Postharvest Handling and Storage

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go.uvm.edu/ageng
capsvt.org

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VVBGA Annual Meeting – Fairlee, VT

THE UNIVERSITY OF VERMONT EXTENSION

OUTLINE

Introductions: Who we are and what we want to accomplish

Postharvest: Introduction to postharvest physiology and produce safety

Flow: Planning for flow of product, people, and water

Infrastructure: Buildings, utilities, design, materials, and construction

Equipment: Wash lines, spinners, cleaning and sanitizing, and coolers

Tools: Containers, hoses, cleaning tools, thermostats, and records

...and whatever else you want to cover...

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Introductions

NOTE: When you see onions in the upper right, it means it is audience participation time!

Name

Farm

Location

Recent challenge & success in postharvest

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Fresh Produce…

Illustration by Virginia Jaquish.
More info: USDA Handbook 66 – go.uvm.edu/respiratorymetabolism

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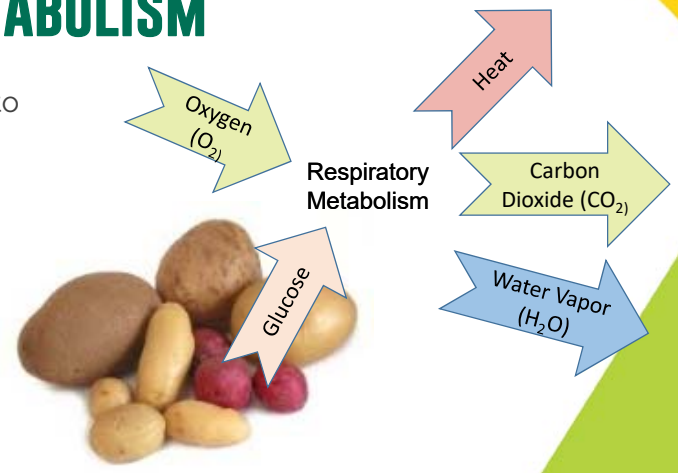
Respiratory Metabolism

- Cells in produce continue to respire even after harvest.
- We are handling, storing, a selling living things.
- It is a natural chemical reaction that consumes sugars.



More info: USDA Handbook 66 – go.uvm.edu/respiratorymetabolism

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Respiratory Metabolism

So… why does this matter?

What can we do about it?

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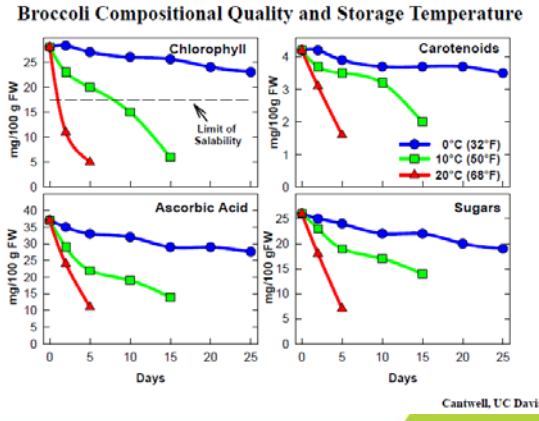
RESPIRATORY METABOLISM

- Slowing the reaction down maintains harvest quality.
- Reduced temperature decreases rate of respiratory metabolism.
- Controlled Atmosphere (CA) storage limits oxygen available for reaction.



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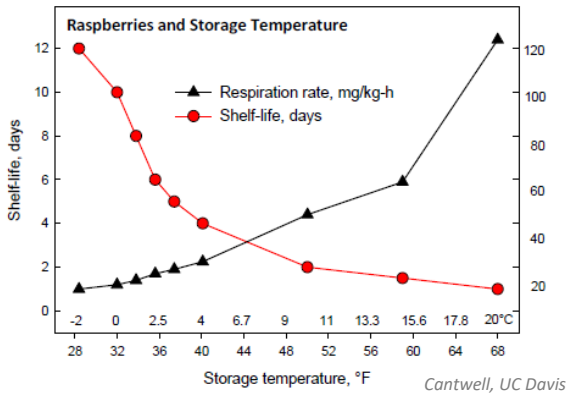

Cantwell, UC Davis

More info: USDA Handbook 66 – go.uvm.edu/respiratorymetabolism

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Postharvest Pathology

- Postharvest is a **hotel**, not a **hospital**.
- Quality out depends on quality in.
- Careful attention to temperature and humidity is important.
- Cleanliness and occasional sanitation helps with plant pathogens.


