may be the factor determining whether a profit or a loss shall be made. It is likely that some sugar bushes are so difficult to work as to preclude any possibility of a profit. They may pay better if left for lumber.

One of the prime requisites in making efficient use of labor is to keep the labor profitably employed. One way of cutting labor cost is to have a large enough sugar bush to keep the labor busy. There is a fairly definite number of trees which one man can handle (tapping, boiling, and so forth) in sugaring. If he handles only one-half or one-fourth as many as this number, the labor cost is likely to be high.

TABLE 8. Relation of Size of Sugar Bush to Hours of Labor Used in Producing 100 Gallons of Sirup, 43 New York Farms, 1922

<table>
<thead>
<tr>
<th>Range in number of trees per sugar bush</th>
<th>Average number of trees per sugar bush</th>
<th>Number of farms in group</th>
<th>Hours of human labor per 100 gallons of sirup</th>
</tr>
</thead>
<tbody>
<tr>
<td>449 or less</td>
<td>294</td>
<td>11</td>
<td>206</td>
</tr>
<tr>
<td>450 to 699</td>
<td>541</td>
<td>12</td>
<td>183</td>
</tr>
<tr>
<td>700 to 999</td>
<td>701</td>
<td>13</td>
<td>157</td>
</tr>
<tr>
<td>More than 1,000</td>
<td>1,793</td>
<td>7</td>
<td>139</td>
</tr>
</tbody>
</table>

The producers with the largest sugar bushes used labor most efficiently (table 8). Sugar bushes averaging about 1700 trees required only 1.39 hours of human labor per gallon as compared with 2.06 for sugar bushes averaging about 300 trees.

Production of maple sugar per tree

For the years 1918 to 1925, inclusive, Vermont is credited with producing an average of 1.94 pounds of maple sugar per tree and New York 2.15 pounds per tree.29 There were, however, wide variations in yields per tree

in both States. In 1922, ten New York farms produced only 1.65 pounds of sugar per tree, while sixteen farms averaged 3.55 pounds per tree; in Vermont during 1921, 18 farms averaged 1.2 pounds per tree, while 23 farms averaged 2.3 pounds per tree.

The production of sugar per tree exercises a considerable influence on the cost of producing a pound of sugar or a gallon of sirup. The sugaring season of 1921 was not a normal one; it opened early and the run of sap was short and below average. Under these circumstances, the number of pounds of sugar produced per tree seems markedly to have influenced the cost of production (table 9).

### TABLE 9. Relation of Yield of Sugar per Tree to Cost of Production per Gallon of Maple Sirup, 60 Vermont Farms, 1921

<table>
<thead>
<tr>
<th>Number of farms in group</th>
<th>Range in yield of pounds of sugar per tree</th>
<th>Average pounds of sugar per tree per group</th>
<th>Cost per gallon of sirup</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>1.5 or less</td>
<td>1.2</td>
<td>$2.08</td>
</tr>
<tr>
<td>19</td>
<td>1.6 to 2.0</td>
<td>1.8</td>
<td>1.36</td>
</tr>
<tr>
<td>23</td>
<td>More than 2.0</td>
<td>2.3</td>
<td>1.28</td>
</tr>
</tbody>
</table>

The sugaring season of 1922 in New York would probably be termed a fairly normal and average one. There was, however, a wide variation in the yield of sugar per tree on the various farms (table 10). The lowest yield was 1.09 pounds per tree; the highest yield was 6.4 pounds per tree. Altho the average yield of sugar per tree was greater in New York in 1922 than in Vermont in 1921, yield was still a very important factor in determining the cost of production.

Young concluded, from his studies in Vermont in 1922, that: "No single factor has as great an influence on the cost as the production per bucket, but since there is no known method of improving production this factor has little practical significance except to help settle the question.

### TABLE 10. Relation of Yield of Sugar per Tree to Cost of Production per Gallon of Maple Sirup, 43 New York Farms, 1922

<table>
<thead>
<tr>
<th>Number of farms in group</th>
<th>Range in yield of pounds of sugar per tree</th>
<th>Average pounds of sugar per tree per group</th>
<th>Cost per gallon of sirup</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Less than 2</td>
<td>1.65</td>
<td>$1.76</td>
</tr>
<tr>
<td>17</td>
<td>2 to 3</td>
<td>2.34</td>
<td>1.44</td>
</tr>
<tr>
<td>16</td>
<td>More than 3</td>
<td>3.55</td>
<td>1.12</td>
</tr>
</tbody>
</table>

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30 Young, H. P. Cost of producing maple syrup and sugar on 52 Vermont farms in 1922. College of Agriculture, University of Vermont, Burlington, Vermont. ( Mimeographed report.)
whether the trees should be kept for sugar or cut for lumber or wood, especially in orchards of consistently low production."

