

# From Field to Storage: High Quality Carrots



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New England Vegetable and Fruit Conference 2013

# Expanding **Winter** Harvest and Sales for New England Vegetable Crops

*3 year project (2010-2013) funded by USDA/Northeast SARE*



## Key Elements of Project

- Using low tunnels
- **Winter storage – infrastructure and crops**
- Winter farmers markets & marketing
- Farmer to Farmers exchange/educational programs
- Website



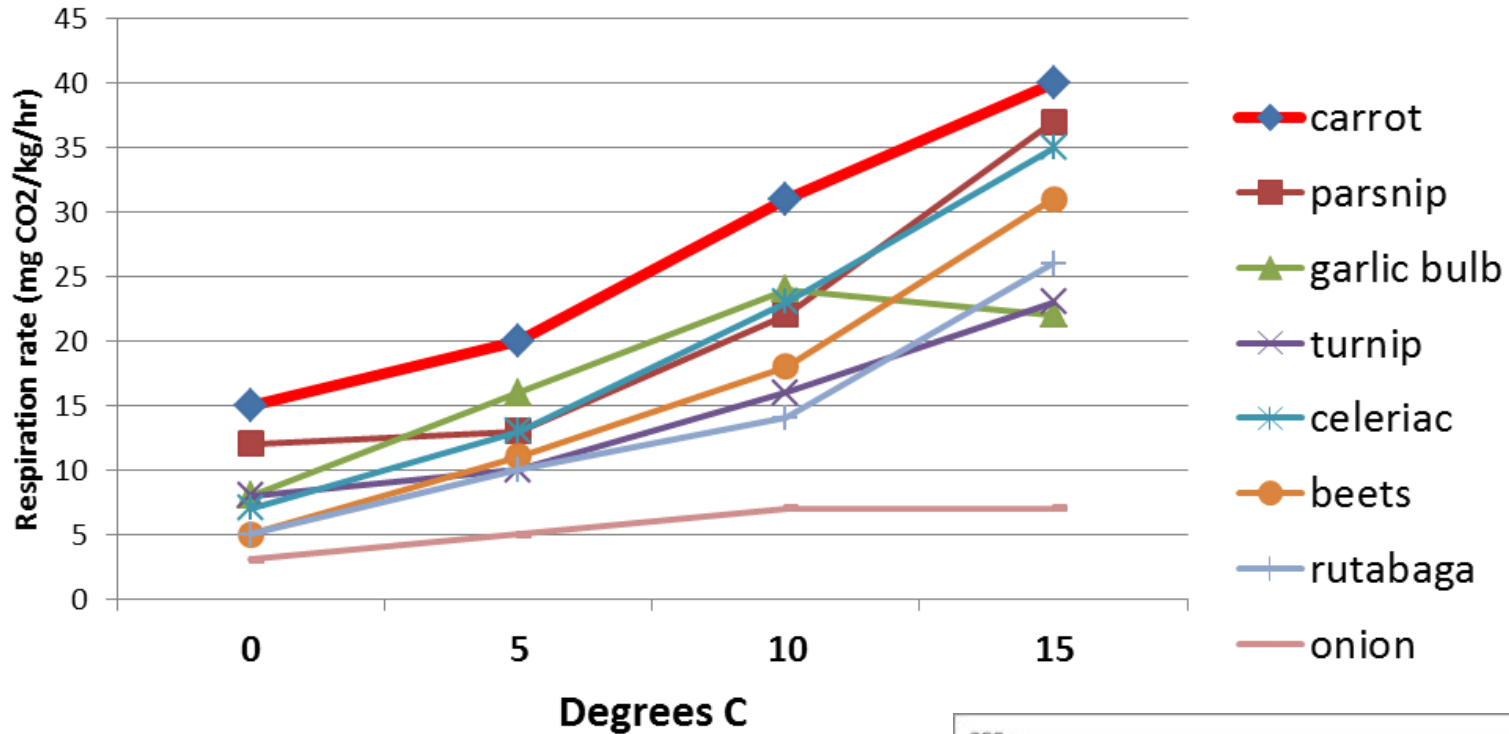
*central goal is to help farmers expand vegetable harvest and sales from December-April, and thereby increasing winter income*

# Why study carrots?

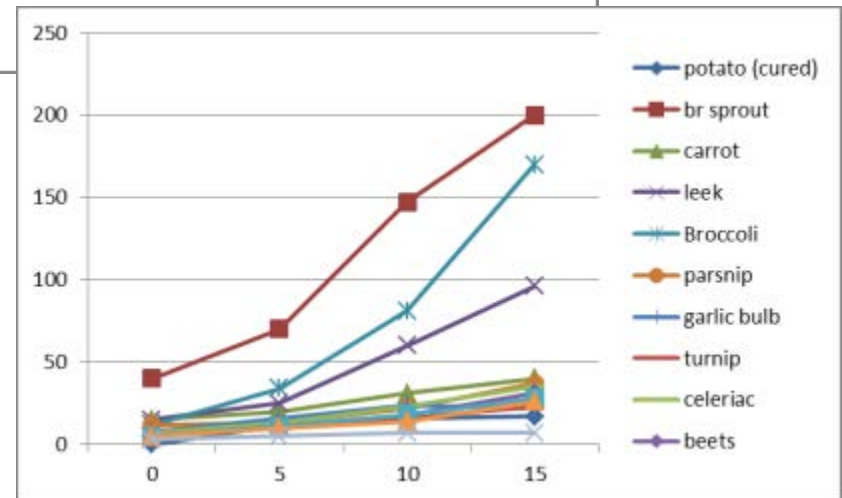
- Winter markets are growing
- Key winter crop to keep customers happy
- Most commonly grown root crop
- Declines rapidly with poor postharvest treatment
- Can be stored 6 months if handled well.
- Model crop for the 'cold moist' storage group



