Maple Syrup Digest

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Sanitation Study Summary
Sap's Sweet Spot Moving North

The Newsletter of the North American Maple Syrup Council


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Greetings from your President

It is hard to believe, but two years as your President has come and gone. These two years have seen a few changes in our organization and much has been done towards starting the revised edition of the *Maple Syrup Producers Manual*. We will also see first hand at this year's conference the results of our educational grants that we started just a short time ago. Many things have been accomplished but our work will never be finished. There will always be issues to deal with and places where we can improve.

I will take this opportunity to thank the Minnesota Maple Syrup Producer's Association and the many other volunteers who helped put on this year's NAMSC and IMSI annual general meetings. We are all looking forward to having great meetings among our colleagues and peers. I am sure we will be entertained.

We recently held a delegate conference call discussing many issues at hand. Research and education are always on the agenda, and we learned of some fairly new issues that need our attention. One of those issues is the Spotted Lantern Fly, an invasive species plaguing parts of New York and Pennsylvania. This new predator's favourite treat is grapes and its next favourite plant to munch on is maple trees. Another topic of concern, particularly in New York, is the issue of maple production being classified as manufacturing rather than agriculture. This will mean maple producers will have to follow different and more stringent building codes, ones that may put them out of business. Government officials are trying to implement this but hopefully it can be avoided.

I would welcome the new Executive Director for the International Maple Syrup Institute, Jean Lamontagne from New Brunswick. Jean started with the Institute earlier this year, replacing Dave Chapeskie. Jean lives just a short hour and half drive from me in the Saint John area. Jean and I had a recent meeting where we shared a coffee and got to know a bit more about each other. With Jean's food background combined with his eagerness to get going I feel that the IMSI will do well in the days ahead.

To wrap up my final column, I would very much like to thank my fellow delegates, alternates, producers, executive team, specialists, industry leaders, and all those involved with NAMSC and IMSI for your continued support over the last two years. Much has changed and yet there is still much to come. It is not without your continued contributions and efforts that our industry thrives in today's ever-changing world. I would like to welcome our incoming President, Debbi Thomas, from Michigan. I look forward to working with Debbi over the next couple of years and I will continue to work toward bettering this organization as much as I can. I leave you in good hands and I trust you will support Debbi and her team 100%.

Please continue to learn, educate and better yourself in this sweet business called "Maple." Always do the best that you can with whatever tools or methods you have, and please always strive to make the best maple syrup that you can.

Cheers,
David Briggs, President, NAMSC

In this issue...

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Seeking Photos

We're alwats looking for good maple photos for the *Digest*. Send to editor@maplesyrup-digest.org.

Cover photo: Justamere Tree Farm, Workington MA, by Marian Welch.

A Decade of Spout and Tubing Sanitation Research Summarized

T.D. Perkins and A.K. van den Berg, Proctor Maple Research Center, University of Vermont, Underhill, VT
S.L. Childs, Arnot Forest, Cornell University, Van Etten, NY

More then a decade ago there was a renewed realization that microbial contamination of maple sap collection systems was having a significant detrimental impact on sap yields. Several research studies to investigate ways to improve sap yields from tubing systems were undertaken at both the University of Vermont Proctor Maple Research Center (Underhill, VT) and at the Cornell University Arnot Forest (Van Etten, NY) starting at about the same time and proceeded both as independent and joint projects from 2009-2018. The results of many of these studies have been reported in the past in numerous individual publications and presentations. This article seeks to combine and present this extensive body of work into a single, comprehensive, but concise summary of our results.

Methods

Since this paper is meant to be a broad overview and because methods have been previously described for individual studies (see https://projects.sare.org/sare_project/lne13-326/ for descriptions), the specific approaches used will not be covered here. In general, however, controlled and replicated field trials of different sanitation approaches were investigated for various years using different treatments conducted over several years. In these studies, sap was typically collected and measured from individual trees flowing into small vacuum chambers, groups of 3-5 trees on single lateral lines flowing into larger vacuum cannisters, or larger groups of 60-120 trees on mainlines emptying into calibrated releasers with counters (Figure 1A-C). Regardless of the experimental approach, the average sap yield (gallons of sap/tap) could be determined for each sanitation treatment each season and compared. Using multiple approaches and methodologies provides a check on consistency of findings, provides a level of scalability in the results, and provides a higher degree of confidence in the results.

All the studies presented in this summary were performed with 5/16" tubing on pumped vacuum tubing systems. These results and recommendations do not apply directly to 3/16" tubing systems.

The sanitation approaches tested included: 1) replacement strategies, wherein one or more component of the spout/dropline/tee is/are replaced each year; 2) cleaning strategies in which a chemical sanitizing solution is introduced into the tubing system via injection or by sucking it in under vacuum; and 3) a combination of replacement and cleaning.

Costs are estimated from studies examining the amount of time and materials needed to employ each strategy. Labor costs are based upon $12.00/hr. Chemical sanitizers also included the expense of either rinsing with water after treatment or by allowing the first run of sap to flow on the ground (thus reducing yield).

The specific methods examined were:

- Spout replacement (**SR**), where a new spout was placed on a previously used (age varies, but generally ranged from 1-5 years old) dropline.
- Leader Check-valve use (**CV**), in which a new check-valve type spout or spout adapter/stubby spout combination was placed on a previously used (but not cleaned) dropline.
- New droplines (**ND**), where a new piece of tubing, new spout, and typically a new tee was used.
- Bleach-sanitized (**BS**), in which the spout and dropline were sanitized with a calcium or sodium-based hypochlorite solution. Both short-contact (sucking in a small amount of solution under vacuum) and long-contact time treatments (soaking or injecting a sanitizing solution into the spout and allowing it to remain in the dropline for an extended period, minimum of 10 min) were studied.
- Peroxide-sanitized (**PS**), like the above treatment, but using a hydro-

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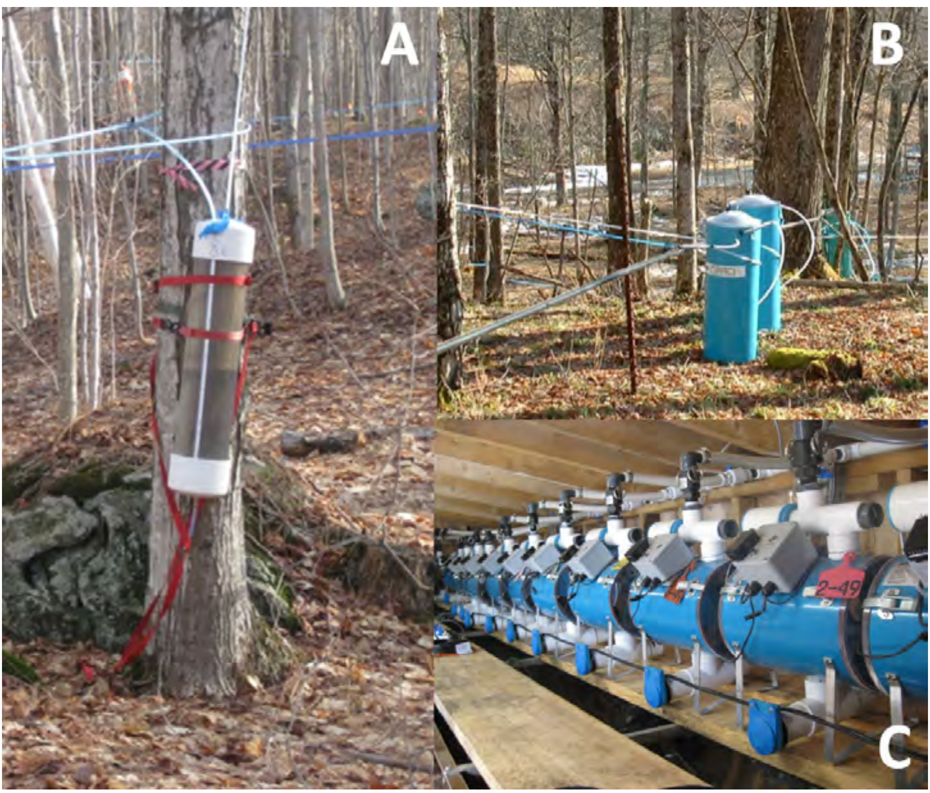

Figure 1. Various methods to measure sap yields from trees under vacuum conditions in sanitation studies. A) Single-tree vacuum chamber, B) Lateral line canisters for multiple trees (typically 3-5), and C) releasers connected to mainlines with 60-120 trees each.

