Question: Could a grower in Maine use the alternatives to root cellars shown in Mike and Nancy Bubel's book, Root Cellaring?

Below are the experiences people shared, I told those who asked that I'd share any information I received.

There are also some miscellaneous notes about the methods, And there's some basic information at the end—type of produce stored, harvesting issues—which someone asked me to include for a use they had in mind. There's also some basic information—type of produce stored, harvesting issues—which someone asked me to include for a use they had in mind Any information beyond the shared experiences comes from my understanding of the material in Bubel and various Cooperative Extension materials. Hopefully I'm not including any false information! I'd highly recommend that you get all your facts from Bubel, who covers everything—but I like hearing things a few times in a few different ways, so I kept my notes attached to this, in case others were like me. Oh, and for shorthand, I took to calling the alternatives "traditionals." And I'm doing this document on the fly, just after moving, so excuse me if it is a little rough!

Thanks to the growers who responded, Bob St. Peter, Will and Mary Bonsell, Margo of WCP, Lisa F., Portland Permaculture Group, Eliot Coleman, Aaron Locker and Susan Slomin, John Bartok, Carol Bryan, Mary Mandello, Tom Roberts, Mary and John Belding, Lloyd Griscom, Bambi Jones, Lejen. Chalrotte Young and Jim Baranski, and Robin McDermott of the Vermont Localvores. And to Russell Libby and Eric Sideman of MOFGA, Marjorie Peronto, Jim Dwye, and Kyle McCaskill of the Maine Cooperative Extension; Holly Hyde of NRAES; and Bethany DeMarco of Storey Publishing. And to Storey Publishing Because this work was intended for educational purposes, they gave permission to reference Root Cellaring, particularly for information about the alternatives on pages 113 –128

Storey Publishing, North Adams, MA
www.storey.com
Root Cellaring, Mike and Nancy Bubel

If I made any errors--cutting, pasting are hazardous activities! If you corrected your name spelling and here it is, wrong again, I apologize. If I've made any errors, or you would like to add to or challenge any of the material here, please let me know, I'd love to hear more.

Some thoughts:

There is an NRAES pamphlet on food storage, No. 7, that is designed for northern climates and which gives detailed plans for using the alternatives—including dimensions for insulation. I thought I'd just share what people had passed on, and then refer people to Bubel and to the NRAES pamphlet. But NRAES 7 is out of print, although in circulation, and when I talked to NRAES about citing it, they asked me not to, as the science in the material hadn't been re-confirmed. FYI.

I wrote to John Bartok, Connecticut Cooperative Extension Service, (retired), who was one of the scientists who worked on NRAES-7, and asked him whether he thought the alternatives would work. He questioned whether the traditional methods could provide ideal storage temperatures.. And whether they could provide sufficient ventilation and air circulation to keep temperatures uniform and to let off heat and humidity generated in produce respiration.

> "The best home storage would be a small, insulated room built in the basement of the home. It would have either natural ventilation, allowing cool air to enter through a duct to near the floor and an exhaust vent near the ceiling. Installing a fan to supplement this would be better. The basement room storage also allows easy access to the crops for inspection and adding or

removing the fruit and vegetables. It needs to be managed by adjusting the ventilation levels as the weather changes."

"Of the methods shown (in NRAES-7), the (buried) garbage can and cold frame storages are probably most practical. They provide easy access if located where they don't get buried by too deep snow. They can also be insulated fairly easily."

But I am still am interested in whether the altenratives could be used here if one took advantage of additional protection, especially after reading Eliot Coleman's observation about hoop houses, that "As a rough estimate, each layer of covering is equivalent to moving your plants one and a half USDA zones to the south." (Four Season Harvest, p. 109). Perhaps the protection of a hoop house over the traditional methods would help with the two most significant problems they have in our climate—that they use passive temperature control, and that access would be difficult if the storage were covered with snow and/or ice.

EXAMPLES PEOPLE SHARED
Examples, In-Field Storage
Margo, Jeff and their fellow members
Winter Cache Project, Portland, Maine

The members of the Winter Cache Project planted parsnips in July and mulched them heavily with straw in October. The following spring, once the ground had thawed a few inches, they harvested very sweet parsnips.

They didn't use any additional protection (row cover or cold frame) and didn't have trouble with rodents. The members had a great work party in early May, enjoyed the parsnips and stored the rest of the harvest in their community root cellar.

