

# SEASON EXTENSION

It's nice to fool Mother Nature



**PERHAPS YOU'LL REMEMBER THIS....**

<https://www.youtube.com/watch?v=ijVijP-CDVI>



## WHO AM I AND WHY AM I HERE?

- Tim Dungan
- Married to the lovely and talented Mitzi
- Dad to Charles and Nicholas
- Lifelong gardener and dedicated season extender
- UNL Extension Master Gardener Volunteer
- Pursuing a Masters degree at UNL in Horticulture / Minor in Entomology
- Interested in Extension education, Integrated Pest Management, and landscape management



## OUR DISCUSSION THIS EVENING

- **Season extension**
  - What is it and what are we trying to accomplish?
  - Germination and soil temperature
  - Cold tolerance and plant hardiness
  - Fall and spring season extension
- **How do I start?**
  - Tools and techniques



## WHAT IS SEASON EXTENSION?

Season extension refers to a farming or gardening technique that allows a crop to be cultivated beyond its normal outdoor growing season (and harvest



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## WHAT IS SEASON EXTENSION?

### Commercial and market gardeners

- Commercial farmers – year round, heated greenhouses
- Market gardeners – season extension

### Home gardeners

- You and I
- Season extension



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## WHAT DOES SEASON EXTENSION MEAN FOR THE COMMERCIAL OR MARKET GARDENER?

- Potential year-round income
  - Depending on your market and location
- Higher prices, but perhaps at a higher cost
  - Ability to deliver fresh, local in the off-season
  - Higher inputs - fuel (heat), electricity (lights)
- Higher yields
  - Controlled environment (to some extent)
  - Cultivars specific to the environment – cucumbers, tomatoes



## WHAT DOES SEASON EXTENSION MEAN FOR THE COMMERCIAL OR MARKET GARDENER?

- Better quality
  - Maybe - depending on who's doing the evaluating
- Extended employment for workers
- Customer retention / Customer gain



## SOME NEBRASKA EXAMPLES



[www.nebraskarurallivingpage.com](http://www.nebraskarurallivingpage.com)

- Oak Ridge Farms – Ord
  - Hydroponic green and red Bibb lettuce
  - 1000 heads/ week in winter, 2000 heads/week in summer
  - Actually....season elimination !



## SOME NEBRASKA EXAMPLES

- Pekarek's Produce - Dwight
  - Regular vendor at Lincoln and other farmer's markets
  - April through December harvest season
    - Meaning, of course, they extend their season at both ends !



<https://pekareksproduce.files.wordpress.com>



## COMMERCIAL GROWERS VERSUS YOUR BACKYARD THE APPROACH IS THE SAME!

- Warm the soil
- Protect from spring frost
- Earlier production – seeds and transplants
- Protect from fall frost
- Later production
- Overwintering



## MOST IMPORTANTLY.....

- Improved mental well-being
  - More gardening time!
- Neighborhood bragging rights
  - First tomato
  - First and last fresh green salad of the season

