U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF FORESTRY—BULLETIN No. 59.

GIFFORD PINCHOT, Forester.

# THE MAPLE SUGAR INDUSTRY.

BY

WILLIAM F. FOX,

COLLABORATOR, BUREAU OF FORESTRY,

AND

WILLIAM F. HUBBARD, Sc. Pol. D.,

FOREST ASSISTANT, BUREAU OF FORESTRY.

WITH A DISCUSSION OF

## THE ADULTERATIONS OF MAPLE PRODUCTS.

BY

H. W. WILEY,

CHIEF, BUREAU OF CHEMISTRY.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1905.

## BUREAU OF FORESTRY.

GIFFORD PINCHOT, *Forester.*

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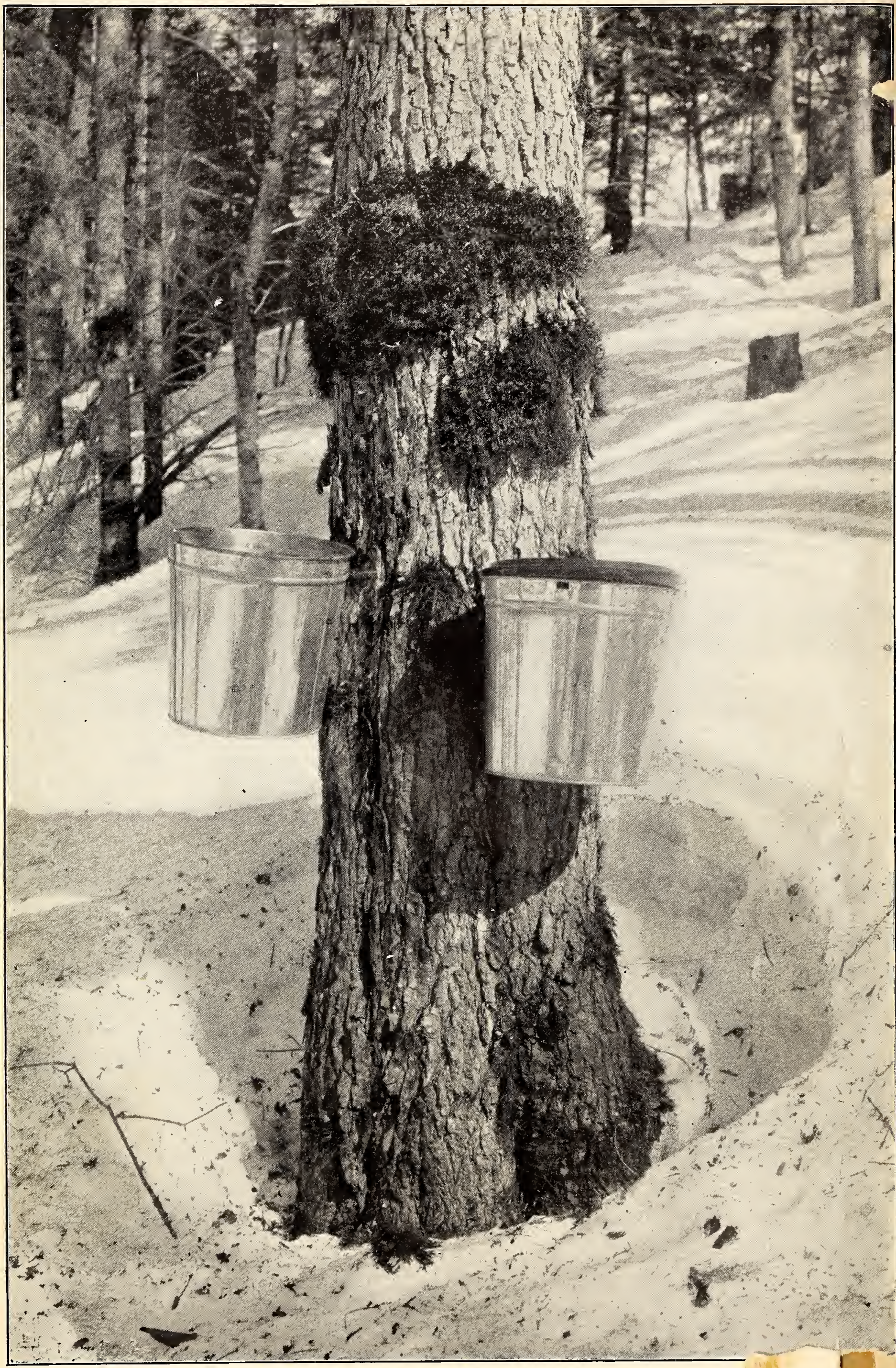

ADIRONDACK SUGAR MAPLE.

A productive tree in the sap season. Modern buckets properly hung.

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# LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Forestry,
*Washington, D. C., February 14, 1905.*

Sir: I have the honor to transmit herewith a report entitled "The Maple Sugar Industry," by Col. William F. Fox, Collaborator in the Bureau of Forestry, and Dr. William F. Hubbard, Forest Assistant in the Bureau of Forestry, accompanied by a discussion of "The adulteration of maple products," by Dr. H. W. Wiley, Chief of the Bureau of Chemistry, and to recommend its publication as Bulletin No. 59 of the Bureau of Forestry.

The eight plates and ten text figures accompanying this report are necessary for its proper illustration.

Very respectfully,

Gifford Pinchot,
*Forester.*

Hon. James Wilson,
*Secretary of Agriculture.*

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# THE MAPLE SUGAR INDUSTRY.

## HISTORY OF THE INDUSTRY.

### SUGAR MAKING BY THE INDIANS.

From time unknown the Indians tapped the maple trees for sugar. This they did by making a diagonal cut in the trunk of the tree and driving a reed or concave piece of bark into its lower end to convey the liquid into a bark trough or other receptacle. The sap was boiled down in clay or bark vessels by repeatedly dropping hot stones into it. A settler who was captured by the Indians tells us that his captors had sufficiently developed the art to store the sap in large troughs made of elm bark, often of a hundred gallons capacity, and to keep up a continuous production throughout the sap season.[a]

The Indians are also said to have converted sap into sugar by freezing it in shallow vessels of bark and throwing out the ice until sufficient water was removed to allow the sirup to crystallize. This method, although not much used, probably gave better results than boiling, since it did not afford so many chances for the collection of impurities.

### SUGAR MAKING BY WHITE SETTLERS.

For a hundred years or more conditions did not allow the white settlers to change materially the Indian method of producing maple sugar, save by the substitution of iron or copper kettles for vessels of clay or bark, and by the use of better utensils. Even the most progressive settlers did little more than to introduce greater cleanliness into the old, crude methods. The sugar was made on a small scale and merely for home use; cane sugar was a luxury and often unobtainable by the pioneer farmer at any cost. The trees were tapped in the Indian way and the sap was carried in buckets from the wooden troughs that stood under the spouts to the boiling kettle, or was temporarily stored in large troughs made by hollowing out logs. If the men at the fires could not keep ahead of the carriers in their work, the stock of sap accumulated and sometimes spoiled.

[a] Capture of James Smith in the years 1755–1759, written by himself. Philadelphia, 1851.

The boiling was generally done in the open woods, with no shelter from sun, rain, and snow. Leaves, pieces of bark, ashes, drippings from the trees, and miscellaneous impurities fell into the open pails and kettles. Green or dead and down timber, cut as fast as it was needed, generally supplied the fuel. The old-fashioned potash kettle (Pl. II, fig. 1), which was made to do duty each season, was suspended over the fire from one end of a long, heavy pole, which was balanced with weights at the other end so that it could be easily manipulated, either to regulate the distance from the heat or to swing the kettle on or off the fire. Cold sap, cold water, or milk was occasionally dashed into the kettle, or a piece of fat pork was suspended by a string just above the level of the liquid, to prevent the sap from boiling over. Impurities were skimmed from the surface, and after the sap had been boiled down to the consistency of thin sirup it was stored until a considerable quantity had been so treated. Converting the sirup into sugar was known as "sugaring off," and consisted in further boiling down the thin sirup until it would become waxy if dropped on snow. It was then ready to be poured into molds, where it crystallized into sugar.

In the course of time, however, the industry assumed commercial importance in the Northern States, with Vermont, New York, and, subsequently, Ohio leading in production. With the increasing demand for maple products a rapid improvement in the methods and machinery employed took place.

## IMPROVED METHODS OF SUGAR MAKING.

No exact date can be fixed for the beginning of maple sugar making as an industry. Sugar was doubtless bartered at country stores during the first years of the nineteenth century, but it probably did not begin to be shipped to central markets until about the middle of the century.

The crude product of early days was dark in color and very variable in quality, while in quantity it was quite inadequate for a large trade. An increased demand soon introduced more economical methods, both in tapping the trees and gathering the sap, and in the actual boiling and production of sirup and sugar. The improvements in the first direction consisted merely of conveniences or labor-saving devices, but in the second an absolute revolution in the process was effected.

One of the first important changes was the adoption of the auger hole and wooden or metal spout in place of the old destructive ax cut and open wooden spout. It was soon learned that an auger hole, while securing almost as great and a more prolonged flow of sap, was practically harmless to the tree as compared with a deep ax cut. At first a large auger (often 2 inches in diameter) was used, but gradually the hole has been reduced to its present size of three-eighths of an inch. Wooden spouts were employed for some time after the introduction of the auger hole, but metallic ones soon came into general use. Similarly, wooden and then tin or galvanized-iron pails gradually took the place of the rough wooden troughs which formerly caught the sap.

At first the sap was generally carried to the fire or sugarhouse in buckets, by hand or with a shoulder yoke; occasionally a barrel and sled, drawn by an ox team or horses, were added to the gathering outfit. But as the scale of operations increased the gathering tank was introduced, and is now used in all but the smallest groves. Where the work is on a large scale, pipes are often run through the bush, as the grove is sometimes called, connecting with the sugarhouse or with large storage tanks on the roadside, while in one large Adirondack sugar grove a narrow-guage railway is used for collecting sap.

The first great change in the actual process of sugar making came about the middle of the nineteenth century with the adoption of an iron pan in place of the old kettle. The earliest form of evaporator was a shallow pan 30 inches wide, 6 inches deep, and from 6 to 10 feet in length. This was supported by a thin-walled fire box of stone or brick. Nearly the entire under surface of the pan was exposed to the heat, which resulted in much more rapid evaporation, the use of less fuel, and the manufacture of a better quality of sirup and sugar. With the introduction of these evaporator pans, buildings for shelter were erected, most of them very rudely-constructed open shanties. A few lengths of rusty stovepipe placed at the rear end of the arch, as the fire box is called, carried the smoke outside. This form of pan was filled to a certain depth with sap, which, when reduced to a thin sirup, was poured out and the evaporator refilled. In 1865 pans with partitions to cause an alternating flow were introduced. This improvement allowed the sap to enter at one end of the evaporator and to flow from side to side through succeeding compartments, reaching the other end in the form of sirup, where it was drawn off into a receiving tank.

Thus the modern evaporator, an apparatus remarkable for the ingenuity displayed in its construction, and for its adaptability to the needs of the industry, has been evolved from the old, plain sheet-iron pan. Those in use to-day by the best sugar makers are of all sizes, but average about 6 inches deep, 40 inches wide, and from 10 to 18 feet long. They are often made with corrugated bottoms to increase the heating surface. Partitions from side to side, and open at alternate ends, are placed in them at intervals of from 8 to 10 inches. The sap, whose flow from the storage tank is carefully regulated, enters the evaporator at one end and flows slowly across the pan from side to side, around the partitions, until it reaches the far end. By that time it is reduced to the desired density.

The rate of sap flow into the evaporator is of the utmost importance. All of the latest models have automatic regulators, by which the inflow of sap increases or diminishes with the heat under the pan, and the sap is entirely cut off when the fire gets low. With such an arrangement no scorching of the sap is possible unless the supply tank becomes empty.

Improvements in the method of firing have kept pace with those in boiling. From the old, rough fire box has been evolved the modern portable arch, made of iron, with a flue running beneath the evaporator. It is lined with fire brick, and has grate bars and accurate dampers, so that the heat is more regular, while no smoke is allowed to escape. Its economy of fuel is many times greater than that of the old fire box. (Fig. 9.)

The latest improvement in sirup making was introduced by a large manufacturer in the Adirondacks. A series of steam pipes is placed in the evaporating pan and the sap made to flow over and around them. The process is most effective and cleanly, but, of course, can be carried out only where sugar is made on a large scale. (Pl. II, fig. 2.)

The sugar house has advanced with other improvements, and in well-ordered groves to-day it is a neat, well-built affair, with two rooms and a wood shed. The utmost cleanliness is insisted on and maintained.

It must not be supposed that the adoption of these improved methods has been universal. They are practicable chiefly for large operations. There are still many parts of the country in which sugar is produced only in a small way, or for home use, and almost every form of sugar making, even the primitive, may yet be found. But in the great producing centers of the North Atlantic and Lake regions, which mainly supply the market, improved methods are almost universally practiced.

## PRESENT STATUS OF THE INDUSTRY.

### DEVELOPMENT OF PRESENT CONDITIONS.

Maple sugar was made by the early settlers as an article of food, the West Indian cane sugar being costly and difficult to transport inland. The commonest kind of "muscovado," however, was preferred to maple sugar, if it could be obtained. With the increased supply of cane sugar there is little doubt that maple sugar would have almost ceased to be a commodity on the market but for its peculiar flavor, which, while objectionable for general purposes, created a special demand. Thus, while the cheaper and unflavored cane product has almost displaced maple sugar as an article of food, the demand for maple sirup and sugar as luxuries and flavoring materials not only keeps the industry alive, but calls for a continually increasing supply.

It would naturally be supposed that this growth in demand would have been followed by a corresponding increase in production. Such, however, is not the case; while the demand for maple sugar and sirup is continually increasing, the production has been more or less station-

FIG. 1.—BOILING MAPLE SAP IN THE WOODS.

FIG. 2.—MODERN STEAM EVAPORATOR.

The sap is reduced by passing over steam pipes in the pans.

ary for twenty years. (See p. 12.) The explanation lies in the fact that, at the very lowest estimate, seven-eighths of the product sold to-day is a spurious article, which is only in part maple sugar, or is manufactured entirely from foreign materials.

When maple sugar began to come into general demand, the market fell naturally into the hands of the wholesale dealers. The farmers were unorganized, and, as a rule, out of touch with the consumers. Consequently the sugar, made in the early spring, when the farmer was most in need of ready money, was generally either sold to the country store at a low price, or exchanged for cane sugar, pound for pound, irrespective of general market conditions. It was then bought again by the "mixers," and used to flavor a body of glucose or cane sugar six or ten times as great, making a product which was marketed as "pure maple sugar." The mixers preferred to buy a dark, inferior sugar, because it would go further in the mixture. If the season was bad they bought less, but at almost the same price, and increased the proportion of the adulterant. Thus a shortage in the maple sugar crop has no effect whatever on the general supply. It is also true that while the trade in maple sugar has been steadily growing, the production from the trees has remained stationary. The mixer controls the situation, with the effect of lowering the profits of the farmer, preventing a compensatory increase in price when the crop is short, and retarding progress in the industry by the demand for a low-grade tub sugar.

But there has always been a certain amount of trade in pure maple sugar and sirup. A part of the city and town population comes from the country, where they have known the genuine article, and they have generally been able to supply their wants by dealing directly with the producers. The progressive and well-to-do sugar maker has also worked in this field. Of course there are farmers and others who, having pride and capacity, do their utmost to produce the best goods and market them in the most advantageous manner. Such sugar makers are unwilling to sell their high-grade goods to the mixers at a low price, but make every effort to reach a steady market of regular customers.

In the effort to make such a market more general, several maple sugar makers' associations have come into existence. That of Vermont is the most notable. The annual meetings of this society have done much to stimulate improved methods, as well as to build up a legitimate trade. The association has established a central market, has adopted a registered trade-mark, and guarantees absolute purity. Its trade, through advertising and other business methods, has reached good proportions. But there is only a very small part of the business, even at the present time, which is not in the hands of the mixers.

