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More Resources

IDENTIFYING MAPLES

West Virginia Trees: Basic Tree Identification : This is a guide to basic tree identification for common trees across West Virginia as a downloadable pdf.

Trees of West Virginia Farms and Woodlots: A more in depth guide to trees of West Virginia and their identification as a downloadable pdf.

West Virginia Division of Forestry: West Virginia Division of Forestry home page hold links to many of the state forestry resources as well as how to get in touch with your local state forester.

TREE SCALE STICK

Measuring tree diameter using a Biltmore stick: This video details how to use a Biltmore stick.

FOREST STAND ANALYSIS/WOODLOT MANAGEMENT

Cornell Cooperative Extension: Woodlot Management

Growth Rates of Sugar Maple Trees Tapped for Maple Syrup Production Using High-Yield Sap Collection Practices: This article dives in how to maximize tapping potential of your maple stand, while taking into account the growth rate of the trees.

A Silvicultural Guide for Developing A Sugarbush: This article looks at how to manage and develop you sugar bush to be healthy, productive, and sweet.

Assessing the Access of a Sugar Bush: This video from Cornell looks at what you should look at when choosing which maple stand to tap.

Assessing the Commercial Potential of a Site for Maple Sap Collection: This article details everything to consider when assessing the sugaring possibilities of a woodlot. It also gives instructions on assessing a sugar bush using an angle gauge.

HOW TO TAP

How do I Tap a Maple Tree?: This video from the University of Maine details how to tap a maple tree.

Growth Rates of Sugar Maple Trees Tapped for Maple Syrup Production Using High-Yield Sap Collection Practices: Listed above, but relevant here as well, this article dives in how to maximize tapping potential of your maple stand, while taking into account the growth rate of the trees.

A Decade of Spout and Tubing Sanitation Research Summarized: This article summarizes the research has been done on spout and tubing sanitation methods.

Assessing Strategies for Spout and Drop Sanitation in 5/16 Tubing: Sap Yield, Cost, and Net Profit: This study assessing the efficiencies and costs of different forms of spout and drop sanitation.

Check-valve spouts vs. standard clear spouts: This study looks at the efficiencies and differences in the use of check-valve spouts and standard spouts.

Does Color Matter? Spouts come in variety of hues. Does it affect yield? : This study looks at how the different color of commercially available spouts affects yield.

Tapping Zone Model-Tubing: This model estimates the amount of clear, tappable wood in a maple tree under different tapping methods over one hundred years of tapping.

Ask Proctor: Why are my tapholes leaking and what can I do about it?: This article discusses common causes of taphole leaks and how to stop leaks.

HYDROMETER BASICS

Maple Syrup Hydrometer – Roth Sugar Bush – Cadott – Wisconsin – Maple Equipment – Maple Syrup: This video details how to use a hydrometer the measure syrup sugar content.

Maple Syrup Density Measurement : This website holds the basics for measuring syrup density and sugar content in commercial syrup production, using a number of different tools.

When is it Syrup? Tools and techniques for measuring syrup density: This article walks through different methods of assessing if your syrup is done and the science behind each method.

COLLECTION & STORAGE

Getting Started with Small-Scale Maple Syrup Production: A Short document on the basics of

maple syrup production, with a large section on collection.

Viability of probiotic bacteria in maple sap products under storage and gastrointestinal conditions: This research paper looks at the probiotic content of maple sap and it's related products.

Bacterial Adhesion to Plastic Tubing Walls: This research paper looks at the types of bacteria that adhere to the insides of plastic tubing.

The Control of Bacterial Contamination of Maple Sap Stored in Field Storage Tanks by Ultraviolet Irradiation: This article looks at the use of ultraviolet light to reduce bacterial growth in maple sap

EVAPORATING

Evaporation Methods as Applied to the Food Industry: This is a section of a larger book that walks through the many different types of evaporation used throughout the food industry, including in maple syrup.

Improving Maple Sap Quality, Efficiency, Production and Profitability Through Collection and Processing Enhancements: Article detailing a large amount of research done by Cornell University.

How to Make a Cheap Maple Syrup Evaporator for Under $50: Article detailing how to make a small cinderblock evaporator.

Sap Preheaters: Efficient Maple Syrup Processing: This article looks at the efficiency gained by adding a preheater to a sugaring operation.

