Future Generations University

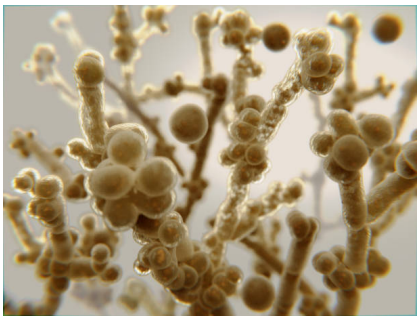
# Sanitation Workshop

## Workshop Agenda

9:00 - Welcome and sugarhouse tour by workshop host

10:00 – 12:00 – lecture/discussion on:

- Tree biology and response to microbial invasion
- Sap flow physiology and temperature fluctuation
- The theory of 3/16 tubing systems
- Microbial contamination and growth
- Proctor and Cornell sanitation research summary
- The Krueger method of 3/16 sanitation



12:00 – 1:00 – Lunch (provided)

1:00 - Field practice sanitizing host sugar camp lines

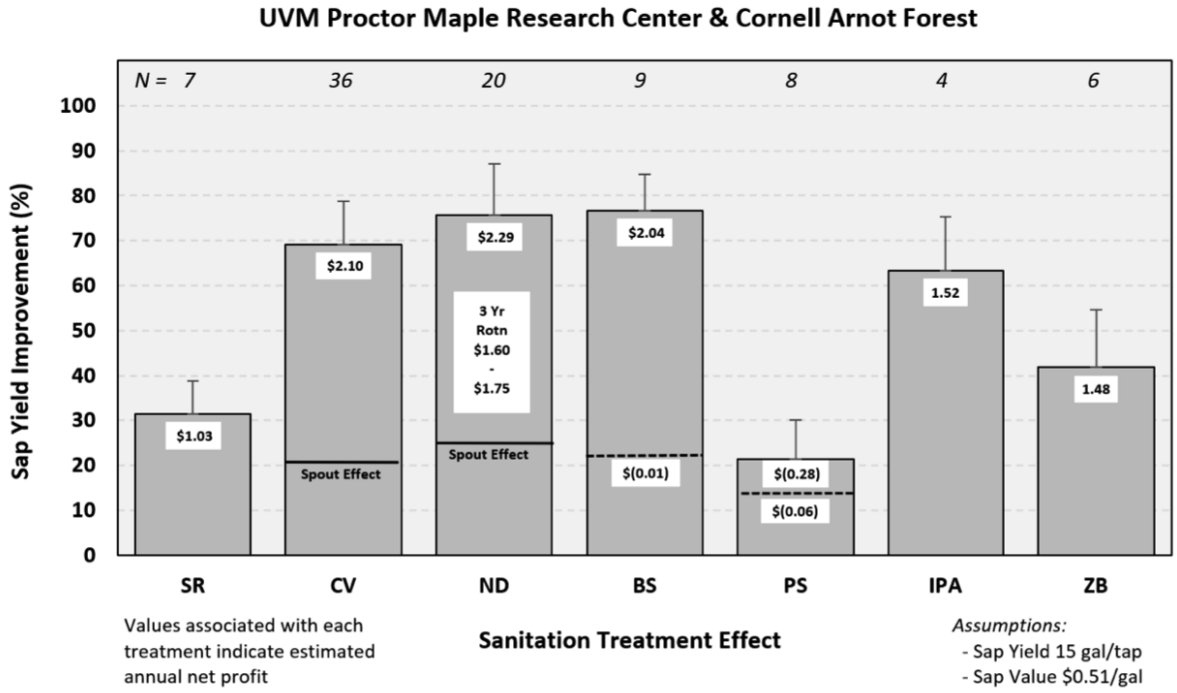



**Figure 2.** Average annual sap yield improvement (%) for each sanitation treatment in studies conducted at the UVM Proctor Maple Research Center and the Cornell Arnot Forest from 2009-2018. Values within each bar represent the estimated annual net profit above the cost of no sanitation (replacement 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.



Perkins, T. D., A. K. van den Berg, and S. L. Childs. "A Decade of Spout and Tubing Sanitation Research Summarized." *Maple Syrup Digest,* October 2019, p. 11. https://mapleresearch.org/pub/1019sanitation-2/

How 3/16" tubing systems work

In the December 2015 issue of Maple News, a person discussing 3'16" tubing said that one needed 10' of fall for the system to work. At best, 10' would only give a vacuum of 9" of mercury (9" hg on your vacuum guage). Not exactly a high vacuum system. 40' or 50' of fall is required for high vacuum. If set up right, these systems will develop a high vacuum in the tubing itself without a pump or releaser.

To see why this is so we must understand some basic physics. Look at the diagrams in figures 1 and 2. Figure 1 shows the first mercury barometer developed by Torcelli in Italy in 1643. Figure 2 shows how it compares with a water or sap barometer. Shortly thereafter, Pascal in France built one using red wine with a 46' glass tube. The empty space in the top of the tube is practically a perfect vacuum. Note 30" of mercury is equal to 34' of water. This is because mercury is much more dense. As far as I know, neither Torcelli nor Pascal made maple syrup. We had to wait almost 400 years for Tim Wilmot to apply their concept to our industry.

Our 3/16" system is simply a sap barometer without the cup at the bottom, tilted at the slope of the sugarbush. Sap has about the same density as water, but since the sap in a 3/16" line is interspersed with air, you actually need 40' to 50' of fall to get a good vacuum. You really want to see this fall happen below your lowest tap, but this is not always possible. 3/16" systems necessarily have long tails after the lowest tap and before the mainline or tank. See Figure 3.

The ideal situation would be to have all your taps on a plateau with a vertical cliff giving a 50' fall. You put your tank at the bottom of the cliff and all you need is a 50' tail. However, these sites are very rare and most of us have more gradual slopes. For a 30% slope (a very steep hill) a 50' fall would require 150' of tail; 10% 500'; 3% 1500'. 3% seems almost flat. A steep bush works best. Mainlines are short and really it is better if you can hook the end of your 3/16" tube directly to the holding tank. These ends must be above the sap level in the tank.

With these long lines economics dictate that you should have as many taps on each line as possible. I found 35 to be okay, however some people have found the system is overloaded during high flows with more that 25. With short mainlines and no vacuum pump or releaser this is a cheap system and pretty easy to install.

There is a limit here. The theoretical highest vacuum is 30" hg. That is only obtainable at sea level. The highest vacuum that you can get is equal to the atmospheric pressure at your site. The higher in elevation, the lower the pressure. My sugarbush is at 1600' and the highest vacuum I could possibly get is 28". You should put a vacuum guage at the top of every line.

We do get readings in the 25" hg range. The temperature needs to be at least 40 degrees F and the sap flowing well before high vacuum is developed. A slight leak diminishes the vacuum considerably, so walk your lines. Because of the practical layout of the bush, we do have some lines with falls that are quite low. The highest vacuums on these are in the 10" to 15" hg range. Falls of more than 50' don't really add more vacuum. Vacuum diminishes the further down the line you go and is zero at the bottom end.

Arthur G. Krueger, P.E.
Krueger-Norton Sugarhouse

Inches of Mercury (inHg)