Amy LeBlanc
Whitehill Farm, East Wilton, Maine

Amy left her leeks, carrots and black radishes in the ground under the protection of an unheated plastic house. She mulched them with leaves that were held in place by a covering of agricultural cloth. Carrots stored the best, leeks got a little soft but stayed delicious.

The storage place was away from the home and rodents were a bit of a problem, although the Snap-E traps (an Elliot Coleman recommendation) were effective. Snow-shoeing out to the storage, and shoveling snow away from the door worked fine and didn't discourage use.

John and Mary Belding
Little Falls Farm, Harrison, Maine

John and Mary mulched carrots and parsnips in the field, for harvest in the spring. Carrots didn't hold up as well to the freeze-thaw cycle and became mushy at the head. Parsnips did better,

The parsnips were closer to the house and had less rodent damage. The carrots were further out, and suffered more.

Carol Bryan
Shore Road Farm, Perry, Maine

Carol left carrots in the ground all winter, with a bale of hay on each side and two tiers of bales on top. Depending on the snow and ice cover, the carrots were accessible during the winter by pulling up parts of the bales.

At the end of March, she pulled the bales back. The ground was unfrozen and the carrots were delicious and lasted in the fridge for some time. A few carrots on the edge had frozen, but otherwise they did well.

She also mulched leeks with hay and harvested them in early spring. The tops were mushy, but the white lower stalks were fine and tasty.

The gardens were near by and convenient to get to, she'd harvest a few times during the winter, keeping the carrots in her fridge. Rodents weren't a problem.

Tom Roberts
Snakeroot Organic Farm, Piitsfield, Maine:

"In-field storage of any sort: it's a crap shoot. You could wind up freezing your crop or feeding the mice. The amount of work involved, at both ends of the season, in storing under a big mound of soil or hay seems to make that method marginally worth it. And you'd have little or no access in the deep winter. In heavy snow years, in-field storage works better than in years with open winters, but how do you plan for that? I have tried carrots, rutabagas and beets this way, under two feet of hay, and what didn't freeze, the mice ate. I suppose with more trial and error it could be made to work, but I have to ask myself, under what conditions is it worth the bother & risk?"

"Many such ideas are from areas in Virginia or Pennsylvania, where winters are a might easier on in-field stored roots. Or they are from people who had little or no resources (money, time, knowledge or being pioneers) to build a proper root storage. And it was before the miracle of polyethylene films."

"Of course the hardiest of veggies (burdock, parsnips, sunchokes) can be left in the place they grew and essentially ignored until spring with very little loss. However, you don't have access to them until spring. Then you have maybe a month to get them out of the ground before they begin to grow again. We store part of each of those crops in situ and harvest the rest like any other root crop for winter sales and eating. In spring we harvest what we left in the fall, and stick it in the cooler, which, in April and May, is colder than outdoors."

Tom's design for the cooler he built follows later.

Example, Buried Container
Eliot Coleman
Four Season Farm, Brooksville, Maine

Eliot used buried containers at one time, to hold a mixture of root vegetables for winter storage. By having several vegetables together, he could get a variety of foods at one visit. He insulated the lid of the container, and then buried it inside an unheated hoop house. He has a root cellar now, but the buried container worked fine at the time.

Example, Trench Storage
Bambi Jones
Hidden Valley Farm, Whitefield, Maine

Bambi asked her friend Lejen to share her experience with trench storage in Beijing, China. Beijing winters are short and dry, and temperatures can drop to 10 degrees. Beijing's latitude is roughly comparable to southern Maine's (Beijing is 39 to 41 degrees north, Maine extends from 43 to 48 degrees north), but it is sheltered from the worst cold by mountains to the north

From Lejen: "This is how we dug trenches for our Chinese cabbages this past winter.

"The trenches can be any length and about 1 1/2 meter wide (this makes it easier to take out the cabbages from the sides). They need to be one meter deep to prevent freezing."

"The cabbages must dry in the sun on the ground for 3-4 days. The outer leaves dry out and act like packaging to protect the interior leaves. Remember to rotate the cabbages so the outer leaves dry evenly.

"The cabbages are placed in the trench stem end down (the same position as when they were growing), side by side. It is best to do only one layer. However our staff sometimes adds another layer on top of this due to lack of space."

