

Season Extension



Four Season Gardening

Master Gardener
Workshop Series
Edited by Ron Christie,
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Rockingham County



UNH Cooperative Extension
www.extension.unh.edu

Today's Objective:

Learn about growing and harvesting vegetables year round.



Why a Four Season Harvest?



You can:

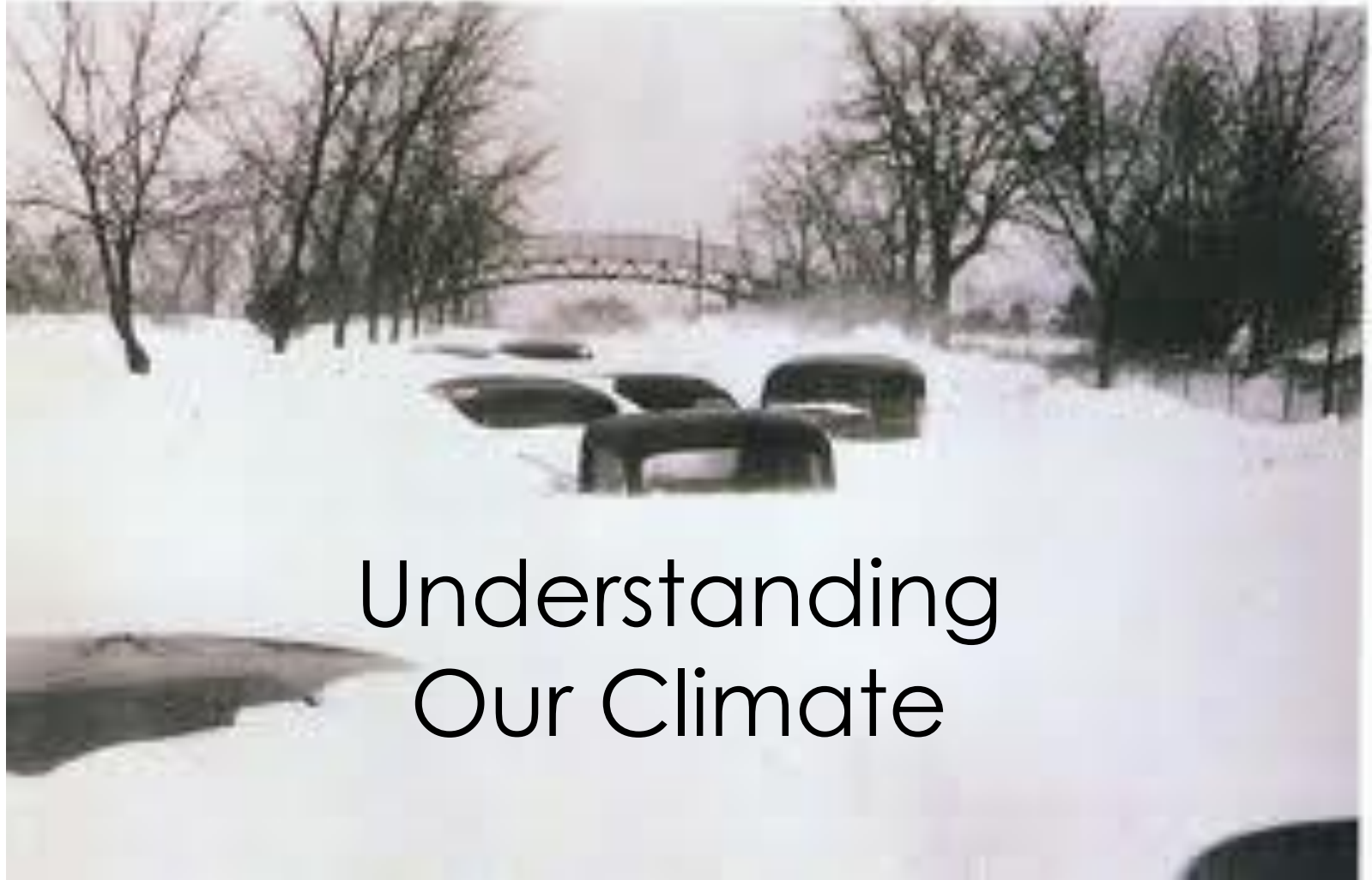
- 🍅 Eat fresh veggies all year long
- 🍅 Grow longer season vegetables
- 🍅 Optimize garden output
- 🍅 Chase the winter blues away



How Do You Extend Your Growing Season?

- 🍅 Understand climate and plant growth
- 🍅 Understand plant needs
- 🍅 Proper site selection and bed design
- 🍅 Tools and techniques
- 🍅 Select the right vegetables
- 🍅 Diseases and pests





Understanding Our Climate





This is the French Riviera.

They have palm trees.



This is New Hampshire...



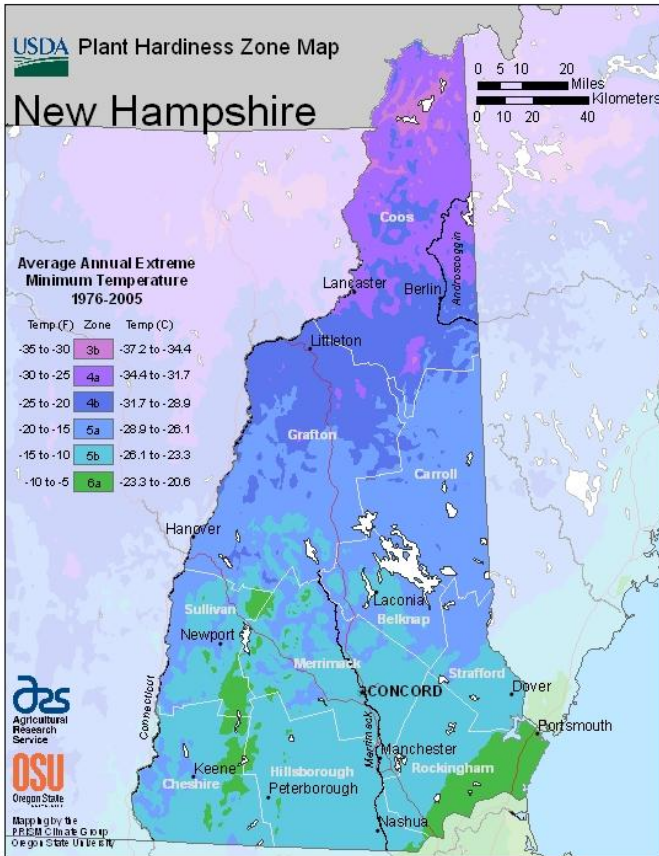
...We don't have palm trees!



Yet, we get the same amount of sunlight as the Riviera!

