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Maple Syrup Production

Making maple syrup is one of the oldest food-processing traditions in upper North America. Native Americans began boiling maple sap into sugar long before European habitation of the continent. Production in the United States is mainly in the Northeast and the northern Midwest. According to the National Agricultural Statistics Service (NASS), national production averages more than 1.3 million gallons a year with an average income of slightly over $37.5 million. Pennsylvania ranks from fifth to seventh in production with around 60,000 gallons per year and an average crop value of over $1.9 million. Vermont consistently produces the most maple syrup in the United States, producing more than half a million gallons each year. Quebec is by far the largest producer of syrup in North America with production exceeding 6.5 million gallons.

The production of maple syrup requires access to suitable woodland and many hours of labor within a short season. The distance of the maple trees (or "sugar bush") from the storage and production facilities and the collection method you use will determine the time required for you to collect sap. Then, depending on the size of your evaporator, it will take many hours to boil the sap down to syrup. The sugar maple has the highest sugar content of all the maple species and it still takes approximately 43 gallons of sap to make 1 gallon of syrup. It is recommended that you begin production by tapping a few trees and making a small amount of syrup to see if the enterprise is suited for you. Beginning this enterprise requires extensive planning and may include a considerable capital investment depending on the size of the operation.

Marketing

There are two options for marketing. The first option is to sell the raw sap to a neighboring producer who will produce the syrup. This will reduce your initial investment and give you the opportunity to learn proper tapping techniques without the pressure of syrup production. Marketing sap will yield lower returns because syrup production is where most of the value is generated. The selling price of sap is determined by sugar content, cleanliness, and freshness with prices ranging from $0.10 to $0.70 per gallon.

The second option is to tap trees and make the syrup yourself. The first time you make syrup, you may not have a marketable product. With patience and practice, producing maple syrup can be very rewarding and provide additional income.

This publication was developed by the Small-scale and Part-time Farming Project at Penn State with support from the U.S. Department of Agriculture-Extension Service.

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The syrup you produce must conform to United States Department of Agriculture (USDA) grade and classification standards. U.S. Grade A has three classifications: U.S. Grade A light amber, U.S. Grade A medium amber, and U.S. Grade A dark amber. U.S. Grade B is used for processing and is often used in cooking and baking because of its stronger maple flavor. The third grade is labeled as Substandard and fails to meet the requirements of U.S. Grade B. There are many different tools available to determine grade. Some are somewhat expensive, while others are less expensive but may only be accurate for a short time period. Check with a maple syrup equipment dealer, cooperative extension, or a local producer to see which tools are used locally. Syrup taste is generally reflective of the color. Light amber syrup has a more delicate maple flavor, while medium amber has a slightly stronger maple flavor and is most often used as table-grade syrup. Dark amber has a stronger maple flavor and is also used as table syrup, depending on individual preferences. In order to meet the legal definition, maple syrup must have a sugar content of at least 66 brix (this equates to 66 percent sugar content) at 60°F.

Many producers also further process the syrup into value-added products. These products include (but are not limited to) hard sugar (candy), maple cream, and crumb (appears similar to brown sugar). Making candy or other confections requires you to reheat and then cool the syrup. Temperature, cooling time, and stirring will determine the resulting confection. Value-added products will increase profits, but they do require more time, effort, and equipment than just making syrup.

If you decide to make and sell maple products, your operation and facility will need to meet standards set by the Pennsylvania Department of Agriculture and your facility will likely be examined by a department inspector. You may obtain a copy of these standards from your local Department of Agriculture office.

When selling syrup, a grade label must be visible on the bottle, can, or jug. High-quality containers can be purchased from equipment dealers, distributors, or other producers. You also need to have your farm or business name and contact information visible on the container. Nutritional information should also be included; most commercially available containers already have this information listed.

Production

Site and Tree Selection

The best species of maple for syrup production in Pennsylvania is sugar (often called hard or rock) maple (*Acer saccharum*). However, red, silver, and Norway maples may be used. Generally, the sugar content of the sap of these species is not as high, requiring more sap to produce syrup. Also, red and silver maple will break bud (swelling of the buds) sooner than will sugar maple, which shortens the sap-collection season. The best trees to tap have large crowns with no defects. Check with your local extension office or forester if you have questions about the maple species you have.

