University of Idaho

# EXTENDING THE GROWING SEASON FOR FRESH VEGETABLES


Ron Patterson

Extension Associate Professor

Bonneville County

# OVERVIEW

INTRO TO HIGH TUNNELS

TUNNEL MANAGEMENT

GROWING CALENDAR

# HORTICULTURE TOOLBOX

- Building rich soil
- Variety selection
- Maximized plant spacing
- Consistent watering
- Targeted fertilization
- Cover cropping
- Training
- Successive planting
- Plant protection

# HIGH TUNNELS

- Walk in
- Drive in
- Space for mature plants
- Passively heated and cooled.

# HIGH TUNNEL DESIGNS

# USU GARDEN TUNNEL

**$275.00**

**http://extension.usu.edu/files/publications/publication/Horticulture_HighTnnels_2012-03pr.pdf**

# BENEFITS OF HIGH TUNNELS

- Earlier Season
  - Wind protection
  - Warm soils earlier in spring
  - Warm ambient temperature faster and longer
- Easier to shade plants
- Higher quality fruit
- Higher yields
- Some frost protection
- Fun.

# DISADVANTAGES OF HIGH TUNNELS

- False sense of security
- More management
- Different disease pressures
- Different insect pressures.

# HIGH TUNNEL MANAGEMENT

- Cold management
- Heat management
- Space management.

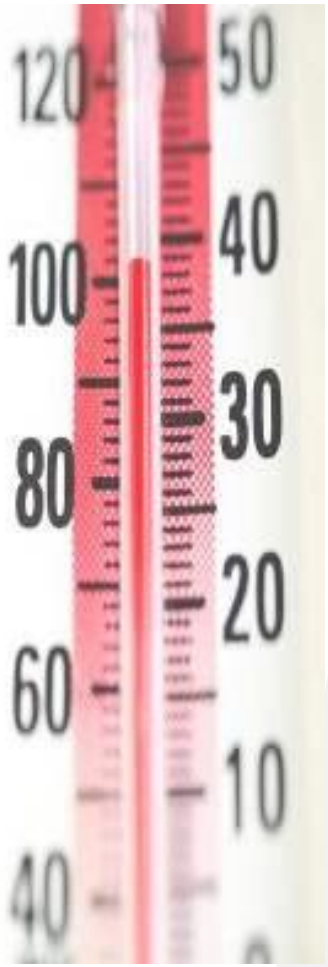
# CULTURAL AND ENVIRONMENTAL

- Microclimates
- Plastic mulch
- Raised beds.

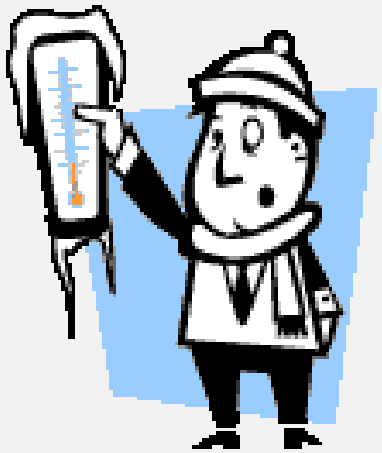
# FREEZE DATES

| Spring and fall freezing dates for three temperature thresholds | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 24°F threshold | | | 28°F threshold | | | 32°F threshold | | |
| Site | Spring | Fall | Growing season days | Spring | Fall | Growing season days | Spring | Fall | Growing season days |
| Pocatello | 12-Apr | 16-Oct | 186 | 29-Apr | 6-Oct | 159 | 16-May | 20-Sep | 127 |
| Montpelier | 9-May | 24-Sep | 137 | 30-May | 13-Sep | 106 | 15-Jun | 30-Aug | 76 |
| Fort Hall | 25-Apr | 10-Oct | 168 | 8-May | 26-Sep | 141 | 25-May | 13-Sep | 111 |
| Idaho Falls | 17-Apr | 15-Oct | 180 | 3-May | 2-Oct | 152 | 22-May | 20-Sep | 121 |
| Arco | 4-May | 2-Oct | 151 | 12-May | 19-Sep | 130 | 10-Jun | 6-Sep | 88 |
| Grace | 28-Apr | 8-Oct | 162 | 1-May | 25-Sep | 132 | 6-Jun | 12-Sep | 98 |
| Dubois | 25-Apr | 12-Oct | 169 | 8-May | 30-Sep | 145 | 28-May | 18-Sep | 113 |
| Mackay | 14-Apr | 14-Oct | 183 | 18-May | 26-Sep | 131 | 8-Jun | 13-Sep | 97 |
| Preston | 18-Apr | 20-Oct | 185 | 5-May | 3-Oct | 151 | 20-May | 22-Sep | 124 |
| Ashton | 29-Apr | 2-Oct | 155 | 16-May | 18-Sep | 125 | 11-Jun | 4-Sep | 85 |
| Hamer | 19-Apr | 8-Oct | 172 | 30-Apr | 19-Sep | 142 | 14-May | 3-Sep | 112 |
| Salmon | 28-Apr | 6-Oct | 160 | 7-May | 20-Sep | 126 | 4-Jun | 9-Sep | 97 |
| Rexburg | 5-Apr | 27-Oct | 205 | 30-Apr | 16-Oct | 169 | 13-May | 16-Sep | 126 |
| Driggs | 12-May | 25-Sep | 135 | 27-May | 10-Sep | 105 | 20-Jun | 28-Aug | 68 |
| 50% probability--data from University of Idaho Extension Bulletin 744 | | | | | | | | | |