FILTERING

Fundamentals of Filtering Maple Syrup: A video made by UVM Extension covering both gravity and pressure syrup filtering and why it is needed in the maple syrup making process.

Low Cost Maple Syrup Filtering: A video detailing at home cheaper methods for filtering maple syrup.

Ask Proctor: Filtering syrup in small batches is a huge pain. Any advice on how to make it easier? : This is a short article detailing options for small batch filtering for maple syrup producers.

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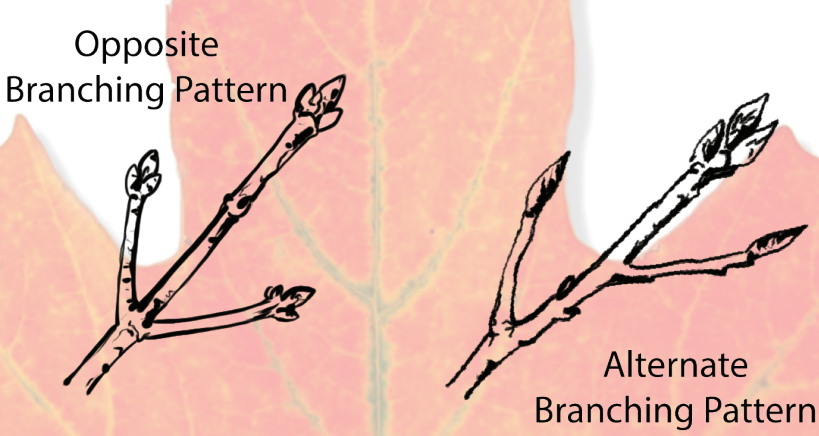
Identifying Maple Trees

LEAF SHAPE

Identifying maple trees by their leaves is easiest in the Summer, when the leaves are out. Maples have distinctive, deeply lobed leaves. All maple species can be tapped, though the best for sugaring are the sugar maple *Acer saccharinum*, and the black maple *Acer nigrum*. The most prevalent maple species in West Virginia is the red maple *Acer rubrum*.

TREES OF WEST VIRGINIA

https://www.wvdnr.gov/Wildlife/PDFFiles/WVtrees.pdf



KEY FEATURES

Maple leaves are palmate, meaning the main veins in the leaf all stem from the same point. The branches have an opposite pattern—meaning two branches stem from a larger branch at directly opposite sides of the same spot—versus alternate. If a branch has broken off, it might look to have an alternate pattern at first, but if you see any opposite branching at all, then the tree is opposite. Alternate branching trees will never have branches in the opposite position. In our forests, there are a few other trees with opposite branching patterns. These can be remembered as MAD. Maple, Ash, and Dogwood. Familiarize yourself with the other species so you don't tap the wrong trees. The branching patterns might be similar, but the barks are quite distinguishable. Maple barks can vary widely, but are typically described as brown or grey with vertical fissures. It is generally fairly smooth and thin on younger specimen and becomes more deeply furrowed and scaly in older specimen.

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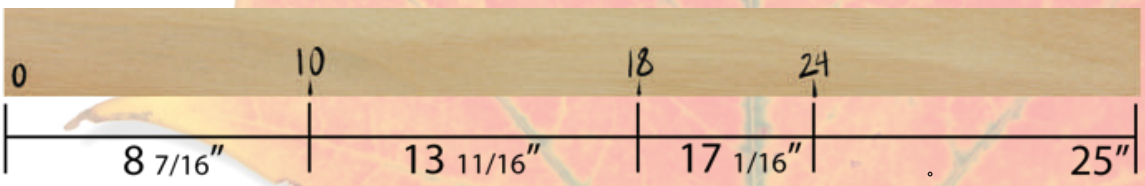
Make Your Own Tree Scale Stick

A tree scale stick helps to quickly measure the diameter of a tree's trunk at breast height.