"For the second layer, the cabbages lay down on its side stem to stem. This helps to keep the moisture where it is most needed. So you will have rolls of cabbages with its stems touching."

"On top of the trench you place wooden poles about a meter apart. Then we cover the top of the poles with straw mats (about 1 inch thick). The entire trench surface needs to be covered with the mats. This keeps the trench dark but it still has ventilation. If it rains or snows you need to cover the mats with a layer of plastic. But remove it when the weather is dry again."

"We used the cabbages throughout the winter, and were able to keep the cabbages until mid-March."

"This method was also used for our Xinlimei, beautiful heart radishes. They are green skinned with bright pink meat about the size of a grapefruit."

Example, Building a Cooler Shed
Tom Roberts
Snakeroot Organic Farm, Pittsfield, Maine

Tom's story follows below, verbatim. He shares more information drawn from his farming experiences on his website: tom@snakeroot.net

"We, too were faced with the "how to store it all" question a little over a decade ago, and considered building a root cellar. Trouble is, not only would the excavation be a big deal, but, for our location, the only place that would remain dry enough wouldn't be especially convenient for access, either during the winter or during the summer months when we wanted it for short term storage of cukes, lettuce, etc."

"So what we came up with was a well-insulated box, 8' x 8' x 8' with a slightly sloped asphalt-shingled roof. On the walls we used 2 x 4 studs with OSB on both sides, with a layer of plastic on the inside between the studs and the OSB. This is to keep moisture from migrating into the walls. The walls are all insulated differently, one with regular 3-1/2" fiberglass, one with cedar sawdust mixed with quicklime (to deter insects), one with styrofoam peanuts, and one with used remay. The peanuts and sawdust we poured in from the top before the roof went on."

"The floor deck is made of pressure treated 2 x 6's with a layer of plastic on top and 6" of fiberglass in between the joists. The whole thing is supported on several large rocks to keep it off the ground. The ceiling/roof is constructed with 2 x 4 studs with fiberglass between."

"Then, believing that more insulation is better, we went over the entire outside walls with 4' x 4' sheets of polyurethane foam bonded to OSB, held on with 4" screws. Over this is recycled cedar shingles."

"The door is made similarly to the walls, all home made, and uses thin sheets of styrofoam packing material as weather seals"

"For the first eight years, we used it primarily for winter storage, using a combinations of two or three 75 watt and 40 watt incandescent bulbs for heat, and a household window fan set on the floor to keep the air circulating in order to prevent cold spots from forming. This works great, and since we are targeting a temperature of 33 degrees F, it was easy to maintain that temp with the few light bulbs, plus the heat of the fan motor. Checking every day or two, or if the outdoor temp took a plunge, we were able to maintain the inside temp between 32 and 35 degrees F by turning lights on and off, which is an ideal storage temperature for most root crops. The only caveat is to keep the potatoes covered well enough so that they don't see the light and turn green."

"The fuller the cooler is, the more thermal mass, and thus the easier it is to prevent temperature swings."

"In the cooler (as we call it) everything is stacked on pallets on the floor or on the back shelf, and nothing is stacked so as to touch the walls. It is critical to keep air circulation space all around the stored veggies."

"In 2006 we bit the bullet and had a local commercial refrigeration installer do a little moonlighting and set us up with a brand new compressor and coils, so now we have a real cooler, useful not only in summer for keeping things cool, but now it works even better for winter root storage since the compressor comes on when the temp gets into the high 30's come late March, April and May. So the veggies that made it through a long winter don't start to sprout or rot when spring comes, because we can

maintain the "winter temp" in the cooler as the outside weather warms. We tried doing this for one season using two sets of twenty milk jugs of ice made in the home freezer, but it was a lot of work and didn't do that good a job. So we sprang for the compressor. Also, the condenser (inside) coil fan runs all winter, so we don't use the window fan any more. It also has a bigger motor, throws more air, and provides more winter heat, so we don't have to use as many light bulbs."

"Our cooler sits in a shady cedar grove, which helps save summer cooling bucks. It is right beside our veggie washing and prep area for going to market."

"Note that before we "upgraded" to a compressor, the cooler worked just fine for winter storage, and only became less effective as the spring began to warm it up. Leaving the door open on cold spring nights helped extend the season a bit, but by mid April the true roots were waking up since we had mo means of maintaining the cold."