# KEY ISSUES –



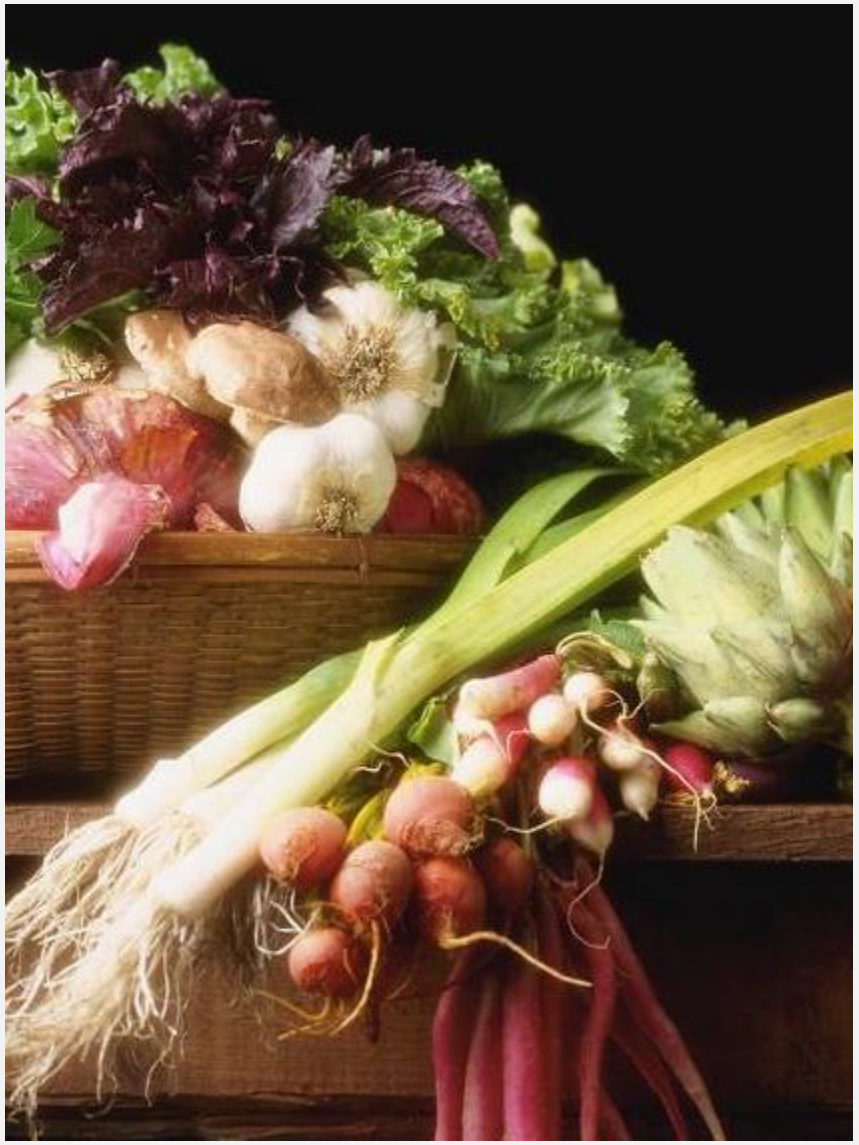

- Know base and upper temperature thresholds
- Know general cool season plants requirements
- Know general warm season plant requirements
- Don’t mix them
- Understand impact of extremes on plants.



