Northern NY Agricultural Development Program
2015-2016 Project Report

Evaluating 3/16" Maple Sap Tubing Sytems Under Natural-Flow And Artificial Vacuum Systems in NNY

Project Leader:

- Michael Farrell, Director, Uihlein Research Forest, 157 Bear Cub Lane, Lake Placid, NY 12946, mlf36@cornell.edu, 518-523-9337

Collaborator(s):

- Michele Ledoux, Cornell Cooperative Extension Lewis County
- Sara Bull, Cornell Cooperative Extension Clinton County
- Richard Gast, Cornell Cooperative Extension Franklin County
- Charlie Hitchman, Cornell Cooperative Extension St. Lawrence County

Cooperating Producers:

- Dr. Sam Yancey, Croghan, NY, Lewis County
- Chateauguay High School FFA, Chateaugay, NY, Franklin County
- Paul Smith's College, Paul Smith's, NY, Franklin County
- Mike Kenny, Sweeter Creations Sugarhouse, Madrid, NY, St. Lawrence County

Background:

Maple syrup production is an important component of the rural economy in Northern NY, providing hundreds of jobs and millions of dollars in revenue each year. The maple industry has been estimated to have a value of $10 million annually with the potential to grow into $20 million annually.

Although some maple producers still use buckets for collecting sap, the vast majority of commercial operations rely on tubing systems to collect sap from trees in a more economical and efficient manner. Furthermore, producers who add a vacuum pump to the system are able to gather 2-3 times the amount of sap from a tree as compared to traditional gravity based systems.

Research has shown that each additional inch of vacuum (on a scale of 0-29" Hg) results in an average increase of 5-7% more sap. Thus, achieving vacuum levels of 20" Hg would result in 100-140% more sap than if no vacuum was applied to the tree.

While it is possible to achieve some natural vacuum in a standard 5/16" tubing line without an artificial vacuum pump, gravity-based systems using 5/16" tubing usually perform poorly and not much better (sometimes significantly worse) than traditional buckets. If there are not any leaks in a tubing line to the taphole, natural vacuum can be created in a tubing system when the weight of sap in tubing pulls on a taphole. Whereas natural vacuum is very difficult to achieve with 5/16" tubing systems, newly developed 3/16" interior diameter tubing systems allows for much greater and easier natural vacuum development since a foot of 3/16" diameter tubing only holds 36% as much sap as a foot of 5/16" diameter tubing. Thus, the 3/16" tubing is able to fill much more rapidly with much better adhesion of sap to itself and the tubing walls within the smaller diameter tube. Initial trials at the University of Vermont, Cornell University, and other locations have proven the effectiveness of 3/16" tubing systems when properly installed and maintained on the proper site (especially when compared to 5/16" gravity tubing systems).

Despite the benefits of natural vacuum in 3/16" tubing lines, there remains significant skepticism among maple producers who have already invested in artificial vacuum pumps and 5/16" tubing. Some producers are concerned that the smaller diameter tubing is more likely to plug up with bacteria slugs, woodchips from tapholes, or other debris. Others worry what will happen when there isn't naturally occurring sap flow to get the tubing lines filled to induce natural vacuum to take over (artificial pumps can often create sap flow when it wouldn't otherwise occur).

While installing 3/16" may be a good investment that could greatly increase yields, many producers are waiting to adopt this new technology until more research and experience have proven its effectiveness. Many questions and uncertainty also remains about how to install 3/16" tubing systems under natural gravity and in a hybrid vacuum-assisted setup

Although most of the research on 3/16" tubing systems has been done under gravity-based systems without a vacuum pump, there are opportunities to combine the benefits of utilizing artificial vacuum pumps to achieve some vacuum at the taphole along with 3/16" tubing to enhance the vacuum levels within the tubing system, especially for trees further up the lateral line. If we are able to demonstrate the effectiveness of this hybrid system, it could result in many maple producers throughout Northern NY adopting the newer technologies to boost yields and profits in both the short and long term.

Methods:

Our research was designed to answer two main questions:

(1) what is the benefit of adding a 3/16" dropline to an existing 5/16" tubing system, and

(2) within a tubing system aided by an artificial vacuum pump, will 3/16" or 5/16" tubing yield more sap per taphole.

