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

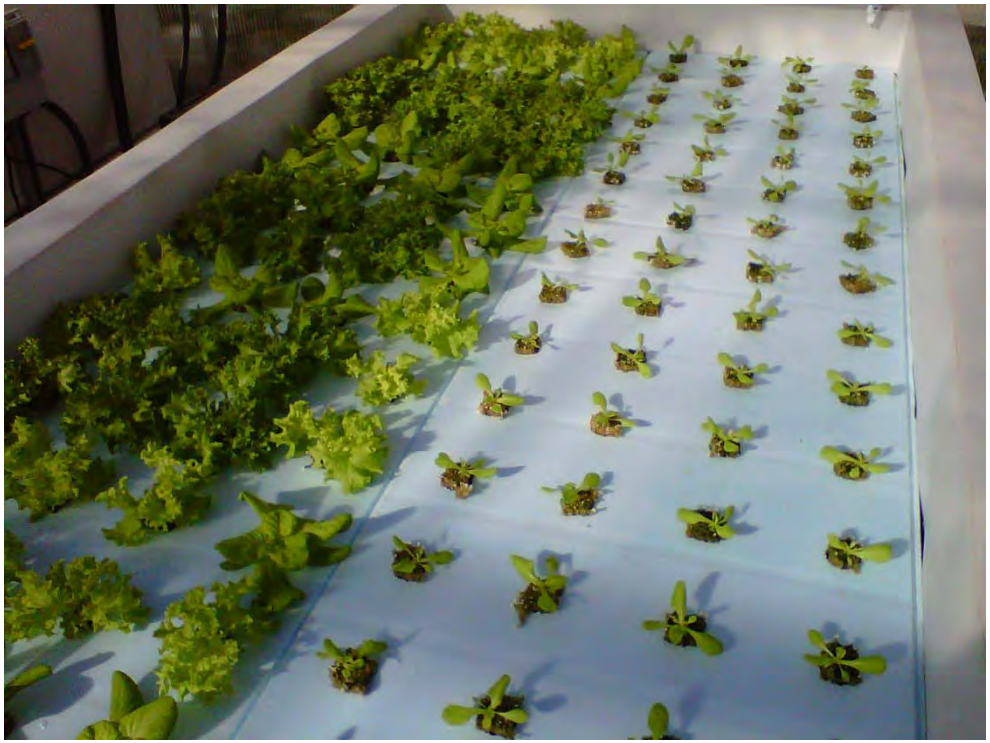
- Crops can be grown where soil is unsuitable
- Reduced plant disease
- More control
- Bigger yields