# COOL SEASON VEGIES

## Hardy & Half-Hardy

- Able to withstand frost
- Germinate at cooler temperatures (35-40$^{o}$ F)
- Smaller plant size
- Biennials may flower
- No chilling injury but can be frost damaged
- Base temp ~ 35-40$^{o}$ F
- Upper limit ~ 70-80$^{o}$ F.



# WARM SEASON VEGIES

## Tender & Very-tender

- Frost damaged
- Chilling sensitive
- Germinate at warm temps (55-60$^{o}$ F)
- Large plant size
- Chilling injury < 50$^{o}$ F
- Base temp ~ 50+$^{o}$ F
- Upper limit ~ 80-95$^{o}$ F.

# POTENTIAL CROPS CHOICES

## Cool Season

- Lettuce/spinach
- Cabbage/broccoli/etc.
- Carrot/parsnip
- Beets/Swiss chard
- Onion/garlic
- Peas
- Rhubarb
- Asparagus

## Warm Season

- Tomato/Pepper/Eggplant
- Watermelons/Others
- Summer Squash
- Cucumber
- Sweet Corn
- Beans
- Basil
- Sweet potato

# SOIL TEMPERATURES

- Soil Temp – NOON – 1-2 inches deep
- Cool crop germination temperatures
- 55-75° F.

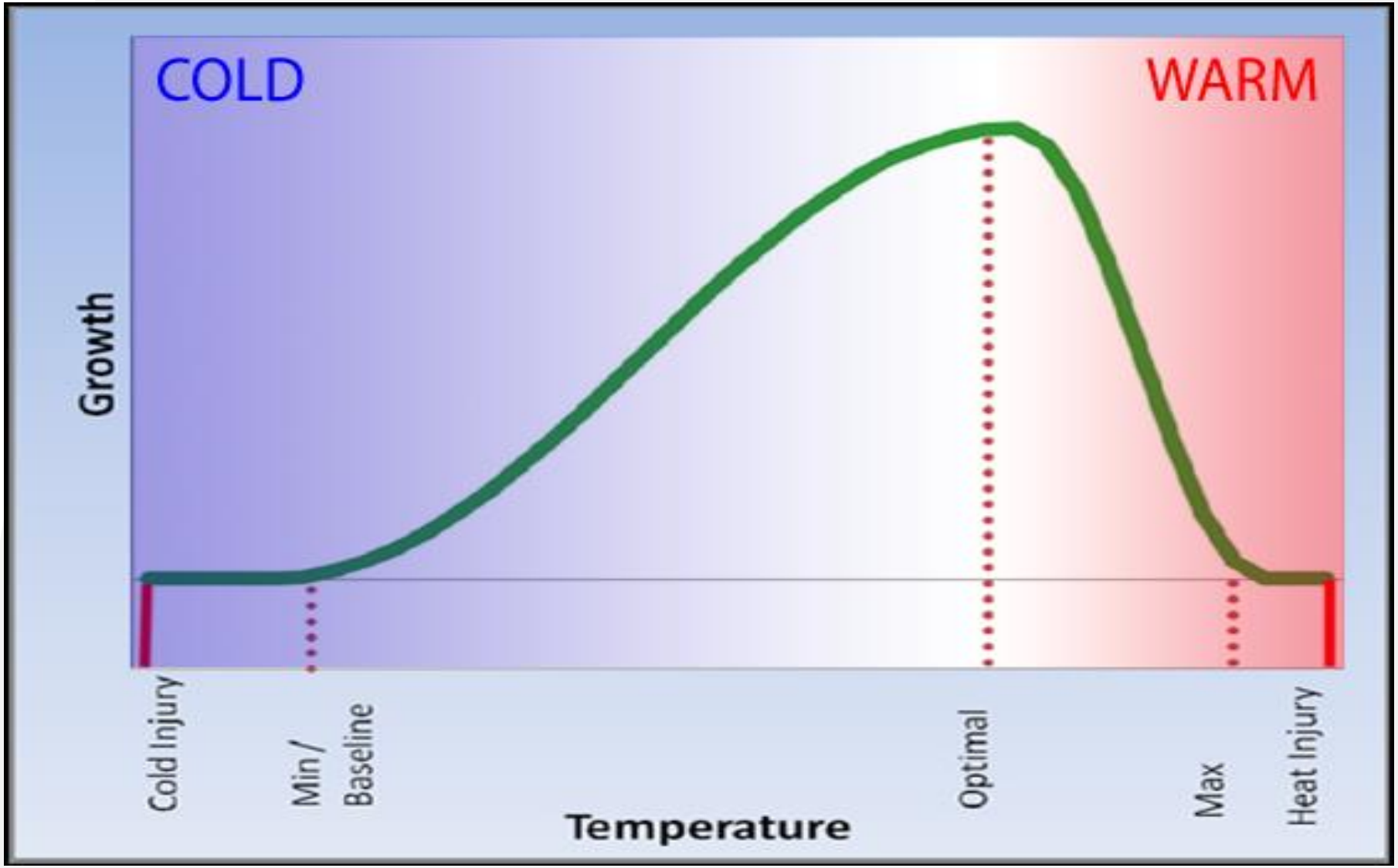
| Veg | Min. | Opt Range | Opt | Max |
|---|---|---|---|---|
| Parsnip | 35 | 50-70 | 65 | 85 |
| Spinach | 35 | 45-75 | 70 | 85 |
| Lettuce | 35 | 40-80 | 75 | 85 |
| Onion | 35 | 50-95 | 75 | 95 |
| Celery | 40 | 60-70 | 70 | 85 |
| Pea | 40 | 40-75 | 75 | 85 |
| Parsley | 40 | 50-85 | 75 | 90 |
| Carrot | 40 | 45-85 | 80 | 95 |
| Cauliflower | 40 | 45-85 | 80 | 100 |
| Radish | 40 | 45-90 | 85 | 95 |
| Cabbage | 40 | 45-95 | 85 | 100 |
| Beet | 40 | 50-85 | 85 | 85 |
| Chard, Swiss | 40 | 50-85 | 85 | 95 |
| Turnip | 40 | 60-105 | 85 | 105 |

