Best Practices in Hydroponics and Sustainable Greenhouse Production

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Outline

• Review of Current Best Practices for Hydroponic Systems

• Snapshot of NJ’s Greenhouse Industry

• Review of EcoComplex’s Sustainable Greenhouse Activities
Burlington County Research and Demonstration Greenhouse
Hydroponics may be defined as the science of growing plants in soilless, inert media, to which is added a water soluble nutrient solution that contains all the essential elements needed by the plant for optimum growth and development.
Advantages of Hydroponics

- Can be utilized on most sites regardless of whether there is poor soil, contaminated soil or no soil at all (e.g. sites with marginal soil, rocky soil, brownfields, pavement or rooftop)
- Quick setup time, modular, lightweight and easy to relocate
- Lower startup costs than imported soil beds
- Adaptable to many types of crops and climates
- High yielding
- Water efficient – up to 90% reduction in water use vs outdoor field production
- Can be installed at a comfortable work height
- Can reduce labor inputs if designed properly
- Clean and sanitary
Common Types of Hydroponic Systems

• **Solid Media Based Systems** – These systems use inert materials such as rockwool, perlite, oasis block, coconut coir, sawdust, gravel or sand
  – Blocks and slabs
  – Loose media

• **Water Based Systems** – These systems usually start with a solid media seedling block and are transferred to water
  – Nutrient Film Technique (NFT)
  – Ebb and Flood
  – Deep Trough, Raceway, Raft or Floating

• **Other Variations**
  – Aeroponics (roots suspended in air)
  – Aquaponics (aquaculture and hydroponics)
Tomatoes in Perlite Bags
Tomatoes in Dutch or Bato Buckets with Perlite Media
Cucumbers in Rockwool Slabs

Photo by Neil Mattson, Cornell University
Orchids in Peatmoss
Peppers growing in Coconut Coir Slabs
Vertical Garden Displays in Foam
Ebb and Flood Benches with Rutgers Limited Cluster Tomatoes
Lettuce in Nutrient Film Technique (NFT) System

Photo by Neil Mattson
Cornell Univ.
NFT Hydroponic Fodder System

http://www.farmtek.com/farm/supplies/prod1;ft_ag_growing_supplies-ft_hydroponic_supplies-ft_fodder_pro_2;pg111628.html
Cornell Floating Lettuce System
Aeroponic System Design
Automated Controls

Photos by Neil Mattson, Cornell University
Aquaculture + Hydroponics = Aquaponics
Small-Scale Packaged Aquaponic Tanks
NJ Greenhouse Production - Snapshot

- $406 Million/year in revenue for Nursery, Greenhouse, Floriculture and Sod (approximately 50% of this was greenhouse production)
- 702 farms (down 10% from 2007) with 36.8 million square feet (844 ac) of production (up 21.5% from 2007 Census).

*Data from 2012 Census of Agriculture*
Sustainable Greenhouse Production

EcoComplex: Energy & Material Flow Diagram

- Landfill Gas
  - Microturbine
    - Electricity
      - Import & Export to Grid
        - Heat Recovery System
          - Cooled Water
            - Saltwater IN
              - Concentrated Brine OUT
                - Freshwater OUT
                  - Fish Feed
                    - Aquaculture Tanks
                      - Nutrient-rich Water
                        - Nutrient-depleted Water
                          - Solid Filtration & Biofilter
                            - Aquaculture Effluent
                              - Aquaculture Loop
                                - Hydroponic Vegetables
Co Generation – Heat and Electricity

• Many smaller generation systems can be modified to recover heat making them much more energy efficient, 60-70% vs. 25%

• Biomass feedstocks are well suited for Co-gen applications especially on farms and rural businesses with a large heating demand

• State and Federal incentives may be available to help with equipment costs

• Good LFG clean-up is essential
Landfill Gas Fired Boiler

- Direct use of Landfill Gas has presented many challenges - need to work with experienced contractors
- Minimal gas cleanup needed as compared to other uses
- Floor-based hot water radiant heating can efficiently use water in the 80 – 120 F range
- Most boilers have dual-fuel capability
**Anaerobic Digester** - 500 pound-per-day Food Waste Demonstration at EcoComplex Greenhouse
Challenges to Producing Low-Carbon, Sustainable Food in Controlled Environment Ag

Economic and Environmental Comparison of Tomatoes Grown Using Conventional and Sustainable Controlled Environment Agriculture and Field Production; He Zang, Serpil Guran, David Specca
## Carbon Emissions Comparison

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<th>Energy Related CO₂ per acre</th>
<th>Fertilizer &amp; Pesticide Related CO₂ per acre</th>
<th>Structure Related CO₂ per acre</th>
<th>Transportation Related CO₂ per acre</th>
<th>Yield per acre (tons)</th>
<th>Total tons CO₂/ year/ acre</th>
<th>Tons of CO₂ per Ton of Tomatoes</th>
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<tr>
<td><strong>Conventional Greenhouse</strong></td>
<td>910.4</td>
<td>8.51</td>
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<td><strong>Sustainable Greenhouse</strong></td>
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<td><strong>Field Tomatoes</strong></td>
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<td>(incl./w energy)</td>
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<td>2.0</td>
<td>20</td>
<td>9.57</td>
<td>0.48</td>
</tr>
</tbody>
</table>
High Tunnel Greenhouse
High Tunnels – To Move or Not to Move?
Thank You!

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