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MAPLE SUGAR AND SIRUP.

BY

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, D. C., March 17, 1906.

SIR: I have the honor to submit herewith a paper on Maple Sugar and Sirup, by William F. Hubbard, based upon Bulletin 59 of the Forest Service, The Maple Sugar Industry, and to recommend the publication of the same as a Farmers' Bulletin.

Very respectfully,

GIFFORD PINCHOT,
Forester.

Hon. JAMES WILSON,
Secretary of Agriculture.

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MAPLE SUGAR AND SIRUP.

HISTORY OF THE MAPLE-SUGAR INDUSTRY.

The art of making maple sugar was first learned by the early settlers from the Indians.

For a hundred years or more the methods of production remained without material change save the substitution of iron or copper kettles for vessels of clay or bark, and the use of better utensils.[a] The sugar was made 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.

The boiling was generally done in the open woods, with no protection from sun, rain, snow, and miscellaneous impurities. Green or dead and down timber, cut as fast as it was needed, generally supplied the fuel. After the sap had been boiled down to the consistency of thin sirup it was stored until enough was on hand for "sugaring off."

The crude product of early days was dark in color and quite variable in quality, while in quantity it was wholly inadequate for a large trade. 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. About the middle of the last century a rapid improvement in the methods and machinery employed took place.

PRESENT STATUS OF THE INDUSTRY.

Maple sugar, at first an article of food, has now been almost displaced for this purpose by the cheaper and unflavored cane product. Yet the demand for maple sugar and sirup for special purposes, owing to their peculiar flavor, not only keeps the industry alive but calls for a continually increasing supply. Production has not kept pace with this growth in demand, but has been more or less stationary for

[a] The Indians boiled the sap down by repeatedly dropping hot stones into it.

twenty years. 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. The wholesale dealer, or "mixer," uses the maple sugar to flavor a body of glucose or cane sugar six or ten times as great, making a product which is marketed as "pure maple sugar."

But there has always been a certain amount of trade in pure maple sugar and sirup. A part of the city and town people come 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 worked in this field. 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, which have done much to stimulate improved methods, as well as to build up a legitimate trade. But there is only a very small part of the business which is not in the hands of the mixers.

Quantity and value of maple products made on farms in the census year 1900.

[From United States Census Report.]

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

PAST AND PRESENT OUTPUT OF SUGAR AND SIRUP.

The history of the maple-sugar industry of the country may be read in the census figures. In the census of 1860 the total production of maple sugar and sirup reached its height. It 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 nearly a third less than in 1850.

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 condition indicates that sugar making for home use is giving way to a market production.

In Vermont the production in 1899 was especially small, not only because of the poor season, but on account of a serious attack on the groves by the "maple worm." (See p. 12.) 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. But in western Maryland and the adjacent part of West Virginia the production has decidedly increased, showing that sugar and sirup are there being produced for the market, and that the southern mountains possess latent possibilities 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 be producing 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 table on page 6 gives the 1900 census figures of maple sugar and sirup production. The decrease for the year, both in quantity of sugar and in sugar-producing area, comes from a number of causes, some of which are permanent, but some only temporary. In the New England States, New York, and to a less extent in Ohio, the sugar season of 1899 (that reported in the census of 1900) was

very poor. For this reason the figures do not fairly indicate the present condition of the industry.

It is plain that for climatic reasons the maple-sugar 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 AND THEIR WORK.

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. 6 and 7.) Every maple-sugar dealer in a 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.

In the present state of our knowledge, it is difficult to determine in any particular case whether or not other sugars have been added to maple sugar.[a] There are of course some differences between the maple sugar of commerce and other sugars, which serve as indications for the analyst. The consumer who is familiar with genuine maple sugar and sirup can protect himself to some extent by tasting a sample before buying. Under present conditions, however, the best guaranty of purity is the word of an honest producer or dealer.

One of the most common adulterants used is glucose. Common cane sugar is also used. A flavor like that of maple is said to be imparted to sirup by mixing with it an extract of hickory bark. An Indiana man a few years ago took out a patent to protect him in the use of such an extract from the wood and bark of hickory trees for flavoring sirup.

