

# Harvest and Beyond

## Harvesters, Drying Oasts, and Pelletizing

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Morrisville, NY

Chris Callahan

UVM Extension Ag Engineering

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# Mechanized Harvesting

- Economics
  - Capital cost
  - Labor savings
- Quality
  - Harvest timing and duration
- Logistics
  - “Feeding the machine”
  - Will need more drying capacity
- Net Yield

***Strip and Sort***

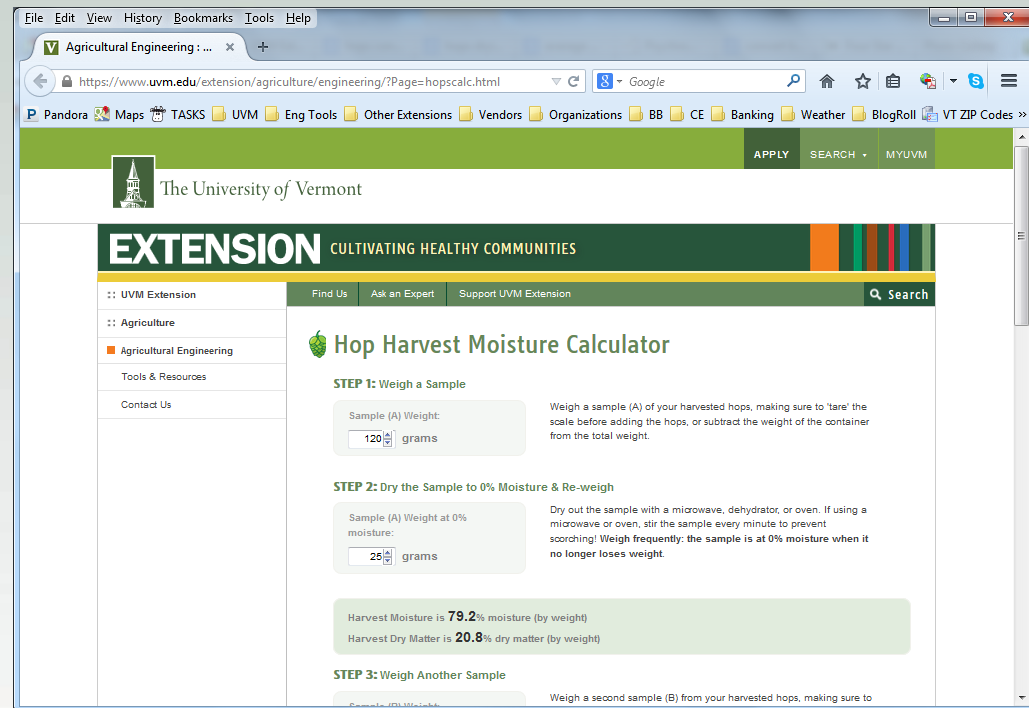
# Harvester Characteristics

- Cost
  - material, labor, assembly, retrofit, recurring
- Capacity (bines/hr)
- Crew
- Power source
- Portable vs. Stationary
- Effectiveness



# Harvest Timing / Readiness

- Should be based on dry mater.
- 20-23% DM, depending on variety
- DM determined by weighing/drying



The screenshot shows a web browser window displaying the 'Hop Harvest Moisture Calculator' on the University of Vermont Extension website. The browser's address bar shows the URL: <https://www.uvm.edu/extension/agriculture/engineering/?Page=hopscale.html>. The website has a green header with the University of Vermont logo and the text 'EXTENSION CULTIVATING HEALTHY COMMUNITIES'. A sidebar on the left contains a navigation menu with links to 'UVM Extension', 'Agriculture', 'Agricultural Engineering', 'Tools & Resources', and 'Contact Us'. The main content area is titled 'Hop Harvest Moisture Calculator' and contains three steps: 'STEP 1: Weigh a Sample', 'STEP 2: Dry the Sample to 0% Moisture & Re-weigh', and 'STEP 3: Weigh Another Sample'. Step 1 includes a text input for 'Sample (A) Weight:' with the value '120' and a unit dropdown set to 'grams'. Step 2 includes a text input for 'Sample (A) Weight at 0% moisture:' with the value '25' and a unit dropdown set to 'grams'. Below these inputs, a green box displays the results: 'Harvest Moisture is 79.2% moisture (by weight)' and 'Harvest Dry Matter is 20.8% dry matter (by weight)'. Step 3 includes a text input for 'Sample (B) Weight:' and a description: 'Weigh a second sample (B) from your harvested hops, making sure to...'. The browser's toolbar shows various icons for navigation and search.

