Postharvest Storage

New Farmer Webinar

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Chris Callahan
UVM Extension Ag Engineering
chris.callahan@uvm.edu 802 773 3349
http://blog.uvm.edu/cwcallah

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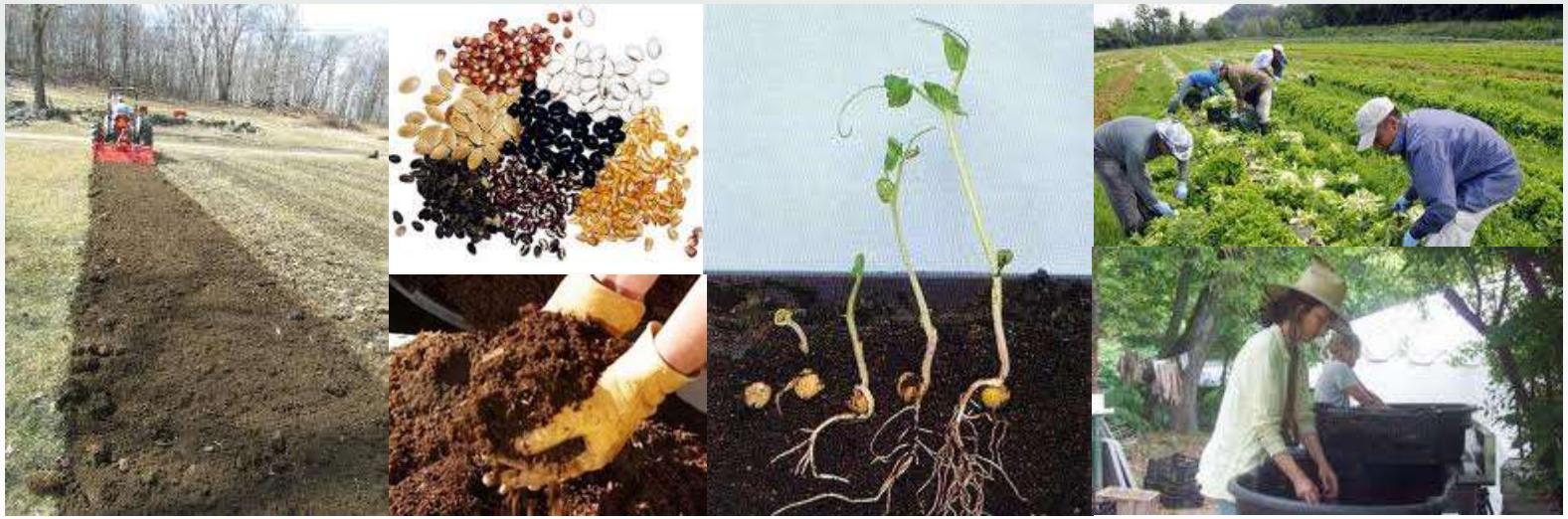
Outline

