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New Fitting Design

Climate Change and Maple Production

The Newsletter of the North American Maple Syrup Council

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NAMSC's Vision is for all sugarmakers to consistently and sustainably produce high quality maple products.

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President's Note

Greetings, maple people.

Thank you to all of the delegates who recently attended our quarterly Zoom Meeting. I did it from a hotel room in Maine. If anything good came from COVID it was that it forced us to embrace technology and got a bit more comfortable with the medium. It really makes it easy for most to participate. Especially for NAMSC, as we span from Minnesota to Nova Scotia.

At the writing of this article it is almost February. The weather in Western MA is much warmer than "normal," but what is "normal?" All we seem to have now are averages! Somewhere between extremes.

Some of you have been sugaring for a month or more, others like me, are still hoping for winter to come! We are in a time in the history of the earth that things are changing more rapidly than ever (save an astrological collision or something of the sort).

As I anticipate retiring from my regular job in a few short months, I ask myself: will I be sugaring from Christmas to Easter in the future? Do I even want to? Will things moderate some in the last 1/3 of my life, (climate-wise that is)?

I'm sure I'm not the only one who ponders these things. But here we are! So let's do our best to make the best of it, while playing the hand we are dealt.

I plan on starting tapping on or about Valentine's Day, a full month earlier than my grandparents did 50 years ago! I hope to be tapping frozen wood. We will know in April how it went.

Please keep in mind that our trees are also stressed by this meteorological blender that we are now experiencing. Keep using sustainable methods that have been developed, to ensure a resource for future generations.

We all know that maple sugaring is a long term investment.

After the season is well behind us and things are cleaned up and put to bed for a while, plan on attending the NAMSC conference in Massachusetts this October. And maybe the grading school that will follow it. We have been and will continue to work diligently to provide you with a worthwhile, informative and fun experience. Trade show, maple tours, taste of Massachusetts, research updates, educational sessions, and more!

Please join us and rub elbows with fellow producers, industry professionals, extension folks and your favorite equipment manufacturers.

In the meantime: Happy sugaring! And remember: make maple a staple!

Respectfully,

Howard Boyden
President, NAMSC

In this issue...

Cover: Anyone know who this is? The photo is from the cover of the 1972 USDA publication "Installing Plastic Tubing to Collect Sugar Maple Sap."

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We're always looking for good maple photos and articles for the *Digest*. Send to: mapledigest@gmail.com.

Digest Online

The online archives of the *Maple Syrup Digest* at www.maplesyrupdigest.org are now accessable on your smartphone and tablet devices, as well as on your computers.

2023 Hall of Fame Ceremony

The International Maple Museum Centre would like to congratulate Simon Trepanier and Pam Green for being selected as the 2023 NAMSC Maple Hall of Fame Inductees.

The Maple Hall of Fame Induction Ceremony will be held Saturday, May 13th starting approximately at 10:30am at the museum in Croghan, NY.

There will be a pancake breakfast held from 7 - 9:30am, followed by the Induction Ceremony, then followed by a lunch at noon.

If you have any questions, please email or call the International Maple Museum Centre: (315) 346-1107; info@maplemuseumcentre.org.

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Innovations in Maple Sap Collection Systems: Increasing Yield in 5/16" Lateral Line Tubing

Timothy D. Perkins and Wade T. Bosley, University of Vermont, Proctor Maple Research Center

Ongoing research at the University of Vermont Proctor Maple Research Center over the past thirteen years has examined a variety of approaches to increases yield from 5/16" maple tubing systems on vacuum. Several factors are important, including vacuum level (https://mapleresearch.org/pub/m1007sapcollectionvacuumlevel/), spout and dropline sanitation (https://mapleresearch.org/pub/1019sanitation-2/), leak detection and correction (https://mapleresearch.org/pub/4221det/), and tubing system design (https://mapleresearch.org/pub/m0216vacuumtubingresearch/). Large increases in sap yield have resulted, however improvements in the 5/16" lateral line system have proven elusive or have been determined to be cost prohibitive for the gains anticipated.

Sap and gases move together through lateral line tubing under vacuum (https://tinyurl.com/sapflow). As this movement occurs, these two interact with each other and with the tubing in a fashion termed "slug flow," a highly inefficient mode of liquid transport in pipeline systems. When alone, sap can flow smoothly. When alone, gases will also move freely in tubing. However, when together, the presence of liquid restricts the transit of gases substantially in tubing of this size (which incidentally is one of the reasons 3/16" tubing systems develop natural vacuum well). These gases, if not removed quickly, result in a reduction of vacuum level from the mainline to the end of the lateral line. This drop in vacuum is greatest when sap is flowing strongly and when more tree gases are being produced. This is why keeping lateral lines short and having fewer taps per lateral (introducing air from tree gases and leaks) results in higher vacuum levels and higher yields than lateral lines that are long with many fittings (tees, unions, etc.) on them (https://mapleresearch.org/pub/manual/, Chapter 6). Modeling studies of this problem indicate that that frictional losses in lateral line tubing systems may approach several inches Hg of vacuum depending upon the length of laterals, the number of fittings in the line, sap flow rate, and the presence of microleaks (Perkins unpublished). Reducing friction in the system is therefore a reasonable goal.