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gen peroxide or hydrogen peroxide + peroxyacetic acid solution under either short-contact or long-contact periods.

- Isopropyl-alcohol sanitized (**IPA**), where IPA is injected into the spout/tubing and allowed to remain for a long period of time (typically until the following flow season). NOTE that IPA, while commonly used in Canada, is not permitted for use in maple tubing systems in the U.S.A.
- Zap-bac use (**ZB**), a spout impregnated with antimicrobial silver, typically used for 3-year period. A new spout is used in year 1, and then reused in years 2-3.

Results

The average annual sap yield improvement (%) for these various sanitation methods compared to control systems (used, but unsanitized) across multiple studies, field sites, and years (Figure 2). The numbers across the top (in the line starting with "N =") represent the number of individual studies which examined that sanitation treatment approach. The values in the boxes just below each bar are the average net profit ($/tap) per year generated by that sanitation regime as calculated for a used system generating 15 gallons of sap/tap with a value of $0.51/gal. Using different sap yields, sap valuations, and costs to calculate estimated profits will provide somewhat different results, but in general, the patterns of yield and net profits remain relatively stable and proportional to sanitation approach, sap yield, and sap value.

Both the **CV** and **ND** approaches automatically incorporate using a new spout each year. However, because multiple overlapping trials of most studies were done each year, we are able to separate out the relative contributions of spout replacement independent of the overall **CV** effect (which combines the **CV**+**SR** effects) and **ND** effect (which includes both the **ND**+**SR** effect). This is represented as a solid intermediate line within the **CV** and **ND** bars.

Dashed lines within the **BS** and **PS** bars show the level of the short-term treatment gained by sucking in sanitizer under vacuum, while the full height of the bar shows the long-term treatment effect, achieved by soaking in sanitizer solution or flooding the system with sanitizer.

In general, over several years across two study sites (Underhill, VT, and Van Etten, NY), annual spout replacement (**SR**) produced an average 31.4% increase each year in sap yield above the profit achieved if no sanitation strategy is used (no replacement and no chemical sanitizer use), producing about $1.03 in net profit. In seven studies, while **SR** generally resulted in only about 1/3 of the sap improvement yield of the best approaches due to the lower cost to implement, it produced nearly 50% improvement in net profit above not using any sanitation strategy.

CV, **ND**, and **BS** (long-contact time) treatments produced similar results to each other, generating about 70-75% more sap [than no sanitation treatment and resulting in a net profit increase around $2.00-2.30. Because these approaches appeared to be the most promising early on, they were also those most intensively examined, with 36, 20, and 9 studies performed respectively. Thus, besides being the treatments found to be most effective, they are also the treatments in which we have the highest confidence.

Looking deeper at the **CV** and **ND** treatments, we see that the new spout alone contributed about 21% of the 69% improvement in sap yield for the **CV** treatment, and about 24% of the 75% improvement from the **ND** treatment, or a little less than one-third of the total sap yield improvement. This clearly indicates that while a new spout is rather important to the overall sanitation effectiveness, replacing the spout by itself does not achieve the highest possible level of sap yield improvement or produce equivalent net profits.

The high net profit presented with **ND** is somewhat artificial in these studies in that older drops were used for comparison each year, which inflates the beneficial results of this treatment. In actual practice, once a drop was replaced, it would age (and build up microbes) slowly over time. By using

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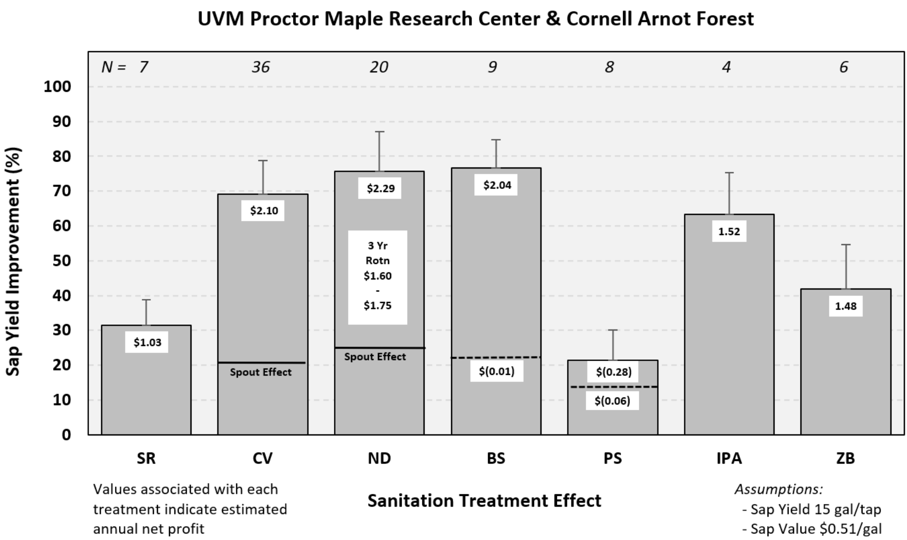

Figure 2. Average annual sap yield improvement (%) for each sanitation treatment in studies conducted at the UVM Proctor Maple Research Center and the Cornell Arnot Forest from 2009-2018. Values within each bar represent the estimated annual net profit above the cost of no sanitation (replacement or sanitizing) with a base sap yield of 15 gal/tap and a sap value of $0.51/gal after subtracting out the cost of materials and labor or lost sap required for each treatment. **SR** = new spouts, **CV** = use of Check-valve spouts or Check-valve adapters, **ND** = new dropline, spout, and tee, **BS** = bleach sanitized, **PS** = peroxide sanitized, **IPA** = isopropyl alcohol sanitized, **ZB** = Zap-Bac spouts or adapters. The solid line within the CV+Spout and Drop+Spout Treatments represents the contributory effect of the new spout alone to the overall effect of the overall treatment. The dashed line in the bleach and peroxide treatment is for short-contact time exposure (sucking solution in under vacuum) while the total bar height is the long-contact time exposure (soaking in sanitizer solution or flooding the tubing system with sanitizer). The text within the **ND** bar represents the estimated net profit range associated with using a 3-year drop replacement interval along with new spouts annually. The total number of research studies conducted for each of the treatments is shown at the top of the figure; error bars represent standard error of the mean for the studies of each treatment.

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older drops for comparison, the baseline level was kept low. This artifact does not affect the results for the other treatments since the drops were the same age as the baseline treatment (no sanitation).

A short-contact time **BS** treatment resulted in a 22% improvement in sap yield, but the cost required to sanitize resulted in a break-even situation, with no gain in net profit realized. Both long-contact and short-contact **PS** produced only modest improvements in sap yield, but due to cost both resulted in a net loss economically.