The main sites for our research were Uihlein Forest, Cornell University's Maple Research & Extension Field Station in Lake Placid, NY and Paul Smith's College in Paul Smith's, NY. We also had research collaborators in Lewis, Clinton, and St. Lawrence counties who provided demonstration sites for 3/16" tubing under natural vacuum.

Research Question #1: What is the benefit of adding a 3/16" dropline to an existing 5/16" tubing system?

At Paul Smith's College in Franklin County, we installed new 3/16" droplines of varying heights within their existing 5/16" tubing system. Vacuum gauges were placed at the height of the spout for both the 3/16" dropline and 5/16" tubing. Vacuum measurements were recorded on a periodic basis when the sap was flowing.

Research Question #2: Within a tubing system aided by an artificial vacuum pump, will 3/16" or 5/16" tubing yield more sap per taphole?

This research took place at the Uihlein Forest. We installed 12 cannisters that were strategically placed within the sugarbush to collect sap under vacuum and measure it before release into the mainline system. Six cannisters had 3/16" tubing with 20-30 taps per line entering the tank and six had 5/16" tubing with a total tap count of 20-30 taps spread out over multiple lateral lines. All of the tubing and taps were brand new in order to eliminate the differences that may occur from comparing an old tubing system to a new one and all of the treatments used the same type of 5/16" spout. Every day the sap was flowing, we measured the total sap volume from each container as well as vacuum level at the tank and at the last taphole on the lateral line(s) connected to the tank to determine if there was a difference in vacuum at the taphole using 3/16" or 5/16" tubing.

Results:

Table 1 shows vacuum levels at the top of a 3/16" dropline and a 5/16" dropline at the same height within a vacuum tubing system at Paul Smith's College. The first column is the date the readings were taken, the second column is the reading at the vacuum pump, and the 3rd and 4th columns show the vacuum reading within the 5/16" tubing system and at the top of the 3/16" droplines, respectively, with readings taken next to each other.

Table 1. Simulatenous vacuum levels at the pump, at the 5/16” lateral line, and the 3/16” dropline, Paul Smith’s College sugarbush, maple sap tubing systems evaluation, 2016.

date	at pump	at lateral	3/16" dropline
15-Mar	20.5	19.5	24
19-Mar	20.5	19.5	24
23-Mar	20.5	19.5	24
27-Mar	20.5	19	24
31-Mar	17.5	17	21
4-Apr	17.5	16.5	21.5
8-Apr	17.5	17	21
11-Apr	20	19.5	24
15-Apr	18	16.5	20.5

Figure 1. Maple tree with a 3/16” dropline and 5/16” dropline used to measure the difference achieved in vacuum from using 3/16” tubing, Paul Smith’s College sugarbush, maple sap tubing systems evaluation, 2016.

Table 2. Running total of the gallons of sap per taphole for 12 cannisters utilized in 3/16" vs 5/16" tubing under vacuum trials, Uihlein Forest, maple sap tubing systems evaluation, 2016.

cannister	tubing	#taps
a3	5/16	28
a3c	3/16	17
b7b	5/16	25
b7c	3/16	26
c11a	5/16	18
c2	5/16	22
c3	5/16	33
c4	3/16	17
c4a	3/16	23
c4c	3/16	19
c7	3/16	23
c9	5/16	23