GET STARTED

Take a straight stick, piece of wood, or yardstick

- Cut it to 25"
- Write 0 on the far end of your stick
- Measure 8 7/16" from the starting edge of your stick (the one that says 0), mark it, and label it "10"
- Measure (from the same starting edge) 13 11/16", mark it, and label it "18"
- Measure 17 1/16" from the end, mark it, and label it "24"



HOW TO USE

The stick should be held straight out at 25" from the eye and up against the trunk of a tree (at your breast height, known as DBH). This is why we cut the stick to be 25" long, so you can use it to measure the distance from your eye. We are only concerned with knowing if the trunk is more than 10" (tappable), more than 18" wide (can put two taps), or more than 24" wide (three taps—more is not recommended, and some people stop at 2). Hold your stick and, using both eyes, line up the "0" edge with one side of the tree. Follow your eyes down the stick to where the other edge of the tree lies. If it is past your "10" mark, it's a candidate for tapping. Use this method to determine how many possible taps you have.

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Forest Stand Analysis

Sample Plots help you evaluate the syrup potential of your woodlot and estimate material needs

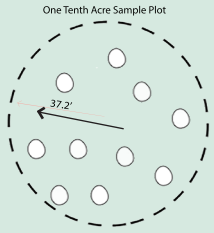
MATERIALS

What you need:

- A piece of rope measured 37’ 2.5”
- A clipboard, pencil, and the Forest Stand Analysis Worksheet
- A tree scale stick (see Make Your Own Tree Scale Stick sheet if you don’t have one)
- It’s best to do this with a friend who can hold one end of your rope and record information.

MEASURE YOUR SUGARBUSH

First, you will want to identify where your sugarbush is. If you can, take a gps and plot your sugarbush. Google Earth can also be helpful for making measurements of area if you can determine where it lies on the satellite image, or pin points using your phone. We like to create a path by walking the entire perimeter of the best concentration of trees with the gps. There are a lot of things to consider when determining where your sugarbush will be. Search “nature-based enterprises Tubing Theory and Lay-out” on YouTube for a helpful video. Pay attention to slope and concentration of maple trees.



PUTTING IN SAMPLE PLOTS

Next, you will put in sample plots. Choose your plots to be somewhat evenly spaced, but the idea here is to get a good sampling of what your forest is like. If you measure a plot with a high concentration of maple trees, but notice that the rest of your woodlot is not so densely maple, be sure to get a sample plot in each different forest “type”. Aim for one sample plot per acre.

MEASURING SMAPLE PLOTS

A sample plot is 1/10th of an acre. Have your partner stand in the center of the plot, holding one end of the ropE. Walk the rope out until it is fully extended and move in a circle around your partner, measuring and counting all the maple trees that lie within the plot diameter. If a maple tree is at least halfway in the plot, it gets counted. Count the number of trees, and also the number of taps in separate columns. Remember: if a tree is larger than 10” diameter, it gets one tap. Larger than 18”, it gets two taps, and you can decide whether you want to put three taps in trees larger than 24”. When every tree in your plot has been accounted for and measured, move to the next acre to do your next plot. If your sugarbush is only 1 acre, do more than one sample plot to get a good average. If your sugarbush is small enough and you can walk through, keeping good track, you can count the actual number of taps you will be putting in and measure the lengths of tubing needed instead.

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Forest Stand Analysis
Worksheet

SUGARBUSH AREA

GPS logical sugaring area boundary, upload onto Google earth, determine area. Attach printout of sugarbush area from Google earth.

- Sugarbush area: _____ acres
- Number of plots: _____ (one plot/acre)
- Allocate plots by marking on map to cover entire area.

SAMPLE PLOTS

	DBH 10 to 18 inches (one tap trees) *count these with tally marks and add them up to the right	**DBH 18 to 24 inches** (two tap trees)	**# Trees**	**# Taps**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Forest Stand Analysis
Worksheet

CALCULATIONS

Average trees/plot: _____
add up all of your trees and divide by the number of plots you have

Average trees/acre: _____
multiply average trees/plot by 10, since we measured 1/10th acre plots

Estimated trees in the sugarbush: _____
multiply average trees/acre by the total acreage of sugarbush

Average taps/plot: _____
add up all of your taps and divide by the number of plots you have

Average taps/acre: _____
multiply average taps/plot by 10

Estimated taps in the sugarbush: _____
muyltiply ave. taps/acre by total acreage

Average distance between trees: _____
Sq. rt. of 43,560 divided by ave. trees per acre

Sap storage needs (2 gallons/tap) _____

Primary Maple composition: (circle one)