Two lines of evidence further suggest that it is possible to get at least 20-25% more sap from maple trees. The first is the high yields from trees in some experimental studies. These setups use canisters connected to vacuum, typically with one tap per lateral with a single dropline. Only the short segment of dropline contains both sap and gases and there are few or no other fittings inline that can restrict sap movement.

Another piece of information comes from dual 5/16" lateral lines, with one serving as a "dry" line and the other as a "wet" (sap) line (https://tinyurl.com/dual-lateral). Both of these types of systems regularly produce high sap yields, a testament to the fact that lateral lines are somehow restricting vacuum and reducing yields. Estimates are that sap yields could be as much as 20-25% higher if these restrictions could be engineered out of the system. While it is unlikely that all restrictions in the system can be eliminated, given the relationship between vacuum and an increase in sap yield of 5-7% for each inch Hg of vacuum (https://mapleresearch.org/pub/m1007sapcollectionvacuumlevel/), reducing restrictions in a labor and cost-effective manner would produce positive results.

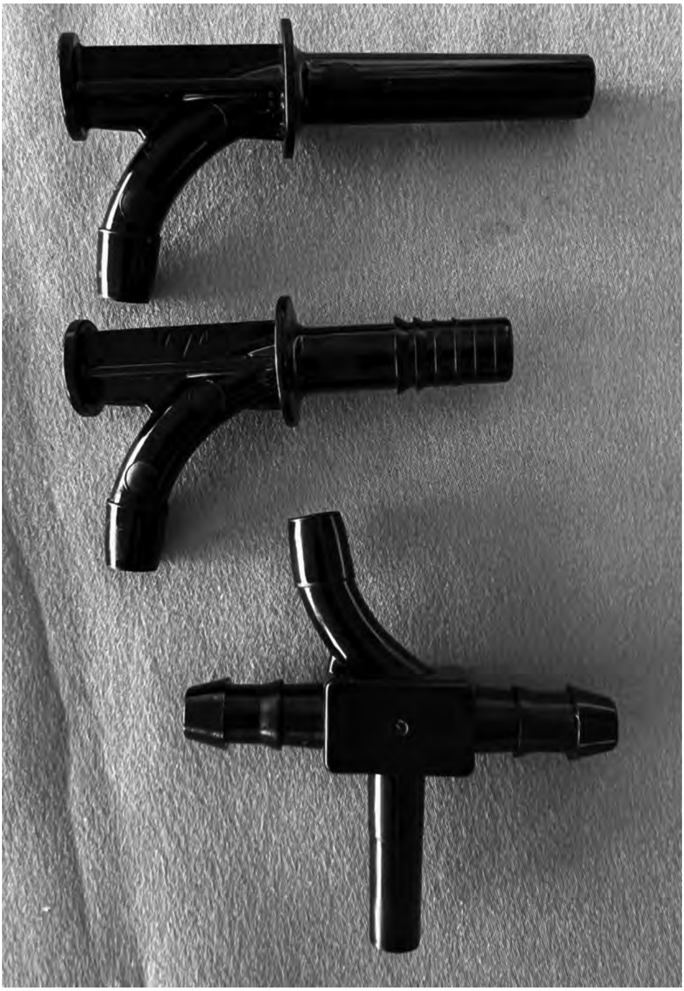


Figure 1. Spout and "tee" designs incorporating the arc-flow design. Standard 5/16" nylon spout (top) with Arc-Flow, Barb-spout with Arc-Flow (middle), and Arc-Flow Tee (bottom). For the Arc-Flow Tee, sap would flow from the lateral line from left to right. The dropline would connect to the curved segment of the tee at the top. The pin is located at the bottom (rather than coming out of the fitting towards the reader) to allow the fitting to be used on either side of the tree either in a normal configuration or in an inverted fashion (tapping below the lateral). University of Vermont Patents Pending.

Considerable experimentation has taken place to get around this problem. Major "losses" in efficiency in hydraulic systems are often solved by making pipes larger and/or smoother. In theory, increasing the diameter of lateral lines larger can reduce the friction of air and liquid movement by allowing room at the top of the tubing for air to slip past the liquid on the bottom, however in practice turns out to be costly (material cost increases rapidly) and difficult to achieve good results given that larger tubing and resultant higher sap weight within that tubing requires laterals be supported on wire to prevent sags and to maintain proper grade (costly in terms of material and labor). An alternative approach using a wet/dry lateral line system akin to the wet/dry dual-mainline system is too costly to be economically viable given current maple syrup prices. Therefore, we have to look to other solutions to reduce vacuum (and thus sap yield) losses in 5/16″ maple lateral line systems.

