

## EXTENDING VEGETABLE HARVEST AND SALES USING TUNNELS, ROW COVERS AND WINTER STORAGE

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In response to increasing demand for local vegetables through the winter months, growers are expanding the use and diversity of protective growing structures, as well as increasing production and storage of root vegetables. From 2010 to the present, UMass Vegetable Program has partnered with Univ. of New Hampshire Cooperative Extension and two buy-local marketing organizations, CISA and Seacoast Eat Local, to investigate and support production and marketing during the months of December through April.

**Row Covers** are used in fall and spring to raise air and soil temperatures, and to protect from frost and winds. In the fall, crops gain additional weeks to reach harvest or remain marketable, starting with frost sensitive crops such as eggplant or pepper and ending with hardier lettuce, broccoli, bok choy, spinach, and sometimes root crops. In spring, row covers without hoops are frequently used on salad mix, lettuce, and early Brassicas to provide heat as well as insect protection. With hoops and plastic, summer squash and zucchini transplants can go out in late April or early May depending on the season; and eggplant, pepper, or tomato can get an early start. Row cover weights are generally 0.55 oz/sq yd or slightly heavier. Less often, wide sheets of heavier covers are used for overwintering hardy crops such as carrots or spinach for early spring growth.

**Low Tunnels** are temporary, small (4-8 ft tall, 5-10 ft wide) unheated structures with hoops made of PVC or metal conduit, covered with various materials. While low tunnels afford less winter protection than high tunnels and access is limited after snowfall, they can be erected for \$0.50-\$1.00 per square foot, estimated to be 5% of the cost of a 4-season greenhouse or 15-30% of the cost of an unheated high tunnel. They are easily moved, simplifying rotation of winter production areas. While these may be used for late fall harvests (November and December) they also are designed to carry snow and provide protection through the winter for regrowth in March and April, targeting an April–June harvest depending on the crop. They need to be in place before the ground freezes, as the most reliable way to secure the plastic is soil mounded along the edge. Over the past 4 years, UMass has partnered with UNH to test various coverings, crops, varieties and plant dates for optimal spring harvest. Our studies found that an inner layer of heavy (1.25 oz/sq yd) row cover with outer layer of 0.6 mil IR greenhouse plastic (RCGH) gives greater protection from cold than a row cover with perforated plastic or double row cover. In studies of tunnels from central NH and western MA to southern RI, the winter minimum temperature in the RCGH tunnels ranged from 20 to >40°F higher than outdoor temperatures, and soil T rarely dropped below freezing. This combination also provides flexibility in spring when sun returns and T can rapidly exceed 95°F. Removing the plastic while leaving the row cover layer gives the protection needed for tender new growth that burns easily in dry, cold spring winds, and can also get the crop through cold spells or snowfall in March. As a general rule, crops tend to bolt more rapidly in spring if planted too early, but yield less if planted too late. Onions, seeded in August or September and

transplanted in October and grown on to be harvested green or as early bulb onions are one of our most successful low tunnel crops. Spinach and kale, both Winterboror Siberian kale types also do very well. *Brassica rapa* type greens (bok choy, mizuna) bolt too quickly when overwintered in low tunnels and beets do not survive well so neither are recommended for low tunnels. Carrots are very promising(cv Napoli is often used) ; in 2012-13 UMass trials an early October seeding date gave us the best yield of fresh spring bunching carrots, but the best date will depend on your location and the season.

**Caterpillar Tunnels** are temporary, movable structures using steel or PVC bows set in or over ground posts, creating 10 to 15 ft wide space that covers 1 to 3 growing beds. Bows are generally 6-8 ft apart and 20 ft long. Diagonally crossed ropes linked to tie-downs bolted into the base of the ground posts, and plastic gathered tightly and staked at each end are key to structural integrity. Cost per sq ft is under \$1.00, cheaper than high tunnels with excellent net income potential. They are typically used in spring, summer and fall but more recently in New England are being used to carry crops through the winter. They allow for 2 to 4 succession crops per season, moving from cold hardy greens or roots to heat-loving crops (fruiting vegetables, flowers), or the reverse, as the season progresses. Black plastic, inner row covers and use of transplants give additional boost to survival and growth. Ventilation and access are accomplished by raising the sides. Yields and quality are enhanced as is winter survival. Advantages over low tunnels are winter access and more heat and cold buffering; these tunnels can however suffer from wind and snow damage and require more attention to structural integrity for winter use.

