When to Add a Second Tap Under Vacuum? - Part 2

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In a previous article we reviewed previous work and described an approach to determine the amount of syrup gained by adding a second taphole to a tree (Perkins et. al. 2025). This study follows up on that work by determining yields from trees across a wide range of sizes with either a single, or two tapholes, over several seasons.

This work was conducted at the UVM Proctor Maple Research Center in Underhill Center, Vermont, from 2019-2024. In 2019 and 2020, red maple trees were studied. Sixteen trees averaging 15.1 inches dbh (range 13.1-19.4 inches dbh) were used. Half the trees had a single taphole with the other half having two tapholes. When two-taps were used, one taphole was drilled above the lateral and the second taphole drilled below the lateral on the opposite side of the tree. This approach was chosen to maximize the separation of tapholes on the stem as a way to maximize sap yield. Droplines were 36" and tapholes were 5/16 inches diameter drilled 2 inches deep. All tapholes within a season were drilled on the same day by the same person. Vacuum was supplied by a Busch rotary-claw pump running at 27-28.5" Hg.

From 2021 to 2024 (4 seasons), the yield from sugar maple was measured. For the 2021 and 2022 seasons, 20 trees were selected with an average dbh of 15.8 inches (range 12.7-23.4 inches), with 10 trees having a single tap and 10 trees having two taps. Again, tapholes were on opposite sides of the stem and above and below the lateral line. During the 2023 and 2024 seasons, larger trees were used, with an average diameter of 24.7 inches (range 18.7-32.5 inches dbh), again with tapholes placed for maximal separation.

Tapholes were connected to individual vacuum sap collection chambers in which sap could accumulate during each flow period. Sap yield and sap sugar content was measured after each flow and totaled for the season. In some cases, particularly with red maple in 2020, tapholes for undetermined reasons produced little or no sap. In those cases, the data for those trees was discarded.

For red maple in 2019, two tapholes from one tree produced on average 21.8% more sap than one taphole. In 2020, two tapholes produced only 1.8% more sap than a single taphole.

As noted earlier, the 2020 results included several dry (or nearly dry) tapholes, so it is unclear whether the low additional sap yield was due to seasonal variation, was normal, or was due to the high number of dry tapholes.

With sugar maple, the additional amount of sap collected from 2021-2024 averaged 28.8% with a range from 22.7-37.7%. In general, the amount of sap collected across the two tapholes in the two-tap trees within each season was roughly equal. The greatest difference occurred in 2024, when by the end of the collection period 60% of the taps placed below the lateral (on the south side of the tree) had dried out, compared to only 10% of the taps placed above the lateral line, including both the single and double-tapped trees. This also likely reduced sap yield from the two-tap trees, thus causing a somewhat lower additional amount of sap from those trees that year. Additional sap yield from the two-tap trees over the one-tap trees for red maple in 2019 was 21.8%, close to the low end of the difference seen for sugar maple trees.

Sap sugar content did not differ substantially between one and two-tap trees, averaging 1.86 and 1.78°Brix, respectively. In three of the seasons, sap from one-taphole trees was marginally higher – in other years the sap from the two-taphole trees was slightly higher.

Over the six years of study, including both red and sugar maple, the average increase in sap yield with a second tap for trees was 23.1%. If we exclude 2020, the average increase in sap yield for red and sugar maple with two taps is 27.4%, which is close to the 28.8% average increase of sugar maple alone.

In order to examine the effect of tree size on sap yield increase, plots of sap yield by tree diameter were constructed and linear regressions of sap yield by tree size calculated for one-taphole and two-taphole trees for each year. From these relationships, the amount of additional sap that could be produced from two-tapholes above that of a single taphole was calculated for a range of sizes for each year of the study (Figure 1). Due to the low number of trees and the high number of dry tapholes, data from 2020 (red maple) was not used in this analysis.

Trends for sugar maple trees from all years showed general steady increases in the amount of sap produced from two tapholes as compared to one as tree size increases. Results from the 2021/2022 seasons (sugar maple, smaller average tree size) produced a higher amount of additional sap with two tapholes than the 2023/2024 seasons (sugar maple, larger tree size). This may somehow reflect the differences in experimental setup, or simply differences among the individual seasons. The amount of flow during individual seasons is strongly related to the number of high-flow events (Perkins et. al. 2025). Seasons with more high-flow events produce more sap whereas seasons with low-moderate flow flow events have little impact on total seasonal production. This is likely a result of the number, depth, and duration of thaws during each season, which is

highly variable from year-to-year.