There can be little doubt that the yield per tree has a very important influence on cost of production. It is doubtful, however, whether the individual can do much to increase the production per tree beyond careful pruning and clearing of the sugar bush to insure a maximum of leaf surface exposed to sunlight.

More recent studies of the cost of producing maple sirup in Vermont (1925) and in Pennsylvania (1931) substantially confirm the conclusions given on the preceding pages.

In a study of 457 Vermont farms in 1925, Hitchcock concluded that:31

The cost of production of maple syrup, as herein computed, is made up of the following items: labor, 27 per cent; horse labor, 10 per cent; wood, 16 per cent; interest on equipment, 9 per cent; repairs and depreciation on equipment, 13 per cent; interest on orchard, 18 per cent; taxes, 7 per cent.

Three factors, size of orchard, quality of the sap, and yield of syrup per bucket, were found to affect production cost. Of these orchard size is of considerable importance, sap quality is of minor importance, and yield is extremely important.

The price secured by the farmer for his product depends in any given year upon the market in which it is sold and its grade.

The margin between wholesale and retail prices for maple products is wide enough to repay well the extra effort involved in sale direct to the consumer.

Production costs were no higher, in fact they were somewhat lower, in the orchards in which syrup of high quality was made than they were in those producing poor syrup. The competent sugar maker reaped the double benefit of prices above and costs below the average.

Average costs of producing a gallon of sirup in bulk in Vermont in 1925 were given as follows:32

<table>
<thead>
<tr>
<th>Item</th>
<th>Rate</th>
<th>Cost per gallon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Man labor</td>
<td>$0.258 per hour</td>
<td>$0.452</td>
</tr>
<tr>
<td>Horse labor</td>
<td>0.162 per hour</td>
<td>0.172</td>
</tr>
<tr>
<td>Fuel</td>
<td>4.51 per cord</td>
<td>0.275</td>
</tr>
<tr>
<td>Interest on equipment</td>
<td>5 per cent</td>
<td>0.154</td>
</tr>
<tr>
<td>Repairs and depreciation</td>
<td>6.9 per cent</td>
<td>0.313</td>
</tr>
<tr>
<td>Interest on orchard</td>
<td>5 per cent</td>
<td>0.312</td>
</tr>
<tr>
<td>Taxes</td>
<td>2 per cent</td>
<td>0.115</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
<td>0.005</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1.698</td>
</tr>
<tr>
<td>Credit, byproducts</td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td>Net cost of sirup</td>
<td></td>
<td>1.694</td>
</tr>
</tbody>
</table>

In 1931, McIntyre studied the cost of producing maple sirup on 41 Pennsylvania farms,33 and found that the size of the maple-products enterprise (expressed as number of trees tapped, number of buckets hung) was

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the most important factor. Cost of producing a gallon of maple sirup ranged from $2.087 where less than 500 buckets were hung to $1.542 where more than 2000 buckets were hung. Other factors influencing costs in Pennsylvania, according to McIntyre, were investment costs, quality of sap, and yield of sap per bucket.

INTERPRETATION OF COST FIGURES

Figures should not always be taken literally. Great care should be exercised in attempting to interpret these cost-of-production data, and conclusions should be arrived at only after a careful study of the facts and one's personal problem.

Depreciation and interest on equipment and interest and taxes on a sugar bush comprise from 37 to 44 per cent of the cost of production annually. If a sugar maker should decide not to engage in sugaring operations in any one year, he would still have at least interest and taxes to sustain, without any product to help him pay expenses.

Sugaring comes at a time of year when it may be difficult to find enough profitable employment on the farm. On many New York and Vermont farms where a sugar bush is worked, practically the only work done during the winter is that of taking care of livestock. This work does not usually occupy the full day, as is proved by the practice of many farmers in seeking to engage in teamwork, lumbering, and the like. In some sections, the end of the sugaring season does interfere slightly with the spring plowing.

In Vermont and New York it took on the average 1.863 hours of human labor and 0.847 hours of horse labor to produce one gallon of sirup (table 11).