- Postharvest Basics
- 4 Crop Case Studies
- Systems & Monitoring



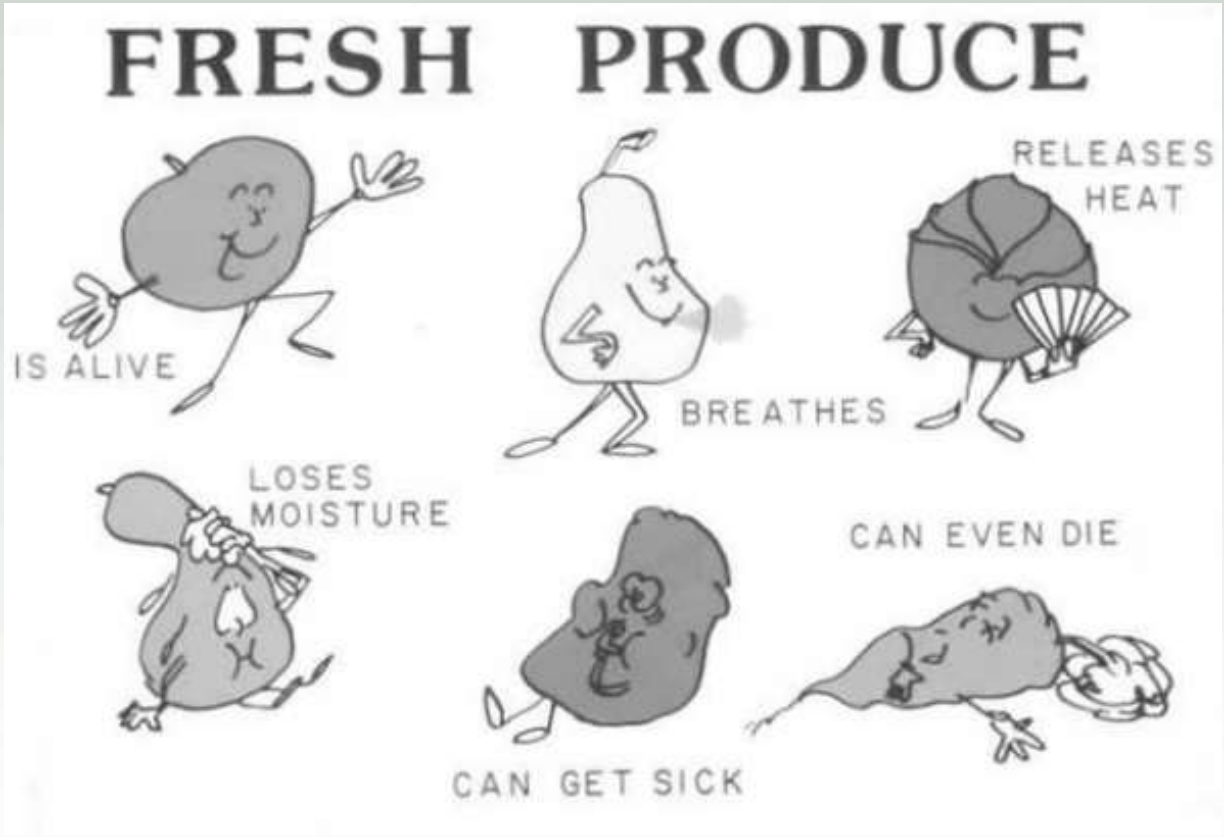

You Grew It... Now what?

- By the time you harvest, most costs are sunk.
- Lasting quality depends on good storage.
- Profitability is directly related to waste.
- Market and season expansion