Although there is significant variation from year-to-year, by combining the trends for sugar maple trees (2021-2024 seasons) and assuming an average sap sugar content of 2°Brix we see the average relationship between tree size and the additional amount of syrup produced (Figure 2). The estimates provided in this study broadly overlap with the estimates given in the previous work (Perkins et. al. 2025).

In this study, a tree of 13 inches diameter would produce 1.5 lbs of additional syrup with two taps over that with a single tap. A 15-inch diameter tree would produce 1.8 lbs more syrup. At 18 inches, the size at which a second tap is recommended in revised tapping guidelines (Perkins et. al. 2022, Isselhardt 2023), 2.1 lbs of additional syrup would be produced with a second tap. At 20, 25, and 30 inches diameters, 2.3, 2.8, and 3.4 lbs of additional syrup would be gained respectively. At a bulk price of US$2.50 per lb, this represents an increase in gross profit of $5.23 at 18 inches diameter (ranging from $3.85 at 13 inches to $8.40 at 30 inches). If selling retail, the gross profit would be considerably higher. However, the additional cost in terms of materials (tee, dropline, and spout) as well as labor for tapping and leak-checking should be subtracted to determine net profit with a second taphole. Given that costs are highly variable among operations, we won't attempt to calculate net profit from these es

timates, but will instead leave it to producers to use this information to decide for themselves at what point it is appropriate to consider adding a second tap to trees.

It should be noted that the amount of internal compartmentalization could also impact the amount of sap produced. Trees that have been tapped for many decades or large trees that are internally hollow have less wood volume to produce sap during a flow period. This similarly applies to vacuum level. The higher the vacuum, the further sap will be moved within the stem. Lower vacuum will draw sap to the taphole from a smaller volume than high vacuum, thus impacting the amount of sap produced by each taphole.

Consideration should also be given to the growth rates of trees, which typically are low for large, mature individuals. Adding a second taphole may not always be sustainable in terms of new wood growth and identifying adequate tapping areas on the stem (van den Berg et. al. 2016), although keeping tapholes widely separated within the tapping band (opposite sides and high/low) tapping below the lateral (Perkins et. al. 2016, Rademacher et. al. 2024) along with other tapping practices may help reduce the problem of hitting nonconductive wood (van den Berg et. al. 2024).

A second tap also has a cost in terms of materials (dropline) and time to install/maintain. Once installed, the potential exists for neglecting to actually drill the second taphole during tapping. If an

operation is diligent about leak checking this oversight will likely be found early in the season. . If this goes unnoticed however, the loss of sap would extend beyond that theoretical 20-30% additional sap and impact all the trees along the lateral line until the mistake is fixed. The ultimate decision of "if" and "at what diameter" to add a second taphole must largely be a personal decision of individual maple producers based upon their production goals, the tapping history, site quality which in turn influences growth rate of the trees, and the sap collection technology employed in the operation .

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Table 1. Sap yield from one or two tapholes from 2019-2020 in red maple and 2021-2024 in sugar maple on high-vacuum. The "2:1 Tap Sap Yield shows the additional amount of sap produced with two tapholes above that of a single taphole. "Taphole Sap Yield" compares the amount of sap produced by each of the two tapholes. 100% indicates the tapholes produced the same amount of sap.

Year	Species	Average Diameter (inches)	Sample Size (# Trees)	Sample Size (# Chambers)	1 Tap Sap Yield (gal/tap)	2 Taps Sap Yield (gal/tap)	2:1Tap Sap Yield (ratio)	Taphole Sap Yield (ratio)
2019	Red Maple	15.1	16	24	40.3	49.1	21.8%	95%
2020	Red Maple	15.1	16	24	41.4	42.2	1.8%	92%
2021	Sugar Maple	15.8	20	30	29.8	39.4	32.2%	101%
2022	Sugar Maple	15.8	20	30	42.7	58.8	37.7%	100%
2023	Sugar Maple	24.7	20	30	62.1	76.2	22.7%	109%
2024	Sugar Maple	24.7	20	30	79.4	97.4	22.7%	166%

