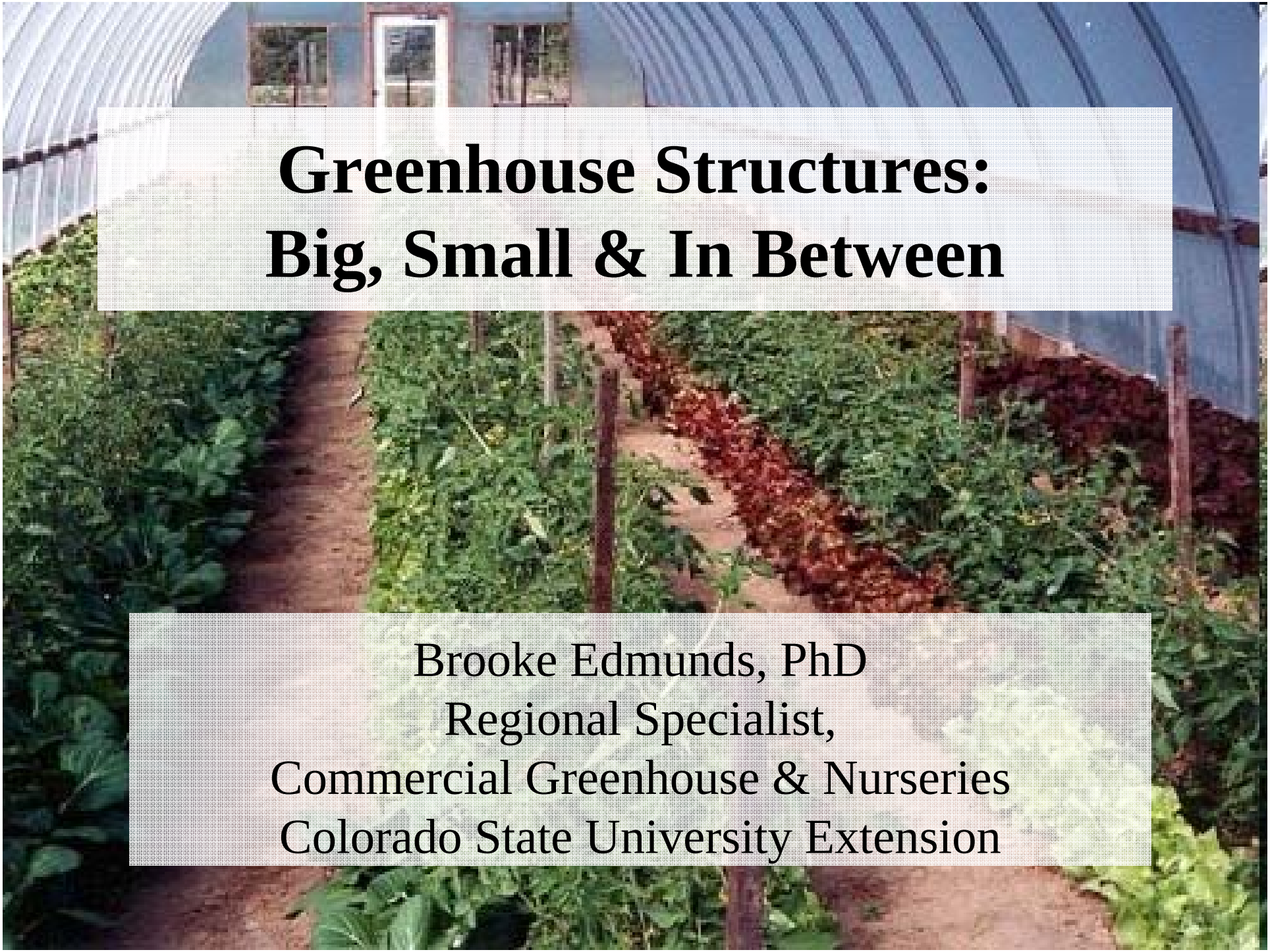


Greenhouse Structures: Big, Small & In Between

Brooke Edmunds, PhD
Regional Specialist,
Commercial Greenhouse & Nurseries
Colorado State University Extension

What are your needs?

- Commercial or home-scale production?
- Year-round production?
- Season extension?
- Sunspace (addition to house)?
- Kitchen herb production in winter?

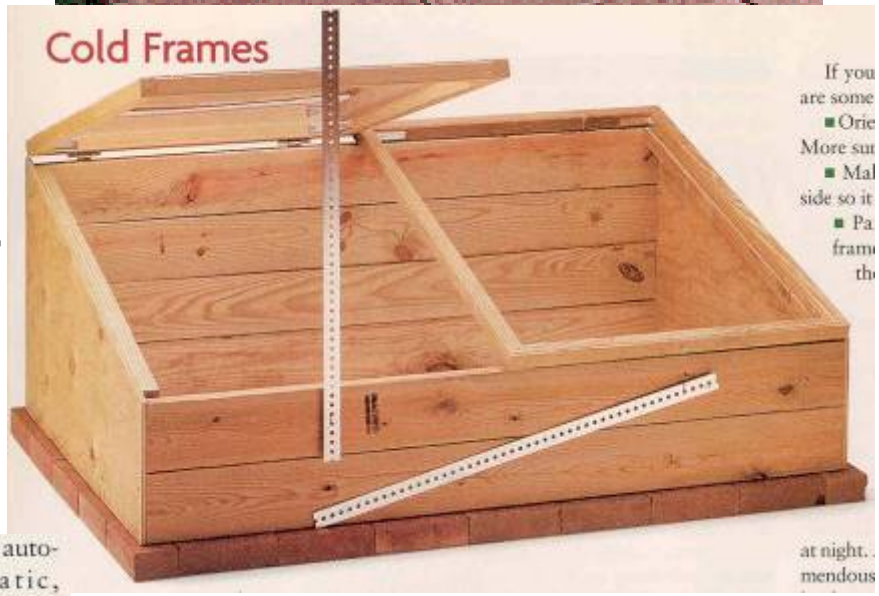
- **A greenhouse does not have to be expensive**
- **BUT it must provide the proper environment for growing plants!**

Greenhouse Types

- Cold frames
- Window design
- Attached/lean to
- Free standing
  - Traditional
  - Hoophouse

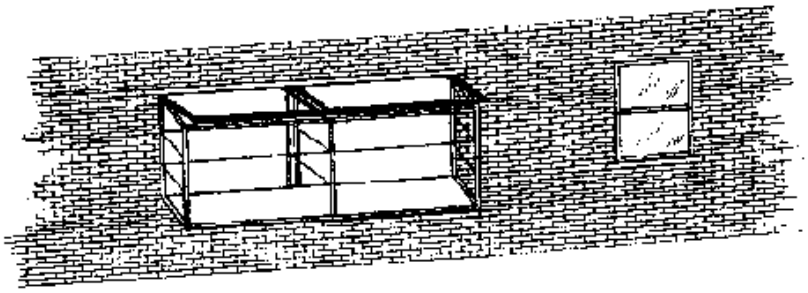
Cold Frames

- Used to warm the soil and as “mini greenhouse”
- Orient frame to run east to west
- Make the frame lower on the south side to catch more sun
- Vent



Window Greenhouses

- Advantages
  - Good for limited space or limited time
  - Possibly- more environmental control than windowsill
- Disadvantages
  - Temperature swings
    - Heat up very quickly
    - Cool down very quickly
  - Fill up very quickly



A window-mounted unit extends a house's growing space.

