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

Great Diversity in Greenhouse…

- Size
- Style
- Components
- Cost

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

Gothic Style

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

20’ x 30’ poly film house
$4000

44 acres under glass
$20+ million
Gutter Connected

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

Open Roof Structures

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

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
- PLASTIC
- FIBERGLASS
- POLYCARBONATE
- WOOD

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
Profitable Greenhouse Production of Local Produce
Joyce Latimer, Virginia Cooperative Extension

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

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 – Open Roof
- Gutter-connect

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 greenhouse
  - Rapid return on investment
- Individual or combination products

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

Air Ventilation and Circulation
- HAF fans should run whenever you are not ventilating

Costs of Greenhouse Construction
- 30’x48’ Greenhouse
- Double Poly Glazing
- Inflator 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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