United States Department of Agriculture

Progress Report

Title:	**Research and Extension to remove barriers that limit transition from conventional to organic maple syrup production**

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Non-Technical Summary

Although maple producers are paid a large premium for organic maple syrup and the product is currently in very high demand, less than 5% of U.S. maple operations are currently certified organic. Maple producers, certifying agents, and other stakeholders have identified two primary barriers which exist that deter producers from transitioning from conventional to organic maple production: a lack of empirical data to support tapping guidelines for certified organic maple production, and a lack of an effective certified organic defoaming agent for use in maple syrup processing. These factors pose significant risks of reducing crop value, and thus they both discourage producers from becoming certified organic, and can cause substantial financial losses for currently certified operations. The overall goal of this project is thus to conduct the research and extension outreach activities necessary to remove these barriers and increase the number of certified organic maple operations in the U.S.

First, organic certifying agents specify guidelines for tree tapping practices that must be followed by certified organic maple operations, and that are aimed at ensuring that sap collection is sustainable in the long-term. However, the current guidelines are based on little scientific data on whether these practices actually result in the desired sustainable outcomes, and following them can result in significantly reduced yields and revenues for producers. The risk of reduced economic returns without a substantiated need supported by scientific data presents a significant barrier that deters producers from transitioning to certified organic maple production, and thus the first objective of this project is to collect the data necessary to support guidelines for sustainable tapping practices for certified organic maple production. Also, organic maple producers are required to utilize a certified organic defoaming agent for foam control during processing of sap into syrup, and most opt to use organic vegetable oils. However, because these products are not specifically formulated for this purpose, they exhibit poor foam control and contribute to the development of off-flavors that substantially reduce the value of the syrup produced. This presents a substantial risk of profitability reduction that deters maple producers from becoming certified organic, and thus the second objective of this project it to identify an effective certified organic defoamer for maple syrup production.

To accomplish the project objectives and overall project goal, we will first conduct experiments to determine the volume of nonconductive wood generated by taphole wounds in maple trees, the impact of tapping on tree growth and health, and the sap yields from smaller diameter trees. These data will then be used in model analyses to develop and support guidelines for

tapping practices required to ensure that organic maple syrup production sustains the growth and production of maple trees. We will also conduct a series of laboratory and commercial-scale experiments to identify an effective certified organic defoaming agent, and develop best practices for its implementation. Once the project's experiments are complete, we will conduct a variety of extension outreach activities to communicate project information and results to maple producers, organic certifying agents, and other stakeholders throughout the maple-producing region of the U.S. to help remove existing barriers and encourage conventional maple producers to transition to certified organic maple production, including technical articles, a project website, presentations at maple industry conferences and meetings, and online seminars. These activities will help achieve the overall project goal of increasing the total number of certified organic maple operations in the U.S. In addition to numerous benefits to forest and tree health, ecosystem processes, food safety, and syrup quality, the achievement of this goal will also directly benefit producers by increasing the value of their syrup crops and net annual revenues. Thus, the outcomes of this project will ultimately help increase the competiveness and economic sustainability of certified organic maple producers, as well as those transitioning from conventional to organic production.

Accomplishments

Major goals of the project

The overall project goal is to conduct the research and extension outreach activities necessary to remove existing barriers that limit transition from conventional to organic maple syrup production, and increase the total number of certified organic maple operations in the U.S. This overall goal will be met by accomplishing four primary objectives:

Objective 1: Collect the data necessary to develop and support guidelines for tapping practices required to ensure that organic maple syrup production sustains the growth and production of maple trees and meets the NOP standard for Wild Crop Harvesting. Four supporting objectives will be accomplished to achieve this main objective:

1. Determine the volume of nonconductive wood generated by taphole wounds in maple trees,
2. Determine the impact of tapping and sap collection on tree growth rates and health,
3. Determine the average sap yields attainable from smaller-diameter trees and whether the value of these yields balances production expenses, and
4. Determine recommendations for the minimum diameter and tapping practices required to ensure that the growth and production of maple trees is sustained.

Objective 2: Identify an effective certified organic defoamer for maple syrup production and best practices for its implementation. Two supporting objectives will be accomplished to achieve this main objective:

1. Identify one or more defoaming agents that meet maple processing requirements and optimize rapid foam control with the quantity required, and
2. Identify and develop best practices for the effective application of the identified defoamer(s) in maple syrup processing.

Objective 3: Extension - Disseminate and communicate project information and the results of project research to maple producers and stakeholders throughout the maple-producing region of the U.S.

Objective 4: Evaluation - Monitor progress and evaluate the achievement of project objectives, outcomes, and impacts.

What was accomplished under these goals?