IPA, widely used in Canada, produced a result intermediate between **SR** and **CV/ND/BS**, with an average improvement of 63% over 6 studies. The higher cost of this approach meant that the net profit was proportionally reduced, producing an average net gain of $1.52/tap. This is intermediate between **SR** and the top three sanitation approaches, economically matching the performance of the **ZB**.

ZB spouts, when averaged out over their intended lifetime of three years, produced nearly a 42% improvement in sap yield, with a net profit of $1.48/tap. While this is nearly a 44% improvement in net profit over **SR** (if a standard spout is employed), it is not as good as other approaches (**CV**, **ND**, **BS**), although it does approach the strategy of a multi-year rotation of drop replacement with annual spout replacement. A possible disadvantage for some maple producers is that the **ZB** is generally not allowed in certified organic maple operations. Because of the small number of studies focused on the **ZB** approach, the multi-year nature of their use, and season-to-season variability in sanitation effectiveness, more research is required to fully understand this system.

The result of all these studies spanning a decade of study is that three approaches appear to be roughly equivalent in producing the best results in terms of the highest net profit: annual use of the Check-valve spout or adapter (**CV**), dropline replacement with new spouts (**ND**), and long-contact time bleach sanitizing (**BS**). Dropline replacement (**ND**) on a three-year rotation, with new spouts (**SR**) each year produces somewhat lower yields and profits, but has gained fairly widespread acceptance in the industry.

The advantage of the **CV** system is that it is simple to implement since it does not require periodic drop replacement until such time as the tubing or associated fittings begin to fail. Since the **CV** system is available both as a spout or as an adapter, producers can choose which style they prefer – the gains in sap yield are similar with either style.

Annual replacement of drops (**ND**) is cost-effective and typically produces excellent results in terms of high sap yields, but can be very time consuming to implement. One advantage of this strategy is that producers have a wide variety of spouts to choose from. It should be noted however, that the yield improvements and net profits as presented here are achieved only when drop replacement is conducted every year. More typically however, drops are replaced (**ND**) on a 2-4 yr rotating schedule with only spouts (**SR**) replaced during intermediate years. Under that approach, sap yields (and net profits) will drop off during each intervening year in which drops are not replaced, so that average net profits over that time period will fall somewhere between that of **ND** and **SR**. Depending upon the drop replacement frequency, a **ND** rotation of every three years with **SR** in intervening years could be expected to produce a net profit in the range of about $1.60-$1.75/tap.

While any type of chemical sanitization is labor intensive, **BS** is something that maple producers are very comfortable and familiar with and is effective in both producing higher yield and good net profits, as long as it is performed in a way that allows long-contact time. It is important to recognize that after bleach cleaning, rinsing of tubing should be performed OR the first run of sap allowed to run on the ground to prevent contamination and off-flavors in syrup. In addition, sodium-based bleach can attract animals, which may damage tubing systems and create leaks. In our testing of calcium-based bleach sanitizers, we did not encounter any such issues, however we cannot (yet) totally discount it. Further research and producer experience is needed.

During these studies, several other observations were noted:

- Systems without replacement or chemical sanitizer treatment display rapid drop off in yield and result in lower net profits than those that employ some sanitation strategy. This drop off occurs fairly rapidly in the first few years before leveling off over a 4-5 year period to about 50% of the sap yield of a new tubing system.
- Sanitizer-based treatments are probably best applied in the late-fall just before the onset of freezing weather. This allows less time for microbes to recolonize tubing systems. Similarly, new spouts, CVs, or new drops should be deployed to the woods

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only after the return of cold weather for the same reason.

- The older the tubing (especially droplines) the greater the response to any sanitation treatment (replacement or chemical sanitizing).
- Different seasons result in different sanitation-related results. Sanitation approaches in short, cold seasons and short, hot seasons produce modest to highly muted effects. Moderate, long seasons display the best results to good sanitation practices.
- Vacuum pump/releaser systems and management can produce varying results. Leaving the pump running until the tubing system solidly freezes reduces to some degree the negative impacts of poor sanitation. Similarly, using an electric releaser appears to lessen backflow conditions (movement of sap towards the tree) that are common with mechanical releasers. While these management strategies and choices of equipment can lessen sanitation-related issues, they do not totally negate good sanitation as a factor critical in achieving good yields.
- Tighter (higher vacuum) tubing systems show lessened sensitivity to sanitation-related impacts. Conversely, tubing systems prone to

leaks appear to be more susceptible to sanitation issues.

- Sap yield increases due to sanitation treatments consistently tended to be slightly higher at the Cornell Arnot Forest compared to the UVM Proctor Maple Research Center.
- Lateral line sanitation typically has only a minor effect on sap yield, while mainline sanitation has essentially a negligible impact on sap yield.

Summary

Producers should choose what works best in their woods given the advantages and disadvantages of time, labor, and cost in relation to the gains in sap yield in net profit they can expect to experience. The use of **CV** and **BS** (with long-contact time) offer the highest net profits for maple producers with annual net profits estimated to increase by over $2.00/tap compared to no sanitation. While **ND** produces the highest sap yields, the cost of annual replacement is generally prohibitive unless yields are very high (excellent vacuum, large trees). Thus, producers typically replace drops at some interval, typically in a three-year rotation with **SR** each year. This strategy results in somewhat reduced yields, with net profits in the range of $1.60-1.75/tap annually. At minimum, producers should consider annual spout replacement (SR), which achieves an estimated net profit per year of approximately $1.00/tap above the base level of no sanitation. While this approach does not result in the highest sap yields or net profit, it is simple to implement and does provide some amount of benefit, especially when combined with a very tight vacuum system, proper pump management, and an electric releaser.

Acknowledgements

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We appreciate the efforts of the many individuals at the University of Vermont and Cornell University who contributed to this work either directly or indirectly.

The Shifting Sweet Spot of Maple Syrup Production: Climate Change Impacts on Sugar Maple Sap

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Selena Ahmed, Dept. of Health and Human Development, Montana State University
David Lutz, Environmental Studies Program, Dartmouth College
Ryan Huish, Department of Natural Sciences, University of Virginia's College at Wise

How may climate change impact the maple syrup industry? Our team of interdisciplinary researchers, ACERnet (Acer Climate and Socio-Ecological Research Network), has been working to understand the complex answers to this question for the past several years. In particular, we are interested in examining how climate impacts the timing of the maple tapping season as well as both the quality and quantity of sap collected during the tapping season.

As part of our research, ACERnet is carrying out observations and collections following a standardized protocol at six sites distributed across the range of sugar maple (Figure 1; www.blogs.umass.edu/acernet). Initial observations and collections started in 2012 at Harvard Forest in central Massachusetts where research focused on understanding changes in sugar content and quantity of sap, and subsequently expanded to sites in Virginia, New Hampshire, Quebec, and Indiana.

Members of our ACERnet team recently reported on how the timing of the tapping season, the volume of sap collected, and the sugar content of the sap is related to climate in a scientific article published in the journal Forest Ecology and Management (Rapp et al. 2019). As part of this study, we used projections of future climate from the World Climate Research Programme (CMIP5; Taylor et al. 2012) based on the RCP 8.5 climate scenario of the Intergovernmental Panel on Climate Change (IPCC 2014) to make projections of average sap and syrup production over the next several decades.

What we did

We tapped trees over multiple years according to guidelines of the North American Maple Syrup Producers Manual (Heiligmann et al. 2006) at six sites across sugar maple's range. These included sites near the southern limit of where sugar maple grows in southwest Virginia, near the northern limit of sugar maple habitat in Quebec, and in eastern (Massachusetts and New Hampshire) and western (Indiana) parts of sugar maple's distribution. Together, these sites cover most of the range of climate conditions experienced by sugar maple trees in their native range. Our data collection included years with unusually warm (2012, 2016) and unusually cold (2014, 2015) winters. This allowed us to better understand how sap quality and quantity vary with climate conditions.