According to data gathered by the Bureau of Agricultural Economics, United States Department of Agriculture, the price received for maple sirup by Vermont and New York producers for the years 1921 to 1925,

<table>
<thead>
<tr>
<th>Item</th>
<th>Vermont</th>
<th>New York</th>
<th>Both States</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1921</td>
<td>1922</td>
<td>1923</td>
</tr>
<tr>
<td>Human labor</td>
<td>2.03</td>
<td>2.00</td>
<td>1.9</td>
</tr>
<tr>
<td>Horse labor</td>
<td>0.998</td>
<td>0.8</td>
<td>0.7</td>
</tr>
</tbody>
</table>

has ranged from $1.32 to $2.20 and has averaged from $1.90 to $1.93 a gallon. With an average cost of production (minus human labor) of 99 cents, and allowing 15 cents per can for containers, it appears that the producers in Vermont and New York on the average have received 76
cents for their human labor, or about 41 cents per hour. Assuming that the average cost of production, minus human labor and plus the cost of container, was $1.14, the returns per hour of human labor at varying prices per gallon are estimated in table 12 for the convenience of any farmer who desires a rough basis for calculating the probable profit or loss in sugaring.

<table>
<thead>
<tr>
<th>Price paid producer per gallon of sirup in gallon container</th>
<th>Gross returns for human labor per gallon</th>
<th>Returns per hour of human labor†</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1.30</td>
<td>$0.16</td>
<td>$0.086</td>
</tr>
<tr>
<td>1.40</td>
<td>0.26</td>
<td>0.140†</td>
</tr>
<tr>
<td>1.50</td>
<td>0.36</td>
<td>0.193</td>
</tr>
<tr>
<td>1.60</td>
<td>0.46</td>
<td>0.247</td>
</tr>
<tr>
<td>1.70</td>
<td>0.56</td>
<td>0.301</td>
</tr>
<tr>
<td>1.80</td>
<td>0.66</td>
<td>0.354</td>
</tr>
<tr>
<td>1.90</td>
<td>0.76</td>
<td>0.408</td>
</tr>
<tr>
<td>2.00</td>
<td>0.86</td>
<td>0.462</td>
</tr>
<tr>
<td>2.25</td>
<td>1.11</td>
<td>0.596</td>
</tr>
</tbody>
</table>

* Assuming the average cost of production (minus human labor) to be 99 cents, and adding 15 cents as the estimated cost of a one-gallon tin container, the gross cost to producer (minus human labor) would be $1.14 per gallon.
† Assuming an average of 1.863 hours of human labor per gallon.
‡ The returns per hour of human labor would increase $0.0053676 for each increase of one cent in sales price per gallon.

In interpreting the foregoing data, it must be borne in mind that price levels and wage levels have changed materially during the past fifteen years. From 1921 to 1923, the index number of farm prices received by New York farmers averaged 140, or 40 per cent above the pre-war index, as compared with 147 in 1925, 102 in 1931, and 92 in 1934. The index number of farm wages with board paid by New York farmers averaged 170 during 1921 to 1923, as compared with 197 in 1925, 142 in 1931, and 95 in 1934.

Before deciding not to sugar in any given season, a farmer may well ask himself three questions: (1) What costs will have to be borne whether sugaring is carried on or not? (2) What other employment is available which will pay as well as sugaring? and (3) With what farm operations will sugaring interfere and how seriously?

The average cost figures seem to indicate that some farmers lose money sugaring. In the majority of cases, however, they probably receive a somewhat lower return for their labor than they feel reasonably entitled to, and still make some profit. No attempt is made to judge as to the fairness of the returns per hour, but it is obvious that even a low return is better than
nothing, especially if it serves to keep labor employed which would otherwise be idle.

In general, sugaring has added to the labor income of producers in the sugar-producing regions. It should probably be continued as an important farm enterprise in those regions.⁴⁴

**MARKETING MAPLE PRODUCTS⁴⁵**

The data available concerning the marketing of maple products are meager and, for the most part, general in character.

It is estimated that from 15 to 20 per cent of the maple sirup and sugar produced goes directly from the farms to the consumers. The remaining 80 or 85 per cent is ordinarily sold to manufacturers or processing plants in 55-gallon steel drums, if sirup, or 35-pound tubs, if sugar.