TABLE I.—*Quantity and value of maple products made on farms in*

[From United States

| State. | Farms reporting. | 1900. Sugar. Quantity. | Sugar. Value. | Sirup. Quantity. | Sirup. Value. | Total value. | Percentage of total value. | Rank of sections and States. |
|---|---|---|---|---|---|---|---|---|
| | | *Pounds.* | | *Gallons.* | | | | |
| United States[a] | 62,718 | 11,928,770 | $1,074,260 | 2,056,611 | $1,562,451 | $2,636,711 | 100 | ........ |
| New England States | 13,142 | 5,425,160 | 530,961 | 246,652 | 216,510 | 747,471 | 28.3 | 3 |
| Maine | 641 | 5,500 | 643 | 16,024 | 15,277 | 15,920 | .6 | 11 |
| New Hampshire | 1,631 | 441,870 | 44,312 | 41,588 | 38,314 | 82,626 | 3.1 | 7 |
| Vermont | 9,811 | 4,779,870 | 464,132 | 160,918 | 134,821 | 598,953 | 22.7 | 3 |
| Massachusetts | 1,000 | 192,990 | 21,124 | 27,174 | 27,112 | 48,236 | 1.8 | 8 |
| Connecticut | 59 | 4,930 | 750 | 948 | 986 | 1,736 | .1 | 19 |
| Middle Atlantic States | 28,650 | 5,478,100 | 457,744 | 595,832 | 466,013 | 923,757 | 35 | 2 |
| New York | 20,567 | 3,623,540 | 307,184 | 413,159 | 323,996 | 631,180 | 23.9 | 2 |
| New Jersey | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Pennsylvania | 6,154 | 1,429,540 | 115,910 | 160,297 | 123,863 | 239,773 | 9.1 | 4 |
| Maryland | 209 | 264,160 | 20,561 | 5,825 | 3,622 | 24,183 | .9 | 10 |
| Virginia | 213 | 19,310 | 1,816 | 1,677 | 1,534 | 3,350 | .1 | 16 |
| West Virginia | 1,507 | 141,550 | 12,273 | 14,874 | 12,998 | 25,271 | 1 | 9 |
| Southern States | 21 | 1,180 | 117 | 129 | 117 | 234 | ........ | 4 |
| North Carolina | 21 | 1,180 | 117 | 129 | 117 | 234 | ........ | 21 |
| South Carolina | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Georgia | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Alabama | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Mississippi | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Louisiana | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Texas | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Central States | 20,901 | 1,024,330 | 85,438 | 1,213,827 | 879,638 | 965,076 | 36.6 | 1 |
| Ohio | 12,067 | 613,990 | 48,736 | 923,519 | 616,490 | 665,226 | 25.2 | 1 |
| Indiana | 4,467 | 51,900 | 4,372 | 179,576 | 161,935 | 166,307 | 6.3 | 5 |
| Illinois | 248 | 4,090 | 478 | 9,357 | 9,363 | 9,841 | .4 | 12 |
| Kentucky | 93 | 2,340 | 291 | 2,367 | 2,450 | 2,741 | .1 | 18 |
| Tennessee | 64 | 1,160 | 167 | 171 | 169 | 336 | ........ | 20 |
| Arkansas | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Missouri | 296 | 12,055 | 1,288 | 5,474 | 5,271 | 6,559 | .2 | 14 |
| Iowa | 83 | 2,320 | 280 | 2,662 | 2,640 | 2,920 | .1 | 17 |
| Michigan | 3,168 | 302,715 | 26,693 | 82,997 | 73,903 | 100,596 | 3.8 | 6 |
| Wisconsin | 268 | 4,180 | 400 | 6,625 | 6,478 | 6,878 | .3 | 13 |
| Minnesota | 147 | 29,580 | 2,733 | 1,079 | 939 | 3,672 | .1 | 15 |

[a] Values were not reported at any census prior to 1900. [b] Sugar only was reported at this census.

*census year 1900, and quantities reported in the census years 1850–1890.*[a]

Census Reports.]

| 1890. | | 1880. | | 1870. | | 1860. | | 1850.[b] |
|---|---|---|---|---|---|---|---|---|
| Sugar. | Sirup. | Sugar. | Sirup. | Sugar. | Sirup. | Sugar. | Sirup. | Sugar. |
| *Pounds.* | *Gallons.* | *Pounds.* | *Gallons.* | *Pounds.* | *Gallons.* | *Pounds.* | *Gallons.* | *Pounds.* |
| 32,952,927 | 2,258,376 | 36,576,061 | 1,796,048 | 28,443,645 | 921,057 | 40,120,205 | 1,597,589 | 34,253,436 |
| 16,900,264 | 407,136 | 15,069,241 | 304,999 | 11,269,877 | 59,871 | 13,509,872 | 110,349 | 8,588,083 |
| 84,537 | 71,818 | 153,334 | 82,006 | 160,805 | 28,470 | 306,742 | 32,679 | 93,542 |
| 2,124,515 | 81,997 | 2,731,945 | 79,712 | 1,800,704 | 16,884 | 2,255,012 | 43,833 | 1,298,863 |
| 14,123,921 | 218,252 | 11,261,077 | 128,091 | 8,894,302 | 12,023 | 9,897,781 | 16,253 | 6,349,357 |
| 558,674 | 33,632 | 878,793 | 13,017 | 399,800 | 2,326 | 1,006,078 | 15,307 | 795,525 |
| 8,617 | 1,437 | 44,092 | 2,173 | 14,266 | 168 | 44,259 | 2,277 | 50,796 |
| 12,497,995 | 635,963 | 14,134,760 | 445,648 | 9,044,539 | 117,421 | 14,588,593 | 356,350 | 13,961,611 |
| 10,485,623 | 457,658 | 10,693,619 | 266,390 | 6,692,040 | 46,048 | 10,816,419 | 131,843 | 10,357,484 |
| 210 | 134 | 2,496 | 334 | 419 | 5 | 3,455 | 8,088 | 2,197 |
| 1,651,163 | 154,650 | 2,866,010 | 140,667 | 1,545,917 | 39,385 | 2,767,335 | 114,310 | 2,326,525 |
| 156,284 | 1,021 | 176,076 | 2,043 | 70,464 | 374 | 63,281 | 2,404 | 47,740 |
| 26,991 | 3,468 | 85,693 | 7,518 | 245,093 | 11,400 | 938,103 | 99,605 | 1,227,665 |
| 177,724 | 19,032 | 310,866 | 28,696 | 490,606 | 20,209 | ........... | ........... | ........... |
| 7,713 | 1,142 | 4,103 | 582 | 21,384 | 5,453 | 32,368 | 17,779 | 29,080 |
| 7,713 | 1,142 | 4,103 | 582 | 21,257 | 418 | 30,845 | 17,759 | 27,932 |
| ........... | ........... | ........... | ........... | 2 | ........... | 205 | ........... | 200 |
| ........... | ........... | ........... | ........... | | ........... | 991 | 20 | 50 |
| ........... | ........... | ........... | ........... | ........... | 3 | 228 | ........... | 643 |
| ........... | ........... | ........... | ........... | 125 | ........... | 99 | ........... | ........... |
| ........... | ........... | ........... | ........... | ........... | ........... | ........... | ........... | 255 |
| ........... | ........... | ........... | ........... | ........... | 5,032 | ........... | ........... | ........... |
| 3,546,943 | 1,214,094 | 7,367,555 | 1,044,617 | 8,103,886 | 738,070 | 11,985,508 | 1,112,888 | 11,674,634 |
| 1,575,562 | 727,142 | 2,895,782 | 495,839 | 3,469,128 | 352,612 | 3,345,508 | 370,512 | 4,588,209 |
| 67,329 | 189,702 | 235,117 | 242,084 | 1,332,332 | 227,880 | 1,541,761 | 292,908 | 2,921,192 |
| 13,260 | 13,978 | 80,193 | 40,077 | 136,873 | 10,378 | 134,195 | 20,048 | 248,904 |
| 11,259 | 10,468 | 66,535 | 27,530 | 269,416 | 49,073 | 380,941 | 140,076 | 437,405 |
| 9,167 | 1,186 | 31,296 | 3,688 | 134,968 | 4,843 | 115,620 | 74,372 | 158,557 |
| 335 | ........... | ........... | ........... | 1,185 | 75 | 3,077 | 124 | 9,330 |
| 20,182 | 8,333 | 58,964 | 16,224 | 116,980 | 16,317 | 142,028 | 18,289 | 178,910 |
| 45,120 | 14,413 | 50,710 | 17,766 | 146,490 | 9,315 | 315,436 | 11,405 | 78,407 |
| 1,641,402 | 197,775 | 3,423,149 | 131,990 | 1,781,855 | 23,637 | 4,051,822 | 78,998 | 2,439,794 |
| 128,410 | 48,006 | 448,837 | 58,012 | 507,192 | 31,218 | 1,584,451 | 83,118 | 610,976 |
| 34,917 | 12,091 | 76,972 | 11,407 | 210,467 | 12,722 | 370,669 | 23,038 | 2,950 |

[c] Totals for United States include small amounts not reported by individual States.

## PRESENT OUTPUT OF SUGAR AND SIRUP.

In Table I the figures of the census are compiled to show the recorded farm production of maple sugar and sirup since 1850, the first year in which such data were given. The accompanying maps (figs. 1 and 2) are compiled from the same source for the census years 1880 and 1900. A glance at the table will show that the industry reached its height in

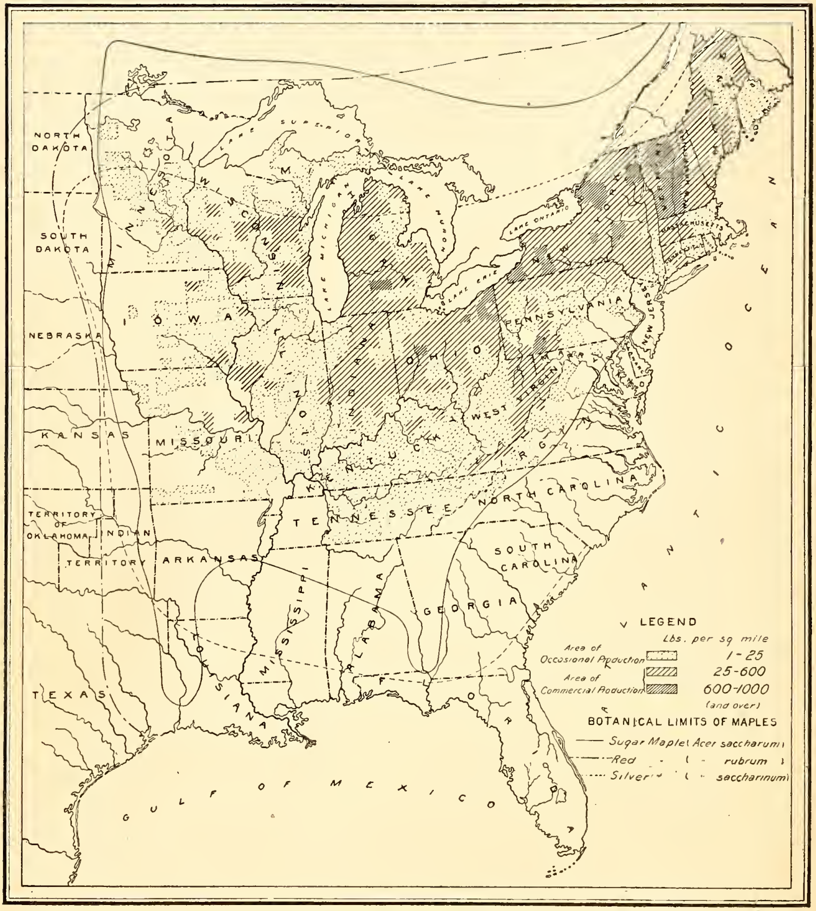


Fig. 1.—The field of maple sugar production in 1880.

1860, fell heavily in 1870, rose again to large proportions in 1880, remained stationary in 1890, and then suddenly fell almost 50 per cent in 1900, when the total amount produced was almost a third less than in 1850. This state of affairs would seem at first sight to point to a very sudden decline in the output, having its root either in the production or in the market. Yet such generalizations are dangerous, especially when one deals with single years at ten-year intervals, and with so wide an area of country. The maps of 1880[a] and 1900 have been chosen to show the production at practically its height and at its lowest point, and should be examined in conjunction with Table I. From these the following deductions can be made:

(1) The area within which maple sugar and sirup are made has shrunk decidedly. Nor do the maps show the entire movement in this direction, for in the earlier censuses there are records of a small

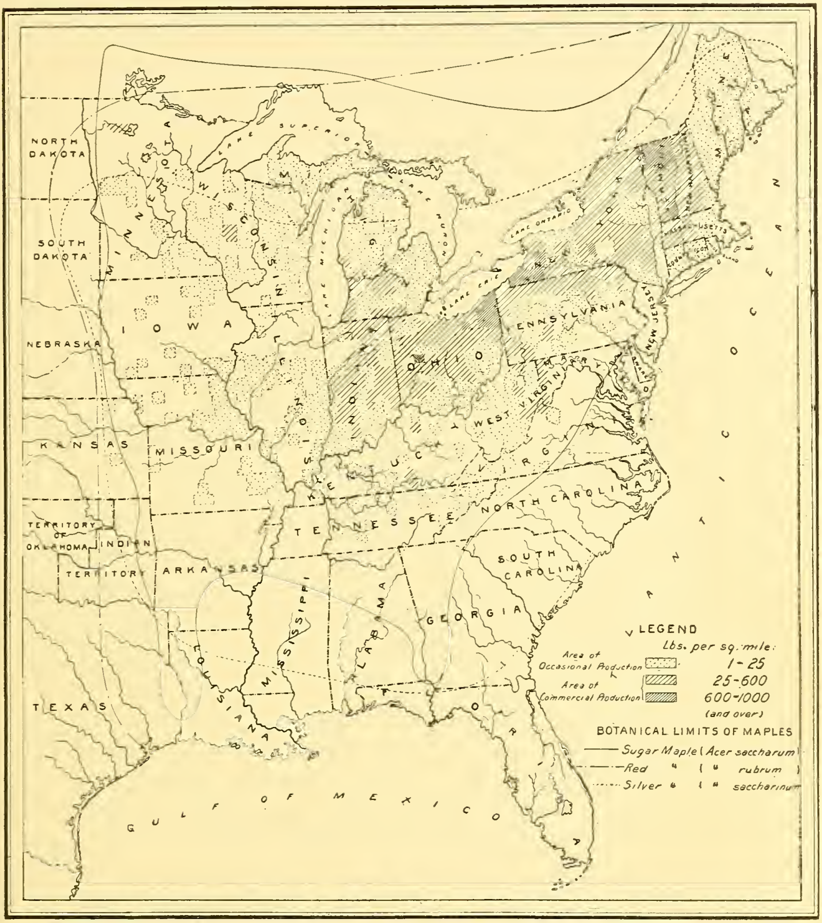


FIG. 2.—The field of maple sugar production in 1900.

maple-sugar production in South Carolina, Georgia, Alabama, Mississippi, Louisiana, Texas, and Arkansas. (See Table I.)

(2) The production of sugar and sirup per State and per square mile has fallen off in the most decided manner throughout the whole area. This is noticeable in every district, Ohio and Maryland being the

[a] The census year 1880 is taken instead of 1860 to get nearer periods and a more equal money standard.

only States in which the output for the census year 1900 in any way approaches that for 1880 or 1890.

(3) Apart from the actual decrease in product, there has been a great reduction in the area over which the maple is tapped. This decrease was 34 per cent between 1880 and 1890. The decided falling off in the distribution of the industry has taken place to a much greater extent in the area of occasional production than in that part of the country where maple-sugar making has commercial features. The tendency for sugar production to concentrate in the region of best climatic and soil conditions indicates that sugar making for home use is giving way to a market production, and argues well for makers' combines and a systematized attempt to control the market for a pure product.

The decrease, both in quantity of sugar and in sugar-producing area, comes from a great number of causes, which differ entirely in different districts. In the New England States, in New York, and to a less extent in Ohio, the sugar season of 1899[a] was very poor. The sap ran only a few days, and less than half the usual amount of sugar was made. For this reason the figures are not indicative of the condition of the industry, which most assuredly has not fallen off in recent years. In Vermont the production in 1899 was especially small, not only because of the poor season, but from the effects of a serious attack on the trees by the "maple worm." (See p. 21.) Since that time the groves have recuperated, and Vermont is in a position to turn out as large a crop as at any time in her history.

In the Southern Appalachians and Kentucky the decrease seems permanent, and undoubtedly comes from the cheapening of cane sugar in the mountain districts. Maple sugar and sirup in those regions never had more than a local sale, and were merely used as substitutes for the cane product.

A noticeable exception to this is observed in western Maryland and the adjacent part of West Virginia, where the production has decidedly increased. This undoubtedly means that sugar and sirup are being produced for the market, and shows the latent possibilities of the Southern mountains for the development of the maple sugar industry.

In Indiana, Michigan, and Illinois the decrease undoubtedly comes from the cutting of the maples, which have been heavily lumbered in the last ten years. This is particularly true in Michigan and Indiana, both of which would otherwise produce large quantities of maple sugar and sirup. Another cause of the decrease is the competition of adulterated products from the large towns of this section.