Calculator (Web and Excel):

<https://www.uvm.edu/extension/agriculture/engineering/?Page=hopscale.html>

Instructional videos and wiki:

<http://www.uvm.edu/extension/cropsoil/hops>

## UVM Mobile Hop Harvester



Aroostook Hops – Westfield, ME - 2013





Northscape Photography

Aroostook Hops – Westfield, ME - 2014



# UVM Mobile Hop Harvester

- Open source design
- \$9,500 - 30,000
- 60 - 170 bines per hour
- 2 – 4 person crew
- Hydraulic power (tractor PTO)
- Strips and sorts
- Auto feed

Chris Callahan  
UVM Extension  
[chris.callahan@uvm.edu](mailto:chris.callahan@uvm.edu)  
802-773-3349

Google “UVM Hops Wiki”





Wolf WHE170 – Nicolas Schaut (Ontario)



**Wolf WHE170  
Four Star Farms  
(Northfield, MA)**



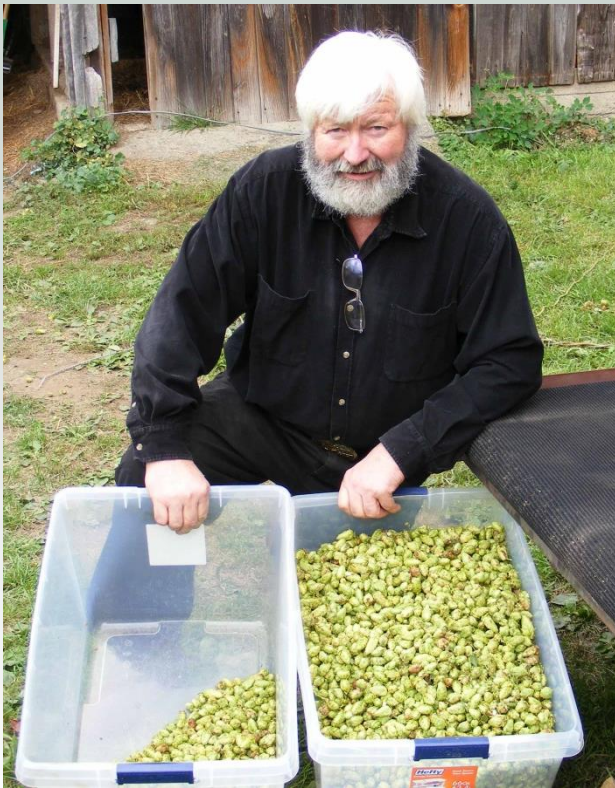


# Wolf Harvesters

- \$30,000 – \$45,000
- WHE140: 120-140 bins/hr
- WHE170: up to 170 bins/hr
- 1-8 person crews
- 3 Phase electrical power
- Strips and sorts (and can chop bins)
- Auto feed

Tom Frazer  
Dauenhauer Mfg, Co.  
707-546-0577  
tfrazer@dmfg.com  
www.dmfg.com

# Wolverine



Patrick Comerford  
607-661-7473  
[puckster5@juno.com](mailto:puckster5@juno.com)



# HopsHarvester.com



John Bonzo  
Mendon Precision, LLC.  
Honeoye Falls NY 14472 us  
[hopsharvester@gmail.com](mailto:hopsharvester@gmail.com)

Option	Initial Cost	Crew	Bine/Hour
Hand Picking	Zero	1	1
Crafty Hop Plucker	\$5,000	1	30-60
Bine 3060 (Addison Hop Farm, Addison, VT)	\$14,250	1-3	20-40
Steenland Hop Harvester 1000	\$11,800	1	120
LaGasse Mobile Harvester	TBD (custom harvest)	2	150-200 (est.)
UVM Mobile – Open-Source (UVM and others replicating Dean Heltemes, Todd Wycoff, Pat Comerford)	\$9,500-\$30,000	4	60-120
Wolverine	\$29,990	2-3	120
HopsHarvester.com	\$22,500	2-3	120
Wolf WHE140-170	\$43,500 complete	1+	140-170