Sugar Maple **Red Maple** **Sugar/Red Maple**

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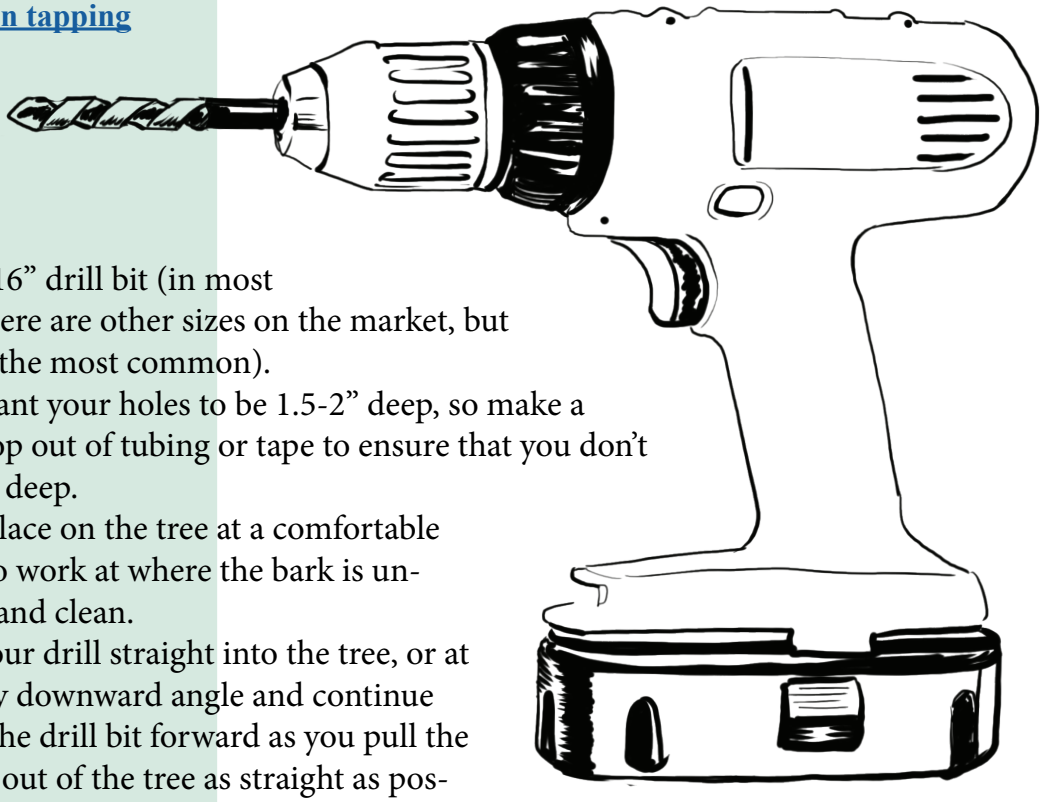
How to Tap a Maple Tree

[For more information, check out our YouTube video on tapping]



THE BASICS

- use a 5/16” drill bit (in most cases, there are other sizes on the market, but 5/16” is the most common).
- You’ll want your holes to be 1.5-2” deep, so make a short stop out of tubing or tape to ensure that you don’t drill too deep.

- Find a place on the tree at a comfortable height to work at where the bark is un-marred and clean.
- Drive your drill straight into the tree, or at a slightly downward angle and continue to spin the drill bit forward as you pull the bit back out of the tree as straight as possible. This will pull out shavings rather than leaving them in the hole. Resist the temptation to blow in the hole, as our mouths are full of bacteria and cleanliness is crucial. An immune response to bacteria and pathogens is what causes the tree to close up, and bacteria in sap will spoil it. Keep this in mind in all you do! Make sure your drill bit is sharp and clean (not rusty or muddy) and use a small piece of clean wire to knock shavings out of the hole.
- Align your spout with the hole and gently “tap” (do not whack!) the head of the spout into the tree. As you tap, note when the hollow tap sound changes pitch to a dull thud. Give it one more gentle tap: the spout is now stuck and there is no need to tap further. In fact, further whacks with the hammer can reduce sap production from that hole by as much as 20% per whack.

Here’s a tapping study for more information

NOTE The shavings that come out of your drill hole should be of clean white wood. If the shavings that come out are partially or all the way brown, abandon this hole and try a new one. Brown shavings indicate dead wood that will yield little or tainted sap.