Disadvantages

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

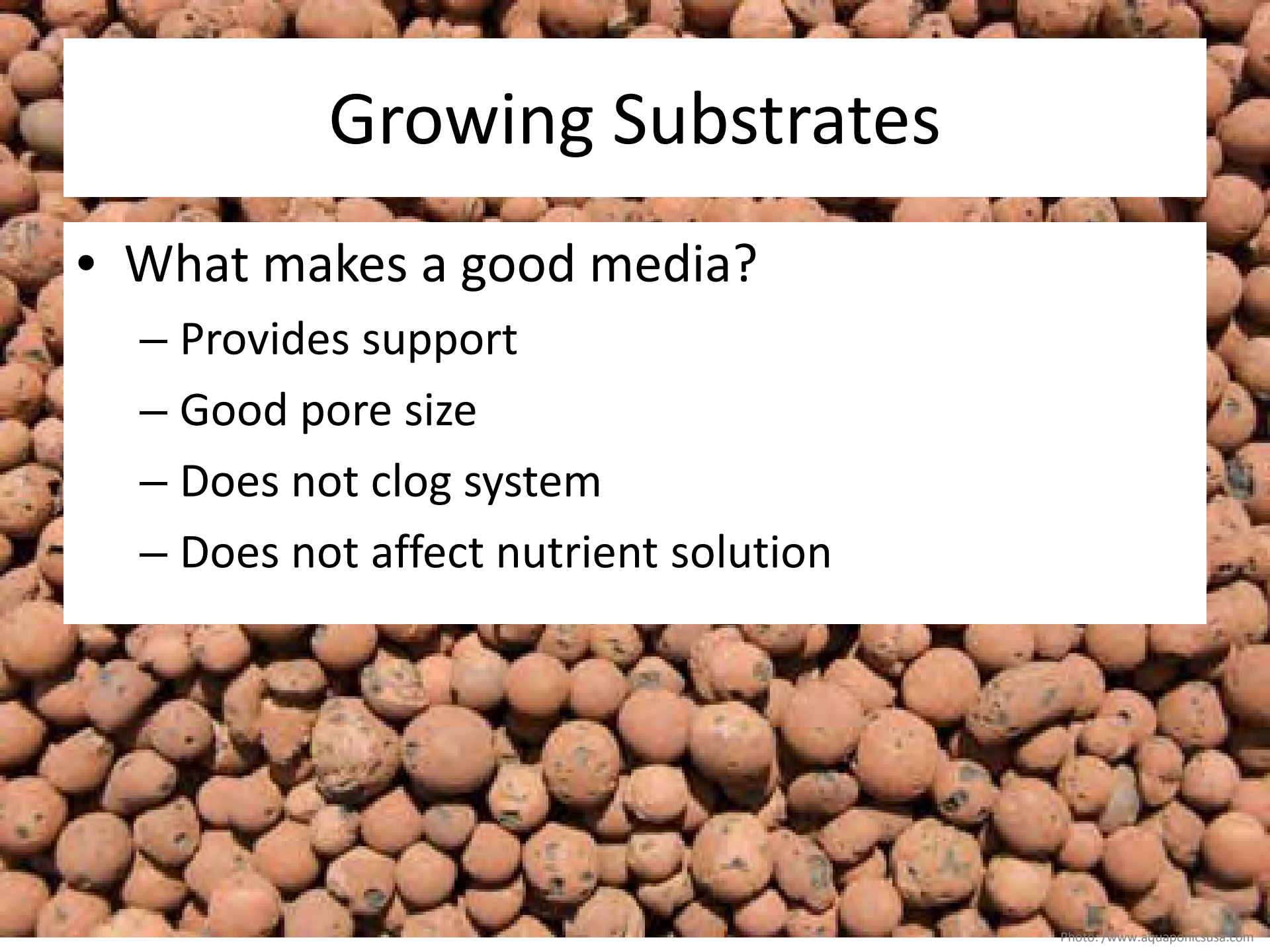
The basics

- 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

Photo: grodan101.com

Expanded Clay

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

Photo: /www.aquaponicsusa.com

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

Photo: www.hidhut.com

Oasis ‘Horticubes’

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

Photo: www.gchydro.com

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

Photo: www.autopot.com.au

Photos: www.jasons-indoor-guide-to-organic-and-hydroponics-gardening.com
onpointhydroponics.com

Nutrient Solutions

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

Photos: www.amazon.com

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

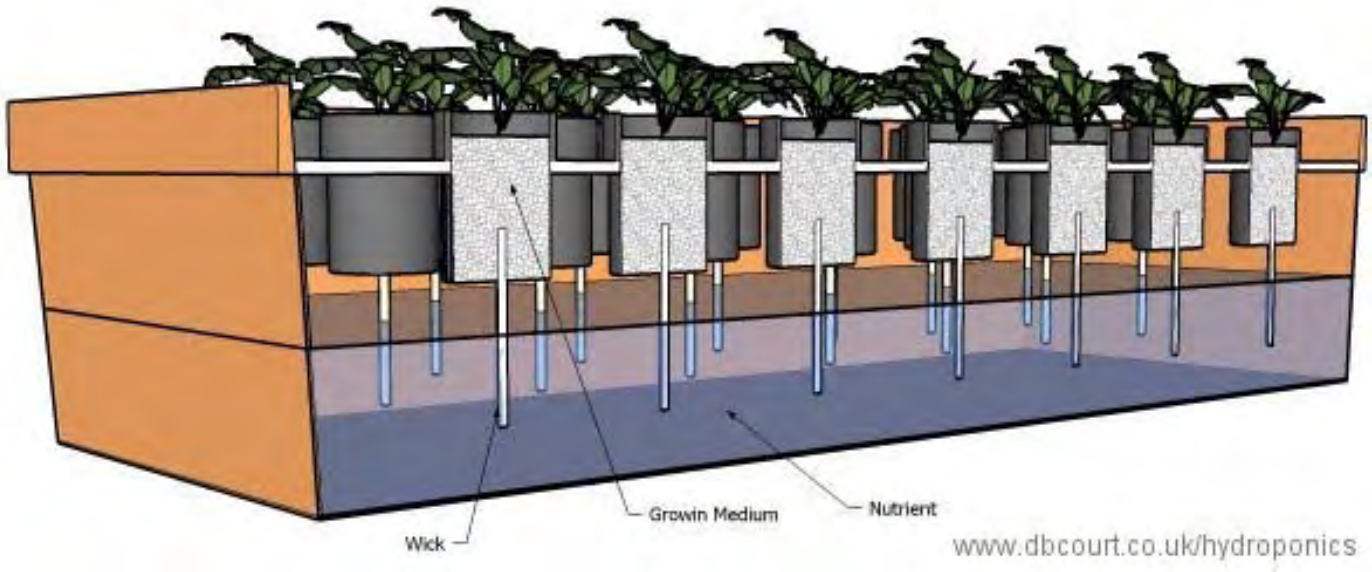
- Mycorrhizal fungi
- Carbohydrates
- Single nutrient solutions (K alone)
- Flower boosters
- Silicates
- Root healers
- Flushes/clearing solutions