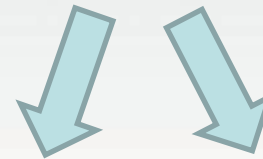
# Harvester Cost / Benefit

- Assume \$35,000 cost of harvester
- 120 bine/hour harvesting rate with machine
  - compared to 1.5 bine/hour manually
  - \$7.25/hr wage assumed
- 6 acres harvest per year
- 1500 bines per acre
- 1 lb dry cones per bine
- Retail pricing of \$10 per lb (dry)

**Machine simple  
payback period  
0.43 years**

# Drying

- Removing water
  - 77-80% moisture at harvest
  - 8-10% for stable storage
  - For every dry pound of hops, need to “boil off” 3.5 pounds of water.
  - Race between evaporation and oxidation



22% stuff  
your  
customers  
want  
(really less)

78%  
water



# Air and Water and Water in Air

- “Psychrometrics”
- Air can carry a fixed amount of water vapor
  - Depends on temperature
  - Relative Humidity is a measure of how much of the maximum water vapor is in the air

# Impact of Air Temp

Burlington, VT		
Month	Temp (DB, F)	RH (%)
Jan	19	75
Feb	22	66
Mar	31	63
Apr	46	57
May	57	62
Jun	67	69
Jul	70	68
Aug	68	72
Sep	59	74
Oct	48	72
Nov	37	69
Dec	29	67

68 F Air, 72% RH,  
**no heat** added



**24** CFM for 8 hrs  
of dry time per 1  
dry lb of hops

**24-48** ft<sup>2</sup>  
footprint

68 F Air, 72% RH,  
heated to **118 F**  
(14% RH) – 30  
Watts per dry lb



**2** CFM for 8 hrs of  
dry time per 1 dry  
lb of hops

**2-4** ft<sup>2</sup>  
footprint

Heat: About 1 BTU/hr (or 0.3 Watts) per CFM-degF heat  
Air Velocity: 0.5-1.0 ft/s – influences tray area (ft<sup>2</sup>)



# Simple



# Bigger

- Higher volume of fewer varieties



Square Nail Hops Farm –  
Ferrisburgh, VT



# More Complex



The oast includes two 4'x4'x8' cabinets with independent access doors and controls. Total capacity is 600 lbs wet hops which can be dried in 8 hours.



Different hop varieties can be kept separate in the oast by placing them in different trays. A total of 8 trays can be accommodated in each cabinet. Wire mesh is used as the bottom for the trays which allows air flow through the hops.

# Multi-tray Oast

- Good for lower volume of fewer varieties
- Well mixed
- Well controlled drying environment
- Fact sheet online at [UVM Wiki](#)



The fan and heater are installed on the ceiling of the cabinet. A PID controller (inset) rests on top of the cabinet and ensures temperature control.