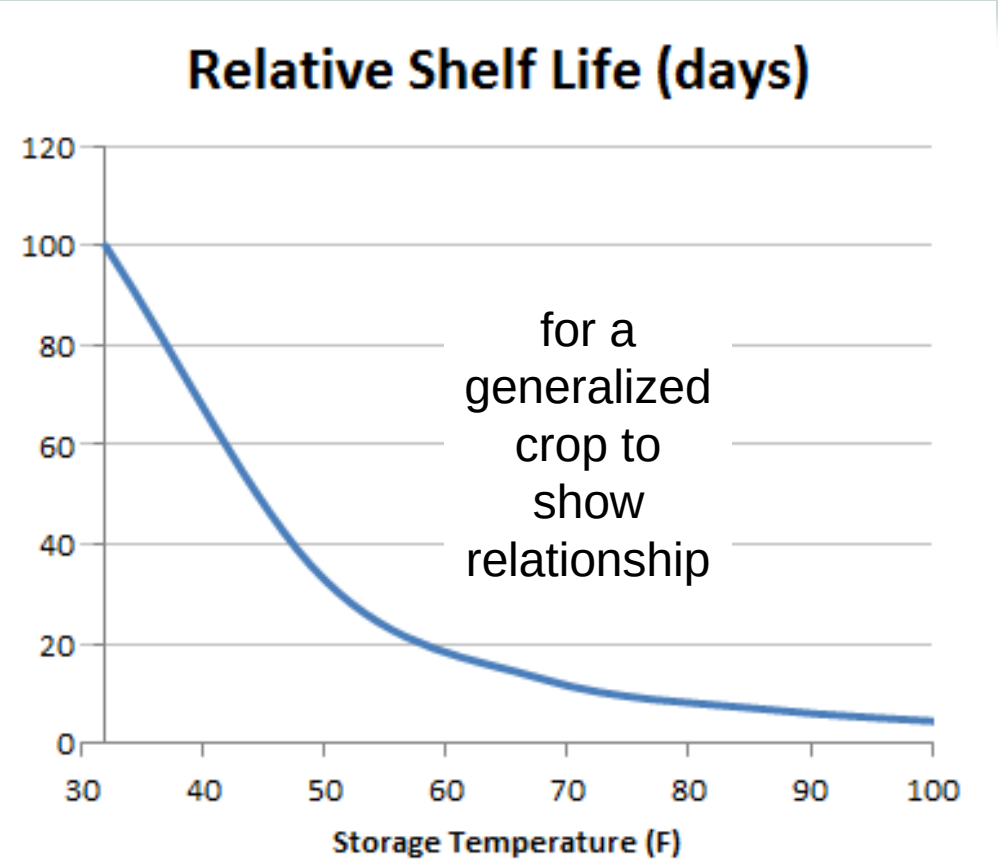
Storage Characteristics of Food

- Respiration & Metabolism
- Temperature
- Humidity
- Ethylene
- Food Safety
- Pathology



Postharvest Basics

- Stored crops are still alive.
- Metabolism continues after harvest (respiration).
- …and it is highly dependent on temperature.



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What happens in storage?

- Chilling / Freeze Injury
  - Tissue damage
  - Variable over body of plant
  - Min temp not same as freezing temp
- Desiccation / Drying Damage
  - Cool or cold air
  - Heat from respiration
  - Moisture (H2O) available at surface of produce
  - Need humidity (H2O) in air, “RH” or relative humidity

What happens in storage?

- Ethylene
  - C2H4
  - Produced in stored produce (at various rates)
    - plant hormone
    - physiologically active at very low concentrations
      - (0.1 to 10ppm)
  - Stored produce is variably sensitive to Ethylene
    - Bittering effect
    - Premature decay

And each crop is different

- Recommended storage conditions
  - Temperature
  - Relative humidity
- Ethylene production rate
- Ethylene sensitivity
- Chilling/Freezing Injury
- Variety differences

USDA Handbook 66 – "The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks"
http://www.ba.ars.usda.gov/hb66

4 Crops – Case Studies




Crop	Units	Carrot	Onion	Potato	Cabbage
Storage Density	lb/ft^3	22	20	42	17
Temp	ºF	32 – 34	32	40	32
RH	%	98 – 100	65 – 70	99 – 100	98 – 100
Duration	Months	7 – 9	6 – 9	Up to 12	3 – 6
Resp. rate at temp	$\frac{\text{mg } CO_2}{\text{kg - hr}}$	10-20	3 (cured)	6 – 18 (cured)	4 – 6
	$\frac{\text{BTU}}{\text{ton-hr}}$	138	28	110	46
Ethylene Prod. Rate	$\frac{\text{uL}}{\text{kg-hr}}$	< 0.1	< 0.1	< 0.1	< 0.1
Ethylene Sensitivity	$\frac{\text{uL}}{\text{L}}$	High ~ 0.2	Low > 1500-2000	Low	High ~ 1.0

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Zoned Storage

- Zoned by temperature and relative humidity
- Also consider ethylene production and sensitivity
- Low cost – perforated bags, vapor barrier walls
- Higher cost – dedicated structures
- Could also be useful to have a zone dedicated to precooling / removal of field heat.