A simple analysis of lateral line systems indicates some possible approaches to reducing friction to gas and liquid flow in lateral line systems. Vacuum and gravity "pull" sap down lateral lines. Friction "uses up" energy. The energy that is lost in this case is vacuum (gravity is constant). Reducing friction in the tubing system preserves energy and preserves vacuum further up the line. If making tubing larger or smoother due to cost or implementation issues, the next best way to reduce friction in tubing is to reduce turbulence, especially at fittings. This can be readily achieved through two simple modifications.

The first method is to incorporate a bevel into the entrance and exit of all fittings (https://tinyurl.com/fittingflow). This simple change "channels" sap flow better by reducing turbulence where tubing meets fittings. If sap encounters a beveled edge, it speeds up and smoothly transits the fitting where it exits smoothly with less turbulence.

The second modification is to incorporate an arc where sap streams meet (https://tinyurl.com/fittingflow). The simplest example is a tee. In most systems, sap flows down the lateral line from trees that are upstream, with sap entering from the dropline into the lateral line through a tee at a 90° angle to the lateral line. This creates a large amount of turbulence at the confluence of the two streams (the sap coming from the dropline and the sap running down the lateral line). This turbulence results in higher friction and reduced vacuum. The simple solution to this problem is to change the geometry of the tee. Y-fittings (30, 45, or 60°) reduce head loss by about 15-18%. Better still is an "arc-flow" fitting configuration (Figure 1), which provides a smoothly curved flow path for sap from the dropline to enter into the lateral line stream. This type of fitting reduces head loss by about 50%. How?

Think of the lateral line as a heavily travelled highway with cars (sap) running down it quickly and smoothly. Air bubbles are the empty spaces between cars. What is the best way for more cars to enter traffic? Obviously, traffic flows better if cars enter via an entry ramp where they can merge smoothly into already flowing traffic. Having cars enter a busy highway at a right angle results in mayhem where all traffic slows down (or stops) and traffic is stop and go (turbulence). A smoothly curved on-ramp greatly reduces the turbulence of cars (or sap) entering the traffic (or sap) flow.

To further the analogy, these frictional losses are additive. Each time sap has to merge (at a tee) or change direction (in a spout, a saddle, etc.), friction reduces the energy in the system, in a similar fashion that a lot of intersections in roads will reduce traffic speed and flow. In other words, the head losses build up and vacuum drops the further you move from the mainline in the lateral line system due to these restrictions.

It is important to note that changing intersections from a right angle to a curve will produce the greatest improvement in head loss. Thus using an arc-fitting wherever sap must change direction (spouts, saddles, etc.) would result in the highest degree of improvement. Liquids tend to flow best in straight lines and create the most turbulence at confluences (tees) and where there is a change in direction. If we're going to incorporate an arc into "tees," then we might as well go full-in and also use the same design principle in all other components of the lateral tubing system (unions, saddles, etc.).

You're probably wondering why hasn't this been done before? We can't say for sure, but it is likely that the main reason is that putting an arc into an injection-molded part is not easy. The engineering to build the tooling is considerably more complicated than building a mold incorporating right-angles. The good news however is that once that design modification is accomplished, that tool can produce the parts for close to the same cost as a simpler tool when spread across millions of individual fittings.

Researchers at the University of Vermont Proctor Maple Research Center (PMRC) have spent a considerable amount of time and energy looking into the various factors involved. Over the past few years we have worked with a highly experienced injection molding company that understands the maple industry. Together we were able to design new fittings incorporating these design elements. Patent applications have been filed to cover these innovations. We anticipate large-scale field testing of the final designs during the 2023 sugaring season at PMRC and other sites across the maple belt. If successful, new fittings incorporating the arc-flow principles will be made available in the fall of 2023.

Come to Massachusetts for the 2023 International Maple Syrup Conference

Quality from Tree to Table

October 25-28 • Sturbridge, MA

The Massachusetts Maple Producers Association invites you to join us for the 2023 **International Maple Syrup Conference: Quality from Tree to Table**. The industry's largest and longest-running annual conference and trade show will be held October 25-28 in Sturbridge, MA, within a day's drive of 90% of the world's maple syrup producers, convenient to interstate highway travel and easily accessible from several airports.

The event has been held every year for decades, and attracts sugarmakers of all sizes, along with researchers, regulators, and professionals from related industries for four days of research presentations, practical skills workshops, meetings, tours, and networking.

