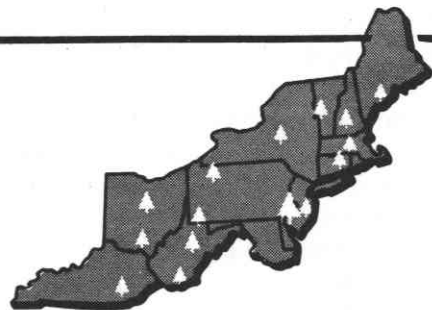


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VACUUM TRANSFER SYSTEM INCREASES SUGAR MAPLE SAP YIELD

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Abstract. Yields of sugar maple sap collected from three plastic pipeline systems by gravity, vacuum pump, and a vacuum pump with a transfer tank were compared during 2 years in northern Vermont. The transfer system yielded 27 percent more sap one year and 17 percent more the next year. Higher vacuum levels at the tapholes were observed in the transfer system.

The yield of sugar maple sap collected with a plastic pipeline and vacuum pump can be as much as 385 percent greater than that collected from the same trees by gravity (Blum and Koelling 1968), and this system is being used in many sugarbushes (Walters 1975). However, sometimes the distance from the trees in the sugarbush to the location of the vacuum pump is great, and there is a substantial loss in vacuum due to friction. The vacuum-transfer system was devised to reduce such loss and consequently increase the volume of sap collected.

During two maple sap-flow seasons in northern Vermont, larger volumes of sap were collected from a pipeline with a vacuum-transfer tank than from a similar pipeline without a transfer tank.

The pipeline with the transfer tank maintained higher vacuum levels at the tapholes.

THE STUDY

This study was conducted in a sugarbush in the town of Jericho, Vermont¹. The stand is typical of a northern Vermont even-aged sugarbush. The trees ranged from 40 to 71 cm in dbh.

A total of 111 study trees were tapped in 1973, and in 1974 the number was increased to 135.

¹ This sugarbush is located within the boundaries of the Ethan Allen Test-Firing Range, and is available for forest research by permission of The Adjutant General, Vermont National Guard.

Three tapholes were drilled in each tree in late February of both years. The tapholes conformed to industry standards.

Each of the three tapholes per tree were connected at random to one of three parallel pipeline systems. The systems were as identical as possible in all respects except the method by which sap was collected from them: gravity, vacuum pump, or vacuum pump with a transfer tank. The plastic pipelines were installed according to recommended procedures (Smith and Snow 1972, Lancaster and Walters 1974, and Walters 1975) (Fig. 1).

In the gravity system, the sap flowed downhill through the pipeline to the collection tank where it could be measured. The second pipeline was connected to a 151.4-liter steel tank where vacuum was created by a compressor-type vacuum pump. This tank was emptied by a water pump that was controlled by a float switch inside the tank (Fig. 2). As the sap was pumped from the vacuum tank, it was measured by a water meter. The third system—the vacuum-transfer system (Fig. 3)—differed from the vacuum system only in that a second tank was placed in the sugarbush (Fig. 4). Conduit lines from this tank branched out to different parts of the sugarbush. This system was designed to place the source of the vacuum closer to the trees. In this study, the tank was approximately 160 m from the vacuum pump. The slope from the transfer tank to the vacuum pump averaged

Figure 1.—The sap collection networks were constructed of 5/16-inch plastic tubing as unvented, aerial-line systems with droplines at least 18 inches long. The small lateral lines were connected to 1/2-inch main lines.



Figure 2.—Schematic of a sap collection vacuum tank. The float switch inside the tank automatically controls the water pump for sap removal.