At each site, we collected sap from between 15 and 25 trees using gravity tapping techniques (buckets or sap bags) on each day where enough sap was running to be collected (usually at least 1 quart of sap per tap). For each

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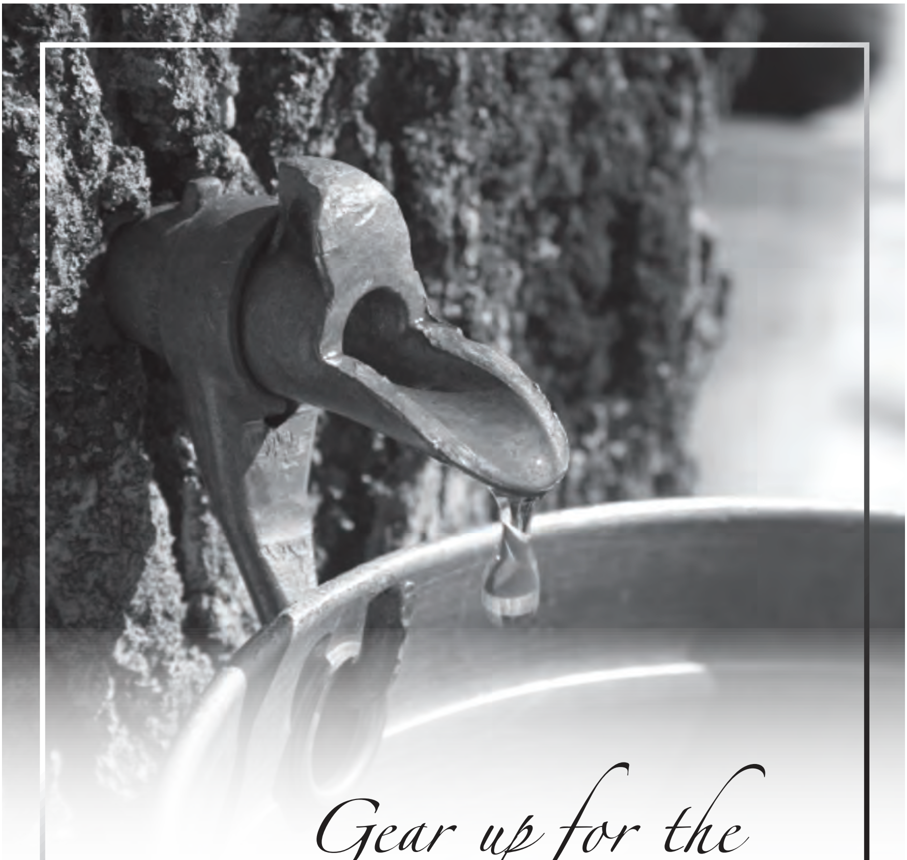

Climate: continued from page 17

sap collection from individual trees, we weighed the amount of sap collected and used a hand-held digital refractometer to measure the sugar content of the sap dripping out of the taps (Figure 2). Sugar content is one key parameter of sap quality. With these daily sap data, we were able to calculate the total amount of sap and the average sugar content of the sap over the entire season. In addition, we were able to determine the day on which half of the sap collected during the season occurred as a measure of the timing of the tapping season. The day when half of the season's sap has been collected is a better measure of the timing of the tapping based on the physiology of trees than the traditional measure of the date of tapping, since the date of tapping can be affected by human-decision making rather than being a true measure of when the sap is flowing.

After collecting data on sap flow and sugar content, we compared these data to temperature and precipitation both during the tapping season as well as the previous growing season. Specifically, we analyzed climate during the tapping season in relation to the timing of sap collection and the amount of sap collected, and we analyzed climate of the previous growing season in relation to sap sugar content. The sugar in sap is a product of photosynthesis, and we hypothesized that the previous growing season climate would influence how much sugar the trees could make and how much would be stored in the wood to be released into the sap the following year. We tested several climate metrics including average temperature and precipitation for each individual month. Ultimately, we found that the average temperature between January and May had the strongest association with both timing of the tapping season and the total amount of sap collected. This January to May period corresponded with our network-wide sap flow season (sap began flowing in Virginia during January and ended in Quebec in May). The average temperature of the previous growing season (May – October) had the strongest association with sap sugar content.

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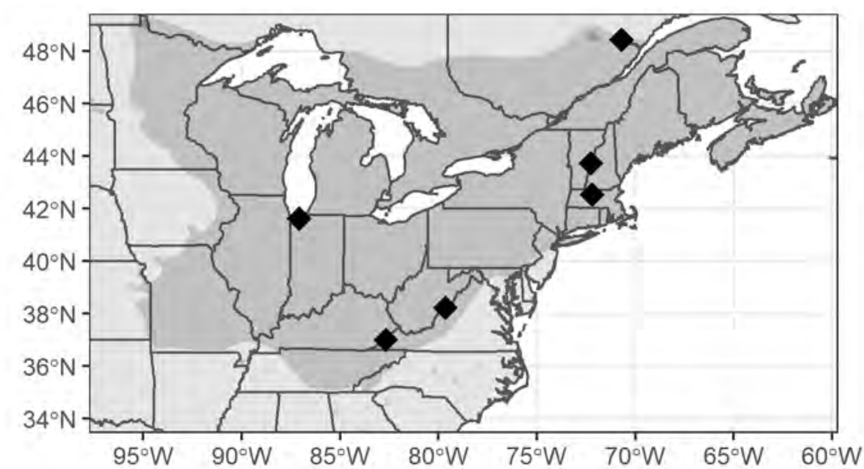

Figure 1. Location of ACERnet sap collection sites. Gray area shows the distribution of sugar maple.

Climate: continued from page 19

After determining the relationships between the sap flow quantity, sugar content, and climate, we then used projections of future climate to project future sap and syrup production at our sites and across sugar maple's range through the end of the century. We used projections from 14 different climate models that have been shown to be reliable for the northeastern United States (Karmalkar et al. 2019). Results of each of these projections were combined to show the average and range of values expected for the timing of the tapping season, the amount of sap collected, the sugar content of sap, and the amount of syrup that could be produced from that sap through the end of the century.

What we found

Our results showed that the timing of the tapping season, amount of sap collected, and sap sugar content were all related to climate (Figure 3). The warmer the tapping season, the earlier the tapping season, with the midpoint of the sap collection season moving about 2 days earlier for every 1 °F warmer the overall season average temperature. The greatest amount of sap was collected when the average temperature of the tapping season was approximately 34 °F (1 °C), with much less sap collected when season average temperatures were higher than 40 °F or lower than 30 °F. Warmer growing season temperatures were further associated with a lower sap sugar content in the following tapping season with a change of 10 °F in growing season resulting in a 0.5 °Brix in sugar content.

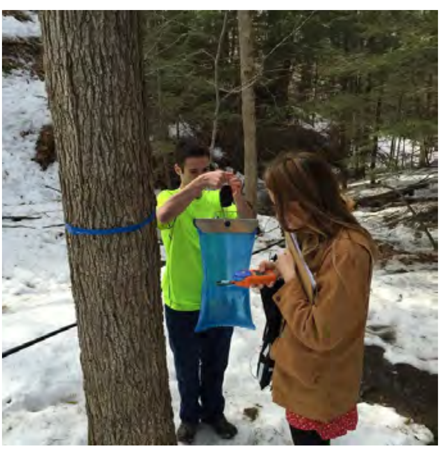

Figure 2. Students at the Dartmouth College Organic Farm measuring sap as it is collected. On the left, Dennis Reilly weighs the sap in a sap bag, while on the right, Emily Grotz measures sap sugar content using a digital refractometer.