# Respiration Rates of Root Crops, by Temperature



*Respiration:*  
 $Sugars + O_2 = \text{'vital heat'} + CO_2$



# What does a carrot need?

- Prevent freeze injury (Freezes at 29.8°F, 1.2°C)
- Prevent water loss and desiccation
- Keep respiration rate low
- Adequate Oxygen (>3%)
- Avoid CO<sub>2</sub> buildup (<5%)
- Avoid Ethylene

# How do we provide it?

- No more than brief periods below 30°F
- RH >95% (98-100%) in package and/or room
- Ideal T 32°F (0°C) (7 mo),  
OK T 32-41°F (0 to 5°C)(5 mo)
- Permeable packaging
- No apples



# Postharvest affects carrot 'flavors'

**Bruising & shock** stimulates ethylene, respiration

- Bitterness (6-methoxymellein)
- Terpene, green, earthy odor or flavor



**Barrel wash gently**  
**Minimize bruising**  
**\*\*No big drops**



# Postharvest affects carrot 'flavors'



- **Tight packaging** causes low O<sub>2</sub>, high CO<sub>2</sub> & ethylene
  - Ethanol odor and taste, sickeningly sweet taste
- **High temperatures (>10 C = 50 F)**
  - All of the above, plus acidic, after-taste
  - Diseases
- **Low humidity affects texture**
  - Rubbery, shriveled, maybe sweeter

# On-farm carrot storage study 2012-2013

**Objective: observe effect of different storage conditions on carrots.**

- Grown at UMass: Bolero, seeded July 9, harvested Nov 13-14.
- Carrots placed into each storage same or next day
- Four farms that store all winter, different types of storage
- Matched storage conditions:
  - Washed/unwashed
  - Perf. plastic/mesh/grain bag
- Monthly samples:
  - All bags weighed for waterloss
  - One set taken for Brix, rot etc.





# Farm A: Basement Root Cellar

- 1300 sq ft underground root cellar
- Cement floor & walls to earth
- 4 in spray foam insulation ceiling
- Active cooling with ambient air: 8" pipe with intake/exhaust fan
- Passive cooling other openings - PVC pipes, elevator shaft.

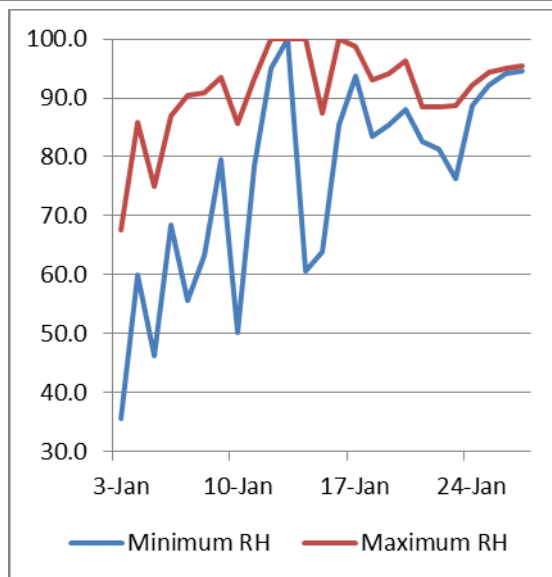
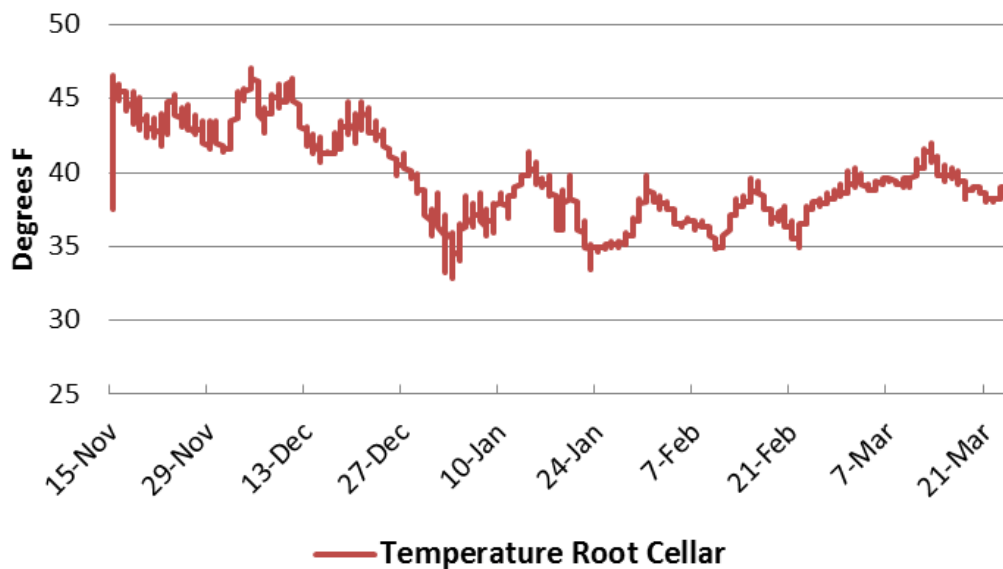


