

# Maple Research at The University of Vermont

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## General Background

The Proctor Maple Research Center (PMRC) is a field station of the Vermont Agricultural Experiment Station of the College of Agriculture and Life Sciences of the University of Vermont. Established in 1947, it is devoted exclusively to the study of the biology of the sugar maple tree and to the development of new techniques for maple sap and syrup production. The PMRC is located in Underhill Center, Vermont, at 44°31'30"N 72°51'59"W at an elevation of 1300-1500'.

Approximately one-third of the 200 acre site is managed as an operating sugarbush supporting approximately 1,400 taps, with ample young trees, saplings and seedlings for replacement due to mortality. Remaining lands are equally divided among other non-sugarbush forest land, either unmanaged or utilized for timber and firewood extraction, and open land. The majority of the wooded land falls within the sugar maple - beech - yellow birch forest type. A few research plantations of pure sugar maple, balsam fir, or red spruce are also maintained.

## History

Research on biology of maple trees, methods to improve sap production, and economics of maple operations has been ongoing since at least the 1890s. In 1946, Governor Mortimer Proctor donated the funds to purchase the "Harvey Farm" in Underhill Center, thus creating the Proctor Maple Research Farm (later "Center"). Initially work on sap flow and other aspects of maple tree physiology were conducted out of an 8' x 12' research shed, but within a year, the first sugarhouse was constructed to allow research on syrup production techniques. Several years later, the C.H. Jones Laboratory was constructed, and served as the primary laboratory until it burned down in 1998.

## Current Facilities

Facilities at the PMRC include an 8000 ft<sup>2</sup> modern, high-quality laboratory constructed in 1990, with a second phase expansion in 1994, with space available for basic and applied ecological and physiological research of forest trees and chemistry of sap and syrup. Portals located in the main laboratory section allow instrumentation to remain in the lab while connected to forest trees. The lab is equipped with standard

equipment and apparatus, e.g., water purification, microscopes, centrifuges, balances, glassware, standard and ultralow freezers, and fume hoods. Specialized equipment available for this work include: a Spectronic Genesys 8 UV/VIS scanning spectrophotometer, Minolta SPAD and Optisciences chlorophyll content meters, and three chlorophyll fluorometers with varying capabilities.

A demonstration/research sugarhouse, constructed in 1993 is located near the laboratory. Sap is collected from experimental and demonstration tubing installations and processed into maple syrup. The sugarhouse is also used for educational tours and workshops. Currently the PMRC sugaring operation utilizes a reverse osmosis machine and a 3' x 10' Leader Evaporator Co. "Revolution" front pan, back pan and oil-fired arch. The backpan is equipped with a Steam-a-way unit for added efficiency of sap processing. Approximately 700-900 gallons of maple syrup are produced annually from about the end of February through mid-April, and sold through the University of Vermont bookstore. The majority of the sugarbush tubing supporting this operation was replaced in 2004, and the current installation represents a state-of-the art maple vacuum tubing system. The focus of the entire maple operation is on efficiency and yield. Since installation, the yield of the system has been 0.60 gal maple syrup per tap (2004) and 0.52 gal maple syrup per tap (2005). Production in the ten years preceding the new installation averaged 0.35-0.40 gal per tap. Regional U.S. averages are typically 0.15-0.25 gal maple syrup per tap.

Other structures include sheds, sap and barrel storage, as well as field research huts and shelters for instrumentation.

## Computing Environment

Computing at PMRC is via 10-15 personal computers (IBM compatibles) running the Windows XP Professional Operating System connected via a 100 mbs Ethernet switch and via a wireless A/B/G hub. A monochrome network laser printer, a color laser printer, and a large format (36" poster) printer provide hard-copy capabilities. Data integrity is ensured through the use of a high-speed 20-gigabyte Iomega backup system accessible across the LAN and from dedicated NAS (network accessible storage) drive located in the main laboratory and automatically backed up to a ghost unit located in the sugarhouse. Continuous access to the UVM campus mainframe system, the Internet, and library databases is accomplished through a high-speed satellite link, with dial-up connections serving as backup.

## Research Activities

Most of the research at PMRC has focused upon the basic biology of sugar maple trees, methods to improve the sap collection and processing, and on the chemistry, biochemistry, and microbiology of sap and syrup. Seminal findings have included:

- a better understanding of the sap flow mechanism and its dependence on meteorological changes.
- the observation that trees vary considerably in sap sugar content, and that sugar content is moderately heritable.
- development and improvement of methods to install plastic tubing.
- the invention of the dropline to prevent sap reabsorption.
- improvements in using vacuum pumps to increase sap yields.
- greater understanding of the role of microorganisms in determining syrup grade
- methods to detect adulteration of maple syrup by adding other sugars

More recent research at PMRC has focused on:

- hydraulic architecture and water relations of sugar maple
- contaminants of pure maple syrup
- adulteration via decolorization
- continued improvements in vacuum tubing installation
- evaluation of new sap collecting equipment
- impacts of global climate change on maple syrup production
- interrelationships among nutrition, forest health and sap production
- causes and ways to reduce or eliminate off-flavors in maple syrup
- foliar pigments and the light-harvesting apparatus

Research plans for the next five year period (2005-2010) include further work on improving and maintaining high yields of sap production from a maple tubing system, and studies on the impacts of sap processing technologies on chemistry, quality, and flavor of maple syrup.

## Vermont Monitoring Cooperative (VMC)

In addition to the work focusing on maple, PMRC is the site for a number of monitoring programs. Acid deposition was first measured in 1981 as an EPRI sponsored project. Since that time, the number of projects has grown to encompass several state, national, and international environmental monitoring (including forest health) studies. These programs are administered by the Vermont Monitoring Cooperative (<http://vmc.snr.uvm.edu>), a cooperative program of the State of Vermont, the University of Vermont, and the Green Mountain National Forest. The goals of the VMC are to promote an improved understanding of the conditions, trends, and relationships in the physical, chemical, and biological components of the forested ecosystems in Vermont, and to promote the efficient coordination of multidisciplinary environmental monitoring and research activities among federal, state, and private agencies and institutions with common interests in the long-term understanding, management, and protection of forested ecosystems.

## References

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