The relationships we found from our data analysis imply that over the last half of the 20th century, the sweet spot for maple syrup production was a wide swath across the center of sugar maple's range, covering the Great Lakes, southern Ontario and Quebec, and New England (Figure 4). During most years in this region, the midpoint of the tapping season was in March, sap flow was 40 quarts or more per tap, sap sugar content was greater than 2.2 °Brix (the sugar content required for the traditional 40:1 ratio of sap to syrup), and more than 1 quart of syrup per tap was produced.

Projected changes in climate from general circulation models imply a shift in the optimal area for maple syrup production to the north, and a reduction in overall syrup production on a per tap basis across most of the area that was formerly the most productive region for maple syrup production (Figure 4). Projections for the end of the century include the midpoint of the tapping season occurring before March 1 across most of the U.S. range of sugar maple except for the region near Lake Superior, the Adirondacks, and the northern Appalachians. The tapping season is expected to move earlier in Canada, with a midpoint in March in most areas except southern Ontario and Quebec in the St. Lawrence River valley. This same region is expected to have sap flow greater than 40 quarts per tap in most years, with warmer areas having lower sap yields. Sap sugar content is expected to decrease across the range, with sap sugar contents exceeding 2.2 °Brix projected to occur only in the northernmost part of sugar maple's range. Syrup production per tap is expected to decline in most areas, only increasing and being greater than 1 quart per tap in the far northern edge of where sugar maples grow.

For more detailed analysis and additional maps of projected sap productivity, please see the original open-access scientific article which is freely available at: https://www.sciencedirect.com/science/article/pii/S0378112719303019.

Climate: continued on page 24

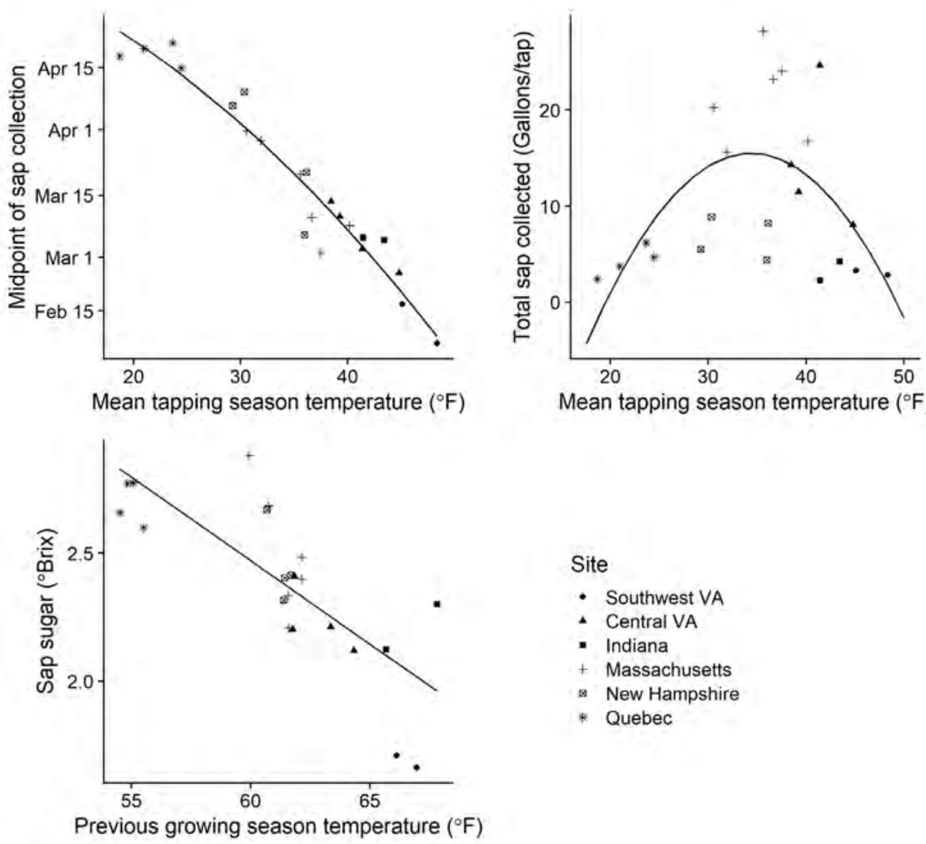

Figure 3. Mean tapping season (January – May) temperature was related to both (a) the day on which 50% of the total sap was collected for the season, and (b) the total amount of sap collected for the season. (c) The previous growing season (May – October) mean temperature was related to sap sugar concentration. Points represent means for each site in each year of sampling, while the lines show the overall modeled trend.

Climate: continued from page 23

What it means

For producers, the effects of climate change on maple production will depend on where one's sugarbushes are located. More southern areas are expected to experience the most detrimental effects of climate change, with the production of maple syrup being near impossible in some years. This is true even now for our Virginia field sites in the southern Appalachians. In areas such as the northern Appalachians, Adirondacks, northern Great

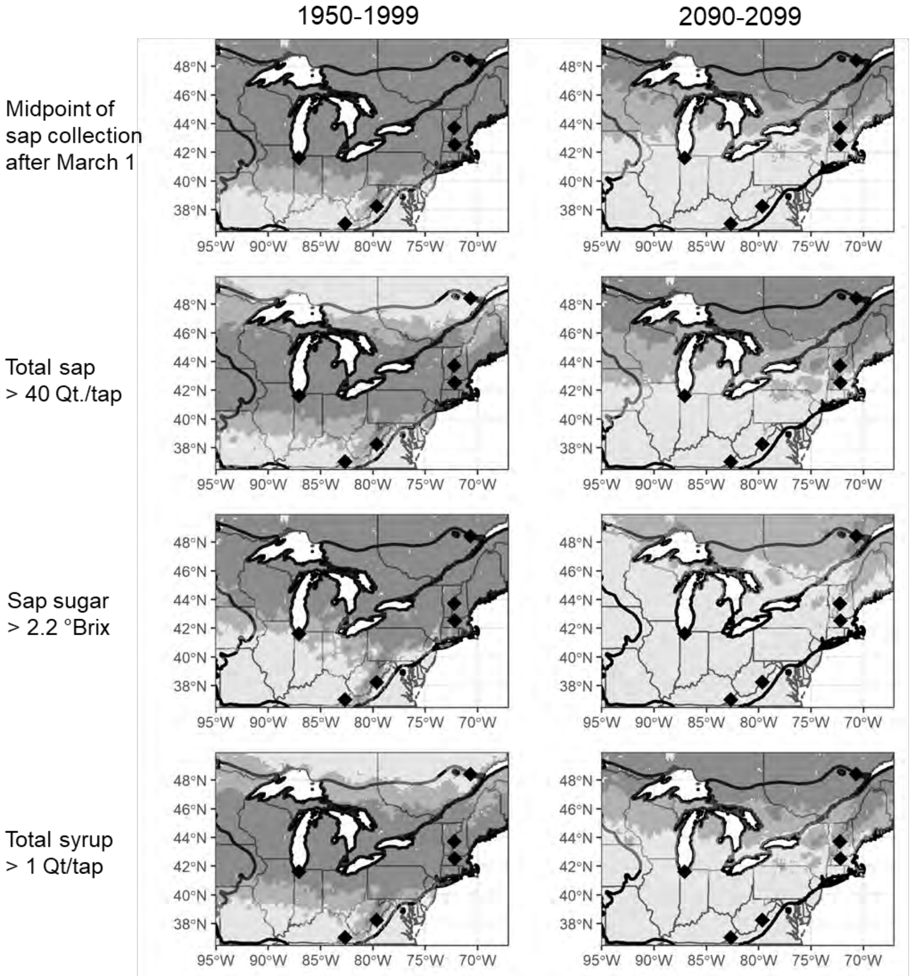

Figure 4. This figure shows the percent of years expected to exceed a threshold in the past (1950–1999) and future (2090 – 2099) based on the relationships between climate and sap flow from ACERnet data, and historical climate data or future climate projections. Thresholds are derived from traditional rules of thumb for maple syrup production: the midpoint of sap collection being during March, the ratio of sap to syrup being 40:1, and a good crop being more than 1 quart of syrup per tap. The thick black line outlines the range of sugar maple.

