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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Program Name: Organic Transitions

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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 was initiated to quantify the volume of nonconductive wood (NCW) generated by taphole wounds in maple trees. First, activities to locate and recruit certified organic maple producers to participate in this portion of the study were conducted, including distribution of project information and announcements during presentations at maple conferences and meetings, through producer networks, online producer forums, the project website, and numerous calls and emails to individual producers. Ultimately, 13 certified organic maple producers agreed participate and have 10-20 of trees in their operation be destructively harvested for the project. Appropriate trees at each operation were identified and their size and overall health indices (crown condition, etc.) measured. Producers were instructed to place a standard taphole in each study tree during the 2018 production season. After the season, spouts were removed as usual and the taphole location marked. The process of felling study trees at each site will begin in fall 2018. When completed, this experiment will 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.

Objective 1.2: An experiment was initiated to determine the impact of tapping and sap collection on tree growth and health. More than 30 stands across Vermont and New York were evaluated to identify potential stands suitable for the experiment, stands in certified organic maple operations with sugar maple trees that had never been tapped before but were planned to be tapped starting in the 2018 production season. Study stands must also not have been recently thinned, logged, or impacted by any insect, disease, or other significant stressor. Ultimately, 15 stands appropriate for the study were identified, and detailed assessments were conducted at each to collect data on tree size (diameter at breast height, dbh), health (crown condition including dieback, transparency, and live crown ratio), and canopy position, for all sugar maple trees in the stand. These data were then used to select pairs of healthy trees matched for size, canopy position, and crown condition. At each stand, 5 pairs in each of 5 size classes (6, 8, 10, 12, and 14") were selected. Half of the trees were randomly assigned to the "Tapped" treatment, which were to be tapped as usual for maple production beginning in 2018. The other half were assigned to the "Control" treatment, which will remain untapped for the duration of the study. Once selected, study trees were marked with their assigned treatment, the location of dbh measurement was semi-permanently marked for future measurements, and the initial dbh for each tree was also measured. Dbh and tree health indicators will be measured annually for the remainder of the study. The first season of tapping was completed in spring 2018, and the first re-measurement of crown health variables is currently underway in summer 2018. 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: To accomplish this subobjective, an experiment was initiated to quantify the average sap yields from trees of varying sizes near the current minimum diameter specified in tapping guidelines for organic maple production. 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 (2/21/18) 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, concluding on 4/23/18. These data were used to calculate the total yield (syrup equivalent) of each tree, and the average total yield for each size class. Ultimately 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.

For all 3 subobjectives, data collection and analysis are ongoing, as such no results or impacts can be reported at this time.

Objective 2.1: To accomplish this subobjective, a search was first conducted to identify all possible certified organic defoaming/antifoaming agents that would be appropriate for use in maple production (processing conditions, neutral flavor, etc.). In addition, other potential candidate agents or non-chemical defoaming techniques were identified from the literature and from maple producer experience and anecdotal accounts. Laboratory-level experiments were then conducted to identify which of the identified candidate agents or techniques exhibited better efficacy than the current standard organic defoamer used in maple production (certified organic vegetable oil), and also resulted in no impact on flavor or production of off-flavors in finished syrup. Briefly, experiments were conducted with concentrated maple sap under identical conditions (sap volume, temperature, volume and timing of agent addition, etc.) to measure the efficacy of 15 candidate agents and techniques, as well as current industry standard certified organic and conventional defoamers. Efficacy was assessed as the height of the initial foam column and the speed of foam dissolution. The experiments were repeated 3 times with each agent/technique, and the results averaged. The flavor of each syrup produced in each experiment was also evaluated to assess flavor impacts and/or the presence of defoamer off-flavor. Results were analyzed and indicated that only one of the candidate agents or techniques had efficacy significantly greater than that of the current standard organic defoamer, with no impacts on flavor or off-flavors. This agent was thus selected to use in the pilot-scale evaluations planned as the next step in the project activities to accomplish the overall objective of identifying an effective certified organic defoamer for maple production and best practices for its use.

Other general project activities: The project website was designed and launched (http://www.uvm.edu/~pmrc/?Page=organictapping.htm), and the project advisory board was formed and its members

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 2018. Updates on project activities have also been posted on the project website.

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. The process of felling study trees for this experiment at each site will begin in fall 2018. Slabs from each that contain the nonconductive (NCW) column above and below each taphole (~8' in length) will be brought back to the Proctor Maple Research Center lab and systematically cut into 2"-wide cross-sections. Each cross-section will be photographed, and the volume of NCW measured using ImageJ software. 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.

Objective 1.2: The first measurement of radial growth of trees at each study site will be completed during November 2018. Study trees at each stand will again be tapped (or remain untapped) during the spring 2019 production season, and crown health indices re-measured during summer 2019. 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 guidelines for sustainable tapping practices.

Objective 1.3: The sap yield experiment will be repeated in the 2019 spring production season to help mitigate impacts of seasonal variations in climate and sap flow conditions on yields, and overall average data will be used to calculate the total sap yield from trees in each diameter class, and the net economic return (revenue from sap yield minus costs). 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 candidate defoaming agent identified in laboratory-scale experiments in Project Year 1 will be evaluated in pilot-scale experiments with commercial maple equipment. Four certified organic maple producers will be recruited as cooperators, and each will receive the candidate agent to use in pilot testing for the spring 2019 production season. They will use the defoamer as instructed for the full production season, and record notes on their observations and experiences with defoamer effectiveness, problems encountered, application issues, etc. In addition, syrup samples will be collected from each of the cooperating operations, and the flavor of these samples will be evaluated to determine if any defects in flavor or texture are detected in the syrup samples. These data will be used with the results of the laboratory-scale experiments 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 2019, 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

Accession No. 1010375 **Project No. VT-0077CG**

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	0.6	0	0	0	0.6
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	1.4	0	0	0	1.4

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

Type	Status	Year Published	NIFA Support Acknowledged
Other	Other	2018	YES

Citation

"Proctor Maple Research Center Research Update (included results of organic defoamer experiments)". Presentation at Dominion and Grimm Open House, St. Albans, VT, April 27 and 28, 2018.

Other Products

{Nothing to report}

Changes/Problems

{Nothing to report}