Potato Affected by Fusarium Dry Rot

Rhizopus Soft Rot on Sweet Potatoes

Potato Affected by Soft Rot

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As you think about storing these vegetables …

…What would you worry about?
What is common about these vegetables and what is different?

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Common Storage Zones





	Carrot/ Cabbage	Onion/ Garlic	Potato	Sweet Potato	Squash
Storage Zone	Cold Humid	Cold Dry	Cool Humid	Warm Humid	Warm Dry
Temp	32 – 34 °F	32 °F	40 °F	57 °F	50 °F
RH	98 – 100 %	65 – 70 %	99 – 100 %	90 %	50-70 %
Duration (Months)	7 – 9	6 – 9	Up to 12	3 – 6	1-3

More info: USDA Handbook 66 – go.uvm.edu/handbook66

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Produce Safety Overview

Risk Reduction

Ain't Rocket

Science,

BUT….

More info - capsvt.org & producesafetyalliance.cornell.edu

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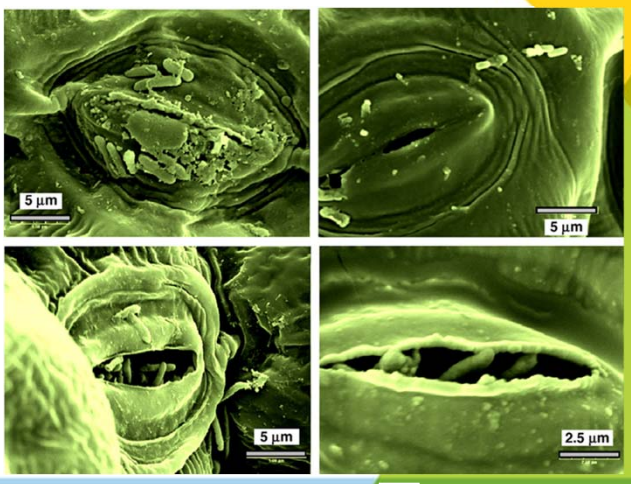
YOU OFTEN CAN'T SEE OR ELIMINATE CONTAMINATION



More info - capsvt.org & producesafetyalliance.cornell.edu

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Produce Safety Challenges

- Fresh produce is often consumed raw (i.e., not cooked)
- Microbial contamination on produce is extremely difficult to remove once present
  - Natural openings, stem scars, bruises, cuts
  - Rough surfaces, folds, netting
- Contamination is often sporadic
- Bacteria can multiply on produce surfaces and in fruit wounds, provided the right conditions are present



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17

What is the Risk from Fresh Produce?

1 in 6 get sick with food born illness symptoms (48 million)—self reporting

SOLVED cases related to fresh produce
(underestimate—2004-2013 averages)

- 64 produce -linked outbreaks/ year
- 2,000 produce-linked illnesses/ year (hospital)
- Less than 40 produce-linked deaths/year

Crops Most Frequently Implicated: % Outbreaks


Leafy greens = 30%


Herbs = 11%


Tomatoes = 17%


Cantaloupe = 13%


Green Onion = 5%

More info - capsvt.org & producesafetyalliance.cornell.edu

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Not much risk, but it is worth it because…

1. A local outbreak would have **huge costs**.
2. We **can easily do something** to lower risk.
3. Risk reduction can have **multiple full farm benefits**.

More info - capsvt.org & producesafetyalliance.cornell.edu

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Contamination Sources

Humans

Soil

Produce

Animals

Buildings
Equipment
Tools

Water

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Steps Towards Produce Safety

1. Assess Produce Safety Risks
2. Implement Practices
3. Monitor Practices
4. Use Corrective Actions
5. Keep Records

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Principles of Lean

Identify Value – What does your customer want?

Map the Value Stream – How do you provide value to the customer? Where is there waste? How can you remove that waste?

Create Flow – Avoid interruptions, delays and bottlenecks. Plan for movement.

Establish Pull – Customer can depend on "just-in-time" delivery as needed.

Seek Perfection – Always look for opportunities to improve.