In spite of the well-known fact 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—from 13 cents a pound for sugar and $1.25 a gallon for sirup in 1882 to 11

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

cents a pound for sugar and 91⅔ cents a gallon for sirup in 1903. Meanwhile the census returns show that the actual production of the groves has not increased since 1860. 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.

By 1875 cane sugar had become cheap enough to undersell the maple, which it has now supplanted everywhere. Since 1885 maple sugar has been an article of luxury only. 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.

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 article 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.

A similar situation has been successfully met, in the case of certain other farm products, by organized cooperation of producers, sometimes aided by government action. Canadian dairy products, which formerly had little sale in Great Britain, are now in good demand in the English market. 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 to improve the methods of production and to furnish 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 unite in forming a stock company, thus securing capital for the

necessary equipment. In every case all sugar and sirup should be sent to a central point, where it should 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. 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, 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, the mature tree has 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. In such a condition the struggle between the young trees is so fierce that the development of even the most thrifty is seriously retarded. 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, 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 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 are of vital importance. (See pp. 14, 15, 26.)

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 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," concerning which information may be had by application to the Bureau of Entomology, United States Department of Agriculture.

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. 14.) 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 Ameriea. 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 and 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 seeds, 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. 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, 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.

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] Bul. 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. 11); 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.

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

(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, 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. These trees have their normal forest form—a long, smooth stem and compact crown. There is little to be gained in actual sap production by thinning such a stand (p. 14), 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, 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.

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.

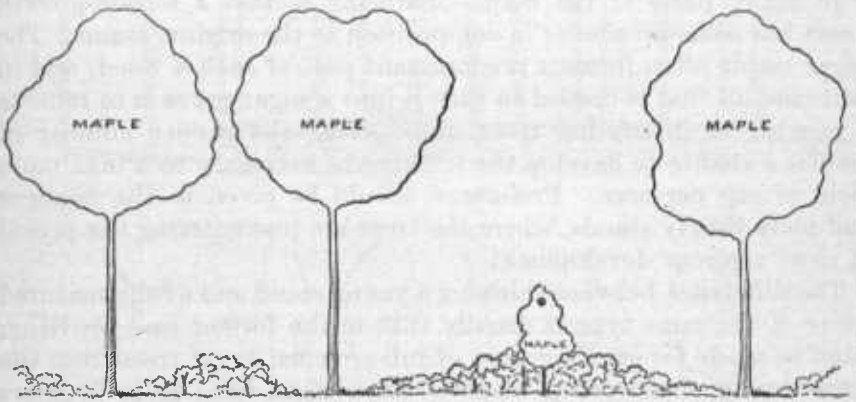

FIG. 1.—Method of improving an open grove.

After laying out proper driveways for sap gathering, the seedlings should be allowed to come up everywhere else. All unsound and dying trees should be cut out and young growth of all 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. 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 supply 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 1 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.

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 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 2. 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