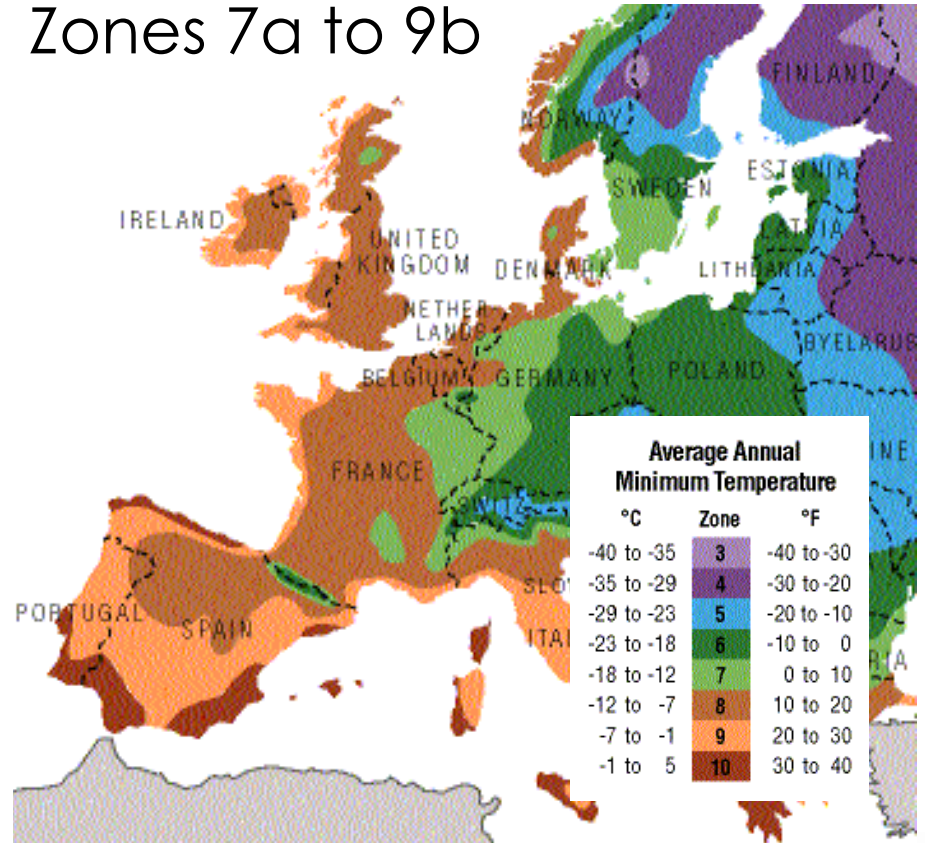


We are just a lot colder.



Zones 3b to 6a

Zones 7a to 9b



Understanding Plant Growth



How Hardy Plants Survive

Plants send water outside the cell wall or the plant, reducing freezable water in the cell (may even form a protective layer of ice outside the cell).

Plants build up sugars and plant material in cells, making the liquid in the cell more dense (a natural antifreeze).



In the Fall

Shorter day-length and cooler temperatures trigger hardiness.

Acclimation is a two-stage process:

- 🍅 It is initiated by decreasing day length (resulting in partial hardiness)
- 🍅 Colder temperatures force full hardiness and acclimation

Genetic capacity determines the hardiness ability of a plant.



In the Spring

As temperatures rise in the spring plant respiration increases:

- Stored sugars start to get used up
- Water reenters through cell walls and decreases the density of materials in cells
- Plants lose their ability to acclimate to cold (become susceptible to a hard frost or freeze)

Leaf and root crops lose their sweetness very quickly, become bitter and tough, and may bolt.



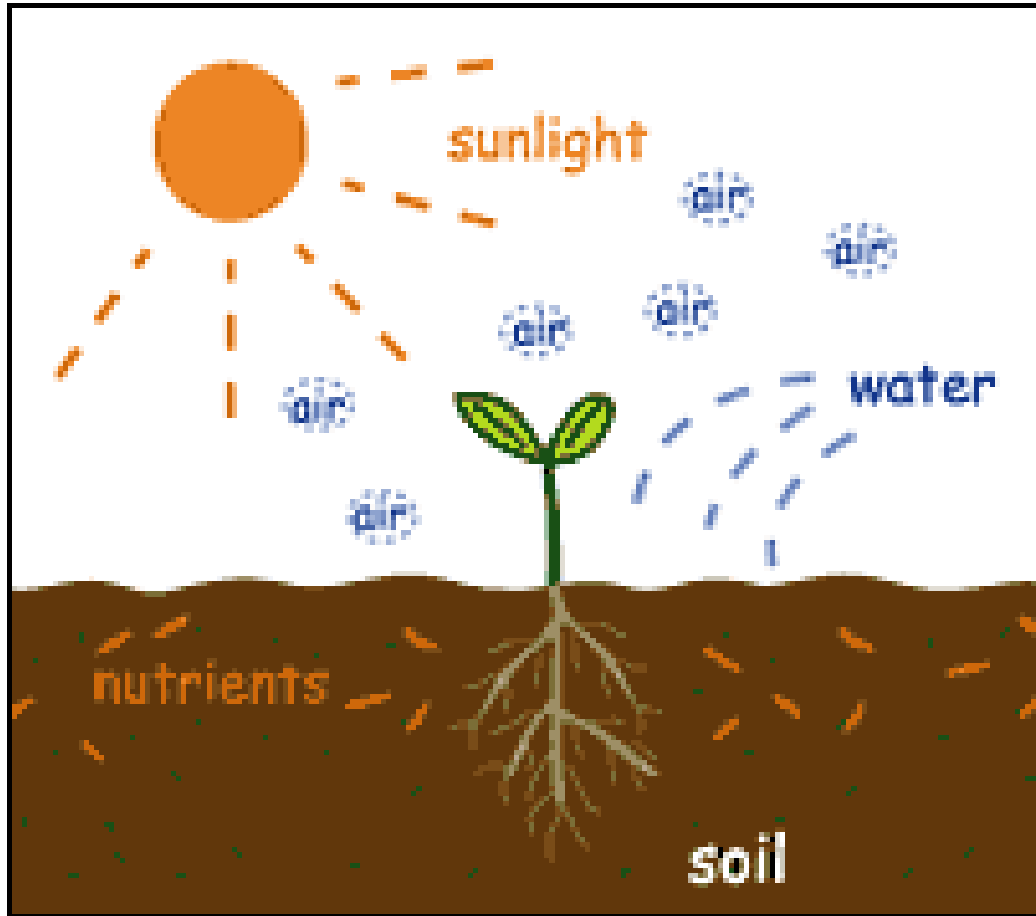
Cool Season Vegetables and Cold Weather

Higher sugar content and denser cell material lead to:

- Better taste – sugar content increases sweetness of vegetables
- Leaves thicken and become more tender
- Longer storage life (spinach up to five weeks)



Plant Needs



Minimum Sunlight Needs

	<u>Day length</u>	<u>Direct sunlight</u>
Leaf vegetables	<u>10 hours</u>	<u>4 hours</u>
Root vegetables	<u>10 hours</u>	<u>6 hours</u>
Fruiting vegetables	<u>12 hours</u>	<u>8 hours</u>



Sunrise to Sunset is called “Duration”

Duration of daylight for Concord, NH in 2012 - based on U.S. Naval Observatory:

- After November 7th there is less than 10 hours of daylight (plants stop growing)
- After February 2nd there is more than 10 hours of daylight (plants can start growing)

Little plant growth happens in November, December and January.