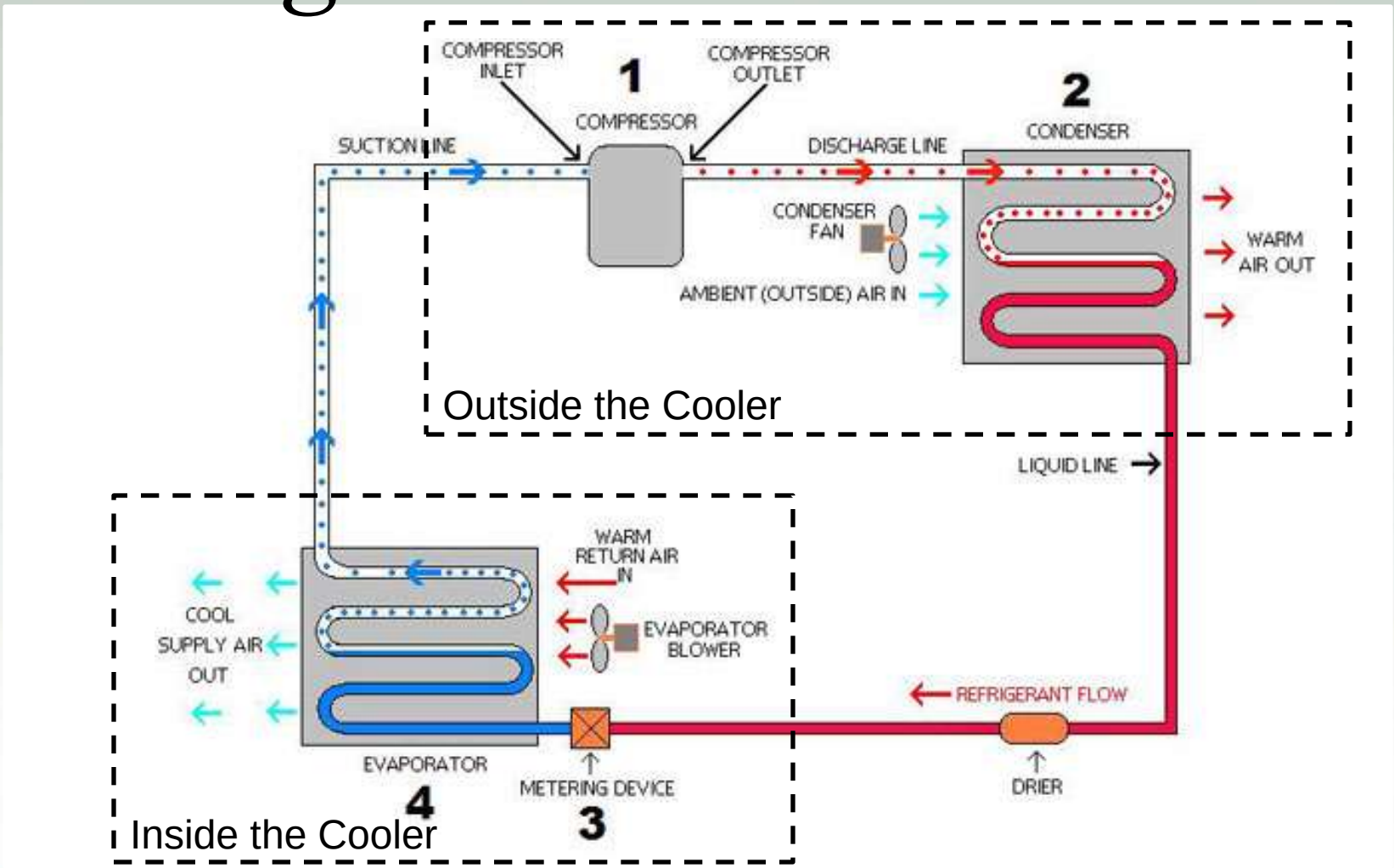
Removing Heat

- Root Cellar
  - Essentially a cool sink with high humidity
- Air Exchange
  - Exchanging cool outside air with warm inside air using fans and thermostat controls
- Cooler
  - Mechanical refrigeration to “pump” heat out

Adding Heat

- For higher temperature crops
  - Electric, propane, biomass/pellet heaters

Refrigeration



Refrigeration

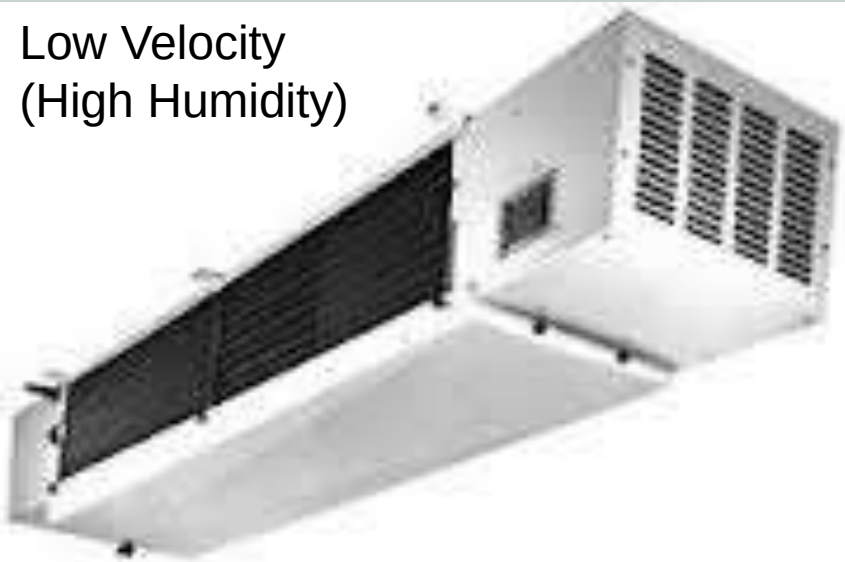
Evaporator Unit

Compressor / Condenser Unit

Evaporator Options

Standard

Low Velocity
(High Humidity)



Plates

CoolBots™

- Adapt an air conditioner for use as a refrigeration system.
- Air conditioners are basically “packaged” refrigeration systems run at higher temperature.
- Build a “good box” first.