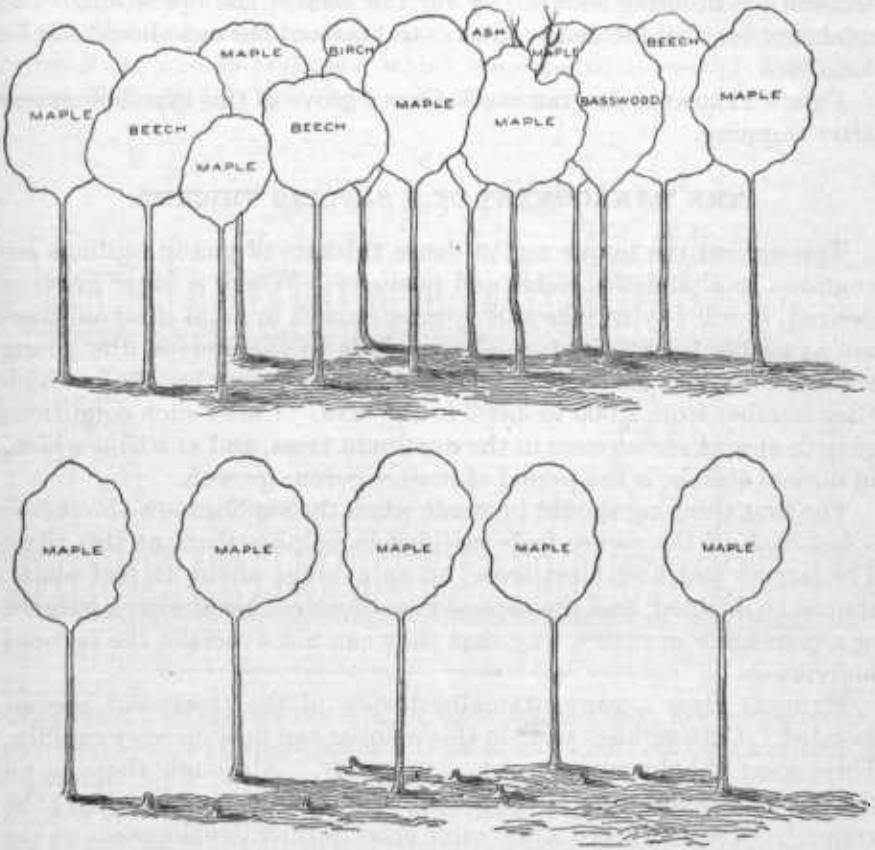

FIG. 2.—A young, close-grown grove before and after thinning.

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 2 shows in diagrammatic 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.

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

Figure 3 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 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.

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

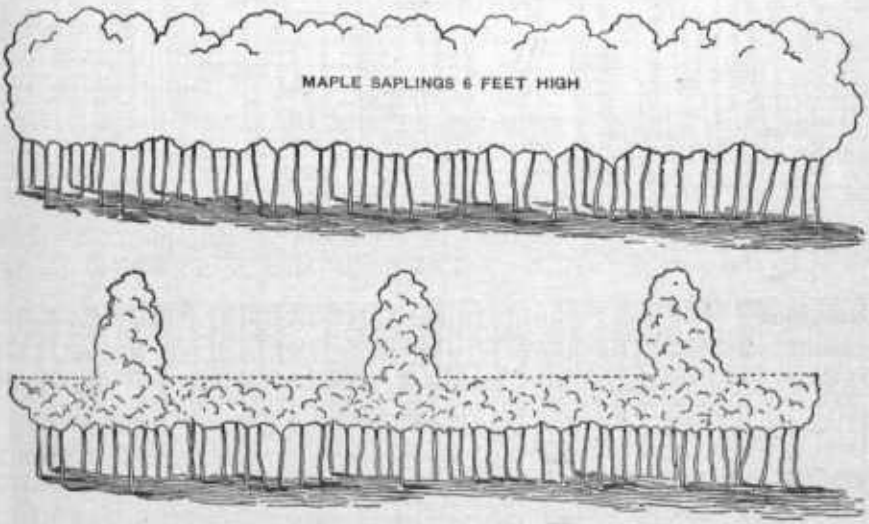

FIG. 3.—Method of improving a thicket of maple saplings.

(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 Forest Service. 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 diameter for the stand, suppressed trees included, of 2 inches,

breasthigh. 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:

Thinning of a maple-sugar thicket, showing the number of trees per acre of various diameters in the original stand, the number removed, and number 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

Figures 4 and 5 show the tract before and after thinning. Twelve cords to the acre of fair firewood were cut, an amount which should

FIG. 4.—Stand of maple saplings in need of thinning.

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 trees which are 4 to 7 inches in diameter, the remainder acting as a reserve in case the selected trees should meet with accident. The heaviest cutting was made in 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

