2010 Sap Production Season
Northern New England/New York
Timothy Perkins, Director
UVM Proctor Maple Research Center

• Strange year
  – Started fairly early
  – Large variability in weather conditions from site to site
  – Moderate-low sap sugar, moderate-high niter
  – Short season
  – Relatively few freeze events
  – Extended thaw periods (vacuum-dominated flow)
  – Record high temperatures ended season abruptly

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Poor set of conditions for CV adapters to function
UVM Proctor Maple Research Center

2010 Air & Branch Temperatures
(courtesy of Tim Wilmot, UVM Extension)

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UVM Proctor Maple Research Center – Syrup Production

2004 - 2010

2,653 taps
1,548 gallons syrup
0.58 gal syrup/tap
Vacuum 21” Hg / 25” Hg

Syrup Production (gal/tap)

<table>
<thead>
<tr>
<th>Year</th>
<th>Syrup Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>0.73</td>
</tr>
<tr>
<td>2005</td>
<td>0.52</td>
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<tr>
<td>2006</td>
<td>0.67</td>
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<tr>
<td>2007</td>
<td>0.53</td>
</tr>
<tr>
<td>2008</td>
<td>0.51</td>
</tr>
<tr>
<td>2009</td>
<td>0.69</td>
</tr>
<tr>
<td>2010</td>
<td>0.58</td>
</tr>
</tbody>
</table>
2010 Sap Production Season at the UVM Proctor Maple Res Ctr

Research Studies

– Check-Valve Chambers (Timing of Tapping & Sanitizer)
– Equipment Comparison Study (CV and Drops)
– “Strategies” Study (Adapters vs CV & Drops)
– Survey of Maple Producers
– High Sap Yield Study (Mainline)
– High Yield Extraction Methods (Other)
– Sap Flow Rates under Vacuum
– Vacuum Transfer in Tubing Systems
– Sap Flow within Individual Trees
– Efficiency Study (Plate Heat Exchanger)
NEW tubing is better than old (but cleaned) tubing. The newer polyethylene (PE) tubing is better than the old polyvinyl chloride (PVC) tubing. 

**Tubing systems experience reduced sap yields as they age.**
Designed to prevent sap backflow

When the vacuum is interrupted (system shut down, leaks, releaser tips), sap can flow backwards in the tubing system back into the taphole (backflow).

Developed by UVM & Leader based upon the *UVM Check-Valve* concept (Patent Pending) under exclusive license agreement with Leader Evaporator Co., Inc.

Why is backflow of sap bad?

Spouts and tubing become contaminated within a short time (1-2 years), reducing maximum sap yields in vacuum tubing operations as they age. Microbial biofilms develop in the system that are nearly impossible to remove regardless of cleaning method.

Various methods of tubing washing will result in cleaner tubing, but will NOT completely eradicate microbes in the system. Residual microbes in the tubing result in rapid recolonization of the system by microbes as soon as it gets warm enough.

When sap flows backward into the taphole, it carries microbes from the spout, dropline and even the lateral line back into the taphole. The level of microbial contamination is affected by cleaning and tubing age.

Taphole “drying” (sap flow cessation) is a normal reaction of tree to microbes (fungi, yeasts, bacteria). This is part of the normal process of wound healing, but it does limit the amount of sap that can be extracted from a taphole. Sap could flow from tapholes longer in the season in many years.

The more sap backflow there is, the more microbes get into the taphole, the greater the wound response, the faster the taphole will dry out.
SUMMARY OF PREVIOUS SAP YIELD RESEARCH
WITH CHECK-VALVE ADAPTERS

2008 Chamber Study
25% Improvement in Sap Yield

2009 Chamber Study
32% Improvement in Sap Yield

2009 Equipment Study
58 – 91% Improvement in Sap Yield

2009 Sugarmaker Testing
12,000 spouts tested by selected maple producers

Important to distinguish the separate and combined contributors to increases in sap yield:

New Dropline Effect    New Adapter Effect    Check-Valve Effect

Due to the abrupt end of the 2010 season caused by the record high temperatures, we would expect all of these approaches to improve end-of-season sap yield to be muted.

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2010 SAP YIELD STUDY
CHAMBERS

Total of 48 trees (average 10.3” dbh)

One chamber per tree. Same direction.

Common vacuum source (~24” Hg)

30” drop 30P USED lines (7 yrs old)

Measured sap volume after each flow period throughout the 2010 season.

Calculated total sap volume for season.

