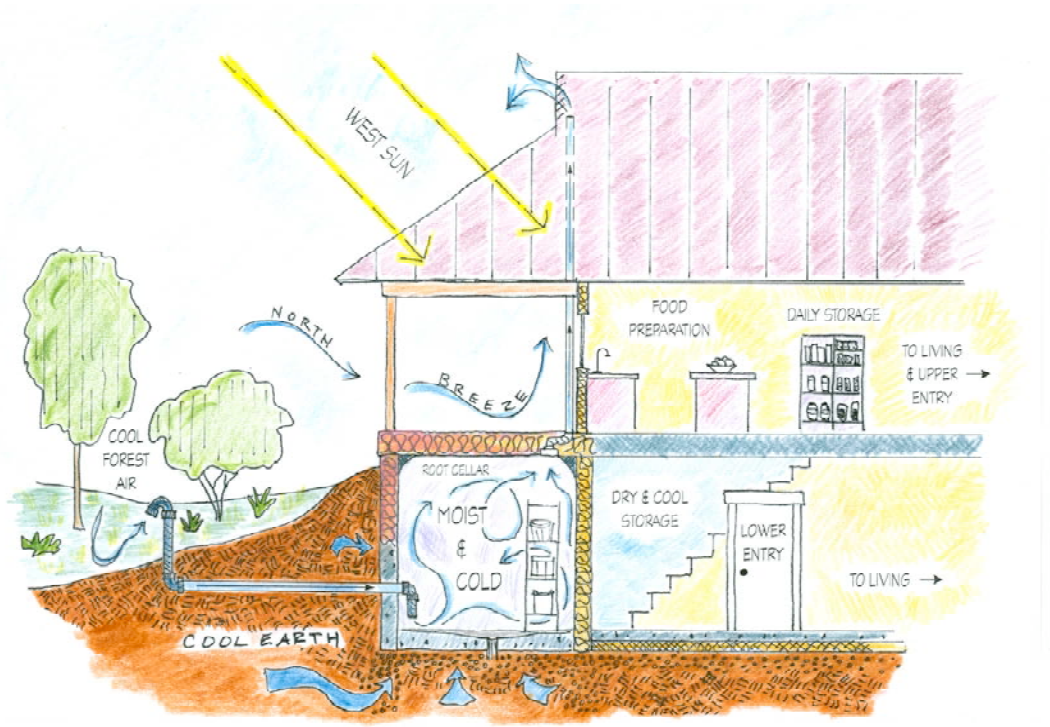
Root Cellar Report

Spring 2007

Jesse JW Selman
Small Farm Builder
jesselman@gmail.com



Commonfire Foundation Root Cellar

The root cellar project was part of an 11 person housing co-op created by the non-profit, Commonfire. We designed the root cellar as a way for the co-op to fortify their connection to local food producers.

The root cellar was designed with three separate compartments, each with their own microclimates and varying temperature and humidity, in order to create a variety of storage conditions to optimize the storage of different fruits and vegetables. Multiple rooms also allow the separation of foods that are ethylene producing from ethylene sensitive (eg. the ethylene gas emitted by apples will cause potatoes to sprout). The traditional root cellar uses the constant temperature of the earth (approx. 50 deg F), with the passive introduction of outside winter air, to create a cool damp storage condition. We used thermostats and low-wattage fans to enhance the ability to create specific climates and maximize the storage season with cold night air. The large storage capability (approx. 2000 cubic feet) allows the co-op to work with local food producers for storage crops (apples, onions, potatoes, squash, and much more), purchase dry goods in bulk, as well as having a low-energy refrigeration alternative. The materials used in the creation of the cellar were chosen for their inert qualities, resistance to water, and ability to insulate the cellar from outdoor air fluctuations. Combining ancient practices with modern green-building technique, the root cellar connects us to local agriculture and the seasonality of food.

Apples still crisp in April!

Currently, we are monitoring temperature and humidity of the root cellar to see how it performs, what micro-climates form in the chambers, and how the design could be improved. This cellar represents one version of a broad spectrum root cellar systems and other community food storage techniques.

ROOT CELLAR MANUAL

LAST UPDATED: 08 April 2007

Introduction –

There are two main purposes for this manual. The first is to document the basic construction principles and operating guidelines for the root cellars. The second is to provide a space to gather and organize any further information gained by the users of the cellar. I encourage any new/relevant information to be added to this document.