**High Tunnels**, which typically have no permanent furnace or end-wall fans, use passive ventilation through roll-up sides and end or peak vent, and grow crops in the ground, are well known in the mid-Atlantic region. They are used widely to gain an early start or continue later in the fall with summer crops. For winter production, a gothic shape with high vertical sides is needed to shed snow and diagonal bracing is key to handling a snow load. A double inflated plastic system protects the plastic and adds insulation. An interior row cover (one or more layers) 18-30 inches above the crop, supported by hoops or rails, helps hold in the heat that builds up during sunny days and moderates cold nights but is opened on all but the coldest, cloudy days. Ventilation in winter is through end vents. Often growers build up their supply of greens in the fall, then pick them down during the December and January 'dead zone' of shortest days and lowest light. Growth rates pick up by the beginning of February for overwintered and newly seeded crops. Crops that can handle the repeated freezing of a winter high tunnel include spinach, Siberian kale, bok choy, Tatsoi, and chard. Movable tunnels provide options for crop rotation and succession plantings making best use of the protective cover; for example, keeping fall tomatoes covered longer, while greens get started in the open or under row cover.

**Storage.** Good postharvest handling (including curing) and proper storage conditions make it possible to store and sell root crops that can only be grown in the summer months. Ideally, farms should have four storage units, each with specific temperature and RH conditions (see Figure 1) for crop groups. The 'cold moist' group also includes cabbage, Brussels sprouts, celeriac, turnips, and rutabaga. It is important to manage RH as well as T. Growers who are scaling up their winter sales often start with smaller, more basic storages and build better infrastructure over time. Ambient air can be used for cooling, especially with thermostatically controlled intake fans, but may not provide the rapid cooling needed in fall and the steady cold needed in spring for best crop quality. We have found that a 'good enough' storage (eg

34-38 °F for the ‘cold moist’ group can carry crops till February or March while ideal conditions will take crops till May or June. For sweet potato and winter squash, preventing cold injury by keeping temperatures above 50 to 55 °F is critical.

Carrots, beets	Cold Moist	32-34°F and 98-100% RH.
potatoes	Cool moist	40-45 °F and 95% RH
squash, sw potato	Warm, dry	55-60°F and 50-70% RH.
onion,garlic	Cold Dry	32°F and 65-70% RH

**Figure 1. Storage Conditions Needed for Vegetable Crop Groups**

**Summary.** To meet the demands of winter CSA’s and farmers markets and year-round wholesale, New England farmers are putting together a fairly complex system of growing structures and storage units. Meeting the needs of winter markets requires changing your planting schedules, labor force, and your way of thinking about the six month period from October to March. Winter production and sales is not for everyone, but for some growers it provides a chance for the farm to expand, an increased winter income, a year round labor force, and a more balanced yearly workload.

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See also articles by Becky Sidemann, including

[http://extension.unh.edu/resources/files/Resource003239\\_Rep4688.pdf](http://extension.unh.edu/resources/files/Resource003239_Rep4688.pdf)

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Bio:

**Ruth V. Hazzard** works for University of Massachusetts Extension as an Extension educator and researcher in ecological pest management and vegetable cropping systems. She grew up in upstate New York and earned her BA from Goddard College in 1979. Since getting her MS from UMass Amherst in Entomology in 1989, she has worked with both organic and conventional farmers throughout New England on integrated pest management strategies in vegetable crops. Her focus in recent years has included production systems for winter harvest and sales of vegetable crops, including experiments with fall carrots, storage systems, and low tunnels. She started the year-round Student Farming Enterprise program, now in its 8<sup>th</sup> year, which gives UMass students practical experience in growing and marketing organic vegetables. She and her husband have four grown children, and recently built a home next to the North Amherst Community Farm in Amherst where they are establishing fruit and vegetable gardens and a high tunnel.