# Farm A: Basement Root Cellar

- Carrots are stored unwashed in plastic bulk grain sacks.
- Humidity from respiration of vegetables & water on floor if needed.
- CSA pickup site



## Farm A (Root Cellar) Temp. Nov 2012 to March 2013



# Farm A

- Outside:
  - Nov and Dec were warm
  - nights 25-34, days 40-50
  - below 20 – early Jan.
- Root cellar stayed above 40 until January
- Higher T means air holds more moisture,
  - $RH < 90\%$

# Farm B: Walk-in Cooler inside a barn

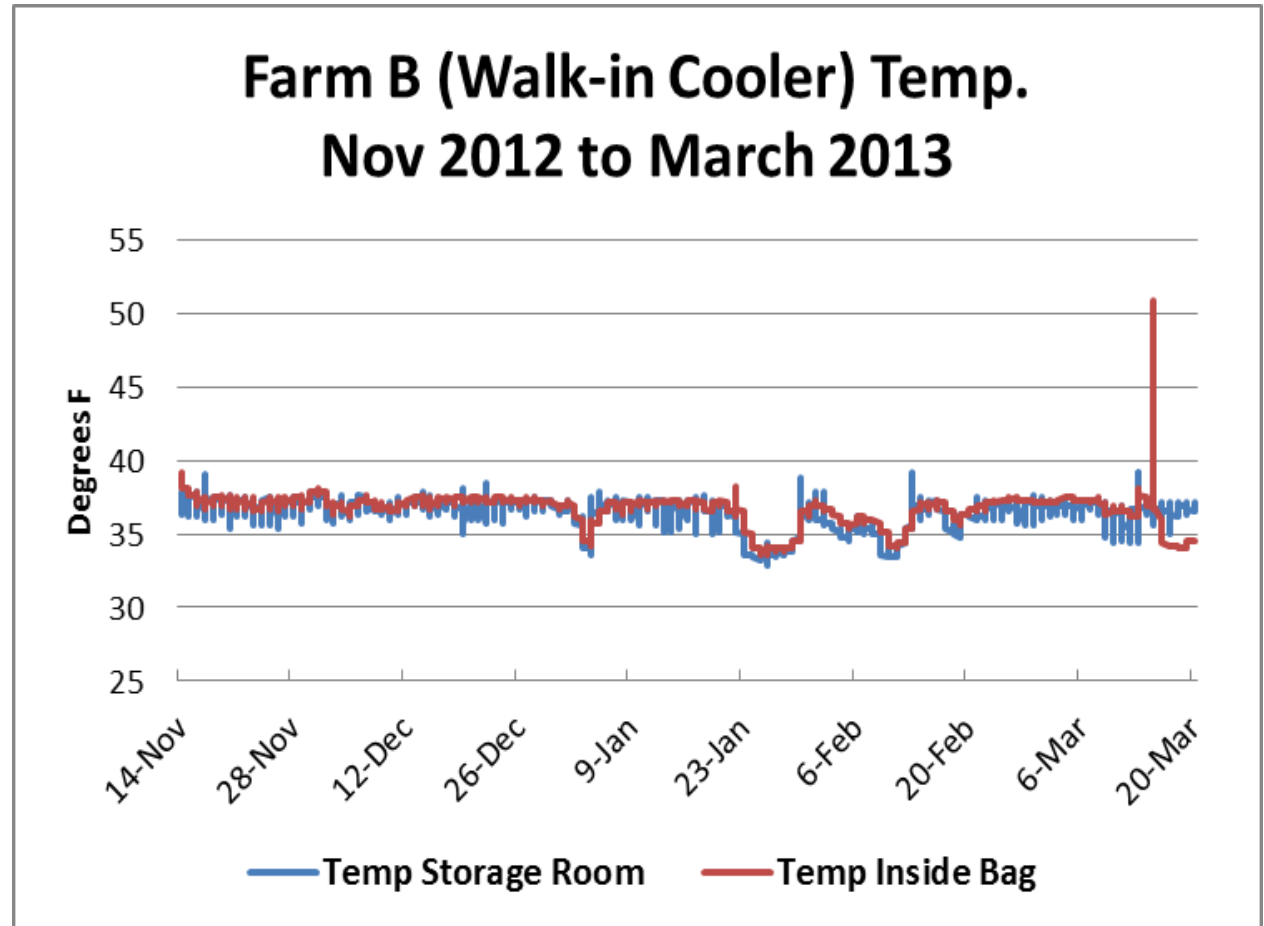
- Insulated, 8X8X10' tall
- Thermostat set to 38 F
- Compressor, condenser, and fans
- Cool-Trol system and fans
- Carrots in Perf. Plastic 25lb bags





# Farm B: Walk-in Cooler inside a barn

- Temperature consistently in 35-38 °F range
- Dips lower in cold spells
- RH recorded steady >95%
- Carrot bag T more steady than room T



# Farm C: Retrofit in Barn Basement

- Chamber 21' x 47' x ~7' tall
- Insulated 4+ inches of spray foam, plywood walls, concrete floor.
- Heated and cooled by an underground geothermal system and cold air from outside,
- Storage temp set to 35 F