Air Temperature and Growth

Cool Season Vegetables

Daytime:

- 🍅 Minimum temperature for plant growth is 40°
- 🍅 Optimal temperature is 65° to 80°

Nighttime:

- 🍅 Greater than 32° for tender transplants
- 🍅 Down to mid-20s° and lower for established plants



Soil Temperatures for Germination

Crop	Min / Opt / Max		
Arugula	40	50	55
Beet (for greens)	65	80	85
Broccoli	60	80	85
Brussels Sprouts	60	80	85
Cabbage	60	85	95
Carrot	50	80	85
Cauliflower	60	80	85
Chives	60	70	85
Cilantro	50	65	85
Claytonia	50	50	55
Corn Salad (Mache)	41	55	68
Cress (Persian)	55	65	75
Endive / Escarole	45	75	85

Crop	Min / Opt / Max		
Kale	65	70	95
Kohlrabi	50	80	90
Leaf Lettuce	55	75	80
Mustards	50	75	85
Onion	55	75	95
Parsley	60	75	85
Parsnip	50	65	70
Peas	40	70	75
Radish	45	85	90
Rutabaga	60	70	85
Spinach	50	70	75
Swiss Chard	50	80	85
Turnip	50	80	105



Soil Temperatures for Growth

Crop	Optimal	Crop	Optimal
Arugula	50 - 65	Kale	60 - 65
Beet (for greens)	65 - 75	Kohlrabi	50 - 65
Broccoli	60 - 65	Leaf Lettuce	55 - 65
Brussels Sprouts	60 - 65	Mustards	50 - 70
Cabbage	60 - 65	Onion	55 - 75
Carrot	50 - 70	Parsley	60 - 65
Cauliflower	60 - 70	Parsnip	60 - 65
Chives	55 - 70	Peas	45 - 65
Cilantro	50 - 75	Radish	45 - 65
Claytonia	50 - 65	Rutabaga	45 - 65
Corn Salad (Mache)	50 - 68	Spinach	40 - 65
Cress (Persian)	50 - 75	Swiss Chard	50 - 65
Endive / Escarole	45 - 65	Turnip	40 - 75



Winter Water Needs



Plants use a minimal amount of water in the winter:

- 🍅 Water less as temperatures drop in October
- 🍅 Water every 3 to 4 weeks in November, December and January
- 🍅 Water more as temperatures rise in February



Nutrient Needs

Apply nutrients based on soil tests and plant needs.

Work nutrients into soil before seeding.

Biological activity, plant growth and nutrient uptake slows as soil cools.



Fall and Spring Nutrient Needs

In the fall:

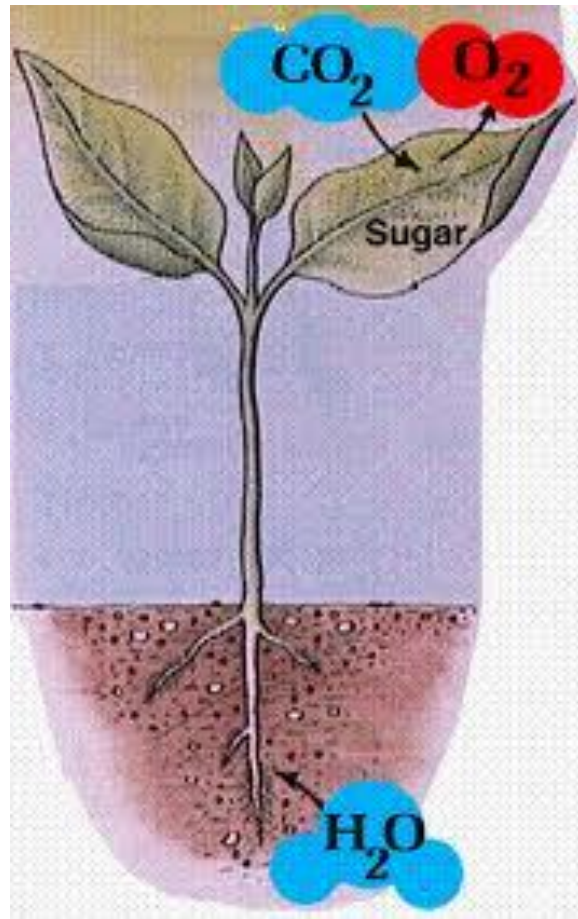
- 🍅 Soil stays biologically active later into fall
- 🍅 Nutrients will still be available for plant growth

In the spring:

- 🍅 Cold soil suppresses biological activity
- 🍅 Nutrients (especially nitrogen) may not be available for plant growth
- 🍅 Crops like spinach may need supplemental feeding (fish emulsion)



