When to Add a Second Tap Under Vacuum? - Part 1

Timothy D. Perkins 1 , Abby K. van den Berg, Mark L. Isselhardt 2 , Brendan Haynes, Wade Bosley 1 , and
S. Abair 11 Proctor Maple Research Center, University of Vermont, Underhill, Vermont, U.S.A. and
2 Extension Maple Program, University of Vermont, Underhill, Vermont, U.S.A.

Determining the proper diameter at which to put a second tap in a maple tree can be difficult. The decision can be affected by numerous factors, including: tree diameter, tree growth rate, previoustapping history, whether vacuum is used and if so, what level, the additional yield of sap, and the cost/benefit ratio (factoring in both time and $), among others. These considerations have factored intothe development and use of tapping guidelines. In some cases, guidelines were developed with science-based answers to some of these questions. In other cases, guidelines were more of a "rule-of-thumb"used by producers in broad regions. While tapping guidelines are mostly, as the name implies, non-regulatory suggestions, in other cases such as in organic production or when producers lease taps, neglecting to adhere to guidelines can have undesirable consequences such as revoked organic certification or losing the ability to access leased taps.

A review of the history of tapping guidelines relating to 7/16" spouts was published in the Maple Syrup Digest in 2004 (Chabot 2004). Since that time, most maple production has switched to the "small" spout ranging from 1/4" to 5/16" in diameter. Chabot followed up his initial tapping guidelines paper with another paper (Chabot 2005) which discussed many of the factors involved and was aimed at introducing new tapping guidelines. He suggested that a second tap was generally not indicated unless trees had very high growth rates or were very large.

For those able to read French, Grenier et al. (2008) provides a detailed analysis of the factors involved in determining the number of taps per tree. One of the primary results was that many trees in Quebec did not possess a growth rate high enough to sustain long-term tapping with even a single large spout. This work likely hastened the adoption of smaller (19/64" and 5/16") spouts by the maple industry in the U.S. and Canada.

Due to the considerably smaller wound produced, the minimum diameter for tapping was lowered after the introduction of the "small" spout in the mid-late 1990s. However, given the lack of research available at the time, the North American Maple Syrup Producers Manual 2nd Edition (2006) recommended the same tree diameter guidelines as those developed for 7/16" spouts. Despite this, many producers began tapping smaller trees shortly af.

ter the small spout was released, and tapping guidelines were revised to lower diameters over the following decade

On the topic of using multiple tapholes in the same stem, Wilmot (2013), in a study during the 2010 and 2011 seasons, found that with approximately 24″ Hg of vacuum, a second taphole produced an average of 52% and 66% additional sap in 16″ and 19″ diameter trees, respectively. In the same timeframe, van den Berg et al. (2013) suggested adding a second taphole only in healthy trees with excellent growth rates to avoid excessive and unsustainable rates of non-conductive wood formation. These and other studies led to the conclusion by Rademacher et al. (2023) that a second taphole on vacuum provides only a marginal increase in sap yield. At present, many producers using high-sap yield practices place only one taphole per tree regardless of diameter, or add a second taphole only sparingly.

As part of the focus at the UVM Proctor Maple Research Center to provide science-based research on the effects of various tapping practices on sap yields, we are interested in the amount of additional sap produced by a second taphole from both red and sugar maple stems. .

Our first approach to answer this question utilized data that were collected as part of a previous study examining syrup production (calculated from sap yield and sap sugar content) from individual trees across a wide range of sizes on a vacuum tubing system. These results (Figure 1) were first published by Isselhardt et al. 2018 and show a steady, linear increase in syrup yield as tree diameter increases, as indicated by the dashed line. In general, for each 1″ diameter increase, an additional 0.67 lbs of syrup was produced.

A closer examination of these data show that, although there is a great deal of variation, the best-fit trend (shown as a solid line) is not actually linear, but rather is a second-order polynomial (curved) line where increasing syrup yield with increasing tree diameter starts to deviate from the linear trend at about the middle of the tree size range in this study (13 inches dbh). The difference between the linear and best-fit trends in syrup produced increases as tree size gets larger. This variance reflects, in part, the potential amount of sap that is left uncollected in the absence of a second taphole. Given the physiology of sap flow this makes sense, as at some point the amount of time in the average sap flow event becomes insufficient for the majority of sap to be able to exit from a single taphole.

Figure 2 depicts the difference between the linear and curved trends more clearly. At a tree diameter of 13 inches no additional syrup is collected. At 15 inches, there is a gain of 0.09 gal of syrup (1.0 lbs) with a second tap. At 20 inches diameter, 0.3 gal (3.3 lbs) more syrup would be collected with a second tap, at 25 inches, the increase would be 0.42 gal (4.6 lbs) more syrup, and at 30 inches diameter the additional syrup would total 0.47 gal (5.2 lbs). Above 30 inches dbh, the projected additional syrup levels off, indicating that the maximum additional projected syrup gain with a second tap has been reached.

At what diameter the additional amount of syrup gained from a second tap makes sense to implement depends largely upon the overall cost of production for a given operation. Besides the material cost (dropline, tee, spout), there is also the time spent tapping and leak checking the additional tap. Producers frequently indicate that a second tap is easily missed while tapping, leading to leaks and delays reaching a tight vacuum system. Since the economic calculation will vary from operation to operation, the decision of whether or not and at what point to add a second tap is best left to each individual maple producer to make. As a rough example however, if the commonly used diameter of 18 inches to add a second tap is used, after subtracting out material cost the additional syrup gain will add a net profit of approximately $5.75 (discounting labor) for each second tap (at that size) at prevailing 2024 bulk syrup rates.