The decrease in the production of the States near the western limit of the sugar maple has been very steady since the sixties. This results from a combination of causes. The first settlers came from

[a] The product of 1899 is that reported in the census of 1900.

the old maple-using States, and immediately commenced tapping in their new homes. Trees were scarce, however, and the tapping for sugar grew less as the demand for wood increased. Here, also, the adulterated sirup plays a part in the decrease, as many of the largest mixers are in this district.

Figure 3 shows the relative position of the maple sugar producing States since 1850. It is plain that for climatic reasons the maple sugar

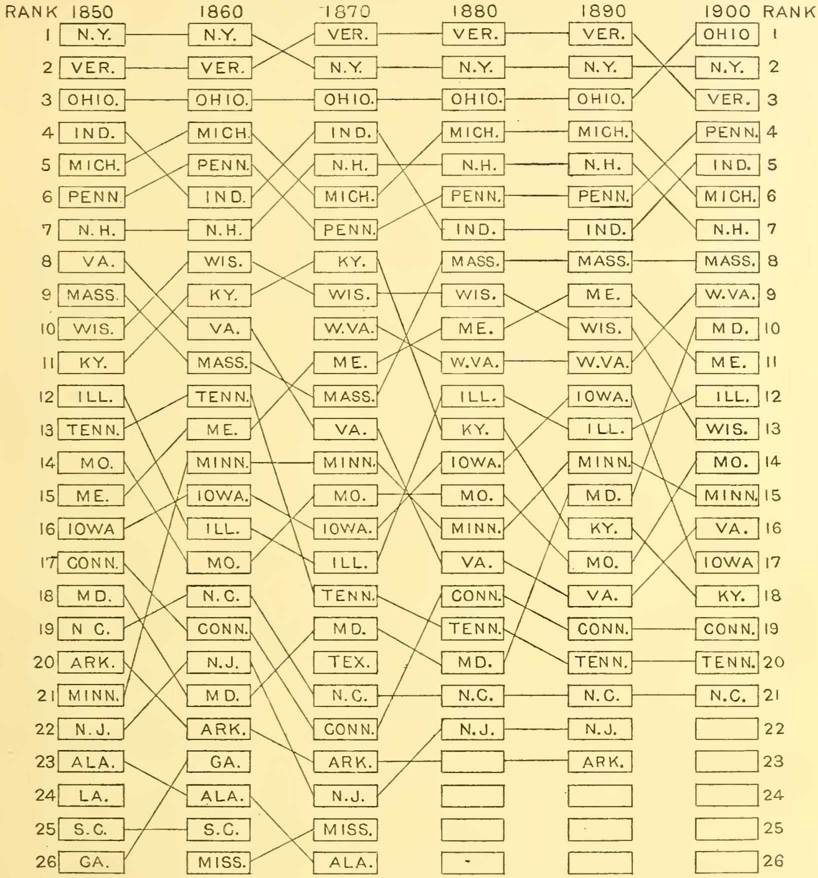


FIG. 3.—Relative rank of maple sugar producing States since 1850.

industry will always center in the North, but there is nothing to prevent most of Pennsylvania and West Virginia, western Maryland, all of Indiana, and parts of Kentucky, eastern Tennessee, and western North Carolina from being included within the area of greatest production. Outside of these limits progressive farmers in favorable situations may profitably cultivate the sugar maple, but a general extension of the industry is barred by natural conditions unfavorable to the production of sap in paying quantity.

### SUGAR "MIXERS" AND FABRICATORS.

If complete figures were available to show the amount of so-called maple sugar and sirup turned out by large houses in the Eastern and Middle Western cities, they would offer a startling contrast to the census report of the amount of maple production on the farms. (See pp. 8–11.) Every maple sugar dealer in the maple-producing section tells of the large orders for coarse sugar which come from the cities, and of the many carloads which are shipped there every year. A large amount of such sugar is also imported from Canada. It is asserted by those who have studied the trade that not more than one-eighth of the maple sugar and sirup which reaches the market is a pure product.

### PRICES OF MAPLE SUGAR AND SIRUP.

Table II gives the wholesale prices of maple sugar and sirup for each year from 1882 to 1903, and shows that the business must be controlled by the mixer, for, although it is well known that the demand for maple sugar and sirup has increased and is increasing enormously every year, the price of both sugar and sirup has steadily declined, and this in the face of the fact, shown in Table I, that the actual production in the groves has not increased since 1860.

TABLE II.—*Wholesale prices of maple sugar and sirup in New York.*[a]

APRIL, MAY, JUNE.

| Year. | Average price. | | Year. | Average price. | |
|---|---|---|---|---|---|
| | Sugar,[b] per pound. | Sirup,[c] per gallon. | | Sugar, per pound. | Sirup, per gallon. |
| 1882 | \$0.13 | \$1.25 | 1894 | \$0.10$\frac{4}{5}$ | \$1.00 |
| 1883 | .12$\frac{3}{4}$ | 1.15$\frac{1}{4}$ | 1895 | .10$\frac{4}{5}$ | 1.00 |
| 1884 | .12$\frac{3}{4}$ | 1.16 | 1896 | .10$\frac{4}{5}$ | 1.00 |
| 1885 | .11$\frac{7}{16}$ | 1.16 | 1897 | .10$\frac{4}{5}$ | 1.00 |
| 1886 | .11 | 1.12 | 1898 | ...... | ...... |
| 1887 | .11 | 1.00 | 1899 | ...... | ...... |
| 1889 | .12 | 1.10$\frac{5}{12}$ | 1900 | .11 | 1.04$\frac{1}{6}$ |
| 1890 | .12$\frac{1}{2}$ | 1.08$\frac{1}{3}$ | 1901 | .11 | 1.00 |
| 1891 | .11$\frac{4}{5}$ | 1.08$\frac{1}{3}$ | 1902 | .11 | 1.02$\frac{1}{12}$ |
| 1892 | .11$\frac{1}{2}$ | 1.08$\frac{1}{3}$ | 1903 | .11 | .91$\frac{2}{3}$ |
| 1893 | .11$\frac{1}{2}$ | 1.08$\frac{1}{3}$ | | | |

[a] From the Merchants' Review, New York.
[b] Sugar sold in cases of 30 one-pound cakes.
[c] Sirup sold in cases of 12 one-gallon cans.

No other statement could show more eloquently the position of the trade or make clearer the fact that the grower has not profited by the development of maple sirup into an article of luxury. The cheaper the price of cane sugar the easier it is to adulterate the maple product.

TABLE III.—*Average wholesale prices of raw brown and granulated sugars in New York.*[a]

| Year. | Raw brown, per pound. | Granulated, per pound. |
|---|---|---|
| | *Cents.* | *Cents.* |
| 1860 | | 9.78 |
| 1865 | | 12.56 |
| 1870 | 11.50 | 13.53 |
| 1875 | 9.16 | 10.72 |
| 1880 | 8.21 | 9.60 |
| 1885 | 5.73 | 6.44 |
| 1890 | 5.44 | 6.17 |
| 1895 | 3.27 | 4.15 |
| 1900 | 4.57 | 5.32 |

[a] Furnished by Willett & Gray, New York.

By comparing the prices in Table II with those in Table III it is made quite clear that by 1875 cane sugar could undersell the maple. In the country districts the decline in cane sugar prices was naturally slower, and the substitution of cane sugar for maple as an article of food was delayed. But the cane sugar soon came into competition with the maple everywhere, and inevitably supplanted it. For some years brown sugars were commonly consumed, but as the cost of refined sugar fell, they in turn were replaced by the high-grade granulated product. Thus after 1885 maple sugar must be considered as an article of luxury alone. In this capacity its prospects are many times greater than under the old conditions; yet the grower is likely to have little share in the benefits to be reaped from this broadened field.

## BOUNTY ON MAPLE SUGAR.

The reduction in the United States customs duties on imported sugars made in 1890 was accompanied by a provision granting a bounty to the producers of granulated sugars—cane, beet, and maple—throughout the United States, as compensation for any loss they might sustain by reason of the change of tariff. Under the terms of this act maple sugar which tested 90° by the polariscope might receive a bounty of 2 cents per pound, and that testing 80° might receive one of $1\frac{3}{4}$ cents per pound. Nothing was paid on sirup, and sugar that did not reach the test of 80° was debarred. Altogether the sum of $66,119 was paid in maple-sugar bounties during the three years that the law was in force. Of that amount Vermont makers received $36,225, and New York makers $11,703. Yet less than 7 per cent of the total maple-sugar product of the United States received any bounty, and the industry was in no way improved. Only a small proportion of the sugar makers even made application for the bounty, as the test was a severe one, calling for the highest grade of sugar manufactured; while the preparation of the necessary applications and affidavits, together with other requirements, deterred many of the larger producers, and all of the small ones, from taking advantage of it. Unless a farmer had a large output, the sum collected would hardly offset the trouble and annoyances incurred. On this account the sugar bounty was rather harmful than helpful to the maple sugar industry. It forced a high polariscope test, when the actual sugar value of the maple product is secondary to its flavor and delicacy. The fact that sirup did not share the bounty tended to cause a decrease in its manufacture, although it is desired by the best class of consumers, and it stimulated the manufacture of sugar, which fell into the hands of the wholesale dealer and mixer. Nor did it always increase the price to the farmer, for those who received an extra 2 cents bounty per pound are said, at least in some cases, to have had the same amount deducted from the price given them by their only customers, the dealers. In other words, a large part of the bounty really fell into the hands of the mixers, who were already profiting by the low price of cane sugar following the reduced duties of 1890. Instead of helping the maple-sugar grower, there is every reason to believe that the bounty really inured to the profit of his rival, the wholesale dealer.

### NECESSITY FOR SUGAR MAKERS' ORGANIZATIONS.

With a steadily growing demand for maple sirup, which to-day is almost entirely supplied by the mixer, the producers of pure sirup can hope to control the trade only through organization. The difference between the pure and the adulterated product is so marked that there would be little question as to choice, were the genuine sugar known to the popular trade. A large number of the consumers hardly know pure maple sirup when they taste it, and as so great a part of that on the market is spurious, they have little chance to learn. Under such a condition the market can be gained for the pure product only by means of united action. An example of such action is the present Vermont Sugar Growers' Association.

The situation is very similar to that which has already been successfully met, in the case of certain other farm products, by organized cooperation of producers. Sometimes, as in Germany and Canada, this has been initiated and substantially aided by government action; sometimes, as in Ireland and England, it has been carried through entirely by private enterprise. Some years ago Canadian dairy products formed but an insignificant proportion of the exports of these articles to Great Britain. Now, through the efforts of the Canadian government to foster intelligent and honest methods of production, an English market has been secured for the Canadian output. The Irish Agricultural Organization Society has gone far toward bringing about an economic regeneration of the island, and in Germany rural prosperity has been vastly increased by the same methods.

In all these cases the principal purposes aimed at have been the improvement of methods of production, and furnishing a guaranty of purity to consumers.

In the case of maple-sugar producers the first necessity is a market for high grade, unadulterated sugar and sirup. This they should be able to secure without much difficulty through responsible association, which can guarantee the quality of all the product bearing its name or stamp. Where desirable, the growers of a county or region could combine to form a stock company, thus securing capital for the necessary equipment. In every case all sugar and sirup should be sent to a central point, be graded according to quality, and packed in a uniform manner. A commission charge on sales would furnish the income from which the expenses of the association or company would be met.

Under careful, conservative business management the purchase of utensils, packing cases, etc., for sale to the members at the lowest prices, might be successfully arranged, and perhaps the loan of capital, on good security, for the installation of modern equipment could be successfully added.

Annually, if not oftener, the members should meet for the transaction of business, to interchange ideas, and to listen to addresses on matters pertaining to sugar making. The publication and free distribution of the proceedings at these meetings might be made a further means of advancing the interests and improving the methods of the sugar makers.

## SUGAR MAPLES.

All the maples have sweet sap, but only from a few of our native species has sugar been made in paying quantities. The first place is held by the sugar maple (*Acer saccharum*) and a variety of it, the black maple (*Acer saccharum nigrum*). The red maple (*Acer rubrum*), the silver maple (*Acer saccharinum*), and the Oregon maple (*Acer macrophyllum*) are of less importance, and the box elder (*Acer negundo*) is least important of all.

### THE SUGAR MAPLE.

The sugar maple spreads over a wide area, but as a tree for the production of sugar in paying quantities its range is limited to western New England, New York, Pennsylvania, the southern Appalachians, the Ohio Valley, and the Lake States and adjacent parts of Canada. (See figs. 1 and 2.) In the Gulf States and as far north as southern Arkansas the tree is represented by a variety (*Acer saccharum floridanum*) from which no sugar is made.

The sugar maple is a stately and vigorous forest tree, capable of growing in dense stands. It bears a plentiful crop of seeds, which in most localities ripen in the early fall. These seeds germinate readily, and under favorable circumstances the entire forest floor is heavily carpeted with seedlings (Pl. III, fig. 1), the succulent, sweet foliage of which is eagerly devoured by all kinds of stock. The young seedlings are very thrifty and can stand the shade of a complete forest cover. This tolerance of shade is one of the distinguishing features of the sugar maple, and, although it is less pronounced in later years, even mature trees have one of the most persistently heavy crowns in the forest.

Seedlings, although not killed by complete shade, are kept suppressed and grow slowly; but if they have germinated in the open, or the forest above them is removed, they grow up into thickets of remarkable density. (See Pl. III, fig. 2.) In such a condition the struggle between the young trees is so fierce that the development of even the most thrifty is seriously retarded (see p. 31). The species being so tolerant of shade and by nature so vigorous, no individual gives up the struggle, but does its utmost to overtop the others and gain the sunlight. As a result the stand keeps its extreme density for a long period, and each tree grows long and spindling. The forest-grown tree develops slowly on this account, and has a long, clean stem and a small crown (Pl. IV, fig. 1), while the roadside maple has a short trunk and a great egg-shaped crown of dense foliage. The root system tends to be shallow, with many laterals and an undeveloped taproot. In the forest this character is more marked (Pl. IV, fig. 2) than in field or roadside specimens, and any sudden opening up of the stand may result in loss by windfall or by a drying out of the roots.

There is no doubt that the quantity of sap that a tree yields stands in direct relation to the size of its crown, but many sugar makers believe that trees in a forest produce more sap than those in a grove. The explanation is found in the fact that the forest floor with its covering of litter and humus contributes to the vitality of the trees more than the grass carpet of a grove. To obtain a heavy sap production, a complete crown cover and a rich deposit of humus is of vital importance. (See pp. 25, 26, 36.)

Within its wide range the sugar maple appears as a predominant tree only in the New England States, New York, southern Canada, northern and western Pennsylvania, and in parts of Ohio, Indiana, Illinois, Michigan, Wisconsin, and Minnesota. In the southern Appalachians it occurs in scattered bodies where climatic conditions are similar to those of the North, confining itself chiefly to north slopes or to the coves, on moist, well-drained, rich soils where the heat of the sun is tempered. As a rule, it associates with the beech, birches, and basswood, but also mixes with the yellow poplar, hickories, and other hardwoods, and with hemlock and some of the eastern spruces. At the heads of the coves and in the bottoms it often forms pure stands fit for commercial tapping, and its reproduction is everywhere excellent.

In its northern home it is a principal forest tree (Pl. V, fig. 1) and often forms from 25 to 75 per cent of the total stand. It prefers a moist but well-drained soil, and seems to do its best on glacial drift or on rocky hillsides and benches. In the cool atmosphere of this region all aspects are equally acceptable, but it avoids or grows sparsely on ridge crests, generally leaving the ground in such situations to spruce or to beech. In the extreme northern part of New York State and the adjacent district of Quebec the forest growth is often almost pure maple, and even considerably farther south, where beech and birch become associate trees, the sugar maple holds its own as the dominant species. In northern Pennsylvania, at an altitude of over 1,000 feet, the mixture is much the same as it is in New York. In Ohio, Indiana, and Illinois a similar condition is found; but as the hilly country disappears the maple retreats to the richer and damper soils, leaving great areas to the oaks, chestnuts, etc. This is particularly true of the southern parts of these States. By the time the western and southwestern limits of its range have been reached it has only a scattered occurrence, even in the most favorable positions. In southern Michigan the forests are similar to those in New York, but as one approaches the pine region of the North the maple confines itself to the more fertile places. The same is true of Wisconsin and Minnesota, where the sugar maple reaches its northwestern limit in the United States.