The manufacturer or processor, in turn, bottles or cans the best grade of sirup or converts it into good-quality sugar. A large percentage of the lower grade of sirup is made into block sugar and sold for flavoring purposes to tobacco manufacturers, ice-cream and confectionery makers, and blended-sirup manufacturers.

**COMPETITION WITH OTHER SIRUPS**

Despite the fact that the demand for cane sugar has steadily increased, statistics compiled by the United States Department of Agriculture indicate that the consumption of maple sugar and sirup has actually declined. Several factors seem to have an important bearing on the demand for maple products.

Apparently the demand for pure maple sirup is confined to residents or former residents of maple-sirup-producing regions, or to persons with whom these residents have made contacts. A large proportion of the population of the United States, especially those foreign born or of foreign parentage, are unacquainted with pure maple sirup. A great many native born Americans have never tasted pure maple sirup or are entirely unable to differentiate between a blend and the pure article.

Pure maple sirup is a quality product and its price is always relatively high as compared with sirup made from corn or cane, or even blended sirups. All consumers are probably interested in quality, but the majority of consumers seem unwilling to buy pure maple sirup at a price appreciably greater than that asked for corn or cane or blended sirups. This is partly

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⁴⁴For the convenience of those who wish to use them, blank forms will be found on pages 74 to 75 for calculating cost of production per gallon, cost of marketing per gallon, and gain or loss on the maple-sirup enterprise.

⁴⁵In writing this section of the bulletin, the author (M. P. Rasmussen) has quoted freely from Vermont Agricultural Experiment Station Bulletin 227, "Marketing Vermont Maple Sap Products," by A. W. McKay, of the United States Department of Agriculture, Washington, D. C. Appreciation is due Mr. McKay for his excellent study of this phase of the maple-products industry.
due to the higher cost, but also because the distinctive maple flavor makes no special appeal to them.

The widespread use of maple products in the manufacture of blended sirups may be detrimental to the maple-products industry, but it is doubtful whether the whole crop could be marketed, under existing conditions, as pure maple products. For the present, at least, the blended-sirup industry offers an outlet for lower grades of sirup and sugar which might otherwise be a drug on the market.

"Blended sirup has come into direct competition with pure maple sirup, and now largely dominates the table sirup market. Lack of organization among the maple-sap producers has made possible the virtual elimination of their product from trade channels. At least 65 percent of the sirup now produced is sold in bulk to manufacturers of blended sirup, or to tobacco manufacturers for flavoring purposes. From the point of view of the manufacturer, the blended sirup business is more desirable than the pure sirup business. In the first place, it does not require so great an outlay of capital. The maple sugar or sirup required for flavoring purposes represents, as a rule, only 15 to 25 percent of the total product. This must be purchased during or shortly after the maple-sap season, and capital invested in these goods is tied up for a year, or in any event can not be turned over more than once a year. However, cane sugar, which represents 75 to 85 percent of the finished product, can be purchased on the open market at any time under normal conditions, and in any quantity required. The capital invested in cane sugar, therefore, may be turned over four or five times during the year. In addition it enables the manufacturer to establish a grade which is uniform for each shipment and from season to season. There are seasonal variations in the color and quality of pure maple sirup, and also variations in the product of different producers which make absolute uniformity of grade an impossibility. Furthermore, he has a product comparable with pure maple sirup in appearance which he can offer at a lower price.

The wholesalers, retailers, and the majority of the consumers are kindly disposed towards blended sirups on account of the uniformity mentioned, the fact that there is a dependable source of supply, and because the article is offered them at a lower price.

Added to this, the manufacturers of blended sirup have been active in extending the sale of their goods. The only competition they have had has been of unorganized producers unschooled in business practices. It is not surprising, therefore, that the sale of blended sirups has greatly increased in the last ten years, or that the sale of pure sirup has greatly declined. As an example of the extent to which blended sirups have supplanted pure maple sirup, a Vermont manufacturer stated that in 1920 one of his customers bought 600 gallons of pure maple sirup from him and approximately 22,000 gallons of blended sirup. Ten years ago, this customer handled only pure maple sirup and the manufacturer stated that he would have been insulated if he had been offered blended sirup.

Vermont maple sirup, therefore, and this is largely true of all maple sap producing states, has been marketed under a system which has discouraged the sale of the pure product. Instead of being marketed in pint and quart cans or bottles, as one would naturally expect, the greater proportion of the product is sold in 55-gallon drums or as sugar in tubs or 65-pound blocks. Instead of being placed upon the market in the pure form, as a delicacy, it is sold to a large extent in bulk for flavoring purposes. As a bulk article, and as what must be considered a raw product, it naturally does not command a high price.