Fresh Air



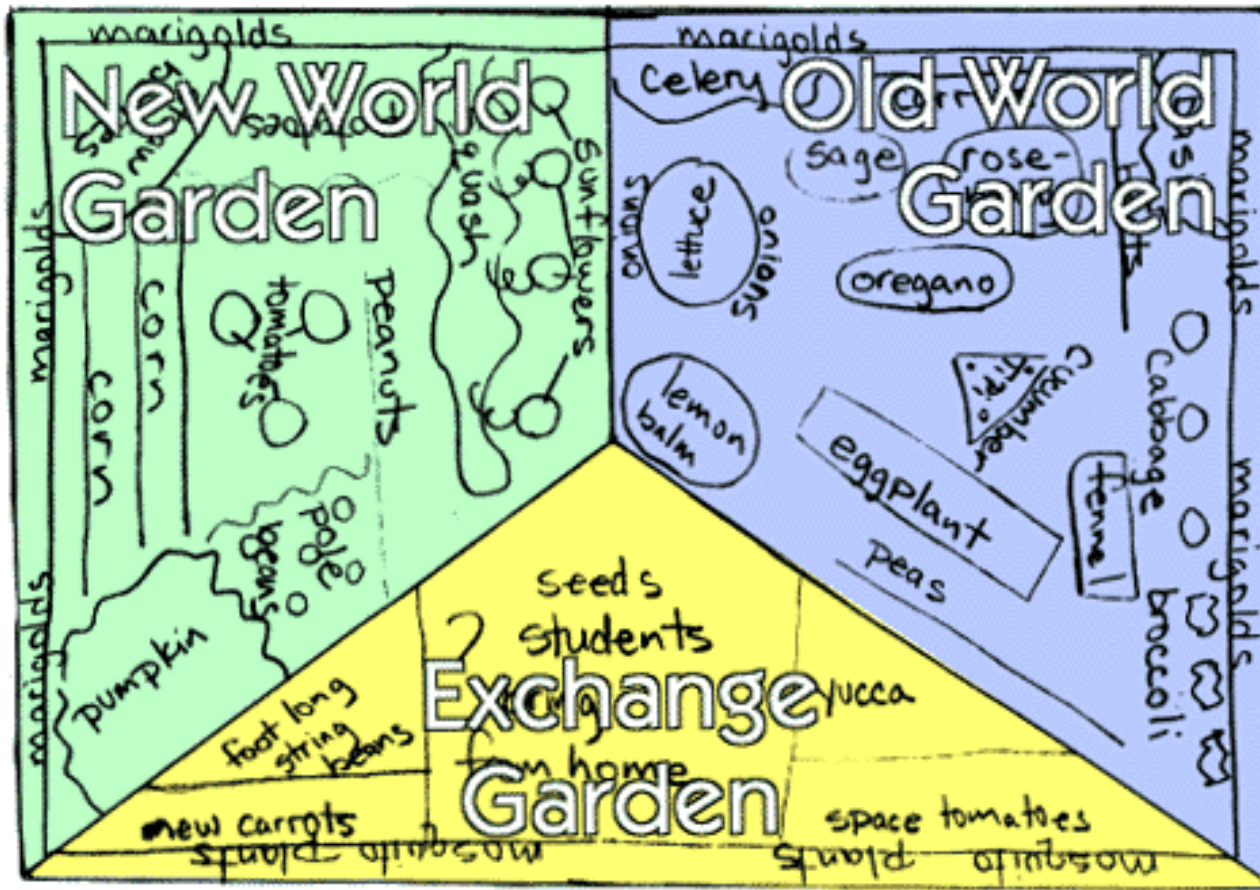
Plants need carbon dioxide for photosynthesis.

Air needs to be refreshed every 24 hours.

Composting manure can add carbon dioxide to air inside a tunnel or greenhouse.



Choosing a Location



Sun and Shade

Be aware of anything that casts a shadow:

- 🍅 Trees (they keep growing)
- 🍅 Buildings and fences
- 🍅 Hills and mountains

Choose a location with the most **winter sun**.

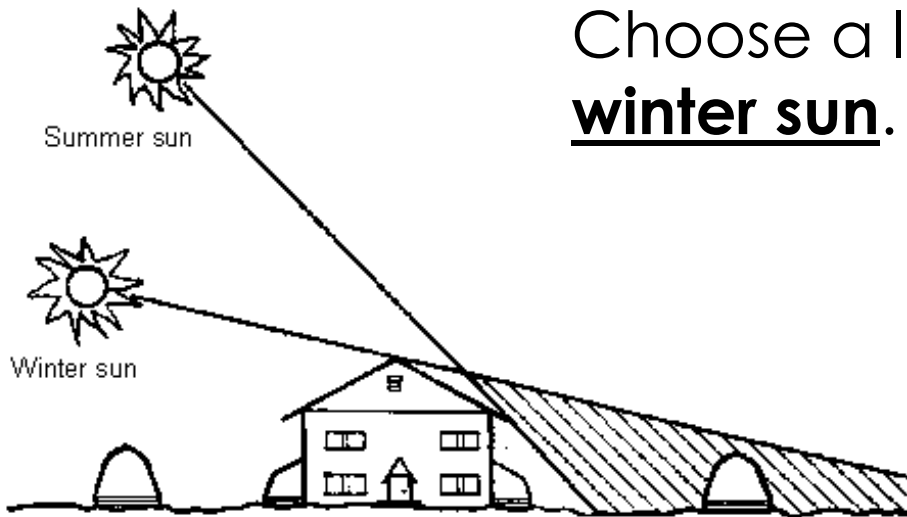


Figure 1. Select location carefully. Note where the shade line occurs in both the winter and summer.



Land Topography

A 5° south slope shifts you 300 miles south.

Rocks and boulders absorb and radiate heat.

Trees and shrubs can act as a wind screen.

Cold air flows downhill and into valleys.

Southern slopes receive about 40 percent more sun intensity than eastern/western slopes.



The Closer to Your Home the Better!

It is easier to maintain and harvest your beds.
Buildings can create a significant microclimate.
Shorter pathways means less snow shoveling.



Soil

Sandy soils hold less heat and experience more temperature swings compared to clay soils.

Darker soil hold more heat (compost can help).

Dark mulches help retain heat.



Bed Design

Raised beds warm faster (and may cool faster).

Raised beds built with wood allow you to attach low and high tunnel framing.



Tools

- 🍅 Plastic and organic mulches
- 🍅 Floating covers
- 🍅 Low tunnels
- 🍅 High Tunnels
- 🍅 Cold frames and hotbeds
- 🍅 Poop House