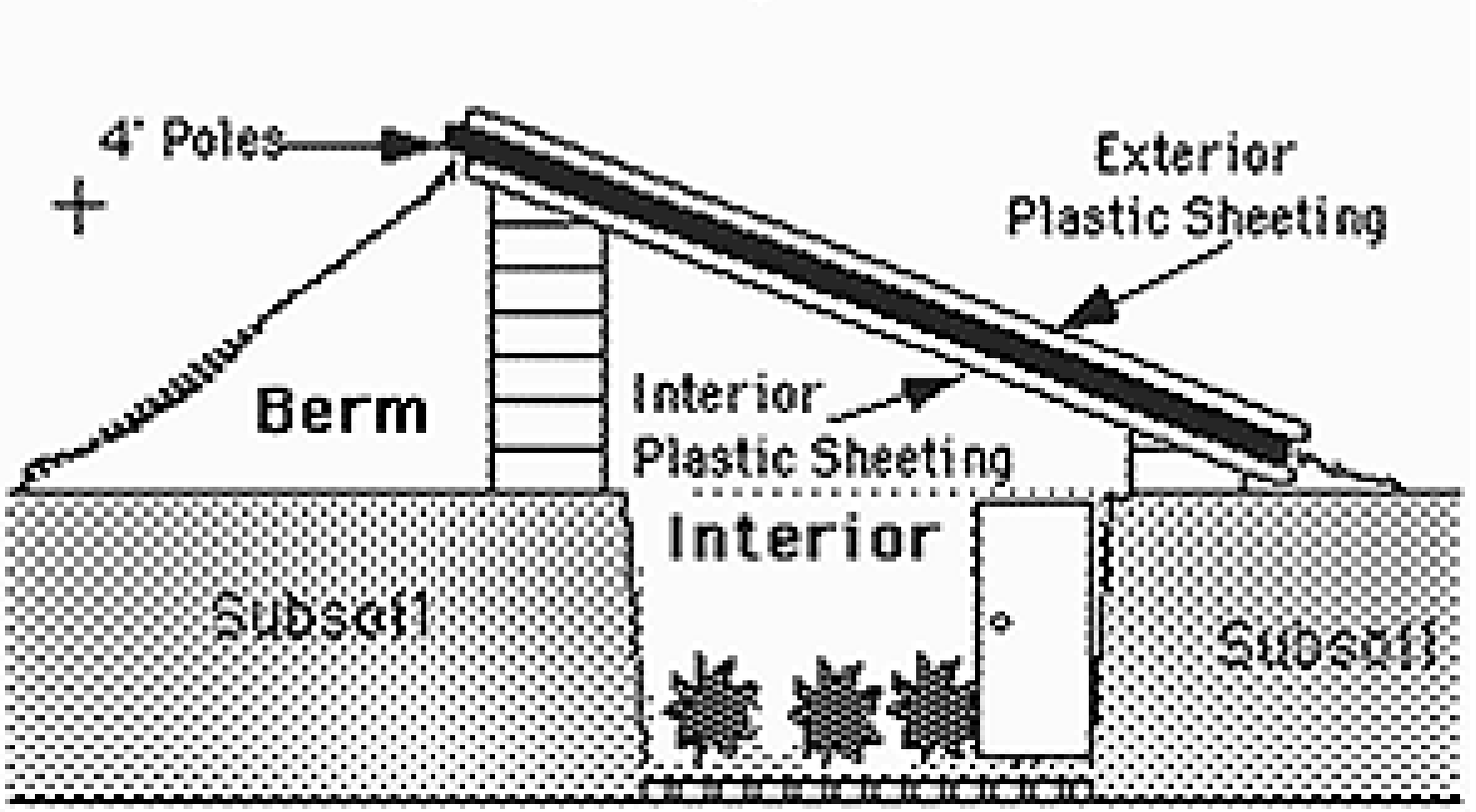
Figure 2D Different types of greenhouses allow many options

Lean-To Greenhouses

Lean-To Greenhouses

- Advantages
  - Most common
  - Least expensive
  - Easy access
  - Insulation for the house/garage
  - Extended living space
- Disadvantages
  - Size limitation
  - Moisture
  - Summer overheating
  - Dirt and insects

Pit Greenhouse



http://benson.byu.edu/Publication/BI/Lessons/volume22/pankar.html

Pit Greenhouses

Temperature is fairly constant

Cool in summer/warm in winter

More expensive to build

Drainage is very important

Free Standing Greenhouses

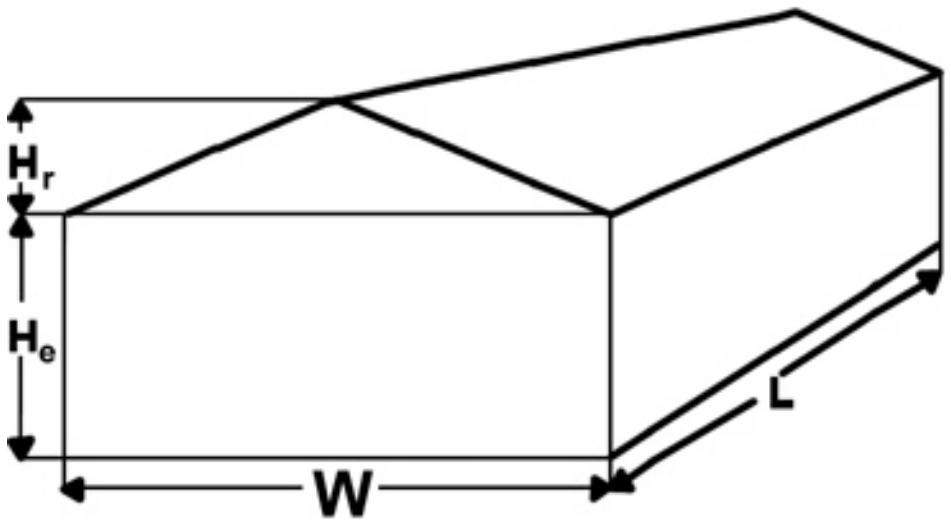
- Advantages
  - More flexibility
  - Easy expansion
  - Private getaway
- Disadvantages
  - Access
  - Utilities
  - Energy
  - Expense