"What would I have done differently? Made it 12' x 8' or 12' x 12' instead. Added even more insulation."

"Our storage containers are black crates ($4 each from Fedco) and standard wooden Eastern apple boxes. True roots go in the containers in plastic bags (trash bags work well). Potatoes and apples are stored without liners, since they don't want100% humidity."

Example, Building Storage Rooms in a Basement
Margot and Jeff
The Winter Cache Project, Portland, Maine

The Winter Cache Project planned a workshop on "How to Build a Root Cellar in Your Basement," in the fall of 2007. About 15 people came to their home and, using shared knowledge and community strength, spent the day building the storage room described below.

WCP built their basement storage room by adding two conventionally-framed walls to a corner. The basement contained a furnace, but they insulated the walls with 3" of recycled denim from Green Building Design in Portland, to keep out any heat. They picked a wall that had windows, so they could use them for ventilation and to let in cold night air when the room needed cooling. The windows can be closed when temperatures drop below freezing.

They pack their produce in banana boxes filled with moist sawdust. Potatoes are stored in the giant paper bags that are used for holding leaves. Vegetables that need warm conditions, such as onions and winter squash, are kept outside the root cellar in the basement room, where the heater provides some warmth.

They haven't had problems with pests or rotting food. Since the storage is in their home, it's been easy to keep an eye on things.

The root cellar is used by Winter Cache Project members and the Local Sprouts cooperative, so that both groups can distribute local and organic food throughout the year. The root cellar provides food to many families and organizations in the Portland area, in as part of their work to gain control of food and food sources year around.

Winter Cache is now working on finding a neutral space in the community where another storage space can be built. This new space would allow r more people to store the summer's bounty.

To learn more about The Winter Cache Project, visit their website, wintercacheproject.org.

Community Root Cellar

The members of the Winter Cache Project, as well as some local organizations, use their storage room in Margot and Jeff's basement as a community root cellar. A similar arrangement could be made by neighbors sharing or building a common cellar, or by communities building a storage area in a common building, such as a church or community center.

Example, Building Storage Rooms in a Building
Aaron Locker and Suzanne Slomin
Green Rabbit Farm, Madison, New York

Aaron and Suzanne built two storage rooms inside a building, taking advantage of one wall that was banked into the earth. They heavily insulated the interior walls and kept things from freezing by using a small ceramic heater with an antifreeze thermostat. The floor and walls were lined with palettes, to promote air circulation and so water could be poured directly on the floor for humidity.

At first, the storage rooms worked well passively. But lately fall weather has been warmer, and the rooms aren't always cold enough at harvest time. Their business is mostly carrots and the crop has to be in storage and cooled immediately after harvesting; even 10 degrees off the ideal would affect quality and length of storage. For now, they've added a compressor so they can cool the rooms if it's needed.

The compressor was a big enough expense that they thought it might only be practical for large businesses. They'd seen people buy old compressors as bargains, but the older ones often weren't efficient, and could end up being expensive to run.

They found that the variety of vegetable planted made a big difference—those designated for storage, such as the #5 cabbage and the copra onion, held up significantly better.

Keeping humidity high was very important.

It did help to keep apples apart from other storage crops such as carrots, potatoes and onions.

Method, Converted Shipping Container

Several people mentioned using converted shipping containers for produce storage, as instant buildings, relatively inexpensive, durable, movable and rodent proof.

Example, Converted Shipping Container
Adam Parke
Kestrel Farm, Barton VT

Adam buried a shipping container into a notched hillside, and then covered its roof with 2' of hay for additional insulation. Where the container was more sheltered, inside temperatures were around 55 degrees, where it was exposed, they could drop to 20 degrees.

He used the container to hold his potato crop, and it worked beautifully into January, when the last of the crop sold. After January, he's not as sure the container would have stayed warm enough. Next year, he'll add insulation to the doors, and see if he can use the storage longer--he'll open the doors on warm days to check the temperature, and keep them closed on cold days.