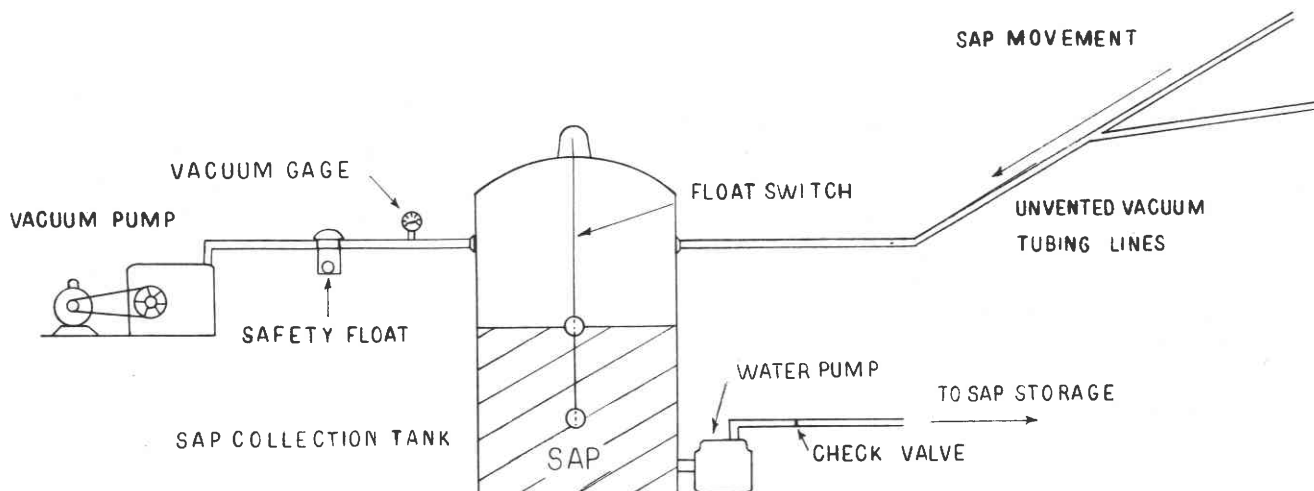
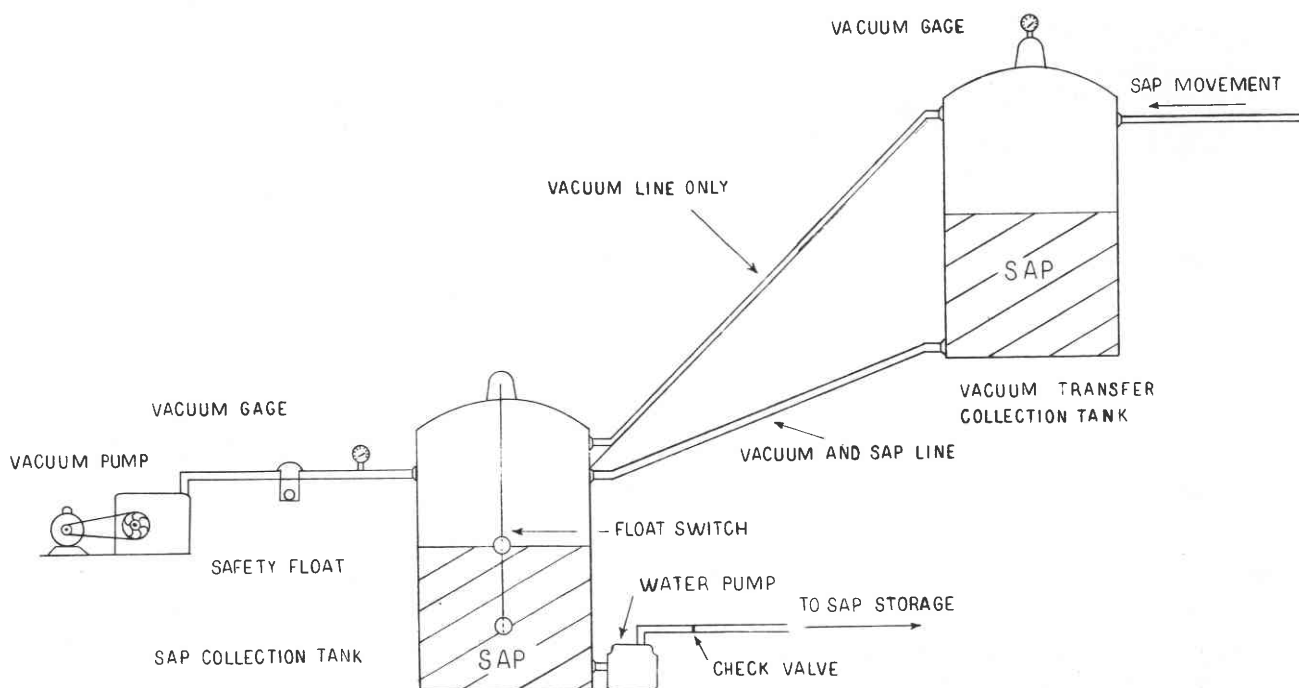


Figure 3.—Schematic illustrates how the vacuum-transfer tank is connected to the sap collection vacuum tank.



about 6 percent. Two pipelines connected the transfer tank to the vacuum tank: the pipe at the bottom carried sap, while the one at the top evacuated gases, which created a vacuum.

The vacuum levels between the two vacuum systems were equalized at the pumps so that one system was not favored. The pumps were controlled automatically by a thermostat set to turn on when the air temperature rose to about -1.5°C .

Vacuum gages were installed on each vacuum tank and on the transfer tank. Gages were also attached to each pipeline at the point farthest from the vacuum pump. The vacuum levels at these points were checked periodically.

The volume of sap for each sap flow was measured, and the average yield per taphole was determined. These data were subjected to an analysis of variance for randomized blocks. Each flow period was considered a block. The number of blocks was determined by the number of flow periods that occurred each year. Treatment means were compared by the Duncan Multiple Range Test (Duncan 1955).

RESULTS

The volume of sap per taphole collected by the vacuum-transfer system during each season was greater than that collected by the other two systems (Table 1). In 1973, the amount collected by vacuum transfer was 27 percent more than was collected by vacuum only, and 109 percent more than was collected by gravity. The amount collected by vacuum alone was 65 percent more than was collected by gravity. All of these differences were statistically significant. In 1974 the transfer system yielded 17 percent more sap than vacuum alone.

Table 1.—Average sap volume per taphole collected by three tubing systems, 1973 and 1974 (in liters)

Year	Vacuum transfer	Vacuum	Gravity flow
1973	43.3	34.1	20.7
1974	52.6	45.0	13.6

All pairs within the same year differ significantly (at $p < 0.05$) except those underscored.