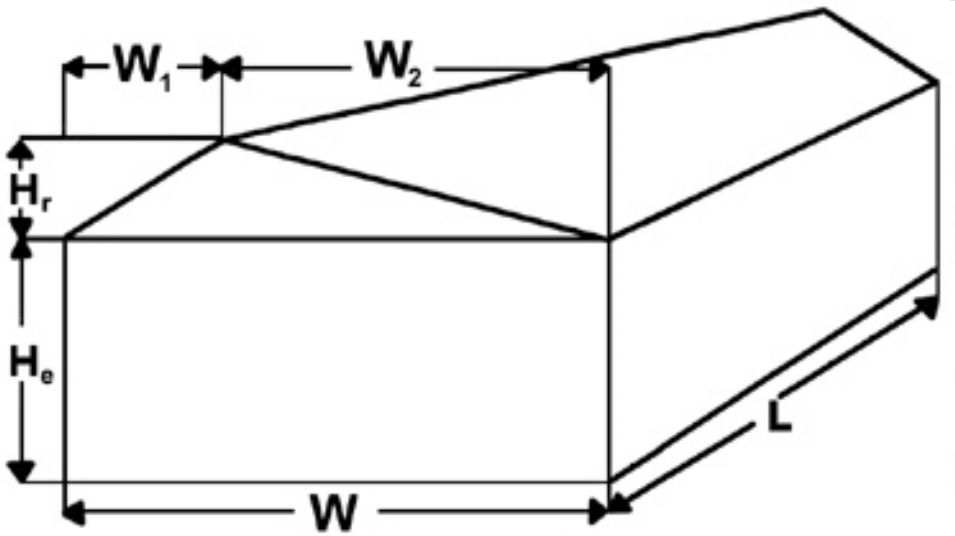
Photo: www.greenhousemegastore.com

Styles

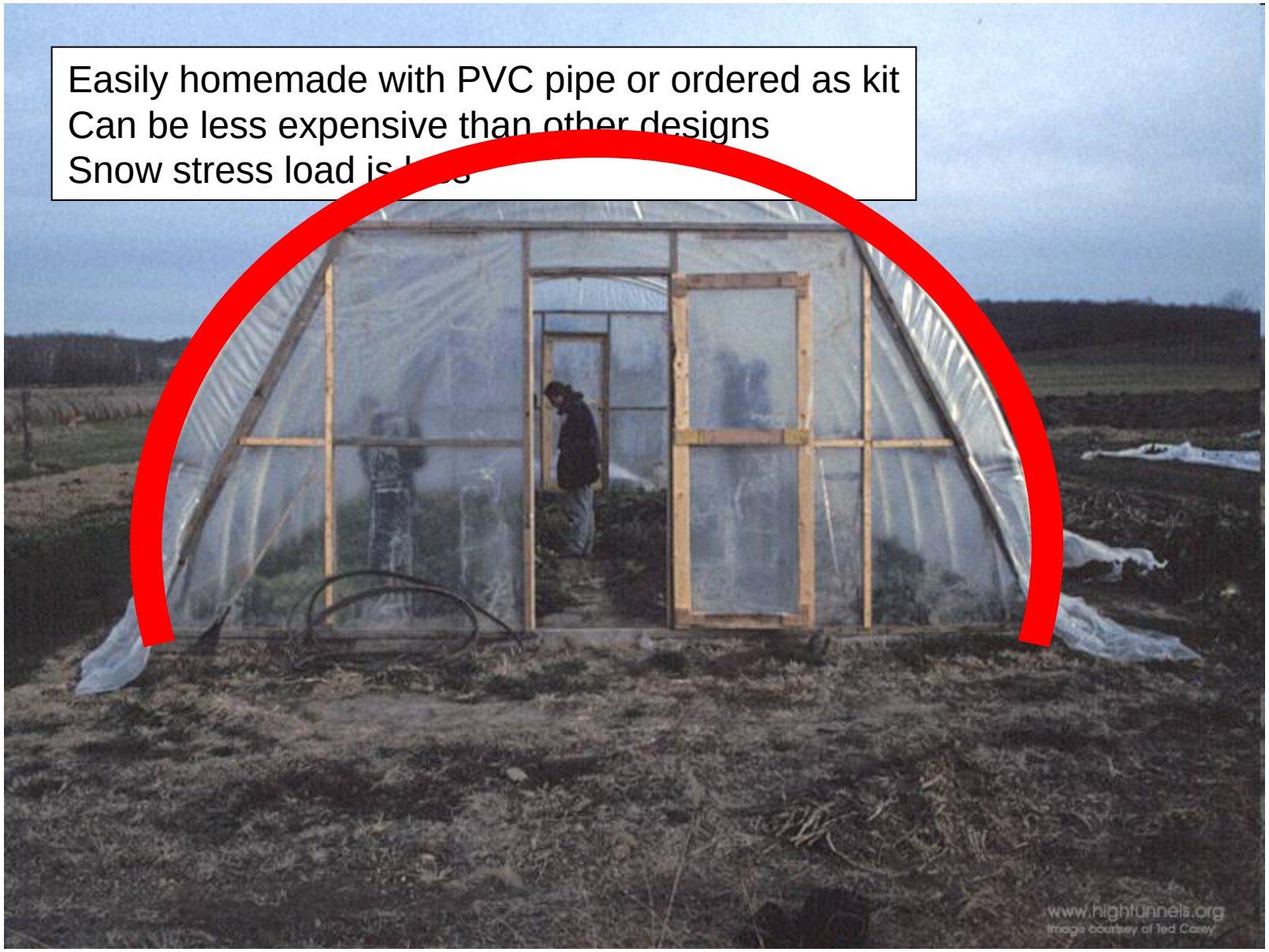
- Even span
- Uneven span
- Quonset
- Gothic arch
- Dome shaped