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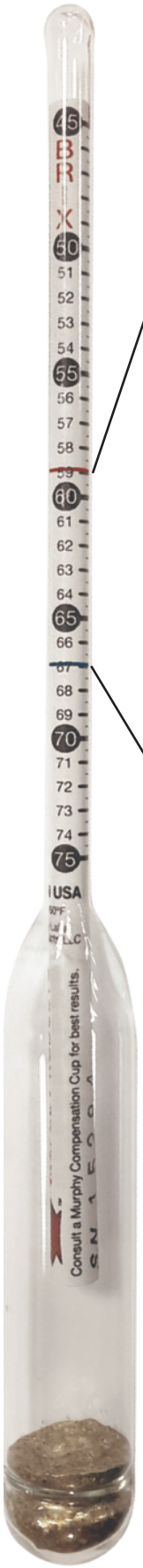
Hydrometer Basics



HOT TEST

1. Warm up your testing cup by placing it either in the hot sap or hot water and fill with boiling maple syrup to within an inch of the top.
2. Take the temperature of the syrup in the cup. Your hydrometer will say at what temperature to do the hot test, usually 211 F. If your syrup is not exactly at the indicated temperature, use a compensation chart to determine which brix measurement indicates finished syrup.
3. *Slowly* lower the clean hydrometer, with the bulb on the bottom, all the way into the testing cup. DO NOT DROP the hydrometer, it can easily break.
4. Allow the hydrometer to float freely. Look at the determined hot test line (compensating for temperature) on the scale.
   - If the line is level to the surface of the syrup, it is perfect density and you are done boiling.
   - If the line is below the surface, continue boiling.
   - If the line is above the surface of the syrup, it has been over-boiled. Slowly add hot sap or distilled water to thin it out and then repeat steps 1–4

COLD TEST

Follow the above steps, but with the syrup at approximately room temperature, or what your hydrometer indicates for the cold test (usually 60 F). Remember to compensate for temperature if it is not at the indicated temperature.

Compensation Chart

Syrup Temp °F	Brix Adjustment
209	59
190	60
170	61
152	62
133	63
114	64
95	65
77	66
58	67
40	68

TIPS

- Make a line at the top edge of the paper in the hydrometer so you can see if it is loose and shifting around. this will indicate how much it may have shifted by.
- To ensure that your hydrometer is calibrated properly, check it with syrup that you know is the proper density (cold test is fine for this).
- properly clean and safely store your hydrometer between uses
- Read the hydrometer when it has stabilized in the syrup for best accuracy
- Always have a spare hydrometer! They break easily.

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Evaporating

THE BOIL

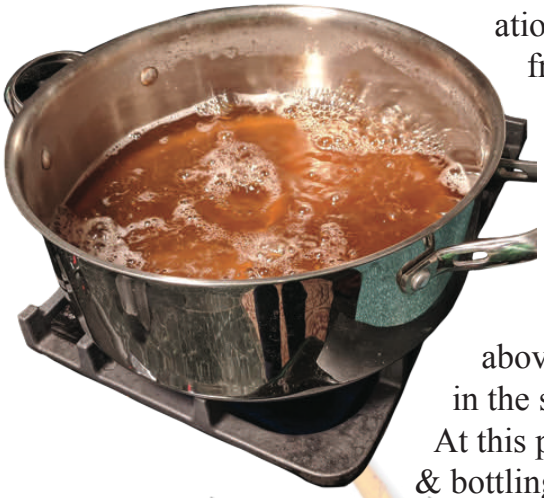
There are many different types and styles of evaporators out there, but the basics are roughly the same.The major differences bettween evaporators are sap capacity and fuel type. The most common fuels are wood, gas, and oil. Again, all surfaces the sap touches should be food grade. There are concerns about copper and brass solders containing lead because it will concentrate in the syrup, so stainless steel and food grade plastics are the best. Use stainless for any parts that will have heat applied. (http://www.internationalmaplesyrupinstitute.com/uploads/7/0/9/2/7092109/gmp_for_lead.pdf) .