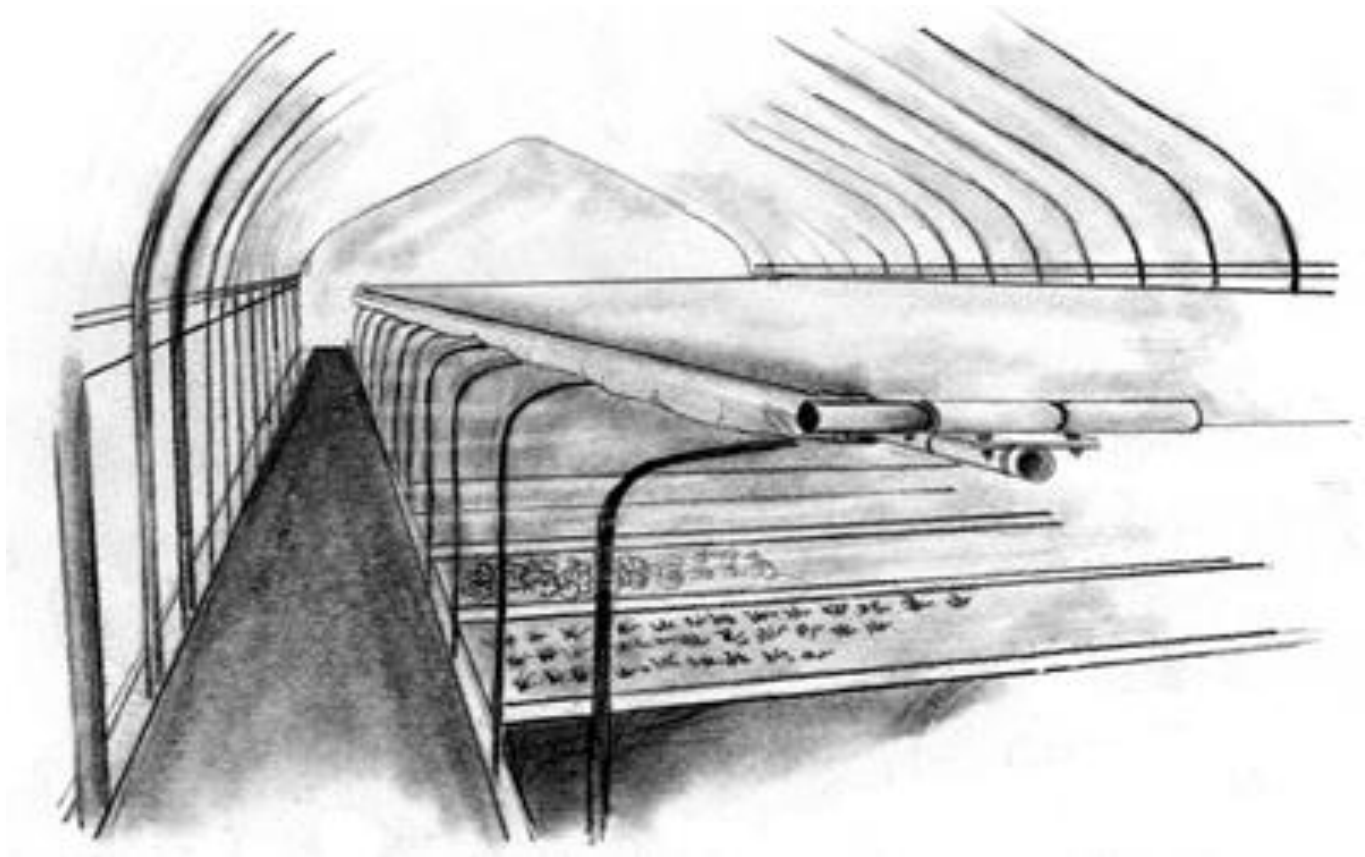
Black Plastic Mulch



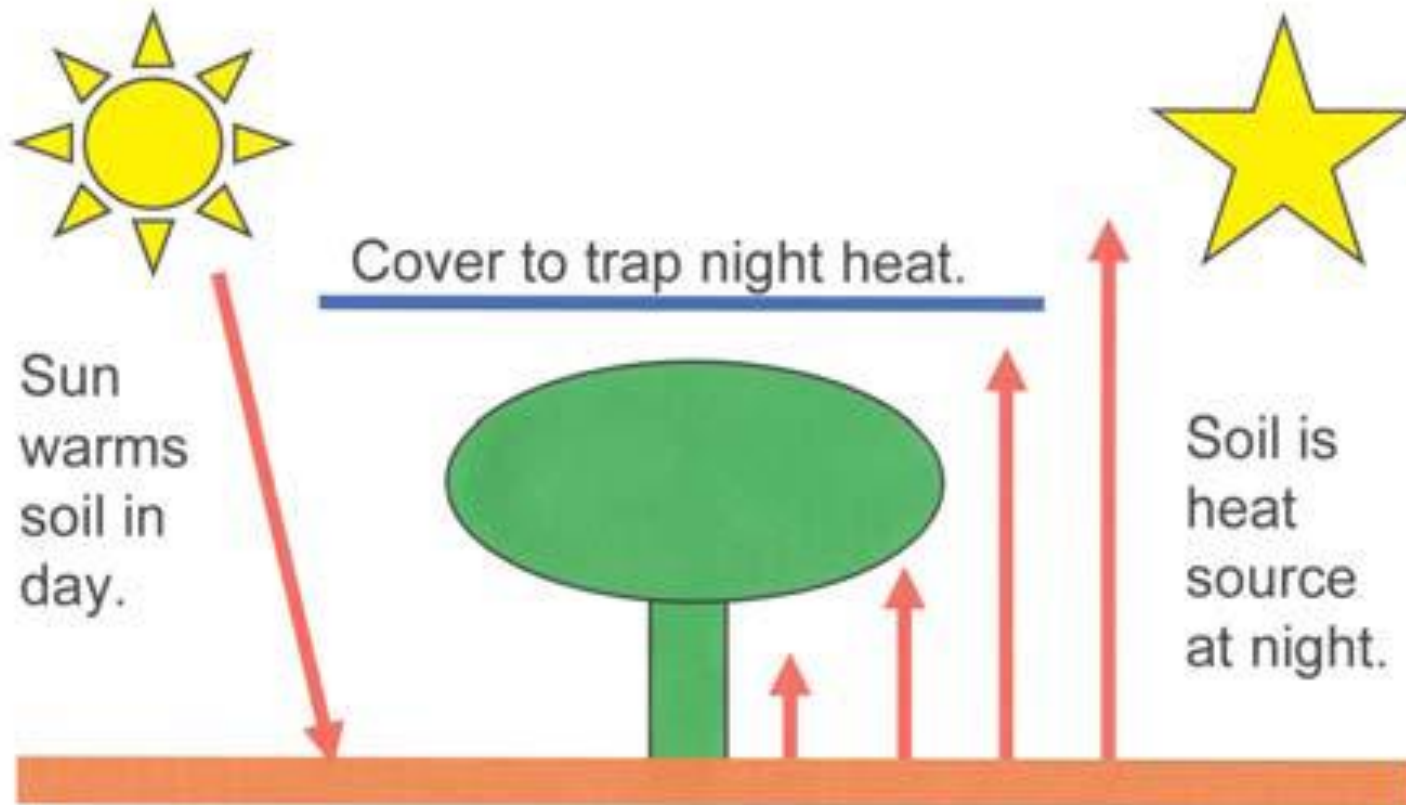
Organic Mulch



Row Covers and Tunnels



How They Work



Row Covers

- 🍅 Allows some rain (less than 50%), air, and sun to penetrate
- 🍅 Better regulate day and night temperatures, especially in spring and fall

You get higher quality fruit and vegetables.



Row Covers

- 🍅 Frost protection – from 2 to 12 degrees depending upon thickness and number of covers
- 🍅 Earlier yields – due to greenhouse affect (warmer air and soil)
- 🍅 Increased yields – as much as 25% for many crops



Row Covers

- 🍅 Wind and blowing sand protection – leads to less plant stress (especially on young plants)
- 🍅 Pest control – insect and animal exclusion (except mice)
- 🍅 Disease reduction – rain and dew roll off cover



Floating Row Covers



Covers rest right on plant material.



Low Tunnels



Low Tunnels



Top Ventilation

Side Ventilation



High Tunnel



High Tunnel



Gothic Style*

Quonset Style



* Best for New Hampshire



Making Magic Happen!