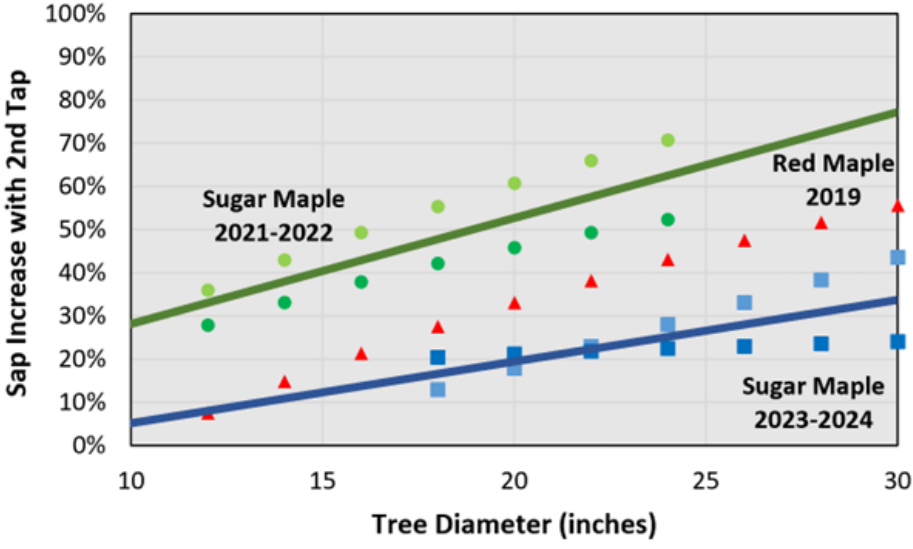

Figure 1. Estimated additional sap produced with two tapholes compared to a single taphole per tree across a range of tree diameters. Values were derived from regressions of sap yield increase with a second tap for red maple trees (2019) and sugar maple trees (2021-2024). Lines represent average linear fit for one set of sugar maple trees in 2021 and 2022 and for larger diameter trees in 2023 and 2024. Variations in the magnitude and slope of the lines probably reflects year-to-year differences in the number and type (low, moderate, high) of sap flows.

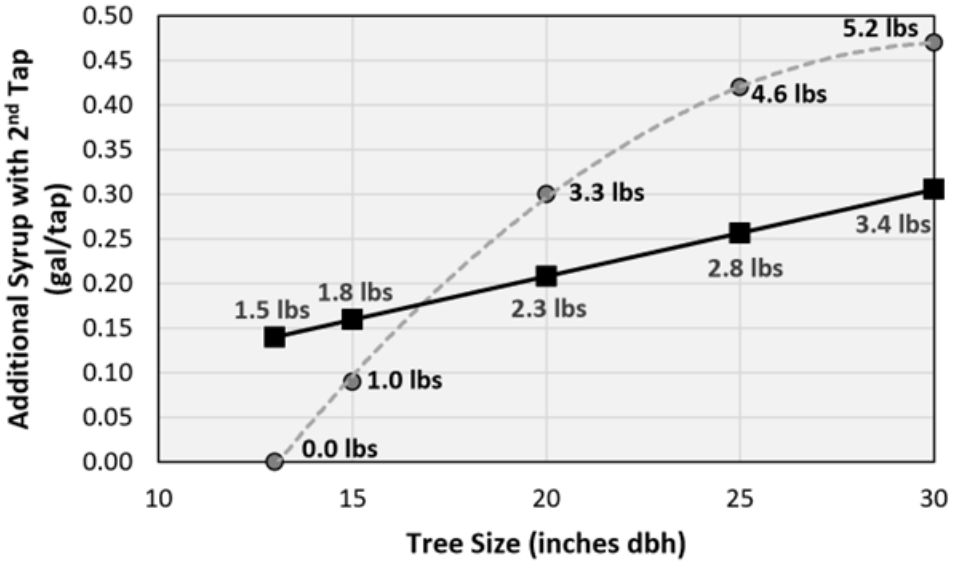

Figure 2. The amount of additional syrup in gallons per tap produced by a second taphole beyond that produced by a single taphole with high vacuum across a range of tree diameters. The squares and solid black line indicate the results of field studies from 2019-2024 described in this paper. The value accompanying each point is the gain in syrup in lbs/tap. The dashed curve shows the estimated results from the previous study (Perkins et. al. 2025, "When to Add a Second Tap Under Vacuum? – Part 1").