One of the most important and most often overlooked factors in maple syrup production is maintaining the sugar maple tree in a healthy and productive condition. To maximize tree health and vigor, the soil should be moist but well drained. Sugar maple is a somewhat demanding species as far as soil fertility is concerned. Thinning your sugar bush is likely going to be needed to improve the spacing among your trees. Adequately spaced trees will be healthier and produce larger crowns, which will eventually lead to higher sap production. By working with a professional forester who is familiar with maple sap and syrup production, you can develop a management plan to maximize production while protecting the sugar bush.

When selecting the site of the sugar bush you plan to use, several factors should be considered. The topography of the land is of particular concern. If you plan to use tubing to collect the sap, the ideal site for the sugar bush will be at a higher elevation than the sugar house. This will allow you to move the sap by gravity and eliminate the need to haul the sap from the trees to the sugar house. If this type of site is not available to you, then ease of moving the sap should be considered.

Your annual sap crop will depend to some extent on environmental factors from the previous growing season. Two other factors play major roles in sap production and the amount of sugar found in the sap. Healthy trees with large crowns will normally produce more sap during a season and the sap will have a higher sugar percentage. As you gain experience with making maple syrup, you will likely discover trees that consistently produce more sap and are sweeter. Much of this is genetically determined. The other major factor is the weather conditions at the time the season begins.

Tapping Trees

In the Northeast, sap begins to flow in late January or early February. However, the most productive runs (times when sap flows) will be from mid-February through March (and occasionally into early April). Warm days (temperatures above 40°F) and cold nights (temperatures below 32°F) will normally start the flow of sap. The sap will often quit flowing if night temperatures exceed 32°F and will begin again when nights drop below freezing. Generally, early runs produce lighter syrups. The further you go into the season, the darker the syrup becomes. Light syrups are preferred for value-added products such as maple sugar and maple cream. You should stop collecting sap before the buds begin to swell because such sap produces off-flavored (called "buddy") and less valuable syrup. Useable sap may flow for four to six weeks depending on weather conditions.

Trees may be tapped when they are between 10 to 12 inches in diameter (measured 4.5 feet diameter breast height [DBH] above the ground). Trees up to 18 inches in diameter should have no more than one tap. Trees greater than 18 inches in diameter may receive two taps. Using more than

two taps per tree is discouraged. Unhealthy trees or trees of low vigor should not be tapped.

You should move the tap hole at least two inches to the side and twelve inches above or below the hole from previous years. Taps placed close to previous holes are likely not to produce sap. Tap holes will usually close within three years. Careful tapping will not damage trees as there are reports of trees being tapped for 100 years.

You will need a rechargeable drill or brace to begin the tapping process. Use a 5/16 inch bit to drill a hole 1 ½ to 2 inch deep into the white wood at a slightly upward angle. The upward angle will help facilitate sap flow. Take care not to oval the tap hole so the tap (spile) will fit snugly and close quickly. Tap holes should not be drilled into frozen wood.

While drilling the tap hole, check the color of the wood being removed. Cream, as opposed to brown, is the desired wood color. Brown-colored wood shavings indicate rotten or unhealthy wood, and you should move the hole to another location. Clean all shavings from the hole (do not blow, place any sort of sanitizing pellet, or spray into the hole) and insert the spile into the hole and tap it gently to secure it snugly in the hole. Keep in mind that the spile will hold the weight of the bucket and sap during collection. Your spiles should be sanitized before using with a 20:1 unscented household chlorine bleach solution. Make sure they are thoroughly rinsed with hot water after sanitizing. If using plastic tubing, any remaining chlorine bleach solution on the spile is likely to attract squirrels. They will damage the spile and make it unusable.

Commercial spiles are available from suppliers in many styles. The style you choose will depend on your collection method. If you use buckets for collection, you will require a different spile than if you plan to use plastic tubing.

Spiles should be carefully removed at the end of the syrup season. Do not leave the spile in the tree. Tap holes do not need to be plugged; this can interfere with hole closure.

Collection and Storage

If you choose to use buckets for sap collection, purchase new or undamaged, clean, used buckets. Make sure that the buckets you purchased are made of a lead-free material. You will need a lid or covering to prevent dirt, rain, snow, twigs, and other debris from getting into the sap. Before collection begins, you should clean all buckets with a 20:1 chlorine bleach solution and rinse the buckets thoroughly several times with hot water. Capped gallon jugs may also be used. Whatever you use, make sure it is of food-grade material and has not previously contained any hazardous or toxic materials.