Get the sap up to a rolling boil. Remember, the greater the sap surface area, the more evaporation you will have. This is why, historically, large flat pans are used rather than a tall skinny pot. If the sap is kept 1-2" deep in the pan, you will achieve the most efficient evaporation without running the risk of burning the syrup. Once the sap is boiling, if you have more to add to your pan, it is best to preheat it first and add it slowly as to not "kill" the boil. Again, there are various methods to achieve this; the most efficient is to utilize the steam or the heat from your evaporator stack to warm the sap as it flows slowly into your pan. This can be as simple as a rack placed above the pan with a pot on it from which you ladle the warm sap.

Always boil without a lid for maximum evaporation. Boil the syrup as hot and fast as you can until it gets close to finished. Many syrup makers pay close attention to how much fuel is needed and set timers for regular intervals to remind them to feed the stove to maintain an efficient boil. As you near syrup state, it is wise to use a slower, more controlled heat to finish off. Some backyarders will move inside to their stovetops or a finishing pan to better control the process. Continuous flow evaporators allow draw-off of finished syrup. This is also a good time to filter (see filtering). Often, unfisinished syrup is left in the evaporator between boils. To avoid bacteria growth in the unfinished syrup, make sure all of the sap in the evaporate has boiled to kill any bacteria.

WHEN IS THE SYRUP FINISHED?

Syrup is officially syrup when it is 66 Brix, meaning it is 66% sugar by mass. There are a few different ways to measure this. In commercial operations, hydrometers are generally preferred, but syrup refractometers can also be used. If you are not selling your syrup and don't want to invest in a hydrometer, all you need is a thermometer. Put a pot of water on your stove on high heat and read the temperature when it comes to a boil. This is your boiling point, which varies with elevation and barometric pressure. Using the same thermometer, boil your syrup until it reads 7 degrees above your determined boiling point. As sugar concentrates in the solution, the boiling point rises, which is why this works. At this point, you can filter and bottle it (see more about filtering & bottling). If you are selling your syrup, you should strive for a more accurate method of measuring sugar content. Hydrometers are preferred for this. See the Hydrometer Fact Sheet.



If you are using a continuous flow evaporator, draw off small batches at first and double check the density with a hydrometer to ensure you are drawing off at the proper temperature, which can change daily based on barometric pressure.

FOAM

Foam-overs happen when the sap is boiling vigorously (and tend to be worst when starting a new batch). This is normal, but can be dangerous. Be ready to deal with this with a defoaming agent. These can be purchased commercially, or a drop of edible oil will break the surface tension of the bubbles (use an oil with little flavor, like sunflower). Sometimes there will be a little scum on the top of your boiling sap. White or grey floating matter is usually bacteria that was killed in the boil. It and all other scum can be skimmed off the top.

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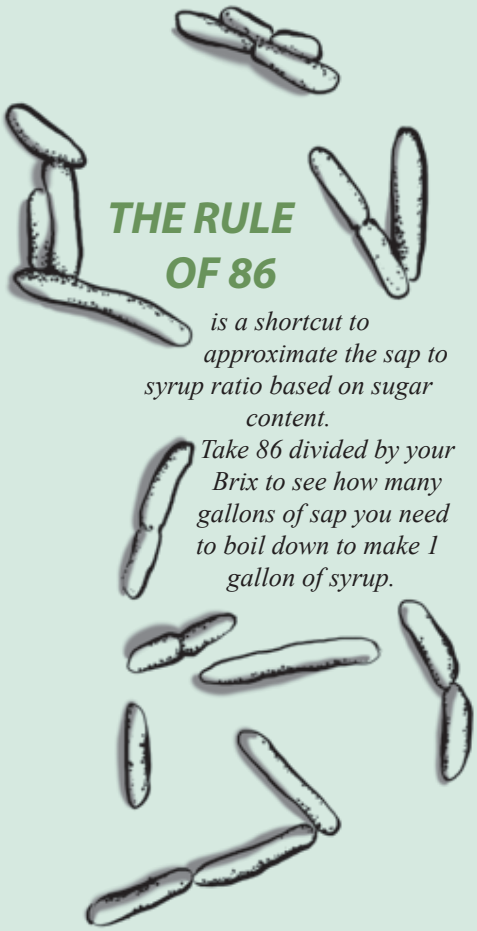
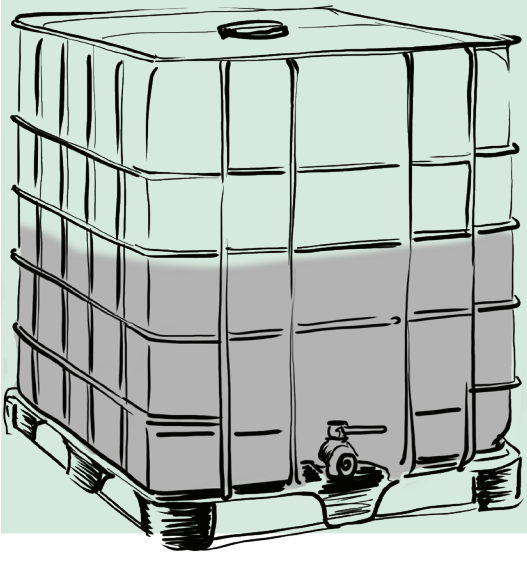
Sap Collection & Storage