Preliminary schedule

- Wednesday, 10/25: Meetings for NAMSC delegates
- Thursday, 10/26: Tours of sugarhouses and local attractions, and a Taste of Massachusetts dinner
- Friday, 10/27: Research presentations, evening banquet
- Saturday, 10/28: Practical skills workshops

Registration information will be available in early June. We are currently seeking submissions for workshop presentations, as well as donations for the annual auction to benefit the North American Maple Syrup Council's Research and Education Fund.. For more information, and to learn more about registration when it becomes available, see:

www.massmaple.org/2023mapleconference/

Judging Syrup: The Industry is the Winner

Brian Bainborough

Judged maple syrup contests originated as a friendly competition amongst producers in the early part of the 20th century. More recently, these competitions have evolved into a valuable opportunity for producers to improve their practice and evaluate their production methods. The grading system employed in the judging process facilitates communication about the uniqueness of pure maple syrup. The world standard definitions, uniform grading system, and related guidelines have been developed to promote uniformity throughout the maple industry. In competition, the same standards apply, regardless of where the contest is being held. As maple judging has evolved, so have the guidelines. Every region has contributed to the refinement of these criteria, as the process of judging has become more sophisticated and widespread. Producers throughout the US and Eastern Canada have begun to embrace maple judging as they understand the value of knowing how to make syrup to a high standard. Consumers benefit from the emphasis on taste, and off-flavored syrup is kept out of the market.

In recent years, the maple judging process has promoted improvements. Historically, density was most often the basis for disqualification of contest entries. Through education, producers are more aware of how to "get it right." This trend was illustrated at the International Conference 2022 at La Crosse, Wisconsin when only one entry was disqualified on the basis of incorrect density. Another basis of disqualification has been submission into the wrong color class, usually to the Golden Class. Sometimes, entries are too dark for the class. Producers should note that syrup may darken over time, and before submitting entrants should confirm that the syrup is entered into the appropriate color class. Presently, off flavors account for the most disqualifications. In LaCrosse, 20% of entries were eliminated for this reason.

Before even contemplating a competition entry, producers must know the grades of syrup. There are several sources to consult in order to ensure that you have accurate information that meets the industry standard. Two particularly helpful aids to learning your grades are the Flavour Wheel developed by Centre ACER research center in Quebec: https://www.centreacer.qc.ca/en and the flavor chart developed by the Proctor Maple Research Center at The University of Vermont: https://www.uvm.edu/cals/proctor-maple-research-center

The North American Maple Contest Guidelines are now well established, having been standardized by IMSI, and ratified by NAMSC and individual State and Provincial Associations. Anyone choosing to enter their product for judging can be assured of bias-free and formally agreed-upon assessments for their entries. The results can be informative to the producer, who is able to compare their product to any others being produced in the North American maple industry.

Present day guidelines are widely shared, and many institutions and organizations make resource materials and expertise readily available to all. The most comprehensive source one can consult to learn and prepare for judging is the document *North American Maple Contest Guidelines*. (https://mapleresearch.org/pub/contestjudging/) This thorough guide explains in detail how to assess one's own product, and how to prepare samples for judging. While the *Guidelines* cover the judging of maple sugar, maple butter/cream, maple jelly, the focus here is on maple syrup. In each category, the criteria are broken down for scoring, and fully explained. For example, Guidelines explore the evaluation of maple syrup for competition in terms of Density (30% of score), Color (20%). Clarity (10%) and Flavor (10%). All of the judging criteria are fully explained for all categories of submission. As well the Guidelines address appearance, packaging, nutritional and aesthetic elements. Most useful are the sample score sheets included in the *Guidelines*.

Once you have an understanding of the categories, you need practice in tasting and identifying flavors in your own product. There are a few tips that can help you to select samples, apply the judging criteria, and compare your product to the standards. Doing this in your sugarhouse requires some organization and record keeping. Suggested practice includes first looking at the color of your product to ensure that you know how to classify it.

You will need to develop your powers of taste. Quality is largely dependent on flavor. There are several flavors that you will easily recognize; others come with practice. Human sensory systems can distinguish about 100,000 different flavors. According to the 2017 Food and Health Survey, 84% of Americans confirm that taste is the top driver of food purchases. Maple syrup flavor

has some unique properties, in that it can be affected by soil type, weather, tree health, and processing methods. Sensory impression is determined by taste, smell and "trigeminal senses" which detect chemical irritants — ammonia, ethanol, acetic acid, carbon dioxide, capsaicin, and menthol, for example — in the mouth and throat. Some foods are altered with natural or artificial flavorants which influence these senses. Flavor is a mix of sensory data, of which taste is just one of the senses. Nevertheless, taste is complex, and can suggest to the taste buds sweet, sour, bitter, savory, fatty, alkaline, metallic and water-like qualities. Regardless, flavor comes down to personal preference. The industry continues to develop terms and language to define and assess flavor in maple products. Producers benefit from an understanding of how consumers perceive flavor, and take this into account when marketing products. Even more important, producers submitting samples for maple judging need to have a good understanding of the characteristics of flavor when assessing their own samples.