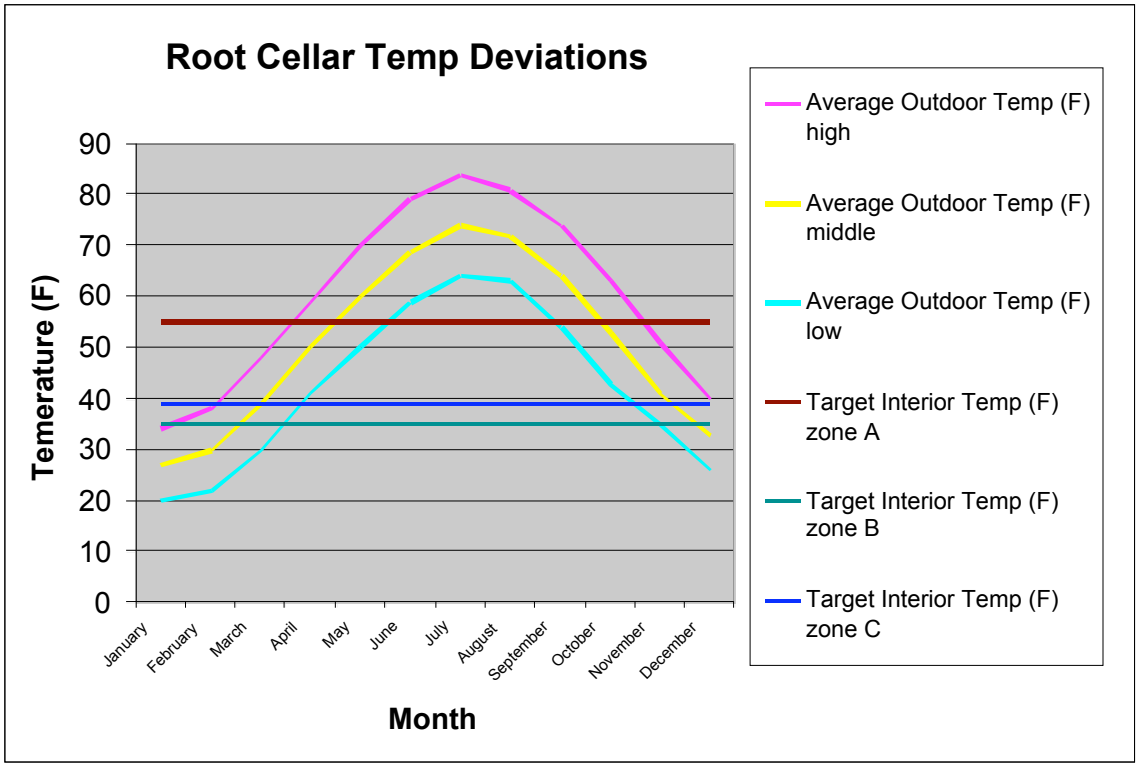
Rooms --

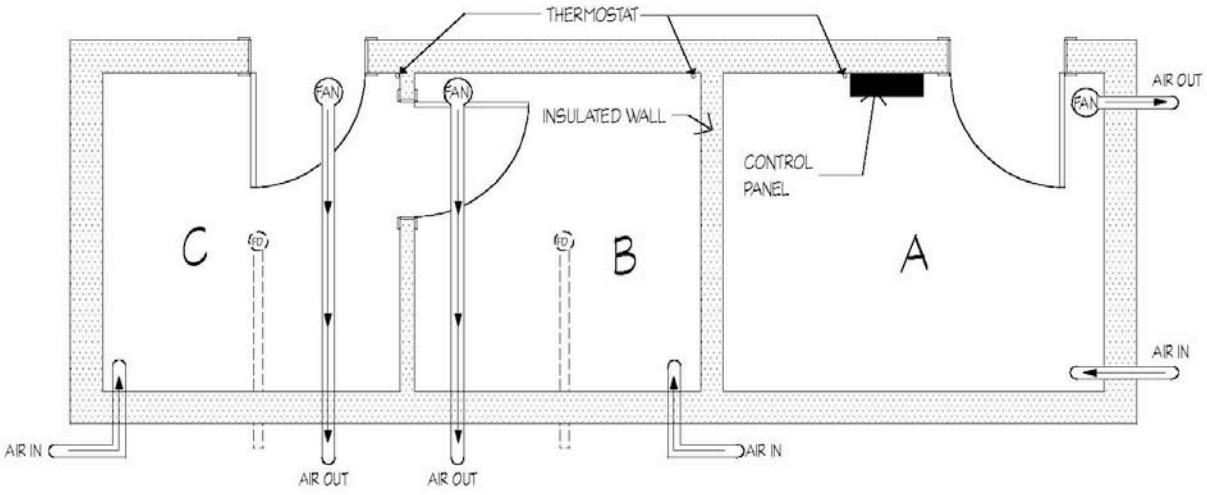
The cellar is divided into three rooms in order to cover the greatest range of storage requirements.