Even & Uneven Span





Quonset Style



Gothic Style

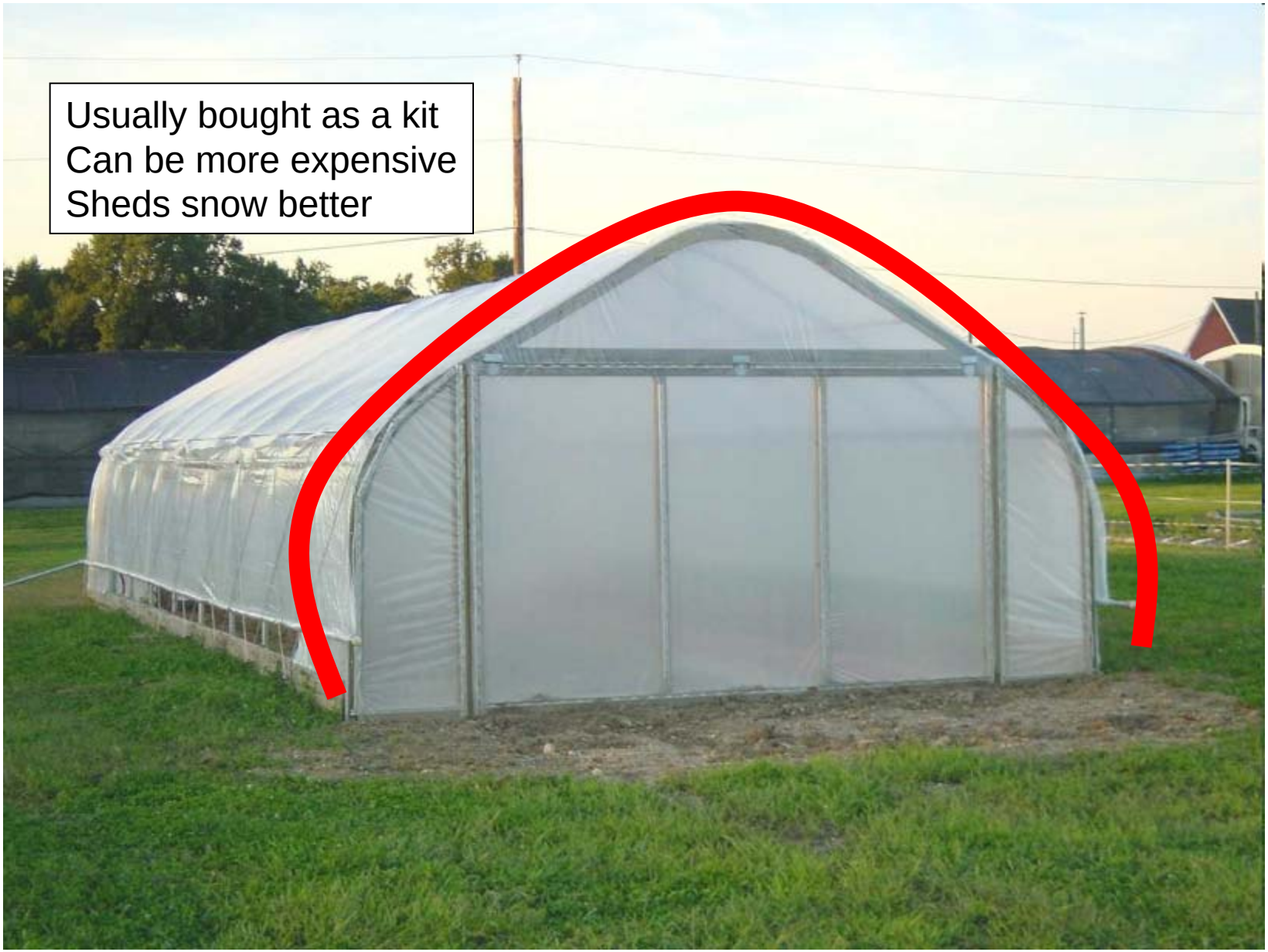


Photo: rutgers.edu

Dome Shaped Greenhouse

- Start at $5000 for 12’ diameter
- Water tank used for passive heating

http://www.geodesic-greenhouse-kits.com

Traditional vs. Hoophouse

- Traditional greenhouse
  - Permanent structure
  - Foundation & concrete floor
  - Fuel-based heating & cooling
  - More expensive
- Hoophouse
  - Temporary structure
  - Plant direct in ground
  - Passive heating common
  - Less expensive

Costs

- Hoophouse estimated at \$3-4.39/ft^2 for materials
- Compare to traditional greenhouse
  - \$4.65-18.58/ft^2 for materials

Depends on your design and material choices

Traditional Framing Materials

- Frame
  - Supports the glazing
  - Hanging plants?
  - Must withstand snowload & wind
  - Limited shading
- Materials
  - Steel
    - Galvanized after its bent
  - Aluminum alloys
    - Easily bent to fit glass
  - Wood
    - Easiest for do-it-your-selfers

Glazing – which to choose?

- Glass
  - Common for home greenhouses
  - Double pane reduces heat loss
  - Can shatter
    - Hail
- Polycarbonate
  - New material
  - More and more commercial and hobby GH are moving towards this
  - Some hail resistance
  - Lighter in weight than glass
    - Less structural framing

Glazing – which to choose?

- Fiberglass (FRP)
  - Can yellow
  - Being replaced by polycarbonate

Heating

- Fuels:
  - Coal
  - Fuel oil
  - Natural gas
  - Alternate-pellets, corn, etc
- Boiler driven hot water heating
- Steam heat
- Distributed by fans and/or poly tubes

Cooling-Fan & Pad

Cooling-Fog & Mist

Cooling-Swamp Cooler

- Portable version of fan & pad
- Smaller greenhouses

High Tunnel/Hoophouse

www.socolofskyfarms.com

What is the difference between a high tunnel and a hoophouse?

