



## Northern New York Agricultural Development Program 2023-2024 Final Project Report

### Shrinking Maple Tap Hole Size to Increase Tree Health

#### Project Leader:

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#### Background:

Maple producers in Northern New York experience unique challenges. Despite these challenges, the six counties of Northern New York produced more than a third (36%) of the total maple syrup production across New York State with 40% of the state's maple taps (U.S. Census of Agriculture, 2024). There has been growth of 185% in maple production in Northern New York since 2000. This growth is seen both in current producers increasing the size of their production and new producers joining the industry. With this increase in operations and new producers, it is important to provide producers with research-based decision-making tools and education that allow them to maximize yield, maintain the long-term sustainability and health of their trees, and ensure producers are providing the highest quality product for the marketplace.

Among the specific challenges to maple producers in Northern NY are the region's short growing seasons and that the regional forests often have soils with low pH and low available nutrients given the native bedrock. Because of these factors, the growth rate of a maple tree in the NNY region is slower than in other areas of the maple sugaring region.

Maple sap is collected from tap holes drilled into the conductive wood of a tree. Once a tap hole is created, trees partition off the wounded area (tap hole area) and create non-conductive wood that acts as a defense to prohibit pathogens from spreading throughout the tree. Trees that maintain adequate growth rates can produce enough new conductive wood to keep up with tapping of maple trees. Trees with slow growth rates are not able to produce enough new wood to keep up with the rate of tapping. This inability to produce sufficient new wood could have long-term impacts on tree health, and impacts maple sap yield by increasing the chance of tapping into non-conductive wood that does not provide sap. By switching to a smaller diameter tap hole, less non-conductive wood is formed and the smaller size taphole reduces the chance of hitting non-conductive wood with future tapping

Smaller diameter spouts are produced by maple equipment companies and often marketed as providing the same yield as traditional size tap holes. Producers have questioned the validity of this claim. A couple

of small studies conducted outside of NY have shown smaller tap holes to yield slightly less than traditional tap holes (Lagacé et al. 2015, Perkins & van den Berg 2019). However, this practice had not been tested in Northern New York. This project funded by the Northern New York Agricultural Development Program has begun the evaluation of the use of smaller diameter spouts for their impact on sap production and tree health under NNY climate and growing conditions. This research addressed the question of whether the suggested slight drop in yield could be outweighed by better production across all trees due to less likelihood to tap into non-conductive wood and the potential to improve the long-term sustainability of the trees in a NNY sugarbush.

Additionally, as climate conditions become more variable, maple producers face the challenge of handling sap during warmer weather and the need to ensure syrup quality. This is true for any maple producer but maintaining quality is especially difficult for new producers. New producers most often struggle with cooking syrup to the correct density which has a direct connection to the syrup quality. The most common reason for this issue is a lack of education. By educating maple producers on research-driven techniques, syrup quality will increase. By providing research results and education to maple producers, Northern New York can continue to thrive and grow as a leader in the maple industry.

### **Project Scope & Methods:**

This “Shrinking Tap Hole Size to Increase Tree Health” project has two components: 1) research on the yield impact of tapping trees with smaller diameter tap holes, and 2) an educational campaign to bring awareness and increase a producers’ capacity to improve maple syrup quality in Northern New York.

### **Shrinking the Tap Hole Diameter**

Primary research for this project took place at the Cornell University Uihlein Maple Research Forest in Lake Placid, NY. The sugarbush at the Uihlein Maple Research Forest reaches 2,300 feet in elevation and Lake Placid is notorious for being a cold region with short growing seasons. Being able to tap with a smaller diameter tap hole and still maintain high yields would be ideal for areas with slow-growing trees. To compare smaller tap holes, we tested sap yield performance from the industry standard 5/16” diameter spout against the smaller 1/4”, and 9/40” (0.225) diameter spouts. In addition, we also tested a newly released short barrel barbed spout claimed to increase production by at least 10%. The barbed spout is 5/16” in diameter but has barbs around the outside of the spout that allow it to hold into the tree without needing to be tapped in as far. The theory is that not being tapped into the tree as far will not block as much wood and thus increase yield. Research on this new spout is minimal.

A small set of trees was tapped in 2022 with three replicates. The majority of the research with different size tap holes or type of spout was performed on trees tapped during the 2023 maple season. The 5/16” spouts, considered the control, 1/4” diameter and 0.225” diameter tap holes were replicated 6 times, while trials with barbed spouts were replicated five times in 2023. Each replicate consisted of a lateral line with either four or five trees along the lateral line flowing into a sap collection canister. Canisters from previous NNYADP grant projects were utilized for this project to minimize equipment costs. For the spouts that had a sixth replicate, a one-inch mainline flowed into a larger canister. The mainline had lateral lines collecting from 14 to 20 trees. Sap volume was collected from each sap canister during individual sap run events.

