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Agroforestry Forest Farming: Have Maples, Will Sugar...

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All over Kentucky, but probably especially in the eastern part of the state, woodland owners may find that they have many maple trees in their woodlots. If these trees are larger than 10 inches in diameter, and if there are 25 to 40 maple trees per acre, woodland owners might want to think about making maple syrup as a possibility for increased income from their woodlots.

Maple syrup has been produced in the United States since before Europeans arrived on this continent, so much information has been printed in many different forms. New England, New York, Ohio, Pennsylvania and Canada have been making syrup for market for many decades. Kentucky is not likely to become a major syrup producer, but producers can find good opportunities for producing Kentucky or southern maple syrup on a small scale, especially as a cooperative or what is called a "cottage industry," meaning small-scale production.

What is maple syrup?

Maple syrup is a natural, organic sweetener, famous for its use on pancakes and waffles. It has been used on this continent since people first lived here. It is made by concentrating the naturally sweet sap of maple trees. Native Americans froze the sap to concentrate it, but today the sap is boiled down until it thickens into a sugary, sweet syrup. It takes many gallons of sap to make one gallon of syrup; 40 gallons to one is the industry standard, which is why the real maple syrup is so expensive. One of the greatest annual maple syrup productions on record was just over 4 million gallons in 1860! This production was exceeded only during World Wars I and II, when wartime activities made it difficult to get cane sugar. However, once cane sugar became easily available and cheap, the demand for maple syrup declined, and it has become more of a high value specialty or gourmet item since the mid-1940s.

What kinds of maple trees make the best syrup?

All kinds of maples (*Acer spp.*) can produce maple syrup. The difference lies in how sweet the sap is to begin with. (Maple syrup is made from box elder [*A. negundo*] in Saskatchewan, Canada!). The higher the sugar content of the sap, the fewer gallons it takes to make one gallon of syrup. Sugar maple (*A. saccharum*) and black maple (*A. nigrum*) are thought to be both the best producers (volume of sap) *and* to have the highest sugar content in their saps. Seventy-five percent of all commercial maple syrup is tapped from sugar maples.

How does one identify a tree that will produce a lot of sap?

The things you are looking for in a good sap-producing tree are not necessarily the same kinds of things you would be looking for in a good timber tree (although maples often *do* make good timber). In a "sugarbush" (the term for a woodlot where syrup production is the major use), the trees are widely spaced so that they will grow in diameter and make large crowns, which is where the food factories (leaves) grow. Trees with crowns greater than 30 feet in diameter can produce as much as 100 percent more syrup from their sap (which can also be as much as 30 percent sweeter) than trees with narrower crowns. Crowns that are both broad and deep are the best for good sap production. If woodland owners want to manage their woodlots for sap production, it is probably a good idea to work with a professional forester, especially one who knows something about maple sap production.

When do you tap maple trees for their sap, and what weather conditions are best for sap production?

For the northern part of Kentucky, it's easy to remember to tap between Valentine's Day (February 14) and St. Patrick's Day (March 17). Further south, it may be important to start earlier. It all depends on that cold night/mild day combination. However, it is wise to have all the necessary equipment ready any time after the New Year. One advantage of tapping for syrup is that it is a small "window" of time—usually 4 to 6 weeks—in the late winter when other farm- or woodland-related jobs may not be demanding too much time.

How many taps could you have in *your* woodlot?

Start by getting an estimate of how many maple trees you have per acre. Run a simple transect (straight line on a compass bearing) and count the number of trees within ten feet of the line on either side for 100 feet. This will give some idea of how dense the maples are in the woodlot. Then measure a sample of the trees at breast height (about 4½ feet from the ground). To protect the general health of the trees, do not put taps in any tree smaller than 10 inches in diameter. The guidelines are:

Tree diameter (inches)	**Number of taps**
10-15	1
16-20	2
21-25	3
25+	no more than 4

It is important to follow these guidelines. Overtapping harms the trees; undertapping reduces the yield of sap without doing anything positive for the trees.

What tree management does the owner need to do to improve sap production?

A commercially profitable sugaring business should have 70 to 90 taps per acre and probably 20 or more acres of woodland to tap. If the syrup is intended only as a contributing part of the total farm/woodlot income, this process can be done on only a few acres. Taking care of the trees—paying attention to the guidelines, clearing competition from around the sap trees, pruning dead branches, etc. —is a good management practice. If sugaring starts with most of the usable trees in the 10-inch size class, it will be important to thin other trees from around the sap trees so that they can grow larger diameters in a shorter period of time. Twenty-five to thirty *productive* trees per acre is a good goal to aim for. Ground cover (herbs, grasses, etc.) is a good thing, as it is important to protect the forest soil from erosion. The park-like woods that may result from this management might look attractive as a place to graze livestock, but the animals' feet compact the soil, and some—horses and goats in particular—might also rub the bark off the trees. Thinning competing trees from around the sap trees should result in trees whose crowns do *not* touch, and which *should be* at least six feet apart.