- Terms sometimes interchangeable
- High tunnels-single layer of poly
- Hoophouse-double layer of poly
  - Inflated with fan
  - Better insulation
  - More expensive? (double poly)

Hoophouses

- Temporary structure
  - Frame
  - Covered in polymer plastic film
- Crops grown in ground ~usually~
  - Many other uses
- Typically unheated
- Economic alternative to true greenhouse structures

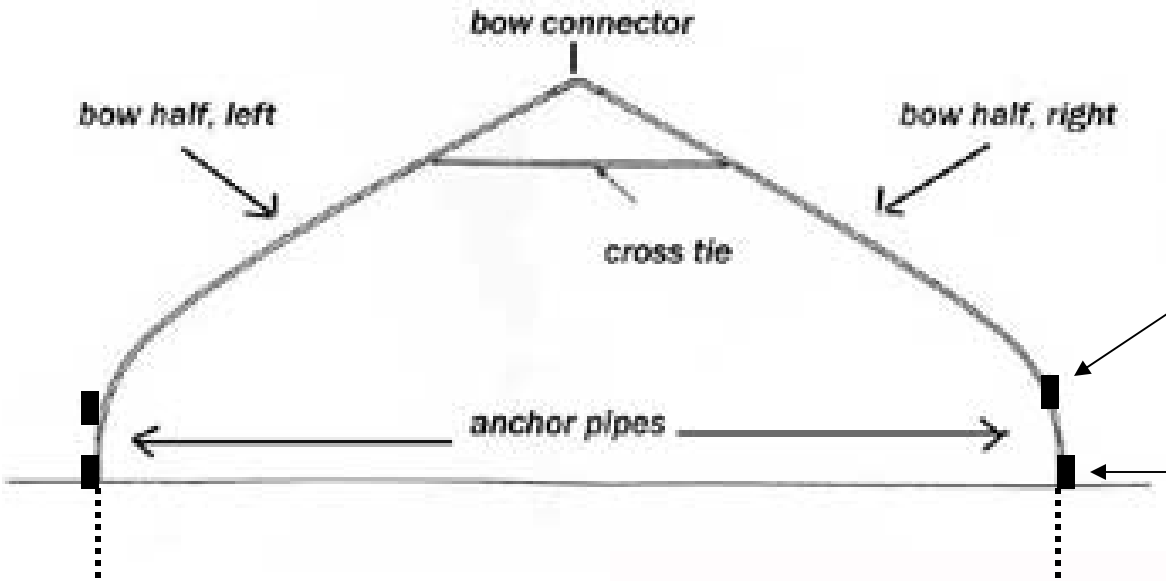
Frame materials

- PVC
- Aluminum
- Galvanized steel
- Wood for hip and baseboards
  - Don’t use treated wood for baseboards if organic!

Plastic covering

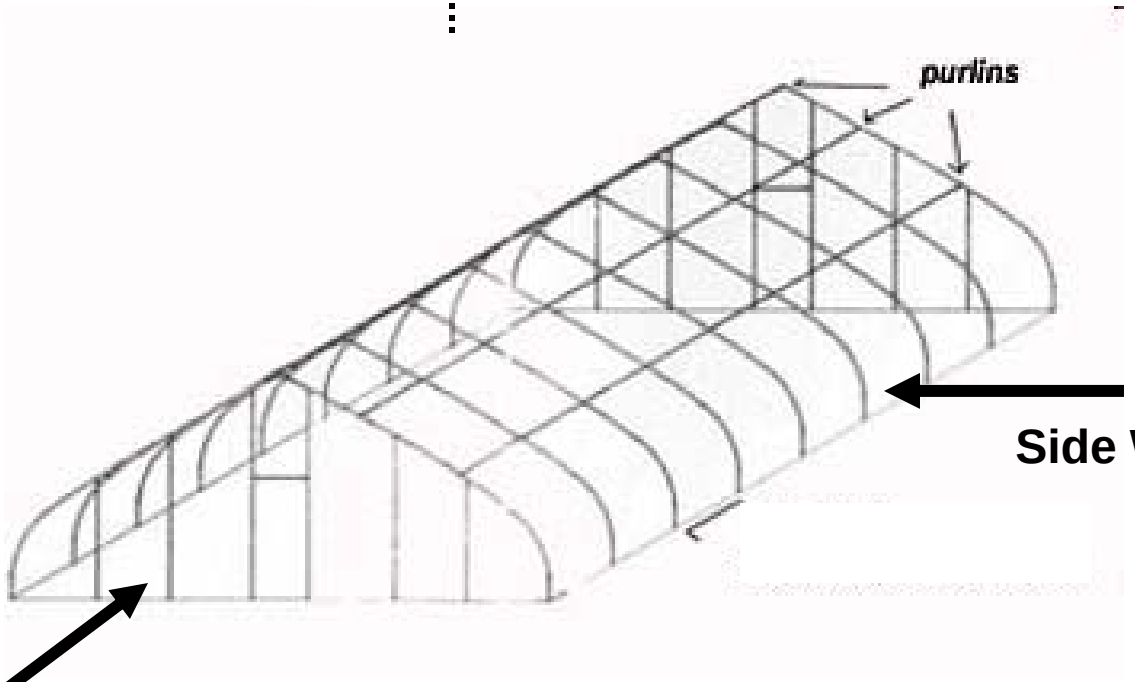
- Polyethylene film
- 6 mil thickness is common
- UV stable film-lasts 2-4 years
- Options
  - Infrared radiation absorbing (holds night heat)
  - Anti-drip (reduces condensation)
  - Specialized for lightwave transmission