Room A
Target Temp/Humidity - 50-60 degrees F / 50-60% relative humidity

Room B
Target Temp/Humidity - 33-38 degrees F / 90-95% relative humidity

Room C
Target Temp/Humidity - 40-45 degrees F / 85-90% relative humidity

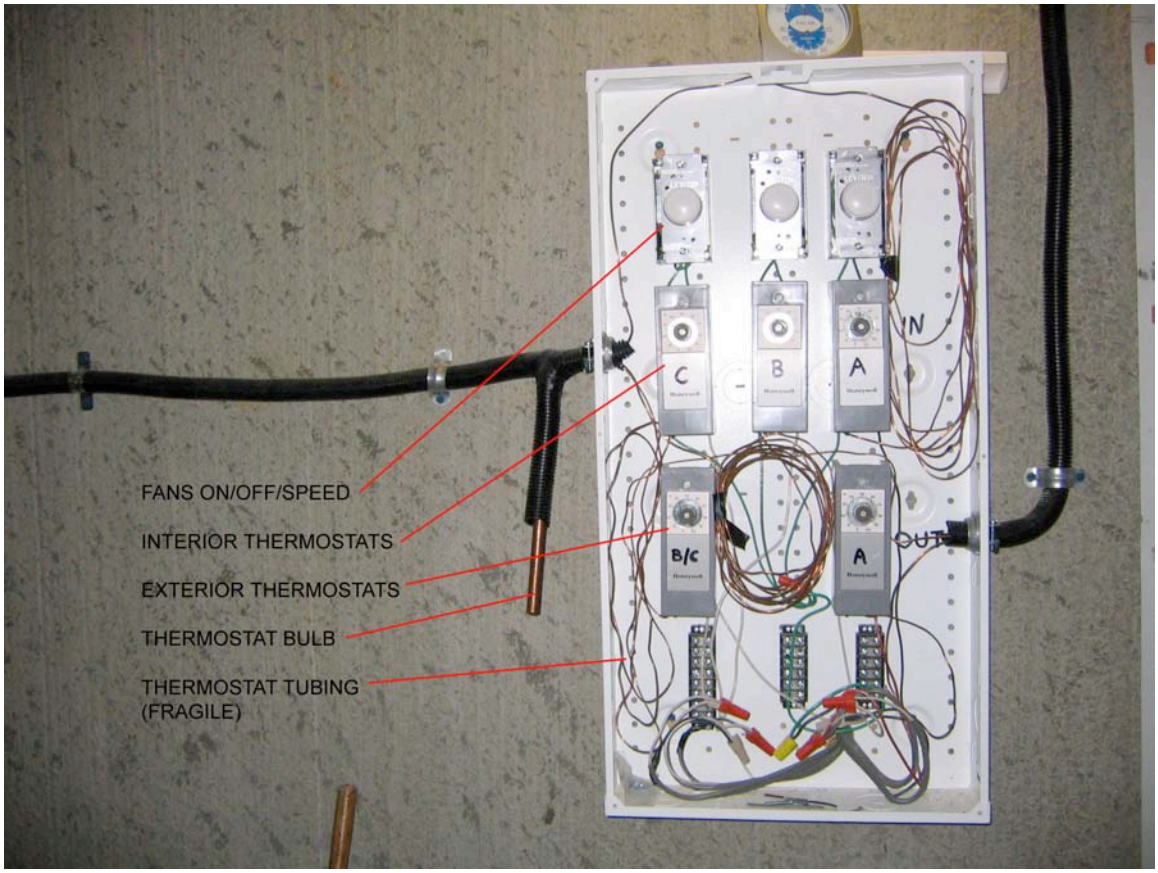




Construction –

- Exterior Walls – Superior Wall w/1" integral rigid foam – R-5
- Partition Wall between A and B – _" DurraRock Cement Panels sealed with cement-based plaster; galvanized metal studs; 1" rigid foam R-5; 2x4 ACQ vertical strapping; _" DurraRock Cement Panels sealed with cement-based plaster.
- Floors – reinforced poured concrete w/plastic sheet vapor barrier below in Room A only
- Ceiling – ACQ treated 2x10 with 4" rigid foam b/t bays; _" foil-faced rigid foam continuous and taped on the bottom of the joists; strapped w/ 2x4 ACQ; sheathed w/ _" DurraRock Cement Panels sealed with cement-based plaster. Total R-30?
- General-Gaps sealed with spray foam or silicone caulk
- Doors – Insulated Steel w/ weather gaskets

Controls –



General

The rooms are controlled by five thermostats wired to fans. This is cooling and ventilating system. A thermostat in each room will engage its fan expelling air from the room, thus pulling fresh air into the room. The thermostat is set to do this until the room's temperature gets below a certain point. Simultaneously, an exterior thermostat prevents the fans from turning on unless the outdoor temperature is below a certain point.