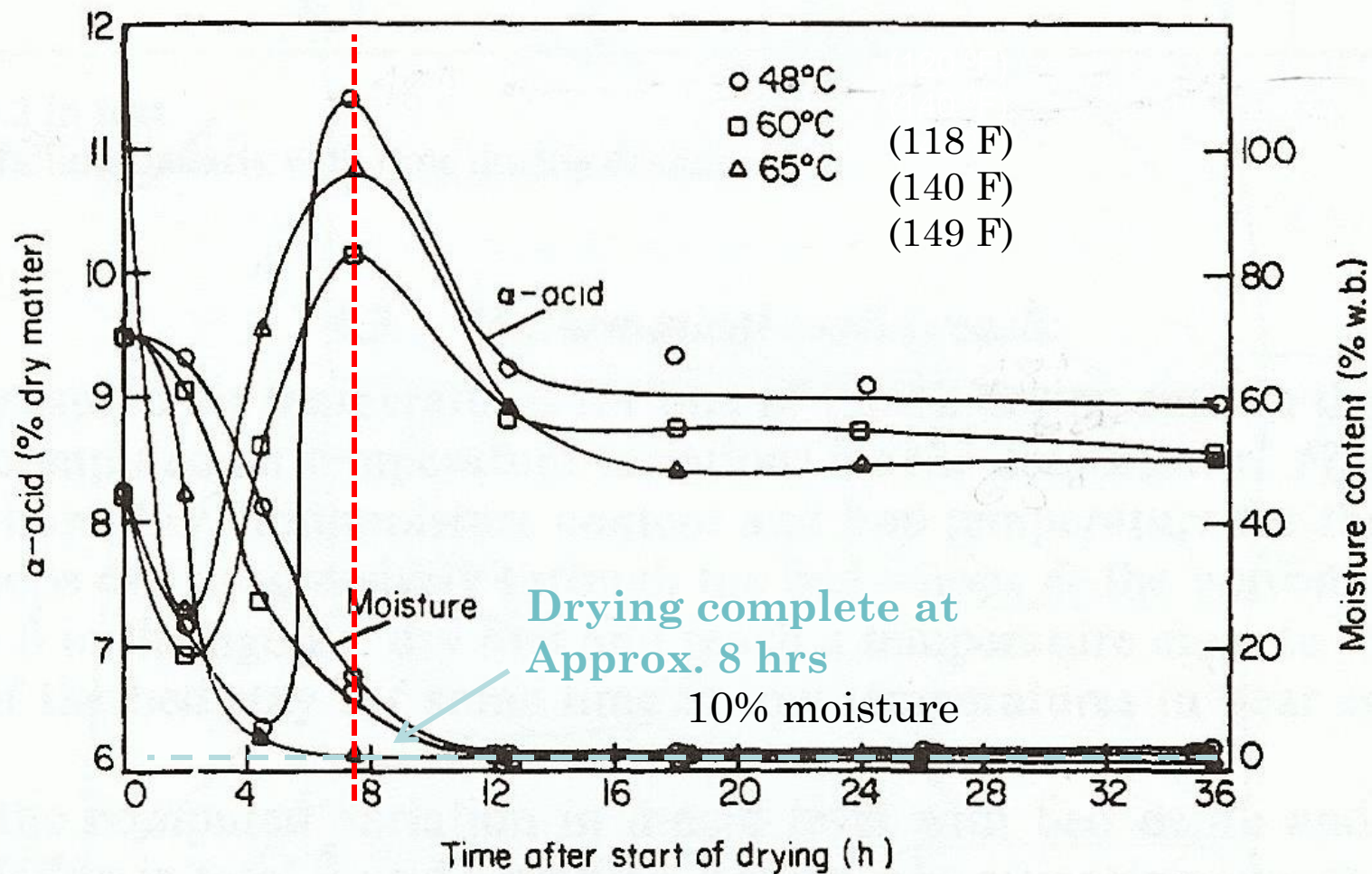


Fig. 7.  $\alpha$ -acid-temperature-time characteristics, 1975 harvest

Peak alpha acid at 48 C (118 F), dried in 8 hours

# Hops Pelletizer

## UVM Engineering Undergraduate Capstone Project

Kris Andersen (Addison, VT) and Bill Powell (Calais, VT) Sponsored







Customized Die

Protruding die fingers intended to allow better cooling of die and pellets with air flow around them.



Original Die

Note the greater number of holes in the original die. This allows greater through put for the same power input.







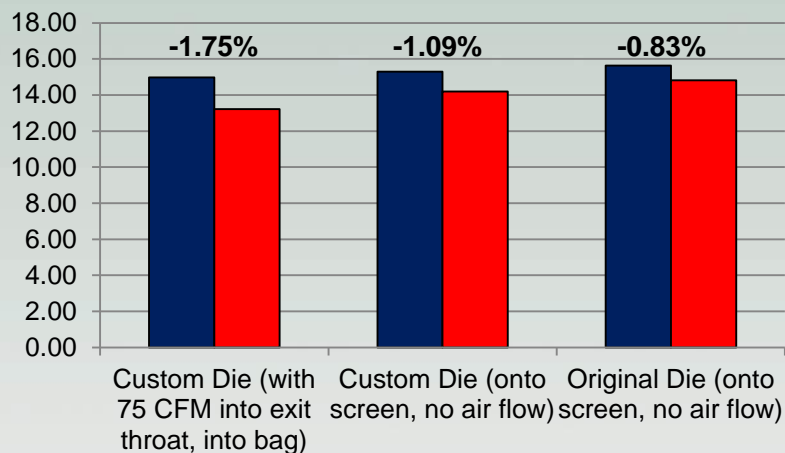
Nugget 2013  
1.35 lbs.