THE RULE OF 86

is a shortcut to approximate the sap to syrup ratio based on sugar content.

Take 86 divided by your Brix to see how many gallons of sap you need to boil down to make 1 gallon of syrup.



THE BASICS

When the trees start running, it's important to be diligent with your sap. No matter how clean and closed your system is, bacteria will be present. While it is not harmful in the final product, as you boil the sap for hours, bacteria will eat whatever sugar you have in your sap (this can be a huge disadvantage if your trees have low sugar to begin with) and can cause spoilage. Spoiled sap yields soured syrup. This is not a food safety issue as much as a food quality issue. Sour syrup cannot be sold. Always use food grade containers and approximate about 2 gallons of storage per tap.

Consider this scenario

When checked with a refractometer, say your sap runs at 2 Brix fresh (or contains 2% sugar), out of the tree.
Using the handy "Rule of 86"

$86 \div 2 = 43$ gallons sap to make 1 gallon syrup (2 = Brix)

This means you will have to boil away 42 gallons of water (which is a lot).

Say you let the bacteria grow in your collection container and eat up .5% of your sugar.

$86 \div 1.5 = 57$ gallons

The reality is that you will simply yield less syrup. On top of less syrup, suppose your evaporator will evaporate 5 gallons per hour (pretty good for a backyard operation), you now have to boil for an additional 2.5 hours to yield the same amount of syrup. This is why it is important to consider the condition of your sap at all times and be diligent. Use clean containers. If possible, place buckets on the shady side of the tree or collection containers in low, cool areas. Empty buckets regularly.

Luckily, the weather is relatively cool during sap season. If temperatures at your collection tank are below 40 degrees Fahrenheit—just like in a refrigerator—bacteria growth will be impeded, and the sap will be preserved better than in warmer temperatures. Any cloudy, yellow, or sour-smelling sap should be tossed. Some smaller producers will store their sap until they have enough to run their evaporators. Some will use reverse osmosis filters to concentrate it (more on that later) and then store the concentrate. Adequate storage options include refrigerators (for a few weeks) and freezing (indefinitely).

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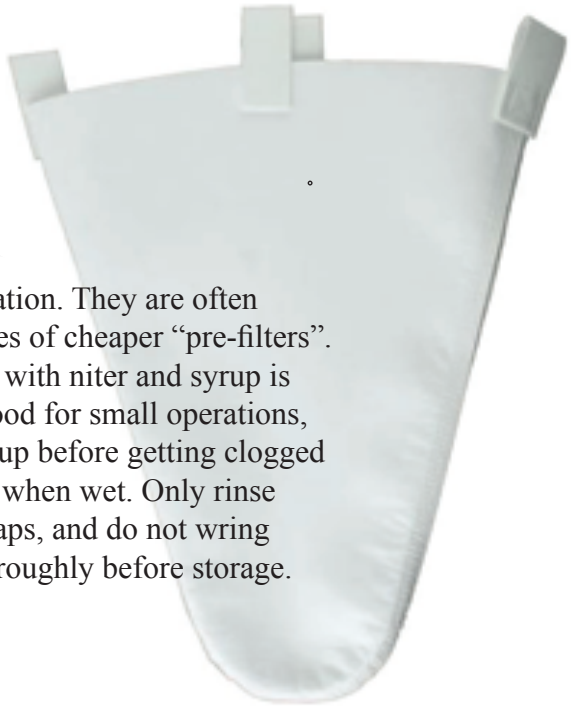
Filtering