# SOIL TEMPERATURES

- Soil Temp – NOON – 1-2 inches deep
- Warm crop germination temperatures
- 70-90° F.

| Veg | Min. | Opt Range | Opt | Max |
|---|---|---|---|---|
| Asparagus | 50 | 60-85 | 75 | 95 |
| Tomato | 50 | 70-95 | 85 | 95 |
| Corn | 50 | 60-95 | 95 | 105 |
| Bean | 60 | 60-85 | 80 | 95 |
| Bean, Lima | 60 | 65-85 | 85 | 85 |
| Pepper | 60 | 65-95 | 85 | 95 |
| Eggplant | 60 | 75-90 | 85 | 95 |
| Pumpkin | 60 | 70-90 | 90 | 100 |
| Muskmelon | 60 | 75-95 | 90 | 100 |
| Cucumber | 60 | 60-95 | 95 | 105 |
| Squash | 60 | 70-95 | 95 | 100 |
| Okra | 60 | 70-95 | 95 | 105 |
| Watermelon | 60 | 70-95 | 95 | 105 |

# GROWTH RESPONSE TO TEMPERATURE



# TEMPERATURES AND GROWTH: COOL SEASON VEGIES

| Temperatures (°F) | | | |
|---|---|---|---|
| Optimum | Minimum | Maximum | Vegetable |
| 55–75 | 45 | 85 | Chicory, chive, garlic, leek, onion, salsify, scolymus, scorzonera, shallot |
| 60–65 | 40 | 75 | Beet, broad bean, broccoli, Brussels sprouts, cabbage, chard, collards, horseradish, kale, kohlrabi, parsnip, radish, rutabaga, sorrel, spinach, turnip |
| 60–65 | 45 | 75 | Artichoke, cardoon, carrot, cauliflower, celeriac, celery, Chinese cabbage, endive, Florence fennel, lettuce, mustard, parsley, pea, potato |

# TEMPERATURES AND GROWTH: WARM SEASON VEGIES

| Temperatures (°F) | | | |
|---|---|---|---|
| Optimum | Minimum | Maximum | Vegetable |
| 60–70 | 50 | 80 | Lima bean, snap bean |
| 60–75 | 50 | 95 | Sweet corn, Southern pea, New Zealand spinach |
| 65–75 | 50 | 90 | Chayote, pumpkin, squash |
| 65–75 | 60 | 90 | Cucumber, muskmelon |
| 70–75 | 65 | 80 | Sweet pepper, tomato |
| 70–85 | 65 | 95 | Eggplant, hot pepper, martynia, okra, roselle, sweet potato, watermelon |

# TEMPERATURE MANAGEMENT

- **Cold outside – cloudy**
  - Minimal ventilation
- **Cold outside – sunny**
  - Moderate ventilation
- **Cool outside – cloudy**
  - Moderate ventilation
- **Cool outside – sunny**
  - Good ventilation
- **Warm outside – cloudy**
  - Good ventilation
- **Warm outside – sunny**
  - Full ventilation
- **Hot outside**
  - Full ventilation
  - Shade.