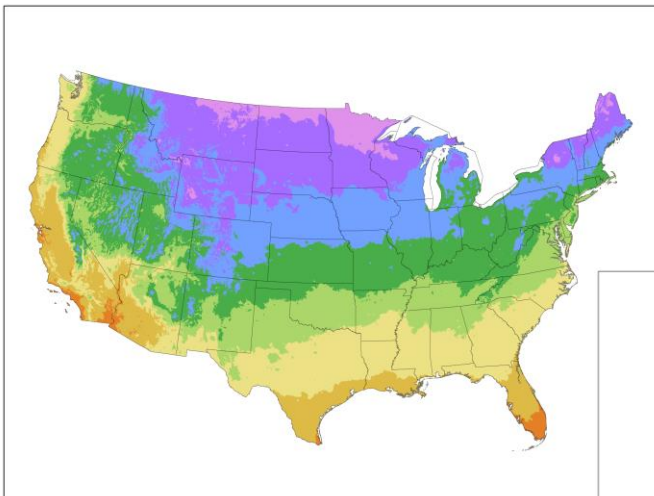


<http://cdn2.bigcommerce.com>



## A QUICK REVIEW OF NEBRASKA'S CLIMATE

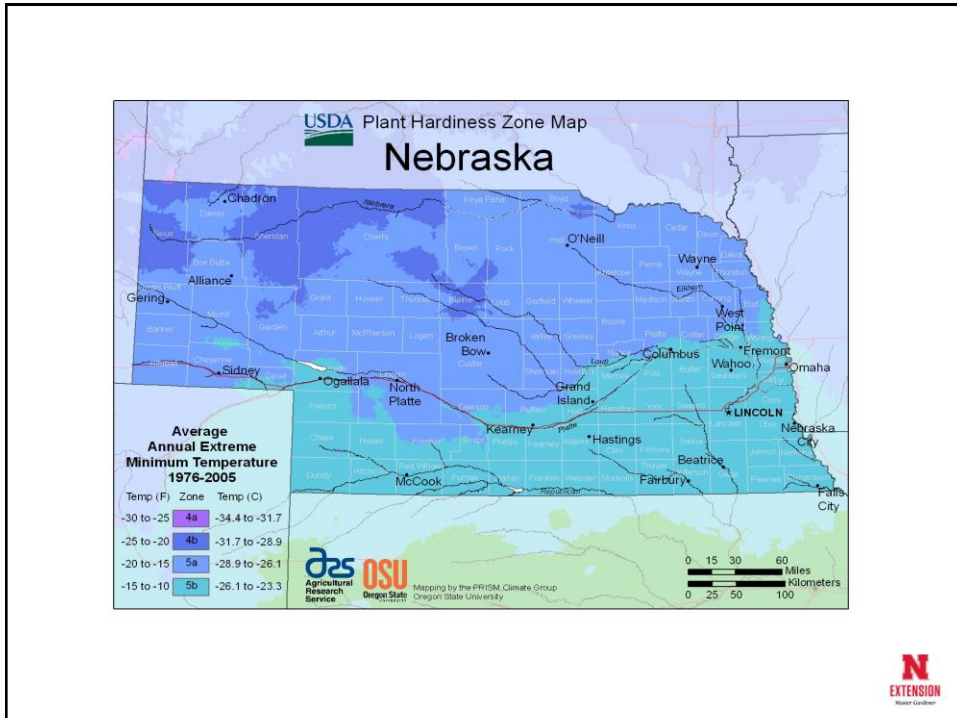
- Which USDA Hardiness Zone is applicable to your region of Nebraska?
- What is your typical last freeze date in the spring?
- What is your typical first freeze date in the fall?
- How much variation do you see from year-to-year in those dates?



**USDA Plant Hardiness Zones**

### Average Annual Extreme Minimum Temperature 1976-2005

Temp (F)	Zone	Temp (C)
-40 to -30	3	-40 to -34.4
-30 to -20	4	-34.4 to -28.9
-20 to -10	5	-28.9 to -23.3
-10 to 0	6	-23.3 to -17.8
0 to 10	7	-17.8 to -12.2
10 to 20	8	-12.2 to -6.7
20 to 30	9	-6.7 to -1.1
30 to 40	10	-1.1 to 4.4
40 to 50	11	4.4 to 10



## GOAL OF SEASON EXTENSION

- Pretty simple, actually....
- Make the last frost or freeze come a little sooner
- Make the first frost come a little later



## HOW DO WE 'CHANGE' THE FROST DATE?

### Control the flow of heat !

- Why do we cover plants before the first light frost?
  - To retain soil heat and prevent plant damage (moderate air temperatures)
- Why do we use season extension techniques in the spring?
  - To capture solar energy and increase soil temperature (and moderate air temperatures)



## MICROCLIMATE

A local set of atmospheric conditions that differ from those in the surrounding area, often with a slight difference but sometimes a significant one

- Small (garden bed) vs. large (coastal area)
- North-facing vs. South-facing slope
- Hilltop vs. valley



# MICROCLIMATE



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# SEEDS OR TRANSPLANTS? OR BOTH?