The goal is to pull the right amount of cold air from the outdoors, but only when it is cold enough outside.

Control Box

CAUTION – There are live electrical wires in the control box. Because the wires are sheathed in plastic it is unlikely that one will contact the wires. However, use caution. TO REDUCE THE RISK OF ELECTRIC SHOCK ALWAYS SHUT OFF THE BREAKER BEFORE CHANGING ANY WIRING

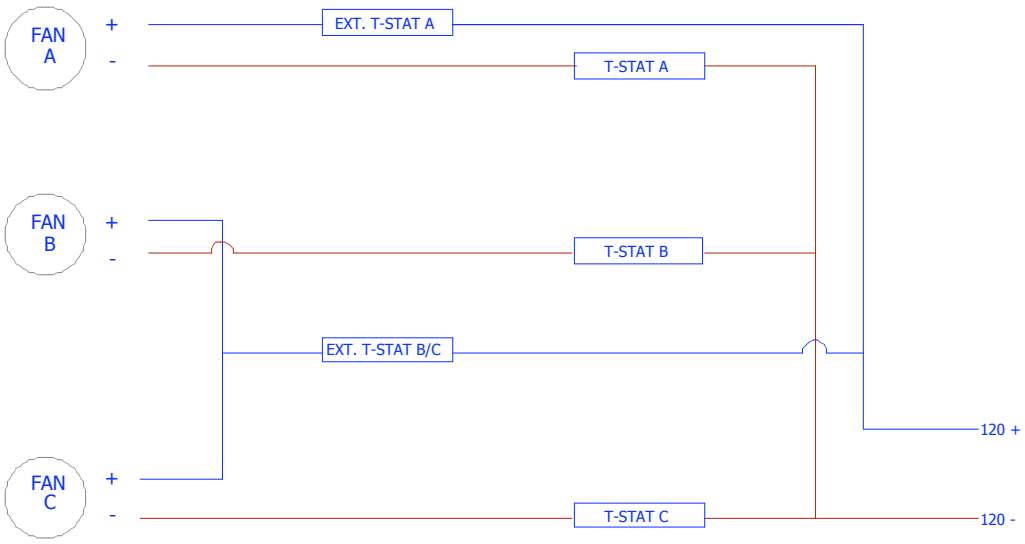
CAUTION--Thermostat lines coiled in the control box and in black protective sleeves in the rooms are NOT WIRES. They CANNOT BE BENT to sharply. These lines are

actually hollow copper tubes filled with fluid. These tubes are FRAGILE and EXPENSIVE. PLEASE HANDLE WITH CARE.

All three of the rooms are centrally wired to the white control box in room A. The entire root cellar system, lights and fans, are on one circuit. The breaker is located in the mechanical/laundry room and is labeled “Root Cellar”

Setting the controls

Rooms A, B, & C all have there own interior thermostats. Rooms B and C, because they require colder temps, share an exterior thermostat. Room A has its own exterior thermostat. This wiring system allows the maximum control with the least amount of thermostats. (see wiring diagram below)



Drains –

IMPORTANT – Only water can go down the floor drains. These drains connect to the foundation drain and then drain to daylight in the woods behind the house. It is very important not to clog this system or to let anything toxic go down it.

