Using Hydroponics for Food Production
History of Hydroponics

• Hanging gardens of Babylon
• Aztec floating gardens
• World War II-hydroponics in western Pacific
• Plastics changed everything!
• Boom in 1990’s
  – Space program
  – Growing in deserts
  – Vertical farming
  – Large scale production
**Advantages**
- Crops can be grown where soil is unsuitable
- Reduced plant disease
- More control
- Bigger yields

**Disadvantages**
- Initial costs higher
- Deeper knowledge is needed
- If introduced, diseases can easily spread
- Needs more attention
The basics

- Growing substrates
- Nutrient solution
- System designs
Growing Substrates

• What makes a good media?
  – Provides support
  – Good pore size
  – Does not clog system
  – Does not affect nutrient solution
Growing Substrates

- Pea Gravel
- Coarse Sand
- Sawdust
- Perlite
- Vermiculite
- Peat moss
- Rockwool
- Expanded clay pellets
- Coconut fiber
- Growstones
- Oasis cubes
Rockwool

- Widely used
- High-water holding capacity
- Good aeration
- Needs a pre-soak to lower pH
- Irritant when dry
- Not recyclable, not reusable
Expanded Clay

- Hydroton/Grow Rocks
- Can be reused (wash and sterilize)
- Inert
- Free-draining
- May get too dry for ebb & flow systems
- Not good for starting seed
Coconut Fibers (Coir)

- Many different sizes
- Good water holding capacity
- Different grades
  - Salt concern?

Photo: www.kalyx.com/store/images/images_j/j_713170.jpg
Grow Stones

• 99% recycled glass
• Similar to lava rock
• Not good for starting seeds
• Not compostable, reusable with sterilization
Oasis ‘Horticubes’

• Similar to florist foam
• Non-reactive in nutrient solution
• Can crumble
• Not compostable, not reusable
• Good for seed starting
Rapid Rooters

• Tree bark/compost based
• Some crumbling
• Good for seed starting
• Usually need additional support

Photo: bestbudsgreenhousesupplies.com
Not recommended

- Jiffy Pots pellets
  - Peat based
  - Can break down and clog up system

- Transplants from soilless mediums
  - Disease concerns
  - Organic matter in tank
Nutrient Solutions

1. Make your own
2. Conventional solutions
   - Liquid or powder
3. Organic solutions
   - Aquaponics
   - Compost tea
   - Premixed solutions
Base Nutrients

Macro Nutrients
- Nitrogen - (N) is primary to foliage plant growth.
- Phosphorus - (P) Phosphorus helps build strong roots and is vital for flower and seed production.
- Potassium (K) - Potassium increases chlorophyll in foliage and helps regulate stomata openings so plants make better use of light and air.

Secondary Nutrients
- Magnesium (Mg), Calcium (Ca)

Trace Elements
- Sulphur (S), Iron (Fe), Manganese (Mg), Zinc (Z), Copper (C), Boron (B), Molybdenum (Mn)
Options, options, options!!!

• Some solutions are complete
• Some are two part (Ca & Mg separate)
• Some require additional purchase of micronutrients
• Formulas for vegetative growth, flowering, and fruiting.
  – Depends on what you’re growing
• Check labels
  – Usually can’t premix
Additives

• Mycorrhizal fungi
• Carbohydrates
• Single nutrient solutions (K alone)
• Flower boosters
• Silicates
• Root healers
• Flushes/clearing solutions
Types of Systems

- Basic wick
- Non-circulating raft system or deep water
- Top feed/Drip
- NFT (nutrient film technique)
- Ebb and Flow
- Aeroponics
- Aquaponics
Basic Wick

• Very basic
• “Self-watering”
• Many options: from pop bottles to 5 gallon buckets and beyond
The EarthTainer™

- Instructions online
- http://earhtainer.tomatofest.com/
Raft Systems

Photo: Geoff Wilson, Aquaponics Network Australia
Small-scale raft culture
Top Feed/Drip Systems

- Rings or standard emitters
- Pumps nutrients to top of pot
Top Feed/Drip System
NFT (Nutrient Film Technique)
Ebb and Flow
Ebb and Flow

Photo: www.hydroponics.net
Vertical growing

Photo: http://www.valcent.net/i/photos/VertiCrop-020909-001.jpg
Aeroponics
Managing the nutrient solution

- pH
- EC
- Oxygen
- Temperature
pH

• Measure of how acidic or basic the nutrient solution is
• 0 (acidic) to 14 (basic)
• Most plants prefer 5.8-6.5
• Can change over time
• Affects nutrient uptake
Managing pH

• Check daily—especially when first setting up or changing nutrients
What is EC?