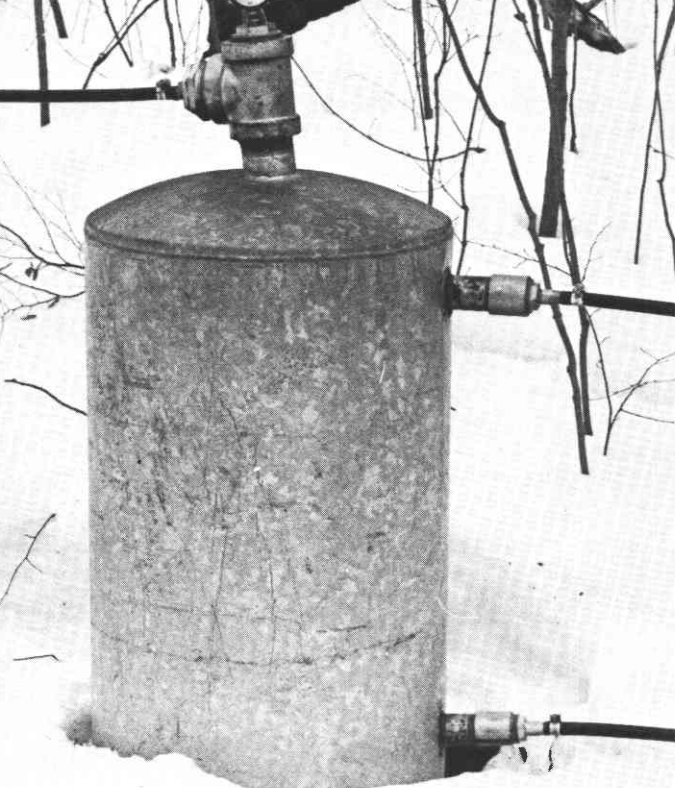


Figure 4.—The vacuum-transfer tank is in the sugarbush. Sap flows from the trees on the left into the tank. The upper pipe on the right removes air from the tank, creating a vacuum, and sap travels out through the lower pipe.

This difference was not significant. The transfer tank and vacuum systems produced 287 percent and 231 percent more sap, respectively, than the gravity system. These differences were highly significant.

The vacuum level created and maintained in the vacuum tanks by the pumps was very consistent, at about 565 mm of mercury (Hg). At the transfer tank, the vacuum level was generally somewhat less, about 450 mm of Hg. The readings at the tapholes farthest from the pumps during the sap flows averaged about 425 mm of Hg for the transfer tank and 350 for the vacuum system. The highest natural vacuum level that was recorded for the gravity system was 100 mm of Hg. However, quite often readings were 0, indicating no natural vacuum.

DISCUSSION

The major advantage of using a vacuum pump with sap collection pipelines is that vacuum can induce sap flow even when conditions are not quite

right for a natural flow. Vacuum can also increase the sap-flow rate from the taphole during normal flow periods (Yawney 1977). In addition, applied vacuum helps sap to flow quickly through the pipelines; this reduces the possibility of back-pressure buildup caused by pipeline overload which inhibits the sap yield. Applied vacuum also empties the pipeline at the end of a sap run so that sap residue does not freeze and block the line.

In the vacuum-transfer system, the two separate pipes from the transfer tank to the sap collection tank evacuated air from the system more efficiently than the single pipe in the vacuum-only system—thus the vacuum level at the taphole in the transfer system was higher, usually by 75 mm. We were able to maintain vacuum levels well above the recommended minimum of 250 mm of Hg (Walters and Smith 1975).

If there had been more distance between the transfer tank and the pump, the vacuum advantage at the tapholes probably would be even greater. If the distance is not greater than 200 m, the advantage may be only slight. In a sugarbush where the trees are as much as twice that distance or more from the vacuum pump and the collection tank, the transfer-tank system would be more effective, and is recommended.

LITERATURE CITED

- Blum, B. M., and M. R. Koelling.
1968. **Vacuum pumping increases sap yields from sugar maple trees.** U. S. Dep. Agric. For. Serv. Res. Pap. NE-106.
- Dufcan, D. B.
1955. **Multiple range and multiple F tests.** Biometrics 11:1-42.
- Lancaster, K. F., and R. S. Walters.
1974. **How to hang plastic tubing to collect maple sap.** U. S. Dep. Agric. For. Serv. Northeast. Area S & PF.
- Smith, J. C., and A. G. Snow, Jr.
1972. **Installing plastic tubing to collect sugar maple sap.** U. S. Dep. Agric. For. Serv. Res. Pap. NE-240.
- Walters, R. S.
1975. **Collecting maple sap with plastic pipelines and vacuum pumps.** Natl. Maple Syrup Dig. 14(3):14-17.
- Walters, R. S., and H. C. Smith.
1975. **Sugar maple sap volume increases as vacuum level is increased.** U. S. Dept. Agric. For. Serv. Res. Note NE-213.
- Yawney, H. W.
1977. **Why vacuum pumping increases sap production.** Natl. Maple Syrup Dig. 16(1):20-23.