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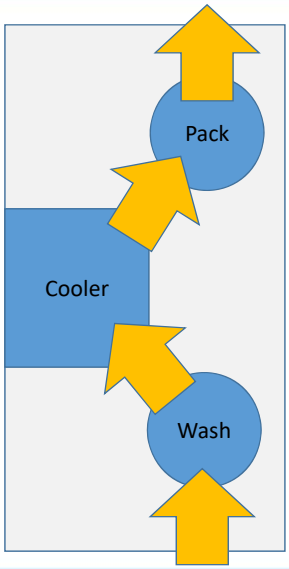
Flow of Product

- Smooth, single pass flow of product.
- Minimizes wasted energy.
- In the direction from field to customer.



Straight pass setup.

Best suited to buildings with long, rectangular floor plans.

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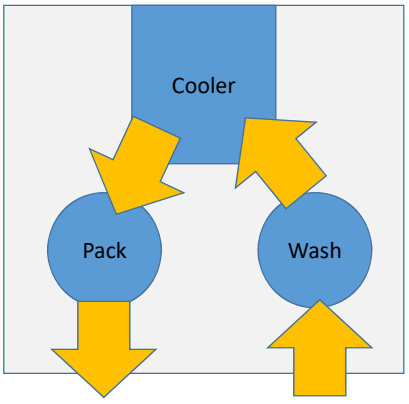

U-turn setup

Best suited to square floor plans.

Can use a single large door.

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Flow of People

- Consider specialization of tasks (e.g. harvest crew, wash/pack crew)
- Location of other tasks (e.g. tool storage, hand washing, break room.)

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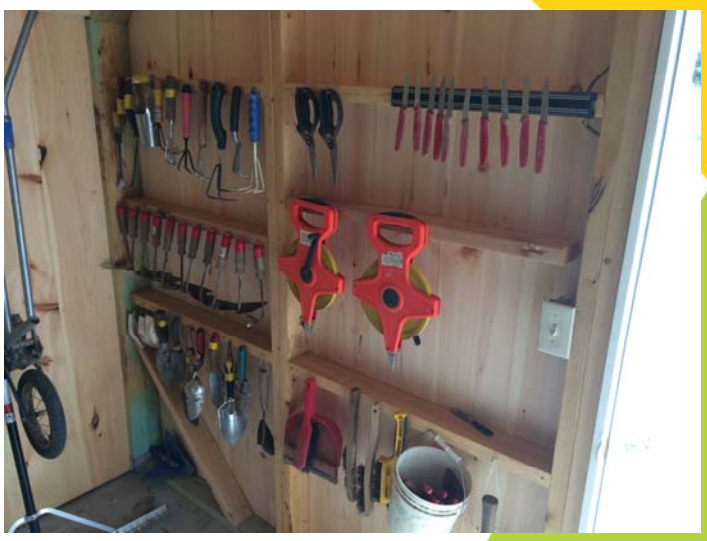

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ANY SCALE, ANY BUDGET…

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Any Scale, any Budget…

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Flow of Water

- Hard plumbed vs. hoses
- Hose hangers / trolleys
- Multiple drops for hoses
- Drains

More info - go.uvm.edu/floors

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BUILDINGS

- A wide range of buildings can be effective
- "Four sticks and roof"
- Key features
  - Sound construction
  - Protection from the weather
  - Exclusion of pests
  - Siting

More info - go.uvm.edu/barnplans

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INSULATION

Foam boards

- Blue (polystyrene)
- White (poly isocyanurate)

Spray foam (poly iso)

Generally avoided due to high moisture issues:

- Fiberglass (pink)
- Cellulose

Insulation Options	$/R/ft2
Spray Foam - Closed Cell	0.1667
Spray Foam - Open Cell	0.1083
Blue Board	0.0968
Poly Iso Board (HiR)	0.0732
Fiberglass Roll	0.0024

More info - go.uvm.edu/coolerwalls

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Structural Insulated Panels

- Pre-fabricated insulated panels that can be used for cooler siding
- Can be load-bearing
- Can be used for roof-insulation
- Think about smooth and cleanable finish surface

More info - go.uvm.edu/coolerwalls

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Avoid Bare Wood & Liquid Water

More info - go.uvm.edu/coolerwalls

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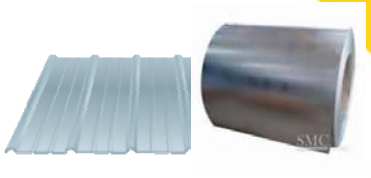
Smooth and Cleanable Materials