Sap should not be left in the collection container for more than two days. After two days microbial action will result in a lower grade of syrup. If the days are warm the sap may spoil. This sap is no longer useful and must be discarded. You will need to plan accordingly to transport, store, and boil the sap as quickly as your evaporation system will allow.

Figure 1. Drilling the tree in preparation for tap insertion.

Figure 2. Maple sap collection using the bucket method.

Figure 3. Maple sap collection using the tubing method.

If your site and conditions allow, plastic tubing may be used to collect and transport the sap to the storage facility. Steep slopes are not required as tubing may be used on slopes as low as 2 to 5 percent. It should be noted that wildlife can affect the use of tubing. Squirrels often chew the tubing and deer occasionally knock the tubing from the spile. Because of these possibilities, you need to check tubing regularly during sap flow. Using hot water for several rinses instead of chlorine bleach to clean the tubing at the end of the season will reduce the amount of squirrel damage. If you wish to expand your operation, consider investing in a vacuum system. Vacuum systems increase sap production over gravity systems.

If not using tubing, you will need to consider transportation to your storage tank. Roads or paths will need to be constructed and maintained to transport the sap in all types of weather. Depending on the quality of the road or path, you may use a truck, ATV, or horses and a sled or wagon fitted with a collection tank to haul sap.

The size of the storage tank will be dictated by the size of the operation. You will need to have enough storage capacity to accommodate two days of sap collection for your operation. Allowing for two gallons of sap storage per tap is a good standard to follow. Storage tanks must be of a food grade material and nonporous. Tanks with lead solder are not acceptable. The tanks should be cleaned regularly during the evaporation season using a 20:1 chlorine bleach solution and then triple-rinsed with hot potable water. It is recommended that you have two tanks so sap can still be stored while the other tank is being cleaned.

Evaporation and Boiling

Once you have collected and transported the sap to a central location, you can begin the process of evaporating and producing syrup. Sap should be filtered to remove debris and other foreign material before boiling. Sap is best boiled in a well-ventilated building to allow steam to escape.

You will need several pieces of equipment: a heating source, evaporating pans or continuous-flow evaporator, thermometer, filtering material, and bottles or barrels for storing the syrup. You may be able to make the evaporator yourself, or you may choose to purchase an evaporator from an equipment dealer. You may be able to find good-quality used equipment from a producer who is expanding his or her operation. You should make sure that any used evaporator was constructed of lead-free materials. A hydrometer and hydrometer cup or refractometer is a must. This will help you determine the sugar content of your syrup. Syrup must have a minimum of 66 brix (this equates to 66 percent sugar content) to be considered syrup. Syrup at a lower concentration is more likely to mold or go sour. There is legally no upper limit for syrup, but syrup with sugar content greater than 68 percent is more likely to form sugar crystals in the container.

The heating source is called an “arch” in maple syrup production. For very small producers, this may be an old stove or constructed from concrete blocks and a smoke stack. If you plan to construct your arch from concrete blocks, it should match the size of your evaporating pans. It should be at least two blocks high and be fitted with a smoke stack to remove the smoke and increase heat efficiency. Wood is the most widely used fuel source, so a smokestack will help move the smoke above head level. The evaporation process may be completed by either a batch process or continuous-flow system. The batch process uses flat pans at least 2 inches deep because the sap should be at least 1.5 inches deep in the pan to prevent scorching and at least 12 inches square. The larger the pans you use, the quicker the entire process. Whatever you use as an evaporator, it must be lead free. If you have more than 50 taps, small continuous-flow systems may be purchased from a supplier.

Sap will boil at the same temperature as water and depends on elevation and barometric pressure. On any operating day, determine the boiling point of water and add about 7.5°F for the finishing temperature of syrup. Barometric pressure varies daily and affects the boiling point by a few degrees. A candy thermometer calibrated to the nearest degree should be used to determine the boiling point. While boiling, the sap will roll and foam. A defoaming agent may be purchased from a supplier to decrease the amount of foam. One to two drops per batch should be sufficient.

You should take care during the evaporation process so that your syrup is as close to 66 percent sugar content as possible. Overboiling will cause the syrup to be darker than desired and may cause the syrup to taste scorched or burned. This will greatly reduce the value of the finished syrup. Faster boiling will yield higher quality syrup, so controlling the heat during the finishing process is critical. Many producers do not finish the syrup in the large evaporator. They will draw it off at a lower concentration and then finish the syrup in a smaller pan where the temperature can be better controlled.