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## SEEDS

- The world of horticulture is in your mailbox
- Cultivars and hybrids
  - Shorter time to maturity
  - Longer bearing season / Increased bearing
  - Hotter – and even hotter - peppers !
  - Cold / heat / drought tolerant
  - Brighter colors / more flowers
  - Disease and/or pest resistance



## TRANSPLANTS

- Warm season vegetables and flowers
- Cool season vegetables and flowers
- Someone else does the hardest part
- But....relatively easy to accomplish at home
  - Basic supplies readily available



## SEEDS VS. TRANSPLANTS

- Limited to cool season vegetables and hardly any annual flowers
- Wide choice – better in catalogs than retail
- Simple
- Early start on warm and cool season vegetables and flowers
- Retail choices could be limited
- Less simple
- More \$\$ than seeds



## SEASON EXTENSION IN THE SPRING

- Earlier start on cool season crops
- Key is soil temperature for germination
  - Need sufficient temperature for germination
  - Sufficient temperature for growth to minimize seedling diseases such as damping off
- Use transplants for crops that tend not like the heat of summer
  - Broccoli – bolts readily in the summer heat (depends on cultivar)



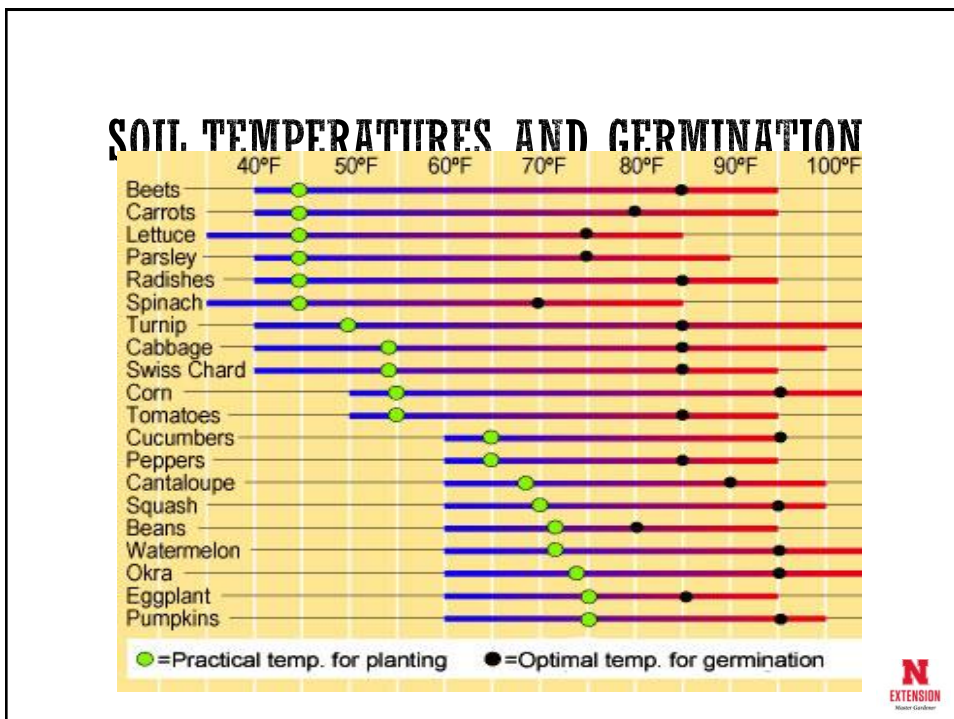
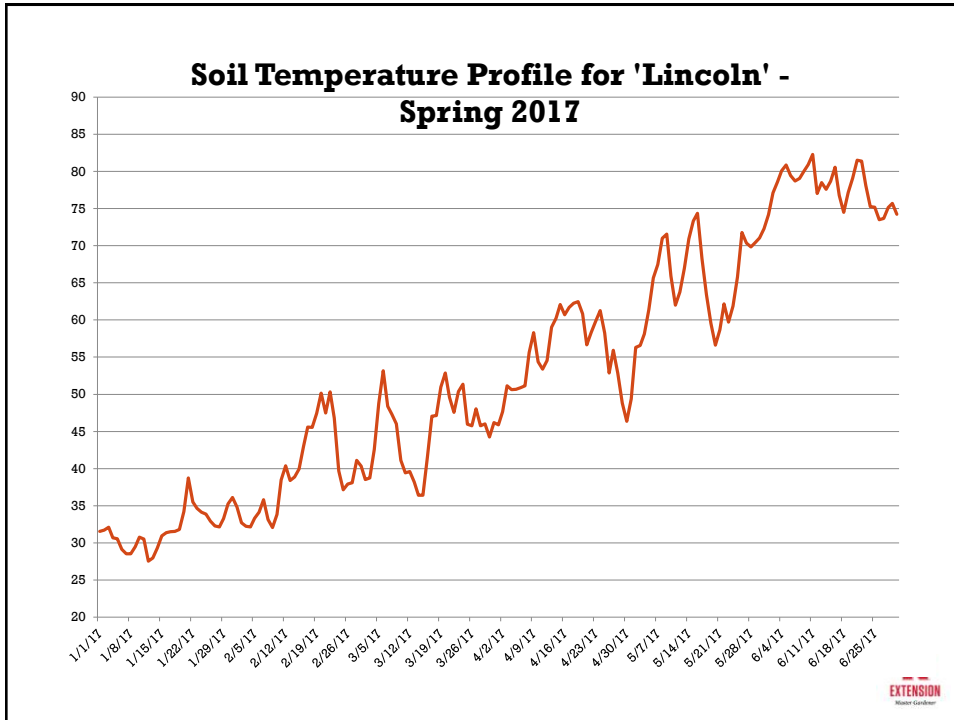
## SOIL TEMPERATURE

