

Greenhouse Structures and Operation

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Greenhouse Site Selection

- 5% slope or less (costs)
- Good drainage in and around structure
- Ability to contain runoff
 - Chesapeake Bay Regs – by 2017 containment ponds
- Availability of high quality water in sufficient quantities
- Availability of services (power source)
- Availability of labor



Greenhouse Site Selection – Intended Use

- Retail
 - Regulations, parking, market, accessibility
- Wholesale
 - Access, fewer regulations
- Part-time operation (seasonal)
- Year-round production
- Room for expansion
- Land use regulations and building codes
- Land use predictions



Irrigation Water Quality

- Get an **irrigation** water test
 - pH: 5.4 to 6.8
 - Alkalinity: 60 to 100 ppm bicarbonates
 - EC (electrical conductivity)
 - less than 0.75 mS/cm
 - Specific ion limitations:
 - Na or Cl – 70 ppm
 - B – 0.5 ppm; F – 1.0 ppm
 - Mg – Ca: ratio 5 Ca to 1 Mg (ppm)
- Refn: Ch. 7A in GOCP manual (cd)

Greenhouse Orientation

- Below 40N latitude (all of Virginia), the ridge should run north to south to minimize shadows
- Avoid light obstructions, trees, buildings
- Consider exposure, prefer south to south-west for longer days, more sunlight and heat

Quonset/Freestanding



- Most common greenhouse style in Virginia
- Allows maintenance of different growing conditions in different houses
- Relatively inexpensive
- With proper planning can easily expand over time

Great Diversity in Greenhouse...

- Size
- Style
- Components
- Cost



20' x 30' poly film house
\$4000



44 acres under glass
\$20+ million

Gothic Style

- The gothic style structure is designed specifically for wind and snow-load areas
- Example: XS Smith Storm King Greenhouse
 - Heavy duty materials



Gutter Connected



- Houses connected at gutters/sidewalls
- Open floor plan for ease of product and worker movement
- Various glazings

Greenhouse Coverings (Glazing)

- Glass
 - Traditional, expensive, excellent light transmission, long life (25+)
- Fiberglass
 - Little used now, relative inexpensive, good life (10 – 15 yr), largely replaced by polycarbonate
- Polycarbonate
 - Newer materials, excellent light rigid, single walled or double walled for insulation, good life (10 -15 yr)

Open Roof Structures

- Natural ventilation
- Greater light intensity
- Shade curtain inside greenhouse
- Gutter connected
- Various glazings



Greenhouse Coverings con't.

- Double layer polyethylene
 - Good light transmission, ~4 yr life, inexpensive, when inflated has less heat loss than single layer glass, fiberglass or polycarbonate
 - Most common covering on quonset style houses
- Single layer polyethylene
 - Light transmission higher than double layer, <4 yr life, inexpensive, heat loss comparable to glass

Double Layer Polyethylene - inflated



Greenhouse Endwalls

- Insulate north ends
- Little light but lots of cold exposure



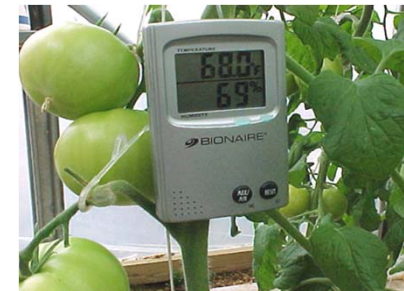
Greenhouse End Walls



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Greenhouse Automation

- Environmental controls
 - First to automate
 - Heat
 - Ventilation
- Irrigation
 - Rapid payback in automation



Greenhouse Environmental Control

- Aspirated thermostat
 - Aspirated with greenhouse air
 - Placed near plant canopy
 - Locate away from sidewalls, vents or doors
- Electronic thermostats are more efficient

Greenhouse Ventilation & Cooling

- Bringing in fresh air
- For temperature control
- For humidity control
- For fresh air
 - Carbon dioxide required for photosynthesis and growth
- Mechanical or passive



Greenhouse Heating Options

- Larger operations frequently use boiler systems
 - Steam or hot water
 - Finned pipes or in the floor
- Smaller operations
 - Unit heaters using propane, natural gas or oil
 - Some use of radiant heaters or in-ground hot water systems
 - Little use of electric heat (expensive)

Mechanical Ventilation

- Exhaust fans on one end of greenhouse
- Wall vent on other end
- Thermostatically controlled in stages for most efficient use



Mechanical Ventilation

- Wall vent filled with cooling pad
 - Ex. Kool cell pads (cellulose)



Natural Ventilation – Open Roof

- Gutter-connect



Natural Ventilation

- Passive ventilation systems; no need for expense of fans
- Open roof
- Roof vents
- Wall vents
- Roll-up sides
- Manual or automatic operation



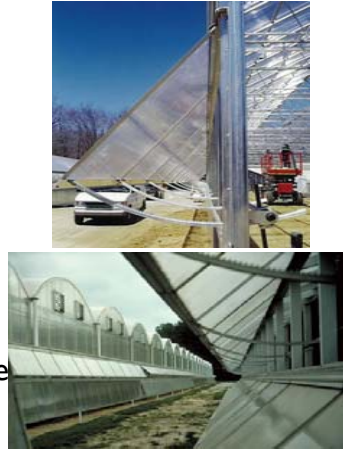
Natural Ventilation – Roof Vents

- Opening at the ridge, roof vents allow hot air which naturally rises to the peak to escape
- Causes a convection current in the house which draws cooler air into the structure from the sides and ends
- Roof vents can be covered in polyethylene or structured polycarbonate sheets
- Freestanding or gutter-connect



Natural Ventilation – Wall Vents

- Located on sidewalls or endwall as intake vents for fresh air – for roof vents or open roof
- May be used on endwalls as part of forced ventilation systems (exhaust fans)
- Typically use polycarbonate (rigid structure)



Natural Ventilation – Roll-up Walls



Natural Ventilation – Roll-up Wall Vents



Natural Ventilation – Roll-up Walls with Insect Screening



Shade Cloth and Thermal Screens

- For cooling and reducing light levels in the summer – inside or outside greenhouse
- For heat retention in the winter when inside gh
 - Rapid return on investment
- Individual or combination products



Air Ventilation and Circulation

- HAF fans should run whenever you are not ventilating



Air Circulation

- tubes
- Horizontal air flow (HAF) fans
- Keep leaf surfaces dry
- Temperature should be uniform through-out the greenhouse
- Reduces disease



Costs of Greenhouse Construction

- 30'x48' Greenhouse
- Double Poly Glazing
- Inflater Fan Unit
- Polycarbonate end walls
- Modine Gas Heating
- Exhaust Fans
- Motorized Inlet Shutters
- HAF Fans
- (Wet Wall optional)
- (Benches optional)

- \$11,995.00 Package
- \$6,800.00 Labor (57%)
- \$18,795.00 Total

2010 Estimate
1440 Square feet
\$13.05 per sq. ft. Cost
(Turnkey)



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For more information

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<http://www.hort.vt.edu/ghvegetables/>