3 Treatments (Incomplete Factorial Design)

• Tapping Date (January or March)

• Check-Valve vs. Normal Adapter

• Sanitizer / No Sanitizer (January only)

Chambers tend to minimize backflow and produce a higher yield, but smaller effect than we would expect to find in actual use.
Effect of Tapping Date (January vs March)

Sap Yield (gal/tap)

-6.6%
-7.8%

Treatment:
- January Normal Spout No Sanitizer
- January Normal Spout Sanitizer
- January CV Adapter No Sanitizer
- January CV Adapter Sanitizer
- March Normal Spout No Sanitizer
- March CV Adapter No Sanitizer
Effect of Spout Type (CV Effect Only)

- January Normal Spout No Sanitizer
- January Normal Spout Sanitizer
- January CV Adapter No Sanitizer
- January CV Adapter Sanitizer
- March Normal Spout No Sanitizer
- March CV Adapter No Sanitizer

Sap Yield (gal/tap)

- 24.4%
- 13.5%
- 7.9%
Summary of Check-Valve Spout Adapter Chamber Study

- Significant effect using CV Adapters (CV effect only)
- Difference in yield between CV and normal adapters is larger over longer time periods.
- Yields using CV Adapters in trees tapped in January continue to be good late in the season.
- Significant interaction between use of CV & Sanitizer.
- Taphole sanitizer use is somewhat effective with new regular spouts, and increases in effectiveness when used with CV Adapters (Note: taphole sanitizers are NOT a currently recommended strategy, more research needs to be conducted)
- Tapping in March resulted in somewhat reduced sap yields compared to tapping in January (highly dependant upon early runs and time tapping occurs).
“Strategies” to Maintain High Sap Yields in Vacuum Tubing Systems

**Objectives**

1. Quantify tubing system age-related losses in sap yield
2. Determine cost-effective management strategies to maintain high sap yields

**Experimental Design**

12 plots (4 trts, 3 reps)
Average 32 trees/plot
Mixed sugar/red maple
Common vacuum pump
Calibrated Releasers

Funded by grants from: USDA Hatch, UVM Agricultural Experiment Station NAMSC, VMSMA, Chittenden Co. Maple Sugar Makers

**Experimental Treatments**

- **Clean /maintain only (control)**
- **Replace all laterals/drops/spouts annually**
- **Check-Valve Adapters/Droplines (2010)**
Replace Laterals, Drops, Fittings, Spouts
Replace Spouts
Annually Replace Spout Adapters
Clean & Maintain Only
Replace Drops & Adapters
Replace Drops & Use CV Spouts

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**Equipment Comparison Study.** In most years, production is fairly equal across the different tubing systems. Normally you can expect about 25% of sap in early-season, 50% in mid-season (strong flows), and 25% in late-season as the sap slows down.
All sections tend to show similar patterns of sap flow over the season. Slight variations in total yield probably attributable to system design and installation.
Check-valve Adapters and Antimicrobial droplines yielded a 51-92% increase. Improvement was primarily observed in two distinct phases of season (early and late), but not during mid-season. Antimicrobial droplines had little effect.
2010 Equipment Comparison Study

Sap Yield (gal/tap)

Dual-pipe 0:0 CV Spouts
Dual-pipe 0:0 CST Spouts
Dual-pipe 7:7
Single-pipe 1:1

Date

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2010 Equipment Comparison Study

Four manifold breaks plus end of mainline valve failure during season

Installer straightened and tightened all lines from sugarhouse to first manifold before season began

New spouts + drops for 2009 season

Original system 1 manifold break in season

Date


Sap Yield (gal/tap)

0 5 10 15 20 25 30 35 40

5.1 gal (17.5%)

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Summary of Check-Valve Adapter Studies 2008-2010

Sap Yield Difference (% of Control)

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</thead>
<tbody>
<tr>
<td></td>
<td>26</td>
<td>32</td>
<td>76</td>
<td>91</td>
<td>65</td>
<td>58</td>
<td>13.5</td>
<td>24.4</td>
<td>72</td>
<td>104</td>
<td>17.5</td>
<td>30</td>
<td>45</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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2010 MAPLE SEASON SURVEY


94 Total Respondents
VT, NY, NH, Ont, OH, ME, MA, PA, CT, MI, WI, WV, Nb, Qbc.

3 bucket, 18 gravity tubing, 73 vacuum tubing
Operation Size from 35-14,400 taps (average ~2,400)
Total of > 224,000 taps represented in survey

Total of 35 questions about maple sap collection practices
Large focus on experience with Leader Check-Valve Spout Adapter

Filtered results to include only those respondents who used CV adapters in > 10% of their taps
Total of 53 producers met this criteria

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Compared to other spouts in my woods or neighbors woods, in terms of sap yield, do you feel the Check-Valve Spout Adapter...

<table>
<thead>
<tr>
<th>Answer</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Didn't use</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Yielded a lot less than a regular spout</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Yielded less than a regular spout</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Yielded about the same as a regular spout</td>
<td>6</td>
<td>12%</td>
</tr>
<tr>
<td>Yielded a little more sap (up to 10%)</td>
<td>11</td>
<td>22%</td>
</tr>
<tr>
<td>Yielded a good amount more sap (11-25%)</td>
<td>15</td>
<td>30%</td>
</tr>
<tr>
<td>Yielded a lot more sap (26-50%)</td>
<td>14</td>
<td>28%</td>
</tr>
<tr>
<td>I was drowning in sap (51%+)</td>
<td>3</td>
<td>6%</td>
</tr>
</tbody>
</table>
Do you feel that the Check-Valve Spout Adapter.....