To date, the following activities have been completed toward achieving these objectives and the overall project goal:

Objective 1.1: To accomplish this subobjective, an experiment is ongoing to quantify the volume of nonconductive wood (NCW) generated by taphole wounds in maple trees. The process of felling study trees for this experiment at each of the 13 study sites began in fall 2018, and continued in spring and summer 2019. 110 trees at 9 sites across Vermont were felled and slabs from each that contain the nonconductive (NCW) column above and below each taphole (~8' in length) were brought back to the Proctor Maple Research Center lab. The portion of the slab containing the taphole wound was removed laterally with a chainsaw, and then systematically cut into 2"-wide cross-sections with a circular saw. Each cross-section was photographed for subsequent digital analyses to quantify the volume of NCW.

Objective 1.2: An experiment to determine the impact of tapping and sap collection on tree growth and health is ongoing at 15 sites across VT and NY. In 2017, plots were established in stands that had never been tapped for maple production at cooperating organic maple operations. In each stand, 10 healthy, dominant or codominant trees in each of 5 size classes (6, 8, 10, 12, and 14" dbh) were selected. Half of the trees in each size class were assigned to the "Treatment" group, and the

other half to the "Control" group. "Treatment" trees were set up by each producer to be tapped for sap collection with vacuum as usual, and "Control" trees were left untapped. During the summer prior to the first season of sap collection, crown health indices of each tree were assessed, and the diameter at breast height was measured in the fall at a location semi-permanently marked for future measurements. Study trees were tapped for the first time in spring 2018, and the health indices and diameter of each were then remeasured in the following summer. During this reporting period, the first re-measurement of radial growth of trees at each study site was completed during November 2018. Study trees at each stand were again tapped (or remained untapped) during the spring 2019 production season, and crown health indices were re-measured during summer 2019. Radial growth will be measured in the fall of 2019. Coordination of study activities and participation with cooperating producers (proper tapping of study trees, stand access, etc.) continued, and data on tree radial growth and health indices continued to be compiled.

Objective 1.3: To accomplish this subobjective, an experiment to quantify the average sap yields from trees of varying sizes near the current minimum diameter specified in tapping guidelines for organic maple production was continued. Forty-eight healthy trees in a uniform stand at the Proctor Maple Research Center (PMRC) research sugarbush were selected, 8 each in 6 diameter classes, 4, 5, 6, 7, 8, and 9". Each tree was fitted with a graduated sap collection cylinder connected to the PMRC vacuum system. All trees were tapped for sap collection on the same date as the PMRC sugarbush using standard taphole depth and size. The volume and sugar concentration of sap produced by each tree was then measured after each sap flow period (typically daily) for the complete production season. The experiment was performed initially in the 2018 maple production season. During this reporting period, the sap yield experiment was repeated in the 2019 spring production season. These data were combined with the data from the 2018 production season and used to calculate the overall average total sap yield from trees in each diameter class. There was a direct linear relationship between tree diameter and yield, and average total production ranged from 0.11 (±0.008) gallons of syrup equivalent per tree in 4" trees, to 0.42 (0.010) in 9" trees.

Objective 2.1 and 2.2: To accomplish this subobjective, previously, laboratory-level experiments were conducted to identify a candidate agent that exhibited better efficacy than the current standard organic defoamer used in maple production (certified organic vegetable oil). During this reporting period, pilot-scale evaluations of the selected agent with commercial maple equipment were performed. Four certified organic maple producers were recruited as cooperators, and each received the candidate agent to use in pilot testing for the spring 2019 production season. They completed pre-season surveys to assess the efficacy of and satisfaction with their current organic defoamer. They also received instructions on how to use the candidate defoamer, as well as general best practices for defoamer use in maple production. They were instructed to use the candidate defoamer for the entire production season. After the season, they completed a survey to assess the performance of the candidate defoamer. The producers were also asked to collect 3 samples of the syrup they produced during the season (early, middle, and late portions) for use in assessment of defoamer off-flavor. Results indicated that the candidate defoamer was significantly preferred over the previous organic defoamer used by the pilot producers, particularly when peristaltic pump-type dispensers were used. Assessment of syrup flavor of each sample was conducted by 6 individuals at UVM PMRC trained to recognize organic defoamer off-flavor/texture. No off-flavor/texture was detected in any of the samples. The results suggest that the candidate defoamer is significantly more effective than current organic defoamers used in maple production, and does not result in impacts on flavor that would be unacceptable.

What opportunities for training and professional development has the project provided?

{Nothing to report}

How have the results been disseminated to communities of interest?