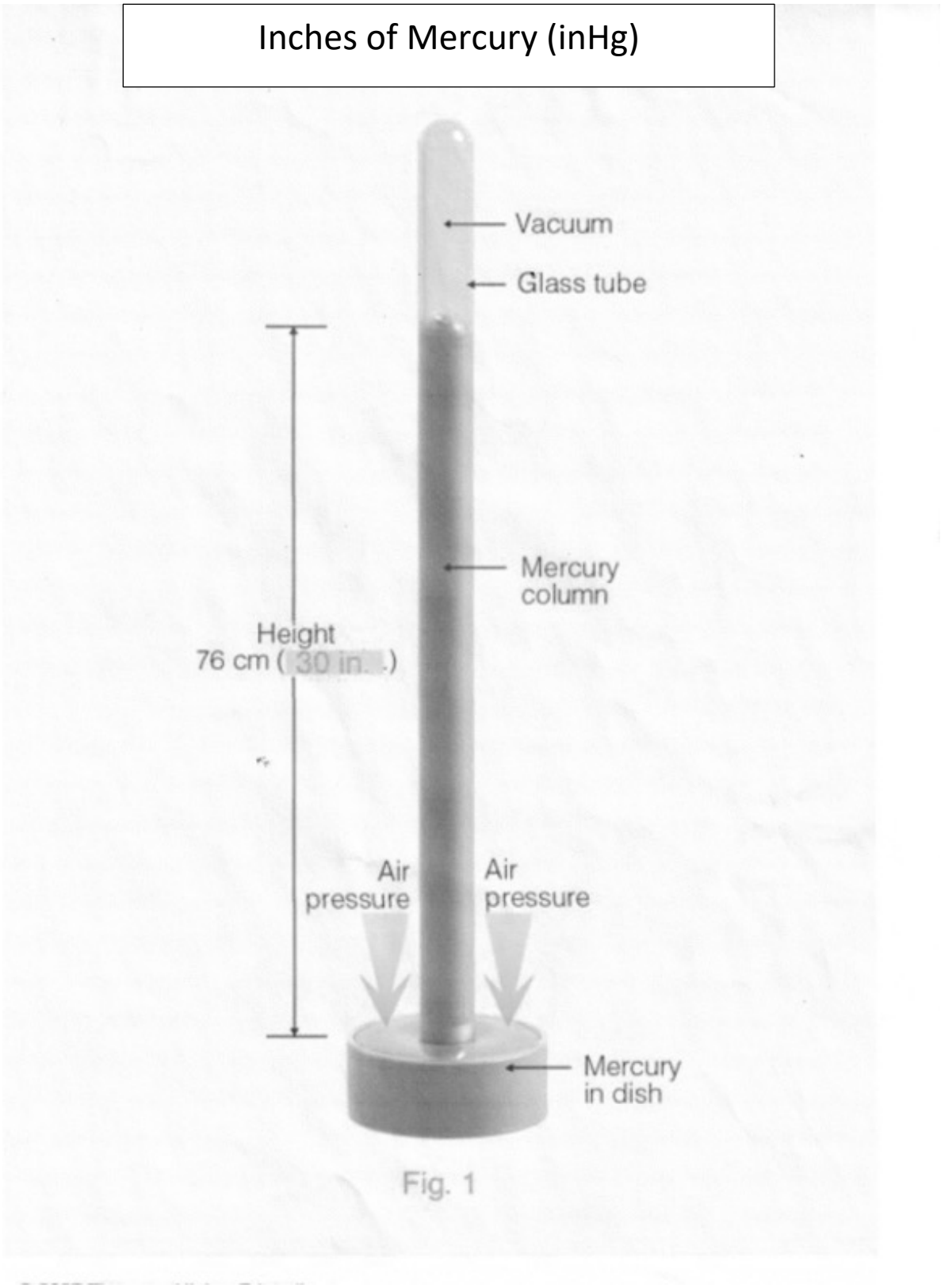



Fig. 1

Atmospheric Pressure Explanation

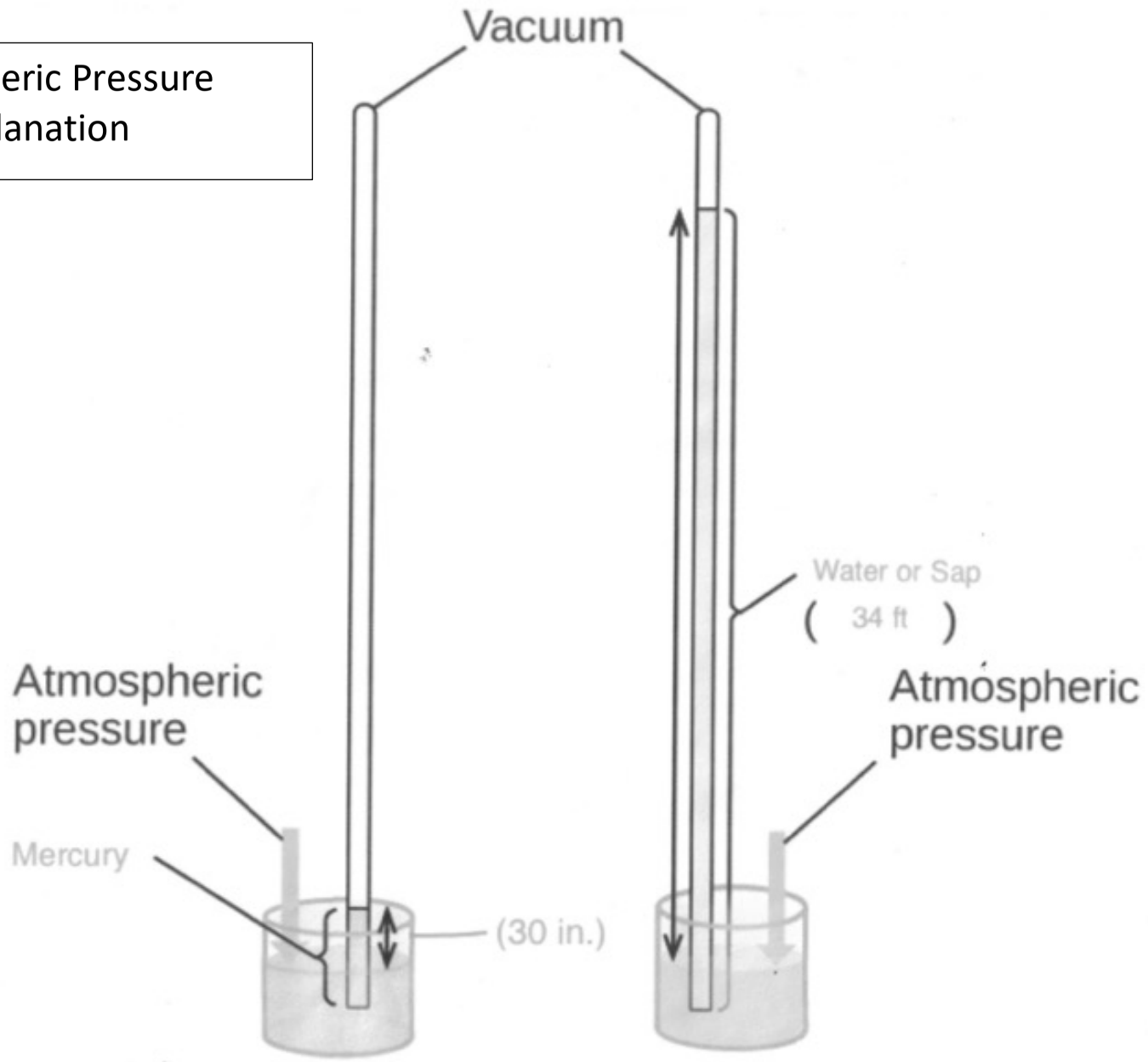
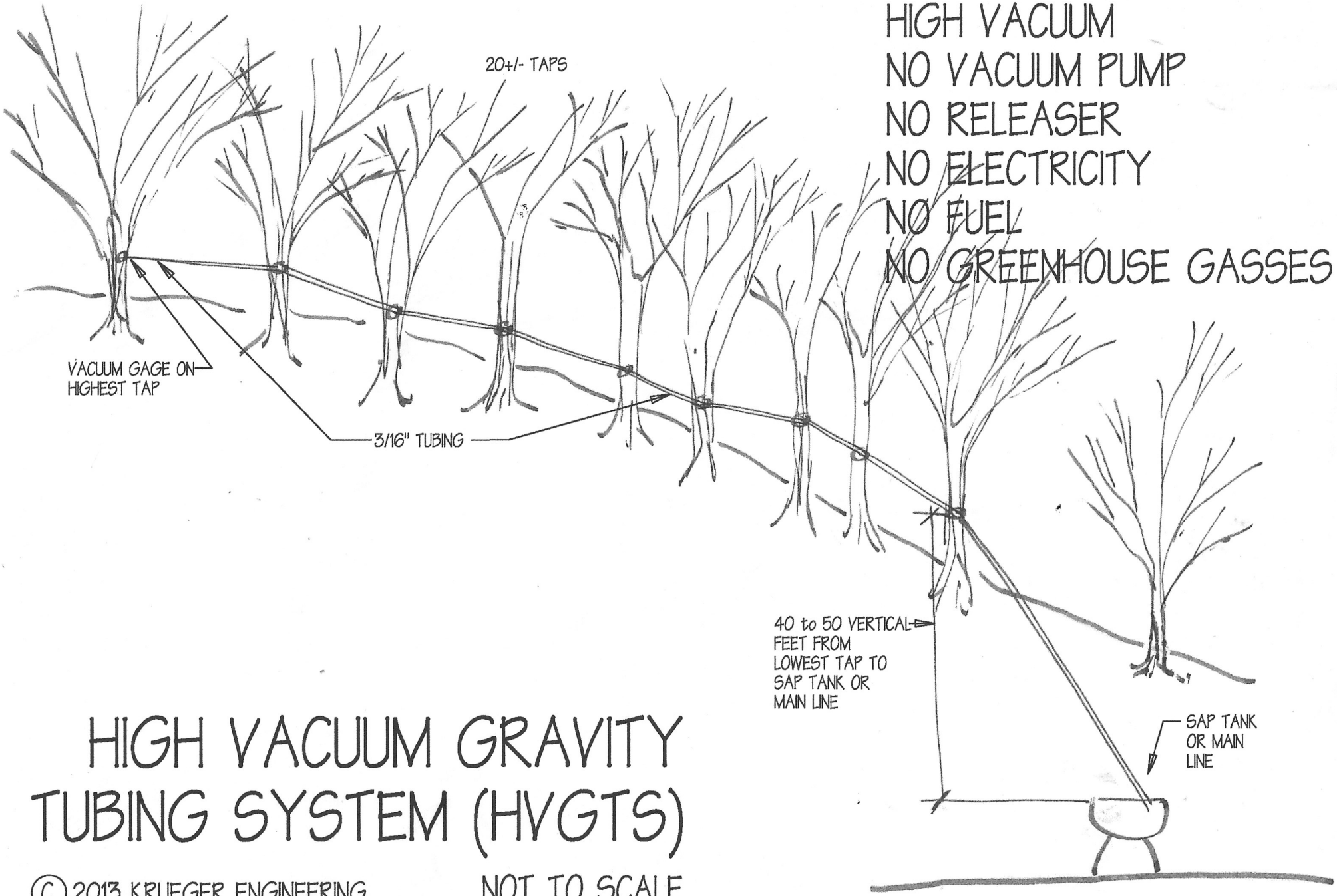