Maple trees are often seriously injured by an insect commonly called the "maple worm." The way in which this pest works and the measures suggested for its control are described in the following paragraphs contributed by Nathan Banks, of the Bureau of Entomology, United States Department of Agriculture:

The ravages of the forest tent caterpillar (*Malacosoma disstria*) in the maple-sugar bushes of New York and other Northern States has for several years attracted considerable attention. The maple seems to be one of the favorite food plants of this insect—so much so that in some localities it is known as the "maple worm." Sometimes they have become so numerous as to strip the maples for many acres, to cover the ground several inches deep with their wriggling bodies, and the marching, hungry hosts to impede wagons and even railroad trains. Although the loss of leaves does little damage to the tree at the time, the continued defoliation year after year can only result in its serious weakening or death.

During the winter the forest tent caterpillar is represented by tiny caterpillars patiently waiting within the eggshells for the advent of spring. The eggs, to the number of 150 or more, are arranged in a cluster or belt around a twig and covered with a shiny, frothy, glue-like substance that protects them from the rigor of the elements. This cluster is of nearly even width throughout, and does not taper at each end as does the egg belt of the closely related insect, the apple-tree tent caterpillar. The clusters are often not more than 20 or 25 feet from the ground. During the latter part of April or in May the little caterpillars issue from these eggs and start to feed on the leaves. At first they are apt to feed in clusters, but they scatter as they grow. They eat during the night or in cloudy weather, and during the day retire to the branches to rest, often in groups of fifty or more. They commonly spin a thread wherever they go, but do not make a web or "tent." They molt four times.

The first molting occurs about two weeks after they have emerged from the eggs, the second a week or ten days after the first, the third about ten days later, and the fourth molting ten days after the third. Newly hatched caterpillars are dull black, with long grayish-white hairs. After the second molting there is seen a row of eleven cream-white, diamond-shaped spots along the back, and two fainter lines on the sides. These markings become brighter and more distinct as the caterpillars increase in size. They grow most rapidly between the third and fourth moltings, and may become 2 to 2¼ inches long.

Full grown "maple worms" are more bluish than black, and have many tufts of yellowish hairs. They have the habit of dropping from the tree when disturbed by birds or the wind. Usually they suspend themselves by a thread, but if suddenly shaken may fall without using a thread. After the fourth molting they instinctively begin to wander about, perhaps forsaking the tree, and crawling in every direction over the ground or along fences. This apparently aimless traveling, which starts in the early days of June, results in the wider distribution of the species. When in great numbers they are apt to be compelled, by lack of food, to migrate before the fourth molting, and then the creeping host may cover large areas of ground in its effort to find sufficient food.

After a few days of roving the caterpillar spins its cocoon, usually at night. This is, perhaps, normally spun within a rolled leaf, but many caterpillars leave the tree and spin on the bark, on fences, or even on the ground. The cocoon is rather loose, and is spun of whitish silk mixed with some yellowish hairs from the caterpillar's body, and dotted with a yellowish powder ejected as a liquid by the caterpillar. Upon finishing it, the caterpillar molts once again, and transforms to the pupal stage. The pupæ are reddish brown in color, and from five-eighths to three-fourths of an inch long. In about ten days or two weeks the adult insect, a four-winged moth or miller, emerges from the cocoon.

This moth is of a buff color with a brownish tinge, each forewing crossed by two oblique dark lines. Sometimes the area between the lines is very dark, and again these lines may be almost wholly lacking. The female moth measures 1⅝ inches in wing expanse, while her mate is much smaller as well as darker, and differs also in having feathered antennæ. The moths fly chiefly at night, and are readily attracted to lights. The great majority of the moths issue forth between the last week in June and the middle of July. They quickly pair and deposit their egg belts or clusters on the twigs. The embryo develops during the fall, but the young caterpillar remains within the eggshell till the warm weather of spring. Since the female moth is not a good flyer and deposits her eggs within a few days after emerging from the cocoon, it follows that she is not a great factor in the distribution of the species. This insect spreads slowly, but the more thoroughly infests the spots where it occurs.

Once established in a sugar bush, the caterpillar is difficult to eradicate. The application of arsenicals is too expensive for general practice. In small isolated maple groves much good may be accomplished by banding the trees with some substance that will bar the caterpillars, and then collecting and destroying the trapped caterpillars. The banding itself accomplishes little. Many substances have been recommended, such as cotton wool, sticky fly paper, cottolene, mixture of tar and raw oil, lard and sulphur, and "raupenleim." The latter should not be applied directly to the bark, but upon paper or bagging. Many have recommended the collection of the cocoons by children, and this, when carefully done, will doubtless keep the insect from excessive multiplication. Destroying the caterpillars when they have assembled upon the trunks or branches, by means of brooms or specially prepared brushes, will help to lessen the pest another season. But the most efficacious remedy is to break off or burn the egg belts in the winter. The twigs may be clipped by means of long-poled pruning hooks, or the belts may be burned by a long-handled torch. If done while the snow is on the ground the fallen egg belts will not be lost, but may readily be gathered and burned. Whenever the caterpillars have become so numerous as to cover the ground, it might be possible to exterminate them, in open groves, by the use of a small, single-horse roller.

Natural enemies do a great deal to keep these insects in check. Various birds have been observed to feed on them with avidity, and doubtless if more were done toward inducing birds to nest in sugar bushes by providing them with suitable nesting places and protecting them from boys and cats, it might be possible to keep the pest under control. A large number of predaceous and parasitic insects have been recorded as feeding on the forest tent caterpillar. Among the former are the large beetles of the genus Calosoma, and the stink bugs of the genus Podisus. Several tachinid flies have been bred from the caterpillars, and many four-winged hymenopterous parasites from the cocoons. In some cases 10 to 20 per cent of the cocoons have been found to be parasitized. Often these natural enemies, if allowed free course, would multiply so greatly during a heavy infestation as to prevent a serious outbreak the following year.

In the present discussion the sugar maple is not considered as a lumber tree, for which a long stem free of branches is desired, but rather as a paying producer of sap. Under this aspect a silvicultural problem is presented radically different from that which ordinarily confronts the forester. (See p. 25.) The full and heavy crown with a large leaf surface must be developed in place of the long, clear stem. The sap flow must be continuous and plentiful. The best sap flow is where the transition from winter to spring is slow, where the days are warm and sunny and the nights frosty. These conditions do not occur throughout the entire range of the species. A locality wherein the ground thaws quickly, and which has no great variation of temperature between day and night is not suitable for sap production. The "season" must be long enough, also, to insure sap in merchantable quantities. Such conditions are characteristic only in the Northern States, and as sugar making goes farther south it can be profitable only at altitudes which reproduce the climatic conditions of the North.

### THE BLACK MAPLE.

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

### THE RED MAPLE.

The red maple has the widest range of all its family in America. (See figs. 1 and 2.) The natural home of this tree is along the borders of streams and on low, swampy ground. In the North it often forms a pure growth in such places, but it is along the Ohio, the Mississippi, and their tributaries that it reaches its greatest perfection. Like the sugar maple it is tolerant of shade, and seedlings sprout plentifully from the heavy crops of fruit, which ripen in the late spring or early summer. As a swamp tree it associates in the Southern and Middle States with the sweet magnolia and loblolly bay, the bald cypress, various oaks, and the red, black, and cotton gums. It does well, also, on less moist lands. It is generally of vigorous growth, but the grown trees are inclined to unsoundness at the butt. As a sugar-producing tree it enters into consideration in the Middle and Western States only where the sugar maple is not plentiful. It has an abundant flow of sap, from which good sugar has been made, and the general opinion that the early starting buds cause "buddy" or discolored sap may prove quite unfounded. As a rule, red maple has been tapped in districts where the climate is unfavorable to any kind of maple-sugar making, and this fact, together with the general lack of care and skill, may account for the existing prejudice against it. Conditions being equal, it is almost certain that the sugar maple is superior to red maple in every way, but there are large districts in which no better sugar tree than the red maple is found. In such localities experiments should be made to determine its true value.

### THE SILVER MAPLE.

The silver maple ranges from New Brunswick to western Florida, and west through southern Ontario and Michigan to eastern North and South Dakota, Kansas, and Indian Territory. (See figs. 1 and 2.) In the North it appears in mixture with the sugar maple, but in general prefers lower altitudes and moister soils. It reaches its greatest perfection in the valleys of the Ohio and Mississippi, where it is one of the characteristic trees on the lowlands of these rivers and their tributaries. The flow of sap is plentiful and sweet, but, like that of the red maple, liable to discoloration, and the season is short and uncertain. It is, like the red maple, only to be considered as a sugar tree outside the region where the sugar maple is a dominant species.

### THE OREGON MAPLE.

This is the only Western species which can be considered as a producer of sugar. In localities where the season is favorable the sap is of good quality and the flow considerable. The tree is found west of the Cascades and Sierra Nevada Mountains, from the Canadian border to southern California. It prefers rich, moist soil, and reaches its best development in the river bottoms of Washington and Oregon. The census of 1900 reports a very small production (126 gallons of sirup) from Columbia County, Wash.

FIG 1.—SUGAR MAPLE SEEDLINGS TAKING POSSESSION OF AN OPENING IN THE FOREST.

FIG. 2.—A THICKET OF SUGAR MAPLE SAPLINGS.

The trees are so tall and slender that they can not stand alone.

FIG. 1.—CROWN DEVELOPMENT OF A FOREST-GROWN SUGAR MAPLE.

FIG. 2.—ROOT SYSTEM OF A FOREST-GROWN SUGAR MAPLE.

### THE BOXELDER.

The boxelder has been occasionally planted in sugar groves because of its rapid growth, but it is an inferior species and may be ignored as a sugar producer.

## SUGAR GROVES.

### GENERAL CONSIDERATIONS.

The ideal sugar grove should contain that number of trees which will give a maximum yield of sap per acre; whence it follows that the formation of a grove must consider the yield per given area rather than the yield per tree. To determine the exact number of trees that should occupy an area would take many years of experiment, but directly and indirectly there has been much information collected on the subject of sap production through a study of individual trees, and from this a number of safe deductions can be made. An equal amount of sunlight being given, the sap and sugar production is proportionate to the leaf area of the tree. This statement is corroborated in a recent bulletin of the Vermont Agricultural Experiment Station,[a] where it is also asserted that the sugar production of the tree depends more on the actual leaf area than on the amount of light which it receives. In other words, if a small-crowned mature tree be set free to light on all sides, the sap production will be stimulated only to a very slight extent. From this it follows that the number of trees per acre must be consistent with the greatest possible crown development of each tree in the grove. At the same time it is not to be forgotten that the maple is inherently a forest species. The large crown of foliage has an extensive leaf area for evaporation, and demands a protected soil which can keep it well supplied with water. Such soil is best found in the forest, where the ground is kept heavily matted with leaves and humus, so that the sun and drying winds will have little access to it, and a comparatively uniform degree of moisture and coolness may be maintained under all conditions. Commercial sugar making is confined to a small part of the botanical distribution of the sugar maple, because of a peculiar climatic requirement. It is the gradual northern spring, with the slow yielding of the frost by the ground, which makes the sap flow long and continuously enough to give a paying production of sugar. A sudden thaw affects both the quality and the duration of the sap flow. On this account it is always desirable to maintain forest conditions in a sugar grove, for if the ground has a heavy carpet of leaves and humus, it will be less sensitive to changes in temperature.

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[a] Bull. No. 103, Vermont Agricultural Experiment Station, Dec., 1903, pp. 117, 118.

Altitude is one of the most important factors in determining the necessary density of the sugar grove. High up in the mountains, where the summer is moist and the spring long, and in the North, the necessity of an unbroken cover is not so great as where the summer is hotter and the spring less gradual in its transition from winter to warm weather. In mountainous regions the forest can be more open, and in every large grove a section on a southern exposure will insure an early sugar season. In lower altitudes the close grove of full crowned trees will have an advantage over a scattered stand of field trees exposed to the effects of a variable spring. It should not be forgotten, however, that trees which have developed from their youth in very open groves have stronger root systems than forest trees, and that they draw their water supply from the moist subsoil (see p. 20); but such groves have a relatively limited production per acre, and, while serviceable for a small home production, would cover too large an area to be profitable for a large undertaking.

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

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

(2) The forest cover should be unbroken, so that in summer little sunlight falls upon the ground. (Pl. V, fig. 2.)

(3) There should be a complete litter of humus and leaves, to the exclusion of grass and light-demanding weeds.[a] (Pl. VI, fig. 1.)

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

(5) No grazing should be allowed in the grove, except in special cases where the cover is perfect and no reproduction is needed. Cattle not only keep back all reproduction (Pl. VI, fig. 2) but also do harm by trampling and breaking the ground, so that it dries out.

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

The first three points vary in importance with the latitude and altitude of the grove, but they are always worthy of consideration.

In discussing the methods required to bring about these results, the several common types of sugar groves will be described. Logically it would be proper to begin with the treatment of a sapling thicket and continue through each stage to the mature grove, but as the earlier stages of growth are the most complicated to deal with, the order of consideration will be reversed.

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[a] French and German experiments have demonstrated that a heavy growth of grass dries the soil, and interferes with the entrance of water even during a heavy rain.

### THE IMPROVEMENT OF A MATURE, DENSE GROVE.

A large number of groves are merely parts of the old hardwood forest, having a preponderance of sugar maple in the mixture. (Pl. V, fig. 1.) These trees have their normal forest form—a long, smooth stem and compact crown. (Pl. IV, fig. 1.) There is little to be gained in actual sap production by thinning such a stand (p. 25), as it has generally passed the period of vigorous growth and would not develop larger crowns, although the sap season may be brought on earlier by opening up the grove to sunshine. The mixture can be regulated, however, and provision made for a pure growth of maple to succeed the old forest as it passes away. The usual mixture of birch, beech, elm, basswood, and ash may be gradually removed, and the reproduction of maple thereby assured. This thinning should pay for itself in most localities, from the resulting fuel and saw timber. In making such a thinning the following precautions should be observed:

(1) When the trees to be removed occur in groups, they should not all be cut out immediately, leaving large gaps in the forest cover, since forest-grown sugar maples have a broad, shallow, root system (Pl. IV, fig. 2), and are subject to windfall when suddenly exposed. The trees which crowd the best maples should be taken out first; the rest should be removed later, when the sugar trees have become more wind firm.

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

(3) Young maples which show possibilities of good crown development should be cut free from interference on every side.

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

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

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

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

### THE IMPROVEMENT OF A MATURE, OPEN GROVE.

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

As a rule these groves are on small farms, where they are used quite as much for pasture as they are for sugar making. In cases where the pasturage can not be spared, and where sugar is only a small item in the farm production, there is little to be done for their improvement. When the grazing can be spared, however, and the owner desires to increase the sugar-producing capacity of his trees, it is undoubtedly better to bring about a reproduction from the old trees than by planting a new stand. (Pl. VI, figs. 1 and 2.)

The first step to be taken in such a process of improvement in a more or less open and grass-grown grove is the exclusion of stock.

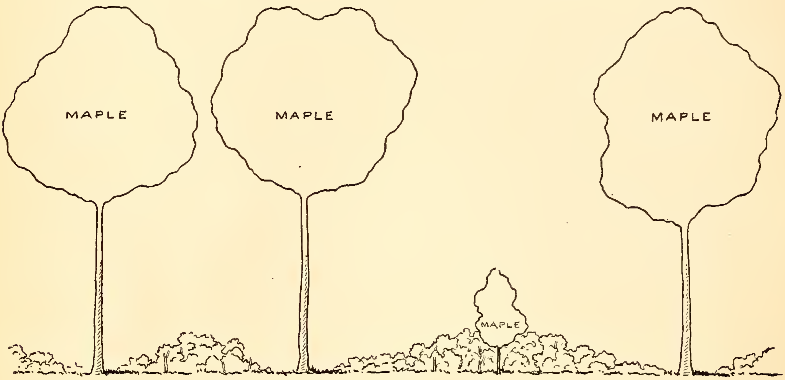


FIG. 4.—Method of improving an open grove.