- Soil temperature is measured at 4" deep under bare soil
- Compost thermometer
- Soil temperature probe purchased from garden catalog/center
- Institute of Agriculture and Natural Resources / Cropwatch
  - <http://cropwatch.unl.edu/cropwatchsoiltemperature>
- High Plains Regional Climate Center (need an account)
  - <https://hprcc.unl.edu/awdn.php>



## SOIL TEMPERATURE PROBES





## GERMINATION OF VEGETABLE CROPS

- Hand outs
- Relationship of temperature to time
- Increased time to germination = increased risk of seed loss (rot, fungus)
- Sustained cool temperatures = increased risk of damping off (fungal disease)



## GERMINATION CONDITIONS FOR FLOWERS

- Annual flowers require higher temperature for germination - typically 70° or higher
  - Even cold hardy varieties like pansies

<https://hortnews.extension.iastate.edu/2000/2-25-2000/annflowgerm.html>



## SEASON EXTENSION IN THE FALL

- Take advantage of soil warmth
  - But sunlight is becoming less intense
  
- Protect established plants
  - Warm season crops – tomatoes, peppers
  - Finish maturation process
  
- Continue to grow cool season crops
  - Planning



## TENDER/ VERY TENDER PLANTS

- Well-known to experienced gardeners
  - Will need the earliest protection
  - Can protect from a light frost
  - Hard freeze will finish them off
  
- Tomatoes, peppers, cucurbits, beans, basil, sweet potatoes, eggplant
  
- Early season potatoes and corn can typically recover from an early season frost after sprouting/germinating (31-32°F)





## SEMI-HARDY

- Tolerant to approx. 20-25°F (depending on your reference)
- Lettuce, many greens
- Carrots
- Beets, Swiss chard
- Peas
- Parsley
- Parsnips



## HARDY

- Tolerant to approximately 10°F
- Brassicas / cole crops
  - Cabbage, Broccoli, Brussel sprouts, Kohlrabi
- Rutabaga, Turnips, Radishes
- Kale
- Onions
- Peas



## VERY HARDY

- Tolerant to approximately 5°F
- Leeks
- Parsnips
- Spinach



## SUPER-DUPER HARDY !!

- Tolerant to approximately -10 °F (survived January cold spell)  
salad / Mache' / Lamb's lettuce
- Corn salad / Mache' / Lamb's lettuce

Dead lettuce



Dead baby bok  
choi

Corn salad



## PLANNING

- Make sure you have seeds
- Know and prep your garden spot
  - Plan for that space
  - Amend before hand
- Supplies ready
  - Proactive, not reactive
  - Structure ready before the first frost forecast
- Plan !
  - When do you need to plant ?
  - Planners – online, apps



## FALL SUCCESS

- Pick the right time for the right crop
  - Is is time to plant / sow ?
  - Is there enough time for my crop to mature ?
- Sun is hot, soil is warm
  - Increased need for watering, especially young sprouts
  - Might need to consider some light shade