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Didn't use</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Flowed for a lot shorter time than my other spouts or my neighbors spouts</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Flowed for a shorter time than my other spouts or my neighbors spouts</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Flowed about the same amount of time as my other spouts or my neighbors spouts</td>
<td>5</td>
<td>10%</td>
</tr>
<tr>
<td>Flowed a little longer (1-2 days) than my other spouts or my neighbors spouts</td>
<td>12</td>
<td>23%</td>
</tr>
<tr>
<td>Flowed a lot longer (3-7 days) than my other spouts or my neighbors spouts</td>
<td>13</td>
<td>25%</td>
</tr>
<tr>
<td>Flowed after all other spouts had stopped</td>
<td>16</td>
<td>31%</td>
</tr>
<tr>
<td>They're still running</td>
<td>4</td>
<td>8%</td>
</tr>
</tbody>
</table>

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Next season I’ll ... 

<table>
<thead>
<tr>
<th>Option</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not consider trying the Check-Valve Spout</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Try the Check-Valve Spout for the first time</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Stop using Check-Valve Spout Adapters</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Use them in about the same percentage as this year</td>
<td>6</td>
<td>11%</td>
</tr>
<tr>
<td>Increase the percentage of Check-Valve Spouts in my operation</td>
<td>14</td>
<td>26%</td>
</tr>
<tr>
<td>Put Check-Valve Spouts throughout my operation</td>
<td>10</td>
<td>19%</td>
</tr>
<tr>
<td>I had Check-Valve Spouts in all my operation this year and will again next year</td>
<td>22</td>
<td>42%</td>
</tr>
</tbody>
</table>
Did you experience any of the following issues with the Leader Check-Valve Spout Adapters?

(Multiple responses allowed)

<table>
<thead>
<tr>
<th>Issue</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Didn't try them</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Spout adapters broke more than usual when tapping</td>
<td>11</td>
<td>18%</td>
</tr>
<tr>
<td>Cage broke and ball came out when tapping</td>
<td>20</td>
<td>32%</td>
</tr>
<tr>
<td>Ball got sucked down lateral line</td>
<td>9</td>
<td>15%</td>
</tr>
<tr>
<td>Balls found in releaser</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Had to reseat them more than other types of spouts</td>
<td>11</td>
<td>18%</td>
</tr>
<tr>
<td>Other</td>
<td>10</td>
<td>16%</td>
</tr>
</tbody>
</table>

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Would you recommend to your friends who are sugarmakers that they try the Check-Valve Spouts?
Maybe the people who had the “best” experience with the Check-Valve Spout Adapter also put them on NEW drops?

Separate into results of two groups:
All used drops (1-6+ Yrs Old) 23 (CV+A)
All new drops 21 (CV+A+D)

If the increases in sap yield are due mainly to replacing drops, we should see a big difference in responses.

THERE IS NO EVIDENCE THIS IS THE CASE
Summary of Check-Valve Spout Adapter Research from 3 Yrs of Use and Study

• Still have some issues to address (breakage, manufacturing issue)
• Increase sap yield by 25-100% (CV + New Adapter Effect)
• Effective even in a year with an abrupt season end (the more prolonged the season, the greater the anticipated effect)
• Does it eliminate replacement of drop lines?
• Results achieved depends upon many factors
• Sanitizer? Not yet recommended. Needs further study.
• Tapping early? Yes
• Cleaning?
• Gravity tubing operations? Buckets?

Economic solution to end-of-season taphole drying
<table>
<thead>
<tr>
<th>Approach</th>
<th>$</th>
<th>Expected Results*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change buckets to tubing (natural vacuum)</td>
<td>$$$</td>
<td>+ 0 – 25%</td>
</tr>
<tr>
<td>Replace spouts and dropline (gravity)</td>
<td>$$</td>
<td>+ 25 – 100%</td>
</tr>
<tr>
<td>Add vacuum (to a Gravity tubing system)</td>
<td>$$$</td>
<td>+50 – 200%</td>
</tr>
<tr>
<td>Vacuum (&lt;15” Hg) to high vacuum (&gt;22” Hg)</td>
<td>$</td>
<td>+ 25 – 50%</td>
</tr>
<tr>
<td>Decrease # taps per lateral (&lt; 5)</td>
<td>$$</td>
<td>+ 10 – 50%</td>
</tr>
<tr>
<td>New spout adapter (replace each year)</td>
<td>$</td>
<td>+ 10 – 15%</td>
</tr>
<tr>
<td>Replace spouts and dropline (vacuum)</td>
<td>$$</td>
<td>+ 20 – 50%</td>
</tr>
<tr>
<td>Silver spout / silver dropline (first year)</td>
<td>$$</td>
<td>+ 15 – 27%</td>
</tr>
<tr>
<td>Silver spout / silver dropline (subsequent years)</td>
<td>---</td>
<td>+ 0 – 5%</td>
</tr>
<tr>
<td>Check-Valve spout adapter use (replace each year)</td>
<td>$</td>
<td>+ 25 – 75%</td>
</tr>
<tr>
<td>Replace tubing (retube woods)</td>
<td>$$$</td>
<td>+ 30 – 100%</td>
</tr>
</tbody>
</table>

* Expected results are based upon those anticipated by application of best management practices and range in effectiveness due to several variables and are not guaranteed.
THANK YOU