Fig. 2

POWERED BY GRAVITY
HIGH VACUUM
NO VACUUM PUMP
NO RELEASER
NO ELECTRICITY
NO FUEL
NO GREENHOUSE GASSES

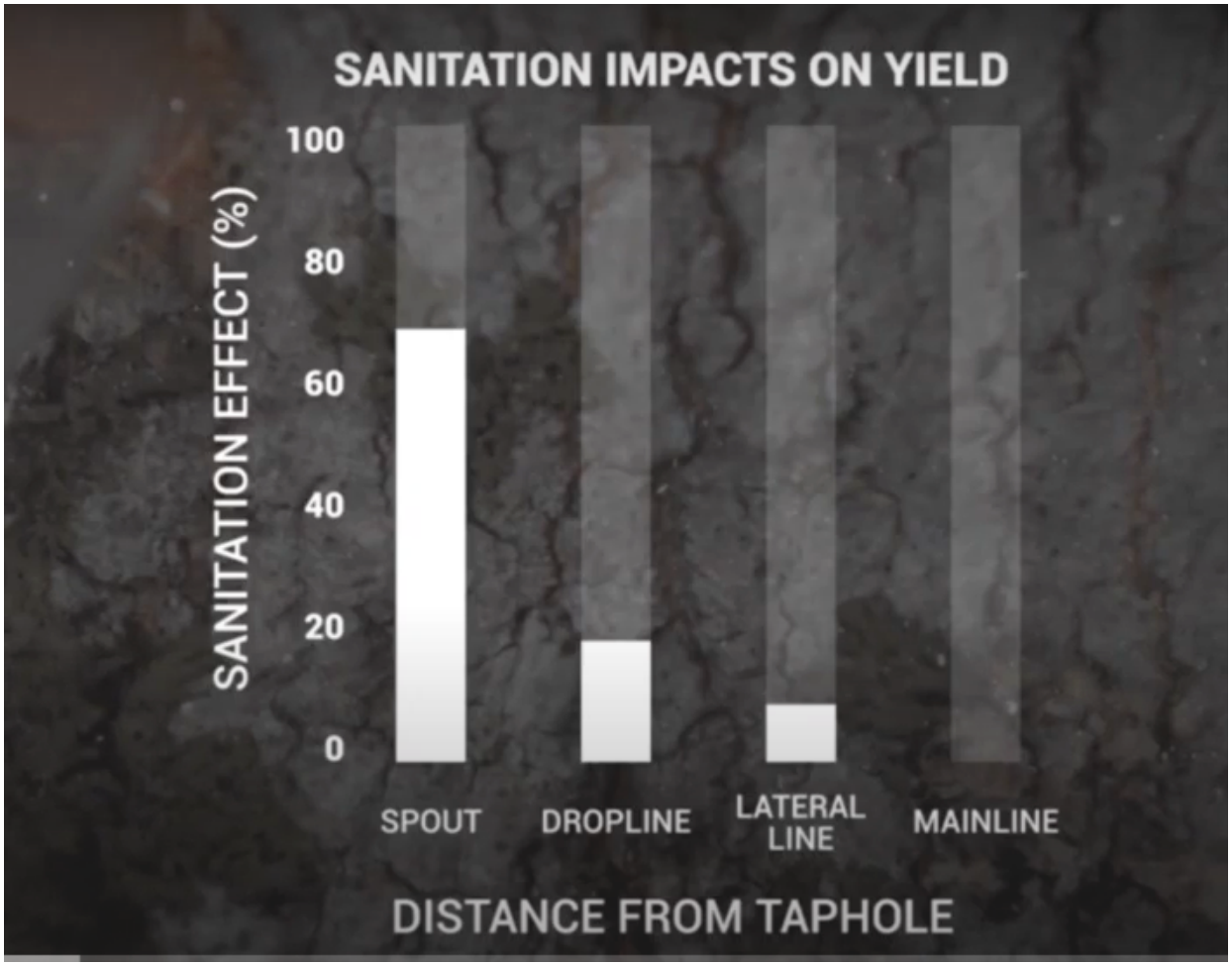



# HIGH VACUUM GRAVITY TUBING SYSTEM (HVGTS)



NOT TO SCALE

FIG. 3




"Spout and Dropline Sanitation for High Maple Sap Yields." *YouTube,* uploaded by UVM Maple Research Center, 1 April, 2020, https://www.youtube.com/watch?v=z35z6oZDz4A&t=114s.

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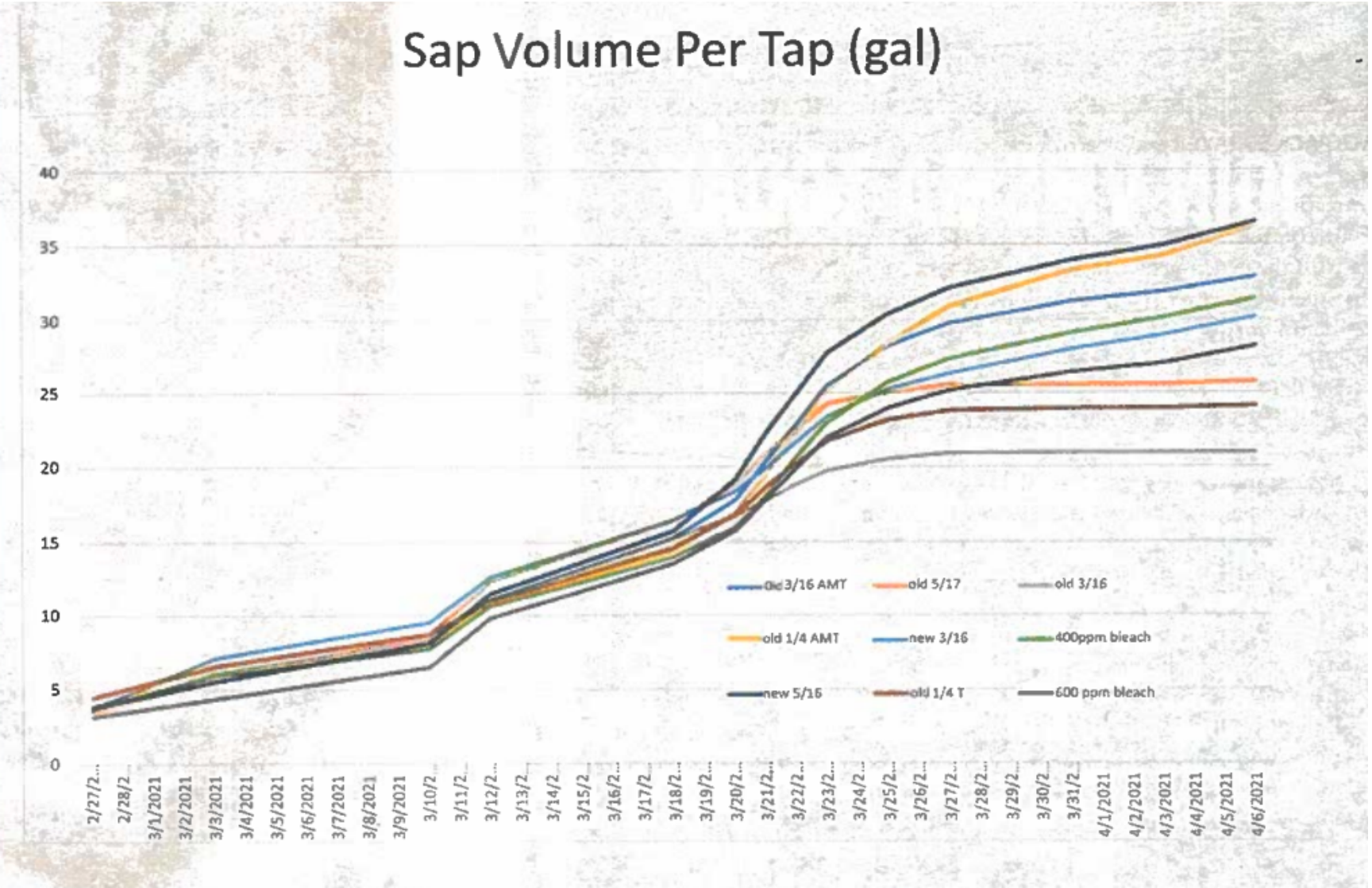


Wightman, Aaron. "Defeating the Drop-off: How to deal with your 3/16 tubing issues." *The Maple News*, May 2021, p. 24.

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**Research Summary**

*Comparison of 3/16 and 5/16 Tubing Sanitation*
The Maple News
T. Perkins and A. van den Berg
October 2019

| Year | 3/16ths | 5/16ths |
|---|---|---|
| 2015 | +15% | |
| 2016 | +3.8% | |
| 2017 | | +10% |

All new in 2015

| Year | 3/16ths | 5/16ths |
|---|---|---|
| 2019 | +53% | +23% |

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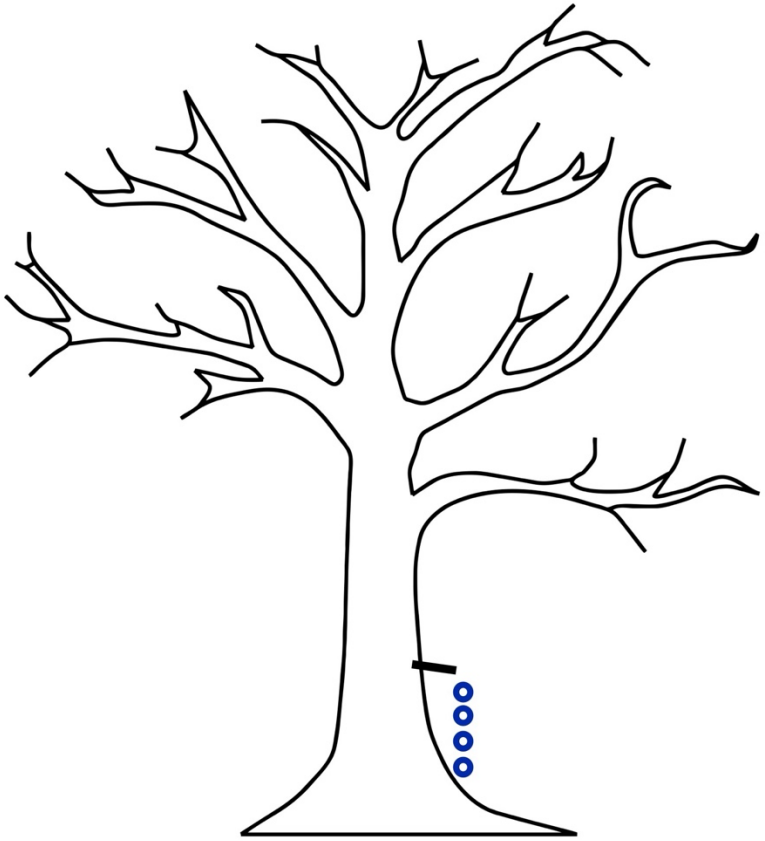

