

Maintaining Quality of Winter Vegetables in Storage

Ruth Hazzard UMass Extension Vegetable Program

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



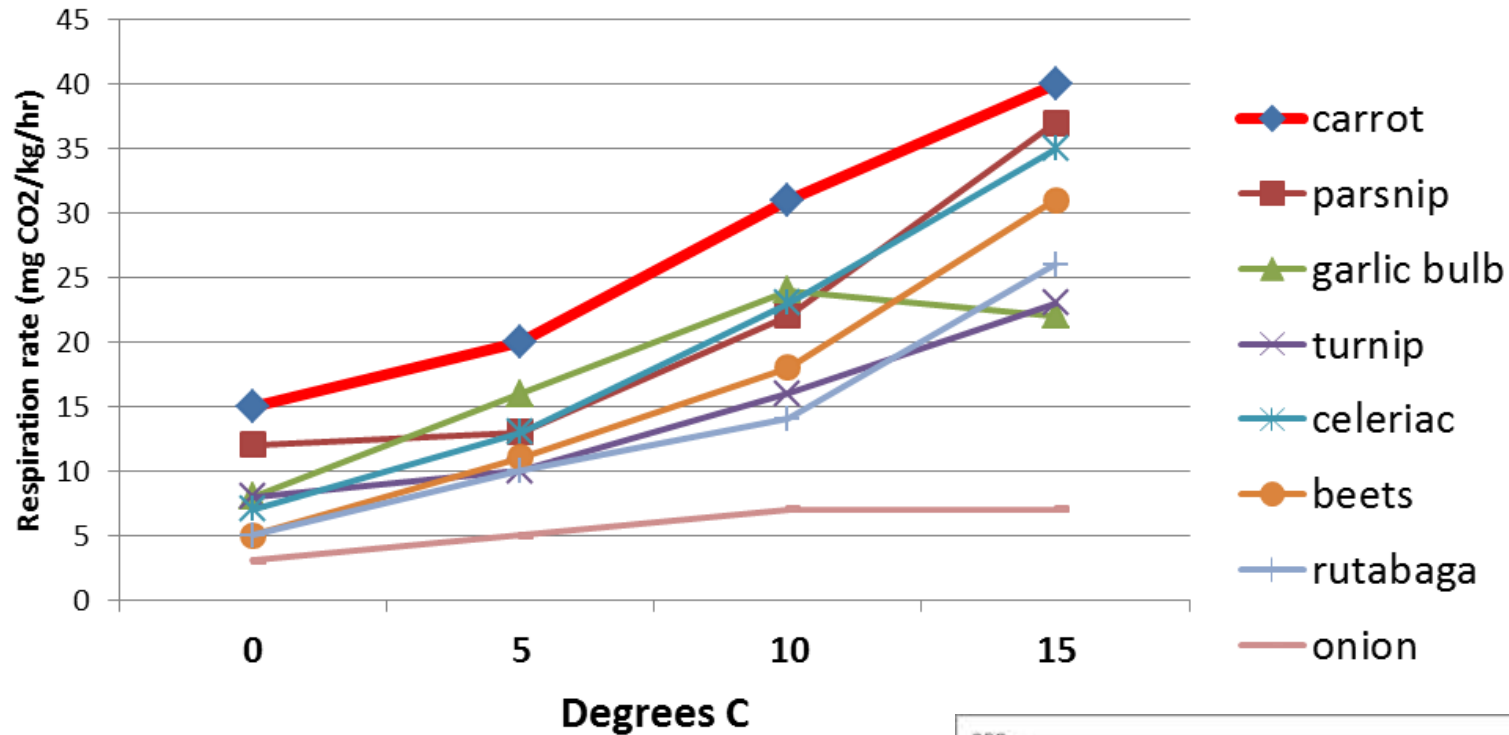
central goal is to help farmers expand vegetable harvest and sales from December-April, and thereby increasing winter income

Why study carrots?