After laying out proper driveways for sap gathering, the seedlings should be allowed to come everywhere else. All unsound and dying trees should be cut out and young growth of all other species than maple removed. In a very short time the young maple seedlings will take possession of the open ground and grow vigorously where they get sufficient light. (Pl. III, fig. 1.) When they are 8 or 10 years old and 6 to 8 feet high, or more, the struggle for supremacy among them will begin. In each opening large enough to permit the development of a tree with a full crown, the strongest and most thrifty seedling which has a favorable position should be selected, and the heads of those within a radius of 12 feet or more about it lopped off with a corn knife. The crowns of at least two-thirds of these trees must be removed; the remaining crowns will insure a good ground protection and leaf fall until the favored tree has filled the opening. In the case of small openings the thicket should remain unthinned; the struggle between the trees will keep them all suppressed, while they will sup-

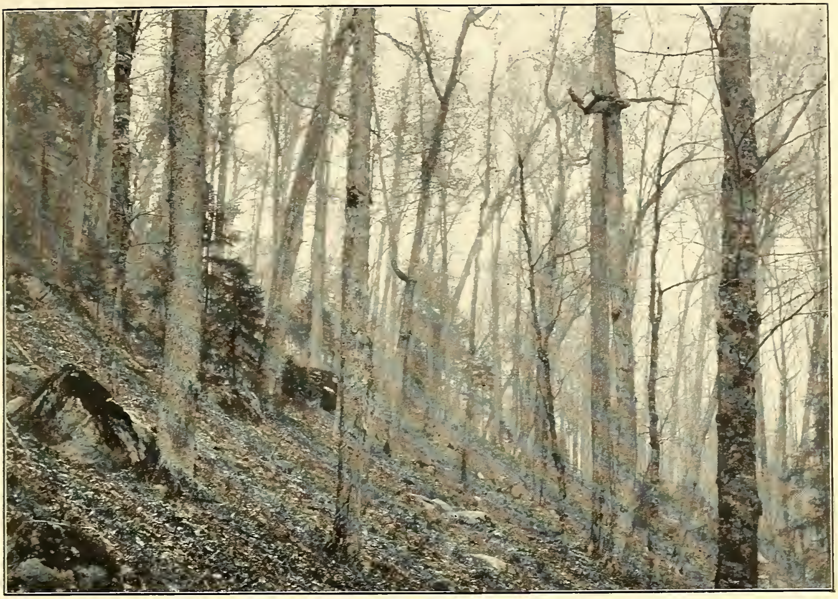

FIG. 1.—VIRGIN HARDWOOD SLOPE WITH MANY SUGAR MAPLES.

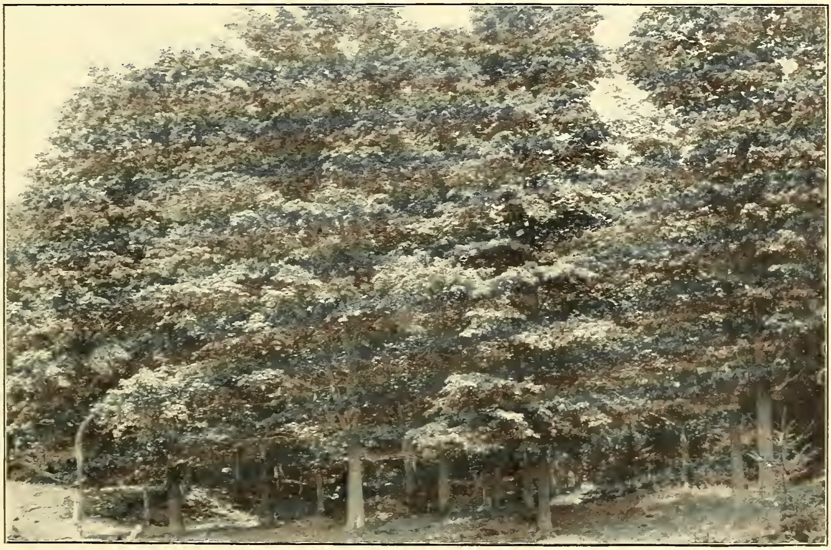

FIG. 2.—SECOND-GROWTH SUGAR MAPLES.

The crowns and the ground cover are excellent, but the stand needs thinning.

FIG. 1.—UNPASTURED MAPLE GROVE.

Seedlings on both sides of the road. Humus and ground cover perfect.

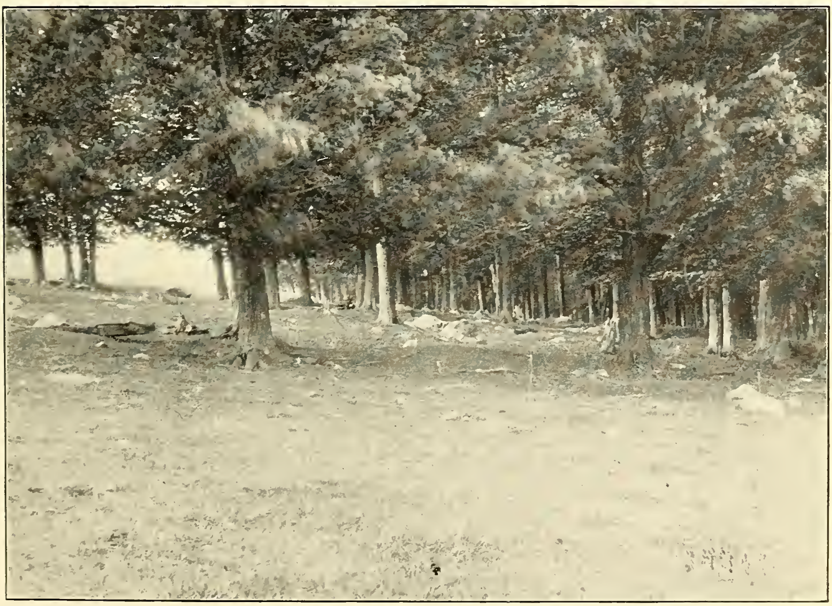

FIG. 2.—PASTURED MAPLE GROVE.

Poor ground cover, little humus, tree roots exposed.

ply the necessary ground cover. The seedlings which come up under the direct shade of the old trees will never develop to any size, unless some of the large trees are removed by age or accident. Figure 4 shows this method of treatment. Cattle may be let in the grove when it has become too tangled for convenient sap collecting, and when the young growth desired for open places has reached a height of 8 or 10 feet. They will soon open up the smaller and undesirable growth. At the same time roadways should be opened and the ground kept free of fallen limbs and trees. The tall, slender seedlings will be a small obstruction in sap gathering, but a little discomfort can be borne for the sake of the undoubted advantages obtained by a ground cover.

### THE IMPROVEMENT OF A DENSE YOUNG GROVE.

In many parts of the maple producing section a second-growth forest has come up, similar in composition to the original stand. The sugar maple often forms a predominant part of such a wood, and in that case all that is needed to turn it into a sugar grove is to remove a number of interfering trees, thus giving the proper number of maples a chance to develop the full crowns necessary to a maximum yield of sap per acre. Preference should be given to the younger and more thrifty stands, where the trees are just entering the period of most vigorous development. Plate V, figure 2, illustrates a typical example of a stand which is in excellent condition, but requires radical thinning to put it in the best form for sugar production.

The difference between thinning a young stand and a fully matured grove of the same type is usually that in the former case provision must be made for growing a set of full-crowned sugar trees from the more thrifty of the young maples. In a stand from 40 to 60 years old it is easy to pick the largest and best-developed specimens and favor them for the future. Some of the directions to be observed in treating a dense young grove are the same as those given for the treatment of the mature grove.

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

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

(3) In case the beech, birch, or other species are so grouped that their removal would make a serious gap in the forest, it will be well to let several of them stand, but they should be so treated that maple

seedlings (which nearly always gain possession of the soil even under beech) will have light enough to come in under them. When these seedlings become established the beech or birch can be removed, and young maples favored after the method shown in figure 5. When practicable always cut out other seedlings than maple.

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

(5) The edges of the grove which border upon open land should not be thinned enough to leave the stand unprotected from strong winds and sunlight. If other species are crowding the dominant maples, they should be removed; but, as a rule, the borders should remain dense and the trees should be covered to the ground with foliage.

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

Figure 5 shows in diagramatic form a grove of this type before and after thinning.

## THE MANAGEMENT OF A SAPLING THICKET.

Throughout the maple region dense thickets of young saplings are common in abandoned fields and pastures. Where a sugar grove is desired, it will pay to take such young growth in hand if no old trees are available in sufficient numbers. Left to themselves, the young trees usually become so densely crowded that even when 20 feet high they number from 2,000 to 3,000 to the acre. Under such conditions growth almost ceases even in the dominant trees, and at a time which, in normal stands, is the period of most vigorous growth. (Pl. III, fig. 2.)

The first thinning should be made when the saplings are about 6 or 8 feet high, if the owner feels justified in helping them at this time. The largest and healthiest trees, on an average about 12 feet apart, should be selected, and the tops of the others cut back with a hatchet or corn knife in such a way that they can not overtake the favored individuals. Plate VII, figure 1, shows such a thicket before improvement, while figure 2 illustrates the method of cutting. Figure 6 gives a conventionalized view of the treatment recommended. Cutting back trees in this manner can be done very rapidly. Three men should cut over an acre a day. Although there is no return in firewood or other material from such early thinnings, the young trees will be given a favorable start in their development at the most critical period of growth. The ground cover at the same time will be kept intact by the sprouts, until the selected trees fill out and close up the space with

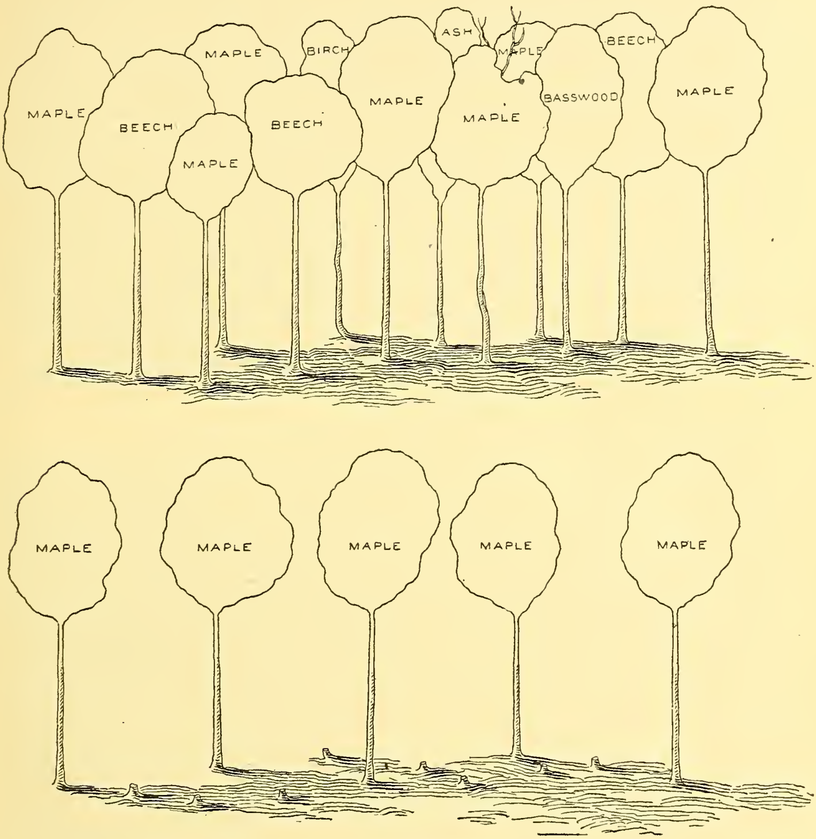


FIG. 5.—A young, close-grown grove before and after thinning.

their crowns. When they are about 25 years old the dominant trees, which are about 12 feet apart, will begin to crowd each other, and another thinning must be made to give the best ones room. Experiments are under way to show how much time will be gained by this method in obtaining a stand fit for tapping. All general forest practice shows that the gain over the unthinned thicket should be at least 25 per cent.

If the thicket to be turned into a sugar grove contains older and larger trees than have been considered, a regular course of thinning should be instituted. The main points to keep in mind in this case are as follows:

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

(2) Remove all long, spindling trees which are likely to bend over. (Pl. III, fig. 2.)

(3) For ground cover, leave all specimens which do not threaten the crowns of the chosen trees, and which are capable of casting even the smallest amount of shade.

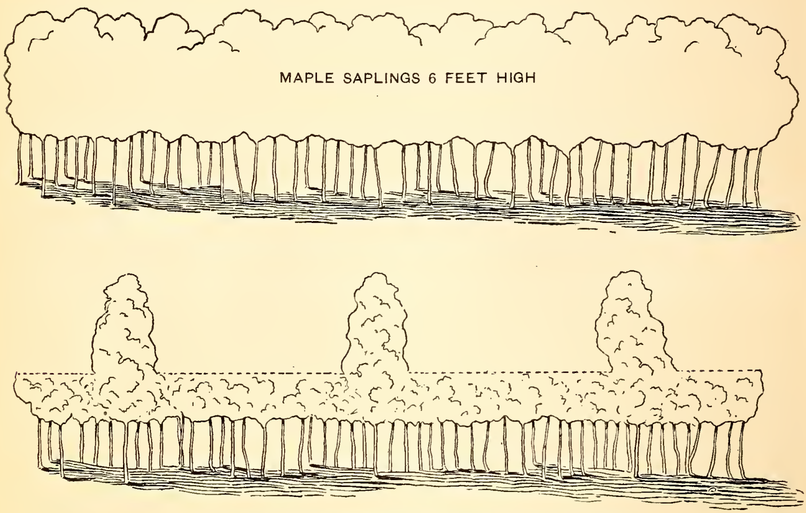


FIG. 6.—Method of improving a thicket of maple saplings.

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

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

To make this system of treatment clearer, a concrete case will be described. In the autumn of 1903 a stand of young maples in Vermont was thinned by a member of the Bureau of Forestry. The stand is situated at an altitude of about 1,200 feet, with a southeastern exposure. It came up in an abandoned meadow, which was seeded from a few old trees along a bordering wall. The dominant trees are from 30 to 40 feet in height and from 15 to 25 years old, with an average

FIG. 1.—THICKET OF MAPLE SAPLINGS BEFORE TREATMENT.

The growth is too dense for proper development.

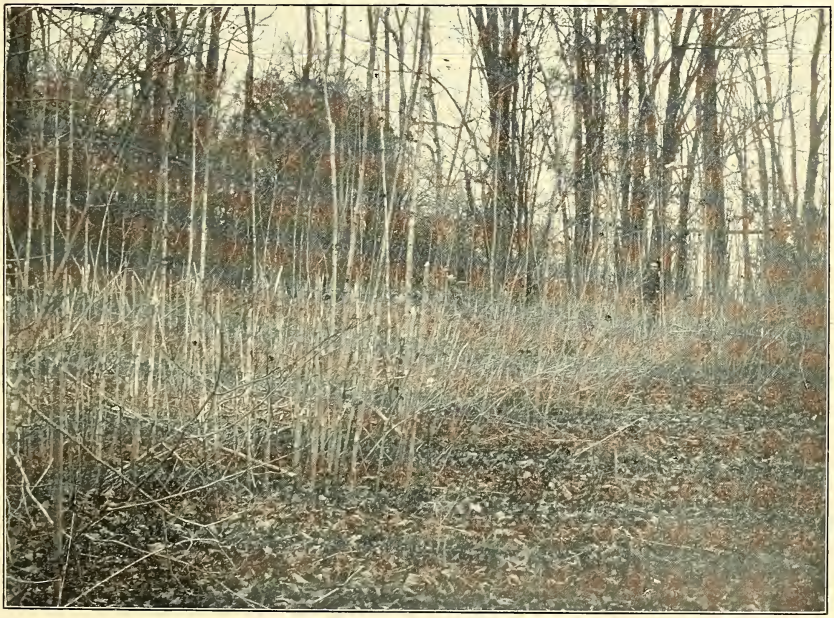

FIG. 2.—THE SAME THICKET AFTER THINNING.

Most of the trees have been topped, but the best are left in such positions that they can develop good crowns.

Fig. 1.—Stand of Maple Saplings in Need of Thinning.

Fig. 2.—The Same Stand After Thinning.

Twelve cords of wood per acre have been removed.

diameter for the stand, suppressed trees included, of 2 inches, breast-high. The entire tract is very dense, and, although the extreme difference in the age of the trees is about ten years, the difference in their size is far greater than the discrepancy in age would explain. More than half the stand is 1 inch and under in diameter, and yet many of these trees are as old as near neighbors three times as large. This results from the extreme vitality of the sugar maple, and shows the urgent necessity for thinning at an early age. Two plats, each 0.7 acre in size, were thinned, with the following results:

TABLE IV.—*Thinning of a maple sugar thicket.*

[Number of trees per acre of various diameters, in the original stand, removed, and left.]

| Diameter breasthigh. | Number of trees per acre. | | |
|---|---|---|---|
| | Original stand. | Removed. | Left. |
| *Inches.* | | | |
| 0.5 to 2 | 1,517 | 755 | 762 |
| 2 to 4 | 1,042 | 653 | 389 |
| 4 to 7 | 309 | 126 | 183 |
| Total | 2,868 | 1,534 | 1,334 |

Plate VIII shows the tract before and after thinning. Twelve cords to the acre of fair firewood were cut, an amount which should ordinarily pay for the thinning. The large number of small trees left after thinning is noticeable in the illustration, and is a point not to be overlooked. All trees that in no way interfered with the dominant stand and had a fairly full crown were allowed to remain as cover. There is no chance of their overtaking the favored trees, and they furnish the needful shade whereby a more radical opening of the crowns in the dominant stand is permitted. The final trees of the grove are to be selected from the 4 to 7 inch diameter class, the remainder acting as a reserve in case the selected trees should meet with accident. The heaviest cutting was made in that part of the stand which ran from 2 to 4 inches in diameter, the class which interfered most with the future sugar trees. Those individuals which gave promise of becoming members of the final stand were given more room than the others. Although the cutting took away such a large proportion of the stand, it will be observed that the trees are still in close order. This will necessitate a later thinning, probably after about six years, but at present further thinning would subject the long, slender saplings to overthrow and the ground to drying.