The most serious shortcoming of the present marketing system, however, is the fact that it has failed to encourage, and as a matter of fact, has actually discouraged the production of maple-sap products of high quality. It is not to be expected that a man will take any great amount of pride in the production of a product which he sells in bulk. During the period of the war, maple sirup and sugar of all grades was sold at a uniform price. In 1921, No. 1 sirup, including fancy quality, was sold very generally.

for only 15 cents per gallon more than was paid for the No. 2 and No. 3 grades. It is hardly possible that the percentage of No. 1 sirup produced in Vermont has declined. On account of the general introduction of patented evaporators, metal bucket, bucket covers, and other improvements, it has probably increased. However, the fact remains that from 60 to 75 percent of the sirup produced in Vermont is not of desirable table quality, and it would seem that the method of marketing the product must bear the primary responsibility for this condition.

CONSUMERS' DEMAND

From a survey of the Boston, New York, and Philadelphia markets in 1922, Elsworth\footnote{Elsworth, R. H. In Marketing Vermont maple-sap products. By A. W. McKay. Vermont Agr. Exp. Sta. Bul. 227:34-35. 1922.} concluded that sales of pure maple sirup are confined largely (1) to comparatively wealthy customers served by fancy grocers, and (2) to individuals reared in maple-sap districts, or accustomed to maple products since childhood. This latter class, in many instances, orders directly from the producers. The wealthy purchasers of maple products buy from their grocers:

At the same time pure maple sirup is sold in many, but not all, chain stores and grocery stores serving people in moderate circumstances. However, the amount sold in stores of this kind is very much less than the quantity of cane and blended sirup sold during the same period. The sirup man for a system of 1,200 chain groceries with headquarters in Philadelphia stated that their sales of pure maple sirup were 1/400 of their cane and blended sirup sales. Another chain of 5,200 retail stores, located north of the Potomac and Ohio Rivers, reports that their sales for last year were approximately 25,000 cases (2 dozen 11-ounce bottles) of pure maple sirup, 25,000 cases of maple blend and 200,000 cases of other sirups.

These stores and others of the same class attribute the greater sales of cane sirups entirely to the lower price.

The high class hotels and restaurants are also customers for pure maple sirup. However, they do not use the quantity of sirup that is commonly supposed. Each of the large, first-class hotels in New York City consumes, on the average, about 300 gallons of maple sirup annually. These hotels must have a light colored sirup, made from the “first-run” sap and put up in gallon cans.

The fancy groceries catering to the best trade for the most part prefer maple sirup in cans and in quart, half-gallon and gallon packages. The small stores prefer sirup in bottles, and in smaller units. An 11-ounce bottle appears to be the most popular size. These trade preferences are well established. Particularly is it necessary to furnish the small groceries with sirup in a small container, as the majority of their customers purchase supplies from day to day and do not care to have a large quantity on hand. Out of 40 stores visited in New York City only 20 handled pure maple sirup.

In October, 1926, the manager of a large maple-products concern advised the author that out of sales of 10,747 gallons of maple sirup during 1925, 43 per cent were in gallon tins and 42 per cent were in quart tins (table 13).

This concern markets its products in units varying from a 50-gallon drum to small cakes of sugar running about 75 to the pound. The data in table 13 cover 347 sales to retailers and include maple sirup only. Sales to jobbers usually include a much larger proportion of glass containers, while sales direct to consumers do not include any glass containers at all.

The manager of this concern expressed great confidence in the possibilities of the round, sanitary quart can as opposed to the rectangular gallon can now so widely used. The 1-gallon can has been the standard retail
TABLE 13. Sizes of Containers Used in Merchandising 10,747 Gallons of Maple Sirup, 1925