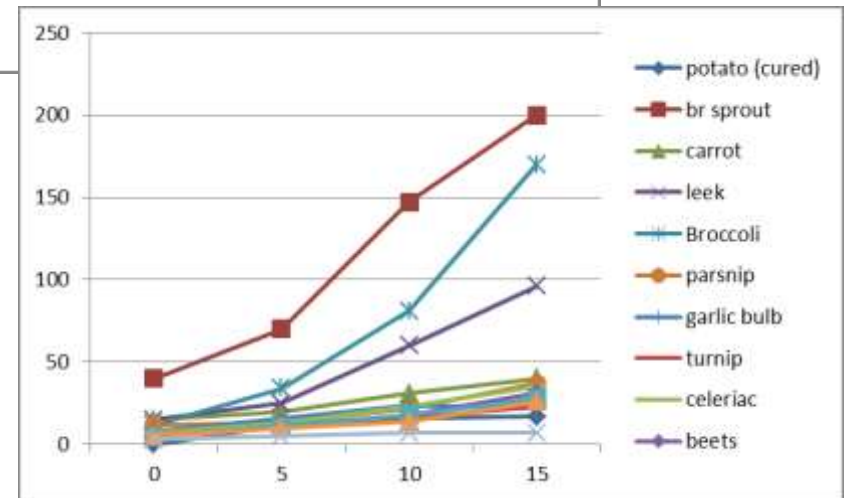
- Winter production and marketing was increasing in New England in response to consumer demand.
- Mostly commonly grown root crop (grower survey)
- Key winter crop to keep customers happy
- Declines rapidly with poor postharvest treatment
- Can be stored 6 months if handled well.
- Model crop for the 'cold moist' storage group



Respiration Rates of Root Crops, by Temperature



Also, carrots are special



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 CO₂ buildup (<5%)
- Avoid Ethylene
- No more than brief periods below 30°F
- RH >95% (98-100%) in package and/or room
- Ideal T 32°F (0°C) (7mo), OK at 32-41 °F (0 to 5°C)
- Permeable packaging
- Permeable packaging
- No ethylene producers eg apples

Postharvest affects carrot 'flavors'



- **Tight packaging** causes low O₂ , high CO₂ & 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



Sources: , USDA Handbook 66; R.Seljasen et al, J Sci Food Agric 84:955-965, 2004

Postharvest affects carrot 'flavors'



Bruising & shock stimulates ethylene, respiration

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

Wash gently
Minimize bruising
No big drops

On-farm carrot storage 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 walls to earth
- 4 in spray foam insulation ceiling
- Active cooling with ambient air, 8" pipe with intake/exhaust fan
- Passive cooling using PVC pipes built into the walls and through gaps around the elevator shaft in one corner.

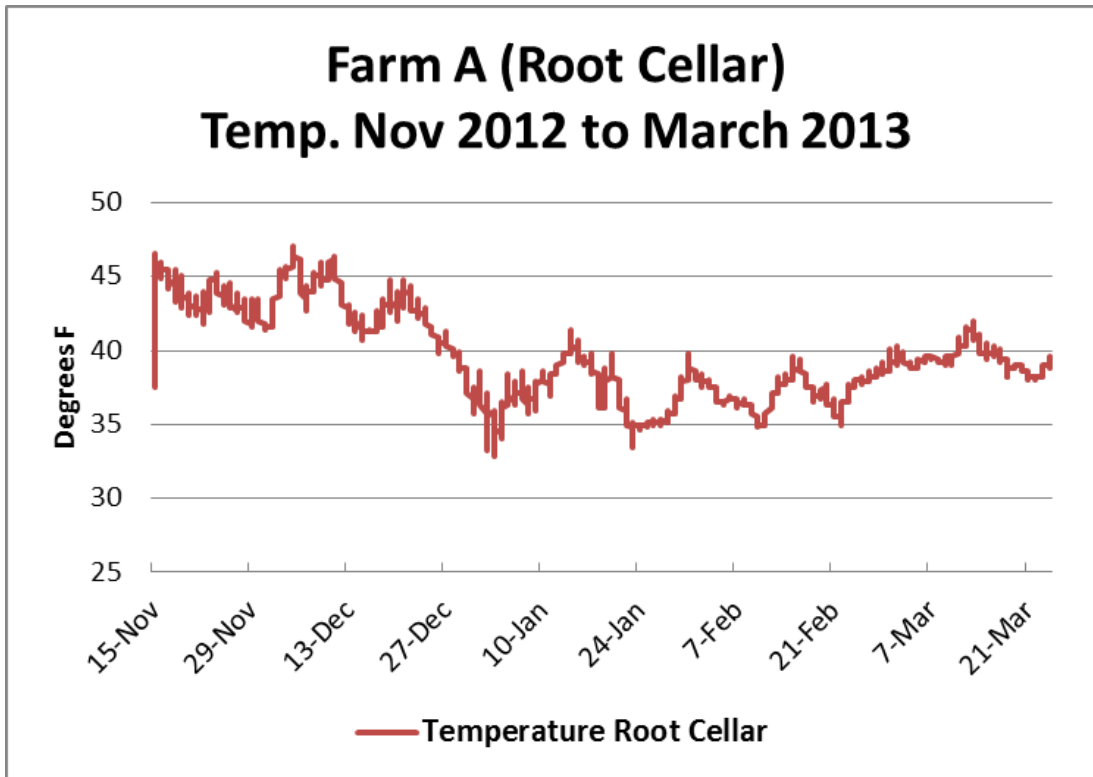


Farm A: Basement Root Cellar

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



Farm A: Basement Root Cellar



- In 2012, Nov and Dec were warm
- Root cellar stayed above 40 until January
- Higher T means water holds more moisture, lower RH
- More water drawn out of carrots