# SPACE MANAGEMENT

17 ½ Feet Wide
3 Feet Between Posts
1 ½ inch PVC pipe is slipped over each T-post

# SPACE USE

| |
|---|
| Outer Wall |
| medium height plants 1 row |
| Walkway |
| trellised plants, 1 row |
| Walkway |
| trellised plants, 1 row |
| Walkway |
| trellised plants, 1 row |
| Walkway |
| trellised plants, 1 row |
| Walkway |
| medium height plants 1 row |
| Outer Wall |

# FOUR PLANTING BEDS
# EIGHT ROWS OF VEGETABLES

| | |
|---|---|
| | Peppers planted 1 ½ feet apart in the row = 22 plants per row<br>Two rows, one foot apart; rows offset |
| | Side Walkway |
| | Tomato plants spaced two feet apart in the row = 16 plants per row<br>Two rows, spaced two feet apart |
| | Center Walkway |
| | Tomato plants spaced two feet apart in the row = 16 plants<br>Cucumber plants spaced one foot apart in the row = 32 plants |
| | Side Walkway |
| | Peppers planted 1 ½ feet apart in the row = 22 plants per row<br>Two rows, one foot apart; rows offset |

# TOMATO PLANTS ON TWO-FOOT CENTERS

# GROW VERTICALLY

- Get more out of each square foot of space
- Simple trellis
- Pruning and training of plants

# TOMATO PLANTS TRAINED TO "Y" SHAPE

Main Stem

The sucker in the leaf axil below the first blossom cluster was retained to form the second arm of the "Y".

All other suckers were removed as the vine grew.

# CLIPS HOLD PLANTS TO TWINE

Plant clips were purchased from a greenhouse supply outlet.

- Inexpensive, easy to use
- Supported plants without damaging stems

One clip was used near every fruiting truss on tomatoes.

# CUCUMBER VINE TRAINING

## MANAGING WHAT GROWS IN THE LEAF AXIL

Plants were trained to a single stem:

- Soil to 18 inches tall – All side shoots, tendrils and blossoms were removed from the leaf axils.
- From 18-48 inches tall – Tendrils and side shoots were removed, blossoms were retained.
- 48+ inches tall – Tendrils were removed; blossoms were retained, side shoots were pinched back to 2 nodes.
- Tendrils and vegetative buds were removed from the leaf axils of side shoots; blossoms were retained.

# CUCUMBER VINE TRAINING

## MANAGING WHAT GROWS IN THE LEAF AXILS

At each leaf axil there is:

- A leaf
- A tendril
- A vegetative bud that will develop into a secondary stem (side shoot)
- One or more blossom(s)

# TRELLISING – USU EXTENSION ON YOUTUBE

**Google** Patterson Small Farms practices

# YIELD

## Tomatoes

- First fruit was harvested on June 21.
- Over 1000 lbs of tomatoes harvested from 144 square feet of planted area.  Yield might have been higher if varieties had been selected specifically for yield potential.

## Cucumbers

- Over 400 lbs of cucumbers harvested from 48 square feet of planted area.

## Peppers

- Over 450 lbs of peppers harvested from 170 square feet of planted area.

# GROWING CALENDAR

Consider how much protection you can give

My experience

- Tender plants — trans mid- to late-April
- Cool season — trans late-Feb or direct seed