# GARDEN PLANNER

## Clyde's GARDEN PLANNER

SPRING

	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT
Onion - Sets	1 <sup>1</sup>	18 <sup>RR</sup>	3 <sup>1</sup>	FP					
Peas	1-2 <sup>1</sup>	30 <sup>RR</sup>	1-3 <sup>1</sup>	FP					
Spinach	1-2 <sup>1</sup>	18 <sup>RR</sup>	3 <sup>1</sup>	FP					
Cabbage *		30 <sup>1</sup>	24 <sup>si</sup>	FP		✓	✓	✓	✓
Cauliflower *		30 <sup>1</sup>	24 <sup>si</sup>	FP		✓	✓	✓	✓
Radish/Turnip	1-2 <sup>1</sup>	18 <sup>RR</sup>	3 <sup>1</sup>	FP		✓	✓	✓	✓
Beets	1-2 <sup>1</sup>	18 <sup>RR</sup>	3 <sup>1</sup>	FP		✓	✓	✓	✓
Potatoes	3 <sup>1</sup>	36 <sup>RR</sup>	12 <sup>1</sup>	FP		✓	✓	✓	✓
Broccoli *		30 <sup>1</sup>	24 <sup>si</sup>	FP		✓	✓	✓	✓
Lettuce - Leaf	3/16 <sup>1</sup>	18 <sup>RR</sup>		si		✓	✓	✓	✓
Carrots	1-1 <sup>1</sup>	14 <sup>1</sup>	24 <sup>RR</sup>		FP		✓	✓	✓
Chard	1-1 <sup>1</sup>	14 <sup>1</sup>	24 <sup>RR</sup>		FP		✓	✓	✓
Green Beans - Bush	1 <sup>1</sup>	30 <sup>1</sup>	14 <sup>1</sup>		FP		✓	✓	✓
Sweet Corn	1 <sup>1</sup>	30 <sup>1</sup>			FP		✓	✓	✓
Cucumbers	1 <sup>1</sup>	60 <sup>H</sup>			FP		✓	✓	✓
Squash - Summer	3/4 <sup>1</sup>	48 <sup>H</sup>	18 <sup>1</sup>		FP		✓	✓	✓
Melons	1 <sup>1</sup>	72 <sup>H</sup>	18 <sup>1</sup>		FP		✓	✓	✓
Peppers *		30 <sup>1</sup>	20 <sup>1</sup>	si		FP		✓	✓
Tomatoes *		40 <sup>1</sup>	30 <sup>1</sup>	si		FP		✓	✓
Okra	1 <sup>1</sup>	40 <sup>RR</sup>	12 <sup>1</sup>		FP		✓	✓	✓
Pumpkins	1 <sup>1</sup>	72 <sup>H</sup>	12 <sup>1</sup>		FP		✓	✓	✓

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# GARDEN PLANNER

## Clyde's GARDEN PLANNER

FALL

	M	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Onion - Sets										
Tomatoes *										
Peppers *										
Melons										
Potatoes										
Sweet Corn										
Cabbage *										
Cucumbers										
Okra										
Pumpkins										
Squash - Summer										
Carrots										
Cauliflower *										
Chard										
Peas										
Beets										
Broccoli *										
Green Beans - Bush										
Radish/Turnip										
Lettuce - Leaf										
Spinach										

**25/02/2018 16:31**

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## QUESTIONS ?



## AN ASSIGNMENT BEFORE BREAK

- You have been provided with a plot of last spring's soil temperature profile
- You have also been provided with a chart of some common germination temperatures for some early season vegetables
- Pick 7-10 vegetables from the chart
- Take a few moments to write the name of the vegetable on the plot where you might be able to actually sow that seed in your garden and expect germination within one week.