When you have finished syrup, you will need to filter it before filling your containers. Commercially available clean wool or orlon is commonly used to filter hot syrup. Paper filters should be used ahead of the wool or orlon filter to extend their useful life. Filtering the syrup is required to remove any “sugar sand,” small mineral particles that have precipitated out during the evaporation process. Removing the gritty sugar sand will make your syrup clearer and results in a finished product that looks and tastes good. If you increase in size, you may consider purchasing a filter press designed for filtering syrup. This will make the filtration process much easier and quicker.

Bottling

After filtering the syrup, you are now ready to begin the bottling process. Syrup should be bottled at a temperature between 180 and 190°F. You may use bottles, canning jars, or commercially available containers to store and sell the syrup. An attractive container will do a lot to help you successfully market your product. To prevent breakage, containers receiving hot syrup should be at room temperature. Separate the filled containers slightly while the syrup is cooling. As mentioned earlier, when selling syrup the containers must be labeled as to grade, net contents by volume, and have your farm or business name and address on the container. You can also store syrup in food-grade drums for future bottling.

Safety

Safety should be of utmost concern throughout the entire maple-syrup-making process. You begin the season in the woods with sharp drills and tools and end by filling bottles with very hot syrup. Care should be used during transportation of the sap, especially if the ground is soft or uneven. You will be using an open flame to boil the sap into syrup and be working with boiling sap. During all phases of the maple syrup production, worker safety should be a primary concern.

Sample Budget

Included in this publication is a template highlighting many costs associated with maple syrup production. The template summarizes these costs but does not provide net returns of a maple syrup enterprise. This template should help ensure that all costs are included in your calculations. Labor and fuel costs vary considerably depending on the size of the enterprise and the fuel source used. The cost of other syrup-making equipment can also change rapidly; check with an equipment dealer for the most current prices of equipment. If possible, discuss your potential operation with an existing producer; their input will be extremely helpful to you.

Costs and returns are often difficult to estimate in budget preparation because they are numerous, variable, and greatly depend on the volume and quality of the sap and syrup produced. Therefore, you should think of this template as an approximation and make appropriate adjustments in the "Your Estimate" column to reflect your specific production and resource situation. More information on the use of crop budgets can be found in *Agricultural Alternatives: Enterprise Budget Analysis*.

For More Information

Any serious producer should obtain a copy of the *North American Maple Syrup Producers Manual* (2nd ed.) from Ohio State University Extension.
Media Distribution
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2021 Coffey Road
Columbus, OH 43210

Huyler, N. K. *Cost of Maple Sap Production for Various Size Tubing Operations*. Newtown Square, Pa.: USDA Forest Service, 2000.

Kime, L. F., J. W. Adamik, E. E. Gantz, and J. K. Harper. *Agricultural Alternatives: Agricultural Business Insurance*. University Park: The Pennsylvania State University, 2004.

Kime, L. F., W. W. McGee, S. M. Bogash, and J. K. Harper. *Agricultural Alternatives: Developing a Business Plan*. University Park: The Pennsylvania State University, 2004.

Kime, L. F., S. A. Roth, and J. K. Harper. *Agricultural Alternatives: Starting or Diversifying and Agricultural Business*. University Park: The Pennsylvania State University, 2004.

Web Sites

Cornell Sugar Maple Research
maple.dnr.cornell.edu

Cost of Maple Sap Production for Various Size Tubing Operations
www.fs.fed.us/newtown_square/publications/research_papers/pdfs/2000/rpne712pdf.