Combining Row Covers and
High Tunnels



Cornell Temperature Study

	<u>Outside</u>	<u>High Tunnel</u>	<u>Floating Cover</u>
Day	59	79	84
Night	29	35	40



Rosemary growing in
Berkshire, NY (Hardiness
Zone 5)



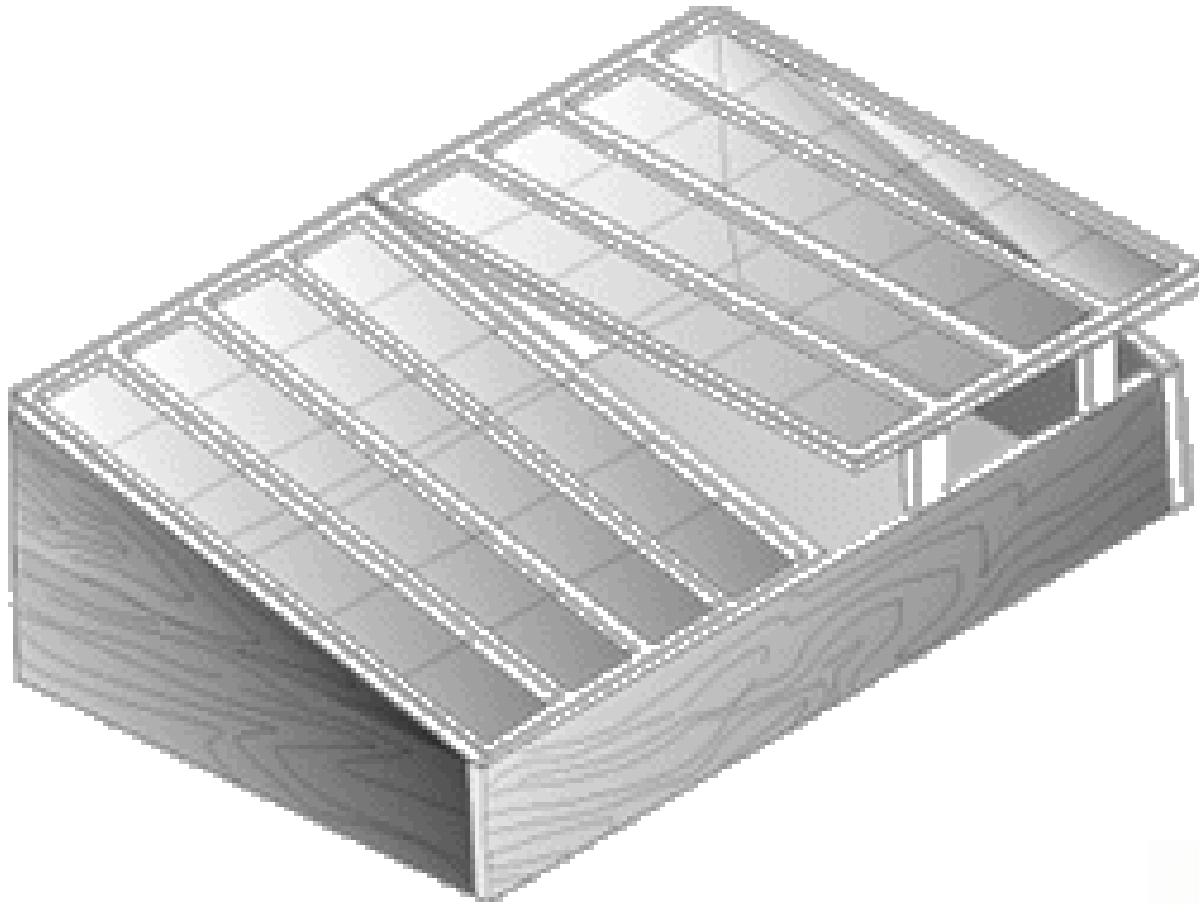
Thermal Blanket



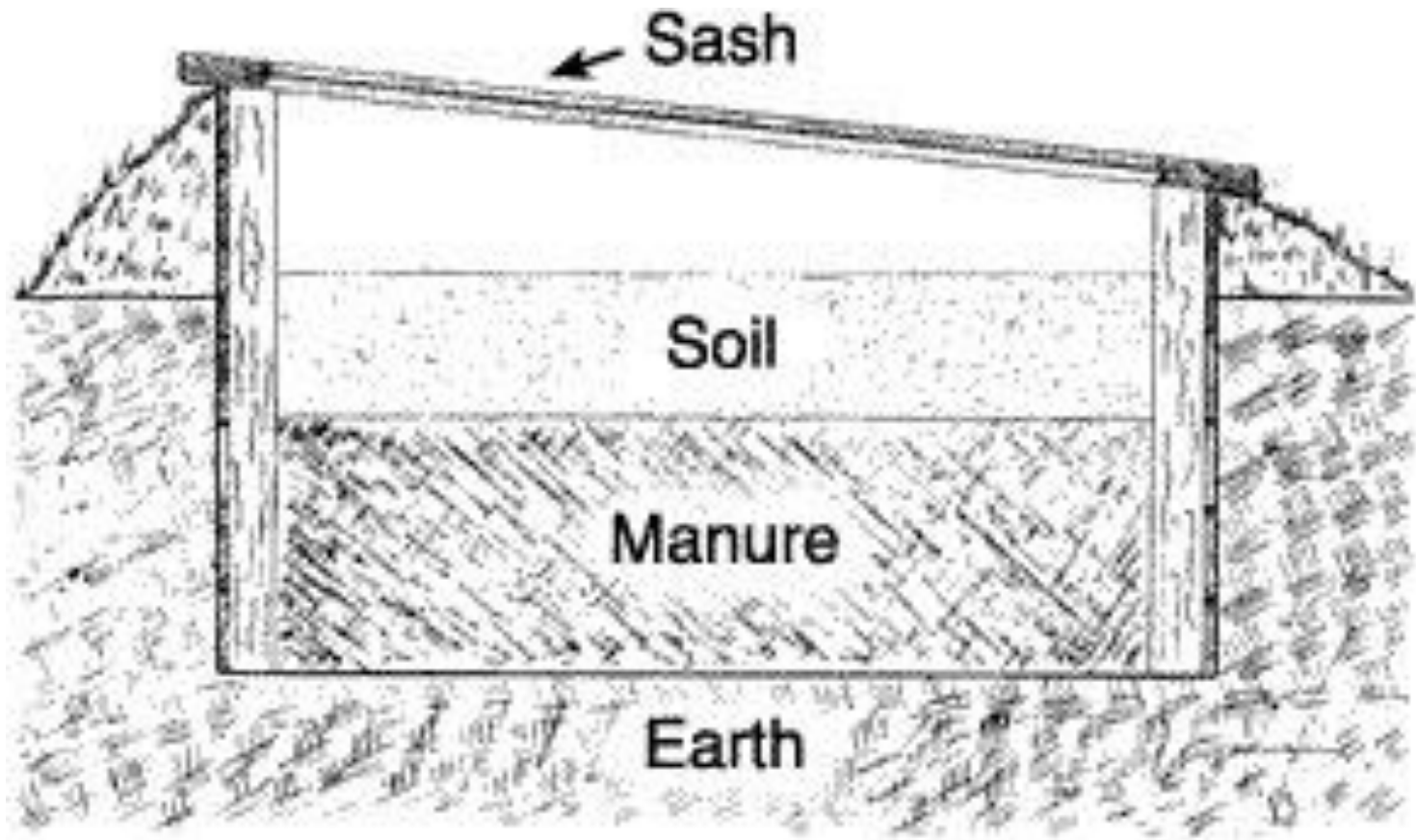
Wall-of-Water



Cold Frame



Hotbed



Selecting the Right Vegetables



Cool Season Vegetables

<u>Crop</u>	<u>Minimum Temp</u>	<u>Crop</u>	<u>Minimum Temp</u>
Arugula	20	Kale	0
Beet (for greens)	15	Kohlrabi	15
Broccoli	10	Leaf Lettuce	15
Brussels Sprouts	10	Leeks	0
Cabbage	10	Mizuna (a mustard)	20
Carrot	15	Onion	0
Cauliflower	10	Parsley	0
Claytonia	20	Parsnip	0
Celeriac	20	Radish (Oriental)	10
Celery	10	Rutabaga	20
Chives	0	Salsify	20
Collard	0	Spinach	0
Corn Salad (Mache)	0	Swiss Chard	10
Cress (Persian)	15	Tatsoi (a mustard)	20
Endive	10	Turnip	10
Escarole	20		
Fennel	20		



Pests and Disease

Annual weeds may be a minor problem.

High humidity can lead to downy or powdery mildew.

Some insects might hang around.

These are all small problems compared to this guy:





The Vole or Meadow Mouse!
They can ruin everything.



Show No Mercy



