Extending Vegetable Harvest and Sales Using Tunnels, Row Covers and Winter Storage

An Overview of How New England Growers are Riding the ‘Buy Local’ Wave through the Winter

Mid-Atlantic Fruit and Vegetable Convention 2014
Ruth Hazzard
University of Massachusetts Extension
Expanding Winter Harvest and Sales for New England Vegetable Crops
3 year project (2010-2013) funded by USDA/Northeast SARE

**Goal:**
expand vegetable harvest and sales from December-April, and thereby increasing winter income
Thanks to:

• Becky Sidemann, Univ. of New Hampshire
• Amanda Brown, Univ. of Massachusetts
• Claire Morenon, CISA
• Kate Donald, Seacoast Eat Local
To deliver vegetables to winter markets from December through March, you need a whole system—

- Row cover
- Low tunnel
- Caterpillar tunnel
- High tunnel/hoophouse
- Greenhouse/HT w/ heat
- Storage

Jeremy Barker-Plotkin, Simple Gifts Farm, Amherst, MA
You also need:

- **Winter Markets**
  - CSA
  - Farmers Markets
  - Wholesale
  - Restaurants
- **Year-round Labor**
  - yours and others’
- **Infrastructure**
  - Growing, washing, storing and packing

Riverberry Farm, VT
Critical challenges for growing

• Short days
  o Less than 10 hours of sunlight from Nov 14 to Jan 27 (Pennsylvania)
  o shortest day = 9hr 20 minutes

• Low light intensity
• Cold temperatures
• Little or no growth
‘Phases of winter’ w/ season extension to match

<table>
<thead>
<tr>
<th>Phase of Winter</th>
<th>Where to grow</th>
<th>Growing conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late Fall (Mid Nov. to mid Dec.)</td>
<td>Field: Row cover (RC)</td>
<td>Hard freeze (20-28°F) &amp; thaw</td>
</tr>
<tr>
<td></td>
<td>Low tunnel (LT)</td>
<td>Shortening days</td>
</tr>
<tr>
<td></td>
<td>Caterpillar (Cat)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High tunnel (HT)</td>
<td></td>
</tr>
<tr>
<td>Some growth, holding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep Winter (Dec through January)</td>
<td>High tunnel</td>
<td>Unheated tunnel:</td>
</tr>
<tr>
<td>stockpile what grew in Oct-Nov</td>
<td></td>
<td>Hard freeze every night( 10-25°F)</td>
</tr>
<tr>
<td></td>
<td>Greenhouse or HT w/ minimal heat</td>
<td>GH, Heated tunnel: &gt; 34°F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low light, short days</td>
</tr>
<tr>
<td>Late Winter (February thru April)</td>
<td>Low tunnel (overwintered),</td>
<td>Freeze at night, days warm to &gt;85°F</td>
</tr>
<tr>
<td>Growth returns Bolting</td>
<td>High tunnel (new plants, regrowth)</td>
<td>Longer, stronger light</td>
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</tbody>
</table>
# Phases of winter = phases of growing

<table>
<thead>
<tr>
<th>Phase of Winter</th>
<th>Crops that can be harvested (roughly*)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Late Fall</strong></td>
<td><em>Row cover:</em> Br sprouts; cabbage; kale*, tatsoi LT, Cat: head lettuce, salad turnips, chard, arugula, cilantro, spinach, kale, tatsoi HT: lettuce, bok choy, RR kale</td>
</tr>
<tr>
<td>(Mid Nov. to Dec – solstice)</td>
<td></td>
</tr>
<tr>
<td><strong>Deep Winter</strong></td>
<td><strong>HT, Cat:</strong> Very Hardy greens: spinach, Ripbor kale, RR Kale, Siberian Kale, tatsoi, miners lettuce With heat: same as Nov-Dec.</td>
</tr>
<tr>
<td>(Dec. to early February)</td>
<td></td>
</tr>
<tr>
<td><strong>Late Winter</strong></td>
<td><strong>LT, HT, Cat:</strong> Regrow: spinach, Kale, carrots, onions, sprouting broccoli New DS or TP: kale, bok choy, salad mix, lettuce, chard, fennel</td>
</tr>
<tr>
<td>(February thru April)</td>
<td></td>
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</tbody>
</table>