Hobby Maple Syrup Production
ohioline.osu.edu/for-fact/0036.html

Maple Candy and Other Confections
ohioline.osu.edu/for-fact/0046.html

Penn State Maple Syrup Information
maplesyrup.cas.psu.edu/maple_syrup.html

Equipment List for Tubing System

Item	Quantity	Cost	Your Estimate
5/16 plastic spout (tap)	1 per tap	$0.39–0.50	_____
5/16-inch sap tubing	15 feet per tap	$2.40–2.60	_____
½-inch mainline tubing	2 feet per tap	$0.40–0.50	_____
¾-inch mainline tubing	1.2 feet per tap	$0.38–0.45	_____
1-inch mainline tubing	0.7 feet per tap	$0.33–0.40	_____
5/16-inch connector	0.05 per tap	$0.01–0.05	_____
½-inch connector	0.02 per tap	$0.02–0.04	_____
¾-inch connector	0.007 per tap	$0.01–0.05	_____
1-inch connector	0.04 per tap	$0.05–0.07	_____
4-way wye	1 per tap	$1.69–1.75	_____
1-x-¾-inch reducer	0.02 per tap	$0.04–0.06	_____
Quick clamp	0.002 per tap	$0.01–0.02	_____
Double tubing tool	1 per operation	$134.00–340.00	_____
Aluminum fence wire	0.004 per tap	$0.01–0.02	_____
Quick clamp pliers	0.082 per tap	$4.50–5.00	_____
Wire ties	0.7 foot per tap	$0.04–0.06	_____
Wire tier	1 per operation	$70.00–90.00	_____
Fence wire stretcher	1 per operation	$90.00–125.00	_____
Power tree tapper with battery pack	1 per operation	$350.00–500.00	_____
Tapping bit and bit file	1 per operation	$13.00–21.50	_____
Hand tool set	1 per operation	$25.00–50.00	_____

Table adapted from research paper NE-712 authored by Neil K. Huyler, United States Department of Agriculture Forest Service, Northeast Research Station.

Cost information estimated for Pennsylvania as of November 2009.

Worksheet for Determining Maple Syrup Production Costs and Profitability

Cost Components

Fixed Cost	Initial Cost	Life Expectancy	Yearly Cost	Your Estimate
Sugar bush				
Sugar house				
Evaporator	$1,100–3,400			
Steam Hood (optional)	$100–200			
Preheater (optional)	$750–3,000			
Forced Draft Unit (optional)	$400–2,400			
Reverse Osmosis Unit (optional)	$1,100–2,650			
Draw-off Accessories	$150–200			
Filter Press/Canning Unit	$600–750			
Storage Tanks (sap)	$200–400			
Evaporator Feed Tank	$1,200			
Miscellaneous Utensils	$200			
Sap Collection Equipment				
Bucket/Bags				
Tubing System per Tap	see equipment table			
Transfer Pumps (if necessary)	$200–400			
Tractor and Trailer	$2,500–5,000			
Gathering Tank	$150–300			
Tapping Unit	$350–500			
Miscellaneous Equipment	$20–100			
Other				
Overhead Management Costs				
Land Taxes				
Land Rental				
Insurance				
Management/Record Keeping				
Total				

Variable Cost	Quantity Used (hours)	Unit Cost	Total Cost	Your Estimate
Labor				
Managemnet	20–40			
Sugar house Operations	100–200			
Tapping and Setup	40–60			
Sap Collection	20–40			
Fuel Production Wood	30–40			
Maintenance/Cleanup	40–60			
Fuel				
Evaporator				
Finishing/Canning				
Tapping and Sap Collection				
Utilities				
Marketing				
Advertising (yearly cost)				
Sales Cost (yearly cost)				
Containers (assorted sizes)				
Total				

Expected Revenues

Amount of syrup produced (gal):	
Anticipated Sales	
Retail (gallons sold_____x average sales price per gallon_____):	
Wholesale (gallons sold_____x average sales price per gallon_____):	
Other products (equivalent gallons sold _____x average sales price per gallon _____):	

Profit Summary

Average fixed cost per gallon of syrup produced (total fixed yearly cost divided by gallons of syrup produced):	
Average variable cost per gallon of syrup produced (total variable yearly costs divided by gallons of syrup produced):	
Total cost per gallon of syrup produced (sum of average fixed and average annual variable costs):	
Total value of all syrup produced and sold (sum of all sales revenue):	
Total of yearly fixed and yearly variable costs:	
Total profit from production and sales of maple products (difference between total sales and total costs):	
Profit per gallon of syrup produced (total profit from production and sales divided by number of gallons of syrup produced):	

Tables reproduced from *North American Maple Syrup Producers Manual*, 2nd ed. (Ohio State University Extension).

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Penn State College of Agricultural Sciences research, extension, and resident education programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

This publication is available from the Publications Distribution Center, The Pennsylvania State University, 112 Agricultural Administration Building, University Park, PA 16802. For information telephone 814-865-6713.

Produced by Ag Communications and Marketing

Code # **UA461** 3M1/10payne3995j