Know Your Enemy

Voles are vegetarians and cause considerable plant damage. Mommy voles:

- 🍅 Can produce five to ten litters a year
- 🍅 Have a 23 day gestation period
- 🍅 Can mate the same day their young are born

Young voles are weaned within 3 weeks and are sexually mature in two months.

Don't confuse moles and shrews with voles. Moles and shrews feed on soil insects and worms, not plants.



Vole Prevention Strategies

There is no "magic pill" for vole control and no single remedy solves the problem:

- Reduce habitat around garden or field.
- Encourage predators – snakes (black and king snakes) and birds of prey (build perch sites for hawks, owls and crows).
- Build raised beds at least 15 inches above ground level (voles have a vertical leap of 12").



Vole Prevention Strategies

Snap traps works in smaller areas like high tunnels:

- 🍅 (2 traps per 100 square feet)
- 🍅 Set traps at 90° angles to their runways
- 🍅 Continue to trap until no mice are caught for several days.

Place hardware cloth six inches deep and out and 15 inches high.



Vole Prevention Strategies

As Mad Eye Moody would say,

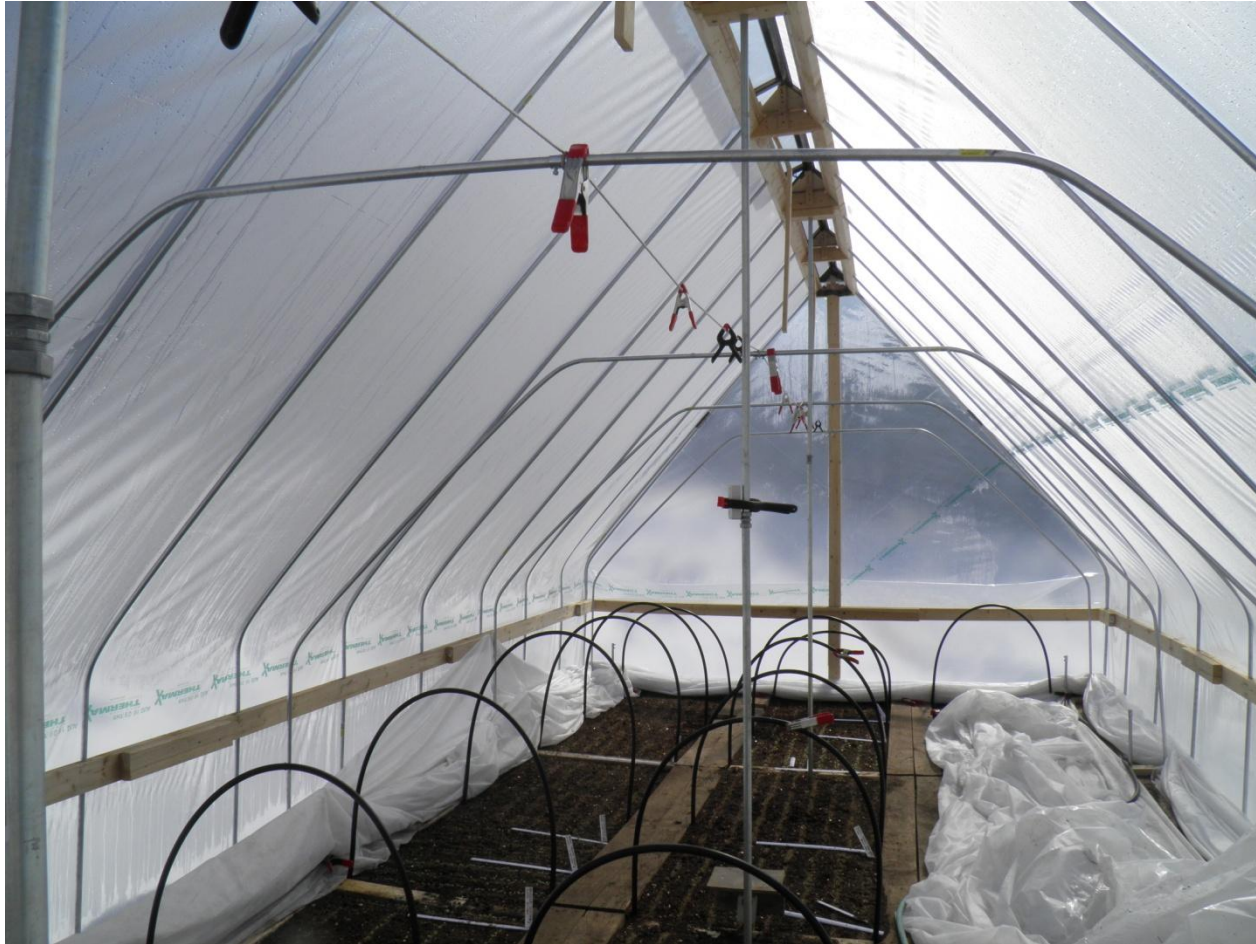


“Constant Vigilance”

