

## 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 their use of protective 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. Introduction

Definition of tunnel

Definition of storage

Row Covers are used in fall and spring to raise air and soil temperatures, 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. Weights are generally 0.55 oz/sq yd or slightly heavier. Less often, wide sheets are used for overwintering hardy crops such as carrots or spinach for early spring growth.

Low Tunnels – 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. In studies of tunnels from central NH, 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.

While these may be used for late fall harvests (November-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. They are not for harvest during the winter. Typical structures use 10' metal electrical conduit, rounded with vertical sides to shed snow and cover a 5 ft span, ends in the ground about 12-18 inches. An inner layer of heavy (1.25 oz/sq yd) row cover with outer layer of 0.6 ml IR GH plastic gives greater protection from cold than a row cover with

perforated plastic or double row cover. 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 wind protection needed for tender new growth that burns easily in dry, cold spring winds, and can get the crop through cold or snow in March. Over the past 4 years, UMass has partnered with UNH to test various coverings crops, varieties and plant dates to optimal spring harvest. As a general rule, crops tend to bolt 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 the most successful crops. Spinach and kale, Winterbor or Siberian kale types, also do well. *Brassica rapa* type greens (bok choy, mizuna) bolt too quickly when overwintered in low tunnels; beets do not survive well; neither are recommended. Carrots are very promising (cv Napoli is often used); in 2012-13 UMass trials an early October seeding date gave the best yield for Napoli, but the best date will depend on your location and the season.

**Caterpillar Tunnels** are temporary, movable structures using steel or PVC bows set into ground posts, a 10 to 15 ft wide space that covers 1 to 3 growing beds. They can be used for late fall, winter or spring growing and allow for 2 to 4 succession crops per season, moving from cold hardy greens or roots to heat-loving crops (fruiting vegetables, flowers) 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. Bows are 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 good net income potential. Yields and quality are enhanced as is winter survival. Advantages over low tunnels are winter access and more heat and cold buffering; they can however suffer from wind and snow damage and are not as winter hardy as low or high tunnels.

**High Tunnels** (definition: no permanent furnace or endwall fans, passive ventilation through roll-up sides and end or peak vents; growing in ground, bags or raised beds) are well known in the mid-Atlantic region, 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. 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. Ventilation in winter is through end vents. Often growers build up their supply of greens in the fall, pick them down during the December and January 'dead zone'. 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 and storage conditions make it possible to store and sell root crops that only grow well 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. 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 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 for the 'cold moist' group can carry crops till February or March

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 Groups**

This work was supported in part by Northeast SARE Project No. LNE10-297; more information can be found at <http://extension.umass.edu/vegetable/projects/winter-production-storage-sales>