Add RH

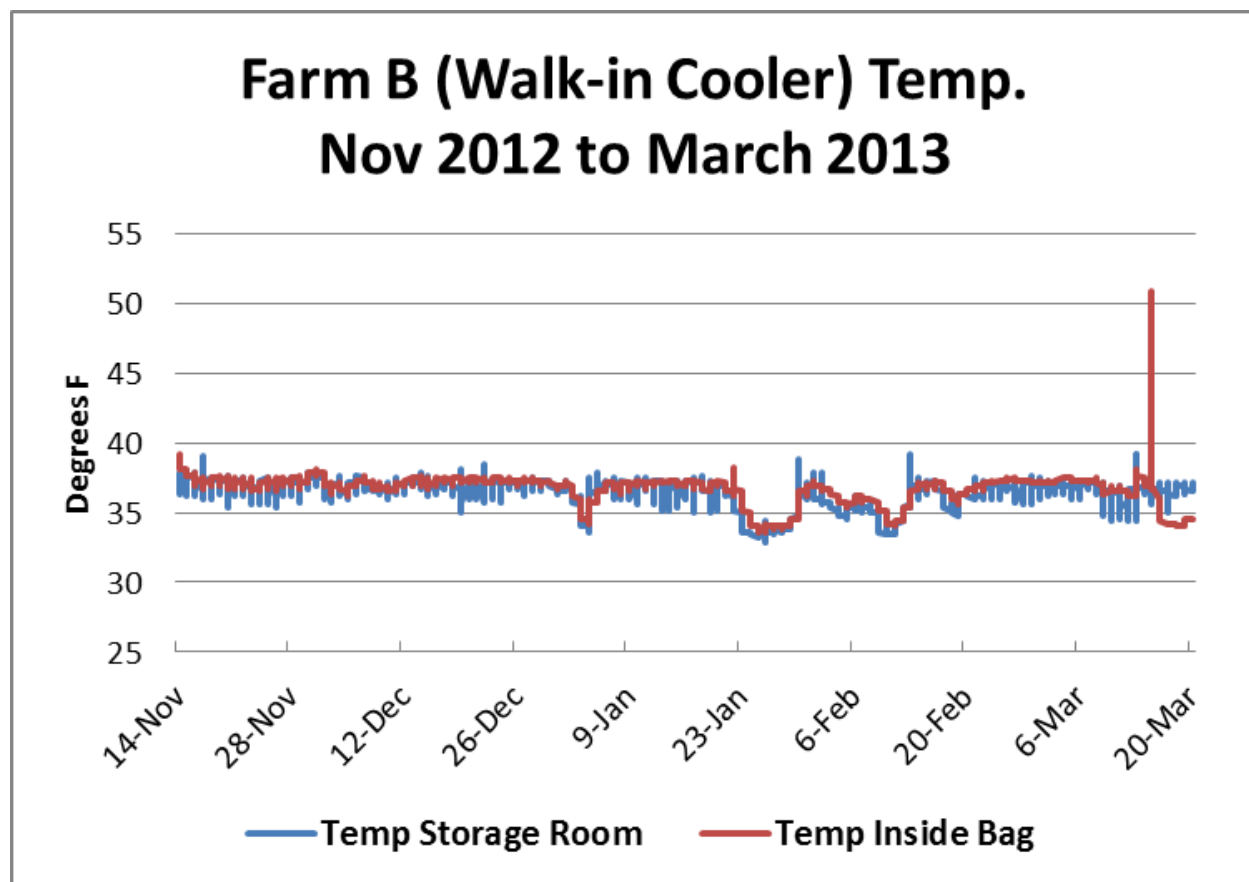
Farm B: Walk-in Cooler inside a barn

- Insulated, 8X8X10' tall
- Thermostat set to 38 F
- Compressor, condenser, and fans
- Cool-Trol system and fans
- Carrots in Perforated 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