If you are ready to think about entering a competition, there are some preparatory steps you can take. During the season, if you think you have produced excellent syrup, put some away and taste it later once it's cooled. Hot syrup usually does taste good, but that can give a false impression. More flavors become identifiable once it's cooled. An important tip: put three glass containers (of contest entry size) away and do your own judging on one of the bottles before submitting to a competition. Check for density, clarity, and color class and most importantly TASTE it. By testing this one sample you can now determine if you want to enter one of the other samples.

When you decide that you are going to submit your own syrup to a competition, there are a few practical considerations. You need to ensure that you follow instructions about the size and kind of container that is acceptable. This should almost always be a glass container (a half pint or 250 ml). While this is a practical feature for the judges, it is also important to help spectators at fairs and events to see and learn from the samples being judged.

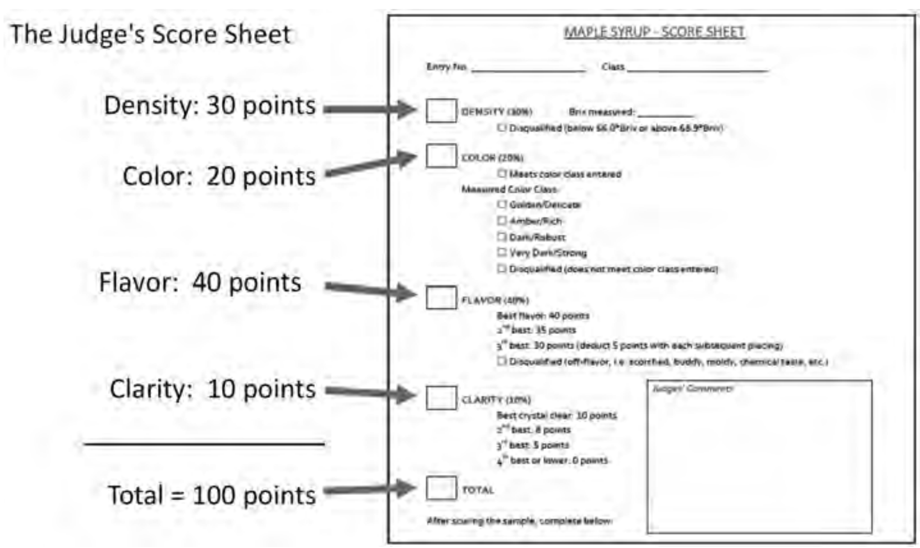
Look at the competition guidelines for submitting entries. Important to keep in mind is how you will make sure that your entry is delivered to the judging site safely, with appropriate packing, and on time.

Once your entry has been submitted, it is in the hands of the judging team. Judging is done blind, and all potential bias has to be ruled out. For that reason, it is essential that none of the judges can identify your product in any way. Know that everyone in the competition is being judged according to the same scorecard. Scoring addresses the same criteria across the regions. See sample scorecards in the *North American Maple Contest Guidelines*.

The judging process will be the same in all areas. Once you submit your entry, the judging will follow a standard set of steps:

- A guardian record keeper takes the entry, records the entry into the class, and assigns a number to it. The record keeper is the only one with the master list.

- The sample is passed blindly to a judge to measure density, check for



clarity and color. Scores are given to each entry for these criteria.

- The sample is tasted, and positioned and ranked within the color category. The higher ranking syrups are tasted numerous times, to come to a consensus of best in class.

- Scorecards are used to record comments and rankings. The same scorecard format is used for all entries, and the judge should provide feedback, especially on submissions that are disqualified, so that the producer understands what went wrong

All the while, the judge only can see a number attached to the entry. Following all these steps, the judges determine the winner and the guardian record keeper announces the individual results. Determining the winner is not the only value of the competition. The feedback that judges provide to all entrants via the scorecard is equally significant. This important step gives the producer the opportunity to learn and take corrective measures to improve the quality of their product.

These events can be a great learning experience if one is willing to take constructive feedback. For example, a producer who was disqualified from a competition in one season was determined to improve their entry the following year. They asked for help, and researched what was required to "make the grade" with subsequent entries. The following year, that producer won the competition.

An individual's willingness to improve and to make a commitment to learning benefits everyone in the industry. As well, contests create a marketing opportunity. Hanging ribbons in the sugarhouse only helps to sell product! Having been recognized for winning a contest at a local, state or international level, a producer can lay proud claim to the excellence of the syrup, and value-added merchandise.