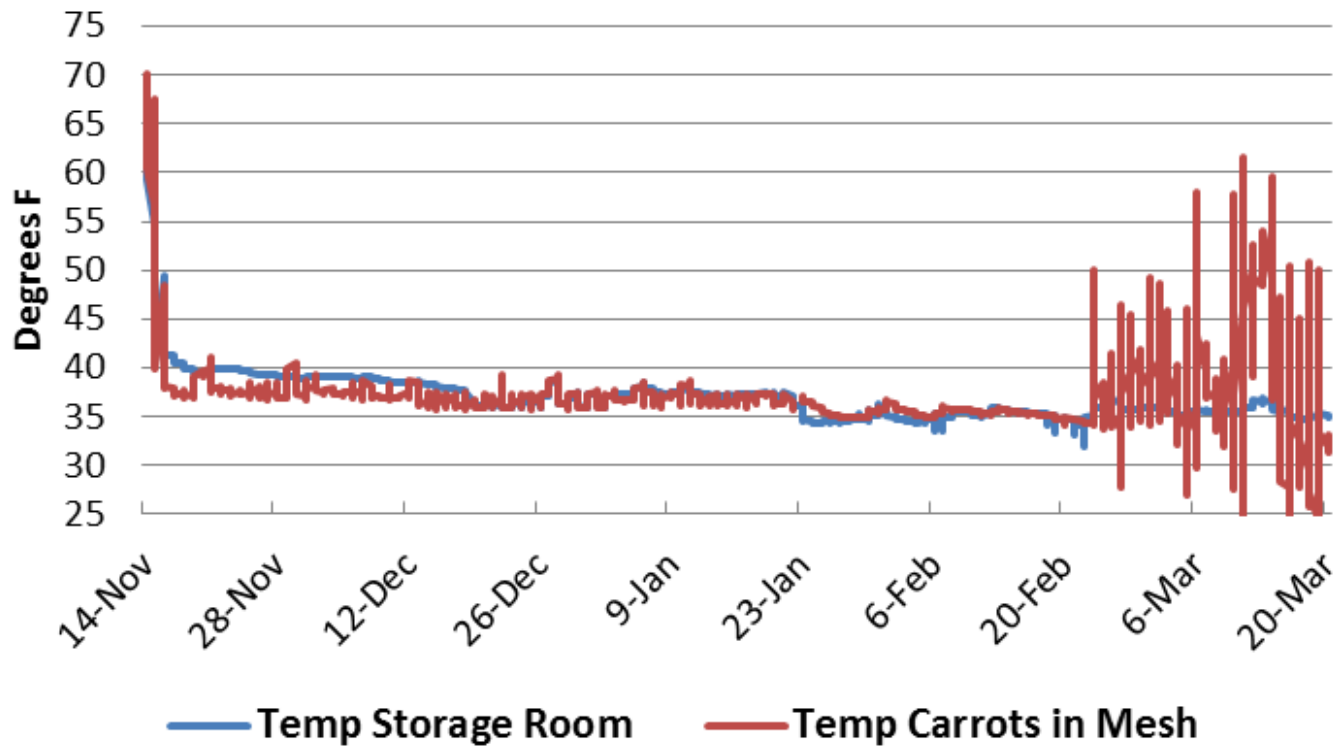
# Farm C: Retrofit in Barn Basement

- Carrots unwashed in large Macro 34 vented bins.
- Bins are misted, or covered with plastic or moist burlap.
- Open airflow is allowed through the bottom of the pallet.
- RH >95%
- (late winter) carrots moved to large walk-ins w/ standard cooler panels.



# Farm C: Retrofit in Barn Basement

## Farm C (Retrofit Barn Basement) Temp. Nov 2012 to March 2013



Feb-March:  
Carrots got  
moved  
around and  
a bit lost



# Farm D: Bunker w/ Mister

- 320 sq ft space for high RH, low T root storage.
- Concrete roof not insulate, sides flanked by other coolers, back side is bermed in earth.
- Compressor: low velocity unit
- Automated spray system kicks in when the humidity falls too low.
- RH>95%