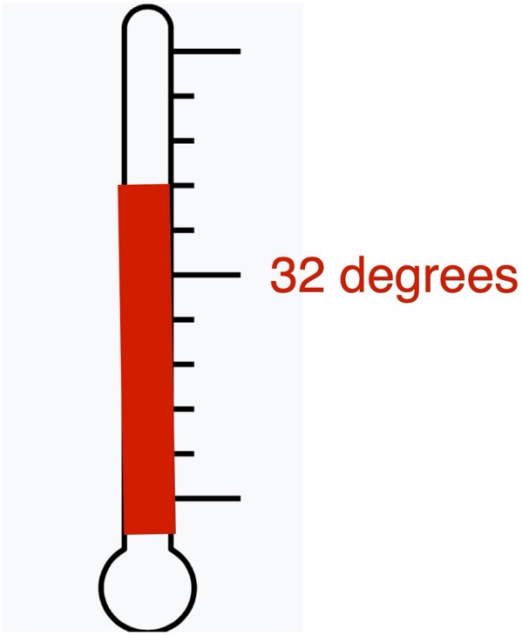


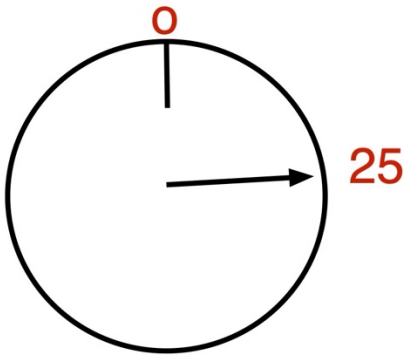

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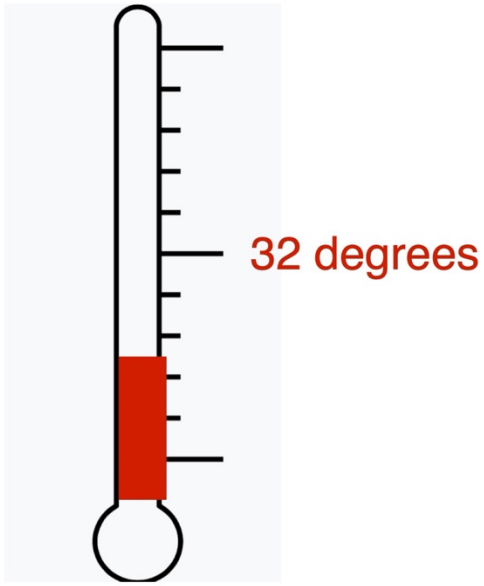
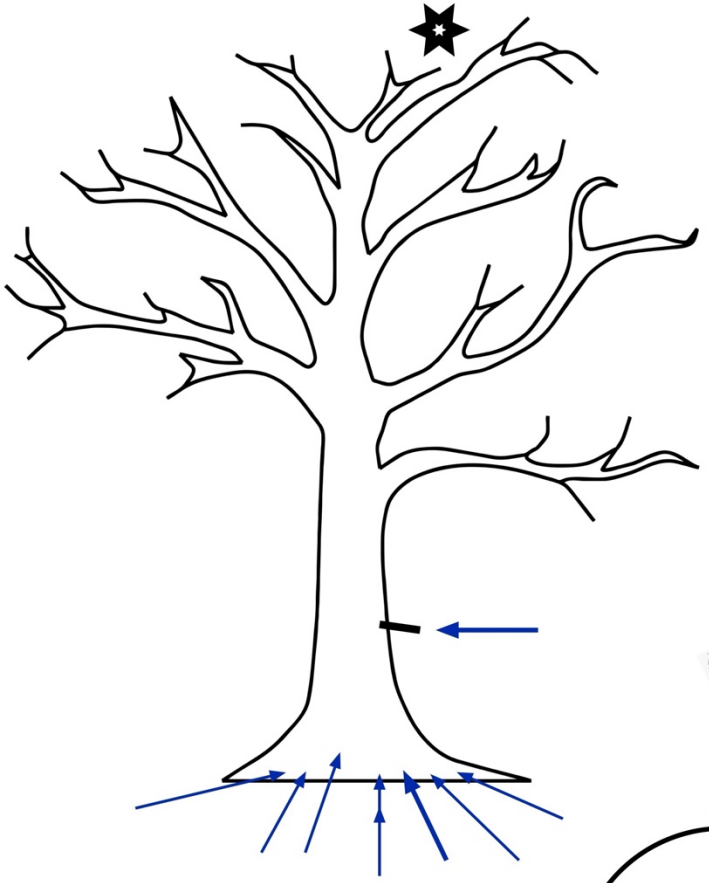
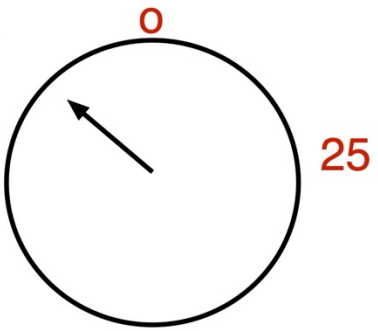






# Sugarmaker shares experiences with 3/16 sanitation

## Art Krueger is 3/16 pioneer in Vermont

By ART KRUEGER | SEPTEMBER 3, 2020

SHREWSBURY, Vt.—My family's sugarhouse finally made some significant breakthroughs using 3/16 tubing.

We managed to completely empty our woodshed of 30 cords and needed to scrounge several cords more to finish up. Certainly a measure of success since, after all, emptying the woodshed is the real objective.

Additionally, we've had our best year ever reversing the disappointing trend of the past several years.

We've even had to sell over 5000 gallons of sap to a neighbor as we were not able to boil it down fast enough.

WHAT WE DID

We bleached our entire network with calcium bleach at a concentration of 400 ppm (a 1 pound packet of Zappit to 200 gallons of warer) as we detapped last spring.

We pumped this up from the bottom of the system.

We made sure each drop was filled with bleach solution, then plugged it off.

The calcium bleach degrades to lime over the summer.

We rinsed most of it in the fall and let a very small amount of sap run on the ground this spring to complete the cleaning. I do believe that leaving the solution in all summer deters squirrels, as the resulting lime solution has a bitter taste.

The only squirrel damage we had before the start of the season was in the new 5/16" drops.

We also changed drops and tees and spouts on all of the lines feeding one of our tanks.

We used 5/16" drops with Zap-Bac silver spouts, and D&G 5/16" x 3/16" x 3/16" tees. (Note that the studs on these tees did not fit the silver spouts. It is not possible to plug these spouts with these tees.)

We only did this on the sugar maples. The 5% or so of red maples in this section were left with old spouts, the theory being it might be beneficial to have these quit early by taking advantage of bacterial growth.

We also installed 2 completely new lines, one with new 3/16" drops with D&G spouts and one with 5/16" drops with silver spouts as a check.

THE RESULTS

The first sap of the season was the cleanest I've ever seen, clear as our spring water. It made some very nice syrup.

Clogging was nonexistent in the lines with the 3/16" drops.

We experienced severe clogging in 4 of the 21 lines with the 5/16" drops and silver spouts. This did not occur until late March, a month after the sap started flowing. It only occurred in the lower sections of the lines, several hundred feet below the lowest drop.

It was not associated with joints but occurred in the tubing itself. I have no idea why this happened. I believe that in the previous years, clogging was a long and persistent problem in the network.

Overall, we got 0.3 gallon of syrup per tap. This suggests that there is considerable room for future improvement, but it is about twice the rate we produced in the previous 2 years.

For the first month all parts of the bush produced very well. We intended to keep track of what the various parts of the system did, but sap flow was so intense that we soon lost track - a veritable sapnami.

We were averaging about 2000 gallons from 2400 taps each day the sap flowed. In the last week of the season the sap flow slowed enough so that we could see some differences that were not present in the beginning of the season.

On the last day that we had our network up we got excellent flow in both of the new lines. We also got excellent flow in some but not all of the 5/16" drops with the silver spouts, but sap flow had diminished considerably in the rest of the system.

Over the last 3 days of flow we got 300 gallons from the section with silver spouts (21% of the bush) and 300 gallons from the remaining 79%.

If the rest of the bush did as well as the silver spouts, our total sap production for that period would have been about 1400 gallons instead of 600, and we might have continued collecting sap a little longer. We would have probably gotten 50 gallons more of syrup during the last week of the season.

In previous years I have tried many replacement strategies in my network. They were all a waste of time and money. This trial with the 5/16" drops and silver spouts is the first time any one of them has worked.

I don't believe this would have worked though without bleaching on the 3/16" laterals.