Above all, use contests to improve the quality of your product. Contest judging isn't easy, as there will be many excellent syrups entered in any competition. While there is only one overall winner, being in the top five doesn't mean your syrup is inferior. Increasingly, we see in competition that there are many good entries, powerful evidence that the entire industry is improving. To become even more proficient in evaluating maple products, consider taking the two-day grading school offered annually at the NAMSC international conference by the University of Maine. As maple judging has continued to evolve in recent years, we see trends and refinements. The international level of competition illustrates for all of us some of the triumphs and some of the pitfalls, but ultimately ensures that our maple products continue to improve in a thriving market.

To learn more about the judging process, and to build your own skills, visit The University of Maine Maple Syrup Grading School at https://extension.umaine.edu/maple-grading-school/related-resources/.

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Effect of Climate Change on Maple Syrup Producers

Paul Renaud

The material in this article was initially gathered and summarized by the Climate Change Committee of the Ontario Maple Syrup Producers Association. In compiling this information, we were careful to only include results for which there was widespread scientific consensus. There have been additional research findings (such as the effect of climate change on Brix levels) that have not yet been substantiated by other researchers and hence are excluded for the time being. The author wishes to acknowledge Jenny Liu and Brodie Berrigan for their contribution to the research and synthesis of the findings reported in this article.

While there are both good and bad impacts on maple syrup producers due to climate change, overall, the effects will be negative. On the plus side, longer summers mean longer growing seasons for maple trees. However, regionally this longer growing season will increasingly be accompanied by periods of extended drought – particularly in more southern latitudes. This in turn may hinder root growth and performance. As maple syrup producers we are aware that anything which negatively effects maple tree roots is a concern because the roots are the origin for sap movement in the spring.

Longer, hotter summers also increase the opportunity for greater impact from invasive species, native and invasive insects, as well as diseases. While these negative factors impact existing maple trees, the longer, hotter summers also have the potential to increase seedling mortality rates. Younger trees must also increasingly compete with invasive tree and undergrowth species better suited for hotter and dryer climates.

The combined effect of greater premature tree death of established mature trees and the diminished replacement rates from younger trees will cause the viable range for sugar maple habitat to shift northward over time. While this may be good news for producers in central Quebec and northern Ontario, it is of long-term concern for producers in Southern Ontario and most of the USA. Fortunately, as maple trees can have a lifetime of over 100 years, the falling level of replacement will take several decades to reduce many sugarbushes to uneconomic levels of tree density.

Of far greater short-term concern is the impact of severe weather events, particularly windstorms. In 2022 both the hurricane event that hit Nova Scotia as their sugaring season was starting, and the derecho event that tore across Ontario and Quebec, demonstrated that the risk of widespread loss of pipeline infrastructure and healthy, productive mature trees is also more likely as wind events continue to increase in both frequency and severity. Increasingly, tornado-scale events are occurring both spring and fall in eastern North America.

Many producers lost over 1/3 of their tappable trees in 2022. Unlike other agricultural harvests that can be easily ensured against annual climate-related losses, maple syrup producers are keenly aware that the loss of a healthy mature tree means the loss of up to 40 years of harvest until a replacement tree can replace it. Currently there is no crop insurance scheme available to deal with this magnitude of productive loss.

As we progress from summer and fall into winter, we can expect to see more precipitation falling as rain which will reduce snowpack that typically insulates fine roots from damage. And as the variability of temperature change increases in spring, maple syrup producers can expect more spring frost events occurring during the vulnerable budbreak period, making both the prediction of buddy sap development more difficult as well as causing leaf dieback. Trees will need to apply more of their energy to leaf replacement which will tend to hinder both tree growth and canopy development.

The same sudden changes in spring temperatures can result in shorter seasons and all regions have seen end-of-season spring dates occurring earlier in the year over time. Similarly, the end-of season fall dates are occurring later and later over time. Long term forecasts suggest that over a period of several decades these two sap movement seasons may merge if climate change continues unabated, meaning that maple syrup may become a winter harvest in some regions. In the shorter-term, shorter seasons in southern regions will make maple syrup production uneconomic for smaller scale producers.

Other economic impacts that accompany climate change include greater difficulty in predicting labour needs (as seasons fluctuate more each year) as well as increasing costs for fuel employed in boiling sap and managing the sugarbush. Labour costs are also likely to increase due to the increasing effort to recover from severe wind events.

The demand for maple syrup may also be affected as consumers increasingly shift their preference towards climate-friendly products. Maple syrup producers who are demonstrably climate-friendly will have an advantage over those who are not. This trend will likely grow much in the same way as the organic trend overtook the industry in the past.