How does one measure the sweetness of the sap?

Sap sweetness is measured by taking a small sample of sap from each tree and floating an instrument called a *hydrometer* in it. A hydrometer measures something called *Brix*, in degrees. The degree measured shows that the solution (sap) has the same *density* as a solution containing a sugar percentage equal to the Brix measurement (e.g., sap that measures 2 or 3 degrees Brix has a 2 percent or 3 percent sugar content—those numbers would be fairly typical for maple sap—which is one reason it takes so many gallons of raw sap to produce one gallon of finished maple syrup). Outside temperature can affect the Brix measurement, so it is important to adjust (subtract) the "reading" according to the current temperature when taking the sap sample:

Outside temperature (°F)	**Brix adjustment (°)**
32-50	-0.4
51-59	-0.3
60-68	-0.2

Re-measure the degree of Brix in the trees that are big enough to tap *every year*. Those whose sap measures less than 1 degree Brix probably should not be used. The boiling process uses lots of firewood, so these trees could be cut for that purpose or allowed to grow big enough for timber at a later date. Boiling down the sap takes plenty of time, energy and resources when the sap has a high Brix; it doesn't make practical sense to use more of them all to produce less syrup!

For example, if you boil down 15 gallons of 1 degree Brix sap, it contains the equivalent of 1.3 pounds of sugar and will yield less than 1/5 gallon of syrup. Fifteen gallons of 2 degree Brix sap contains the equivalent of about 2.5 pounds of sugar and will yield closer to 1/3 gallon of syrup.

How does one make the sap into syrup?

The process of making maple syrup from sap has three major steps before bottling:

- Withdrawing the sap from the trees through buckets, plastic bags, or plastic tubing
- Boiling the sap down to a Brix of 55-60 degrees
- Boiling the sap further (in what is called a "finishing pan") to a Brix of about 66 degrees (the minimum Brix measurement for marketable

maple syrup is 65.46 degrees at 68 degrees F; the best thickness [*viscosity*] and taste is at a Brix of 66-66.5 degrees at the same temperature.)

Tapping the trees is done the same way, regardless of what is used for collecting the sap. The *spile* is the metal spout that is driven into a hole drilled 2.5 to 3 inches deep with a $^{7}/_{16}$-inch drill bit into the tree. Holes are drilled at a slightly upward angle to have gravity aid with the drip-

ping of the sap. If trees have been tapped before, new tap holes need to be at least 6" around the tree and 4" higher or lower than the previous tap. The spiles are specialized equipment for maple sugaring and need to be bought from maple syrup supply vendors. Tap the spiles into the drill holes gently with a hammer or mallet and hang buckets or plastic bags (also specialized equipment for this purpose) on them, or attach tubing if a gravity-feed or vacuum system is being used.

The classic galvanized buckets should have covers on them; the plastic bags used for this purpose usually have a flap to cover where the sap is dripping out. Covers keep the sap free of impurities and contaminants. A vacuum system with tubing is the "high-tech" way to go and costs more than the other methods, but it also can change sap production from only 5 to 20 gallons of sap per tree per season to 25 gallons of sap per tree per season, so it may pay for itself in a short period of time. *Reverse osmosis* is another high-tech method that can be used in the process—this method removes 75 percent of the water from the sap and therefore reduces the boiling time, because before heating, the treated sap is much more dense than untreated sap.

Look at the trade-offs with any new product. Make sure that both costs and benefits are carefully calculated. Once the sap is running, the sugaring operation will demand a lot of attention. Even if the business chosen is just to collect sap for someone else to boil down to syrup, the trees must be checked frequently and as the days get warmer it may be necessary to collect sap from buckets, bags, or the large containers that tubing empties into more than once a day. Sap allowed to "sit" in collection containers is in danger of fermenting or becoming contaminated.

If the business is going to continue on to the syrup-making process, it is best to have the boiling/evaporating equipment in its own structure, usually called a "sugar house." If there are no lids on the evaporators, the steam is very sticky and needs to be in a structure that is well ventilated at the top. If, as usual, the heat source is a wood fire, good ventilation is a must. Once the process of boiling down is started, it needs to be watched carefully. Maple syrup can be done in batches, but if there is a lot of sap running, it may be necessary to keep sap boiling down to syrup around the clock. The building can be very simple and should have a minimum of 4 feet of clearance from all sides of the equipment. The firebox will need both an air intake and exhaust piping. Remember that maple syrup is a food product, so keep the building as clean as possible, and keep that necessity in mind when selecting materials to build the sugar house—choose materials that clean easily! Storage tanks should be located near the evaporator and must be insulated against severe cold.