Maine Trailers, which sells them, provided some information about them:

- The trailers are 20' long, 8' wide, 8.5' tall, and weigh about 5,000 pounds.
- Their steel frame construction means they can be pushed around the property by a bulldozer, or pulled around by a tractor..
- The single-door containers ran about $2295, (as of 6/08) but the price will probably go up, as the price of steel is rising..
- Containers with two sets of doors are popular because they can be loaded in from one side, and then out from the other; for first in, first out storage. The double-door containers are newer and more expensive than the single-door models.
- The containers can be delivered for a fee--from Bangor to Franklin, for example, would be about $210 (as of 6/08).
- You can haul them home yourself, if you have the means, and there's no charge for loading them on to someone's trailer bed. I asked how the person would get the trailer off the bed, and they said that people have tied the trailer to a tree or building, for instance, and then driven away the truck.

Miscellaneous notes:

Insulation, external:

Natural materials such as straw, hay, and dry leaves, insulate because of their air spaces. If they become wet, frozen, or matted, they will lose some of their insulating capacity.

Insulation in bins:

Helps retain moisture, blocks disease transmission, helps minimize produce bruising each other, helps buffer temperature changes.

Damp materials are used in storage rooms where there might not be adequate humidity—but only with vegetables that need very moist conditions. Damp materials wouldn't be used, for instance, with potatoes or cabbage. And I've never seen damp materials recommended with small storage spaces such as buried containers, where there'd be little moisture lost to air, and the bigger problem would probably be dampness encouraging rot.

Since wet produce surfaces do encourage rot, I'd assume that by "damp" insulation materials,they mean "wrung sponge," damp--enough to keep moisture in air, but not to wet down the produce.

Although peat moss is sometimes recommended as an insulating material, we tried it one year and it was awful—it clung to the produce and had to be scrubbed out of crevices. And there are ecological concerns about using it.

Bins:

Shallow bins will make it easier to check for spoiled produce.

Its helpful to provide ventilation to bins, even those that will hold damp insulation materials. Small holes in the sides won't cause insulation materials to leak out.

With some vegetables—potatoes and cabbage, for instance—providing ventilation is a key goal, so their bins might be a different type than those where retaining moisture is key.

Using found spaces:

If you are hoping to use a found space such as an un-insulated room, you'll almost certainly want to adapt it in some way ahead of time—by insulating, by adding a heat source for extremely cold weather. If considering a basement, check that there are openings for ventilation and letting in night air for cooling.

Ventilation and air circulation:

Besides helping regulate humidity, and letting out gasses given off by produce, air movement will keep cold and warm spots from forming in storage. Try to store produce in such a way that air can move across the floor, walls, and ceiling.

Ventilation and traditional designs:

. Some traditional designs have ventilation. Clamps have straw ;chimneys' for ventilation, some trench designs have openings along the roof, and Bubel's buried refrigerator plan mentions that ventilation might be desirable.

But other trench designs, and the rest of Bubel's buried containers, don't mention it.

If I had t hazard a guess, it would be that ventilation in small spaces might be important in autumn and spring, when temperatures are warmer. Produce life would not be as dormant then, and respiration would produce some heat and water vapor. In winter, when temperatures dropped, respiration would slow, there would be less to ventilate, and the priority would shift to keeping out cold.

Note: Keeping insulating materials between produce and the surfaces of the storage will help air to circulate

Humidity:

Earth surfaces will provide humidity. If a storage room doesn't have any earth walls, it will likely need added humidity.

Heating a storage space:

- If you use light bulbs for heat, put them near the floor—the rising heat will create air circulation and help keep cold spots from forming.

I called around to find a brand of portable heater that could be used in a storage room. The following is what I understood from what I was told. I'd just use this as a starting point, I don't know anything about heaters or electricity.

- Thermostats on home heaters don't, as a rule, go lower than the mid-forties. If a home heater has an anti-freeze thermostat, it probably turns the heater on at forty-something degrees, not at thirty-two degrees. A heater that can be set to come on at 32 degrees and turn off at 35 degrees is called a process heater and is the type used in manufacturing. The example I found, from a company on-line, would have cost about two or three hundred dollars. It was ordered in parts—the type of heater, thermostat, controller, and relay wanted—and arrived unassembled.
- An alternative might be to fit a home heater with an electronic temperature controller, such as the Ranco ETC 111000, which can set temperatures between -30 F and .220 F, and has a differential of 1 to 30 degrees.

Rot:

Store only good produce to begin with, damaged vegetables will rot more easily, and the rot will spread. Remove any produce that does spoil. Use packing materials to block the spread of rot.