<table>
<thead>
<tr>
<th>Size of container</th>
<th>Number of gallons</th>
<th>Per cent of total sold</th>
<th>Size of container</th>
<th>Number of gallons</th>
<th>Per cent of total sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 gallons</td>
<td>145</td>
<td>1.35</td>
<td>½ gallon</td>
<td>23</td>
<td>0.21</td>
</tr>
<tr>
<td>1 gallon</td>
<td>4,659</td>
<td>43.35</td>
<td>1 quart</td>
<td>141</td>
<td>1.31</td>
</tr>
<tr>
<td>½ gallon</td>
<td>394</td>
<td>3.67</td>
<td>1 pint</td>
<td>627</td>
<td>5.83</td>
</tr>
<tr>
<td>1 quart</td>
<td>4,472</td>
<td>41.61</td>
<td>½ pint</td>
<td>11</td>
<td>0.10</td>
</tr>
<tr>
<td>1 pint</td>
<td>189</td>
<td>1.76</td>
<td>½ pint</td>
<td>86</td>
<td>0.80</td>
</tr>
<tr>
<td><strong>Total in tin</strong></td>
<td><strong>9,859</strong></td>
<td><strong>91.74</strong></td>
<td><strong>Total in glass</strong></td>
<td><strong>888</strong></td>
<td><strong>8.26</strong></td>
</tr>
</tbody>
</table>

package for maple sirup for a great many years. Retailers are slow in making the change to the quart can because it has hitherto been unprofitable to do so. The growing demand for quart cans, however, seems to indicate that this change will eventually be made.

**MARKETING DIFFICULTIES**

In discussing the marketing of maple products, the widely varying grades and kinds of goods must be borne in mind. A faulty feature of the present marketing system is the failure to make sufficient discrimination between grades of sirup.

The processing and marketing of maple-sap products is a complicated problem. A processing plant and expensive machinery are required and the operation of the plant requires a fair amount of technical skill. The marketing of maple sirup is at least as difficult as that of other farm products. There is apparently a lack of enthusiasm among wholesalers and retailers regarding pure maple sirup, and a consumers' demand must be built up. On the other hand, the product lends itself to preparation in such a variety of ways that an attractive brand and standard product should be quite easily established.

A great many maple-sap producers are indebted to local merchants, who act as buyers for the large dealers. These men are under obligation to sell their sirup to these merchants.

Financial difficulties are also considerable. The most serious is the difficulty of carrying the maple-sap products through the summer. The producers in nearly all cases depend upon money received for their maple-sap products to give them the ready cash necessary to start their farming operations and pay taxes and bills contracted at the local stores through the winter. To merchandise maple-sap products scientifically they must be distributed to the trade throughout the year. In the case of sirup there is an active demand for about two months after the sap season. Demand then falls off until about the first of September and there is then an active demand through the fall and winter months. Hence it is necessary to carry two-thirds to three-fourths of the product for approximately six months, and it seems equally necessary to advance the producers at least a portion of the value of these products.

**The problems**

The problems which now confront the producers of maple sirup and sugar are briefly the following:

1. To improve the methods of gathering and concentrating the sap in order to increase the output of first grade sugar and sirup.

2. To standardize grades, packages and handling methods.
3. To provide marketing machinery for the regular and uniform distribution of pure maple-sap products to the consumers.
4. To widen the market and increase demand for pure products.

On the average, less than one-third of the maple sirup and sugar produced is of sufficiently high quality to sell readily in the pure form. The remainder must be sold as a bulk product and is used largely for flavoring. No. 1 goods, if properly marketed, will bring the producers profitable returns and will advertise the maple-products industry. On the other hand, low grade sirup, in the future, will bring very little if any margin over the cost of production. It does not reach the consumer in the form of a pure product and in no wise adds to the prestige of the maple-sap industry. As a matter of fact it makes possible a large part of the blended sirup business which is strictly competitive with pure sirup.

Methods of producing sirup of a desirable quality have been established for many years. If a farmer now produces a sirup or sugar of low quality, it is either because he has not been worth his while to inform himself as to improved methods or because there is not been worth his while to put into practice the information which he possesses. The facts of the case are that low grade sirup has brought almost as much as the finest quality. No improvement in production methods can be expected until a marketing system is adopted which will reimburse the producer of No. 1 sirup in accordance with quality.

The standardization of grades and packages implies concerted action on the part of the producers, or on the part of the dealers and producers. With regard to grades there is very little to be done. The color standards which have been promulgated, together with proper allowances for flavor and density, constitute a thoroughly satisfactory standard. The standard must be made public, and the support of dealers and producers secured. Following this comes the practical problem of supplying to consumers a grade of pure sirup—uniform year after year in color and flavor—packed in standard containers. In order to secure and maintain uniformity of grade the sirup must be processed and canned at a central point.