Maple syrup producers can take several actions to mitigate the impact of climate change, even if we cannot individually prevent or adapt to it:

- Biodiversity in the sugarbush is the best mitigation for invasive species/insects/disease. Any monoculture is a fertile ground for any invasive threat that can thrive in it and monoculture maple sugarbushes are no exception. Biodiverse tree species slow the advance of these invaders and give maple trees more opportunity to recover should they become afflicted. Biodiverse wildlife also acts as natural predators for invasive insects.

- Depending on the configuration

and topology of your sugarbush, coniferous tree wind breaks planted/encouraged at the periphery of the compartments in your sugarbush can help limit damage from many wind events.

- Thinning practices need to be revisited as tighter packing of trees helps canopy trees support each other during windstorms. Unfortunately, we also know that tighter canopies may mean less sap production per tree. Finding the right balance is an area for greater research and study.

- Ensuring that recovery trees are "pre-positioned" should mature trees be lost prematurely can shorten the recovery time to regrow the replacement by several decades. A "recovery" tree is an immature adult tree approximately 10-20 feet in height that is waiting for a break in the canopy to shoot up. While it still may take 5-10 years for an immature recovery tree to replace a lost mature tree, it is better than waiting 40 years.

- Maple syrup producers in southern regions can start planting Red Maple to supplant Sugar Maples as they ultimately die off. Red Maples can also be harvested for sap and are more heat tolerant. In regions where there is a risk of greater flooding, Silver Maples can be planted as they are more tolerant of wet growing areas.

- Maple syrup producers who are not using pipelines to increase the scale of their operations can consider doing so. With appropriate sanitation practice, pipelines enable trees to be tapped during winter, reducing the need to try to guess when the spring thaws will start as seasons get more variable over time.

- Single-year production losses due to climate events can be insured using crop insurance in many jurisdictions. While this may not mitigate against multi-year losses, it can soften the blow and help mitigate losses from smaller-scale events. Infrastructure insurance can also be purchased for pipelines and pump houses located in the sugarbush.

Maple syrup producers can also contribute by lowering their own emissions in producing syrup. 90% of producer emissions are from heat energy used to evaporate sap into syrup. It does not matter what the fuel used is (wood, pellets, biomass, oil, propane, etc.), they all emit CO_2. Renewable fuels are just as much a part of the short-term problem as fossil fuels as they are only carbon-neutral over the lifetime of a tree. This is longer than the scientific consensus that requires emission reduction within 20 years to prevent greater climate impacts.

There are several strategies maple syrup producers can consider for reducing emissions:

- Reducing the volume of sap to be evaporated via reverse osmosis provides the greatest "bang for the buck." The indirect emissions from using electricity are 100x less compared to direct and indirect emissions from any other fuel source. While quality of syrup is affected by high levels of brix reduction prior to boiling, there is no scientific evidence that quality or chemistry of syrup is affected by reducing sap to a low level of 6-8 Brix – a 50% reduction in total volume of sap.

- Increasing the heat efficiency of the evaporation process is important. Oil and propane-fueled evaporators are generally 90% efficient due to employing the use of condensing heat as part of their operation. Most wood evaporators are less than 50% efficient out-of-the-box because they do not employ all the heat available from secondary combustion of gases released by burning wood. Fortunately, it is relatively easy to modify most wood evaporators to employ secondary combustion. Older evaporators over time can be replaced by the emerging electric evaporators that use compressed steam to accelerate evaporation.

- Keeping the heat in the evaporator and not in the chimney is essential. If your chimney temperature is over 450°F you are losing too much heat up your chimney. The best way to reduce the rate of air movement up the chimney varies based on the type of evaporator. Non-forced air evaporators can employ a draft control on the stack and fan speeds in a forced air evaporator can be better balanced.

Maple syrup producers can also transition their own operation to be net-zero. This will be the topic of a subsequent article.

The NASS Maple Survey is Simplified – Now it's Time to Participate

Mark Canella, David Folino, John Goldberg, Pam Green, Mark Isselhardt, Jean Lamontagne, Les Ober, Adam Wild

The IMSI Statistics Committee chaired by Mark Isselhardt (UVM Extension) and Dave Folino (Vermont maple producer) has concluded its work with the United States Department of Agriculture's National Agricultural Statistics Service (NASS) to simplify the *Annual Maple Survey* to make it easier, faster, and more convenient to fill out by U.S. maple producers.

The new survey has fewer questions and requires less detail and yet will result in a more accurate overall picture of the scale of production and growth of our industry. The survey has been reduced from four pages of questions to roughly two pages. While the timing of the 2023 survey will remained unchanged, the committee will work with NASS to change the timing for the 2024 survey, hoping that a later due date will prevent conflict with end of season and cleanup activities and therefore increase participation.