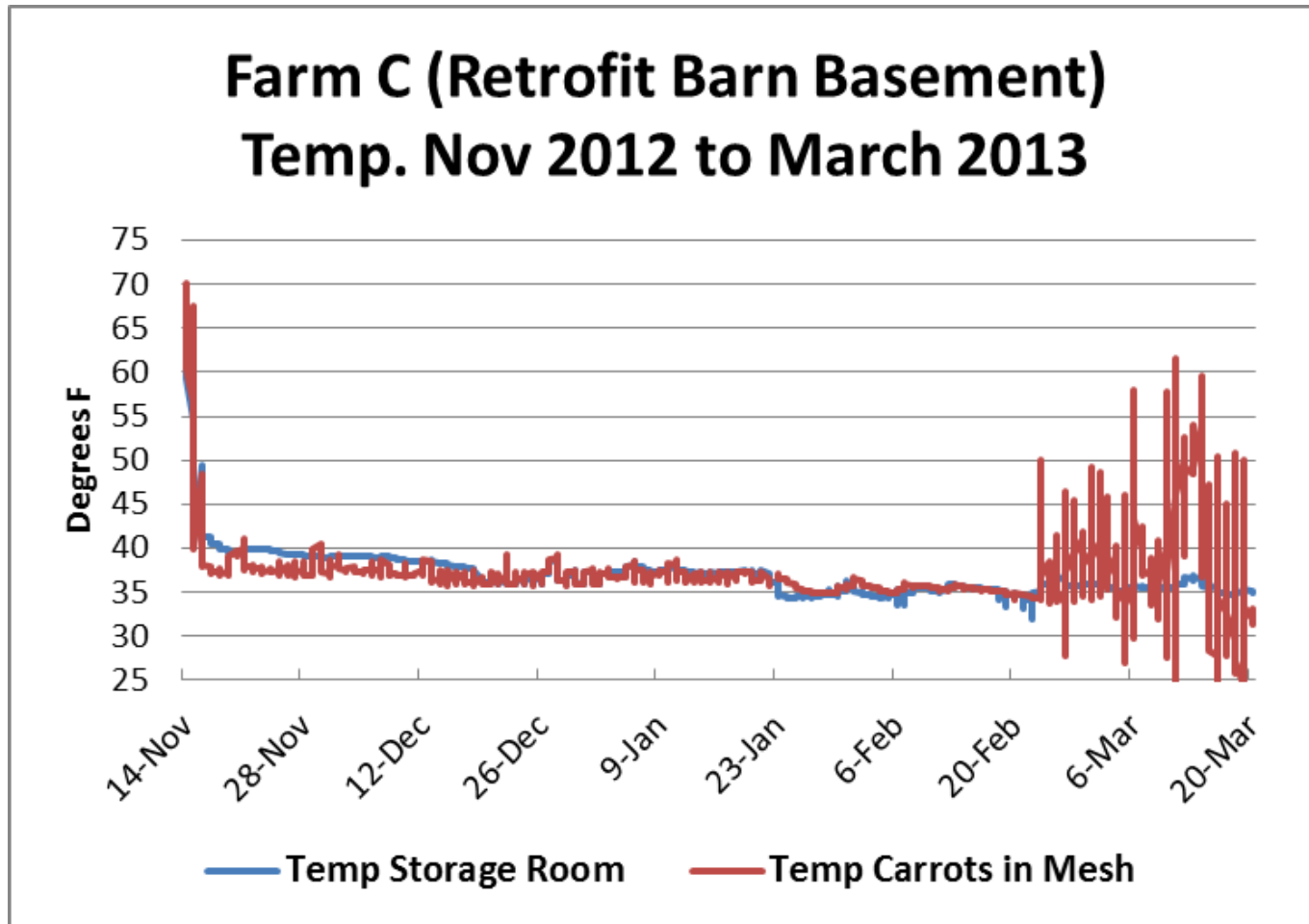


Farm C: Retrofit in Barn Basement

- Carrots unwashed in large Macro 34 vented bins.
- Replaced pallets of black totes, some shrink-wrapped
- Bins are misted, or covered with plastic or moist burlap.
- Open airflow is allowed through the bottom of the pallet.
- (late winter) carrots moved to walk-ins w/ standard cooler panels.



Farm C: Retrofit in Barn Basement



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.
- Temp and RH set for root crops.