## SITUATION OF A SUGAR GROVE.

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

### PLANTING A SUGAR GROVE.

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

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

Avoid planting the trees too far apart. This is the mistake most commonly made. Wide spacing deprives the soil of its needful protection, reduces the yield of sap per acre, and gives a poor return for the expense of planting and for the amount of land used. Planting should always be done in early spring; and as the regions in which it is likely to be necessary are usually at low altitudes (see p. 21), it will be good policy to plant the trees close enough to insure a proper ground condition from the first. This will be best accomplished by setting the trees 6 by 6 feet apart. This gives 1,210 trees to the acre, which will not prove very expensive, as small seedlings, costing about $2 per thousand, may be used, or they may be gathered from the woods, preferably in wet weather. When this is done, care should be taken to select thrifty specimens, not over 2 feet in height, and to plant them immediately.

When the young trees reach a height of about 10 feet and begin to crowd one another, the grove should be treated in the same manner as that recommended for the wild sapling thicket (see p. 31). This will give a maximum number of full-crowned trees to the acre, and the proper ground conditions will be maintained.

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

In some situations it may be advisable to mix with the maple a number of quick-growing trees valuable for posts or farm lumber, in order to secure early returns on the investment. The best species to use in this way can be determined only for definite localities. Advice in such cases will be willingly furnished by the Bureau of Forestry.

## MAPLE SAP.

### SAP PRESSURE AND FLOW.

The quantity of sap produced depends not only upon the size of the tree, but also on its relative situation, and often upon what seem to be peculiarities of the individual tree, not yet explained.

It has been recently shown that the force exerted by the sap of maple trees in the sugar-making season varies from a suction of 2 pounds per square inch at night to a pressure of 20 pounds per square inch in the day, and that it fluctuates in a general way with the rise and fall of temperature during the day and night.[a] Although the phenomenon of sap flow is not yet perfectly understood, it may be asserted that the popular idea of sap rising in the spring and retreating to the roots of the tree in the autumn is a fallacy. Conclusive experiments have shown that on tapping the tree a flow of sap both from above and below comes toward the holes. There is also a very small flow from the sides of the tap holes, the sap moving freely up and down the grain of the wood, but very slowly and in small quantities across it. Since the flow varies with the season, the day, and the variation of temperature between day and night, different quantities of sap are yielded by the same grove and the same trees in different years. These circumstances make an average yield very difficult to estimate. However, it may be said that an ordinary mature and thrifty maple will produce about 12 gallons of sap, or 3 pounds of sugar, per season. This figure is not extreme, for a sugar grove has been known to average 19 gallons of sap per tree during eight consecutive seasons, which included one poor year. Some trees have been credited with enormous yields. For instance, a tree in Vermont is known to have produced 30¾ pounds of cake sugar in one season, its sap being so rich that 7 quarts made 1 pound of sugar. Another maple in the same State gave 175 gallons of sap in one season.[b]

There is no doubt that large-crowned trees yield the most sap, so that those trees grown in the open produce the greatest quantities.

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[a] Bul. 103, Vermont Agricultural Experiment Station, 1903.

[b] Timothy Wheeler: Proceedings of Vermont Sugar Makers' Association, 1900.

A too open grove, however, is not to be recommended, because the yield per acre is necessarily less from the smaller number of trees, and the ground, from lack of proper cover, is more exposed to undesirable extremes of temperature during the sap season. The maple is a forest tree, and should grow under conditions that approach as nearly as possible those of the forest, but there is no reason why the grove can not be so worked that large, full-crowned trees shall occupy the ground and at the same time keep the soil sheltered and the forest cover perfect.

### THE AMOUNT OF SUGAR IN MAPLE SAP.

Maple sap is a nearly colorless liquid composed of water, sugar, and various mineral substances, such as lime, potash, magnesia, and iron; it also contains some organic matter in the form of vegetable acids. The peculiar flavor of maple sugar comes, not from the sugar, but from some one or a combination of all the other substances contained in the sap.

The amount of sugar in the sap of the average sugar maple tree varies greatly, the percentage changing in each tree as the season progresses. Careful experiments have shown that the sap contains on an average about 3 per cent of sugar. The maximum is reported at 10.2 per cent, which was found in a small flow of sap from a sugar maple near the end of a season, during which the tree averaged 5.01 per cent.[a]

## THE MANUFACTURE OF SUGAR AND SIRUP.

### THE SAP SEASON.

The sap season throughout the maple sugar belt of the United States generally begins about the middle of March and continues until the third week in April, but it varies very widely with a late or an early spring. Sugar making has begun as early as February 22 and as late as the first week in April. The season lasts on an average about four weeks. The longest run on record included forty-three days, and the shortest eight days.

### PRELIMINARY PREPARATIONS.

Before the sugar season opens the necessary stock of dry wood for fuel should be provided. Professional sugar makers cut their wood supply six months or more before it is needed, so that it will be well seasoned. Seasoned wood is most conducive to efficient work, but, in its absence, green wood can be used. Yellow birch, in particular, makes a good fire, even when newly cut. The necessity for fuel

[a] Dr. H. W. Wiley: Bulletin No. 5, Bureau of Chemistry, United States Department of Agriculture.

makes thinnings and improvement cuttings in the sugar grove practicable (see pp. 27, 31). The utensils also should be made ready for use. (For list and prices see p. 45.) Spouts, pails, gathering tank, storage tank, and evaporating pans should be thoroughly cleansed by scalding them with boiling water. Absolute cleanliness is the watchword of good sugar making.

### TAPPING THE TREES AND GATHERING THE SAP.

Before tapping a tree, any loose bark which may fall into the sap should be brushed away from the trunk. For this purpose an old stiff broom or brush is useful. Select a spot on the sunny side of the tree if possible, and, avoiding defects or old scars made by tapping, bore a hole 1 inch in depth with a three-eighths or half inch bit. The hole should be directed slightly upward to insure drainage. Trees under 12 inches in diameter at breast-height should not be tapped, and except in the case of the largest and most productive maples there should be but one spout to a tree.

The spouts should be of metal, preferably of malleable iron and heavily tinned (fig. 7, Nos. 8, 9, and 10). These are most lasting, but tin ones can be obtained at a slightly smaller cost. Wooden spouts are usually made of elder or sumach, out of which the pith has been forced with a stick, or burned with a hot iron. When these are used, a supply of them should be made before the sap season and stored in a cool place, where they will not check or warp.

Sap pails should be of tin or galvanized iron; wooden ones are less durable and harder to keep clean (fig. 7, Nos. 2 and 4). If wood is used, the pails should be enameled white on the outside, as a protection against heating by the sun. It is best to keep the pails covered, for rain, snow, or dirt will cause a deterioration of the sap and darken the color of the sugar and sirup. If sugar making is undertaken on a large scale it is well to have the covers reversible, with one side painted red and the other white (fig. 7, No. 6). By turning the red side up when the pail is emptied the gatherer will know it does not require his attention. When covers are used, a pail is hung to the spout by a hole in its rim. In this way the sap falls into a closed space, and the danger of evaporation and souring is greatly lessened. It is usually advisable to throw away the first drippings, for they are apt to be mixed with dirt, or to turn sour and contaminate the later flow. The sap runs very clear at first, but as the season advances it shows a tendency to darken. The most probable explanation of this is the oxidation that takes place about the hole.

### DEPTH OF TAP HOLES.

The relation of the depth of the tap hole to the amount of sap secured has been a point long in dispute among sugar makers, various depths having had their advocates. A nearly uniform depth of about 1 inch is now used by professional sugar makers. The sap is found almost entirely in the living or sap-wood, which in the mature maple is con-

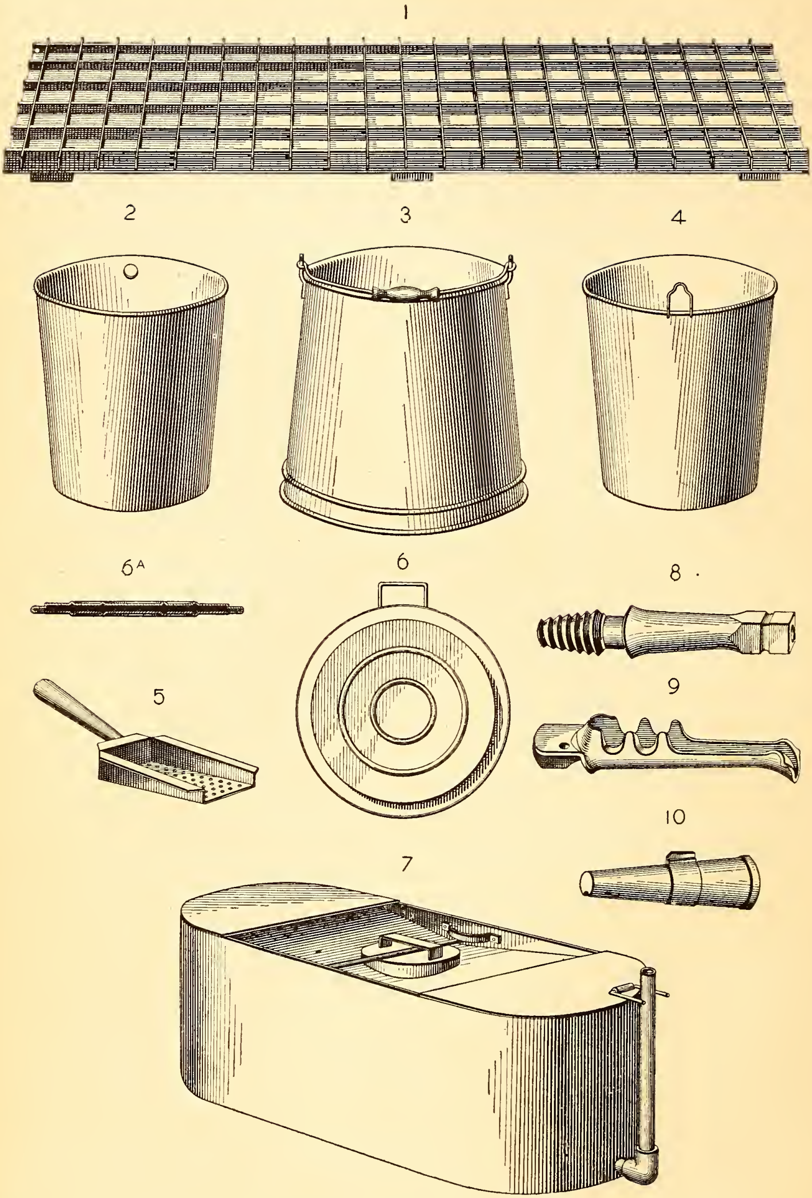


Fig. 7.—Sugar-making utensils: 1, sugar mold; 2, 4, sap buckets; 3, gathering pail; 5, skimmer; 6, cover for sap bucket; 6*a*, cross section of same; 7, gathering tank; 8, 9, 10, sap spouts.

fined to about twenty-five or thirty annual rings, or from 2 to 3 inches of the outer wood, according to the tree. The great bulk of the sap, however, is confined to the outer ten or fifteen rings of growth. The common practice of tapping to a depth of 1 inch seems justified by the fact that the increased cost of deeper boring is not offset by the increased yield, while the sap from deep holes is of darker color and the injury to the tree considerably greater. Sugar makers consider the sap from shallow holes of better quality than that from deep ones, and long experience and observation have resulted in this adoption of 1 inch as the proper depth.

The first requisite for transporting sap to the sugar house is a good system of roads throughout the sugar bush (p. 26). In some respects sap is as delicate a product as milk, and the method of bringing it from the tree to the storage tank must be rapid and systematic. In small groves the carrying can be done by hand, of course, or with the old shoulder yoke, but with larger operations the transportation must be effected by horses, steam power, or gravity, and must be fully organized.

If the grove be of moderate size (from 15 to 25 acres), teams may be used to haul the sap in a gathering tank (fig. 7, No. 7) on sledges or stone-boats. The labor of carrying the sap by hand to the hauling tank will be in proportion to the number of roads and their proximity to the trees. The tank should be metallic, but if of wood it should be painted white on the outside, to keep the sap cooler and prevent souring. When the grove is situated on a steep hillside it will often pay to run a pipe line, with receiving funnels at regular intervals, for the conveyance of the sap to a lower storage tank or directly to the sugar house. The storage tank should be of tin or galvanized iron, encased with wood and covered, to keep the sap cool and to prevent it from freezing. Every practicable precaution should be taken to keep the sap in good condition and free from impurities. As it is very sensitive to changes in the weather, and is likely to sour if it becomes heated, it should be collected regularly, and as soon as possible after it has left the tree. Some sugar makers begin to gather sap as soon as there is a quart or so in each bucket, even at the expense of going over the ground twice in a single day. The gathering tank should have a strainer over the mouth, and the storage tank should be kept at an even temperature, even if it must be cooled with ice during a sudden period of heat. Often during the season the sap runs slowly or stops altogether. Such an occurrence may be taken advantage of to wash and scald the gathering tanks, storage tank, and evaporators.

### THE EQUIPMENT.

The sugar house is the most important adjunct to the grove, and should be planned with reference to the scale of operations undertaken. If only a few trees are tapped the work may be carried on in the old-fashioned way, but even in such a case it is better to have a small, one-roomed house with a woodshed. In this room the small evaporator and sugaring-off kettle may be placed, and the work carried on satisfactorily. Where a large grove is to be operated, a

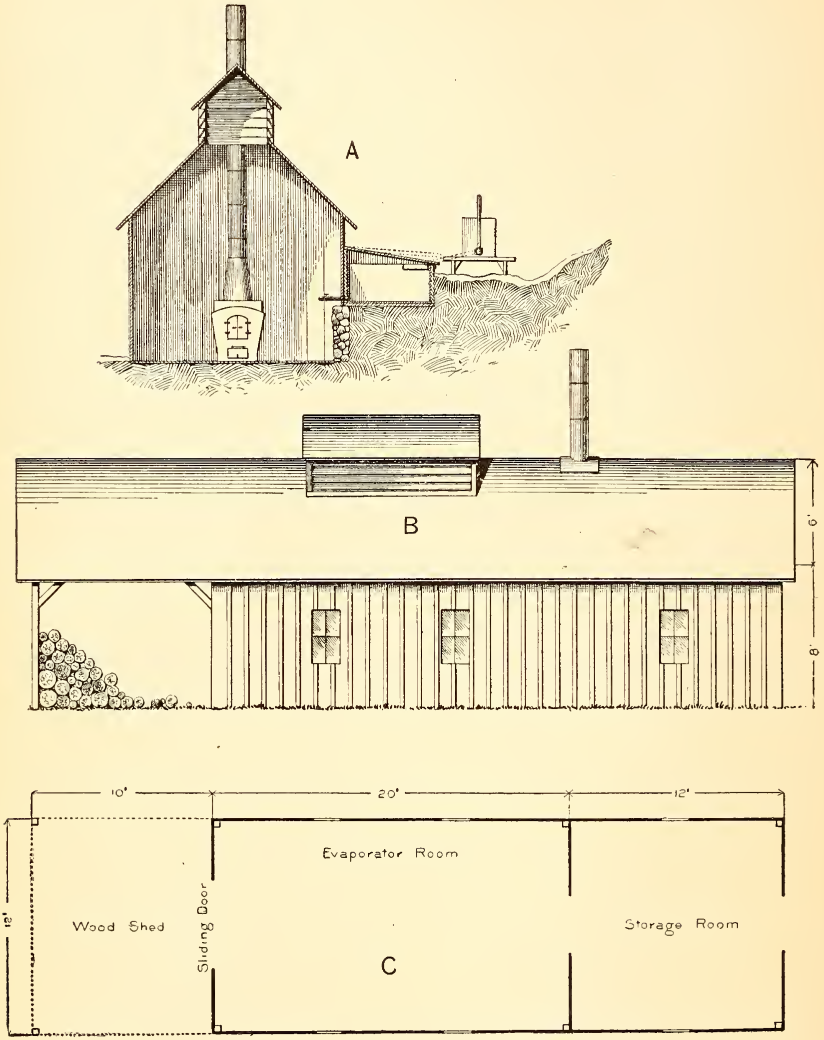


FIG. 8.—Plan of model sugarhouse: A. Sectional view, showing evaporator, storage tank, and gathering tank (on sled). B. Elevation. C. Ground plan.

two-roomed house with a woodshed is necessary. It is always well to put the sugar house on sloping ground, and, of course, in the most convenient place in the grove. If the ground rises above the house, the storage tank can be readily filled from the gathering tanks, and at the same time feed by gravity into the evaporator. If the grove be on level ground it will generally pay to make an artificial elevation upon which to place the storage tank, with room for the sledges to pass and discharge sap into it. (See fig. 8.)