Lakes, and parts of Quebec, effects are likely to be less severe but still negative. Alternatively, in northern areas of sugar maple's range in Ontario and Quebec, production may even benefit from climate change. However, sap sugar content is expected to decline everywhere, making the traditional ratio of 40 gallons of sap to 1 gallon of syrup a thing of the past. This implies that more energy may be needed to make a gallon of syrup, and an increase in the number of taps will be needed to maintain current levels of production. These new taps will be most productive if they are added in more northerly and higher elevation areas, if sugar maple trees can be found in those locations.

Overall, our findings provide evidence that the maple industry is being impacted by climate change including shifts in tapping season characteristics along with sap quality and quantity. The impacts of these shifts vary depending on geographic location as well as management practices. Optimal management of responding to climate effects on the maple industry calls for greater understanding of the social and ecological dimensions of maple production to strengthen the resilience of sugar bushes and maple producers.

Next Steps

While our findings align with studies that suggest that tree health and abundance, tapping season characteristics, and sap quality and quantity are shifting with climate change (reviewed in Rapp 2016), more research is needed to fully understand all aspects of these factors. Our ongoing research includes measuring the chemistry of sap, including phytochemical compounds that influence the flavor and health attributes of maple syrup. In addition, we have been surveying maple producers to understand perceptions and management practices associated with maple tapping in the context of climate change. The results of these studies will be reported in future publications, and we hope to apply these findings towards identifying practices and programs to strengthen the capacity of maple producers to adapt to climate change.

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Ask Proctor

Timothy Perkins and Abby van den Berg
University of Vermont Proctor Maple Research Center

The *North American Maple Syrup Producers Manual* has been the leading resource for information about maple syrup production for decades. Chapters encompass the range of information about maple, including the history of maple, stand management, sap collection, syrup processing, economics, and much more. The 2nd edition of the manual (Heiligmann, Koelling, and Perkins, Editors) has sold over 12,000 copies since its release in 2006.

After an initial update of the manual begun several years ago was delayed by a lack of resources, the effort is now back on track. The University of Vermont was able to secure grant funding to allow the completion of the 3rd edition of the manual. While this is a substantial update, not all chapters currently require revision. Those that do include those focusing on: history, forest management, sap collection, syrup production, grading, value-added products, and economics. A completely new chapter on food safety is being added. Authors for these chapters were selected representing the breadth of maple research, outreach, and industry professionals. Draft contributions were recently submitted to the editors (Perkins, Heiligmann, Koelling, and van den Berg) for initial review and editing.

The preliminary editing stage will continue from now until mid-winter (December 2019/January 2020), after which maple-industry representatives will be asked to review chapters. Reviewers will review one or more chapters of the new manual and may receive a small honorarium for their efforts. Whether an honorarium is given and the amount depends upon the timeliness, completeness, and number of chapters reviewed, with judgements made solely by the editors. Reviews will be due no later than June 1, 2020. If you have interest in reviewing chapters of the new manual, please contact Winton Pitcoff at winton@massmaple.org for further information.

The editors will incorporate the comments of reviewers, then work with professionals to incorporate figures and tables, finalize the layout, and do a final proofing edit.

It is anticipated that the manual will be released in the summer of 2021 and made freely available as a PDF download. Maple organizations may also choose to bind and sell copies to their members if they wish.

Further questions about the manual may be directed to: Dr. Tim Perkins, UVM Proctor Maple Research Center, Timothy.Perkins@uvm.edu or 802-899-9926.

Remembering Brian Stowe

It is with profound sadness that I offer this remembrance of longtime UVM Proctor Maple Research Center employee Brian W Stowe.

Brian served the University for 29 years beginning in 1991. Brian was mentored by Sumner Hill Williams early in his career and Brian's bond with Sumner was significant and enduring. They worked alongside each other for eight years until Sumner's untimely passing in 1999.

Following that tragic event, Brian drew on both his UVM degree in forest management and lived experiences when he assumed the role of running the production sugarhouse and tending the woods at the UVM Proctor Maple Research Center. Brian shared his knowledge, experience, skill and humor with countless sugar makers and aspiring sugar makers during his 30-year career in maple.

Brian oversaw the expansion of syrup production at UVM and achieved above-average production during this time. Brian understood the importance of careful data collection for quality results and how to communicate research findings in the best way to the particular audience before him. Brian understood that like research, making quality maple syrup requires a lot from the producer and he gave it his all.

Tough jobs in all conditions never fazed Brian. He could always be counted on to give 100% to the task at hand. He helped author articles and presented to many sugaring audiences. Brian continued the great tradition of the campus Sugar-On-Snow party at UVM for over 20 years, giving thousands of students their first taste of pure Vermont maple. Brian also served the Chittenden County Maple Sugar Makers Association for over 20 years in many roles including organizing the VT Maple Technology Expo in 2007, answering questions at the maple education booth and as treasurer.

In 2012 Brian was awarded the UVM College of Agriculture and Life Sciences Excellence in Staff Support Award. This significant achievement was an acknowledgement of all he had given to further the College's (and the Proctor Center's) mission of research, demonstration and education. Brian began a new chapter in his career just before the start of the 2019 sugaring season when he started as sugaring manager at Runamok maple in Cambridge, Vermont. Brian successfully tackled the significant challenge of managing a large maple operation and earned the satisfaction of a job well done.

Brian had a great love of history, both globally significant events as well as those local in the extreme. That respect for history informed Brian's deep sense of duty not only for the work he did for Vermont maple but as a longtime member of the Vermont Air National Guard.

- Mark Isselhardt,
University of Vermont Extension

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2019 Cornell Maple Program Research on 5/16" Maple Tubing

Stephen Childs, New York State Maple Specialist

During the 2019 maple season the Cornell Maple Program conducted replicated trials on 5/16" and 3/16" tubing looking at a variety of tubing options for taphole sanitation and tapping. This report will focus on the 5/16" results.

This year the first sap yield measurements were taken on February 8 and the last on April 10. The treatments used as checks are old spouts and drops where the drop has been used for 7 years and the spout has been in use for 4 years. They have been vacuumed dry at the end of each season when the taps are pulled but receive no other cleaning. The second check for standard comparison is completely new laterals, drops and spouts for a completely new system.

This year the old system yielded 26.9 gallons of sap per tap while the all new system yielded 43.9 gallons of sap per tap representing an increase of 63.1% or 17 more gallons of sap per tap.

A treatment was included in this year's study where the spout and drop were removed from the sugarbush before the season and submersed in a bleach solution of one tablespoon of 5.25% sodium hypochlorite in chlorine bleach per gallon of water for 30 minutes followed by through rinse with potable water. The drops were then reconnected to the lateral line that has been in the sugarbush for a number of years with a quick connect fitting.