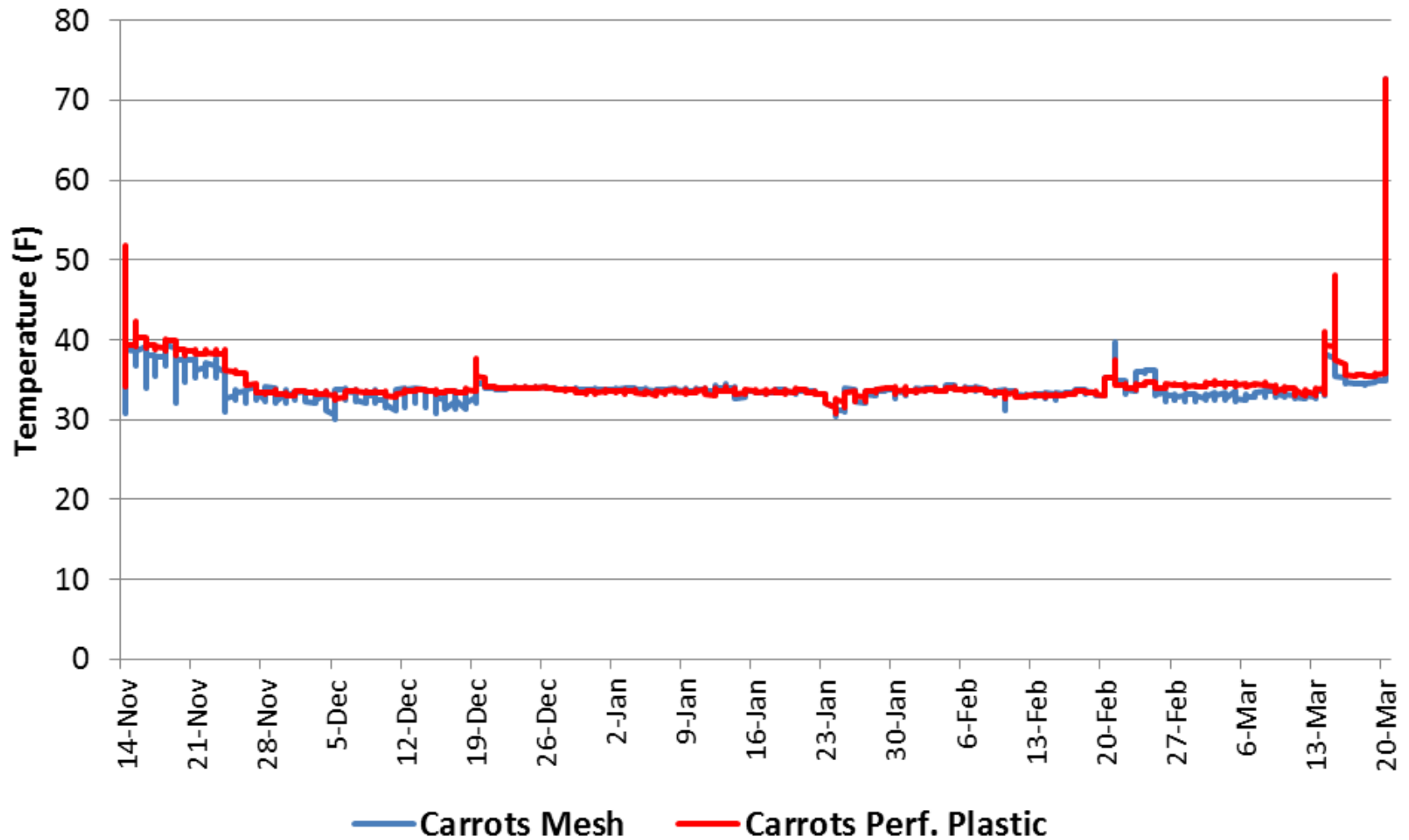
# Farm D: Bunker w/ Mister



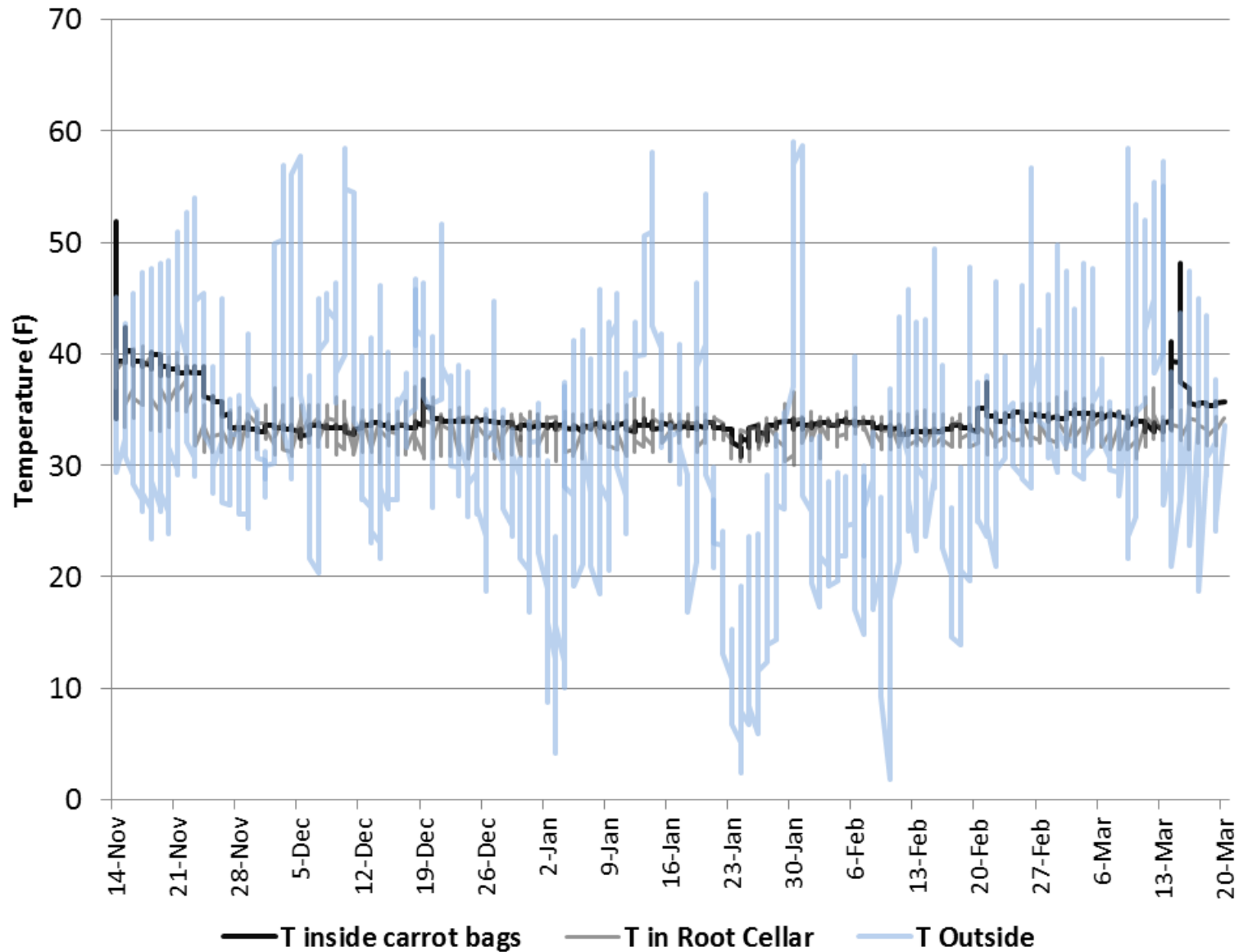
Carrots are

- washed,
- packed in 25# capacity, perforated plastic bags
- then placed in either Macro bins or wrapped pallets.