Types of Systems

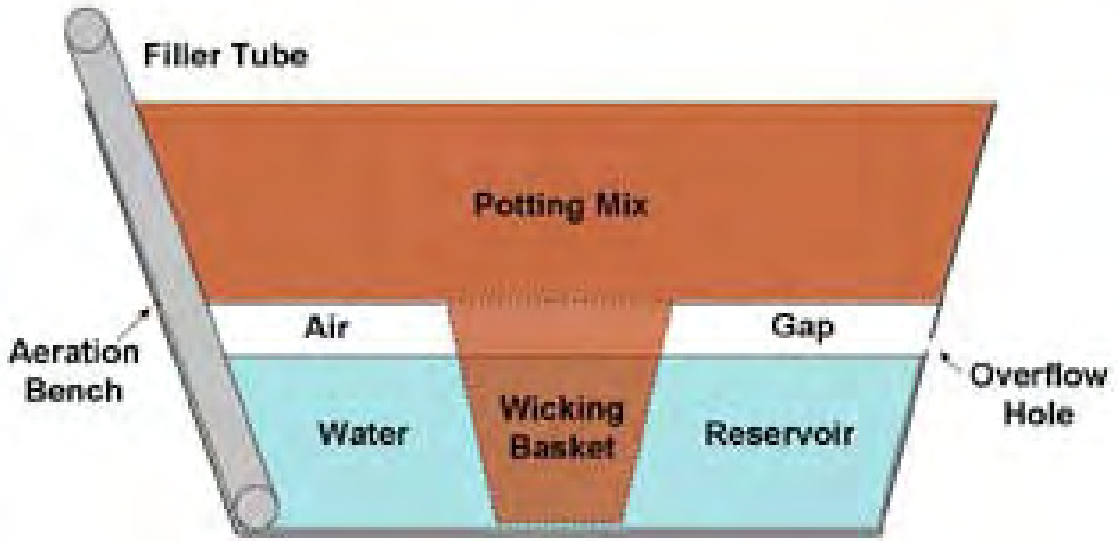
- Basic wick
- Non-circulating raft system or deep water
- Top feed/Drip
- NFT (nutrient film technique)
- Ebb and Flow
- Aeroponics
- Aquaponics