It can be difficult to find and remove spoiled produce in the traditional methods. If several kinds of produce are combined in a storage space, it is worth considering whether all of them will last a similar amount of time. Insulation between produce will help keep rot from spreading.

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Water and rot:

Humidity will precipitate out of the air when the temperatures drop (warm air can hold more humidity than cold air). If temperatures change a lot in storage, precipitation may begin to wet produce, leading to rot. As storage rooms empty out, they become more vulnerable to temperature swings.

The keep produce dry when using and of the traditional methods:

- Begin with a location that has good drainage
- Slant the bottoms of trenches and clamps, and the holes under buried containers, so that water will drain away from the produce.
- Place rocks or gravel under storage.
- Drill small holes in the bottom of buried containers.
- Keep the openings of buried containers a couple of inches above the ground, so water won't run into them.
- Drainage channels can be dug around the storage, to direct water away.

Adding temperature protection to passive methods:

- Insulation can be placed between buried storage, including trenches, and the surrounding ground.
- another layer of covering, such as a tunnel or tent, can be placed over mulches.
- Storage can be placed inside an unheated building.
- Storage can be placed inside an unheated hoop house. If so, some care must be taken regarding daytime temperatures, as hoop houses can become quite heated, especially on sunny days.
- It can help to keep insulating materials between the produce and the sides of the storage container.

Access and the traditionals:

Access can be helped by placing storage in an unheated building or hoop house, or by using some other method to keep the insulating materials dry and unfrozen.

It is also possible to organize trips to storage so that one goes a couple of times a month, for a couple of weeks produce at each visit.

Rodents and traditionals:

Traditional methods are more vulnerable to rodents. Wrapping produce in hardware cloth can help keep them out. Most people who wrote said that storage near the home was relatively trouble free. And _____ wrote that Snap__ traps worked.

TYPE of PRODUCE STORED: Root cellars and the alternatives are designed to create good storage conditions for the produce that needs cold--32-40 degrees—and very moist or moist conditions--85-95% humidity.

ROOTS. Roots do best at temperatures between 32 and 35 degrees. They require high humidity and are often stored in damp insulation materials. In large storage spaces, storing roots closer to the floor will help keep them in the colder part of storage.

Beets

- somewhat frost sensitive, especially if their tops have become exposed, mulch to protect from frosts.
- can last up to five months in storage, but generally not as durable as other roots
- best if up to 3", not larger.
- according to Rodale, they will deteriorate if left in the soil more than 10 days after reaching mature size—but perhaps they meant if temperatures had not cooled enough to slow growth.

Carrots

- slightly frost susceptible, can stay in ground until just before it freezes, but might benefit from protection, especially if root is exposed;
- among the longest lasting storage foods—Lloyd Griscom, Peace and Plenty Farm, Maine, ate his last root cellar carrot on July first.

Celeriac

- use later plantings, early ones might be woody.

Horseraddish

- can winter-over in the ground.

Kohlrabi

- Frost hardy
- best if up to 3", not larger
- use summer plantings, spring plantings may be woody

Parsnips

- the most frost hardy root. Frosts improve their flavor and they can winter-over in the ground.

Raddish, winter

Rutabaga

- can be frost sensitive, especially if tops are exposed.;

- don't store early spring plantings, the root doesn't develop well in summer and won't be good for storage.

Salsify
- Frost hardy

Scorzonera

Turnips
- generally frost hardy but can be sensitive if the root has become exposed. Mulch to protect and harvest before heavy frost;
- use summer plantings, not spring ones;
- best if up to 3", or smaller,

TUBERS

Jerusalem Artichokes
- Will keep well in the ground over winter. If taken out of the ground, keep moist; they have thin skins and lose water quickly.

Potatoes

Potatoes have several storage needs that are different from the other cold/very moist and moist vegetables.. They require curing, they store at the higher end of the temperature range (36 to 40 degrees), they don't need quite as much humidity as roots, and they need protection from light.
- Curing: Potatoes are left n the ground for up to 21 days after the vines die back, to let the skins thicken. After harvest, they are kept in a warm room for a couple of weeks while skin injuries heal over, and then moved to cooler storage.
- Temperature: Starches can convert to sugar when temperatures drop below 35 degrees. This conversion improves the taste of some roots, but when it happens in potatoes, most people find the taste unpleasant. To prevent the starch conversion, potatoes are kept at temperatures between 36 and 40 degrees. In larger storage spaces, this can be accomplished by storing them up high, where warmer air will have risen.
- Humidity needs: Potatoes are a cold/moist, rather than very moist, vegetable. I haven't come across any instance where they are stored with damp insulating materials,. Usually the emphasis in their storage in on providing air circulation, ventilation, and protection from condensation, because water on them would encourage rot..
- Protect from light: Potatoes will turn green where they have been exposed to light. This green is a chlorophyll reaction, but there can also be a mild toxin present.
- Freshly harvested potatoes bruise easily.