Frame Terminology



Hip board

Base board



Side Wall

End Wall

Figures: Rodale Institute

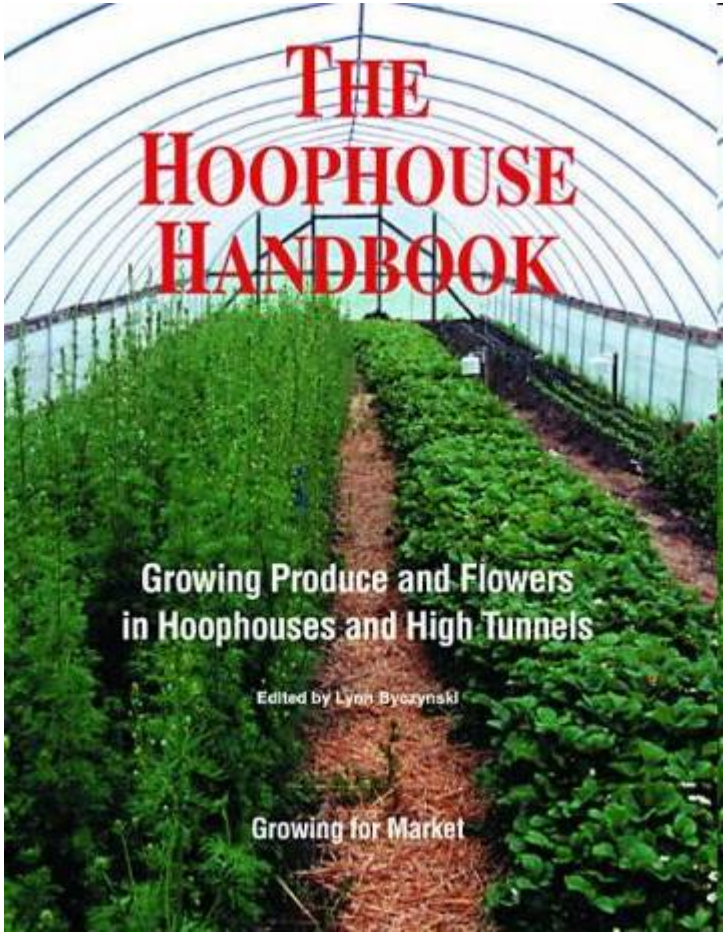
Basic steps to building hoophouses

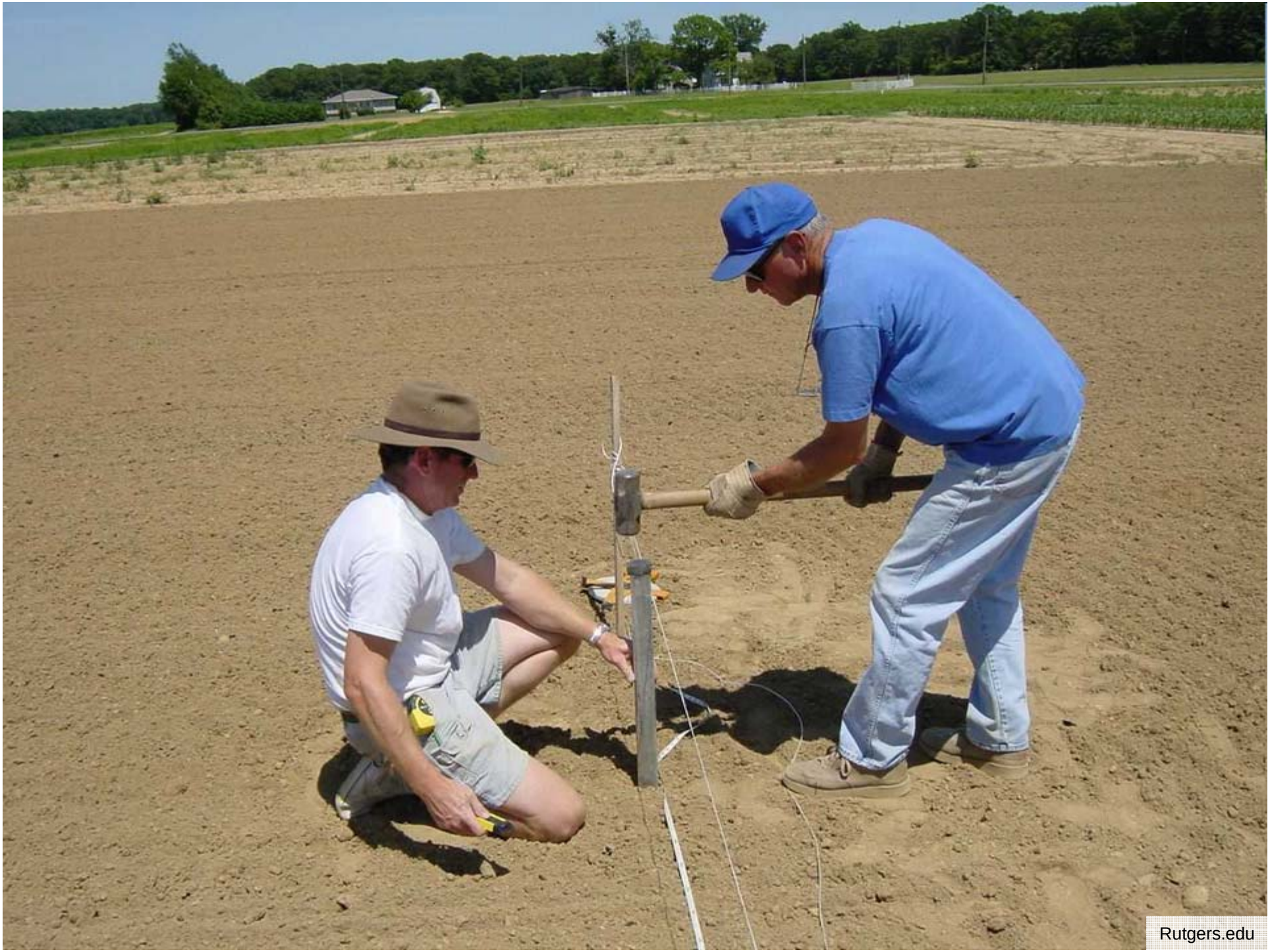
1. Lay out the footprint
2. Square the ‘foundation’
3. Set ground posts (12-24 inches)
4. Assemble hoops & place on ground post
5. Attach purlins
6. Attach hip boards & base boards
7. Construct & add end walls
8. Attach plastic

Putting up the hoophouse!

- Pick a calm day!
- Ask your friends & neighbors to help!