* What’s possible to grow in each structure depends on outer and inner covering, outdoor T, varieties, and other factors.  
**Kale: RR= Red Russian, Sib=Siberian (*B. napa*); RB=Ripbor type, frilly green, *B. oleracea*.
Field Production for late fall harvest under row covers

- Heavy frost: lettuce, salad mix, broccoli, bok choy, chard
- Hard Freeze: spinach, kale
Overwintering under Row Covers

• Crops:
  – spinach, carrots, kale
• Seeding dates:
  – October-November

Row cover types
- Medium: 0.55 oz/sq yd
- Heavy: 1.25 oz/sq yd
  (eg, Dupont 5131, Typar)
Low Tunnels for overwintering

- Goal: survival and regrowth for spring markets
- Low cost (0.50-$1/sq ft)
  - 5% of 4-season GH
  - 15%-30% of unheated tunnel
- Support snow load
- No winter access

Research and Photos by
Becky Sidemann, Univ. of New Hampshire
Amanda Brown, Univ. of Massachusetts
Low Tunnels for overwintering

- Minimum T in tunnel 20-40 °F higher than outdoors
- Ground rarely freezes
- Temp. moderating effect is greatest when outdoors is the coldest
- Best protection: row cover plus GH plastic

<table>
<thead>
<tr>
<th>Location</th>
<th>Outdoors</th>
<th>2 layers Row Cover</th>
<th>RC + Perf Plastic</th>
<th>RC + GH Plastic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enfield, NH</td>
<td>-19.7</td>
<td>13.1</td>
<td>14.3</td>
<td>22.7</td>
</tr>
<tr>
<td>Meredith, NH</td>
<td>-14.2</td>
<td>17.5</td>
<td>23.2</td>
<td>27.0</td>
</tr>
<tr>
<td>Durham, NH</td>
<td>-11.9</td>
<td>-6.7</td>
<td>0.3</td>
<td>13.4</td>
</tr>
<tr>
<td>Millis, MA</td>
<td>-14.8</td>
<td>24.7</td>
<td>27.3</td>
<td>21.4</td>
</tr>
<tr>
<td>Deerfield, MA</td>
<td>2.1</td>
<td>17.0</td>
<td>16.0</td>
<td>19.4</td>
</tr>
<tr>
<td>Little Compton, RI</td>
<td>-0.3</td>
<td>3.4</td>
<td>4.2</td>
<td>*</td>
</tr>
</tbody>
</table>

Testing three types of covering for low tunnels
-- north to south in New England
4b to 6a hardiness zones

Minimum winter temperatures (°F) outdoors and in experimental low tunnels in 2011-12.
R.G. Sidemann et al, 2012
Low Tunnel Construction

- 10 ft hoops (elect conduit or PVC)
- Heavy row cover (1.25 oz/sq yd)
- 0.6 ml Greenhouse plastic
- Post & rope at ends - taut
- Bury edges with soil
- Row cover: onset of heavy frost
- Plastic: before soils freeze
An acre of low tunnels, Redfire Farm, Montague MA

Spaced for tractor to roll soil over edges
Carrots, kale, spinach, onions
Inner row cover stays on longer in spring
Low Tunnel successful crops

• *Brassicas*: Red Russian, Siberian, Winterbor kale
  – Not *B. rapa* -- bolt too fast.
• Spinach
Low tunnels-- successful crops

Onions:

Seed in August
Transplant in late Sept-Oct
Covered Oct-April
Harvest green April
or as bulbs May - June

Photos by : Becky Sideman, UNH Cooperative Extension
Reports:
www.extension.umass.edu
  winter production, storage and sales
www.nevfc.org
  Proceedings and powerpoints,
  Dec 2013 conference
Bulbing: Most bulbed nicely. May 7, 2012

‘Keepsake’

‘Bridger’

‘T-420’

‘Hi-Keeper’

‘TopKeeper’
Two varieties bulbed poorly in 2012

‘winter white’ scallion

‘walla walla’ in 2013
Low tunnels—successful crops

Carrots:
- seed Oct to early Nov
- harvest April-May
- Cv. Napoli works well
Caterpillar Tunnels