Basic Wick

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



The EarthTainer™



- Instructions online
- http://earthtainer.tomatofest.com/

Raft Systems

Photo: Geoff Wilson, Aquaponics Network Australia

Small-scale raft culture

Photo: urbangardenmagazine.com

Top Feed/Drip Systems

- Rings or standard emitters
- Pumps nutrients to top of pot

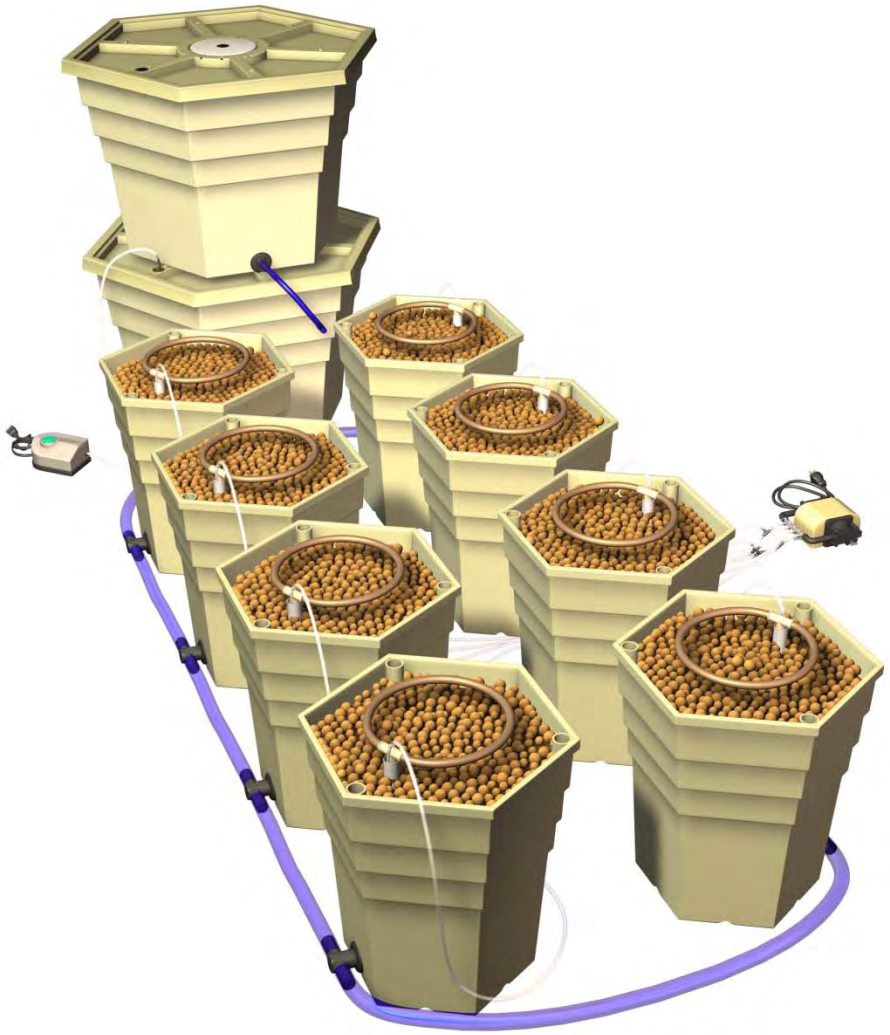


Photo: www.hydroponics.net

Top Feed/Drip System

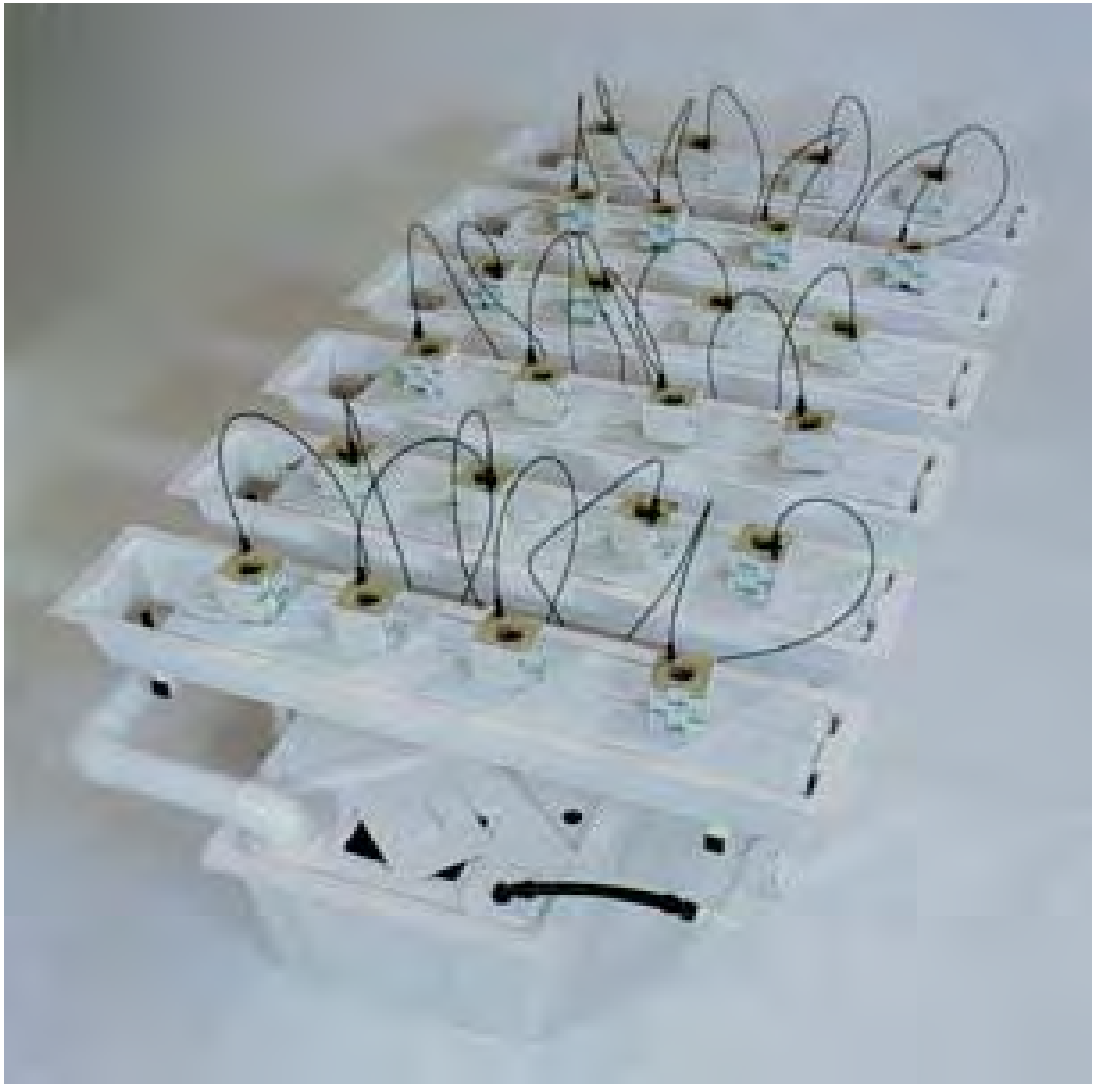


Photo: www.gchydro.com

NFT (Nutrient Film Technique)

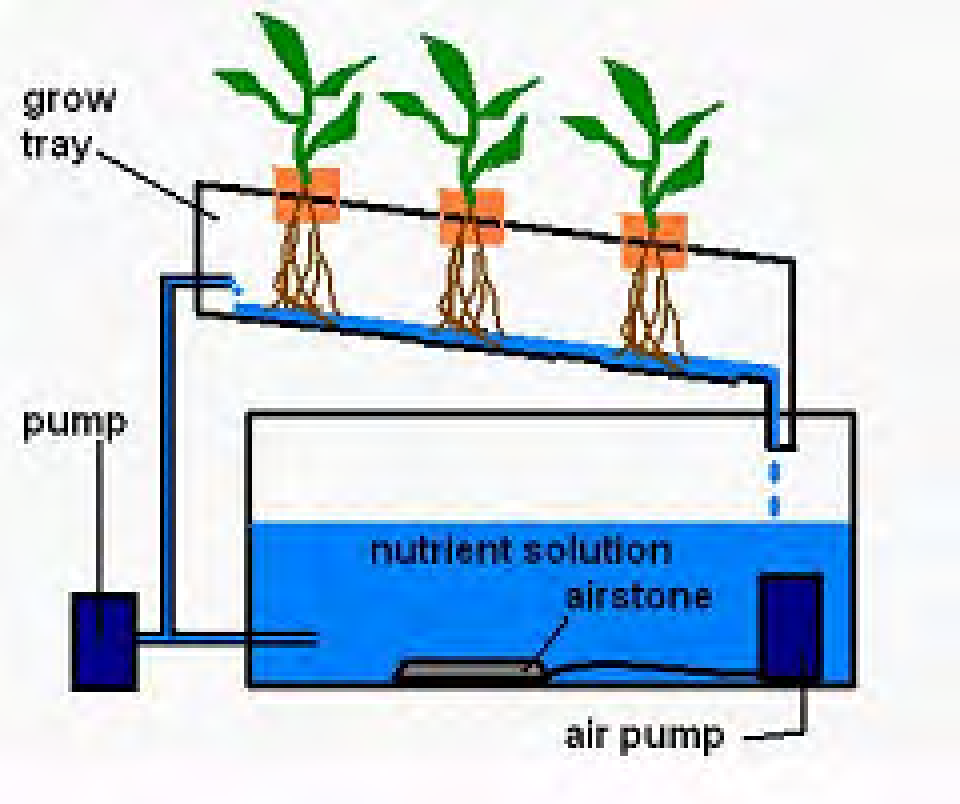
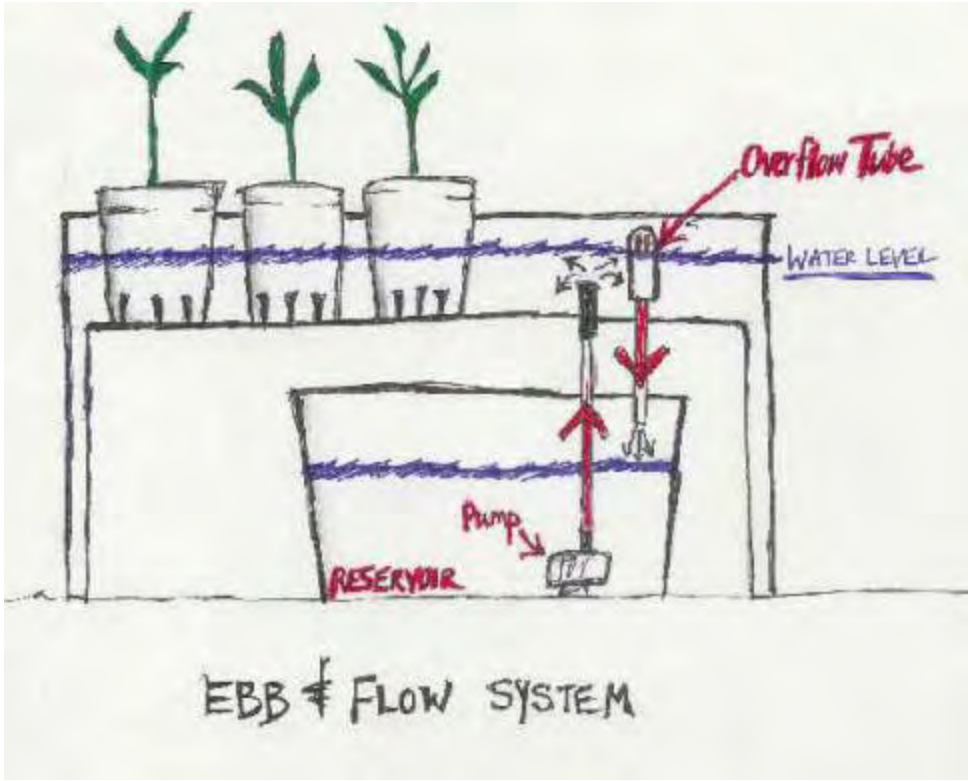