## Farm D: Bunker - Carrot in Perf. Plastic vs Mesh

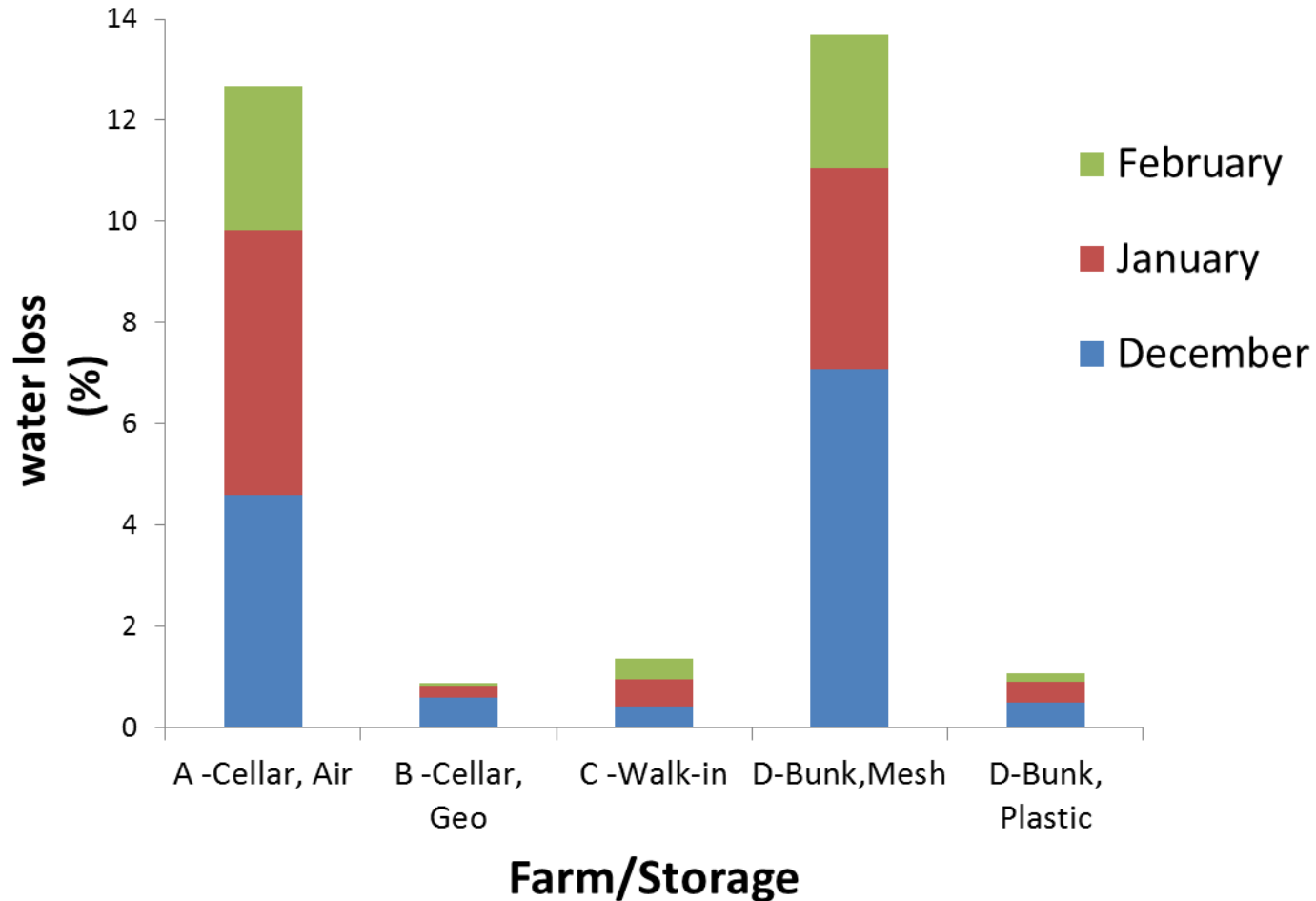


# Farm D: Bunker - Temperature Outside vs Inside Storage

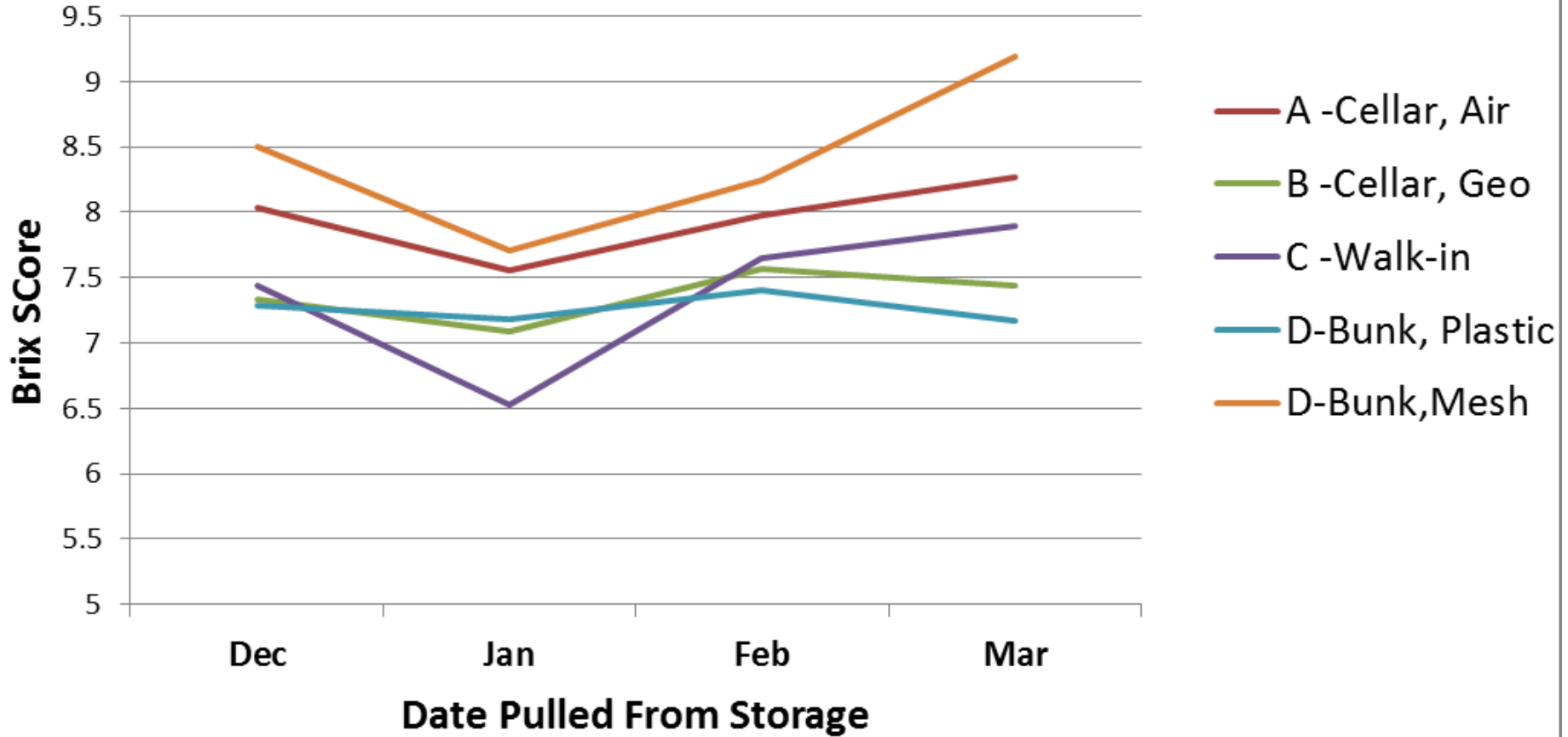




# %Water Loss by Month in Storage, November to February



## Carrot Brix Scores: 4 months, 4 farms



Those with high water loss also higher brix

STATS: A & D mesh differ from the other 3

B,C,Dpp no significant difference from each other

# Carrot storage case study 2012-2013

## Blind Taste tests at Amherst Winter Farmers Market

Texture

Taste

Attractiveness

Would you buy this carrot?

January: those under 'ideal' conditions were rated highest

February: no difference in rating on taste & texture.

low water loss: like the crunch

high water loss: like the sweetness

March: those with highest water loss (sweeter) rated high on taste & texture

96% said they'd buy the root cellar carrots.

Our rating: D-Mesh too rubbery to be marketable





# To wash or not to wash?

## Reasons to wash in the fall before storage:

- Outdoor wash station is still (almost) comfortable
- More labor on hand
- Sort and grade before storage
- Bag in perf. plastic before storage
- Ready to grab and go to market



## Risks:

- Introduce pathogens
- Cause wounding
- Off flavors





# To wash or not to wash?

## Reasons to store unwashed

- Less time from field to storage
- Shift labor to winter when have more time
- Use indoor washing infrastructure
- Freshly washed at market
- Store in bulk bins
- Better flavor?