• 20’ chain link fence tubing
• Hoop bender
• Metal ground posts
• Single layer GH plastic

Simple Gifts Farm, Amherst, MA
Caterpillar tunnel construction

• End ties
• Ropes
• Hitch up sides
Caterpillar tunnels

- Inner row covers add protection
- Benefits: movable, cheap, 4-season use, can be built over field crops
- Limitations: ventilation, wind damage
High Tunnel Management for Winter

- Seed timing depends on harvest goals
  - Seed early fall to ‘stockpile’ for Dec-Jan
  - Seed late fall to overwinter small, grow in Feb-March
  - Seed or TP in February
- Inner covers
  - Multiple layers
- Don’t harvest till crops are thawed
- Little watering is needed
Minimally heated (just above freezing)

Simple Gifts Farm,
January 26, 2014
Queen’s Green’s, Hadley, MA
-Four High tunnels
-Four caterpillars
-Row covers (late fall)
January 27, 2013
Outdoor T -15 this winter
High Tunnel – minimally heated

• Bottom heat
  – Water circulates under the beds
  – Soil warms, row cover captures & holds
  – More costly to set up, less costly to run

• Air heat (furnace)
  – May already be set up in GH with ground production
  – More costly to run

• Air T 34-36

• Continuous growth without frost: lettuce, bok choy, mizuna
Storage

• Summer grown!
• Harvest windows:
  – September: Winter squash, sweet potato, onion
  -October: potato, carrot, beet
  -November: Brussels sprouts, cabbage, carrot, celeriac, beet

Storage goals?
2-6 months
crop quality – healthy going in
storage conditions match the need
# Winter storage of vegetables: four different storage environments

<table>
<thead>
<tr>
<th>Description</th>
<th>Crops</th>
<th>Temperature</th>
<th>Relative Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold, moist</td>
<td>carrots, beets, turnips, celeriac, cabbage, leeks, Br. sprouts</td>
<td>32–34 °F</td>
<td>98-100%</td>
</tr>
<tr>
<td>Cool, moist</td>
<td>potatoes</td>
<td>40-45 °F</td>
<td>90%</td>
</tr>
<tr>
<td>Warm, dry</td>
<td>winter squash, sweet potato</td>
<td>55-60 °F</td>
<td>60-70%</td>
</tr>
<tr>
<td>Cold, dry</td>
<td>onion, garlic, shallot</td>
<td>32-34 °F</td>
<td>65-70%</td>
</tr>
</tbody>
</table>
Basement Root Cellar

- Barn for CSA farm
- Elevator for pallets
- Cement walls to earth (50°F)
- 4 in foam insulation ceiling
- Best: foam under slab

Brookfield Farm, Amherst, MA
Storage rooms in new barn basement

Goransen Farm, Maine

1. Cold, moist roots
2. Cold, dry onions
3. Warm, dry squash

Photos by Rob Johanson of Goransen Farm
Walk-in Cooler inside a barn

- Insulated, 8X8X10’ tall
- Thermostat set to 38 F
- Multiple roots
- CSA share pickup
3 Storage rooms in half-buried bunker

Tangerini Farm, Millis, MA
Using packaging to increase/modify RH

- Totes
- wrapped bins & pallets
- burlap over pallets
- Perforated plastic bags

Atlas, Redfire & Tangerini Farms
High humidity
Root Storage:
• Mister
• Sprinkler
• Water on floor

Sprinklers over bins of carrots/burlap cover
Using outdoor air to cool walk-in for winter storage

- Duct outdoor air into storage when temperatures allow
- Thermostats inside and outside
  - Compressor turns on when desired
    T is less than outdoor T
- Energy efficient & cost effective
- Add humidity
Squash, Sweet potato

>50 F, 50-70 RH for

Fall: greenhouse, inner plastic, heater

Winter: insulated, heated above or below ground
Reports and Articles:

SARE reports database
www.mysare.sare.org
  Project # LNE 10-297. Annual reports

UMass Extension Vegetable Program website
http://extension.umass.edu/vegetable/
  Winter production, storage and sales

New England Vegetable and Fruit Conference
www.nevfc.org
  Proceedings and powerpoints,
  Dec 2013 conference