Now it falls upon us producers to participate in greater numbers. We have a better survey; we need to expand participation to get much better accuracy and utility of the survey data.

The survey is an important tool for producers to understand and leverage the growth opportunities of the domestic U.S. and export market for maple syrup made in the USA. In the past, the weak response rate resulted in underreporting total annual production of syrup and therefore its economic value. It is likely that the underreporting is not uniform across all maple producing states. According to industry experts the magnitude of the underreporting could reach 50% of the published crop totals. **This puts our industry at a competitive disadvantage** compared to others competing for capital and funding for research grants that provide production instruction, technology, and innovation. Underreporting the US maple crop diminishes the industry's ability to influence supportive public policy decisions and our ability to obtain economic development programs (that go to other industries) needed to compete with other substitute products and competing sweeteners.

Confidentiality. The information you provide NASS in this survey is completely confidential with no exceptions and serves only in aggregate. Under penalty of jail and significant fines NASS cannot share this information with any other government department or individual, with absolutely no exceptions.

This year, fill it in! Let's step-up our competitive edge by helping ourselves to a much more accurate maple crop report.

Where to go - If you are on the NASS list, please fill it out. If you do not receive it, email Lance Honig (lance.honig@usda.gov) to be added to the mailing list or go to www.nass.usda.gov.

Any questions for the committee can be emailed to Mark.Isselhardt@uvm.edu or maplesyrupinstituteimsi@gmail.com.

Why Does the Sap Stop Running After a Few Days if it Doesn't Freeze Again?

Timothy D. Perkins and Abby K. van den Berg, Proctor Maple Res Ctr, Underhill, VT

Sap flow from tapholes in maple trees is driven by pressure in the tree. The key concept in understanding flow is that sap (or water) will always move from an area of high pressure towards an area of lower pressure, and the rate of flow depends upon the difference in pressure – the higher the pressure difference the faster the flow rate. After the water uptake phase which occurs as the tree freezes, when the tree thaws, sap will flow out of any severed vessels in the wood (such as a taphole). This is initially due simply to head pressure…the standing column of sap above the taphole flows out via gravity. Immediately after thawing the flow rate is relatively rapid, but then begins to slow down within a few hours as sap flows out and the pressure head diminishes. Most of the flow during this time is downward from a zone roughly above the taphole. Due to the anatomy of trees, the resistance to sideways flow of liquid in wood tissue is about ten times that of downward flow. Over time, as the sap in the zone above the taphole is depleted, some sideways movement of sap towards the taphole will also occur, but the flow rate will be slower, but last for up to about a day if refreezing does not occur.

Without a freeze, the flow of sap will continue to slow and eventually stop because there is no longer a difference between the pressure inside and outside of the tree. However, producers often observe an uptick in sap flow during the daytime over a few days. Why does this occur? Where did the extra sap come from? Typically, these short bursts of increased sap flow happen when the temperature warms over the next few days. The warm temperature causes gas bubbles in the wood fibers to expand and squeeze more water from the wood tissues, where it flows into the vessels and out through the taphole. This might occur for a couple of days, and eventually turn into slow weeping flows before ceasing entirely.

To further complicate things, the entire stem of the tree doesn't all freeze or thaw at the same time. Parts of the tree can be thawed and other parts frozen at the same time. This happens especially on different aspects of the tree. The north sides (in the shade) often thaw more slowly than the south sides (in the sun). Early in the spring only a small part of the southern sides of trees may be thawed and flowing sap, while the center and north sides can stay frozen. Later in the season the opposite may be true. Prolonged thawing can also result in weeping flows continuing for days.

We can use different analogies to describe different aspects of sap flow. In this case, it is easiest to think of sap flow in terms of a sponge. Initially the sponge (wood tissue) is saturated with water. When you pick up the sponge from the bucket, water (sap) runs out very quickly, but then slows to a steady drip-drip-drip, then stops. By lightly squeezing the sponge, you can replicate what happens internally in the tree as the bubbles in the wood expand. More water (sap) will run out for a short time. If you squeeze a bit harder (gas bubbles expanding more), more water will come out. Eventually however, no amount of squeezing will elicit further dripping. The water in the sponge (or the sap in the wood) is exhausted and a refreeze is necessary for the system to recharge.

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Every time you set a tap, fire your evaporator, or put syrup into bottles, you are benefitting from research that helped us all learn how to do these things better. Much of that research has been supported by the North American Maple Syrup Council's Research and Education Fund. The Fund has given out more than $1 million in grants in the last 35 years, catalyzing the research that has helped the maple industry grow and thrive.

The fund gets its resources from industry stakeholders – equipment manufacturers, producer associations, dealers, and individual producers. Alliance Partners commit to making annual contributions that help assure the long-term sustainability of the Fund.

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