The regular and uniform distribution of pure sirup and sugar to the consumers can not be accomplished under the present marketing system. The farmer, working as an individual, can not bring this about, because his marketing is necessarily spasmodic and his product is lacking in uniformity. The greater part of the sirup sold by the producer direct to the consumer is shipped within two months after the sugar season. No provision is made for the demand which arises the following fall and winter. Efficient merchandising of the pure product demands a uniform distribution while the demand is active.

To the average manufacturer, the pure sirup business is largely a side line. His efforts are naturally most strongly directed to the disposal of his main product, which may be commercial maple sugar or blended sirup. It seems likely that only through organization can the producers hope to control the distribution of their crop, or make available a regular, uniform supply preventing gluts and shortages.

The problem of increasing the demand for pure maple sirup and sugar actually exists and must be met. It is a problem which the producers must solve themselves. No one else is interested in extending the market for maple sirup. The dealers naturally are interested in making a profit. It is immaterial to them whether they handle [pure] maple sirup or a blended product. The consumer will accept what he can buy and no doubt consider it entirely satisfactory. Now to increase the demand for any product the producers will probably have to do three things: They must organize, they must standardize, and they must merchandise their products. There does not seem to be any way in which they can avoid these activities.

It will be noted that in this discussion, reference is made only to pure sugar and sirup which is relatively high in quality. So long as low grade sirup and sugar are produced, the manufacturers of blended sirup, the tobacco manufacturers, or dealers supplying this trade offer the best market. The efforts of producers' organizations, however, should be directed towards increasing the production of and extending the market for high quality products. It is this class of goods which will bring them profitable returns and enhance reputation.

Merchandising methods, which include advertising, must be developed. Maple-sap products must be prepared in a form and packed in containers which will meet the needs of consumers and attract new customers. It is essential that demand for Vermont maple-sap products be extended and strengthened and a systematic advertising campaign is necessary to accomplish this.
SUMMARY OF COST OF PRODUCING MAPLE PRODUCTS

1. Fuel: Cords of wood ........ $ ........ per cord ... $ .......
2. Other fuel ........ $ ........ per ton ... $ .......
3. Repairs on equipment ....................... $ .......
4. Depreciation on equipment ............... $ .......
5. Interest @ ....... % on investment in equipment .. $ .......
6. Interest @ ....... % on investment in sugar bush ... $ .......
7. Taxes on sugar bush and equipment ........ $ .......
8. Horse labor ........ hours @ ........ $ per hour ... $ .......

9. Costs other than human labor ............... $ .......
10. Man hours @ ........ $ per hour .......
11. Woman hours @ ........ $ per hour .......
12. Boy hours @ ........ $ per hour .......
13. Total costs of human labor ............... $ .......

14. TOTAL COST OF PRODUCING MAPLE PRODUCTS IN BULK $ .......

15. Total pounds of sugar produced ........ pounds
16. Total gallons of sirup produced ............ gallons
17. Sugar reduced to equivalent of sirup ........ gallons
   (Divide pounds of sugar produced by 8)
18. Sirup reduced to equivalent of sugar ........ pounds
   (Multiply gallons of sirup produced by 8)
19. Total all maple products reduced to sirup ......... gallons
   (Add line 16 and line 17)
20. Total all maple products reduced to sugar ........ pounds $ .......
   (Add line 15 and line 18)
21. Cost per gallon of sirup ......................... $ .......
   (Divide line 14 by line 19)
22. Cost per pound of sugar ......................... $ .......
   (Divide line 14 by line 20)
COST OF MARKETING MAPLE PRODUCTS

1. Gallon cans @ each $.
2. 5-pound tin pails @ each $.
3. 10-pound tin pails @ each $.
4. Wooden pails @ each $.
5. Barrels @ each $.
6. Paper boxes @ each $.
7. Wrappers and labels @ each $.
10. Advertising $.
11. Correspondence $.
12. Miscellaneous $.
13. Horse labor hours @ per hour $.

(Hauling to station, etc.)

14. Marketing costs other than human labor $. (Packing, crating, and hauling to station)

15. Man hours @ per hour $.
16. Woman hours @ per hour $.
17. Boy hours @ per hour $.

18. Total costs of human labor $.

19. TOTAL COST OF MARKETING MAPLE PRODUCTS $. 

20. Marketing cost per gallon of sirup $. (Divide cost of marketing by number of gallons marketed after reducing sugar marketed to sirup basis. Divide pounds of sugar marketed by 8 to get number of gallons marketed)

21. Marketing cost per pound of sugar $. (Divide marketing cost per gallon by 8.)
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