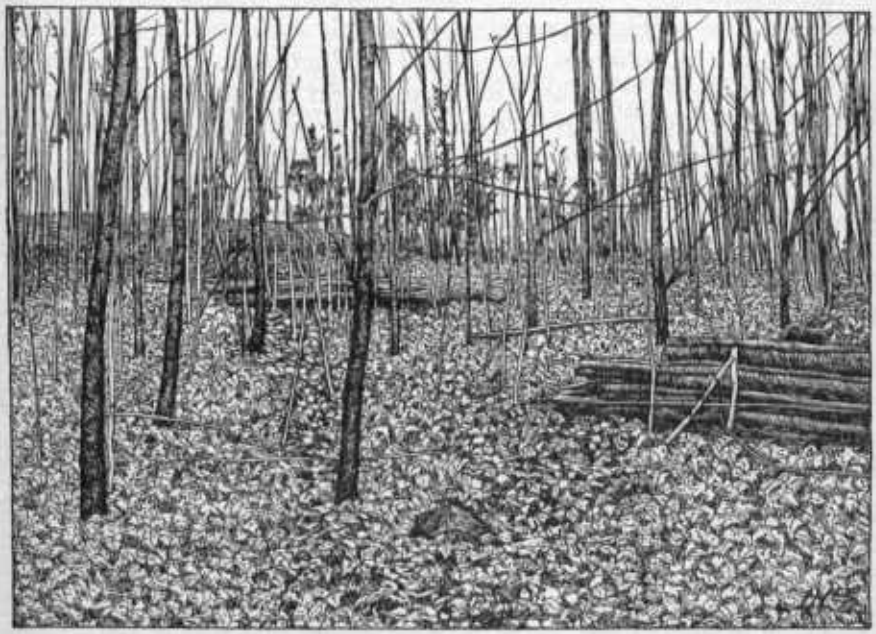

FIG. 5.—The same stand shown in fig. 4 after thinning.

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 danger of overthrow and the ground to drying.

SITUATION OF A SUGAR GROVE.

The best location for a sugar grove is where the maple thrives best under natural conditions. In the Appalachian region this 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 soils rich in 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 useful.

Avoid planting the trees too far apart. This is the mistake most commonly made. Wide spacing deprives the soil of its needful protection, reduces the yield of sap per acre, and gives a poor return for the expense of planting and for the amount of land used. Planting should always be done in early spring; and as the regions in which it is likely to be necessary are usually at low altitudes (see pp. 11, 12), 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. 21). 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 Forest Service.

MAPLE SAP.

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.

SAP PRESSURE AND FLOW.

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. 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

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

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

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.

IMPROVED METHODS.

The increased demand has brought about the introduction of economical methods in manufacture in sharp contrast with the primitive methods which once prevailed and which still persist where production remains on a small scale. The auger hole and the closed metal spout have been substituted for the old destructive ax cut and open wooden spout. Similarly, tin or galvanized-iron pails have gradually taken 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-gauge railway is used for collecting sap.

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[a] Dr. H. W. Wiley: Bul. No. 5, Bureau of Chemistry, U. S. Department of Agriculture.

The change in the actual process of sugar making is absolutely revolutionary. This is chiefly due to the supplanting of the iron kettle for boiling the sap by the modern evaporator, an apparatus remarkable for the ingenuity displayed in its construction and for its adaptability to the needs of the industry. Evaporators are open pans 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. (See fig. 8.) 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 sugarhouse has advanced with other improvements and in well-ordered groves to-day it is a neat, well-built affair, with two rooms and a woodshed. 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.

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 makes thinnings and improvement cuttings in the sugar grove practicable (see pp. 16, 21). The utensils also should be made ready for use. (For list and prices see p. 36.) 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 breastheight 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. 6, 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. 6, 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. 6, 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