Fiber Reinforced Plastic (FRP) aka "Dairyboard"
$1.03-1.92 / ft²

WallTuf
$1.25 / ft²



Galvanized Aluminum (Galvalum)
$0.76-0.95 / ft²

TrussCore
$1.52 / ft²

Extrutech
$2.20 / ft²

Utilite
$1.85 / ft²

Ribcore
$0.77 / ft²

More info - go.uvm.edu/smoothnclean

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Rodent & Pest Control

Remove Food

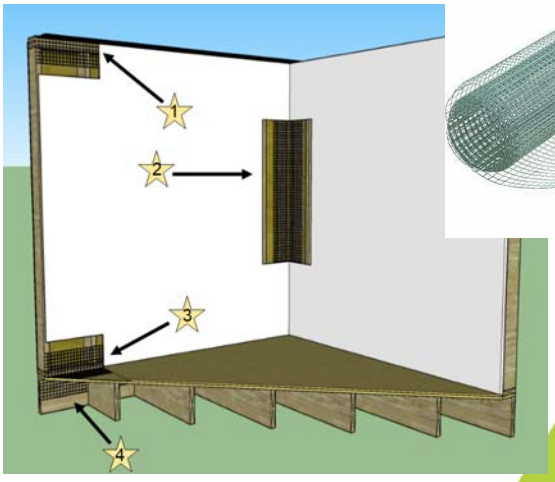
- e.g., cull piles

Limit Access

- Tight construction
- Flashing / wire mesh / hardware cloth at corners
- Closed containers
- Cement curbs

Reduce Population

- Bait, trap, kill



More info - go.uvm.edu/rats

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Evaporator Drains

Lots of moisture collects on the floors in coolers

- Build entire cooler slanted towards the door (or drain)
- Incorporate a drain into the cooler

Route condensation line intentionally.

Also CoolBots™!

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Dunk / Dump Tanks

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Double / Triple Bay Sinks

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Drum / Barrel Washers

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Brush Washers

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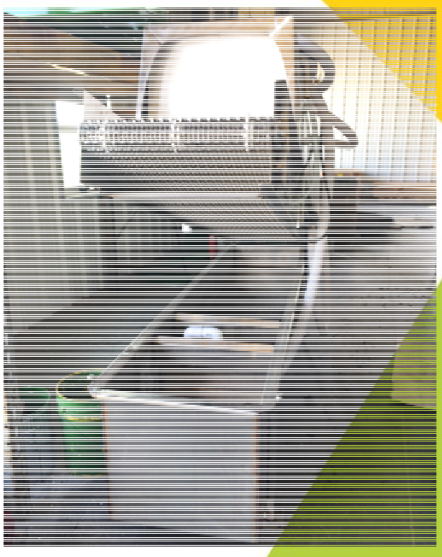
Rinse Conveyor



More info - go.uvm.edu/rinseconveyor

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SPINNERS

More info - go.uvm.edu/greensspinners

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Cleaning vs. Sanitizing

What is the difference and why does it matter?

- **Cleaning:** Physical removal of dirt (soil) from surfaces which can include the use of clean water and detergent
- **Sanitizing:** Treatment of a cleaned surface to reduce or eliminate microorganisms

Important point: You cannot sanitize a dirty surface.

Cleaning always comes first!

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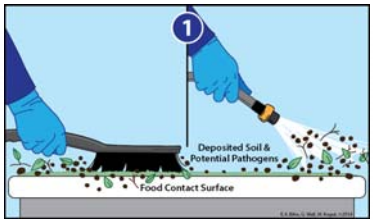
51

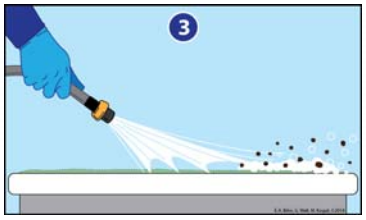
Cleaning & Sanitizing Food Contact Surfaces

1: Remove any obvious dirt and debris from the food contact surface

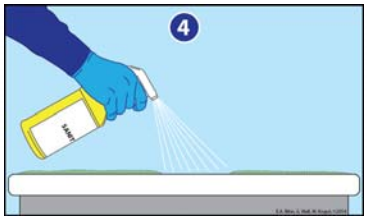


2: Apply an appropriate detergent and scrub the surface

3: Rinse the surface with clean water, making sure to remove all the detergent and soil



4: Apply a sanitizer approved for use on food contact surfaces. Rinsing may be necessary. Let the surface air dry.