Nugget 2013  
1.35 lbs.

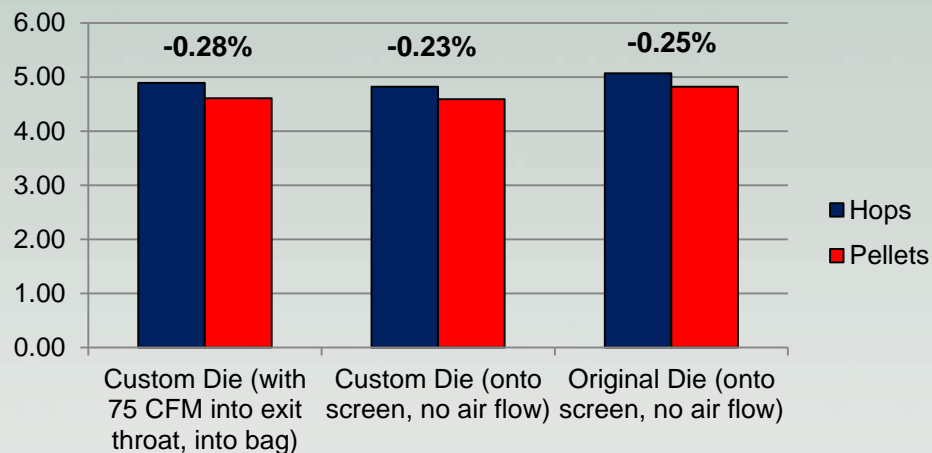
PELLETIZER #142  
SCOPS NUGGET  
COOLING  
1200 RPM PTO  
151 OF MAX THROAT  
111 OF MAX PILE  
149 OF AMBIENT

Approximate example of how much densification you achieve with pelletization. The two bags of baled whole leaf hops are about the same weight as the bag of pellets

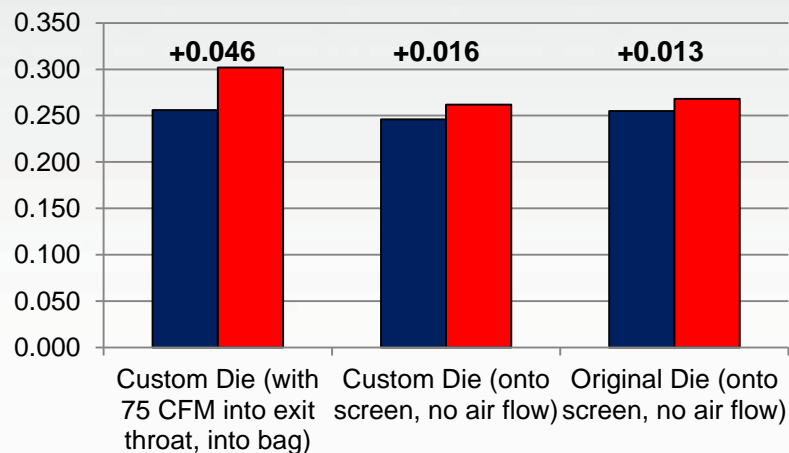
**Alpha Acid Reduction due to Pelletizing**  
Nugget 2013