The drains are equipped with removable bowls to collect solids, but may need to be supplemented by a piece of screen to filter out small particles.

Always sweep the rooms before washing to prevent material from entering the drains.

The drains are also equipped with water filled traps to prevent air from entering the rooms from the foundation drain, followed by one way valves to prevent water from infiltrating the rooms in flood conditions. Ensure that there is always water in the traps.

Vents—

Because the exhaust vent is at the ceiling and the fresh air intake is near the floor there is a natural convection of air in the room. This creates a fuller air exchange as well as a reduction in temperature stratification.

The fans are Fantech FR100 (see PDF) and run at a very low watt consumption – around 18watts. Ideally they would have fit in the ceiling, but there was not room.

The pipes are all 4" ABS. Where they are exposed to sunlight they should be painted with 2-3 coats of compatible paint.

There are screens at the exterior end of each pipe. These should be periodically checked for damage that would allow rodent/insect entry. They should also be cleaned of any debris or spider webs to ensure proper operation.

The pipes are also equipped with a "back-draft" dampers to prevent gusts of unwanted air to enter the rooms. (see PDF)

Calendar --

January – partially full from last year harvest
February – ibid.
March – ibid
April – dwindling
May – nearly empty
June – empty and cleanout
July – out of use
August -- out of use
September – begin cooling
October – continue cooling/ begin filling
November – continue cooling / continue filling
December – in use/ continue filling

Comments / Suggestions –

Door signs with scheduled inspections?
Lots of labels for food?
A food log? Lots of records.
Temp / humidity meters in each room.
Cheap thermometers in different places in the rooms to locate micro climates
Watch out for dripping condensation
Use cheap cedar shingles ($7/bundle) to protect food from drips
Keep lights off and doors closed as much as possible.

First Season (winter 2006-2007) --

The members of the co-op we able to provide over 95% of there winter vegetables from local sources stored in the cellars. Kudos to the members for their dedication to this project.

Space- The given space was enough to serve the 9 residents and their guests. It could probably serve 12. Room A stored squash, onions, garlic, nuts and other dry goods. Room B stored potatoes (sprouted early), cabbage, carrots, beets, rutabaga, jersusalem artichokes etc. Room C stored apples.

Temperature – Despite a warm fall and early winter the rooms were able to achieve their target temps with some fluctuation by December. (see graphs)
In general the temperature ran 5-10 degrees warmer than the thermostat. Temperature was considered a success in the cellar performance. Thermostats were set as follows:

Interior- A = 45; B = 36; C = 34

Exterior- A = 46; B & C = 38

Humidity – Humidity was a recurrent problem throughout the season.

Room A tended to be too humid at 80% RH despite a target of 50-60% RH and required a dehumidifier. (Possible techniques other than dehumidifier?? More venting open door to conditioned space)

Rooms B and C had the opposite problem tending to be far less humid than desired, reaching 30% without added moisture. The addition of moisture was expected. Room C tended to hold moisture longer. A possible technique in the future could be to use the room as a cold zone and create bins of humid zones. However wetting the floor did achieve the desired RH.

Note- consider radiant cooling as an alternative to air cooling.

Responsibilities – The associated responsibilities of the root cellars varied throughout the season. During the stocking period (November) the work load averaged 5 hours per week to locate, purchase, transport, prepare and store the food, as well as set up the boxes and other containment systems such as labels.
Once stocked, the cellar required a check in a few times a week to maintain moisture levels. This usually involved soaking the floor with water, hanging wet towels or wetting the sand that certain crops were packed in. This points to the need (as per the original design) to have a hose spigot in the wet rooms.

Co-op members in charge of dinners would go "shopping in the cellars each night. Would daily visits effect temp or humidity? Could visits be organized to bring a weeks supply of food to the kitchen? Daily visits were informed by lists and informal communications about what food "needed" to be consumed or removed.