## WHERE HAVE WE BEEN SO FAR?

- Season extension = microclimate
- Pick your approach – seeds or transplants
- Pick your crops
- Plan
  - Spring planning
  - Fall planning



## TOOLS AND TECHNIQUES

- Many approaches to season extension in the backyard garden
- Simple, complex, and everything in between
- Inexpensive, homemade, recycled
- More expensive, purchased, designed solutions



## PLASTIC MULCHES

- Primarily used in commercial production systems
- Automated, often with drip irrigation
- Multiple colors
  - Black
  - Clear.....but weeds !
  - Red



<https://www.highmowingseeds.co>

## BIODEGRADABLE MULCHES

- Manufactured from plant starches
  - Wheat, corn, potato
  - Field compostable
- Same function as plastic mulches
  - Weed suppression
  - Moisture retention
- Research by Dr. Sam Wortman of UNL
  - Tomatoes, peppers

## ROW COVERS

- Polyester or polypropylene
- Available on-line, garden centers
  - On-line will have greater variety
- Multiple thicknesses, weights, widths, and lengths
  - 0.3 – 2.5 ounces/yd<sup>2</sup>



## ROW COVERS

- Lightest weights
  - Insect exclusion
  - Minimal heat retention
- Medium weights – 0.5 to 1.25 oz/yd<sup>2</sup>
  - 2 to 4°F frost protection
  - More effective in fall – more heat in soil
- Heaviest weights
  - Most protection for cool evenings, but poor light transmission





## ROW COVERS



## FLOATING ROW COVERS



## SUPPORTED ROW COVERS



## ROW COVERS



[www.bonnieplants.com](http://www.bonnieplants.com)  
[www.gardeners.com](http://www.gardeners.com)



## HOOP HOUSES OR HIGH TUNNELS

- Series/row of semi-circular metal poles
  - Interior height/width vary greatly
  
- Covered with one or two layers of polyethylene
  
- Simple or complex
  - Heated or unheated
  - Ventilation
  - Roll-up sides or ends



## HOOP HOUSES OR HIGH TUNNELS



## HOOP HOUSES OR HIGH TUNNELS



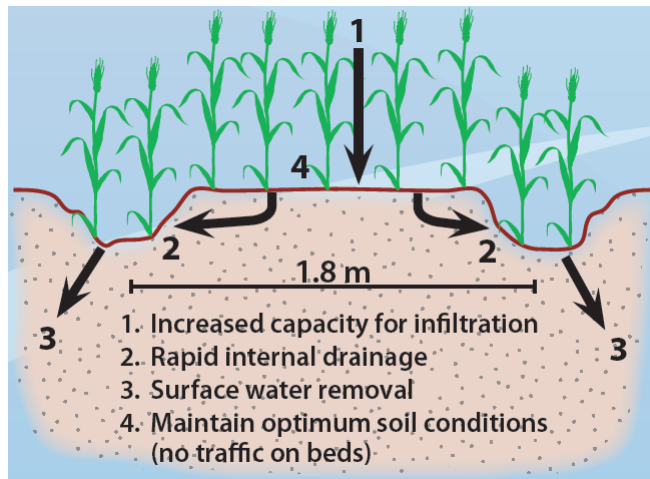
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## RAISED BED

- Warms up sooner / stays warm longer
  - Why?
    - Remember our earlier discussion about microclimate?
- Improved drainage
- Avoid planting bed compaction

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## RAISED BED



[www.soilquality.org.au](http://www.soilquality.org.au)



## RAISED BED CONSTRUCTION

- Dimensional lumber
- Cinder blocks
- Recycled plastic decking
- Purchased
- Recycled 'things'
  - Bathtub
  - old bed frame
  - Tires
  - whatever



## RAISED BED 'IN THE BACKYARD'

- Ergonomic
  - Ease of reaching down / across
- Fill with 'decent' soil
  - 1:1 compost : top soil
- Dries out faster
- Soil warms faster
- Ready to work/plant sooner



## RAISED BED WITH LOW TUNNEL



### RAISED BED WITH LOW TUNNEL



### RAISED BED WITH LOW TUNNEL



## RAISED BED WITH LOW TUNNEL

4' x 8' x 18"

Approx. 1.8 yd<sup>3</sup>

Treated corner posts

Untreated 'rails'