This year the bleach-sanitized spouts and drops yielded 41.9 gallons of sap per tap, 55.7% or 15 gallons more sap per tap than the old spout and drop and two gallons of sap less than the all new system.

A fourth system was tested where a new spout and drop were placed on old lateral lines. In this treatment sap yield for the season was 42.4 gallons of sap per tap, 57.6% or 15.5 more gallons of sap than the old spouts and drops, 1.5 gallons of sap per tap less than all new.

The last treatment on 5/16" tubing

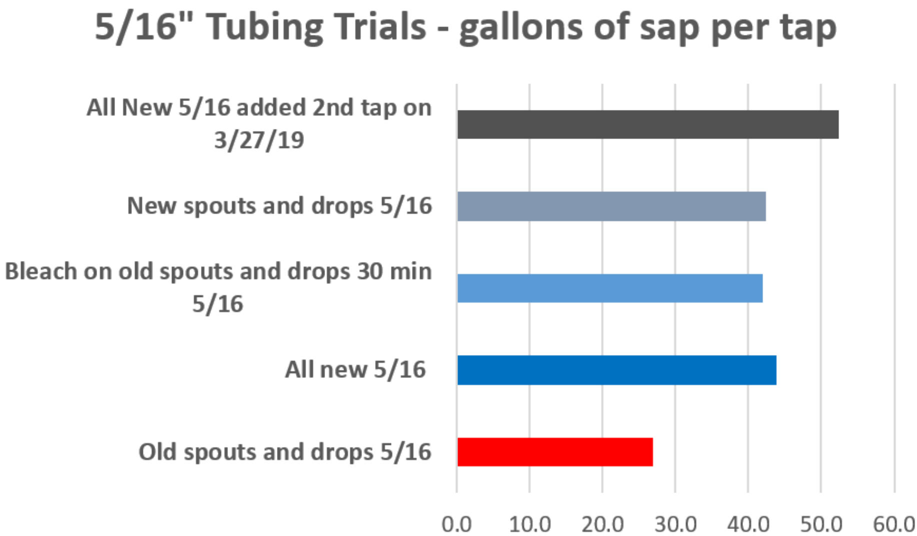
5/16" Tubing continued on page 30

5/16” Tubing: continued from page 29

was a re-tap treatment installed with all new tubing laterals, drops and spouts. A second new spout and short drop and T added into the first drop. It was added in line of the same expected partition zone of the first tap, meaning it is directly above or below the original tap. In this treatment, rather than waiting until the first tap stopped running to conduct the re-tap, it was added after the temperature had gone above 50 degrees F 4 or 5 times. In this case the second tap was added on March 27 (see photo). The reasoning is that by going directly above or below the first tap it would not be adding significantly to the partitioning in the tree so it would not be reducing the future opportunity for tapping into clean white wood in future years.

The re-tap treatment yielded 52.2 gallons of sap per tap, 94.5% or 25.4 more gallons of sap per tap than old spouts and drops and 8.5 more gallons that the all new system treatment.

The 2018 tests where re-tapping was installed after the prior treatment had dried up gave a total sap yield of 49.7 gallons of sap per tap 22.2 before the re-tap and 27.5 after the re-tap, again the taps were designed to fall in the same column but the late season weather was much more friendly to re-tapping than in 2019. More variations on this re-tapping idea will be looked at in future years. Results of the tests using 3/16” tubing will be available soon.


5/16" Tubing Trials - gallons of sap per tap
All New 5/16 added 2nd tap on 3/27/19
New spouts and drops 5/16
Bleach on old spouts and drops 30 min 5/16
All new 5/16
Old spouts and drops 5/16
0.0
10.0
20.0
30.0
40.0
50.0
60.0

How Big are U.S. Maple Producers?

Every five years the USDA measures agricultural production throughout the country. The 2017 USDA Census of Agriculture data was released earlier this year and offers a more complete picture of the maple industry than the annual NASS survey, since it reaches nearly every producer in every state. This table shows how many sugarmakers there are in each state, and for the states with the highest production levels also breaks producers down by size of operation.

		Number of operations with:							
	Total operators	1-99 taps	100-499 taps	500-999 taps	1,000-1,999 taps	2,000-2,999 taps	3,000-4,999 taps	5,000-9,999 taps	10,000+ taps
US TOTAL	**9,492**	**2,755**	**2,948**	**1,256**	**1,021**	**428**	**464**	**334**	**286**
ARKANSAS	3								
CONNECTICUT	199	88	72	15	13	8	1	2	
ILLINOIS	60								
INDIANA	288	123	121	27	10	4	3		
IOWA	53								
KANSAS	1								
KENTUCKY	87								
MAINE	557	184	183	54	40	20	16	5	55
MARYLAND	28								
MASSACHUSETTS	307	93	94	34	34	19	20	10	3
MICHIGAN	875	364	266	108	63	21	24	18	11
MINNESOTA	291	169	91	12	10	3	1	4	1
MISSOURI	37								
NEW HAMPSHIRE	528	89	221	95	63	22	15	14	9
NEW JERSEY	57								
NEW YORK	1,675	385	478	232	222	111	119	92	36
NORTH CAROLINA	8								
NORTH DAKOTA	4								
OHIO	820	265	275	120	103	36	15	6	
PENNSYLVANIA	637	227	130	105	72	25	43	24	11
RHODE ISLAND	22								
SOUTH CAROLINA	1								
SOUTH DAKOTA	3								
TENNESSEE	15								
VERMONT	1,411	73	315	213	260	112	162	129	147
VIRGINIA	29								
WEST VIRGINIA	97								
WISCONSIN	1,399	386	565	211	117	43	41	25	11

Source: https://www.nass.usda.gov/AgCensus/

International Maple Syrup Institute News

The IMSI held three board meetings between 2018/19 maple seasons in Laurierville Quebec, Colchester VT, Lake Placid NY. During these meetings, the IMSI welcomed the participation of U.S. Maple Industry Alliance (MIA) and representatives from the Canadian Food Inspection Agency (CFIA) who presented the new Canadian Food Safety Regulation. If you have questions or want a copy of the CFIA presentation please contact jeanlamontagneimsi@gmail.com.

Maple production was good in 2019. Quebec reports good export levels and stable sales in Canada and export markets. Packers and vendor members report that margins are under continued pressure as the industry grows and competes more aggressively at wholesale and retail sales. Some industry players are consolidating and investing in technology to lower costs and leverage greater economies of scale. Equipment manufacturers reported rising sales in new equipment for expanding production facilities but an overall modest increase in sales. Some industry players are innovating by marketing new varieties and blends that reinforce maple syrup's unique and highly appealing taste as well as new packaging assortment options and more compelling branding. This higher-value and broader-reaching consumer strategy will help distinguish it from other sugary products in the marketplace and command high prices.

An internal commission was established to study how the IMSI can remain highly effective and responsive in serving the North American maple industry. The Commission had the mandate to determine what delivery model would be best and to make recommendations to ensure that the IMSI can continue to represent its members effectively. IMSI members realize that strong maple industry representation is more important than ever. The business environment is changing at a much faster pace and requires timely and competent interventions. Members foresee additional government regulations in areas such as food safety, health, and nutrition. Information technology and social media will continue to accelerate changes in nutritional preferences and lifestyle that influence food consumption behaviors. Climate and environmental changes will influence food production and food choices in the future and will spur environmental regulations that are likely to affect the industry. Finally, a more complex global trade network is also at play with implications for our export business and the protection and integrity our products in-market and abroad. These factors can pose threats to our industry but also present opportunities to shape our regulatory and competitive environment and gain competitive advantages with the help of a strong and proactive industry association.