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COOLERS

- Volume
- Number of zones
- Sizing of refrigeration or heating
- New planning tool:
  - http://go.uvm.edu/cropplanner

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CoolBots™

Pro's

- Low initial cost
- Easy to retrofit into existing spaces with basic construction
- DIY install and maintenance
- BYOB – Build Your Own Box

Con's

- Slow to "pull down" temperature
- Slow to recover from rises in temp (e.g. door openings).
- Can not freeze, only cools down to ~35F

More info - go.uvm.edu/coolbot
www.storeitcold.com – Has loads of info and is very clear.

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Containers – Totes, Lugs, Cartons, Bins, Boxes

- What crops?
- Drain holes or a solid bottom?
- Vented sides?
- Cleanable?
- Durability
- Can you easily label?
- Light blocking and UV resistance
- Stacking/Nesting?
- Different colors?
- Is the container ergonomic?


Bulbcrates


Red and Yellow Harvest Crates


Buckhorn


MacxAce

More info - go.uvm.edu/totes

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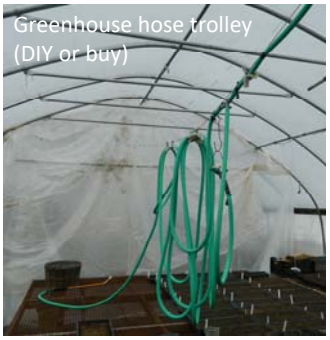
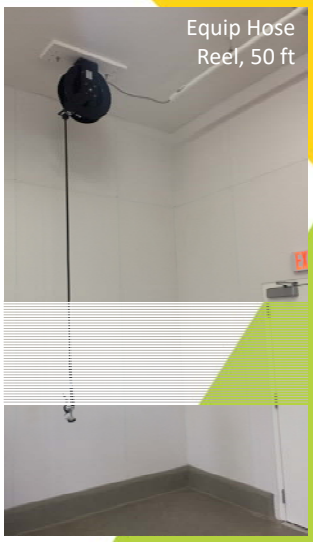
Hoses

- Helpful to have multiple hose drops / spigots
- Aim to keep hoses off the ground
- Many types of nozzles


Greenhouse hose trolley (DIY or buy)


Hannay Reel


Equip Hose Reel, 50 ft

More info - go.uvm.edu/hoses

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THERMOSTATS

- Digital allows for more precise setting and measurement
- Low differential
- Remote probe (can be extended)
- Pay attention to full load amperage limits (may need relay)
- For heating or cooling
- Can be wired with plugs

Johnson Control A419
$60

Ranco ETC11200
$60

Dial Type
$75-90
Not Preferred

DuroStat 102720
$100

More info - go.uvm.edu/thermostats

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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

More info - go.uvm.edu/monitoring

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USB Data Loggers

DATA-Q

www.dataq.com

EL-USB-2+ USB Data Logger
Measures ambient temperature and humidity
Higher accuracy than EL-USB-2
Automatically calculates dew point
-35 to +80 °C (-31 to +176 °F) temp measurement range
±0.3 °C (±0.6 °F) overall temp accuracy
0-100% RH measurement range
±2.0% overall RH accuracy (20-80%RH)
2 User-programmable temp alarm thresholds
2 User-programmable RH alarm thresholds

5 minute readings = 56 days storage
1 minute readings = 11 days storage
Download data to computer

$125 (RH +/-2%)

$99 (RH +/-3%)

$82 (RH +/-3%)

More info - go.uvm.edu/monitoring

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Sensaphone

- Several models
- 400 – 4 inputs
- 800 – 8 inputs
- $460 for the control
- $32 per sensor

- http://www.sensaphone.com/

More info - go.uvm.edu/monitoring

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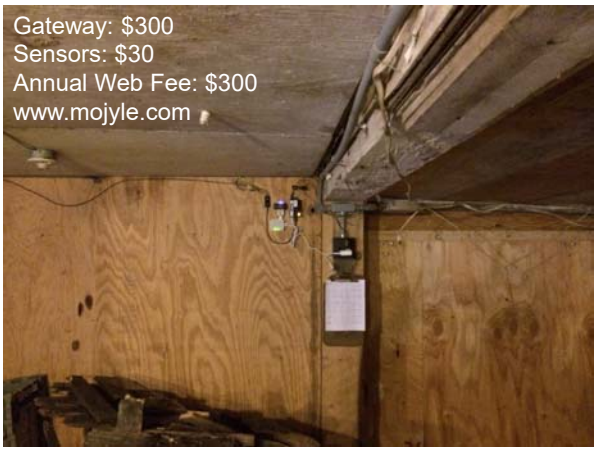
MOJYLE