Boiling down maple sap to maple syrup is similar to making molasses from sorghum. The rectangular sap pan has baffles or flues parallel to the long sides of the pan in order to maximize heat transfer to the sap. The sap pan sits over a firebox, where a wood fire is kept burning—at as even a temperature as possible. (Gas can be used but is more expensive, and if the sugar bush has been thinned to improve the crowns of the maple trees, there should be plenty

Some basic information on how maple trees grow and produce new leaves in the spring: The tree leaves are food factories that make sugars as food for the continued growth of the tree during the growing season. In the fall, when we see the change in the color of the leaves, the trees are shutting down their food-producing activities and preparing to store food for the winter. Starches and sugars are stored in tree roots for the winter, and the trees go dormant. As daylight begins to increase again after December 21 (winter solstice), the trees begin to prepare for the warm days of spring and the production of new leaves. Sap containing the stored sugars from the roots begins to move in the trees. Temperatures affect this sap flow; usually a combination of cold nights (20°-35° F.) and warm days (45°- 55° F.) bring on the greatest activity.

of firewood on hand!). The firebox should be enclosed, with its own exhaust system, to prevent the smoke from the fire creating a smoky taste in the syrup.

Usually, it takes about 90 minutes for the sap to get thick enough and dark enough to go on to the syrup or finishing pan. It is best to keep a steady flow of sap and keep it about an inch deep in the syrup pan, adding it slowly at the sap pan end and drawing the syrup off slowly at the other end. The higher the Brix value of the sap, the shallower the level of sap needed in the evaporator and the shorter time it takes to make the syrup from the sap. The boiling point (b.p.) of standard density syrup depends on the local boiling point of water, which can be different, especially at higher elevations. Syrup b.p. is usually 7 degrees higher than the local b.p. of water. You need to measure the Brix value often while the sap is boiling and move it on to the finishing pan when the Brix reaches 55-60 degrees. When the Brix value of the sap in the finishing pan reaches 66 degrees, bottle it immediately.

If the syrup is produced in batches rather than in continuous flow, be sure to clean the equipment completely between batches, since the bits left in the pan may darken later batches of syrup. It may take as many as 16 hours to make a syrup "run" from the start—including collecting the sap. Sometimes weather conditions make sap collection a "start and stop" process, so clean the boiling equipment between batches—a chemical milkstone remover may be necessary to really clean the pans—and rinse them thoroughly. Collecting buckets, bags, and tubing are usually disinfected with a diluted bleach solution (1 part commercial bleach to 9 parts water) after they have been washed.

For best results in maple syrup production:

- Know the initial Brix of the sap (use the hydrometer)
- Collect the sap as often as needed and make sure it is fresh and unfermented
- Collect and evaporate quickly
- Keep equipment clean

What are the rules and regulations for making syrup for sale?

The USDA standards for maple syrup are:

US Grade AA (Fancy)

- Color must be the same as or lighter than the *light* amber standard
- Clarity must be the same or clearer than the *light* amber standard
- Weight at 68 degrees F is 11 lb/gallon
- Brix is 65.46 degrees
- Flavor is characteristic maple flavor
- Syrup is clean, free from fermentation or other kinds of damage

US Grade A

Standards are the same as for AA, except color and clarity must be the same or lighter than *medium* amber.

For US Grade B

Standards are the same as for AA, except color and clarity must be the same or lighter than *dark* amber.

Ungraded (unclassified)

No standards for color and clarity. The other items (weight, brix, flavor, and damage) apply.

How is syrup packaged for commercial sale?

Package the finished syrup in retail containers when it is between 180° and 200° F. Use tin, hard plastic or glass for containers and use a variety of sizes—most people buy pints and half pints rather than quarts or gallons. Know the weight of the containers and fill by weight rather than by volume, using the 11 lb/gallon as the standard.

Summary

Making maple syrup from the sap of maple trees in a woodlot is only one way to use it profitably and manage it for benefit. Check with a consulting forester or a service forester from the Kentucky Division of Forestry to develop a management plan for the woodlot. If a sugar bush is the desired outcome, a management plan will show which trees should be cut to benefit the maple trees, and some of the material removed can be used to fuel the firebox used in syrup making. Good firewood needs to be seasoned (left to dry) for 6 to 12 months, so it's important to plan ahead. It is true that for most agricultural commodities, profit or benefit comes as the result of hard work. Maple syrup production is no exception, but the intensive work is for a relatively short period of time (4 to 6 weeks) and is demanding at a time of year when there are fewer other demands on a farmer or woodlot owner. Making maple syrup to sell is a good way to sweeten the income from a hardwood woodlot!

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