Additional Data –

Root Cellar storage requiremets

Apples

- Cold and moist
- Do not store with vegetables
- 32 to 40 degrees Farenheit
- 80 to 90 percent relative humidity

Beans, dry

- Cool and dry
- Home and commercially prepared foods also need a cool, dry storage place
- 32 to 50 degrees Farenheit
- 60 to 70 percent relative humidity

Beets

- Cold and very moist
- 32 to 40 degrees Farenheit
- 90 to 95 percent relative humidity

Brussels sprouts

- Cold and very moist
- 32 to 40 degrees Farenheit
- 90 to 95 percent relative humidity

Cabbage

- Cold and very moist
- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity

Cabbage, Chinese

- Cold and very moist
- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity

Carrots

- Cold and very moist

- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity

Cauliflower

- Cold and very moist
- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity

Celeriac

- Cold and very moist
- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity

Celery

- Cold and very moist
- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity

Endive (Escarole)

- Cold and very moist
- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity

Garlic

- Cool and dry
- Home and commercially prepared foods also need a cool, dry storage place
- 32 to 35 degrees Fahrenheit ideal
- 60 to 70 percent relative humidity

Grapefruit

- Cold and moist
- Do not store with vegetables
- 32 to 40 degrees Fahrenheit
- 80 to 90 percent relative humidity

Grapes

- Cold and moist
- Do not store with vegetables
- 32 to 40 degrees Fahrenheit

- 80 to 90 percent relative humidity

Horseradish

- Cold and very moist
- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity
- May be left in the ground undisturbed until needed. Digging can be done unless the soil is frozen hard. A thick layer of mulch may extend your harvest season.

Jerusalem artichoke

- Cold and very moist
- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity
- May be left in the ground undisturbed until needed. Digging can be done unless the soil is frozen hard. A thick layer of mulch may extend your harvest season.

Kale

- Cold and very moist
- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity

Kohlrabi

- Cold and very moist
- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity

Leeks

- Cold and very moist
- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity

Onions

- Cool and dry
- Home and commercially prepared foods also need a cool, dry storage place
- 32 to 35 degrees Fahrenheit ideal
- 60 to 70 percent relative humidity

Oranges

- Cold and moist

- Do not store with vegetables
- 32 to 40 degrees Fahrenheit
- 80 to 90 percent relative humidity

Parsnips

- Cold and very moist
- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity

Pears

- Cold and moist
- Do not store with vegetables
- 32 to 40 degrees Fahrenheit
- 80 to 90 percent relative humidity

Peas

- Cool and dry
- Home and commercially prepared foods also need a cool, dry storage place
- Airtight container
- 32 to 50 degrees Fahrenheit
- 60 to 70 percent relative humidity

Peppers, hot dried

- Cool and dry
- Home and commercially prepared foods also need a cool, dry storage place
- 32 to 50 degrees Fahrenheit
- 60 to 70 percent relative humidity

Popcorn

- Cool and dry
- Home and commercially prepared foods also need a cool, dry storage place
- Airtight container
- 32 to 50 degrees Fahrenheit
- 60 to 70 percent relative humidity

Potatoes

- Cold and moist
- Do not store with fruits
- 38 to 40 degrees Fahrenheit ideal
- 80 to 90 percent relative humidity

Potatoes, sweet

- Warm and moist
- To keep sweet potatoes from spoiling in warm and moist storage, do not let temperatures drop below 50 degrees Fahrenheit
- 80 to 90 percent relative humidity

Pumpkins

- Warm and dry
- 50 to 55 degrees Fahrenheit
- 60 to 75 percent relative humidity

Radish, winter

- Cold and very moist
- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity

Rutabaga

- Cold and very moist
- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity

Salsify, oyster plant

- Cold and very moist
- 32 to 40 degrees Fahrenheit
- 90 to 95 percent relative humidity
- May be left in the ground undisturbed until needed. Digging can be done unless the soil is frozen hard. A thick layer of mulch may extend your harvest season.

Squash, winter

- Warm and dry
- 50 to 55 degrees Fahrenheit
- 60 to 75 percent relative humidity

Tomatoes

- Warm and moist
- To keep green tomatoes from spoiling in warm and moist storage, do not let temperatures drop below 50 degrees Fahrenheit
- 80 to 90 percent relative humidity

Turnip

- Cold and very moist
- 32 to 40 degrees Fahrenheit

90 to 95 percent relative humidity