CoolBots™

- Pro's
  - Low initial cost
  - Easy to retrofit into existing spaces with basic construction
  - Potential efficiency benefit
- Con's
  - Slow to "pull down" temperature
  - Slow to recover from rises in temp
  - Can not freeze, only cools down to 35 ºF

www.storeitcold.com – Has loads of info and is very clear.

CoolBot vs. Conventional

- 2009 NYSERDA Study
  http://storeitcold.com/coolbot%20Report%20May09.pdf
- 8'x10' storage room - Albany, NY conditions
- Cooled to 35 F
  - with evap fan controls
    - Conventional is 74 kWhr/yr more efficient ($10/yr)
  - without evap fan controls
    - CoolBot is 230 kWhr/yr more efficient ($30/yr)
- Coolbot cost $750 (net of cold room)
- Conventional cost $4,400 (net of cold room)

Adding Humidity

- Crops will add some humidity as they respire
- Moist slabs
- Moist burlap / cloth blankets
- Should be cleaned regularly
- Foggers / Nozzles

Removing Humidity

- Outside air exchange can be very effective
  - Small fan with ducting

Controls - Thermostats

- Control a load based on temperature

Measure and Monitor

- "The measured variable improves."
- Temperature ***AND*** Relative Humidity
- Don't assume you have the conditions you want. **Measure**.
- **Low tech –** wall sensors, daily checks, log book
- **High tech –** remote monitoring, email alerts
- Calibration and certification

Scouting

- Daily checks for spoilage, sprouting
- Have different people perform the task
- When pulling stored crops, check other bins
- Check for spoilage, sprouting
- Use all five senses
- “Scout” the mechanicals also

Rhizopus Soft Rot on Sweet Potatoes

Potato Affected by Fusarium Dry Rot

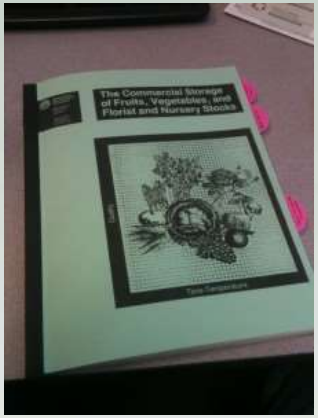
Potato Affected by Soft Rot

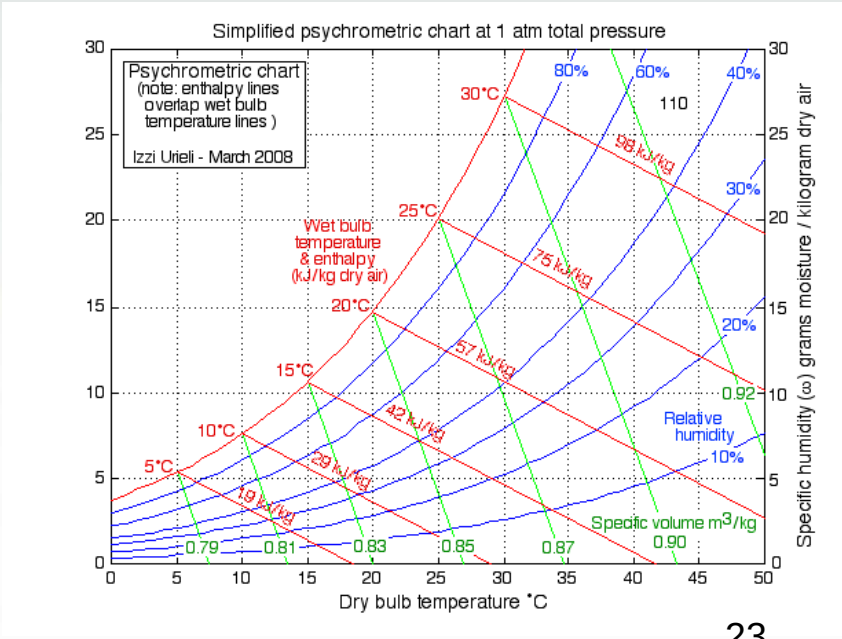
Cooler Audit

- Envelope (“The Box”)
  - All doors close tightly
  - All seals are sealing
  - Signs of degradation
  - Signs of mold
  - Air circulation inside
- Mechanicals (“The Chiller”)
  - Noise is energy
  - Condenser coil is clean and clear
  - Annual refrigeration tuning