The house, whether large or small, is best when built thoroughly tight and shingled. The space overhead should be left open to the roof, in which a ventilator should be built over the evaporator to permit the free escape of steam, but with the slats so arranged that no rain or snow can enter.

If 1,500 trees or more are to be tapped it will pay to have a house with two compartments and a woodshed, something after the general plan shown in figure 8. The evaporator room should form the middle compartment; the room for sugaring-off should adjoin it at one end, and the woodshed at the other. For the evaporating room 12 by 20 feet will be a convenient size, with a sugaring-off room of 12 feet by 12 feet, and a woodshed of slightly smaller dimensions. The latter should be open in front, with a wide sliding door opening into the evaporating room directly in front of the fire arch. With such an arrangement there will be no dust or dirt blown in from the wood pile. The sugaring-off room should be lined with stout shelves, which will be convenient in handling and storing the maple products. If the storage tank is heavily cased in wood and not likely to freeze, its best position is outside of the sugar house on that side where the ground is highest, but if it is in danger from extremes of temperature it should be placed within the house, even at the cost of a little room. Such a sugar house can be kept clean and airy, and will prove comfortable and convenient. The cost should not exceed $125.

To what point the elaboration of the sugar house may be carried is illustrated by Plate II, figure 2. The installation of a steam plant like this of course implies operation on a very large scale. Such a complete equipment is out of the reach of the ordinary farmer, who is, after all, the main producer; nor is it necessary for efficient work on a moderate scale.

## THE PROCESS.

What has been said of the perfect appointment of the sugar house, be it on ever so small a scale, is true also of the appliances, implements, and actual process of sugar making. The best models of evaporators can be bought in all sizes, and a good one will pay for itself, even in the smallest undertaking (fig. 9). In boiling down sap to sirup the following points are to be observed:

The best modern evaporators are made so that the sap feeds automatically into the pans, running fast or slow according to the heat under the pan. Although the pans are about 6 inches deep, the sap in them should be kept very shallow, the best results being obtained from a depth of $1\frac{1}{2}$ inches at the upper end and 1 inch at the lower. As the impurities rise to the surface they should be skimmed off with the greatest care, so that by the time the sirup reaches the lower end of the pan it may be perfectly clear. When the sirup reaches a temperature of 219° F.,[a] or a weight of 11 pounds to the gallon, a deposit of malate of lime, or "niter," will be observed, which gradually coats the pan. This temperature and weight are proper for good sirup, which should be dipped out and carefully strained through flannel to remove the "niter." The flannel strainer is very efficacious, the sirup flowing steadily through it and coming out perfectly clear. After ten or twelve

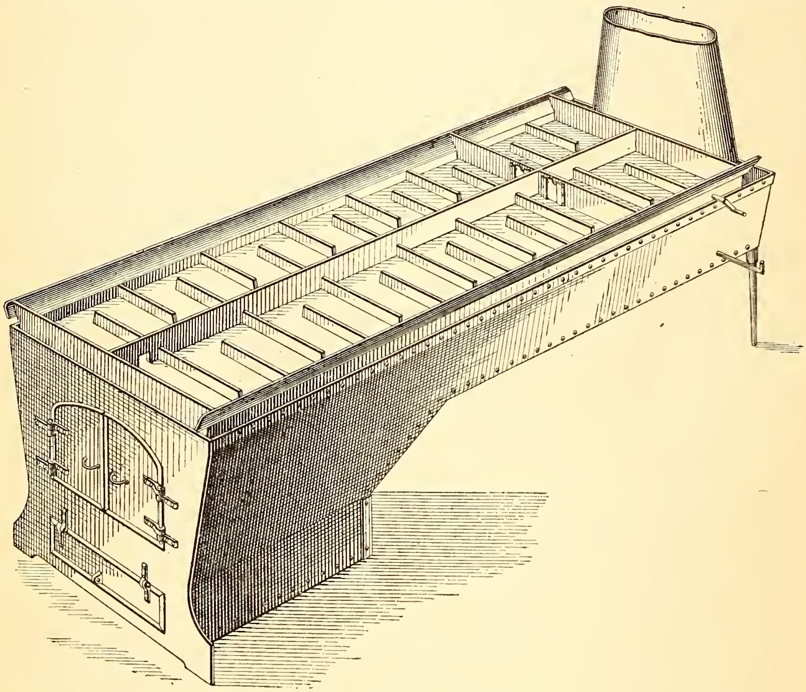

Fig. 9.—Modern maple-sap evaporator.

hours' boiling, the two rear sections of the evaporator will become more or less coated with the "niter" or malate of lime. Instead of scraping this off or cutting it with acids, the pan should be simply turned about, putting the coated sections toward the cold sap and the clean sections in the rear. In an hour or so the boiling sap will dissolve and remove the lime, all of which will be caught in the strainers. Particular care should be taken to see that the sirup finishes at the proper temperature (see note) and weighs 11 pounds to the gallon; to

[a] This figure is accepted in parts of Vermont, but since the proper temperature varies with the altitude of the sugar house, each operator will have to determine by experiment what is right for his situation.

insure this, careful tests should be made with the thermometer and the scales. The sirup should be stored in large tanks and allowed to settle, although if flannel strainers are used it will contain but little sediment.

It is a much mooted question whether the sirup should be put up for the market hot or cold. Both methods are used by experienced makers, but as it has been generally observed that sirup put up hot shows a greater tendency to crystallize, it is usually most satisfactory to put it up cold. In either case, sirup should be canned or tightly inclosed as soon as practicable. Square, oblong, or round cans containing a gallon, half gallon, or quart are used: the first are more general. To fill them, the can should be tipped slightly and filled to

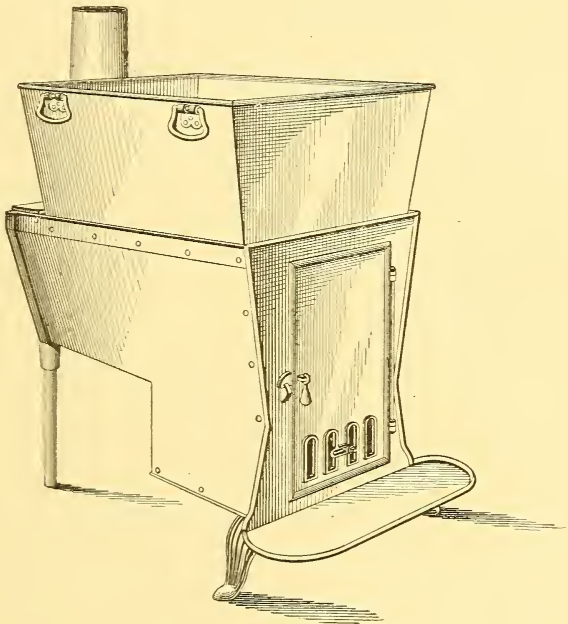

FIG. 10.—Modern sugaring-off arch.

the top. It should then be lifted so that the bottom may sag and the sides bulge out slightly, then filled to the top of its screw-cap mouth and held thus while the cork-lined screw cap is turned down as tight as possible by hand. The can should then be set down and the cap screwed on tighter with a wrench; and afterwards laid on its side to see if there is any leakage. A package containing honest measure is almost as important as sirup of good quality.

In making sugar, the sirup should be reboiled in a sugaring-off arch until it begins to crystallize, or "sugar off." By the old-fashioned methods this point was determined by pouring a little sirup on the snow, or by dipping into it a twig bent into a loop. If the sirup became waxy on the snow, or if it formed an elastic film within the loop, it had boiled enough and was ready to "sugar." Under more modern methods the testing is done with a thermometer, and sugar is made at different temperatures according to the qualities wanted. During the early run of sap 238° F. will make cake sugar, but later in the season the sap will require 242°. If not intended for immediate consumption, or if a cake that will not "drain" is desired, the temperature may be brought up to 245° or 253° (see note, p. 42). At these temperatures, however, the sugar will be too hard to eat comfortably. In practice it is best to reduce the sirup to sugar in small quantities, and before pouring the mass into the molds (fig. 7, No. 1) to lower its temperature slowly by stirring, in order to avoid too rapid granulation.

The most convenient size and form for sugar is in 1 to 5 pound bricks and in 10-pound pails for family use. Sugar put up in bulk is likely to fall into the hands of the mixer at a low price. That in small and attractive sizes is better adapted for personal use, and acceptable to the wholesale and retail trade. The ordinary 10-pound pail is a good package if it reaches the consumer soon after it is filled. If it is to be kept through the summer, a wooden tub or tin pail with a cover that can be hermetically sealed is better, as sugar left in an unsealed package is apt to mold in hot weather. The bricks should be wrapped in paraffin paper and packed in cases of equal lots.

Sugar and sirup should be stored in a cool, dry cellar or storeroom, as excessive heat is bad for them—particularly a combination of heat and moisture, which causes the sugar to mold and the sirup to ferment.

## THE PROFIT.

The production of maple sugar is so largely a home industry that normal conditions of labor and expenditure can hardly be considered. The bulk of maple sugar on the market comes from farms where the families have supplied the labor, where the cost of the sugar grove can not be determined, and where the expenditure is entirely confined to a few utensils and a rude sugar house. An expenditure and profit estimate for such methods would have but little value, and could not be made specific enough to serve as an example. Nevertheless a general table can be given which will serve as a guide for the prospective maker. The following estimate is made for a grove of 15 acres upon which about 1,000 sugar trees are standing. Such woods in Vermont would cost from $5 to $10 per acre, according to location, but to make a perfectly safe figure the price is here taken at $15.

| | | |
|---|---|---|
| Initial expenditure: | | |
| 15 acres of maple woods, at $15 per acre | | $225 |
| Equipment: | | |
| Sap buckets, 1,000, at 20 cents each | $200 | |
| Covers, 1,000, at 5 cents each | 50 | |
| Spouts, 1,000, at 2 cents each | 20 | |
| Gathering tanks, 2, at $10 each | 20 | |
| Storage tank | 20 | |
| Sugar house | 125 | |
| Arch and evaporator | 125 | |
| Sugaring-off pan and arch | 20 | |
| Sirup cans and molds | 12 | |
| | | 592 |
| Total | | 817 |

From this the annual cost may be figured as follows:

| | |
|---|---|
| Rent of land, 6 per cent on $225 | $13.50 |
| Wear and tear, 10 per cent of cost of equipment ($592) | 59.20 |
| 18 cords of firewood, at $2 per cord | 36.00 |
| 3 laborers, including teamster, for twenty days, at $1.25 per day, inclusive of board | 75.00 |
| Team for hauling sap, twenty days, at $1.25 per day | 25.00 |
| Sirup cans, sugar pails, boxes, etc., for packing | 14.00 |
| | 222.70 |

The returns, counting 3 pounds of sugar, or its equivalent in sirup, per tree, will be 3,000 pounds sugar. At 9 cents per pound this will bring in $270, or a net profit of $47.30, equal to 8 per cent on the outlay apart from the land ($592).

This is not a heavy return, but it must not be forgotten that the figures are purposely made conservative. Many farmers will find the labor charge, or the rent item, too high, or they may even be able to cut them out entirely. Maple sugar making is possible only at a season when farmwork is usually slack, and the time devoted to it may be virtually saved. Each prospective operator will be able to make his own calculation from the figures here given, but it should be remembered that the industry has its limitations, and the number of people who can go into it will always remain comparatively small.

No attempt has been made to put into figures the probable results of improved forest methods in the sugar grove, but such considerations are believed to be of the utmost importance. This phase of the matter will receive particular attention in the experiments now being carried on by the Bureau of Forestry.

# THE ADULTERATION OF MAPLE PRODUCTS.

By H. W. Wiley.

*Chief of the Bureau of Chemistry.*

The high price of maple sugar and sirup has rendered the practice of adulterating these articles extremely remunerative. These products are not valuable alone for their sweetening power nor for their nutritive value, but especially because they contain certain aromatic and condimental bodies which impart to them an agreeable flavor. Moreover, this is a flavor which has not yet been successfully imitated by any artificial means, although many attempts have been made to produce, artificially and synthetically, these flavoring matters.

## NATURE OF THE FLAVORING SUBSTANCES.

The exact chemical composition of the peculiar flavoring of the maple is not known, though it is probably an ether or aldehyde possessing a high boiling point. Some of the flavoring matters present in the natural sap of the maple tree, however, are volatile, as is shown by the strongly aromatic odors pervading the air in the vicinity of a maple-sugar factory. The residual flavors, however, evidently have a boiling point considerably above that of boiling water, since they are not entirely removed from the product at the temperature at which the sugar and molasses are made. (See pp. 42, 44.) Detection of this flavoring matter by chemical means has, up to the present time, baffled the skill of the chemist, and for this reason the taste of the expert has been relied upon almost solely to distinguish between the genuine and the adulterated article in cases where the adulterant is cane sugar. Thus it is apparent that pure cane sugar can be utilized to a certain extent in the adulteration of maple products without certainty of detection.

The flavoring matters appear to reside chiefly in the molasses or semiliquid parts of the maple product, and for this reason the refining of maple sugar to a perfectly dry, white, crystalline mass would deprive it of the chief of its properties upon which its high market value depends.

## ADULTERATED MAPLE SUGAR.

In the present state of our knowledge it would be difficult to determine in any particular case whether or not other sugars had been added to maple sugar.[a] There is one difference between the maple sugar of

[a] See United States Department of Agriculture, Bureau of Chemistry, Circular 23, Method for the Examination of Maple Products, by J. Hortvet. Also Jour. Amer. Chem. Soc., 1904. 26: 1523.

commerce and other sugars, viz, maple sugar is never dried by means of the centrifugal or by drainage. In other words, it contains all the molasses and water which the original mass, as it comes from the kettles, holds. It corresponds to that form of cane sugar known as "concrete," which is made in some tropical countries for a limited domestic consumption or for sending to refineries. A genuine maple sugar should therefore contain a considerable quantity of water and some invert sugar, produced chiefly during boiling. The polarizations of a genuine maple sugar—that is, the quantity of pure sucrose which it contains—will range between 80 and 85. In rare cases it might fall below 80 or rise above 85. A valuable indication also in regard to the purity of a sugar may be found by examining it for the nature of the organic acid which it contains. The maple juice contains considerable quantities of malic acid, and a determination of the presence of this acid would be an indication of purity. The best method of judging of the purity of maple sugar, however, is to be acquainted with the manufacturer and dealer. The only method of securing absolute freedom from adulteration would be a rigid State and National inspection of manufacture. This is partly provided for in Vermont, in so far at least as forbidding the addition of other sugars to maple sugar is concerned. The following extract gives the language of the act:

AN ACT to increase the penalty for the adulteration of maple sugar and maple syrup. Approved November 13, 1890.

SECTION 1. Number 81 of the public acts of 1884, approved November 25, 1884, is hereby amended so as to read as follows: "A person who shall adulterate maple sugar or maple syrup with cane sugar, glucose, or with any substance whatever, for the purpose of sale, or who knowingly sells maple sugar or maple syrup that has been adulterated, shall be punished by a fine of not less than fifty dollars nor more than two hundred dollars for each offence, and one-half of such fine, on conviction, shall go to the complainant."

SEC. 2. This act shall take effect from its passage.

It is evident that legislation of this kind is incomplete unless accompanied by a provision for the proper inspection of the factory.