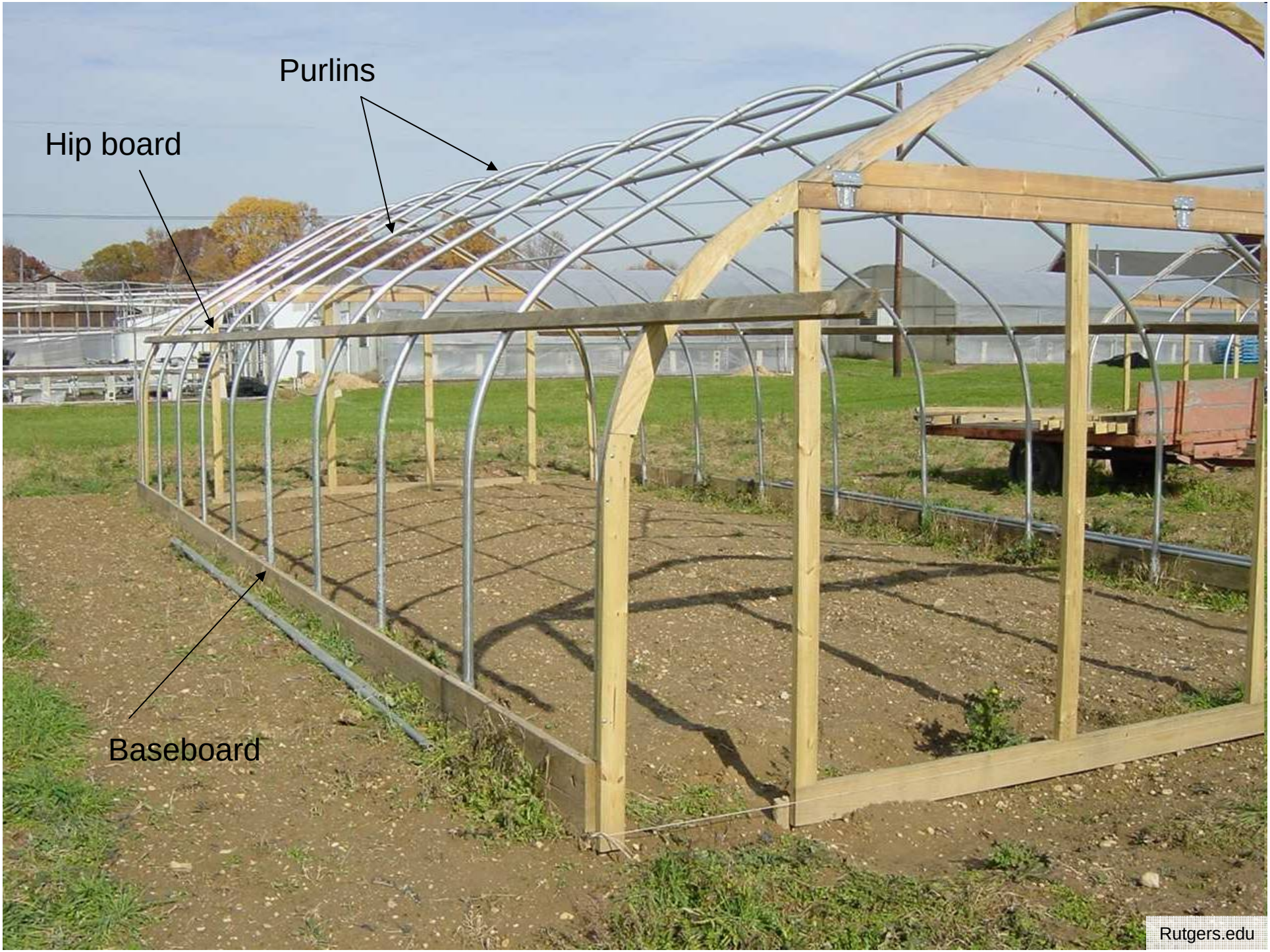
- Recommended reading:
  - The Hoophouse Handbook
  - By Lynn Byczynki
  - Available at growingformarket.com




Rutgers.edu


NEW HOLLAND
Rutgers.edu


Rutgers.edu


Purlins
Hip board
Baseboard
Rutgers.edu


Aluminum channels where plastic is fastened
Rutgers.edu


Wiggle wire
Rutgers.edu


Cross ties
Rutgers.edu

Hoophouse size and shapes

- Very flexible sizes
  - Do it yourself or buy kits
- Shapes Quonset & Gothic
- End wall options
- Side wall options

http://www.flickr.com/photos/localfoodproject/3148389612/sizes/l/

flickr.com/photos/tinyfarm/2274358232/

Hoophouse ventilation/cooling

- End wall designs
- Roll up side walls
- Fans

- Manual
  - Require labor
- Automatic systems
  - Require electricity & equipment investment


Tube motor to automatically open & close side walls
Rutgers.edu

Ventilation Options: Roll up side walls

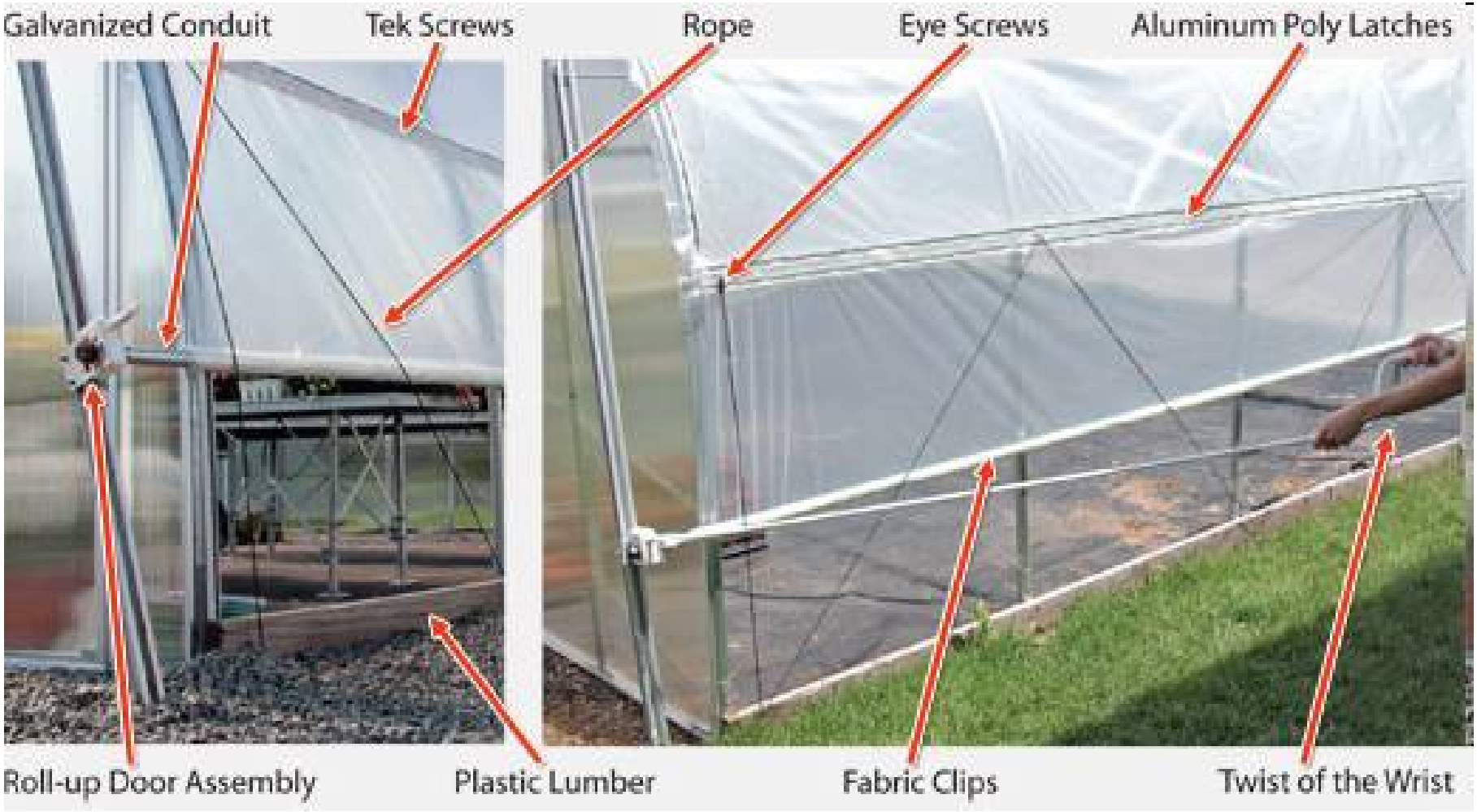


Photo: growerssupply.com

Hoophouse Heating

Most hoophouses are passive heated

- Double poly wall-inflate with fan
- Water barrels
- Inner row covers add another 4+ degrees
  - Spun-bonded fabric cover over mini-hoops
  - Don’t let foliage touch row cover-frost damage

Emergency heat?