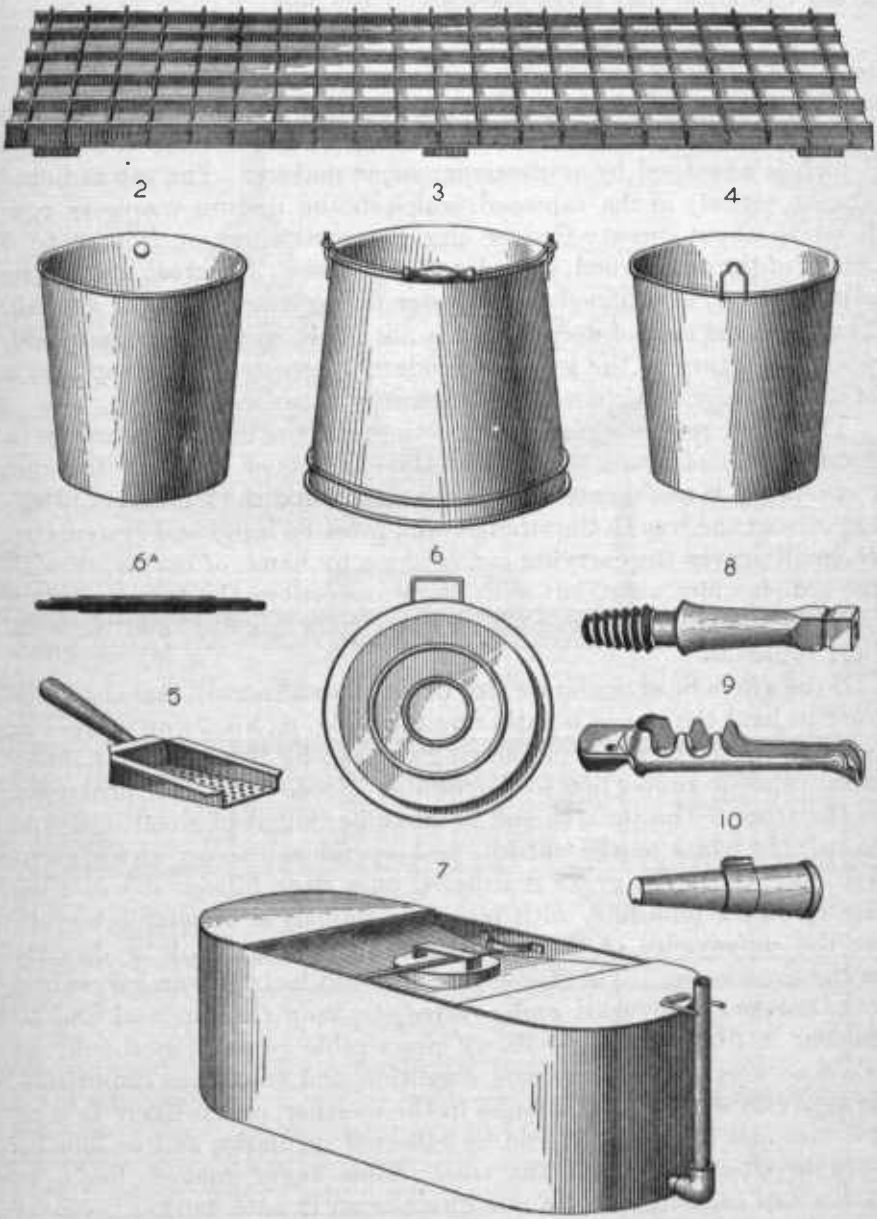

FIG. 6.—Sugar-making utensils: 1, sugar mold; 2, 4, sap buckets; 3, gathering pail; 5, skimmer; 6, cover for sap bucket; 6a, cross section of same; 7, gathering tank; 8, 9, 10, sap spouts.

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 much discussed. A nearly uniform depth of about 1 inch is now used by professional sugar makers. The sap is found almost entirely in the sapwood, which in the mature maple is confined 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 increased cost of deep boring is not offset by the increased yield, while the injury to the tree is considerably greater. The sap also is of darker color and considered inferior by sugar makers.

The first requisite for transporting sap to the sugarhouse is a good system of roads throughout the sugar bush (p. 15). 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. 6, 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 sugarhouse. 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 sugarhouse is the most important adjunct to the grove, and should be planned with reference to the scale of operations under-