In my bleaching technique on the 3/16" drops I was able to bleach the drops and the inside of the spouts but was not able to bleach the outside of the spouts. I think this led to the dwindling of the production in the last week in those areas.

The silver spouts being both new and bacterial static stopped this. I believe if I can find a way to bleach the outside of the spouts I might achieve good results throughout, as bleaching for at least 30 minutes has been found to be very effective by both Proctor and Cornell. The science is very strong here.

NEXT YEAR

One way to proceed would be to do the entire bush, excepting the red maples, with 5/16" drops and silver spouts. But it takes $1 in material and about $1.50 in labor per drop to do this, and there are about 1700 more drops to do.

The math is quite discouraging. If I was going to do a completely new installation though, I certainly would consider this.

Another way to proceed would be to try new 3/16" silver spouts on my existing 3/16" drops. This is much cheaper and not very labor intensive.
A third way would be to do a better job of bleaching the outside of the spouts.

I will use the Stericaps used by Canadians in their isopropyl alcohol cleaning system to do this. (Of course I'm using bleach instead of alcohol.) This is the cheapest in both money and labor. I have ordered 2200 from LaPierre.

Beaching is not very difficult if it is done while detapping and if you are well organized.

It certainly is a lot easier than changing drops! I have made 2 youtube videos describing this. I had hoped to have a workshop here on it this spring but with the coronavirus this is now impossible; maybe next year.

One issue I have found is that we can't tell how effective our cleaning technique has been until the following year.

There is a better way.

The Province of Ontario has been lending luminometers to its sugarmakers to determine how effective their cleaning strategies were.
It would be helpful if other jurisdictions did the same, as they are a bit pricey.

One issue I have found is that we can't tell how effective our cleaning technique has been until the following year.  There is a better way, a luminometer.  Evidently you take a swab of the tubing, add a reagent, and stick it in the luminometer.  It then tells you how much contamination you have.

Both Proctor Research Center and Cornell did the original research on using bleach in tubing sanitation and have been very helpful.  I am indebted to both of these fine institutions for getting me started on this journey.

# Sugarmaker shares experiences with 3/16 tubing sanitation

## How to fight back against the production 'drop off'

By BRANDON DANIELS, CDL WEST VIRGINIA & VIRGINIA | JULY 22, 2020

DAWSON, W.V.—There has been much discussion and some research given to 3/16” and the reduction in flows that most see after the first season.

The information in this article will not be referred to as research, but it will be presented to help maximize your production on 3/16” tubing in seasons two through ten.

Before we jump into that, I will provide a little more information on our facilities and my background.

I started producing maple syrup over thirty years ago with a 2x3 stainless pan in the back yard and ten taps as a young teenager.
This has grown to a modern state of the art operation.

I am running 2,400 taps +/- 10 on 3/16” tubing in five different areas. These taps run into round bottom stainless tanks produced for maple sap.

In all of the areas we have taps, they are within approximately 1.5 miles of each other.

In all five of these locations, there are taps on slopes that face more than one direction and on the 2,400 taps, we have taps that face every direction on the compass.

The spouts used have been three different types of spouts; clear(polycarbonate) seasonal, white nylon spouts and anti-microbial with mostly clear seasonal polycarbonate; we are replacing spouts before every season.

Nearly all of the 3/16” tubing that I will be referring to was installed in 2014 through 2017.

The exceptions to this would be repairs due to damage or some rerouting of 3/16” lateral lines that may have required more tubing to extend. The five areas I will refer to are all on natural vacuum without the aid of any vacuum pump.

One area that has 325 taps on it and has been tapped for over thirty years, had the drop lines replaced on them in just before the 2019 season. The rest of the 3/16” lateral lines, the drops are three to five years old with the exceptions of repairs.

This area of 325 taps that the drop lines were replaced in 2018, are 5/16" drop lines, the remainder of nearly 2,100 taps with three to five year old drop lines with 3/16" drop lines.

All of the 3/16" lateral lines terminate into mainline with none of the lateral lines running directly to a collection tank. Ideally, there should 30' of drop after the bottom tap on a lateral.

Most of the mainlines are in the bottoms of long hollows or valleys with minimal slope so the lateral lines are terminated into the mainline regardless of how much drop is achieved after the last tap.

100% of the tubing is semi-rigid from CDL and the drops are either CDL semi-rigid or flex which will be addressed in more detail later.

The mainline is the same age as the lateral lines with the exception of one of the areas that has 330 taps on it. This was one of the initial areas 3/16" was installed in 2014 and the mainline is a few years older.

The two main things I want to address is loss of production and plugging in 3/16" tubing.

The research points to a large loss of production after the first season.

Most think it will continue to drop off some every year until the tubing is replaced. I have not experienced the loss of production that research suggests we should and the plugging has been minimal.

In fact, the 2019 season was our record production per tap and this was surpassed by over 18% in 2020.

Over the last three years I have discussed several times with Tim Wilmot, retired maple specialist from UVM Proctor Maple Research Center, why this occurs. Tim is the original developer of 3/16" tubing and presented it to the maple industry.

We have discussed why we think this occurs and I'll address some of the reasons that I believe this has prevented this from occurring on my properties. Yes, I do see some plugging and usually find about three to four per year in 15 to 20 miles of 3/16" tubing.

In 2020, I only found three areas of plugging and they were all in the 330 tap section that was installed in 2014.

Two of the three areas that were plugged were in a section of tubing that was flat in the middle of the lateral lines and the tank was moved before the 2020 season.

When I rerouted three of these lines to get more slope, the areas of plugging inside the tubing were not seen until well after they were tapped. The other area of plugging was a result of wood chips that had blocked off at a fitting.

Now I want to address why I think most are seeing a reduction in flow and production after the first year. I strive to have all of our taps pulled and lines flushed in five to ten days after the last boil.

This seems to be where many fail, when season is over, most are ready to move onto other things and pulling taps is not high on the list. Over the last six years, I have tried different treatments on pulling and flushing taps.

What I have settled on in 2019, and again in 2020 is simple and easy. I go to the top of every lateral line and pull the top tap which is usually still under vacuum and flush one to two ounces of distilled water through the lateral line.

The vacuum will pull it quickly down the lateral line and help flush out yeast and residue. We then proceed to pull the taps over the next few days and let the drops hang downward and dry for three to six weeks.

As taps are pulled, lateral lines are pushed upward to above head height and this seems to drastically reduce damage to the tubing during the off season. Even though the flushing is easy, it still takes extra time.

Going back a second time to cap off the spouts also creates even more work, but the tubing that was installed in 2014 still looks about as clean as tubing that would have been through one season.

Back in fall of 2017, I replaced a lot of the drops to help “maximize” production. These were all replaced with a flex 3/16” tubing which is more translucent and also easier to work with.

The biggest disadvantage I see to the flex tubing is that it seems to get dirtier easier and retains mold and yeast worse than semi- rigid tubing. I have not had any issues with semi rigid pulling off of fittings and even the original 3/16” fittings that only had one barb on each side of the connection.

Before the 2019 season, the drops were changed in the section with 325 taps with new 5/16” drops except the top tap which was 3/16”.

The most interesting thing I saw from the new 5/16” drops was that they produced less than the older 3/16” drops on the other four sections and less than what they did the prior three years with 3/16” drops which also goes against what research suggests.

I did not see any higher yields during the 2020 season with these one year old 5/16” drops versus the older 3/16” drops.

In a normal season, I usually see syrup yields of around .25 gpt with average sap sugar content of 1.1 to 1.2 for the season.

In 2019, this increased to .276 gpt and in 2020 to .33 gpt. Obviously, there are many factors that come into play with production and you can never duplicate the same conditions from one year to any other year.

The weather was somewhat better in 2019 and 2020 which also helps production. In 2020, the sugar was a little higher than the past three years which contributes to better numbers.

You are welcome to draw your own conclusion from all the information I have presented, but I will give you a good illustration to further reinforce everything.

In January 2018, I had a customer that installed approximately 700 taps on 3/16". They did not tap until nearly half way through the 2018 season and still made over 1/3 gpt.

In 2019, they installed approximately 300 more taps prior to and during the first part of the 2019 season.

During the season, he called me in distress because he was getting more sap out of the new tubing on 300 taps versus the one year old tubing that had 700 taps. I questioned him if he had been to the woods to check for leaks and he said he did not have time.

A couple of weeks later he called again, really upset that he was not getting much sap out of the 1 year old tubing system even with new spouts. We talked in detail and he finally admitted he did not pull the spouts out from the prior season until the start of the current season.

I explained to him that he probably had a lot of leaks and likely a lot of plugged lines. He agreed to go check out his lines even though the season was winding down. He informed me a couple of days later that he had found quite a bit of damage and a lot of plugged lines.

After fixing the problems and the plugged lines, his sap flow increased dramatically and he pulled all of his taps and flushed his laterals shortly after the season ended in 2019 and he only made .23 gpt.

During the 2020 season, he made nearly .5 gpt without adding any new taps on two and three year old tubing even though nearly everyone reported higher sap flows in 2019 than in 2020.

The only difference, he pulled his spouts out quickly and flushed the lines.

No drops were changed, just new polycarbonate spouts were replaced.

While 3/16" tubing is not for everyone and there are still things we continue to learn, I think sanitation/cleanliness and going the extra mile is extremely important to maximize yields.

Once season ends, most are not eagerly anticipating pulling taps. The additional time and labor of flushing lines and going back a second time to cap off the taps adds up.

I would rather spend some extra time after season when things have slowed down to increase production. I know this all refers to 100% natural vacuum and I am certain that a hybrid system will produce even more sap.