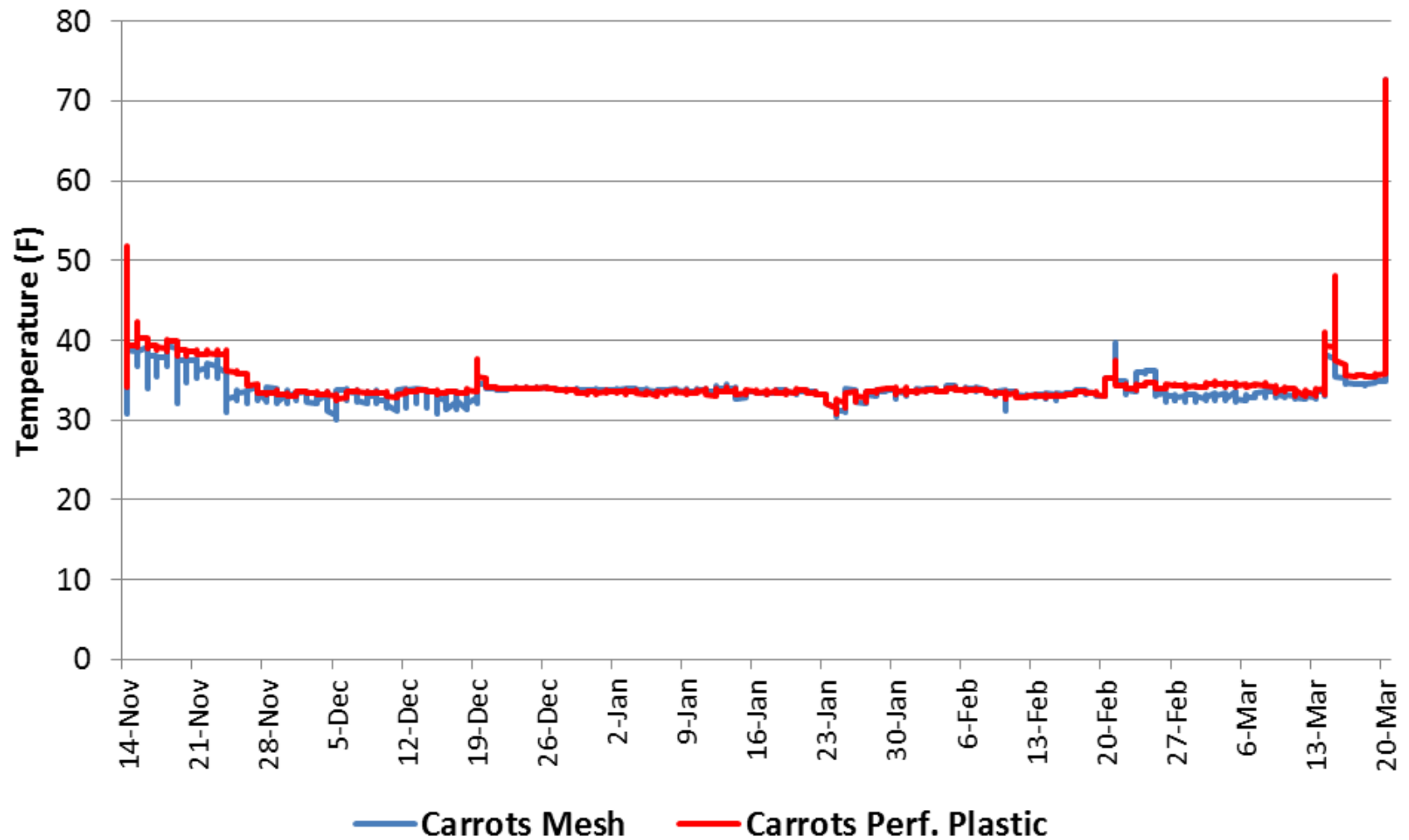


Farm D: Bunker w/ Mister

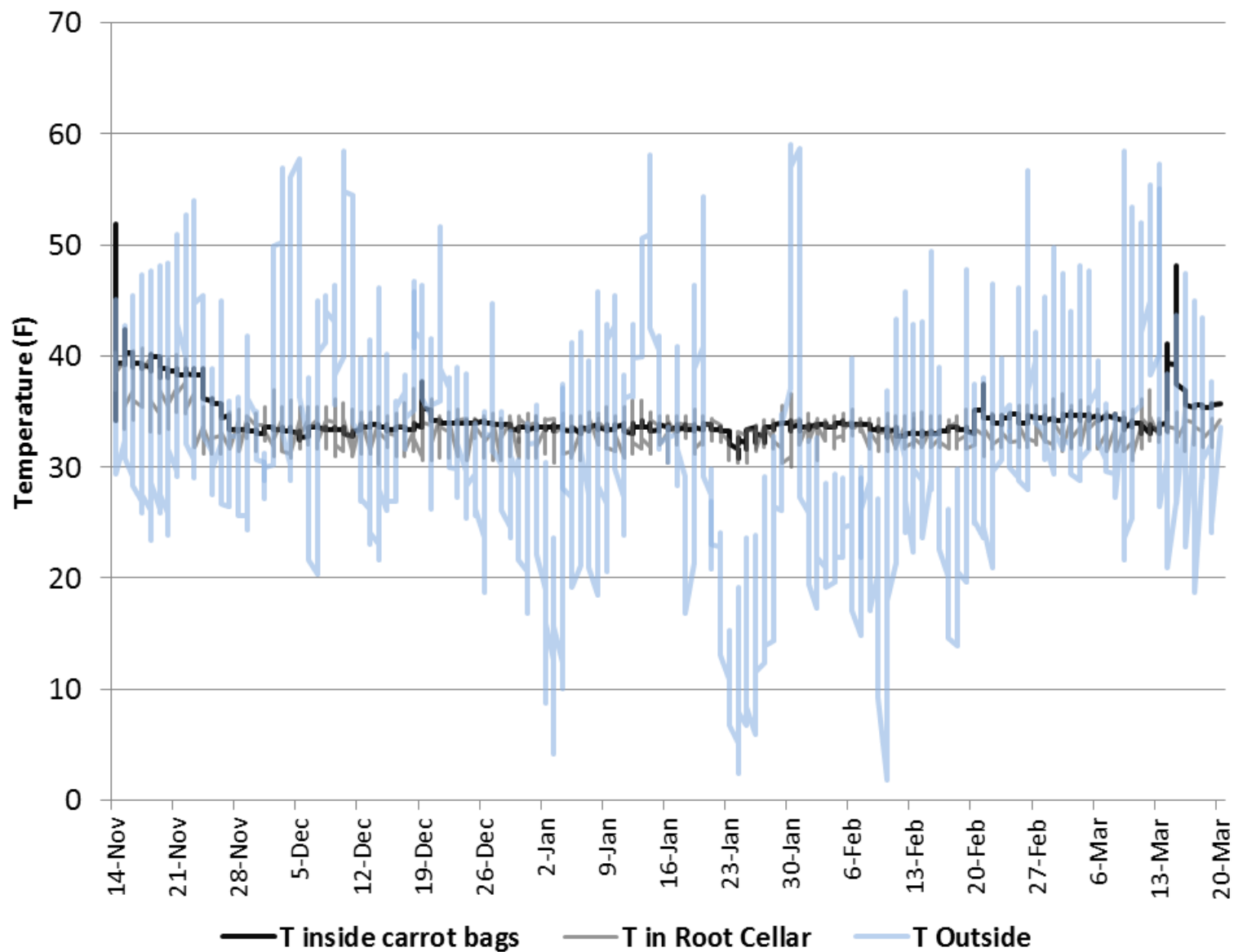


Carrots are washed then packed in 25# capacity, perforated plastic bags and then place in either Macro bins or pallets.