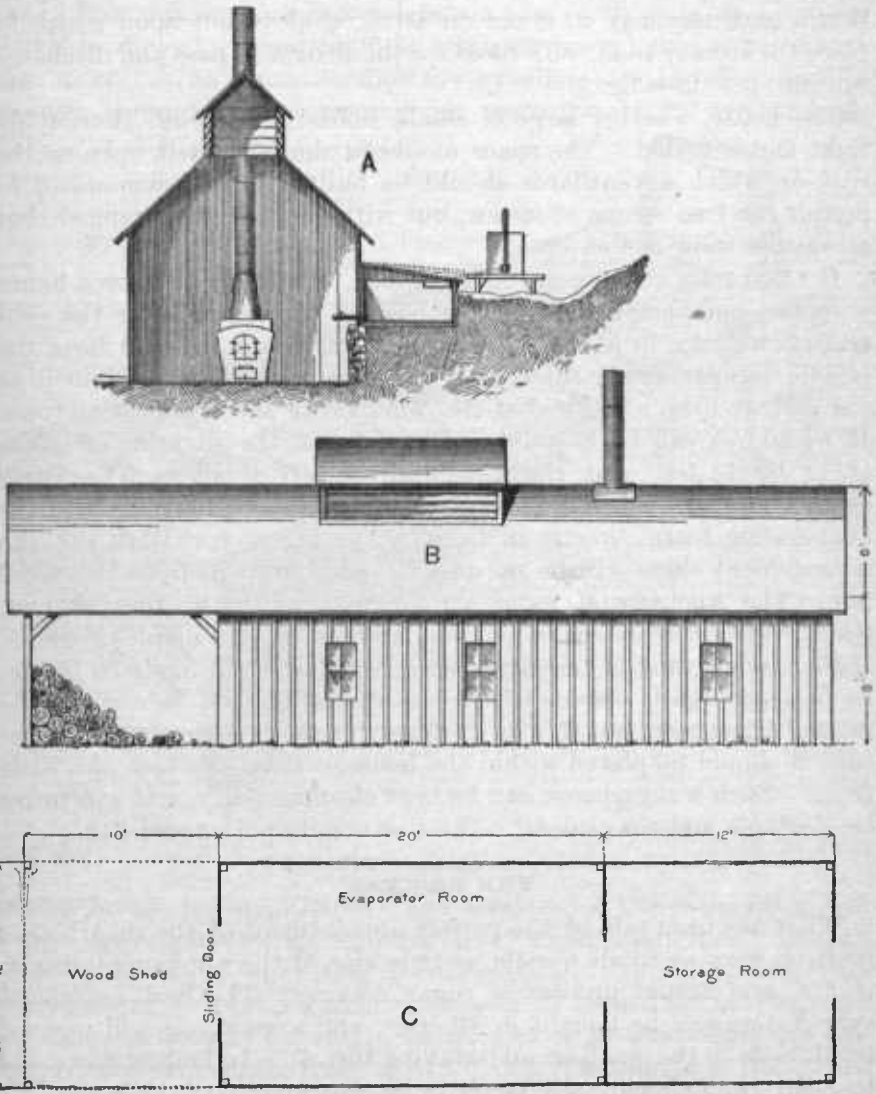

FIG. 7.—Plan of model sugarhouse: A. Sectional view, showing evaporator, storage tank, and gathering tank (on sled). B. Elevation. C. Ground plan.

taken. 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. It is always well to put the sugarhouse 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 fed 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. 7.)

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 7. 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 the sugaring-off room of 12 by 12 feet and the woodshed slightly smaller. 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 sugarhouse 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 sugarhouse can be kept clean and airy, and will prove comfortable and convenient. The cost should not exceed $125.

THE PROCESS.

What has been said of the perfect appointment of the sugarhouse, 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. 8). 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 1½ 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