Technical References

- UVM Extension Ag Engineering Blog
  - http://blog.uvm.edu/cwcallah/
- USDA HB 66
  - http://www.ba.ars.usda.gov/hb66/contents.html
- NE Vegetable Management Guide
  - http://nevegetable.org/
- UC Davis Post Harvest Website
  - http://postharvest.ucdavis.edu
- Psychrometric Charts and Calculators
  - http://www.sugartech.co.za/psychro/index.php





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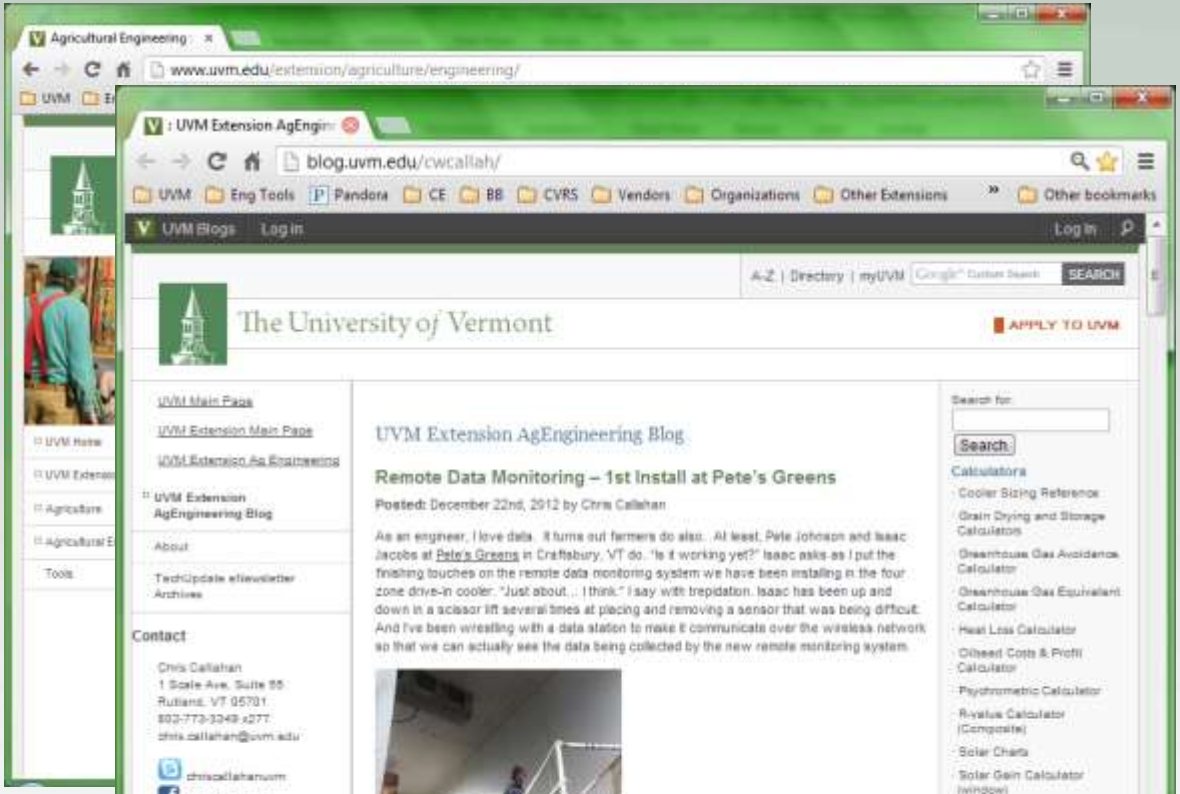

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Chris Callahan
Rutland Office / chris.callahan@uvm.edu / 802-773-3349

http://www.uvm.edu/extension/agriculture/engineering/

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