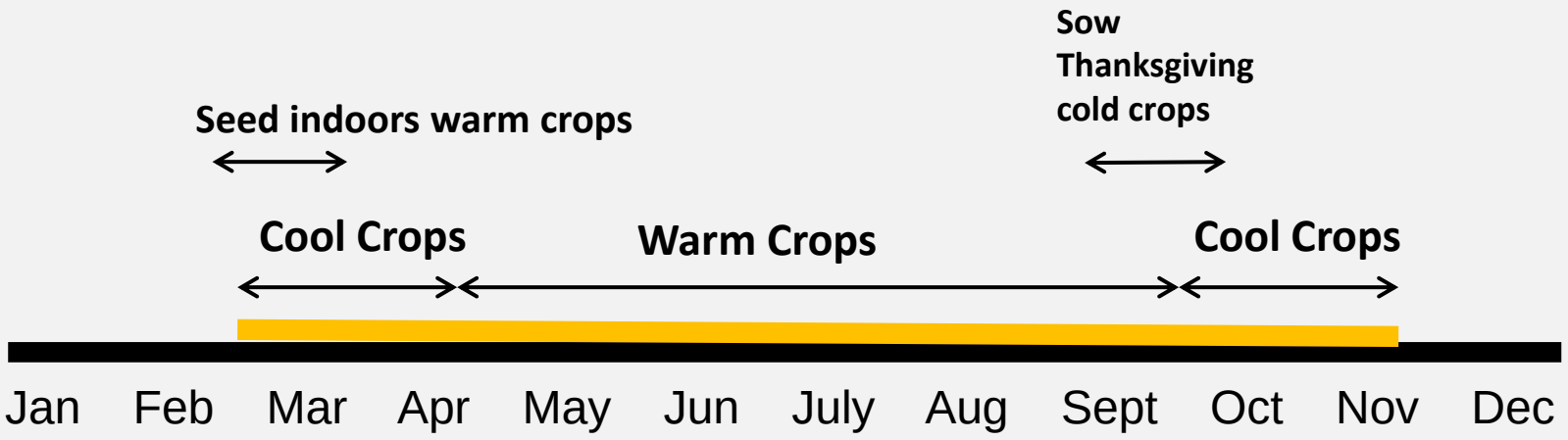
# GROWING CALENDAR

| | |
|---|---|
| Eggplants | 8-10 weeks before trans |
| Peppers | 8 weeks before trans |
| Tomatoes | 6 weeks before trans |
| Cucumbers | 4 weeks before trans |
| Squash | 4 weeks before trans |
| Melons | 4 weeks before trans |

# THE YEARLY GROWING CALENDAR

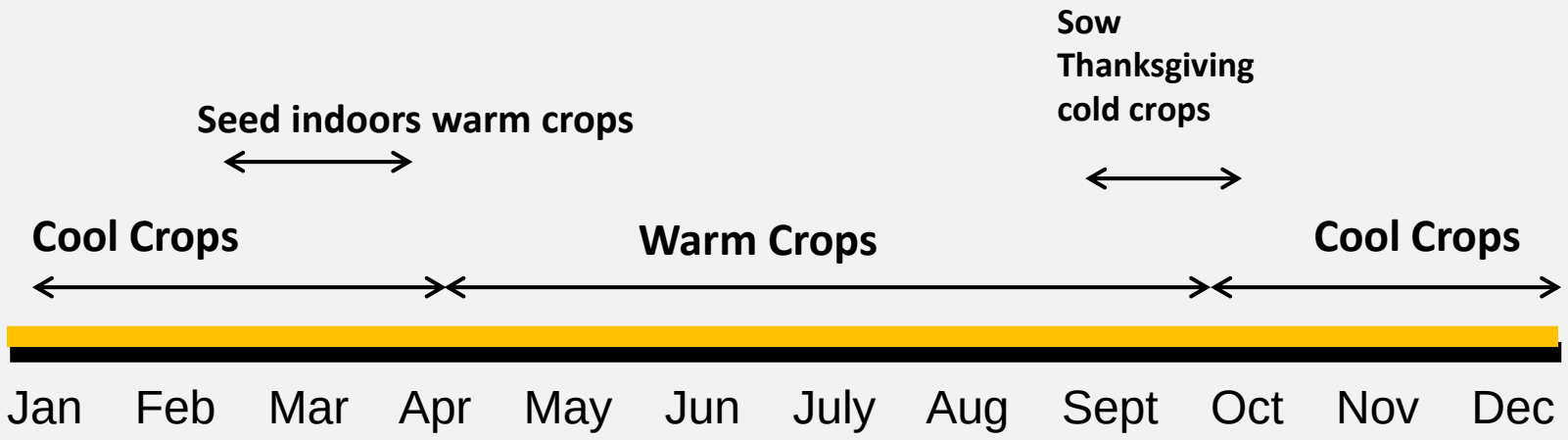
- Mellow Management: Season Extension
  - Small scale growers
  - Backyard gardeners

*May be overlap in cool and Warm crops depending on when they Reach maturity.