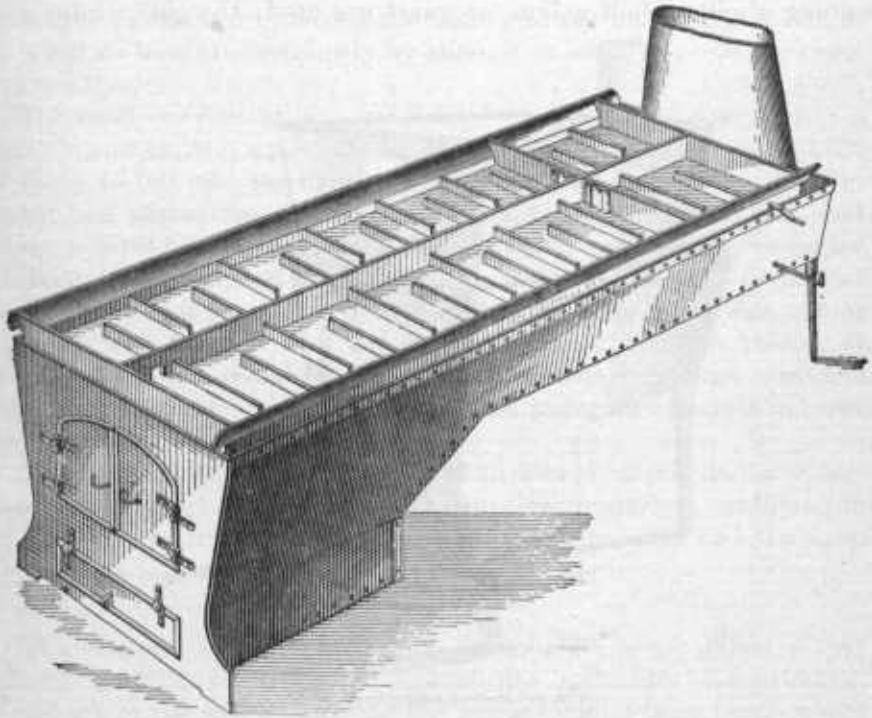

FIG. 8.—Modern maple-sap evaporator.

twelve hours' boiling, the two last 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 simply be turned about, so as to put 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

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

the proper temperature (see footnote, p. 33) and weighs 11 pounds to the gallon. To 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 gallon cans are

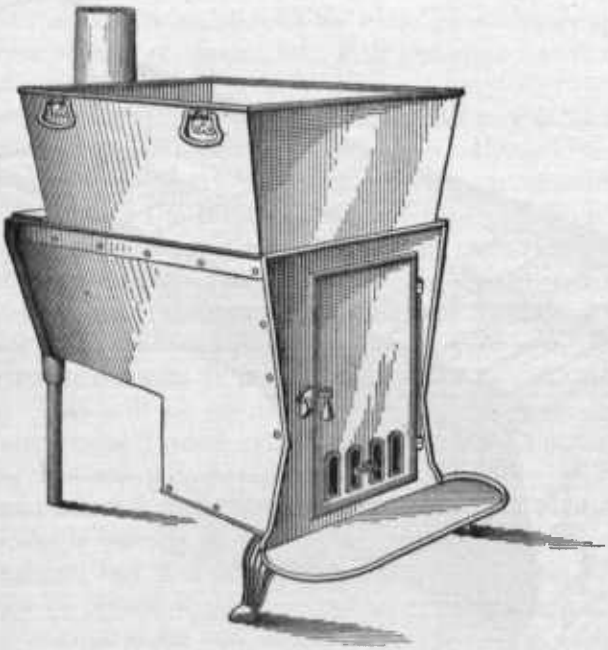

FIG. 9.—Modern sugaring-off arch.

most generally used. In filling, the can should be tipped slightly and filled to the top. It should next be lifted so that the bottom may sag and the sides bulge out slightly, and 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 footnote, p. 33). 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. 6, 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 bricks of 1 to 5 pounds 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 more 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 the 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 sugarhouse. 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	
Sugarhouse	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
Sirups 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 of sugar. At 9 cents per pound this will bring in $270, or a net profit of $47.30, equal to 8 per cent on $592—the amount invested exclusive of the value of the land.

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 farm work 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 Forest Service.

FARMERS' BULLETINS.

The following is a list of the Farmers' Bulletins available for distribution, showing the number and title of each. Copies will be sent to any address on application to any Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C.

No. 22. The Feeding of Farm Animals. No. 24. Hog Cholera and Swine Plague. No. 25. Peanuts: Culture and Uses. No. 27. Flax for Seed and Fiber. No. 28. Weeds: And How to Kill Them. No. 29. Souring and Other Changes in Milk. No. 30. Grape Diseases on the Pacific Coast. No. 32. Silos and Silage. No. 33. Peach Growing for Market. No. 34. Meats: Composition and Cooking. No. 35. Potato Culture. No. 36. Cotton Seed and Its Products. No. 37. Kafir Corn: Culture and Uses. No. 39. Onion Culture. No. 41. Fowls: Care and Feeding. No. 43. Sewage Disposal on the Farm. No. 44. Commercial Fertilizers. No. 46. Irrigation in Humid Climates. No. 47. Insects Affecting the Cotton Plant. No. 48. The Manuring of Cotton. No. 49. Sheep Feeding. No. 51. Standard Varieties of Chickens. No. 52. The Sugar Beet. No. 54. Some Common Birds. No. 55. The Dairy Herd. No. 56. Experiment Station Work—I. No. 58. The Soy Bean as a Forage Crop. No. 59. Bee Keeping. No. 60. Methods of Curing Tobacco. No. 61. 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