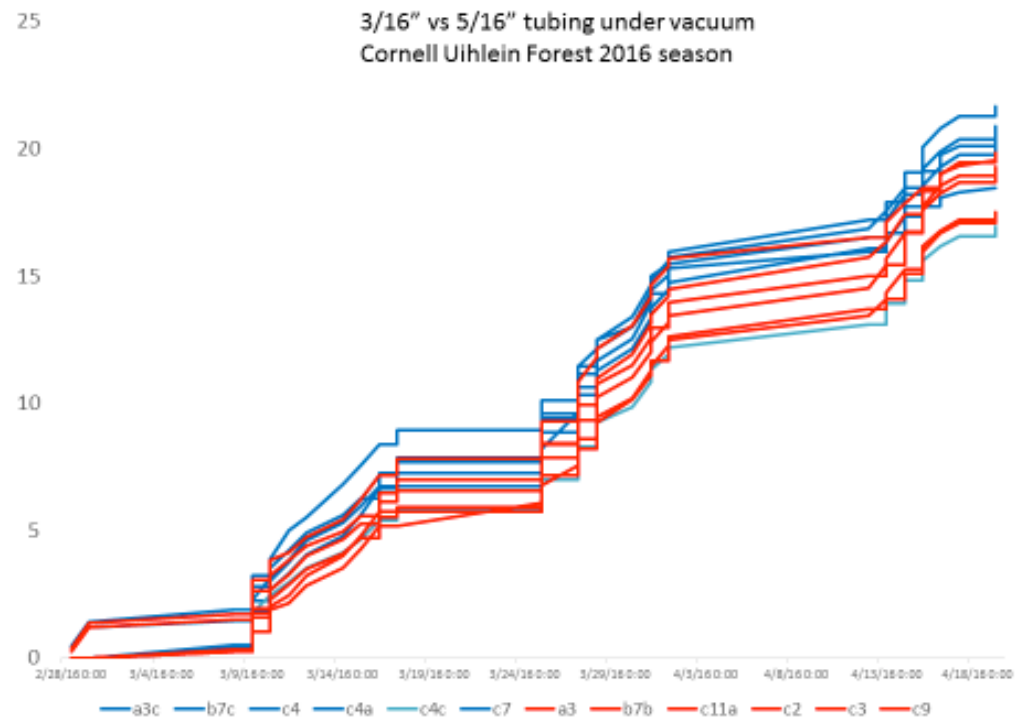

Figure 3. Running total of the gallons of sap per taphole for 12 cannisters utilized in 3/16" vs 5/16" tubing under vacuum trials, Uihlein Forest, maple sap tubing systems evaluation, 2016.

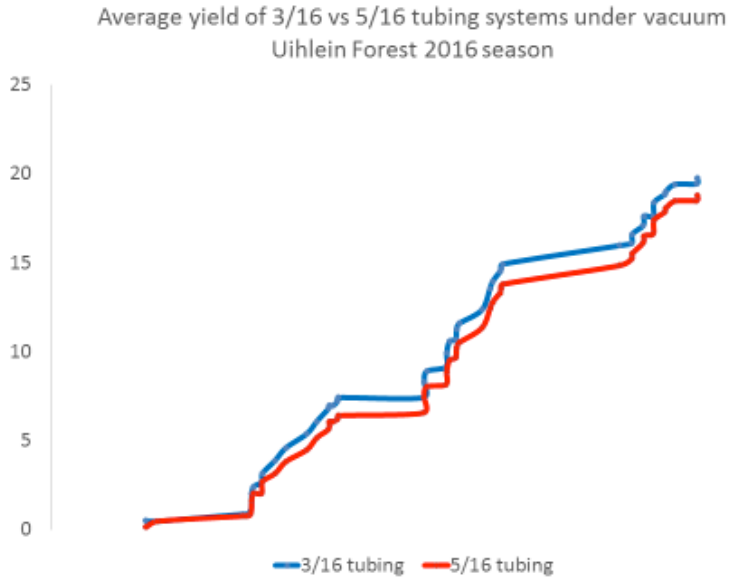

Figure 4. Average yield of 3/16" and 5/16" tubing lines from 12 cannisters, Uihlein Forest, Lake Placid, NY, maple sap tubing systems evaluation, 2016.