## ADULTERATION OF MAPLE SIRUP.

One of the most common adulterants which has hitherto been used in the adulteration of maple sirup is glucose, understanding by this term the liquid product of the conversion of starch into sugar. It is also well known that large quantities of maple sirups are sold on the market which are fabrications of other sweets, to which a little maple molasses is added for the purpose of giving them flavor, or, as is often the case, being entirely free from any addition of maple product whatever. The maple flavor is said to be imparted to sirups by mixing with them an extract of hickory bark, and this product has been made and sold under the term "mapleine." It is safe to say that perhaps the greater quantity of maple molasses or sirup on the market is adulterated in the true sense of the word. These definitions, however, are only of a popular nature, and a sirup without further definition can not be said to be adulterated, legally, unless some statute is enacted establishing a standard by which these products can be judged. For the purposes of this report a molasses or sirup is deemed to be adulterated whenever it contains glucose or any other substance which is not a natural product of sorghum, sugar cane, or the maple tree. Molasses or sirups which are made exclusively of the products of sorghum, sugar cane, and maple sap can not be said to be adulterated in the strict sense of the term, no matter what the method of their preparation may be. The distinction between "molasses" and "sirup" is illustrated in the official standards for these bodies appended hereto.

In regard to glucose it may be said that its presence in molasses or sirup is an adulteration unless the article containing it is distinctly so marked. A few years ago, when sugars, sirups, and molasses were higher priced than they are now, the manufacture of sirups from glucose was very profitable. The price of genuine molasses and sirups, however, has at the present day fallen so low as to make the use of glucose for the above purpose much less profitable than before. The advantage of using glucose, nevertheless, is very great, aside from its cheapness. It gives to sirup and molasses a fine body and a light color. A molasses or sirup, therefore, made chiefly of glucose and flavored with the genuine product, makes a very attractive article for table use, in so far as appearance goes. Neither in regard to wholesomeness is it advisable to condemn glucose. When properly made it is apparently as wholesome an article of diet as cane sugar. In fact, the starches which are consumed in our foods are all converted into glucose during the process of digestion. A glucose food, therefore, is a starch food already partially digested. The use of some acids in converting the starch into glucose would prove detrimental to health unless they were carefully removed. To meet this objection glucose is now often made by hydrolyzing the starch with a small amount of hydrochloric acid under pressure. The residual acid is neutralized by soda and thus converted into common salt. Glucoses are often made with ferments for the purpose of converting the starch into sugar rather than by the use of acids. Diastase is one of the ferments commonly used for this purpose. At the present time the use of glucose in the manufacture of molasses and sirups can not be said to be fraud, if properly labeled. In this country glucose is made chiefly from Indian corn, and the high price of this product makes glucose cost almost as much as the other materials of which ordinary molasses and sirups are made.

In regard to the adulteration of maple sirup, an attempt was made a few years ago to make an imitation article which was sold both under the name of maple sirup and mapleine. This product was manufactured under a patent issued to a resident of Madison, Ind., dated July 18, 1882, and reissued February 13, 1883. This process is best described in the words of the patent itself, which follow:

*To all whom it may concern:*

Be it known that I, Josiah Daily, of Madison, in the county of Jefferson and State of Indiana, have invented a new and useful method of flavoring sirups and sugars and other saccharine matter, of which the following is a full, clear, and exact specification:

The object of my invention is to impart to saccharine matter the flavor of maple sirup, and the invention consists in the use of an extract of hickory for giving the desired flavor.

The extract is to be obtained in any convenient manner, such as making a decoction of the hickory bark or wood, or percolating liquid through the same, or drawing off the sap from the tree. The bark or wood of the hickory tree may be ground to facilitate the extraction of its principle, and the extract may be made more or less strong by increasing or diminishing the quantity of bark or wood, or by boiling the extract for a longer or shorter time.

In preparing sirups I ordinarily add about three tablespoonfuls of the decoction to a gallon of heated or boiling sirup. Of course the stronger the extract the less the quantity required for flavoring a given amount of sirup. The sirup may be manufactured from any kind of saccharine matter or mixture of saccharine matters, or the sirups ordinarily found in the markets may be used. The effect of the extract or decoction is to give to the sirup the flavor of maple, producing a sirup which can not be distinguished from genuine maple sirup.

The high price of maple sirup, as well as its scarcity throughout the country, renders this improved sirup of great value, since a good substitute for maple sirup is thus produced which comes within the reach of all.

It is evident that the flavored sirup may be boiled down and a sugar resembling maple sugar in taste may be produced.

In defining the limits of my invention I would state that I do not claim broadly the use of extracts of the wood or bark of trees for flavoring sirups or sugars, as I am aware that a decoction made from the wood of the maple has been used for the same purpose. The maple, however, belongs to a different genus of tree from that of the hickory, and it is well known that extracts of wood as a rule differ from each other in taste, according to the nature of the tree. I have discovered that the hickory tree will produce the flavor of the maple, and I therefore claim as my invention the use of the hickory extract wherever it may be employed to impart an agreeable flavor.

Having thus described my invention, what I claim and desire to secure by letters patent is—

1. The method herein described of flavoring saccharine matter, including sirup and sugar, which consists in treating or inpregnating the same with the principle or extract of hickory, as specified.

2. An improved sirup or sugar, consisting of any suitable saccharine matter flavored with an extract of hickory, substantially as described.

JOSIAH DAILY.

Witnesses:

A. G. LYNE,
SOLON C. KEMON.

The process of adulteration of maple sirup was fully described in the testimony before the Senate Committee on Manufactures and the House Committee on Interstate and Foreign Commerce.[a]

In the course of the testimony of Mr. Maurice A. Scully (p. 89, Senate Report 516) the following facts were elicited:

Maple sirup is usually prepared by melting to the required consistency maple sugar, though a large proportion is sold just as it comes from the sap maple. The firm with which the witness is connected sells three grades of maple sirup, one being the pure sirup, which is so marked and sold; a second, containing 60 per cent of maple sirup and 40 per cent of glucose, selling for 20 per cent less than the first grade; and a third, containing a still larger percentage of glucose, and selling for 25 per cent less than the second grade. The two lower grades are labeled with their formula for the States having pure-food laws; for other States they are marked "maple sirup." Mr. Scully stated that he was not acquainted with the use of hickory bark or other adulterants than glucose in the manufacture of maple sirup.

The following quotations are from the testimony of Mr. Madden before the House Committee on Interstate and Foreign Commerce, Fifty-seventh Congress, pages 85 and following:

Mr. Madden. Now, I would like to speak to you a moment in regard to maple sirup. That is a subject that will undoubtedly interest you all. We are in a very peculiar position in regard to maple sirup. We do not believe it is right that a sirup composed of maple sirup made from either the sap of the maple tree or from maple sugar and mixed with glucose should be sold as a maple sirup; but we do believe that a maple sirup made from sirup of the maple sugar and mixed with cane-sugar sirup or refined-sugar sirup, I will say—because beet and cane sugar are the same after they have been through boneblack—we do believe that should be sold for maple sirup, and I will tell you why. In the first place, the amount of sap of maple sirup—that is, sirup that is made from boiling the sap of the maple tree without converting it into sugar—is so limited that it would not, in my judgment, supply more than 5 per cent of the demand for maple sirup in the United States.

Now, when maple sap is boiled into sugar—and I want to say before I go further that the reason that the amount of sap sirup is so limited is because it is hard to keep it from fermentation, and the season is so short in which the sap runs that it is difficult to manufacture, to boil enough in the camps to supply the demand; consequently a large proportion of the sap in the States where maple sugar is made is boiled into maple sugar. Now, we have found by experience—not by chemical analysis, but by experience—that the maple sugar made from the sap of the maple tree in Ohio is not so strong as the maple sugar made from the sap of the maple tree in Vermont, and that the maple sugar made from the sap of the maple tree in Vermont is not so strong in flavor as that which is made in Canada, in Quebec Province, because it seems that the colder the climate the stronger in flavor the maple sap is.

Now, we buy these various sugars and reduce them to a liquor to make maple sirup, and I will give you my word, gentlemen, if we take a Canadian sugar, which

[a] See 56th Cong., 1st sess., Senate Report 516; 57th Cong., 1st sess., Senate Report 972; 57th Cong., 1st sess., House of Representatives, "Pure Food Legislation," report of testimony before the House Committee on Interstate and Foreign Commerce.

is the highest priced maple sugar we have, it being worth at the present time 12 cents a pound, while Vermont is worth only 8 cents a pound—I give you my word that if we make a liquor by melting that Canadian maple sugar, without the addition of sugar to reduce the strength of the flavor, it is so strong you could not use it.

Mr. COOMBS. What do you mean by strong?

Mr. MADDEN. Strong in flavor.

Mr. COOMBS. You mean it is positive?

Mr. MADDEN. The flavor is so positive; yes, sir.

Mr. COOMBS. And it is sweet?

Mr. MADDEN. Sweet, yes; but if you put it on a hot cake you would say right away, "Take it away; I won't have such stuff," and you would say ordinarily that it was glucose. You would be wrong, but that is what you would say.

Now, the Vermont sugar is not so strong, and it does not require so much cane sugar to reduce that to a flavor comparing with the natural maple sirup obtained from the sap itself; and I tell you that we can take maple sugar and reduce it, blending it with cane sugar—and by that I mean take ordinary cut-loaf sugar, for instance, and melt it—and we can take this sirup that is made by melting the maple sugar and blend it with the white sirup, and we can produce a maple sirup that is in flavor strong enough and yet delicate enough to satisfy the appetite, and that, in my judgment, is better than the sap sirup made from the maple tree for a great majority of the people.

As an illustration, although we get $11.50 per dozen gallons for a sap maple sirup that is boiled from the sap of the maple tree and the character of the maple sirup that I have just described, about 95 per cent of our business is on the sirup that is made from the maple sugar and the cane sugar rather than on the sirup made from the sap itself. Now, if we have to take this maple sirup and brand it as cane sugar, or have any such restrictions, we can not sell it. Now, what are we going to do? We do not believe in frauds any more than you do. We think just as much of our reputation as you do of yours; but we do not want to be held responsible for conditions that we have not built up.

Mr. COOMBS. It seems to me your whole argument has illustrated that everybody who buys these things knows he is not buying the pure article.

Mr. RICHARDSON. It is either that or you are deceiving them, one or the other.

Mr. MADDEN. Well, I will answer another phase of that question.

Now, it is commonly assumed, I think, that these blends, mixtures, substitutes, and what some of our theoretical gentlemen call commercial frauds, are done for the purpose of palming off on the people something that is cheap or inferior at a high price. Right there is where the mistake is made. The profits on that class of goods are less to us than on the higher class and more expensive goods, because competition forces these lower-class commodities down to such an extent that they pay us less profit than any other.

We could not take a maple sugar and mix it with cane sugar and obtain the price for pure maple-sugar sirup unless it had the quality, unless it cost so much. In other words, in speaking of maple sirup—and here is the part of this I forgot to speak of—if you take maple sugar and reduce it to the liquor, as we call it, and had to sell it without the addition of any reducing sugar or white sirup—not glucose, but pure cane or beet sugar—if you have to sell it without doing that, it would be so expensive as to be prohibitory, because with Canadian maple sugar worth 12 cents a pound to-day, it taking 8 pounds of it to make a gallon of sirup, you would have a price of nearly a dollar a gallon for your liquor as a first cost, without the cost of package. * * *

The above quotations will illustrate sufficiently well the processes of manufacturers and dealers in adulterating maple sirup. It is evident from this testimony that if the pure article be obtained when purchased at random it is by accident rather than by intention. Whatever may be the condition of the products when they leave the manufacturers in Vermont, New York, Ohio, or Canada, it is evident that all that part which goes into general commerce is subject to extensive adulterations. Only that part which enters domestic commerce, that is sold directly by the manufacturer to the consumer, can be considered above suspicion.

It is evident from the above résumé of the subject that the adulteration of maple sirup is practiced to an enormous extent. As stated by one of the witnesses, it is doubtful if more than 5 per cent of the amount sold in this country is the genuine article. It is evident that the makers of the genuine article are forced into competition with these extensive adulterations, thus lowering the legitimate price. Every grove of maple trees in the United States would be worth a great deal more to its owner if the State and National laws should be so framed as to eradicate this great evil. Such laws would permit the sale of these mixed goods under their proper names, and thus protect both the manufacturer and consumer.

The standards for sugars and related substances, including sirups, molasses, candy, and honey, as fixed by the Secretary of Agriculture by authority of Congress, are as follows:

## C. Sugars and Related Substances.[a]

### a. SUGAR AND SUGAR PRODUCTS.

#### SUGARS.

1. *Sugar* is the product chemically known as sucrose (sacchârose) chiefly obtained from sugar cane, sugar beets, sorghum, maple, or palm.

2. *Granulated*, *loaf*, *cut*, *milled*, and *powdered sugars* are different forms of sugar and contain at least ninety-nine and five-tenths (99.5) per cent of sucrose.

3. *Maple sugar* is the solid product resulting from the evaporation of maple sap.

4. *Massecuite*, *melada*, *mush sugar*, and *concrete* are products made by evaporating the purified juice of a sugar-producing plant, or a solution of sugar, to a solid or semisolid consistence in which the sugar chiefly exists in a crystalline state.

#### MOLASSES AND REFINERS' SIRUP.

1. *Molasses* is the product left after separating the sugar from massecuite, melada, mush sugar, or concrete, and contains not more than twenty-five (25) per cent of water and not more than five (5) per cent of ash.

2. *Refiners' sirup* ("treacle") is the residual liquid product obtained in the process of refining raw sugars and contains not more than twenty-five (25) per cent of water and not more than eight (8) per cent of ash.

#### SIRUPS.

1. *Sirup* is the product made by purifying and evaporating the juice of a sugar-producing plant without removing any of the sugar and contains not more than

[a] U. S. Dept. of Agr., Office of the Secretary, Circular No. 13, Standards of Purity for Food Products.

thirty (30) per cent of water and not more than two and five-tenths (2.5) per cent of ash.

2. *Sugar-cane sirup* is sirup made by the evaporation of the juice of the sugar cane or by the solution of sugar-cane concrete.

3. *Sorghum sirup* is sirup made by the evaporation of sorghum juice or by the solution of sorghum concrete.

4. *Maple sirup* is sirup made by the evaporation of maple sap or by the solution of maple concrete.

5. *Sugar sirup* is sirup made by dissolving sugar to the consistence of a sirup.

### b. GLUCOSE PRODUCTS.

1. *Starch sugar* is the solid product made by hydrolyzing starch or a starch-containing substance until the greater part of the starch is converted into dextrose. Starch sugar appears in commerce in two forms, anhydrous and hydrous. The former, crystallized without water of crystallization, contains not less than ninety-five (95) per cent of dextrose and not more than eight-tenths (0.8) per cent of ash. The latter, crystallized with water of crystallization, is of two varieties—70 sugar, also known as brewers' sugar, contains not less than seventy (70) per cent of dextrose and not more than eight-tenths (0.8) per cent of ash; 80 sugar, climax or acme sugar, contains not less than eighty (80) per cent of dextrose and not more than one and one-half (1.5) per cent of ash.

The ash of all these products consists almost entirely of chlorids and sulphates.

2. *Glucose, mixing glucose,* or *confectioner's glucose* is a thick, sirupy, colorless product made by incompletely hydrolyzing starch, or a starch-containing substance, and decolorizing and evaporating the product. It varies in density from forty-one (41) to forty-five (45) degrees Baumé at a temperature of one hundred (100) degrees F. (37.7° C.), and conforms in density, within these limits, to the degree Baumé it is claimed to show, and for a density of forty-one (41) degrees Baumé contains not more than twenty-one (21) per cent and for a density of forty-five (45) degrees not more than fourteen (14) per cent of water. It contains on a basis of forty-one (41) degrees Baumé not more than one (1) per cent of ash, consisting chiefly of chlorids and sulphates.

3. *Glucose sirup* or *corn sirup* is glucose unmixed or mixed with sirup, molasses, or refiners' sirup, and contains not more than twenty-five (25) per cent of water and not more than three (3) per cent of ash.

### c. CANDY.

1. *Candy* is a product made from a saccharine substance or substances with or without the addition of harmless coloring, flavoring, or filling materials, and contains no terra alba, barytes, talc, chrome yellow, or other mineral substances, or poisonous colors or flavors, or other ingredients injurious to health.

### d. HONEY.

1. *Honey* is the nectar and saccharine exudations of plants gathered, modified, and stored in the comb by honey bees (*Apis mellifica*). It is laevo-rotatory, contains not more than twenty-five (25) per cent of water, not more than twenty-five hundredths (0.25) per cent of ash, and not more than eight (8) per cent of sucrose.

2. *Comb honey* is honey contained in the cells of comb.

3. *Extracted honey* is honey which has been separated from the uncrushed comb by centrifugal force or gravity.

4. *Strained honey* is honey removed from the crushed comb by straining or other means.

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