ABOVE-GROUND CROPS

Cabbage
- This is a cold/moist vegetable, and doesn't need extra humidity like roots do. It can be stored on a shelf, or wrapped in paper. I haven't found it stored with added moisture, such as damp insulation materials.
- Can be harvested slightly before full maturity, while head is still compact.
- Cabbage that has split won't store well.

Celery
- Frost sensitive.
- Can be replanted in storage.

Chinese cabbage
- can be replanted in storage.

Leeks
- Can be replanted in storage
- Mild frosts improve flavor.

Sometimes a vegetable is described as frost sensitive, at other times as frost hardy. I think it is because the term is being used relative to other vegetables. Even frost hardy roots may still need some frost protection, especially if have worked partly above soil.

Different sources give vegetables different lengths of storage life. In general, though, the information on relative storage life organized as follows. Potatoes last longer than carrots, parsnips which last longer than celeriac, salsify, rutabaga, turnips, winter radish which last longer than beets, kohlrabi. (I would use this just as "food for thought.")

For some roots, it is recommended that later plantings be used for storage, rather than the earliest spring ones. Celeriac, kohlrabi and turnips can become woody if they are too mature, and rutabagas mature poorly in summer heat, producing roots that don't keep well. I am not sure that Maine's growing season is long enough for this to be a problem?

Using storage varieties does make a difference.. They can combine several good storage qualities—such as maturing late in the season, having less water and more starch in their makeup, being more compact.

HARVEST and STORAGE

For best produce quality and length of storage, produce goes directly from the field into storage. Timing the harvest means juggling the following factors. If your storage is passively cooled, it also means waiting for the prolonged cold necessary to create good storage conditions.

Produce maturity.

- Produce stores best if harvested at maturity.

Cold weather

- It is good for crops to experience cool weather before they go into storage. The cold will signal them to lose tissue moisture and build up sugars and starches.
- Frosts will improve the flavor of some produce.
- For those using passive cooling, prolonged, reliable cold is necessary to create storage conditions. Since early frosts are often followed by weeks of warm weather, passive systems must delay harvest until temperatures are staying cold.
- Frost sensitive plants may need protection until storage conditions are reached.

Dry weather, ideally that has been dry for several days

- Produce will plump up with extra moisture after rains, it's better if they aren't carrying this extra water.
- Wet produce will be more susceptible to rot.
- Wet produce will be dirtier, which means more handling.

Time of day.

- For storage purposes, the best time to harvest is as early in the morning as possible, once the dew has dried.
- Produce harvested in the afternoon will become warmed by the sun, both directly and through the earth. This "field heat" will offset the cold of the storage environment, causing the produce to lose water even at 100% humidity.
- If harvesting is done late in the day, produce can be left out overnight to cool before going into storage.

HANDLING at harvest can minimize rot by reducing bruises and helping keep the skin intact. Bruises won't be apparent at harvest time, but they'll appear later and become the starting places for rot. Skin openings will provide entry points for decay organisms

To reduce bruising, handle produce carefully:

- Try not to let produce knock against each other.
- If produce is piled in a bin, consider whether the weight might be bruising produce at the bottom.
- And since it's hard to handle produce perfectly, it helps to handle it as little as possible.

To keep the skin intact:

- Harvest carefully
- Cut greens away, an inch above where they join the root, so that the skin at the join stays intact.
- Leave rootlets and root tips intact. Trimming them will leave openings in the skin.

Don't wash produce

- Wet produce provides a good environment for decay.
- Washing produce means more handling.
- Light dirt isn't harmful.
- If there is a lot of dirt present, let it dry while the produce is kept cold, and then brush it off by hand.

Don't leave produce out in the sun: They'll build up field heat. Potatoes will start to turn green.