**Beta Acid Reduction due to Pelletizing**  
Nugget 2013



**HSI Improvement due to Pelletizing**  
Nugget 2013



Not milled prior to pelletizing

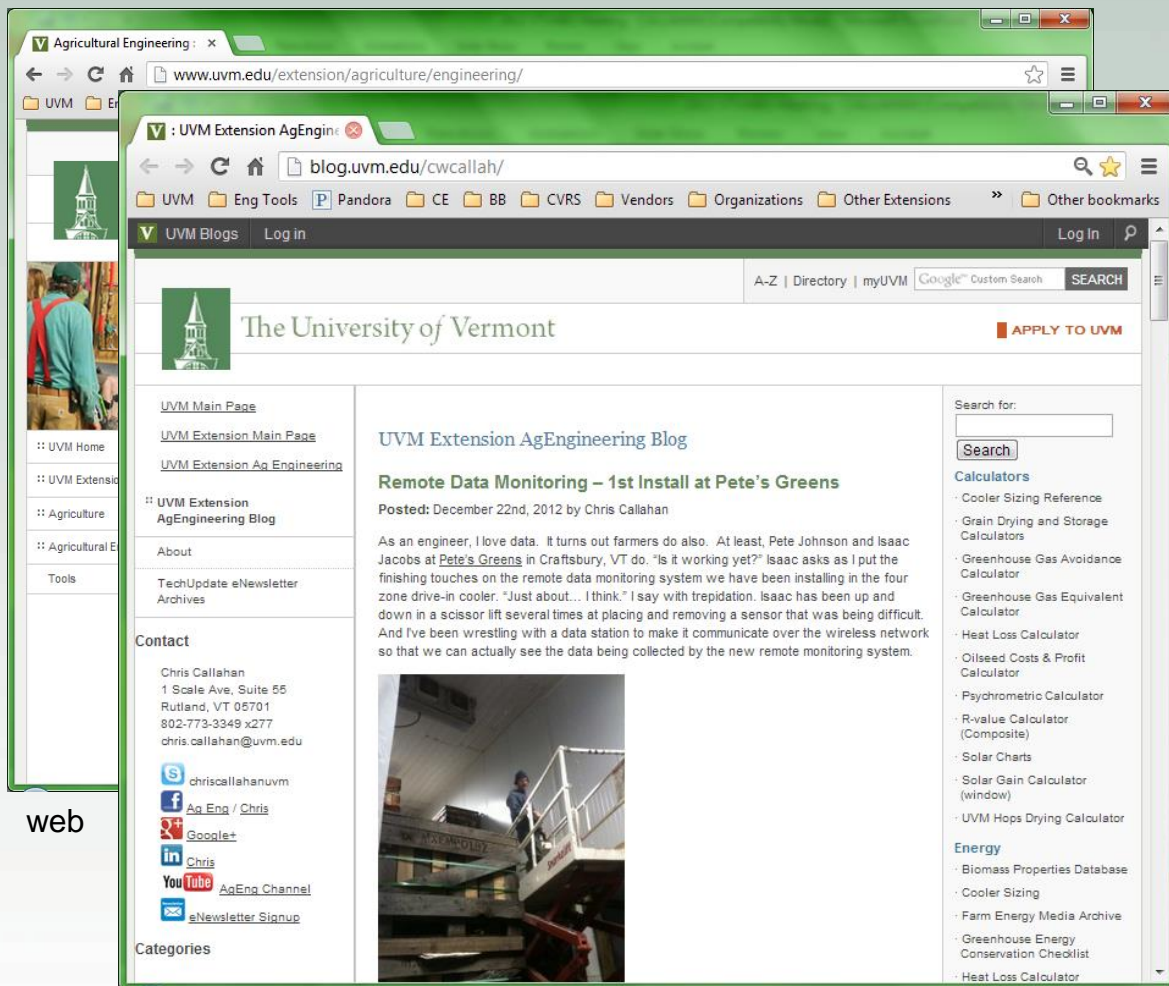
Ambient Temperature 69-75 degF

“Throat Temp” 109-151 degF

“Pile Temp” 106-185 degF

Rate 34-61 dry lb/hr





web

blog



eNewsletter

Chris Callahan

Rutland Office / [chris.callahan@uvm.edu](mailto:chris.callahan@uvm.edu) / 802-773-3349

[www.uvm.edu/extension/agriculture/engineering](http://www.uvm.edu/extension/agriculture/engineering)

[blog.uvm.edu/cwcallah](http://blog.uvm.edu/cwcallah)