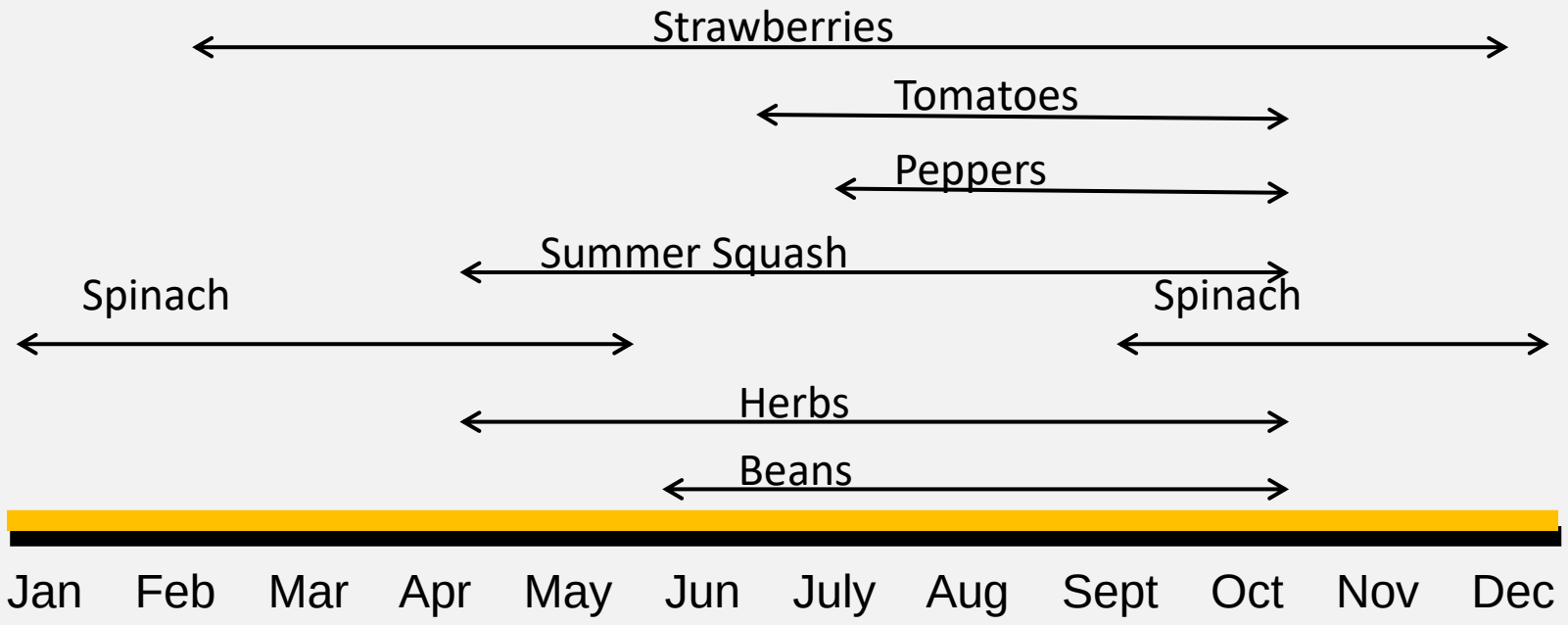


# THE YEARLY GROWING CALENDAR

- Intense Management: Year round production
  - CSA /Farm operations
  - Large family