## RAISED BED WITH LOW TUNNEL





## RAISED BED WITH LOW TUNNEL



$\frac{3}{4}$ " garden hose, 3-4", slit

$\frac{1}{2}$ " PVC, approx.  $\frac{1}{3}$  cut



## RAISED BED WITH LOW TUNNEL

24" x  $\frac{3}{8}$ "  
rebar pin

3-4" exposed



## RAISED BED WITH LOW TUNNEL

½ " thin wall  
PVC tubing

Cut tubing to  
desired  
length for  
raised bed

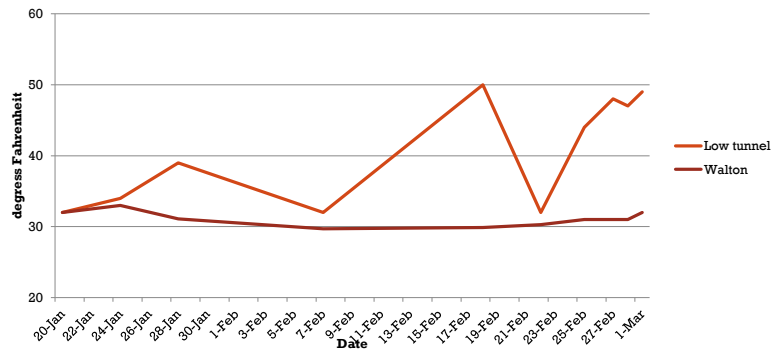


## RAISED BED WITH LOW TUNNEL



## RAISED BED WITH LOW TUNNEL TEMPERATURE PROFILE

Soil Temperatures  
Low tunnel vs. bare soil



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## RAISED BEDS WITH LOW TUNNEL

- Things to be aware of
  - Temperature can rise quickly – pay attention
  - Be ready to open the end, roll up the sides
- It's hot in there – soil can dry out quickly
- New seedlings and new transplants getting established

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## RAISED BEDS WITH LOW TUNNEL

- It's a protected, loving environment
  - Will likely need a little hardening off before full exposure
  - Maybe some temporary wilting
  - Might be a little bit wobbly



## HOTKAPS



## WALL O' WATER NOW CALLED SEASONSTARTERS



[www.mygardengeek.com](http://www.mygardengeek.com), 2014



## WALL O' WATER

- Circle of plastic tubes that are filled with water
- Microclimate
  - Sunlight raises the temperature of the water in the tubes
  - Moderates air and soil temperature within the circle
- Garden centers and seed catalogs
  - About \$5 each (\$14.99/pack of 3)
  - Last 3-5 years



## WALL O' WATER

- Advantages
  - Warms the soil
  - Plants protected well from wind, cold air
  - Combine with short maturity hybrid
    - Win the 'First Tomato in the Neighborhood' Contest !



## WALL O' WATER

- Disadvantages
  - Not so easy to fill (but I have a picture of a trick)
  - Plastic cracks, leaks – repair kits available
  - Algae growth in tubes – can treat with bleach
  - Light penetration - can get plant stretching
  - Environment for early fungal diseases/blights



## WALL O' WATER TRICK



## PLASTIC 'CAP'



## SCIENCE SPOILS THE FUN

'Effects of Three Hotcap Designs on Temperature and Tomato Transplant Development', HortScience, Vol. 28(9), September 1993

Virginia Tech, 1991 – 1992

Systematic, controlled study of:

- HotCaps (24" tall)
- Wall o' Water
- plastic milk jugs



## STUDY CONCLUSIONS

- Only effective on sunny days
- All approaches raised the air and soil temperature
- Temperatures declined faster in milk jugs, followed by HotCaps, then WOW
- WOW did a better job of moderating temperatures
- Fruit harvest 10 days (WOW) and 7 days (HotCaps) earlier than control





## STUDY CONCLUSIONS

BUT....