- Propane heaters
- Alternative fuel heaters

Black Barrels filled w/ water release heat during night

Pros:

- Cheaper heat

Cons:

- Still an added expense
- Block light
- Reduce useable space

Photo: High Plains/Midwest Ag Journal

Row Covers

Spun-bonded Fabric

Hoops

Photo: MN Institute for Sustainable Ag

Photo: MN Institute for Sustainable Ag

Basic steps to greenhouse construction

- Pick a suitable site
- Decide on size and design
- Prepare the site
- Set up the house
- Prepare for use!

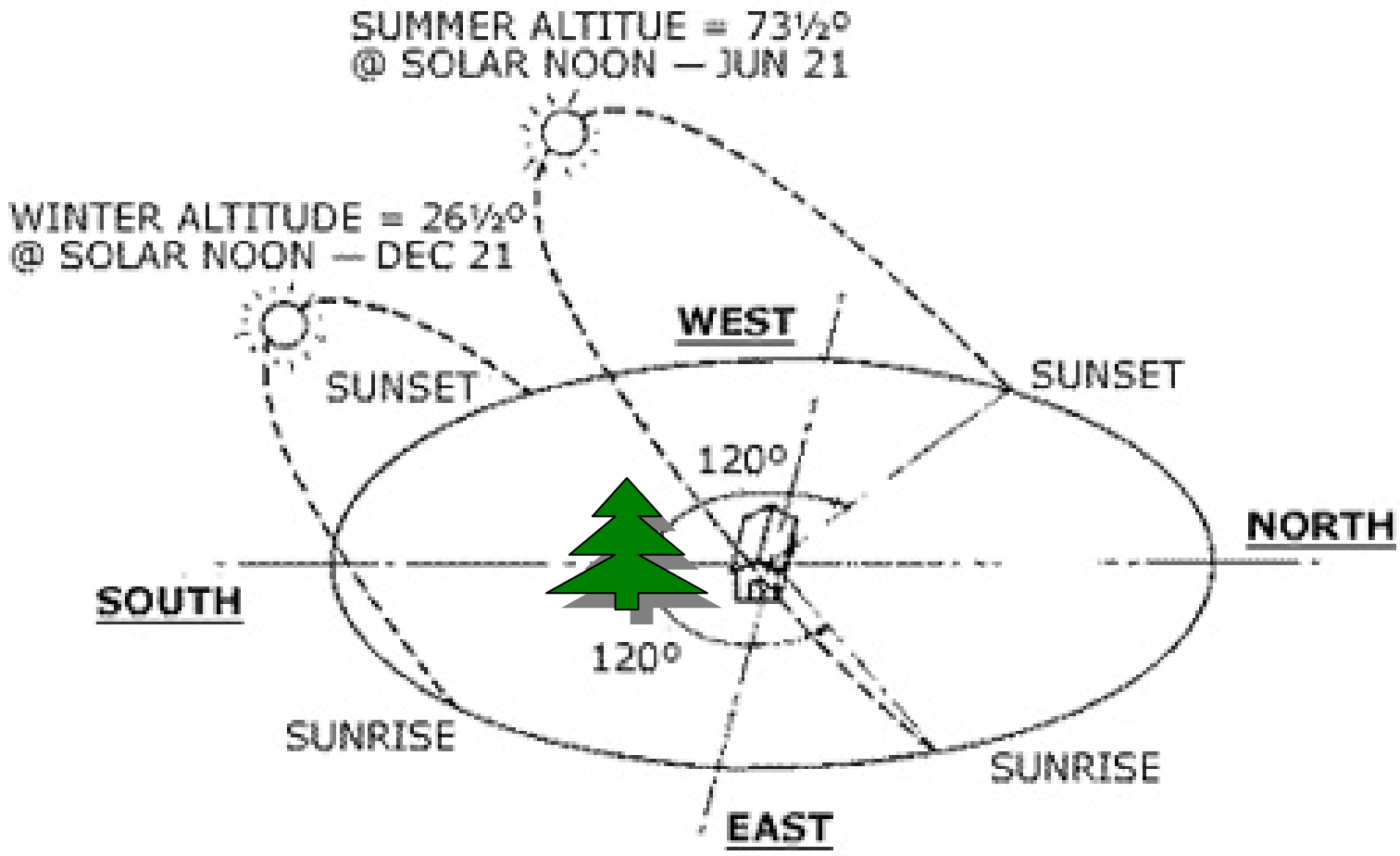
Suitable site selection

- Light & winter shading
- Prevailing wind direction
- Drainage
- Soil preparation
- Distance to utilities
  - Irrigation
  - Electricity
  - Roads

Light

- Know the sun's path in all seasons
- Why?
  - Consider winter shadows
- How?
  - Sun path chart
  - Available online
  - Many different formats
  - Same concept

Know the sun's path in all seasons



Solar path at 40° north latitude

Figure: Alward, Ron, and Andy Shapiro. 1981. Low-Cost Passive Solar Greenhouses. National Center for Appropriate Technology, Butte, MT. 173 p.

Site Preparation is key!

Start a year in advance if possible:
Cultivation to remove weeds
Cover crops to increase nutrient levels
Sheet composting
Add organic matter

Photo: Western Mountain Alliance

Level site is key: both for drainage once crop is established **and** for proper construction of hoophouse!

Consider rainfall:

When it does rain-where will it go?

Drainage ditch needed?

Irrigation

- Overhead
- Mist
- Drip/trickle

How to decide?

Drip irrigation

- Most efficient
- Avoids problems with some foliar disease
- Easy to install
- Dry between rows (less muddy!)

- Soaker hose is alternative for closely spaced crop