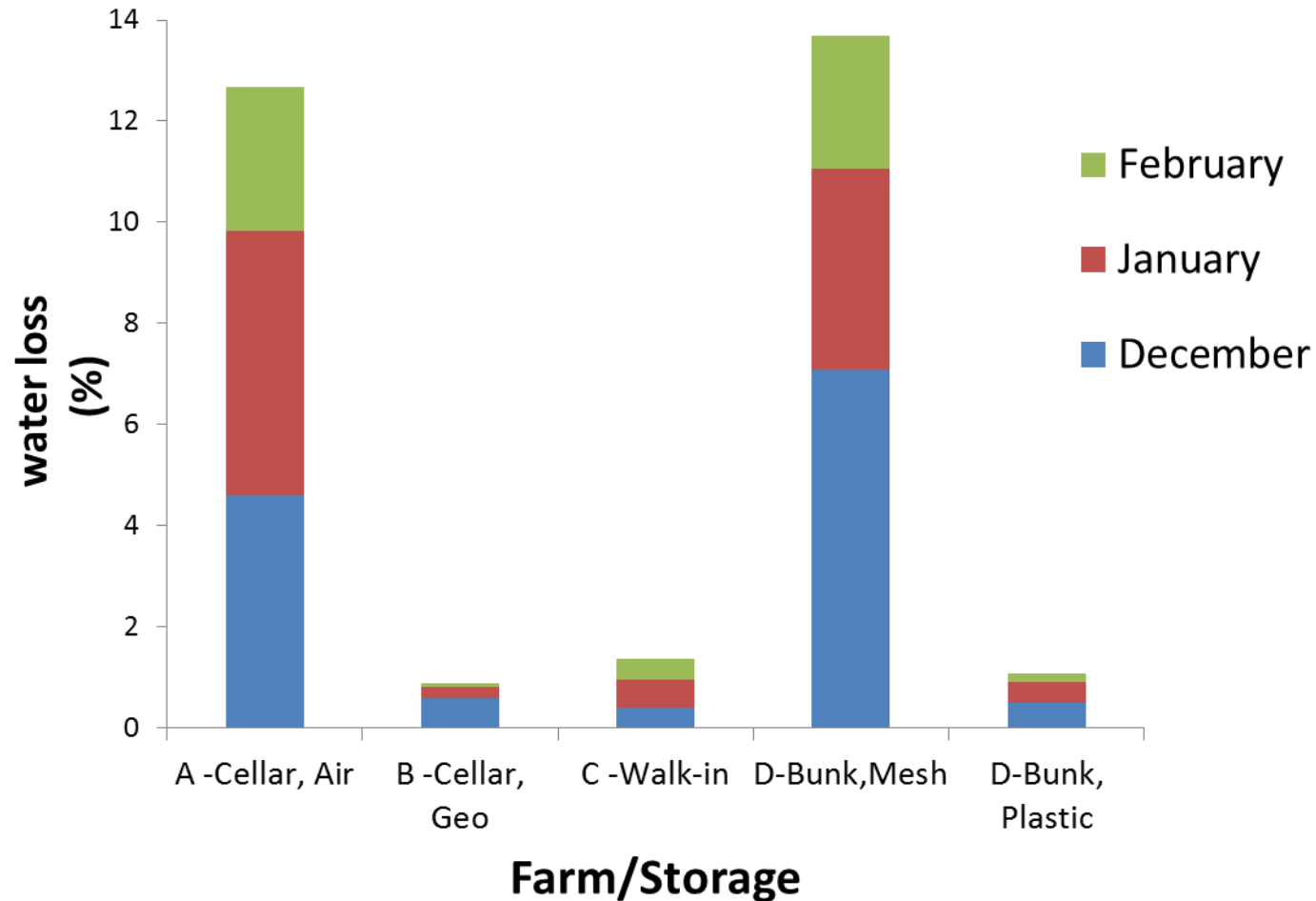
Farm D: Bunker - Carrot in Perf. Plastic vs Mesh