(From Harry Potter and the Goblet of Fire)



Ron's Poop House







Poop House Temperatures

Night Time Temperatures:

Outside -2.0

Inside Low 31.0

Daytime Temperatures:

Outside 25.0

Inside Low 77.0



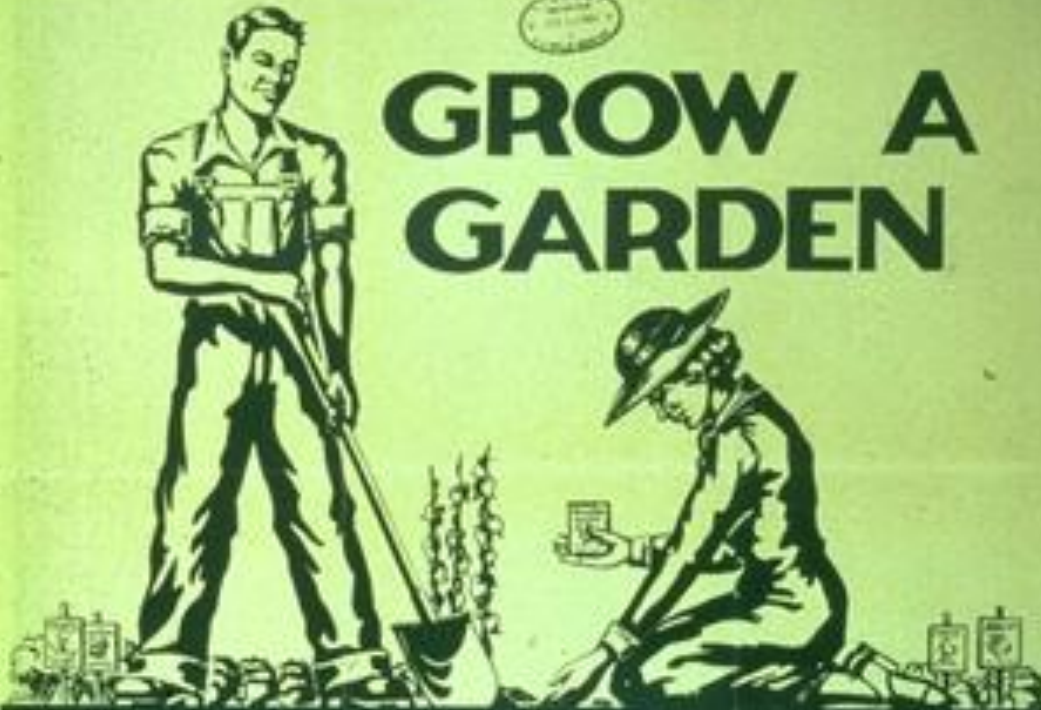
Christmas Salad Mix



SAVE MONEY THE EASY WAY



GROW A GARDEN



IT'S THRIFTY
IT'S PATRIOTIC
PLANT TO-DAY!



Thank You



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Resources and Credits

Plastic mulches: <http://www.ces.ncsu.edu/depts/hort/hil/hil-33.html>

Organic mulches: http://www.aces.uiuc.edu/vista/html_pubs/mulch/MULCH.html

Floating row covers: http://aces.nmsu.edu/pubs/_h/H-251.pdf

Frost Protection: <http://www.cmg.colostate.edu/gardennotes/722.pdf>

Cold frames and Hothouses: <http://extension.missouri.edu/explorepdf/agguides/hort/g06965.pdf>

Fall and Winter Vegetable Gardening in the Northwest: <http://extension.oregonstate.edu/catalog/pdf/pnw/pnw548.pdf>

Four-Season Harvest by Eliot Coleman

Temperature and Respiration: [aces.nmsu.edu/.../AH100%20T%20&%20Respiration%20\(feb'06\).pp...](http://aces.nmsu.edu/.../AH100%20T%20&%20Respiration%20(feb'06).pp...)

Cold Hardy Greens: http://www.hort.cornell.edu/hightunnel/crops/vegetables/salad_greens.htm

Seasonal High Tunnels for Food and Other Specialty Crop Production: <http://www.co.nrcs.usda.gov/programs/eqip/2011EQIP/SeasonalHighFactSheet.pdf>

Meadow Voles and Pine Voles: <http://counties.cce.cornell.edu/oneida/home%20garden/Animals/Voles.pdf>

Environmental Factors and Photosynthesis: <http://aesop.rutgers.edu/~horteng/Workshop/Lecture2.pdf>

Growing Plants Indoors Under Lights: <http://people.umass.edu/psoil120/manual/lab11.html>

The Angle of the Sun's Rays: <http://www.spo.gov.nasa.gov/stargaze/Sunangle.htm>

Light, Temperature and Humidity: <http://aggie-horticulture.tamu.edu/greenhouse/nursery/guides/ornamentals/light.html>

High Tunnels - Using low-cost technology to increase yields, improve quality, and extend the season:

<http://www.uvm.edu/sustainableagriculture/hightunnels.html>

Growing Under Lights: http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-1130/F-6401_pod.pdf

Plant Growth Factors: Light: <http://cmg.colostate.edu/gardennotes/142.pdf>

Measuring Daily Light Integral in a Greenhouse: <http://www.extension.purdue.edu/extmedia/HO/HO-238-W.pdf>

Plant Physiology: Environmental Factors and Photosynthesis: <http://aesop.rutgers.edu/~horteng/Workshop/Lecture2.pdf>

Vegetable Planting Guide: <http://cmg.colostate.edu/gardennotes/720.pdf>

Overwintering Plants in the Landscape: <http://ohioline.osu.edu/hyg-fact/1000/1016.html>

Cold Stress Regulation of Gene Expression in Plants: <http://www.faculty.ucr.edu/~jkzhu/articles/2007/444.pdf>

Roles of plant soluble sugars and their responses to plant cold stress: <http://www.ajol.info/index.php/ajb/article/viewFile/60470/48700>

USE OF LOW TUNNELS TO IMPROVE PLANT GROWTH IN HIGH TUNNELS:

<http://www.hort.cornell.edu/hightunnel/about/research/general/USE%20OF%20LOW%20TUNNELS%20article%202008.pdf>

Some plants make natural antifreeze to cope with winter's wrath: <http://extension.oregonstate.edu/gardening/node/847>

High Tunnel Temperature Management: http://www.hightunnels.org/PDF/JETT_High_Tunnel_Temp_Mgt.pdf

Season Extension Tools & Techniques: <http://www.uky.edu/Ag/CDBREC/introsheets/extension.pdf>