## Risks:

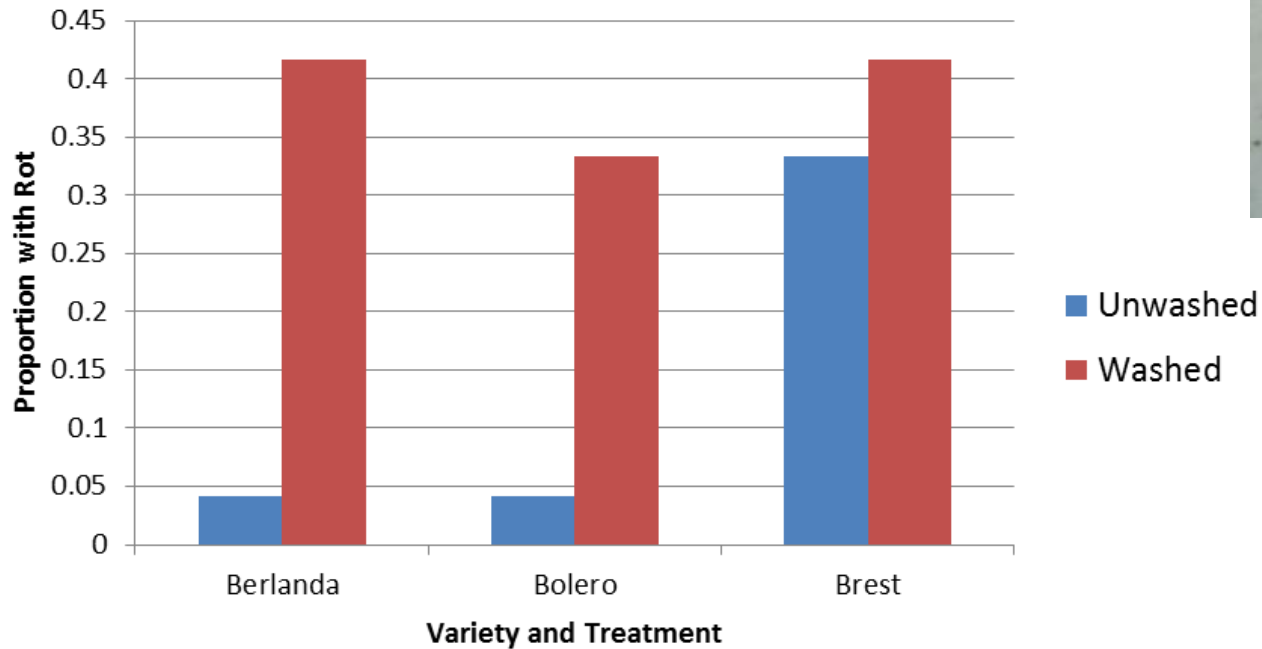
- Staining
- More surface pathogens
- In bulk bins more open to desiccation

# Long-term Storage Washed vs unwashed Trial 2011-12

- Seeded 7/26
- Harvested 11/14
- 3 varieties
  - **Berlanda**
  - **Bolero**
  - **Brest**
- Treatments: Hand washed in tub or unwashed
- Stored 5 months (Nov 14 to May 2) In perforated plastic



## Rot in Washed vs Unwashed by Variety, 2011-2012 after 5 mo in storage



Rot was worse on **washed**  
Staining was *slightly* worse on **unwashed**



# Hand vs barrel washed or unwashed, 2012-13

## Postharvest treatments:

- Hand washed
- Barrel washed
- Unwashed
- Stored in perf. plastic bags, UMass cold storage
- Pulled monthly December - April

**Washing treatment showed no effect** on the following measures of quality:

- Rot
- Staining
- Lenticel dirt
- Water loss



- Slight staining was similar to whitish cast of stored washed carrots.
- Staining may be affected by soil characteristics (see Jerrico Settlers trial)



# What influences staining?

## Jerrico Settles, Vermont washed/unwashed study

Staining up to 10% on  
unwashed carrots

UMass  
studies:  
fine sandy  
loam



- Soil type
- Handling
- Temperature
- Pathogens

# In summary....

- Carrots are .... more complex than we ever imagined!
- Different types of storage designs work very well
  - Need control over fall cooling
- Quality depends on temperature, RH & packaging
  - Need air – but not too much exposure
- Wash timing can be flexible.
  - but results vary, compare on your own farm & soil type
- Flavor and texture can be tricky
  - get feedback from your customers
- Spread your risk
  - Plant and harvest dates, varieties (try new ones!)
  - Methods of storage

- More results of our project will be posted at:
  - <http://extension.umass.edu/vegetable/projects/winter-production-storage-sales>
- Thanks to: Amanda Brown, Zara Dowling, Danya Teitelbaum, Andrew Cavanagh, Sarah Berquist, Drew Hamilton, Becky Sideman, Lisa McKeag, Susan Scheufele, Susan Han, Dan Kaplan, Laura & Charlie Tangerini, Ryan Voiland, Jeremy Barker-Plotkin.
- And to Farmers pioneering new/old winter storage methods

## *What's next?*

# UMass Produce Storage Project

- Survey: baseline current practices -- and what are the needs?
- What is current energy use and how could storages be more energy efficient?
- How to get the most out of ambient air
- Contact Luke Doody, [ldoody@eco.umass.edu](mailto:ldoody@eco.umass.edu)
  - Fill out the survey and get a free energy analysis for your storage !



## *What's next?*

- February 13, 2014. Storage Engineering and Design workshop.
  - Farmers, Engineers. N. Connecticut
- March 6, 2014, Winter Growing and Marketing
  - Publick House, Sturbridge, MA
    - Logistics, Storage, Tunnels, and Marketing

Contact: [umassvegetable@umext.umass.edu](mailto:umassvegetable@umext.umass.edu)