- Fruit and plants smaller than control group
- Poor pollination
- Plants thinner, more slender, more succulent growth  
→ partially attributed to poor light penetration; less than 70% of available light transmitted
- Plastic milk jugs not effective



## COLD FRAME

From Wikipedia:

- transparent-roofed enclosure
- built low to the ground
- protect plants from adverse weather
- transparent roof admits sunlight, prevents heat escape
- miniature greenhouse, to extend the growing season



## COLD FRAMES – BUY IT OR DIY



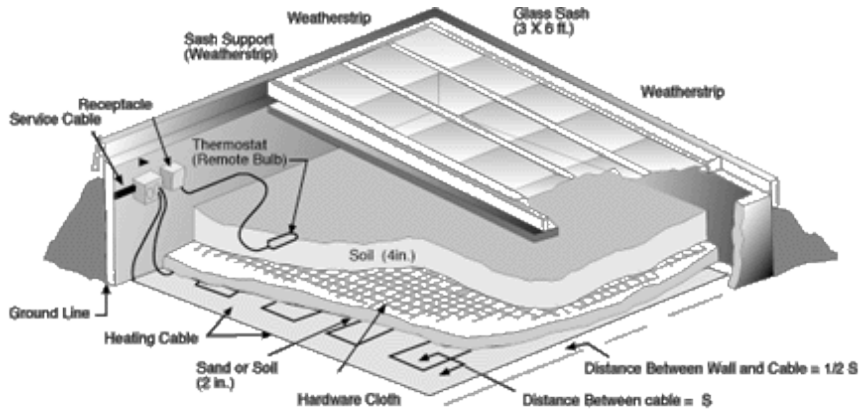
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## HOT BED

- A specialized form of the cold frame
- Soil is warmed from the bottom
  - Electric cables in the soil
  - A composting manure pile
    - Special considerations – materials for compost, need to regenerate the compost
- May make warm season crops feasible earlier
- But...might also take a little more research and practice

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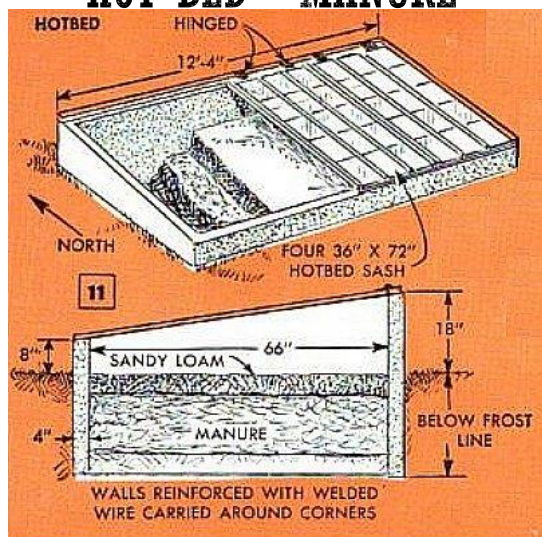
## HOT BED – SOIL CABLES



Construction of an electrically heated hotbed



## HOT BED - MANURE



## THINGS TO REMEMBER

- **Air temperature**
  - hot during the day, close to ambient at night
  
- **Irrigation – especially under clear plastic or glass**
  - Inside air warm or hot, driving moisture from the soil
  
- **Light transmission**
  - Less than full sun – plants may be spindly, light colored
  
- **Hardening**
  - Gradual (if possible) introduction to ‘unprotected status’



## A MORE COMPLEX FORM OF SEASON EXTENSION



## WHAT DID WE LEARN THIS EVENING?

- Think about the microclimate you want to create
- Pick seeds or grow/buy transplants that fit your desired approach
- Plan
- Pick your technique / combine techniques
- Have fun !



## QUESTIONS ?



## REFERENCES AND RESOURCES

- Season Extension, Debbie Roos (North Carolina Cooperative Extension) and Doug Jones (Central Carolina Community College)
- *Early Season Extension Using HotKaps*, NebGuide G1745, Laurie Hodges, August 2007
- *Cold Frames, High Tunnels, and Greenhouses: Choose a Growing Structure Best for You*, NebGuide G2246, Stacy Adams and Kim Todd, September 2014
- Vegetable Planting Guide, CMG GardenNotes #720, Colorado State University Extension, Colorado Master Gardeners Program



## LINKS

[USDA Plant Hardiness Zones](http://planthardiness.ars.usda.gov/PHZMWeb/)

<http://planthardiness.ars.usda.gov/PHZMWeb/>

Crop Watch – soil temperatures

<http://cropwatch.unl.edu/cropwatchsoiltemperature>

Annual Flower Seed Germination Guide

<https://hortnews.extension.iastate.edu/2000/2-25-2000/annflowgerm.html>