THE BASICS

Syrup that will be sold needs to be thoroughly filtered. Just like off-flavors in syrups, sediment in the bottom of your bottle is not a food safety issue, but a food quality issue. If your syrup is merely for home use, you might choose to forgo the sometimes difficult task of filtering. Niter, or the sediment that accumulates on the bottom of your bottle, is minerals that exist in the sap that become concentrated and then fall out of solution as the syrup cools. It is edible, but not palatable. Sometimes called sugar sand, it is primarily composed of calcium and really does feel like sand between your teeth. Every time you reheat syrup and let it cool, more niter will fall out of solution. So, for clear syrup, filter each time it is heated and be sure the syrup is the correct density when you start the filtering process.

Hot syrup filters more easily (185-195 degrees F), the amount of syrup that passes through a filter decreases dramatically as time wears on (and as syrup cools)

For a lot of great info on filtration, go to https://www.youtube.com/watch?v=HNqvFRBbK9A



CONE OR FLAT FILTERS

Cone filters are the most basic form of filtration. They are often made of wool or orlon and used with a series of cheaper “pre-filters”. The pre-filters are removed as they clog up with niter and syrup is transferred to the next prefilter. They are good for small operations, and able to filter about 1 to 3 gallons of syrup before getting clogged and needing rinsed. These filters work best when wet. Only rinse with hot water--do not use detergents or soaps, and do not wring them out, but hang them straight to dry thoroughly before storage.

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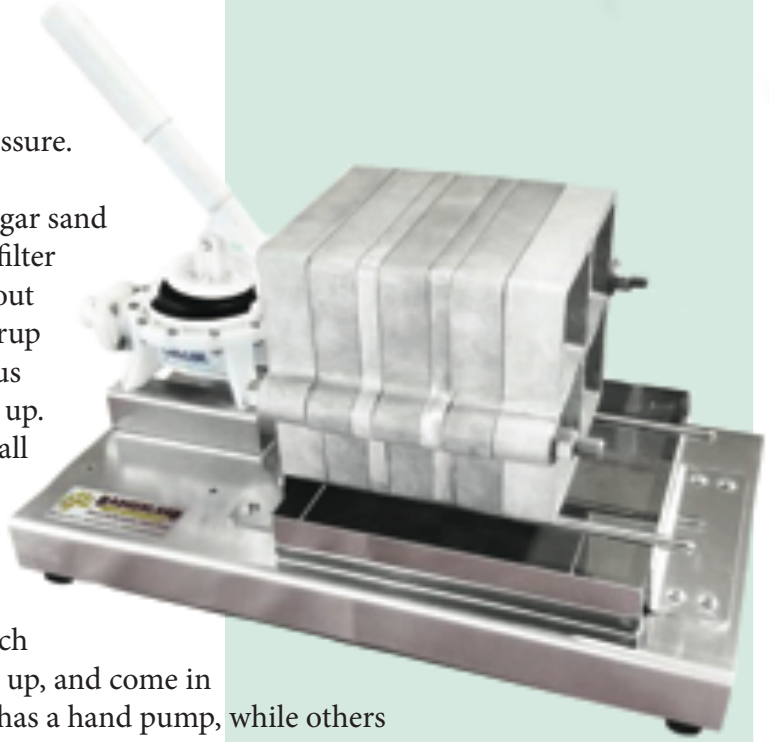
PLATE FILTER PRESS

these use filter paper and "filter-aid", or diatomaceous earth to filter syrup under pressure.



The filter-aid traps even small particles of sugar sand and minerals, and the filter paper keeps the filter aid out of the syrup. The metals plates slide out and filter paper is placed in between. Hot syrup is mixed with a filter-aid, called diatomaceous earth and pumped into the press until it fills up. The diatomaceous earth holds onto even small particles of sugar sand and the filter paper prevents the diatomaceous earth from passing through. The remaing hot syrup is pumped through the press under pressure. These plate filters are capable of filtering much more syrup than cone filters before clogging up, and come in many shapes and sizes. The one to the right has a hand pump, while others use electric pumps. Use only food grade diatomaceous earth.

CANISTER FILTER

These work on the same basic principals as a plate filter press. They generally have fewer parts to contend with but also have less surface area, and can clog up more readily, making them lower-capacity.

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