Nearly all of my taps are remote and 100% of the sap is hauled and none of it runs to the sugarhouse.

Up until the 2019 season, every drop was flushed with permeate or distilled water except in 2015 when vinegar and water was used. It is more labor to flush every drop as they are pulled versus flushing the top tap on each 3/16" lateral line.

Discussions that I have had with Tim Wilmot the last three years, we agree that good sanitation and cleaning of 3/16" tubing may be the key in preventing the loss in production.

Unfortunately, due to his retirement, Tim Wilmot did not have the opportunity to do any research or testing on cleaning and sanitation. The tubing seemed to be the cleanest this year with the additional time to air dry and I plan to continue that in the future.

I also think good slope is very important on natural vacuum on 3/16" and not as important with a hybrid system.

Like any good vacuum system, maintenance and fixing leaks is huge in a good 3/16" system. As we start to make plans for the 2021 season and look towards summer, do not forget the old saying: "An ounce of prevention is worth a pound of cure!"

# Cornell Corner

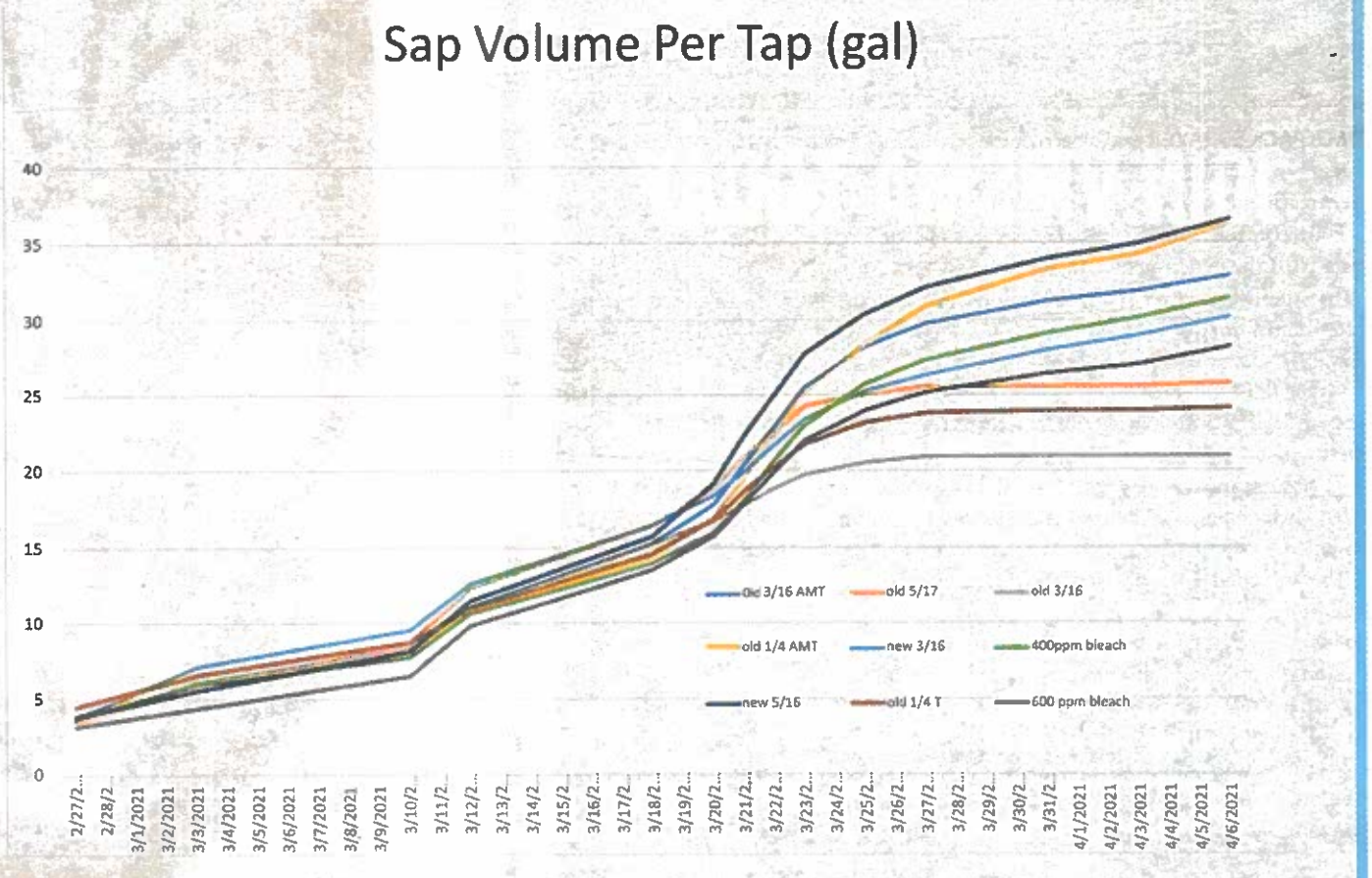
A 1/4" ANTI MICROBIAL T installed in the woods at the Arnot Forest in Van Etten, N.Y. where researchers are trying to solve the dreaded 3/16 drop-off that many sugarmakers experience after the second or third year.

# Defeating the drop-off

## How to deal with your 3/16 tubing issues

### Multiple methods tested and results revealed

**BY AARON WIGHTMAN**
*Co-Director Cornell Maple Program and NYS Maple Specialist*




VAN ETTEN, N.Y. — This season, the Cornell Maple Program tested methods to keep 3/16" lateral line tubing productive over multiple seasons.

Treatments utilizing antimicrobial plastics, larger fittings, and calcium bleach sanitizer all showed promise.

These results offer hope to producers who wish to capitalize on the advantages of 3/16" tubing without suffering production losses two or three years after the tubing is installed.

3/16" tubing has several well-known advantages over 5/16" including lower cost, the capacity for more taps per line, and most importantly, the ability to generate natural vacuum on par with the levels created by expensive vacuum pumps.

These benefits led to a surge in sales over the last decade.

Producers interested in increased sap yields in woods without electric service access installed hundreds of miles of 3/16" in sugarbushes across the US and Canada.

Additionally, many small businesses saw 3/16" as an opportunity to increase yields without investing in expensive vacuum equipment.

After several years of widespread use, it became apparent that 3/16" also has the significant disadvantage of decreased production after its first year in the woods.

By year 2 or 3, sap production from 3/16" lines drops well below that of 5/16" lines.

At first, researchers suspected the smaller diameter tubing amplified the impact of microbial-laden sap contaminating the taphole when the tree freezes and enters a vacuum state.

However, efforts to employ tap hole sanitation strategies such as check valves, zap bac spouts and 5/16" drop lines failed to resolve the issue.

Further tests revealed clogged T fittings as the culprit.

The aperture on these fittings is extremely small which allows them to easily plug with a biofilm of yeast and bacteria that builds up on the plastic.

Many sugarmakers arrived at this realization when untapping at the end of the season with the vacuum on.

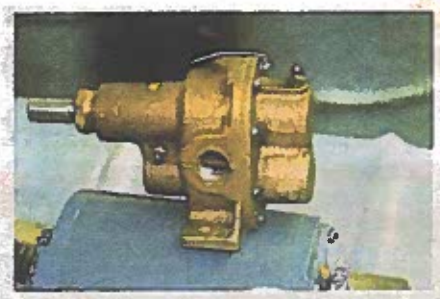
With vacuum, you expect any residual sap to be sucked down the line and the whistle of air through the fitting when the spout is pulled.

However, in old 3/16" tubing with clogged T's the sap dribbles out the spout when it's pulled with nary a whisp of vacuum.

The Cornell Maple Program developed three new strategies to test against the clogged T problem: larger diameter fittings, antimicrobial fittings, and line sanitation with calcium bleach.

Based on findings from the prior two seasons, Cornell tested the following:

Each treatment was replicated 4 times with 4 trees for a total of 16 taps



**Bronze used in the manufacture of gear pumps** usually contains lead, and these pumps can add lead to sap and syrup. Unnecessary pumping, particularly of sap, should be avoided. Other pump models are available which contain little or no lead.

Syrup kept in older, heavy galvanized **barrels** like these had a much higher lead content after 8 months of storage. Newer galvanized barrels do not add appreciable lead in this amount of time.

**Old milk cans** frequently contain terneplate, an alloy with a high lead content, and should never be used for syrup filtering or storage.

**Standards for lead concentration** are based on models of the maximum syrup consumption by children. Standards vary within the maple producing regions of the U.S. and Canada. Syrup producers and health officials share the goal of a healthy and fine tasting product that is safe from contaminants. We are committed to the words "Pure Maple Syrup" that we put on our containers.

***Lead testing is available at:***

Agricultural and Environmental Testing Lab.
220 Hills building, University of Vermont
Burlington, VT 05405
phone: 802-656-3030

Most state universities have a laboratory where lead testing can be performed.

For more information contact:
Proctor Maple Research Center
P.O. Box 233, Underhill Center, VT 05490
802-899-9926
www.uvm.edu/~pmrc
email: pmrc@uvm.edu
or your local extension or agricultural agent.