Tap holes were drilled 2 inches into the tree. Trees were selected for being uniform in size and health across the replicates. Sap production was averaged per tap from each replicate to get a production volume per tap. Total sap production was averaged from each replicate to get one average production value for each tap hole size and spout type. As the industry standard, 5/16” diameter smooth barrel spouts (control) were normalized to represent 100% of production. All other tap hole diameter spouts or barbed spouts were normalized as percentage increases or decreases in comparison to the control.

The 2022 maple season was above average for production at the Uihlein Maple Research Forest. However, the 2023 maple sap season in Lake Placid was below production with a cold, snowy March that kept sap from flowing followed by a couple of weeks of good sap flow in early April. A quick heat wave with summer-like temperature put an abrupt end to the season. Sap data for this project was collected between April 4 and April 14, representing most of the sap flow in Lake Placid during the 2023 season.



**Figure 1: Three different diameter size spouts were tested for yield comparison during the Northern New York Agricultural Development Program-funded “Shrinking Maple Tap Hole Size to Increase Tree Health” research project. In photo at top right: industry standard spout 5/16” spout, two smaller options; center, 1/4” diameter spout and, left, even smaller 9/40” (0.225”) diameter spout. A new 5/16” diameter barbed spout (Figure 4) was also tested.**

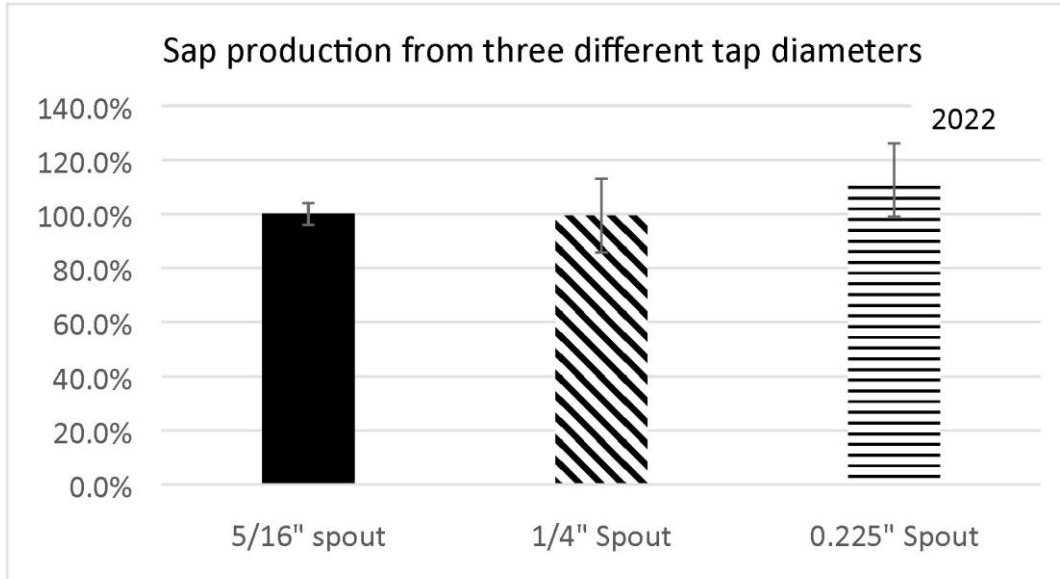
### **Improving Maple Syrup Quality Across Northern New York:**

To improve maple syrup quality, workshops were held across Northern NY to educate maple producers on techniques for finishing and grading maple syrup to ensure premium maple syrup production. With the NNYADP funding support, we were able to bring to Northern New York the International Maple Syrup Grading School and Quality Control workshop internationally recognized as the industry standard to educate maple producers on ways to improve the quality of their maple syrup. The workshop is supported by the International Maple Syrup Institute and the North American Maple Syrup Council, international maple syrup organizations that support and promote the maple industry. The workshop is split into different components educating producers on density, color, flavor, clarity, regulations and safety, and detecting off flavors. During the one-day workshop, six different exercises accompany the lectures and provide producers the opportunity to have hands-on experience with maple grading tools and to become able to identify the correct flavor of maple syrup and detect off flavors. This workshop typically costs each participant \$100 which is used to procure all the materials and supplies and producers get their own take-home set of grading tools along with handouts and useful reference cards. Thanks to the NNYADP funding we were able to offset the majority of the costs for producers to create an affordable and accessible educational opportunity for all producers. Producers were charged only \$20 to cover the cost of lunch and refreshments.