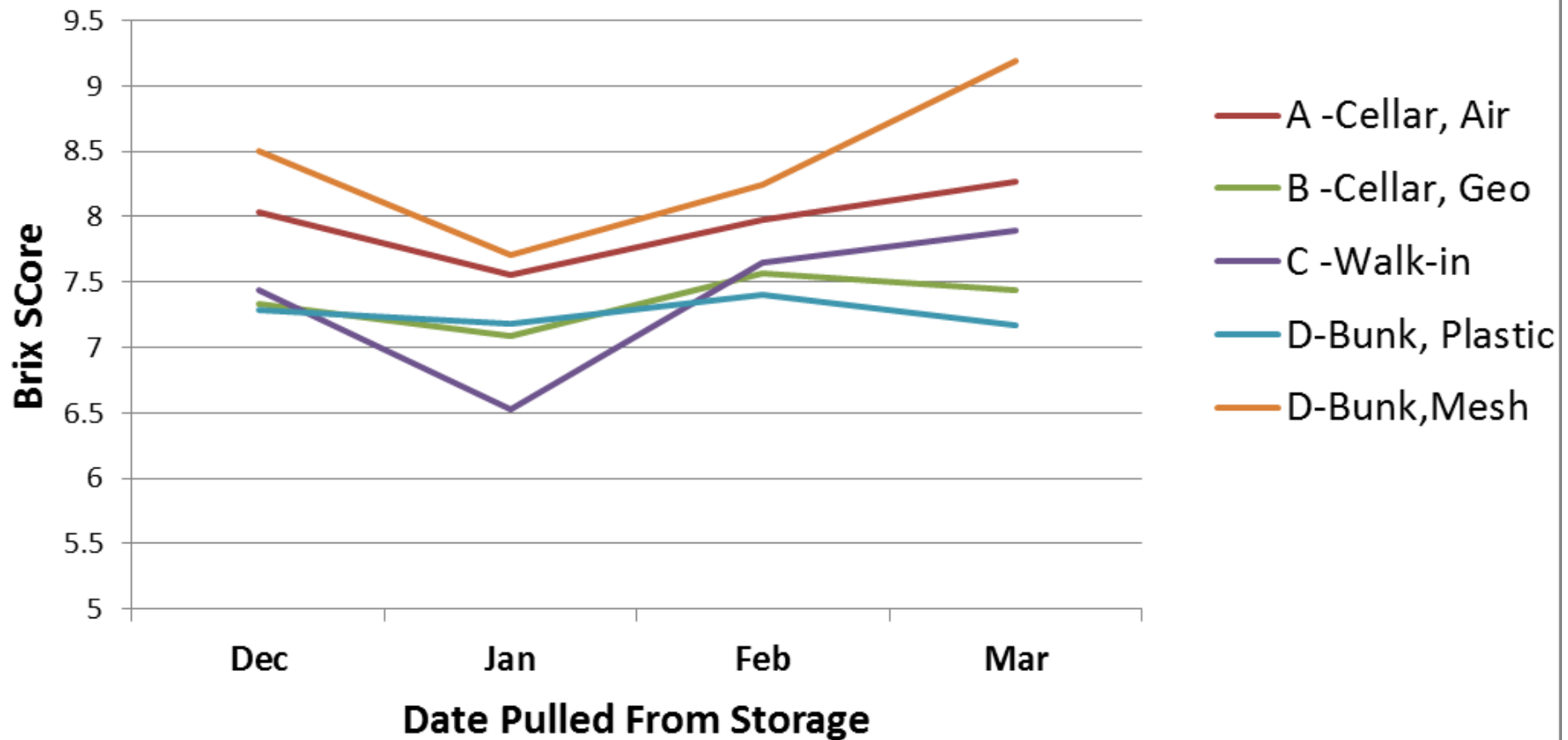
Farm D: Bunker - Temperature Outside vs Inside Storage