Figure: www.diy-guides.com

Photo: Crop King

Photo: Crop King

Ebb and Flow



Photos: www.gchydro.com
www.hydroponics-simplified.com

Ebb and Flow

Photo: www.hydroponics.net

Vertical growing

Photo: http://www.valcent.net/i/photos/VertiCrop-020909-001.jpg

Aeroponics

Photo: www.aeroponicdesign.com

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

Photo: www.dynamicaqua.com
www.generalhydroponics.com/
www. vpmt.com

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

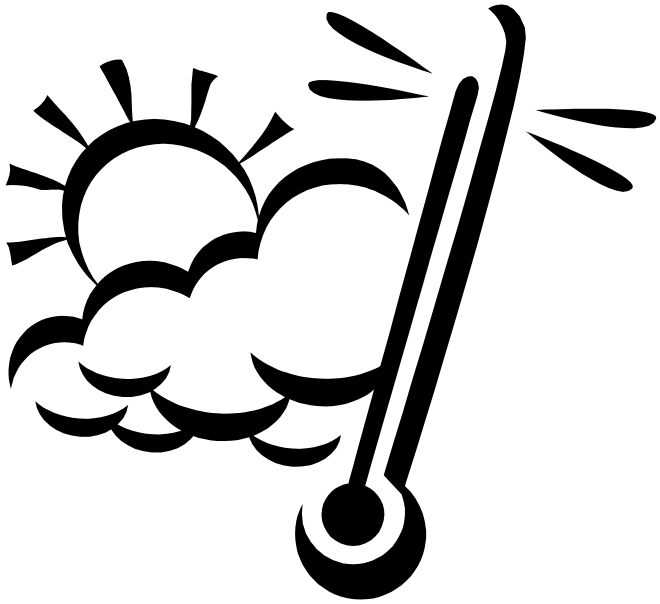
Dissolved Oxygen

- 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

Photo: www.treehugger.com

Lettuce

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

Photo: images.plant-care.com

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

Photo: grodans.com

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

Photo: green-change.com

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

Photo: urbangardenmagazine.com


April 30th


May 17th

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