# HARVEST CALENDAR



# POPULAR HIGH TUNNEL CROPS

## (BUT REALLY, ALMOST EVERYTHING GROWS BETTER IN A TUNNEL)

Tomato

Pepper

Melons

Squash

Strawberry

Raspberry

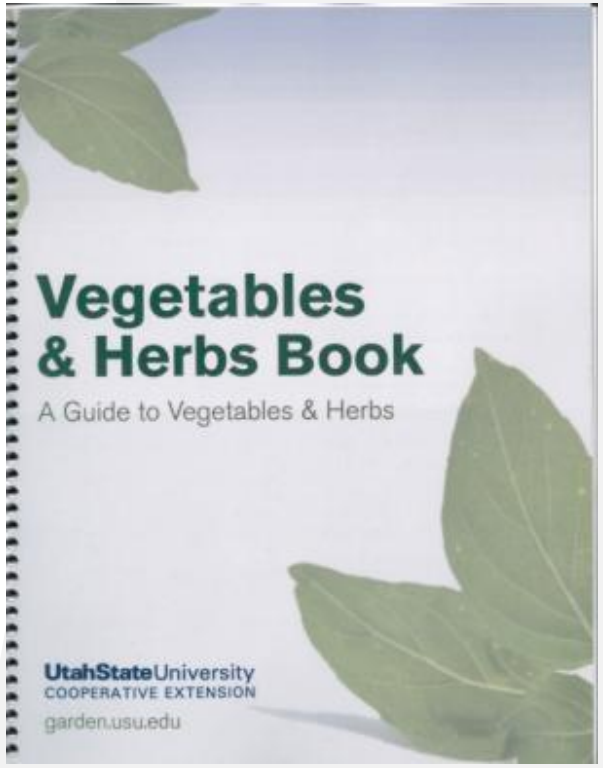
Lettuce

Spinach

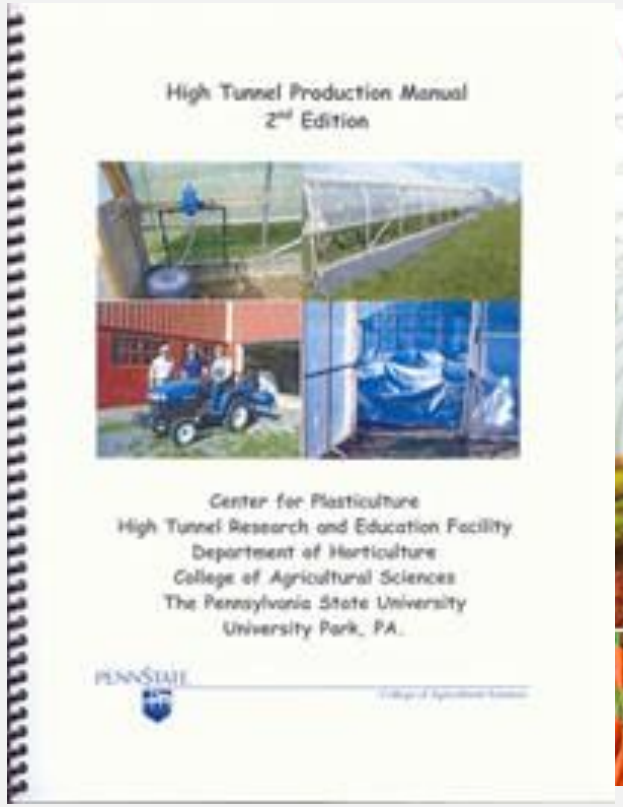
# SUMMARY:

- Covers and structures increases temperatures during the day so plants start growing earlier, and will fruit sooner.
- Ventilation and cooling is <u>critical</u>
- Covers and structures protect plants a little at night, but plants can still freeze

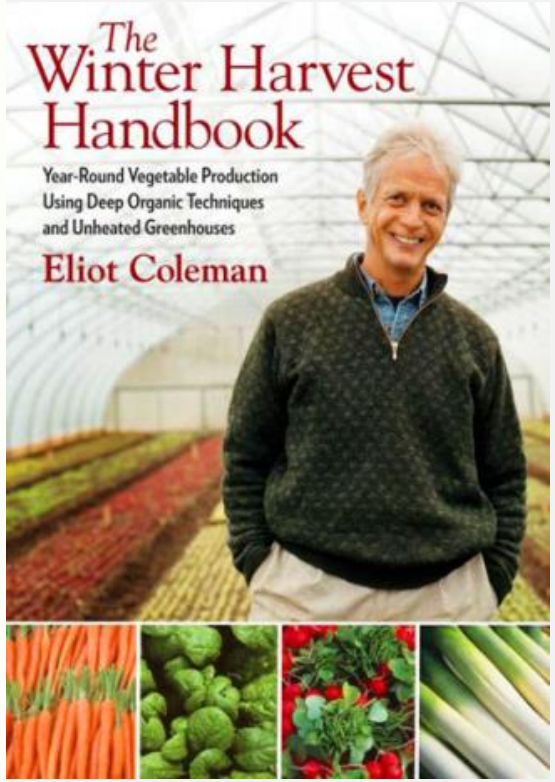
# OTHER RESOURCES




Tunnel.usu.edu




Penn State High Tunnel Production Manual




Eliot Coleman

# HTTP://TUNNEL.USU.EDU

Utah Growing Guides:

Strawberry

Raspberries

Tomato

Lettuce

Spinach

Squash

**Enterprise Budgets $:**

Strawberry

Raspberries

Tomato

Squash

**Cornell:** http://www.hort.cornell.edu/hightunnel

**Penn State:** http://extension.psu.edu/plants/plasticulture

QUESTIONS?