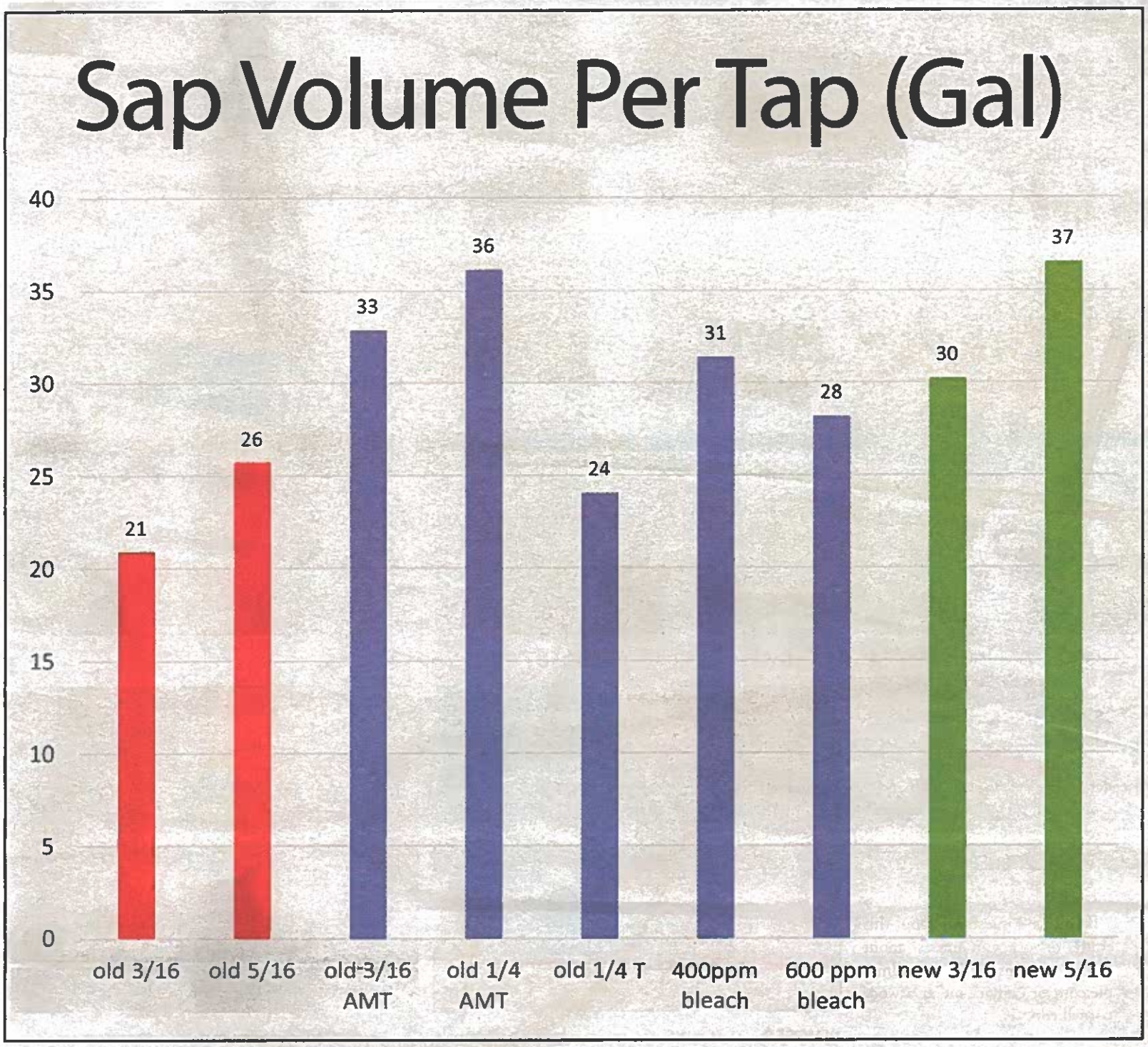
Acknowledgments:
Research on sap and syrup lead reduction was supported by grants from the US Department of Agriculture, Vermont sugarmakers, and the North American Maple Syrup Council.

# Keeping Lead Out of Maple Syrup

*A Guide to the Use of Sap Collecting and Syrup Making Equipment*

*Proctor Maple Research Center*
*Timothy Wilmot*
*Timothy Perkins*

The UNIVERSITY of VERMONT




In this trial, a relatively short contact time was allowed for the bleach to sort out differences between 400ppm and 600ppm concentrations.

This probably explains the limited efficacy of the treatments and why the higher concentration of 600 ppm produced less sap than the 400 ppm treatment.

However, both treatments yielded some productions gains and performed about the same as the all-new 3/16" treatment.

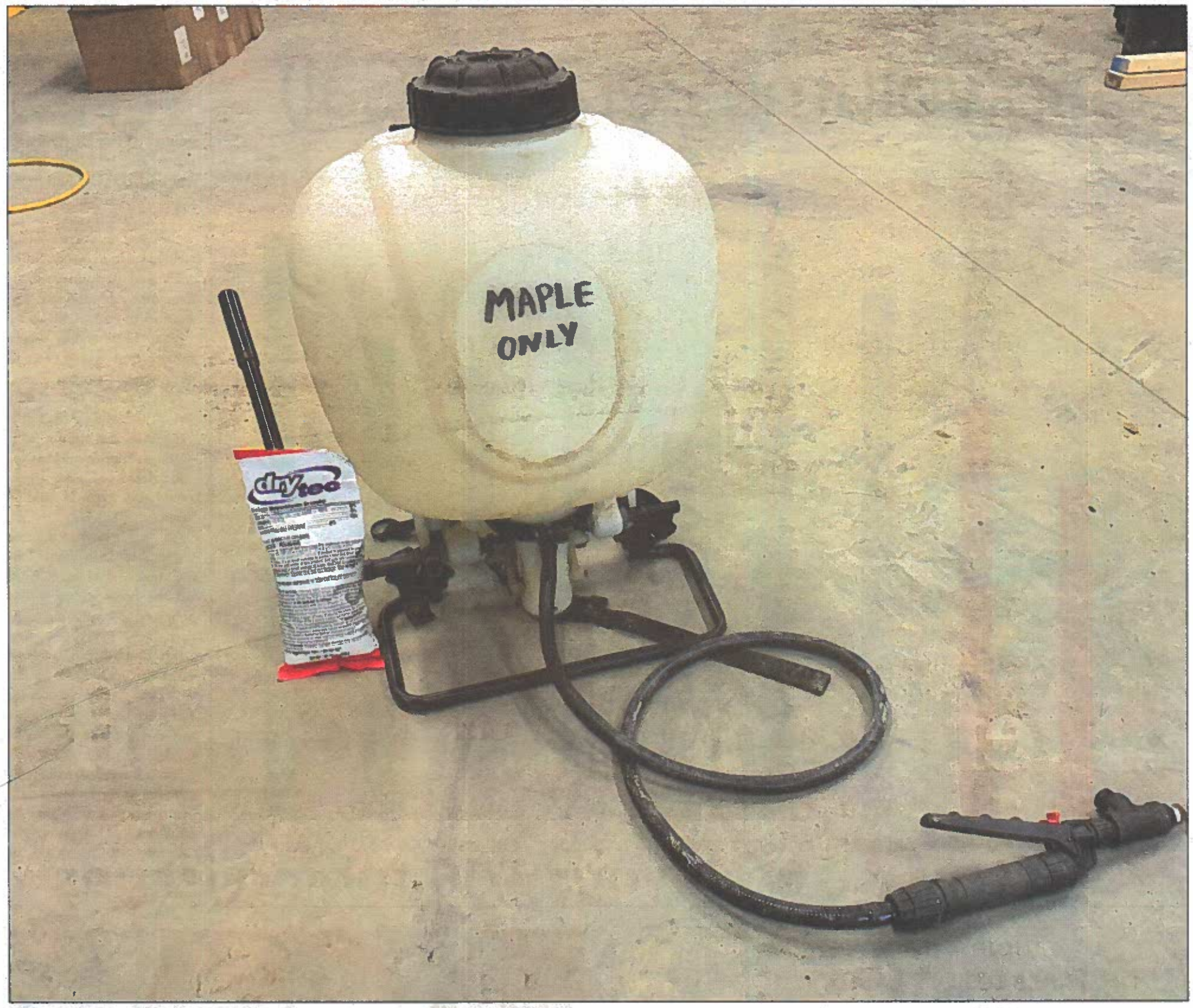
In all likelihood, a longer contact time would lead to improved effectiveness.

Since calcium bleach does not attract wildlife like sodium bleach, leaving the calcium hypochlorite solution for hours, days, or even weeks would not result in wildlife damage.

However, except in the case of extraordinarily dirty tubing, most of the bleach's work will be done within a few hours of injecting the sanitizer.

Injecting bleach with a backpack sprayer in woods with considerable brush cover and three feet of crusty snow was difficult and time consuming.

For this method to be efficient, forest conditions should be accounted for. It may be more feasible to pump the solution out the mainlines and into the laterals in some cases.




**BACKPACK SPRAYER** and bleach powder for calcium bleach treatment used to treat 3/16 tubing at the Arnot Forest in Van Etten, N.Y. by Cornell researchers.

per treatment on four separate lateral lines.

Four control treatments were also installed to compare with the experimental treatment results.

To establish a lower limit control, 3/16" and 5/16" treatments made of old, unwashed tubing were installed.

Other than a new spout, the rest of each lateral line was at least 3 years old and had received no cleaning treatment.

To determine an upper limit control, 3/16" and 5/16" treatments made from all new tubing were installed.

This included new tubing, drop line, and fittings.

Tapping took place on February 25 and 14 sap measurements were made between 2/27 and 4/7.

Sap collection was discontinued after April 7 due to the emergence of leaves and the lack of freezing weather to induce sap flow.

Vacuum was maintained at 20" to 24" for the duration of the season except for a 2-day power outage 3/26 through 3/27.

The 3/16" antimicrobial T had been used for 2 previous seasons.

Although these T's are not designed for rugged outdoor use, they have proven surprisingly durable in the woods, as long as they are carefully installed and the laterals are not overtight.

