STORING VEGETABLES INTO THE WINTER

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To meet the growing demand for local food, more and more growers are producing storage vegetables as a way to extend the marketing season long after the production season is over. To be successful, this requires slowing down the natural process of aging and decay. Vegetables are alive, even after harvest, but the reality is they are doomed to die--the only question is when. So you can think of storage as a life support system designed to reduce a crop's respiration rate, which uses up energy, and minimize its transpiration rate, which causes dehydration. In addition, a good storage system will avoid damage to crop quality from chilling injury, exposure to ethylene or off-odors.

First things first: planning ahead for storage. The steps that growers can take to optimize the storage life of vegetables happen in three stages: from field production, to harvest and handling, to storage. The first stage is still in the field, looking ahead to the quality of the crop at harvest. Since quality only goes down in storage, it makes sense to start with the best quality possible. That involves the usual array of best management practices, from a good soil fertility program, to timely and adequate irrigation, to effective pest management. It also includes selecting varieties that are well suited to storage, and a timing the harvest to make sure the crop is mature but not past its prime and starting to senesce.

Harvest and post-harvest handling is the second stage. The primary concern here is to avoid any and all injury to the crop that will reduce its ability to store well. Cuts, bruises, exposure to direct sunlight and high temperatures should all be avoided.

Storage life depends on the condition of the crop, so careful handling is critical and only mature, undamaged produce should be harvested for storage. Crop last longest when held under optimal storage conditions, which for winter squash is 55 degrees F and 50 to 70 percent relative humidity.

Prompt removal of field heat is very important to slow down the aging process right away. Some crops will require trimming or washing to meet market demands, and others may need curing to get them into best condition for storage. Washed products may be sanitized to kill of the microbes that promote decay. Crops will be packed in some way for storage, and this must be done with care to avoid injury. Storage containers must allow the right amount of air exchange for the crop, and should not pile the crop so deep that bruising occurs.

Curing is an important part of the second stage for some crops. It's used to promote the drying down and toughening up of external tissues, which reduces moisture loss in storage as well as entry points for decay organisms. Just like storage conditions, crops vary in their optimal curing conditions.

Curing is important to promote long storage life for some crops like onions. Curing can be done in the field when the weather is warm and dry, or in a greenhouse. Temperatures should be held below 85 degrees F, with good air movement. Curing is complete when necks are completely dry and tight.

For garlic and onions, cure at 68-86°F, 70% RH with good air flow for 2 weeks or until necks and skins are completely dry and tight. For table stock potatoes, cure at 55-65°F, 95% RH for 2-3 weeks. For sweet potatoes, cure at 80-86°F and 85-95% RH for 4-7 days. For winter squash cure at 80-85°F for 10-20 days to heal wounds; curing may not benefit mature, undamaged fruit.

Storage is the third stage. Vegetable shelf life is manipulated in storage by managing temperature, humidity and the combinations of crops that are stored together (to avoid ethylene injury and odor transfer). The better a storage system can maintain the optimal temperature and relative humidity for different crops, the longer the crops can be held in a marketable condition. Of course, it isn't always possible to meet the needs of every crop you want to store, so you do the best you can with the facilities you have, recognizing that sub-optimal conditions will shorten the storage time you can plan expect.

Optimal storage conditions. A quick internet search will bring up sites that show long lists of vegetable and their optimal storage conditions. The most comprehensive explanation of individual crop storage requirements and handling guidelines is USDA Agriculture Handbook Number 66, The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks,

which is on-line at: http://www.ba.ars.usda.gov/hb66/contents.html. A one-page summary of vegetable crop post-harvest handing information can be found in the 2012-13 New England Vegetable Management Guide on page 26, which is also on-line at: http://www.nevegetable.org/index.php/cultural/foodsafety?start=2.

For practical reasons growers need to group storage crops into common categories so facilities can be created to provide several different conditions. There are basically five sets of ideal conditions for winter storage vegetables. These are: cold and moist, cold and dry, cool and moist, warm and moist, warm and dry. Below are the specifics and the crops suited to them that are commonly stored into the winter on northeastern vegetable farms.

- Cold and moist = 32°F and 90-95% RH. Beets, cabbage, carrots, cauliflower, leeks, rutabagas and turnips.
- Cold and dry = 32°F and 65-70% RH. Garlic and dry onions. (Store seed garlic at 50°F.)
- Cool and moist = 45°F and 90% RH. Potatoes for table stock.
- Warm and moist = 57°F and 85-90% RH. Sweet potatoes.
- Warm and dry = 55°F and 50-70% RH. Winter squashes, including pumpkins.

You may not need all these 'ideal' conditions for the crops you have, or you may not be able to afford to create them, especially if you are only storing small amounts. In that case, slightly less than ideal conditions can work, too—you'll just have to sell crops sooner rather than later in order to avoid storage losses.

For example, a single storage can work for potatoes and roots crops, held 38°F and 90% RH. A single storage also works for winter squash and sweet potato held at 55°F and 60 to 70% RH.

There are many different storage systems for winter vegetables, from root cellars to large walk-in coolers. Many small to mid-size growers are using insulated rooms with an air conditioner and a Cool Bot controller to maintain a cool storage environment. See: http://www.storeitcold.com

Chilling injury. Some crops are more sensitive to low temperatures than others. If your storage system is does not have accurate temperature control then it is best to err on the side of caution with sensitive crops and aim for a few degrees above the optimal temperature. Potatoes and sweet potatoes are very sensitive to chilling injury. Onions, winter squash and carrots are moderately sensitive, meaning they can tolerate brief exposure to sub-optimal temperatures. Cruciferous storage crops are the most tolerant of cold temperature and least susceptible to chilling injury.

Odors. Crops can pick up off-odors from other crops, so some storage combinations that should be avoided include: apples or pears with celery, cabbage, carrots, potatoes, or onions; celery with onions or carrots.

Ethylene is gas naturally produced by some crops in storage that can cause other crops to age faster, develop of colors or blemishes. Storage crops affected by ethylene include cabbage and carrots. Stored crops that produce a lot of ethylene include apples, pears and tomatoes. These two groups should be stored separately, or separated by impervious plastic barriers if they are stored in the same area.

For more information, view a table summarizing the harvest and postharvest needs of fall/winter storage crops at:
http://extension.unh.edu/agric/Docs/HandoutOnePostharvestStorageChart.pdf,
and the slide show 'Maintaining Quality of Winter Vegetables in Storage' by Ruth Hazzard of UMass Extension, at: http://extension.unh.edu/agric/Docs/5_Hazzard_postharvest.pdf

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