Results of the laboratory-scale defoamer experiments were presented to maple producers and industry stakeholders in presentations at maple equipment manufacturer open-house events in April 2019. Updates on project activities have also been posted on the project website.
"Proctor Maple Research Center Research Update (including organic defoamer research)", Dominion and Grimm Open House, St. Albans, VT, April 27, 2019.
"Proctor Maple Research Center Research Update (including organic defoamer research)", Lapierre Equipment Open House, Swanton, VT, April 27, 2019.
"Proctor Maple Research Center Research Update (including organic defoamer research)", Dominion and Grimm Open House, St. Albans, VT, April 26, 2019.
"Proctor Maple Research Center Research Update (including organic defoamer research)", Lapierre Equipment Open House, Swanton, VT, April 26, 2019.

What do you plan to do during the next reporting period to accomplish the goals?

During the next project period, the following activities will be conducted towards accomplishing the projective objectives and overall goal:

Objective 1.1. Image analysis software will be used with the cross-section images to quantify the volume of NCW generated by each taphole wound. These data will be used to quantify the average volume of NCW generated by taphole wounds, an essential factor required to assess the sustainability of tapping individual trees of varying sizes and accomplish the overall objective of developing guidelines for sustainable tapping practices. In addition, the size of the radial growth rings will be measured to assess the growth rate of each tree - these will be used to determine if the size of NCW columns is correlated (either directly or inversely) with radial growth rate. Also, trees at an additional 4 sites will be felled and analyzed.

Objective 1.2: Measurement of radial growth of trees at each study site will be completed during November 2019. Study trees at each stand will again be tapped (or remain untapped) during the spring 2020 production season, and crown health indices re-measured during summer 2020. Tree growth and health indices data will ultimately be compiled and used to determine if significant differences exist between Tapped and Untapped trees, and thus assess the impact of tapping on tree growth and health. These data on the impacts of tapping on tree growth and health will allow assessment of the sustainability of tapping trees of varying sizes near the current minimum diameter specified in tapping guidelines for organic maple production, essential to accomplishing the overall objective of developing data-based guidelines for sustainable tapping practices.

Objective 1.3: Financial analyses will be conducted to determine the net economic return (revenue from sap yield minus costs) of tapping trees in each size class. These data will be used to calculate the benefits (or losses) of tapping trees of varying sizes near the current minimum diameter, another essential element in developing sustainable guidelines for tapping practices.

Objective 1.4: All data from the three previous objectives will be used to accomplish this objective; activities toward determining recommendations for the minimum diameter and tapping practices required to ensure that the growth and production of maple trees is sustained will occur as the data become available.

Objective 2.1/2.2: The results and data from the pilot- and laboratory-scale experiments will be used to develop best practices for use of the candidate defoamer, and thus meet the overall objective of identifying an effective certified organic defoamer for maple syrup production and best practices for its implementation.

Objective 3: Results and information from the work completed thus far (particularly for the identified defoamer and its best practices) will begin to be disseminated to producers and industry stakeholders in presentations at maple producer and industry conferences throughout the maple-producing region, including maple equipment manufacturer open-houses in April 2020, and summer producer organization meetings. Available results and information will also be posted on the project website.

Objective 4: Producer contact information will be collected during all extension activities to facilitate follow-up assessment of project outcomes and impacts. Progress reports for the project will also be posted on the project website.

Participants

Actual FTE's for this Reporting Period

Role	Non-Students or faculty	Students with Staffing Roles			Computed Total by Role
		Undergraduate	Graduate	Post-Doctorate	
Scientist	0.5	0	0	0	0.5
Professional	0	0	0	0	0
Technical	0.8	0	0	0	0.8
Administrative	0	0	0	0	0
Other	0	0	0	0	0
Computed Total	1.3	0	0	0	1.3

Student Count by Classification of Instructional Programs (CIP) Code

{NO DATA ENTERED}

Target Audience

The target audience served by this project consists of conventional and organic maple producers, organic certifying agents for maple syrup production, other maple industry members (equipment manufacturers, etc.), and maple Extension personnel throughout the maple-producing region of the U.S.

Products

{Nothing to report}

Other Products

Product Type

Data and Research Material

Description

Data on growth and health of trees tapped for maple production, the size of nonconductive wood generated by taphole wounds, the sap yields from small-diameter maple trees, and the efficacy of a new organic defoamer for maple production were generated.

Changes/Problems

Five of the cooperating producers in the growth rate experiment (Objective 1.2) were unable to tap the trees in their study stands during the first production season (2018) of the experiment. Most were subsequently able to install the required infrastructure and tap their study trees for the next production season (2019). We have submitted a notification (7/17/19) that we are using our authority to extend the end date by 12 months (without funds) to allow adequate time to complete the project objectives in light of these delays.