%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, wash shortly before market:

- 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:

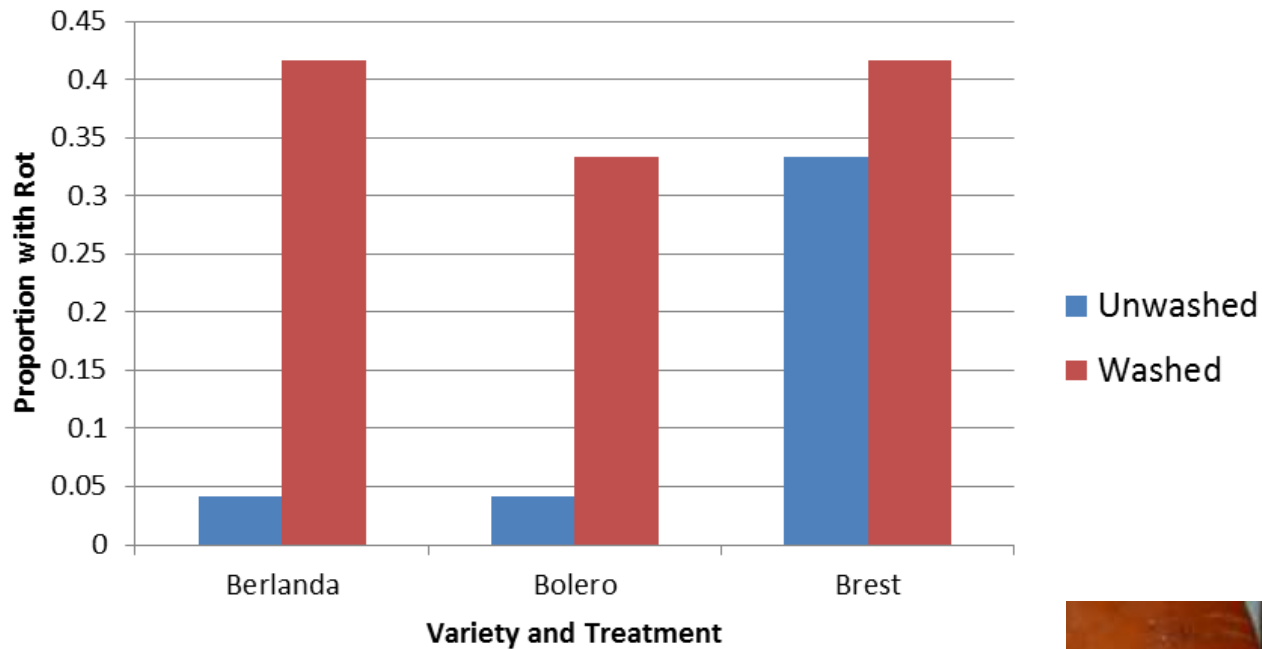
- Staining
- More surface pathogens
- In bulk bins more open to desiccation

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)

In summary....

- Carrots are more complex than we ever imagined!
- Different types of storage designs work very well
 - Its good to engineer rapid fall cooling
- Quality depends on temperature, RH & packaging
 - packaging matters even at high RH
- Wash timing is 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,
 - 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, Becky Sideman, Lisa McKeag, Susan Scheufele, Susan Han, Dan Kaplan, Laura & Charlie Tangerini, Ryan Voiland, Jeremy Barker-Plotkin.

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
 - 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