Aquaponics
What You Need to Know

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Richard Tyson
UF/IFAS Extension Orange County
Local Food Systems

Socially & Environmentally Responsible

More Food Safety Oversight

Economic Benefits to Local Communities
What You Need to Know

- If you want to grow plants
  ~use hydroponics~

- If you want to grow fish
  ~use aquaculture~
pH Optima for 3 Organisms

Hydroponic Plants = 5.5-6.5

Aquaculture = 6.5-8.5

N. Bacteria = 7.5-9.0
TAN = Total Ammonia Nitrogen

\[ \text{NH}_4^+ = \text{NH}_3 + \text{H}^+ \]

pH Determines Ammonia Equilibrium in Water

<table>
<thead>
<tr>
<th>pH</th>
<th>6.5</th>
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</thead>
<tbody>
<tr>
<td>(\text{NH}_3)</td>
<td>0.2%</td>
<td>2%</td>
<td>18%</td>
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</tbody>
</table>
Nitrifying Bacteria

- Nitrification converts toxic ammonia to nitrate

\[
\text{NH}_3 + 1\frac{1}{2} \text{O}_2 \rightarrow \text{NO}_2^- + \text{H}^+ + \text{H}_2\text{O}
\]

\[
\text{NO}_2^- + \frac{1}{2} \text{O}_2 \rightarrow \text{NO}_3^-
\]
Aquaponics Nitrogen Cycle

Figure 1. Nitrogen cycle in aquaponics.
What You Need to Know

○ **Fish density matters** – range 1/2 lb/gal to 1 lb/10gal

○ 1 lb fish / cubic feet (7.5 gallons) or greater

○ High densities require experienced growers, backup pumps, a generator and 24 hour supervision

○ Low densities you can go away for the weekend and not worry about the fish dying before you return
What You Need to Know

- No fish feed provides all the nutrients required by plants – calcium, potassium & iron are low

- Low fish density in home aquaponics will require **supplemental fertilization** with ¼ strength hydroponic mix for optimum plant growth
pH Optima for 3 Organisms 6.5-7.0

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pH Affect on TAN Loss from Biofilters

Error bars represent ± SE (n=8).
Aquaponic Systems

NFT

Floating raft

Bench Bed
Hydroponics = Water Working

- Indoor or outdoor systems
- Low or high tech systems
- Crop sensitive - feasibility considerations
Water & Nutrient Flow

- Re-circulating systems
- Flood and drain systems
- Non-circulating systems
- Flow through systems
Media Systems vs Water Systems

- Water – Using transplants with net pots or other means of holding plants in place as water flows around roots – water loving vegetables & herbs

- Media - perlite, rockwool, coconut coir, peat, vermiculite (or combinations) & clay pebbles – most vegetables & herbs, using transplants
NFT – Nutrient Flow Technique
Home Made NFT / Aquaculture = Aquaponics

- Aluminum roof panels, multiple crops, solar powered
Aquaculture Requirements

- Keep the water circulating, it provides oxygen to the water and exercise for the fish
- Adding pumped oxygen is beneficial
- Solids filter and a place for nitrifyers to attach is recommended
FLOOD AND DRAIN
Floating Raft Leafy Salad Crops & Herbs
<table>
<thead>
<tr>
<th>Leafy Salad Crops and Herbs</th>
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</thead>
<tbody>
<tr>
<td>Bibb</td>
</tr>
<tr>
<td>Boston</td>
</tr>
<tr>
<td>Red leaf</td>
</tr>
<tr>
<td>Green leaf</td>
</tr>
<tr>
<td>Chicory</td>
</tr>
<tr>
<td>Romaine</td>
</tr>
<tr>
<td>Escarole</td>
</tr>
<tr>
<td>Basil</td>
</tr>
<tr>
<td>Watercress</td>
</tr>
<tr>
<td>Mint</td>
</tr>
<tr>
<td>Swiss Chard</td>
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<tr>
<td>Chinese Leafy Greens</td>
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</tbody>
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Plan Requirements

- In general, plants that prefer well drained soils and most fruiting vegetables are best grown in media systems.
- Leafy salad crops and most herbs will adapt to either water or media systems.
- Choose crop varieties / growing seasons carefully – warm/cool season veggies!
WATER SOURCES

- Pond water – nutrients are low - microbial, algae & critter contamination is high

- Well and municipal water sources are safest
FERTILIZER / NUTRITION

- Using natural and organic materials can be problematic
- Water soluble hydroponic fertilizer and Epsom Salts are the easiest to work with using soluble salt meters
- 10% of the protein in fish feed becomes nitrogen in the water!
- Sunlight + Nutrient water = algae
Water Quality Measurements

- pH
- Soluble Salts
- Ammonia
- Oxygen
- Alkalinity
- Nitrate
So Why Aquaponics?

- The Nitrogen Budget!

- Fish produce large amounts of harmful ammonia nitrogen as waste.

- Nitrifying bacteria change it to beneficial nitrate nitrogen for the plant.

- 100 lbs of fish will supply enough nitrogen for 4,050 lettuce plants or 540 tomato plants.
So Why Aquaponics?

- The Water Budget!

- Plants transpire large amounts of water (1pt - 6 qt/plant/day)

- Aquaculture replaces 5 to 10% of tank water/day to maintain quality

- Properly designed aquaponic system minimizes water discharges to the environment
Crop and Fish Choices

- Leafy salad crops, herbs, tomato, pepper, cucumber and strawberry

- Tilapia, catfish, rainbow trout, largemouth bass, yellow perch, bluegill, Barramundi, koi and other ornamental or bait fish
Hydroponics/Aquaculture = Aquaponics
Fish density matters > 1 lb. fish/cubic ft water (7.5 gal)
Low density means supplemental fertilization

Fruiting crops prefer well drained media systems while leafy crops tolerate water systems
Tilapia are the easiest fish to grow but stop feeding at 60F and die at 40F