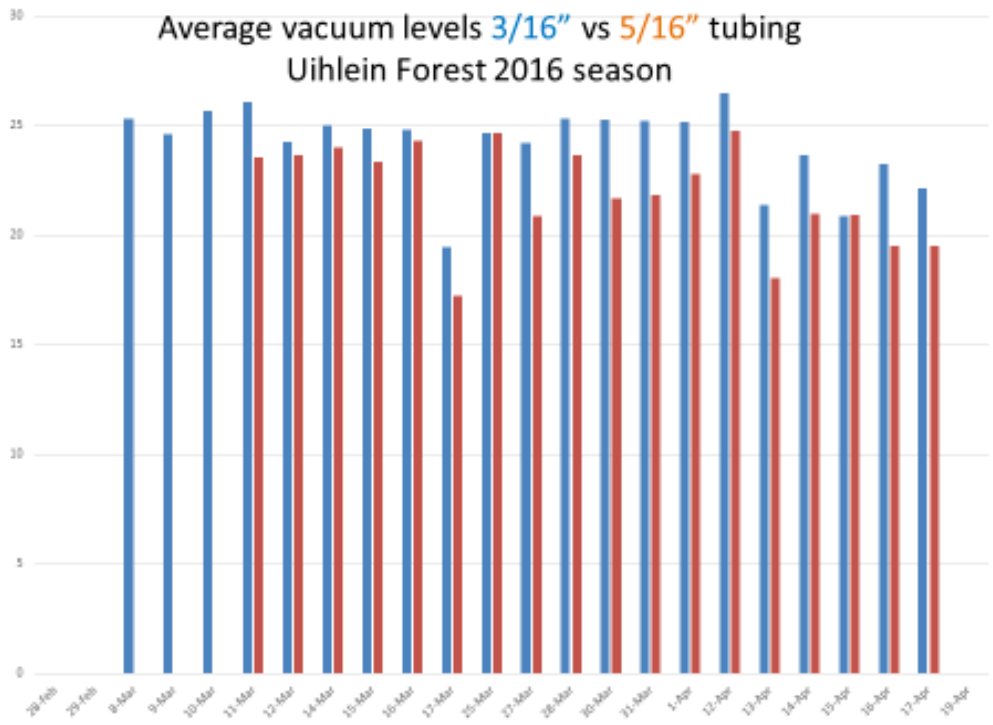

Figure 5. Average vacuum levels at the end of 3/16" and 5/16" tubing lines at 12 cannisters, Uihlein Forest, Lake Placid, NY, maple sap tubing systems evaluation, 2016.

Conclusions/Outcomes/Impacts:

This research demonstrated the effectiveness of utilizing 3/16" tubing systems to collect maple sap. It should now be clear to any producer installing a gravity-based system that using 3/16" tubing is a better alternative than 5/16" tubing.

Our research also showed that 3/16" tubing appears to produced increased yields when a vacuum pump is utilized as well. There are many variables at play, including the slope of the sugarbush and quality of the vacuum pump, but our initial results were promising in this regard. Our average yields were not statistically significant, and more research is necessary to determine how these systems will perform over time with additional replications.

Finally, we have long known that replacing droplines will boost yields as a result of better taphole sanitation of having new tubing close to the taphole. We now know that using 3/16" tubing for the dropline will also boost the vacuum level at the taphole, with longer droplines creating even more vacuum boost.

Outreach:

September and October workshops2016 at Dr. Sam Yancey's sugarbush for Lewis and Jefferson counties, at Mike Kenny's to serve St. Lawrence county producers, and at the Uihlein Forest to reach producers in Clinton, Essex, and Franklin counties. Research results were also presented at the January 2017 winter maple schools in Croghan, Gouverneur, and Chazy. Articles were also published in the Maple News and Maple Digest, in January and February 2017 issues, respectively.

Next Steps:

We will continue to perform the same 3/16" vs 5/16" tubing trials at the Uihlein Forest. Although the first year trial showed that the 3/16" tubing performed better under vacuum, there still remains questions about how they will perform over time. Many producers fear that the smaller diameter tubing will plug up sooner over time, so we will continue to replicate this experiment for several years to determine if yields change over time.

Reports and/or articles in which results of project have been published:

See Outreach section.

For More Information:

- Michael Farrell, Director, Uihlein Research Forest, 157 Bear Cub Lane, Lake Placid, NY 12946, mlf36@cornell.edu, 518-523-9337
- Sam Yancey, wileyracing@yahoo.com
- Mike Kenny, sweetercreationssugarhouse@gmail.com
- Chuck St. John, Paul Smith's College, chuckark60@gmail.com