It should be emphasized that these potential syrup gains with a second tap are estimates only, and that confirmation with field experiments over several seasons is required. Clearly this analysis is a simple projection based upon one data set at a single location, and assumes that all the sap (and sugar) is available and will be collected with the addition of a second tap. In reality, the flow of sap from a taphole within one season is quite variable based upon how the season plays out, the aspect (direction) of the taphole, and (perhaps) the relative position and distance between the two tapholes used. Secondly, this analysis does not factor in the sustainability of adding a second taphole from a standpoint of wounding. Tapping intensity and development of non-conductive wood should always be a consideration, especially if dealing with large, slow-growing trees that have been tapped for a long period of time (van den Berg et al. 2013). Long-held, but incorrect and scientifically disproven recommendations about preferentially tapping on the south side of the tree, under a large branch, or over a large root concentrate nonconductive wood formation within a focused area and lower the changes of finding a clear wood. Those types of practices must be avoided.

Despite these issues, this study provides an estimate of the potential amount of syrup gained with a second taphole in mature maple trees under vacuum collection conditions and provides maple producers with valuable information they can use when making decisions about tapping practices to employ in their operations.

Literature Cited

Chabot, B. 2004. A History of Taps and Tree Size. Maple Syrup Digest 16A(1): 11-15.

Grenier, Y., J. Lavoie, and G. Boudreault. 2008. Vers la formulation de nouvelles norms d'entaillage pour conserver la production acéricole à long terme. Volet B: determination du nom bre d'entailles par arbre. Centre Acer, Saint Norbert d'Arthabaska. 27 pp.

Heiligmann, R.B., M.R. Koelling, and T.D. Perkins (Editors). 2006. North American Maple Syrup Producers Manual. Second Edition. Ohio State University Extension Bulletin 856. 329pp.

Isselhardt, M.L., T.D. Perkins, and A.K. van den Berg. 2018. Tree Size Matters. Maple Syrup Digest 57(1): 36-38.

Rademacher, T., M. Cliché, É. Bouchard, S.Y.S. Kurokawa, J. Raap, A. Deslauriers, C. Messier, S. Rossi, J. Dupras, É. Filotas, and S. Delagrange. 2023. TAMM review: On the importance of tap and tree characteristics in maple sugaring. For. Ecol. Mgmt. 535: 120896.

Wilmot, T.R. 2013. Sugar Maple Sap Yields Using One or Two Tapholes per Tree. Maple Syrup Digest 25A(2): 17-21.

van den Berg, A., T. Perkins, T. Wilmot, and M. Isselhardt. 2013. Technical Research Note – Tapping Guidelines for Current Sap Collection Practices. University of Vermont Proctor Maple Research Center, Underhill, Vermont. 3pp.

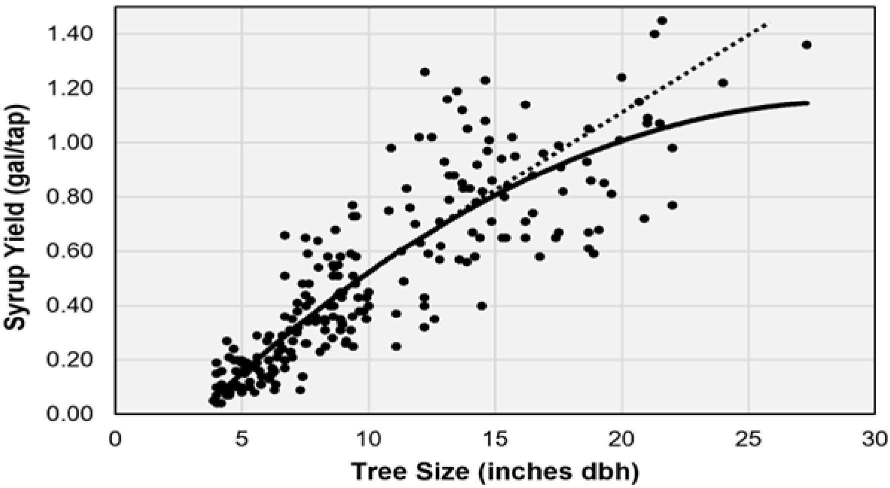

Figure 1. The relationship between tree size and syrup yield (derived from sap volume and sap sugar concentration measurements) on vacuum. All trees had one taphole and collection was done with vacuum. The dashed line is the linear-fit regression. The solid line in which syrup yield drops off as trees get larger is the second-order polynomial, best-fit line (r2 > 0.999). Figure is adapted from Isselhardt et. al. 2018.

Figure 2. The relationship between tree size and additional syrup yield that could potentially be collected from a second taphole in the same tree on vacuum. Figure is adapted from data presented in Isselhardt et. al. 2018. This represents the difference between the linear fit and polynomial fit lines to estimate the projected additional gain in syrup from a second taphole. Y-axis is in gal/tap and values for selected points within the figure are estimated additional syrup in lbs/tap at that diameter. The flattening of the curve above about 25 inches diameter indicates that additional sap might be able to be collected with a third tap in trees above that size, although this is not recommended based upon the impacts of internal wounding on tapping sustainability.