More info - go.uvm.edu/monitoring

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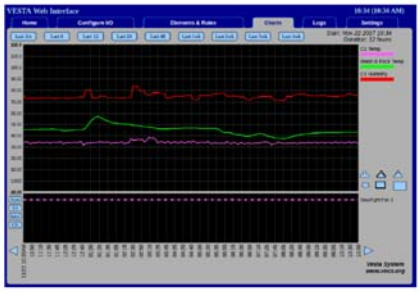
VECS VESTA

- Vermont-based company.
- Web-based
- Control platform
- Sensor agnostic
- www.vecs.org



More info - go.uvm.edu/monitoring

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Simple Works, Too.

More info - go.uvm.edu/monitoring

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Recordkeeping

Records Wanted/Needed

- **Worker Health and Hygiene**
- **Soil Amendments**
- **Land Assessment**
- **Production Water**
- **Postharvest Water**
- **Postharvest Handling**
- **Tracking/Traceability**
- Food Safety Plan*
- Document Center*

User Requirements

- **Quick, Easy & Flexible**
- Inexpensive
- Platform flexible
- Multiple user roles
- Multiple language support
- Data entry, but also pictures, PDF's, etc.
- On and off network
- Integrate with accounting/finance
- Integrate with whole farm management

More info - go.uvm.edu/producetracking

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WHY?

- Federal legislation (FSMA PSR)
- Demanded by wholesale buyers and ingredient certifications
- Help increase data collection, efficiency and farm profitability… the measured variable improves.
- Food safety, increase speed and reduce scope of recalls

More info - go.uvm.edu/producetracking

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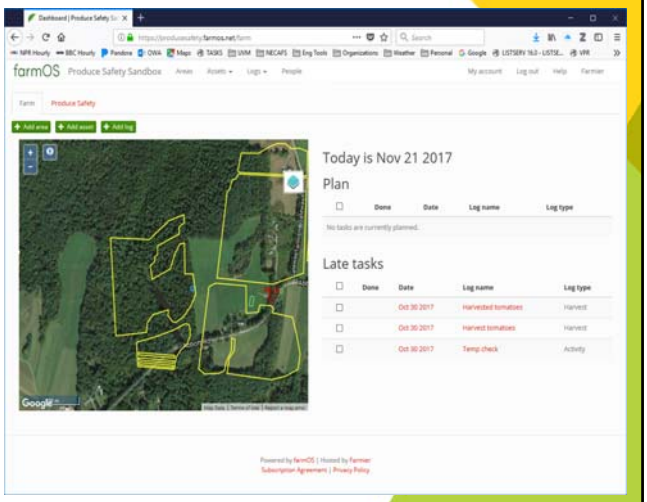
WHAT WE FOUND

For the smaller grower

- PSA Templates
- Spreadsheet based systems
  - Many already in use for production planning and tracking

Cloud-based data system

- FarmOS – open-source farm management system
- Community development project
- Developed as a produce safety module



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Let's check the parking lot list of topics...

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Post Harvest Case Studies

Footprint Farm – BarnHouse Construction ($300k)

go.uvm.edu/footprint

Mighty Food Farm – New Construction ($100k)

go.uvm.edu/mighty

Last Resort Farm – Dairy Barn Renovation ($60k)

go.uvm.edu/lrf

MORE TO COME!

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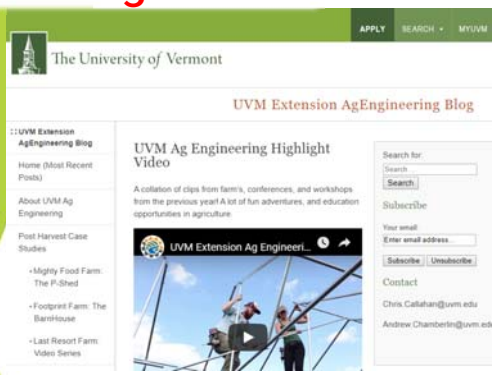

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