The ¼" T's were somewhat difficult to install and did not fit in all types of tubing.

Flex tubing has the elasticity to accept the larger T, but rigid tubing styles had to be heated to the melting point before the T would fit.

A metal expander that could be squeezed into the ends of the cut tubing eased the process.

For the calcium bleach treatment, the bleach powder was mixed according to package instructions to achieve the desired concentration.

The sanitizing solution was then pumped into the lateral from the lowest spout using a modified backpack

rinsed with water.

The best performer was the 2-year-old antimicrobial ¼" T.

It exceeded the productivity of the all-new 3/16" control by 20% and pushed out 71% more sap than the old 3/16" control.

These T's are durable and fit into flex style tubing with the help of an expander.

They are sold by US Plastics for $0.84 each.

Three-year-old 3/16" antimicrobial T's had the second highest yield among the experimental treatments with a 10% higher yield than the all-new control and 57% more than the old tubing control. The T's cost $0.76 each and had the advantage of being easy to install.

At the bottom of the pack, 2-year-old ¼" T's without the antimicrobial additive underperformed the all-new control by 20% and only produced 14% more than old tubing.

These results suggest increasing to a slightly larger inside diameter is less important than the antimicrobial treatment in the plastic.

The ionic silver treatment is clearly effective over multiple seasons.

All three of the T treatments were designed to single out their effectiveness in combating the clogged T issue.

However, in a working sugarbush, the tubing treatment should also include some provision against sap suck-back into the tap hole.

Options include check valves, zap bac spouts, or 5/16" drops.

An innovation that could prove highly useful would be an antimicrobial ¼" T with a 5/16" top connector to accommodate a 5/16" drop line.

This would provide a comprehensive solution for sugarmakers hoping to solve both the clogged T, and the sap suck back issues.

The calcium bleach sanitation trials yielded less clear

**ALTERNATIVE T OPTIONS** used by Cornell in their research. Top to bot-

3



**A 3/16" ANTI MICROBIAL T** identified by Cornell researchers as effective in fighting the third year drop-off that some 3/16ths users experience.

This would require adequate pumping capability, a larger volume of sanitizing solution, and also considerable woods-walking to unplug each spout from its holder, let the sanitizer flow through, and then plug the spout back in.

When working with bleach it is important to wear eye protection and gloves.

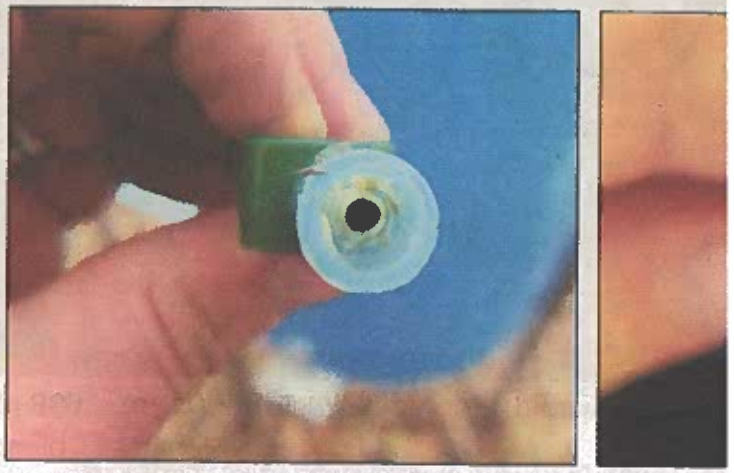
It's easy to be injured by splashing bleach when working with it in this fashion.

This study shows that 3/16" lateral line tubing can be kept productive over multiple seasons with simple, cost effective treatments.

Further tests are needed over multiple sugaring seasons to determine the efficacy of the treatments in different conditions and over a longer period of time.

Future tests may also include new fittings specially developed for maple tubing.

If you have questions about this study or other inquiries about tubing systems, visit cornellmaple.com or contact me at arw6@cornell.edu.



**PLUGGED 3/16 TUBING,** the culprit in keeping sugarmakers from experie

LETTER TO THE EDITOR

# Krueger offers solution for sanitizing the 3/16

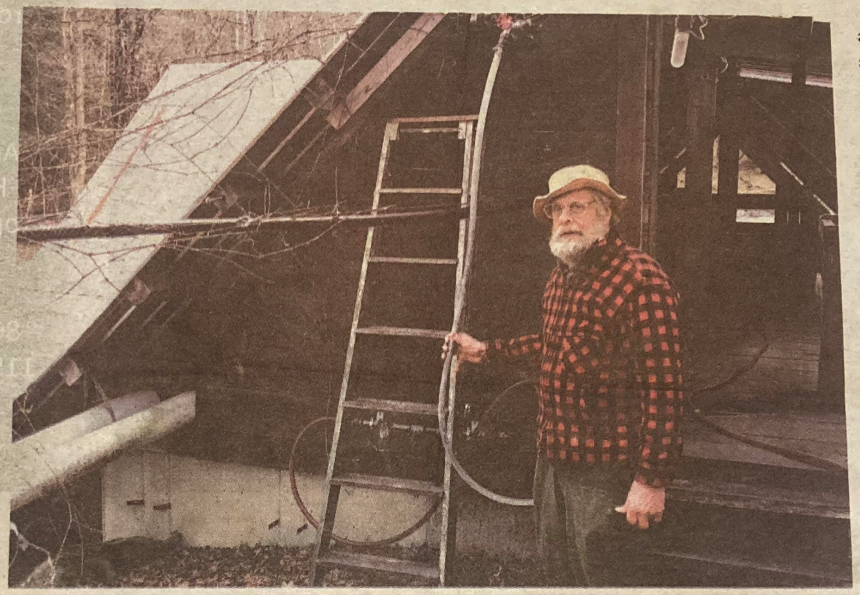
BY ART KRUEGER
Krueger-Norton Sugarhouse
Shrewsbury, Vt.

*(Comments on Adam Wild's article in January 9 Maple News: "Plugging Plight in 3/16" tubing")*

Adam Wild's pictures of plugging in the 3/16 fittings are impressive. They certainly underline the importance of sanitation. Sanitation is a real issue for both 3/16 and 5/16. In 5/16 sanitation can be handled with the yearly replacement of spouts or drops, and plugging is not a major issue. Replacement is useless with 3/16. You might as well burn your money to fuel your arch. Plugging is definitely an issue.

I don't think replacement of all fittings every 3 years, as Adam suggests, would help. You would still be left with the lateral itself contaminated and the possibility of recontaminating the parts you just replaced. I came pretty close to doing this in year 3 of our 3/16 adventure when we replaced all the drops. It did not help. Now, I did not replace all the joints at that time, but there weren't very many of these and I did not observe them clogging.

The only solution I found for sanitizing the 3/16 tubing was a thorough bleaching at 400 ppm in the spring when detapping and leaving the bleach in place until fall. Don't use sodium bleach (chlorox et al). It turns to salt. Use calcium bleach, Zappit for swimming pools. One pound per 200 gallons of water. That way you won't have squirrel problems or a salty taste in your first run of sap. This is quicker and cheaper than replacing stuff and you really have to do this if you use 3/16.



**THE ONLY SOLUTION** I found for sanitizing the 3/16 tubing was a thorough bleaching at 400 ppm in the spring when detapping and leaving the bleach in place until fall, Art Krueger writes.

You might think about using this method if you have 5/16, as it is certainly going to be cheaper and quicker than replacing drops and will eliminate the generation of all that plastic waste every year.

Which system should you use? It depends on your situation. Certainly if your land is flat, 3/16 will give you no advantage. You would need a vacuum pump and a releaser. You really need a sloping site, the steeper the better, to profit from 3/16. The advantage of 3/16 on a sloping site is you can avoid the vacuum pump and releaser, and use the gravity field in your sugarbush to drive the operation. The same gravity that makes us old geezers tired makes the system work. I note that at Cornell, Adam's shop, they are using 3/16 with mechanical vacuum and thus negating its real value.

I used mechanical vacuum for many years and found keeping the pump and releaser going day and night to be a real challenge. I'm off the grid, so running a gas or propane engine for power complicated the system even more. So when Tim Wilmot came along with 3/16 back in 2012 I was all in.

We've had a few bumps over the years, but I'd never go back. It's taken a while to figure out the sanitation issue, and I've learned a lot about how to lay out the tubing. I probably should write a book, or at least a booklet, about it.

There is another advantage of 3/16 gravity over mechanical vacuum. You have much less mainline. We eliminated about 3/4 of our mainline when we switched over, and a modern 5/16 mechanical vacuum requires far more mainline than I ever had. Not only is mainline expensive and a chore to install, it gets in the way when you want to thin your bush. With 3/16 you just push it out of the way and go ahead and cut. As a result, you're more likely to do the thinning that you should do.

Could I gather more sap with the installation of a state-of-the-art mechanical vacuum system? Probably. Because of the topography of my bush I get high vacuum (25"hg) in part of my bush but not everywhere, and a really good mechanical vacuum system would do this and boost production.

Would I make more money? Probably not, as I would have a lot of extra expense. More sap does not always translate into more profit.

Would I be more frustrated? Definitely. It's good not getting up in the middle of the night to check on the releaser. I used to have a vacuum gauge connected to my system outside my bathroom window to ascertain how the system was running. Gravity is always there and you don't have to check on it.

3/16 and 5/16 are different animals with different maintenance characteristics and requirements. For my situation, and I expect for many producers of my size along the Appalachian chain where there is plenty of slope, 3/16 is a better choice but be prepared to bleach throughly every year.