• EC = Electrical Conductivity
• General idea of soluble salts
• Can’t tell you the individual N-P-K
• Always check the unit being measured

Photo: www.nehydro.net
What about TDS and PPM?

- TDS = Total Dissolved Solids
- PPM = Parts Per Million
- Difficult to convert to EC
- Fallen out of favor
Dissolved Oxygen

• Very important!
• Use aquarium bubbler for non-recirculating system
• Use high density airstone

Photo: www.hydroponics-at-home.com/
Temperature

• Optimum depends on crop
• Check air and nutrient solution temperature
• Water chillers and heaters can be used
What about light?

• Natural Light: Greenhouse
• Artificial Light: Supplemental lighting
Supplemental Lights

• Fluorescent (T5 most efficient)
  – ‘shop lights’, low cost
• High-pressure sodium
  – Best for flowering, $$$
• Metal halide
  – Best all-around/vegetative, $$$
• LED
  – Low energy use, research?
Carbon Dioxide Enrichment?

- Commercial growers
- Increases yields by 20%
- Natural gas
- $$$

Photo: www.hydro-gardens.com
What beginners don’t need

• Odor control systems
• Grow cabinets
• Cloning system
• Plant stimulants, additives, bud boosters, etc
• Light rails/tracks

Keep it simple!
When do I replace the nutrient solution?

• Many options:
  – Top off with plain water or nutrient solution

• Full replacement depends on the crop:
  – 7-10 days if high use/fruiting crop
  – 2+ months if low use (lettuce or herbs)
Waste Nutrient Solution?

• The problem: High nitrates & phosphates
• Avoid runoff to surface water!
• Options:
  – Send down sewer to waste water treatment plant
  – Apply to houseplants and garden plots
  – Commercial operations
    • Recycle water
    • Constructed wetland remediation system
What can you grow?
Lettuce
Lettuce

- Good for beginners
- 30-85 days to maturity depending on variety
- Sequential plantings to ensure continuous supply
Lettuce Varieties

• **Bibb**: Deci-minor, Ostinata, Cortina, Rex, Salina, Milou, Vegas, Cortina

• **Looseleaf**: Domineer, Black Seeded Simpson, Grand Rapids, Waldmann’s Dark Green

• **Head/Iceberg**: Great Lakes 659, Montemar

• **Romaine**: Valmaine Cos, Cimmaron, Parris Island Cos

(From: Hydroponic Food Production, H.M. Resh)
Tomatoes

- Pollination required
- Indeterminates can produce for months
- Trellising required
Tomato Varieties

• **Beefsteak:** Dombito, Caruso, Larma, Perfecto, Belmondo, Trend, Trust, Apollo, Match, Blitz, Quest, Laura

• **Cherry:** Favorita, Conchita

• **TOV (tomato on the vine):** Tradiro, Ambiance, Balance, Cronos

(From: Hydroponic Food Production, H.M. Resh)
Cucumbers

- European/English
- Doesn’t require pollination
- Trellising required

Photo: grodan.com
European Cucumber Varieties

- Varieties: Toska 70, Pandex, Uniflora D, Corona, Farona, Marillo, Fidelio, Bronco, Mustang, Exacta, Ventura 1289, Jessica, Optima, Flamingo, Dominica, Accolade, Discover, Milligon

(From: Hydroponic Food Production, H.M. Resh)
Bell Peppers

• Trellising required
• Can be difficult to grow and manage nutrient solution
• 20+ peppers off single plant
Bell Pepper Varieties

- **Red**: Delphin, Plutona, Tango, Cubico, Mazurka, Val Valeta
- **Yellow**: Luteus, Goldstar, Samantha, Gold Flame, Kelvin
- **Orange**: Wonder, Eagle, Narobi, Fellini
- **Purple**: Violetta

(From: Hydroponic Food Production, H.M. Resh)
Basil

- Easy to grow
- All varieties do well
- Pinch back to encourage branching
- Will last many months
Other plants

- Oregano
- Thyme
- Mint
- Strawberries
- Watercress
  - Easy to grow

Photo: www.gourmetsleuth.com/images/watercress.jpg
Desktop Hydroponics

• Raft System: Handout from Urban Garden Magazine
• Cooler setup on display
• Start with lettuce, basil or other vegetative crop
Inputs/Outputs

- Transplants/seed*
- Nutrient solution*
- pH up/down *
- Coconut coir*
- Cooler
- Tubing
- Airstone & pump
- Garbage bag
- Duct tape
- Lights

- Harvest as of July 8th
- 7 clamshells of basil from two plants
- $28 value

- Will add two additional plants to system
7 harvests in ~2.5 months!

July 8th