### **Results:**

#### **Shrinking the Tap Hole Diameter**

An initial small sampling in 2022 (without barbed spouts) showed that the three different tap hole diameters did not yield significant difference when standard deviation was taken into consideration. The smallest, 0.225-inch diameter, spouts in 2022 had 12% more sap than the 5/16” or 1/4” diameter tap holes, although this is not considered to be significant (Figure 2). A potential reason for the smaller spouts yielding higher production is that the smaller surface area of the spout creates less chance of the tap holes having micro vacuum leaks that would have impacted production. Not enough trees were tapped in 2022 to come to a conclusive result though.



**Figure 2: Sap yields from three different tap hole diameters at the Uihlein Maple Research Forest, 2022. Smaller tap holes produced the same amount of sap as the industry standard 5/16” diameter tap hole. There was no significant difference between the different tap holes. Sample size in 2022 was too small to draw a conclusion.**

Based on data from the 2023 trials with more robust replication, there was not a significant difference in sap yields from the smaller tap holes in comparison to the 5/16” diameter tap holes (Figure 3).

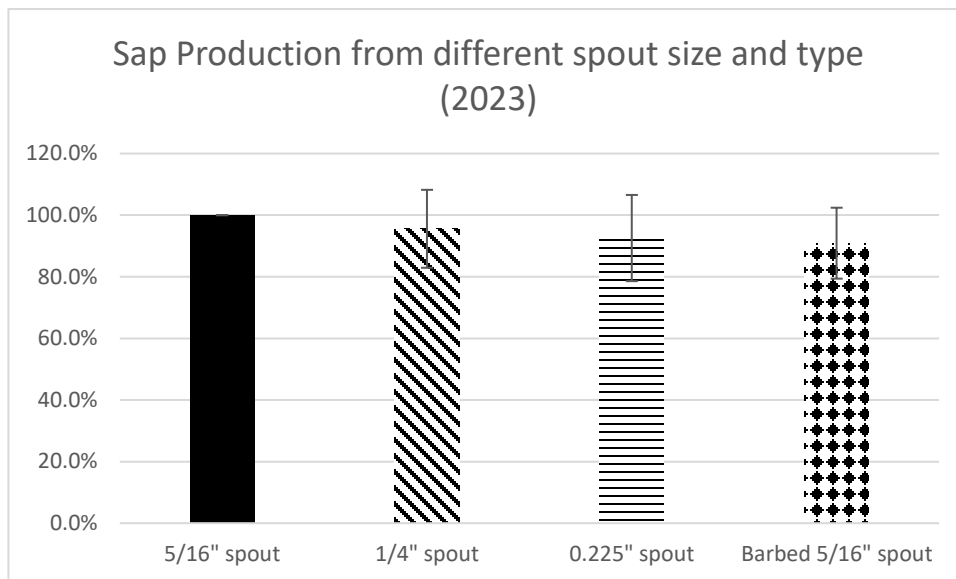
In 2023 the two smaller diameter spouts had less production on average (7.5% less for 0.225 inch and 4.5% less for 1/4 inch diameter) than 5/16 inch-diameter spouts although this was not a significant difference. Considering the error bars which represent the variation between replicates, the variation overlaps between the different tap holes. With an overlap in the production numbers the results are not significantly different to conclude that the smaller diameters produce less sap than the 5/16” diameter tap holes.

Use of the barbed spouts yielded less sap than the traditional smooth barrel spout (9%); however; this was not a significant difference.

It is important to note that the 2023 maple season in Lake Placid was a short season and the data only reflect a couple weeks of production, but it does represent the bulk of production for that season.

After two seasons of trials there was not a significant change in production with the smaller diameter tapholes.

More years of data collection are needed to draw a definite conclusion, but, based on the results to date, smaller tap holes that create smaller wounding in a tree are able to produce similar yields as the industry standard 5/16” diameter spout in NNY. These results suggest a benefit for maple producers in Northern NY switching to the smaller tap holes that do not wound the tree as much and create a better chance for tapping into healthy wood in the future. More research will be helpful in furthering understanding of this potential.