Dave Chapeskie provided the IMSI with 10 years of outstanding service. Dave will continue to be involved as an active member but he chose to leave the IMSI Executive Director position to concentrate on his agroforestry and maple advisory service. Dave provided leadership and expertise and piloted many critical files such as the new grading system, the maple industry's successful response to proposition 65 and the successful conclusion of the FDA added sugar issues. We wish Dave success and we are grateful for his contribution to the industry.

This year IMSI members discussed efforts to continue to position maple syrup as more than just sugar through marketing and within the boundaries of the regulatory environment. The end goal is for maple syrup to become distinct in the sugary products category by promoting the attributes and benefits that make maple products healthier, having a unique and highly appealing taste profile and being pure and natural, much as the olive oil industry did to achieve its status as a superior ingredient.

IMSI: continued on page 36

IMSI: continued from page 35

IMSI members view maple syrup's generally larger serving size (compared to other sweeteners) as a competitive disadvantage. They discussed reducing maple syrup's reference amount (serving size) to compare more favorably with alternative and substitute sweeteners. They also discussed harmonizing the serving size between Canada, at 60ml and the United States at 30 ml.

A smaller serving size may be an advantage because daily value sugar percentage and stated grams are the most obvious nutritional reference for consumers who discriminate about the sources of sugar in their diet. Like honey, maple syrup usage is increasingly used as an ingredient in tea, coffee and other beverages, baking, salad dressings and sauces, and so is used in small quantities. However, decreasing the serving size will reduce the daily values for some vitamins and minerals and preclude the use of certain claims in Canada. There will be more discussion on this subject at the next IMSI meeting.

International Maple Syrup Institute • Institut International du Sirop d'Érable •

Virginia Tree Sap and Syrup Workshops

Presented through "The Expanding Livelihood Options for Virginia Land Owners Through Tree Sap Production Program" Sponsored by the USDA Specialty Crop Block Grant Program through the Virginia Department of Agriculture and Consumer Services (VDACs) and in collaboration with Future Generations

For more information on these and other programs please contact: Tom Hammett at Virginia Tech (email: himal@vt.edu) or VaMapleNetwork@gmail.com

September 14, 2019 - Forest Management for increased syrup/sugar water production

The day-long program will include sessions on: maple syrup production; a silviculture expert explaining benefits of a properly managed maple stand to increase yields; results from two years of data collection on thinned vs unthinned forests; and maple syrup grading – led by certified grading expert. During lunch there will be a dessert contest. Workshop participants should each bring their favorite dessert made with maple syrup. Prizes will be awarded from CDL Maple, H2O Innovations, and Leader Evaporator. The workshop will be held at the Laurel Fork Sapsuckers Sugar Camp, 10677 Mountain Turnpike, Hightown, VA 24465. A fee of $20 per person covers lunch and other expenses. This workshop is co-sponsored by the ACER Access Grant. For more information, please contact Missy Moyers-Jarrells by phone: 540-290-1676 or by email: Laurelforksapsuckers@yahoo.com

November 16 and 17, 2019 - Tree sap and Syrup Production Workshop

The Virginia Tech Catawba Sustainability Center will host a field-based workshop focused on the needs of new and existing tree sap and syrup producers. Sessions will include tapping Black Walnut, hands-on workshop establishing tubing systems on a nearby maple stand, tour of local maple syrup operation, and working session on evaporator operation. A special session on marketing through farmers markets and other outlets will also be included. Please contact Adam Taylor, Manager, Virginia Tech Catawba Sustainability Center, 5075 Catawba Creek Rd., Catawba, VA 24070 Phone: (540) 588-0283 Email: adamht@vt.edu

November 22 and 23, 2019 - The Southwest Virginia Tree Syrup School

We will begin at 3 PM Friday Nov. 22 with a tour of South Fork Farm near Pound, VA (maple syrup and molasses producer), followed by a pancake supper. On Saturday Nov. 23 from 9am to 5pm the workshop will be held at Oxbow Center, St. Paul, Virginia. There will be educational sessions for both beginning and experienced maple producers, including sessions on backyard tapping and syrup making, business expansion and sugar house requirements. There is a possibility of holding special session to discuss maple syrup beverages. CEUs for the Society of American Foresters' Certified Forester program will be available. For more information, please contact Phil Meeks, Extension Agent, Agriculture & Natural Resources, Virginia Cooperative Extension, P. O. Box 1156, Wise, Virginia 24293 Phone: (276) 328-6194 Email: pmeeks@vt.edu

MAPLE RESEARCH.ORG

NORTH AMERICAN MAPLE SYRUP COUNCIL

NAMSC has launched mapleresearch.org, a new online resource for the maple industry. The site is a curated collection of research papers, articles, videos, and tools, representing the most current and scientifically accurate information for maple production, to help all producers make the best products possible using the most current and most sustainable practices.

From *Maple Syrup Digest* articles, to producers' manuals, to how-to videos, the site includes a collection of the best resources available online about all aspects of maple syrup production, at no cost. The site is searchable, and resources can be downloaded and printed.

The site was built in collaboration with the University of Vermont's Proctor Maple Research Center, and funding was provided by the U.S. Department of Agriculture's (USDA) Agricultural Marketing Service.

New York Calendar of Upcoming Schools and Workshops

November 8-9: Lake Erie Maple Expo, Albion PA

December 7: Western NY Maple School, Attica NY. Contact: Deb Welch, Cornell Cooperative Extension of Wyoming County, 401 North Main Street, Warsaw NY 14569; 585-786-2251; djw275@cornell.edu

December 10: Onondaga County Maple School, Contact: Kristina A. Ferrare, Forestry Program Specialist, Cornell Cooperative Extension Onondaga County, The Atrium, Suite 170, 100 South Salina Street, Syracuse, NY 13202, (315) 424-9485 ext. 231, kaf226@cornell.edu

January 3-4: New York State Maple Conference, NYS Fair Grounds, Syracuse NY. Contact: cornellmaple.com

January 11: St. Lawrence County Maple Expo.

January 17: Lewis County Maple Production for the Beginner, Contact: Michele Ledoux, Cornell Cooperative Extension Lewis County, 5274 Outer Stowe Street, P.O. Box 72, Lowville, New York 13367; 315-376-5270; mel14@cornell.edu

January 18: Lewis County Maple School, Contact: Michele Ledoux, Cornell Cooperative Extension Lewis County, 5274 Outer Stowe Street, P.O. Box 72, Lowville, New York 13367; 315-376-5270; mel14@cornell.edu

Thank you to our Research Alliance Partners

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For Sale: Justamere Tree Farm; solar-powered & wood-fired maple farm in Worthington MA. 52-acres including 2,000-sq ft home, 5,100 maple taps,1,000-sq ft commercial kitchen, 3'x12' wood-fired evaporator with steam hood & preheater, 15KW solar system, additional buildings & quality equipment. Contact Marian & J.P. Welch at info@justameretreefarm.com

Please Consider Including NAMSC in Your Estate Plan

The North American Maple Syrup Council has received a number of generous bequests from sugarmakers who wanted to ensure that the important work of our organization can carry on. Those funds helps us promote the maple industry and support our members. Planned giving like this is a way for you to show your support for the maple syrup industry for many years to come. It's a simple process.

Contact your attorney for information on how to revise your will, or your financial institution, plan administrator, or life insurance agent for the procedures required to revise your beneficiary designations.

The information needed for your legal documents is: North American Maple Syrup Council, PO Box 581, Simsbury, CT 06070.

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