**Figure 3: Sap production volume from three different tap hole diameters and the new barbed spouts during the 2023 maple season at the Cornell University Uihlein Maple Research Forest in Lake Placid, NY. Tap holes 5/16" in diameter were considered 100% of production with smaller tapholes showing a percentage change above or below 5/16" diameter tap holes. These error bars reflect standard deviation that shows the range of variation across the multiple replications. By comparing the error bars and not the average production, there is too much variation to draw significant conclusions. There was not a significant change in production with smaller diameter tap holes or from the barbed spouts.**

### Barbed Spouts

From one year of data on the use of the new barbed spouts, it may be best to hold off on using the barbed spouts at this time until more research has been performed. Although previous studies have shown around a 10% increase in production (Perkins & Bosley 2022), our study found an almost 10% drop in production with the barbed spout. This was unexpected and could be the result of the short maple season.

Different results are expected from testing in future maple seasons. However, even if the use of the barbed spouts shows a 10% increase in yield, we are still reluctant to recommend the spouts due to the damage that could be caused when pulling the spouts. The barbs on the spout hold the spout into the tree well, but when the spouts are pulled they remove part of the bark from the tree (Figure 4). The inner layer of bark contains the phloem that is important for transporting sugars throughout the tree during the growing season. Also, between the phloem and xylem is a thin cambium layer responsible for new growth on the tree. It is currently unknown if damaging the bark in this way harms the long-term health and growth of the tree. These spouts could have the opposite result of using a smaller diameter tap hole.



**Figure 4: Barbed spouts pulled from the tree often remove bark with it. Due to the potential damage caused when the barbed spouts are removed, it may be best to avoid them till further research looks at the potential damage to the tree. Photo: Adam Wild**

### **Improving Maple Syrup Quality Across Northern New York:**

Three different Maple Syrup Quality workshops were held in different regions of Northern New York reaching a total of 64 different maple producers. Participants ranged in size from smaller hobby producers tapping less than 100 trees up to producers tapping 150,000 trees. It is estimated that the total number of trees tapped by all the producers in attendance is over a half a million trees. At a production rate of 0.3 gallons of syrup per tap, that totals 150,000 gallons of syrup made from producers who have been educated in ways to better the quality of their syrup. The workshop locations were designed to be in different regions of Northern NY. The first workshop was held in Lowville (Lewis County) NY. The second maple quality workshop was held in West Chazy (Clinton County), one of the largest maple producing region in NY. A third workshop was held as part of the Cornell Maple Camp in Lake Placid (Essex County) and targeted beginning producers which typically need techniques for improving maple syrup quality the most.

Post-workshop surveys showed that all the participants found the lectures and hands-on exercises to be either “effective” or “extremely effective”. Participants rated their ability to use grading and quality control techniques *before* and *after* the workshop, with 95% of the respondents reporting an increase in their confidence level. Only two participants indicated they did not gain any confidence, but they rated themselves as already confident. All the rest of the participants gained confidence in their own ability to use the skills and techniques to produce quality maple syrup, with 67% reporting an increase in their confidence level by two steps or more.

An additional workshop on the basics of producing quality maple syrup for beginner maple producers was held in late February 2024.

### **Conclusions:**

Only two seasons of data is not fully conclusive as to whether smaller diameter tap holes provide similar yields to the current industry standard of 5/16 inches. Although after two years of data collection at the Cornell University Uihlein Maple Research Forest there does not appear to be a significant change in production which can be beneficial for maple producers in Northern NY. Even if smaller diameter tap holes produce slightly less sap, the slight drop in production could potentially outweigh the benefit in areas where trees are slower growing and decreasing wound potential would be more beneficial for the long-term sustainability of the trees. However, more research is needed to better understand non-conductive wood formation with smaller diameter tap holes. An advantage to smaller diameter tap holes is less surface area which could reduce micro vacuum leaks in high vacuum systems.

The trial with barbed spouts did not improve yield and removed bark on 50% or more of the trees when pulled at the end of the season. Due to this potential damage, it may be best to avoid using the barbed spouts till further research on their impacts to tree health is performed.

Our next steps will include measuring sap production volume on the different tap hole diameters and barb spouts during the 2024 maple season.

### **Education and Outreach:**

Results from this research have been published in the three main publications that reach maple producers in Northern NY: the Maple Digest, Maple News, and The Pipeline of the New York Maple Producers Association. Results were shared in person with producers and industry stakeholders at a meeting for NNYAD project updates. Project results were shared outside of the NNY region with the Upper Hudson Maple Producers Association in Greenwich, NY. Preliminary results were shared during an episode of the podcast Sweet Talk, All Things Maple. The Northern New York Agriculture Development Program was identified as the funding source during each presentation, podcast, and publication, at each maple quality workshop and in workshop outreach.

### **For More Information:**

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