Hybrid Aquaponics: Commercial Viability with High Density RAS in Temperate Climates

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Nutrient Dynamics in Aquaculture-Hydroponics

Based on a Study by:
Seawright, Stickney & Walker
(Texas A&M, and Univ. of Washington)

(Before it was called Aquaponics!)
Two Important Questions:

In Aquaculture / Horticulture Systems:

• Can FISH WASTE provide the proper balance of nutrients for plant growth?

• What FISH DENSITY will provide the mineral needs of hydroponic plants?
Nutrient Recycling

NUTRIENTS ADDED:
• FISH WASTES (Tilapia fed fish diet)
• FERTILIZER (minerals)

NUTRIENTS REMOVED:
• LETTUCE UPTAKE (Romaine Lettuce)
• SOLIDS REMOVAL (fish manure)
Dissolved Nutrients in System

- Calcium (Ca)
- Copper (Cu)
- Iron (Fe)
- Potassium (K)
- Magnesium (Mg)
- Manganese (Mn)
- Nitrate (NO$_3$-N)
- Sodium (Na)
- Phosphorus (P)
- Zinc (Zn)
Fish & Plant Biomass in Trials

![Bar graph showing fish and plant biomass in trials.](image-url)
## Composition of Fish Diet:

<table>
<thead>
<tr>
<th>% Dry Diet</th>
<th>mg/kg diet</th>
<th>% Diet</th>
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<tbody>
<tr>
<td>Ca 1.61</td>
<td>Cu 18</td>
<td>Protein 41.6</td>
</tr>
<tr>
<td>K 1.28</td>
<td>Fe 544</td>
<td>Moist. 8.3</td>
</tr>
<tr>
<td>Mg 0.030</td>
<td>Mn 161</td>
<td>Ash 7.9</td>
</tr>
<tr>
<td>Na 0.47</td>
<td>Zn 384</td>
<td></td>
</tr>
<tr>
<td>P 1.48</td>
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</tbody>
</table>
Total Recovery of Nutrients as % of Diet Nutrients

% DIET NUTRIENT

- Mg
- N
- P
- K
- Na
- Zn

0 100 200 300 400 500 600 700 800

Nutrients: Mg 0.33, N 0.83, P 2, K 4, Na 2, Zn 4
Summary of Results

• All minerals declined in concentration in the water over time.
• Lower fish densities were adequate for Mg, N, Na needs of the plants.
• Higher fish densities were required for K needs of the plants.
Conclusions:

• Changes in mineral concentrations differ because of the disparity between what nutrients are produced by fish and what nutrients are absorbed by plants.

• There is no single ratio of fish to plants that satisfies the nutrient requirements for a closed system equilibrium.
...and there is the current Paradox of Aquaponics:

- High water quality for fish...
- ...low nutrient density for plants.
- High nutrient density for plants...
- ...poor water quality for fish.
- There must be a better way !!!
WaterSmith Hybrid Aquaponics:

- Use commercial density RAS for fish
- Collects solids and concentrated nutrients
- Use settling areas and solid traps to clarify
- Use clarified fish waste water for plants
- Continue recycling of hydroponic water with supplements and leachates from separated fish waste solids…or…
- …send fish waste to outdoor plant beds
WaterSmith
High Density RAS
WaterSmith Hybrid Aquaponics

- Focus on Sunlight powered horticulture, not artificial energy-hungry lighting sources
• Focus on more economical horticultural approaches: less high-tech, more low-tech:

Subsidized Operation with High Tech Hydroponics
WaterSmith Hybrid Aquaponics

• Focus on Water Conservation, but not 100% closed looping of water use…
WaterSmith Hybrid Aquaponics

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• …unless you are traveling to Mars…
WaterSmith Hybrid Aquaponics

• Focus on Water Conservation, but not 100% closed looping of water use…
• …unless you are traveling to Mars…
• Optimize Hydroponics with Mineral and Nutrient supplements
• Re-utilize iron removed from well water sources before use in RAS fish culture and supplement iron-deficient hydroponics
WaterSmith Hybrid Aquaponics

- Economical option of outdoor “Ferticulture”
- Seasonal production for main crop
- Seasonal extension with lower cost high or low tunnel structures
- Combination of outdoor fish culture to extend crop season by micro-climate impacts, with or w/o tunnel structures
Fish Waste Storage/Settling Tank with In-line Filter for “Fertigation” (Trickle Irrigation)
Fish Water Irrigation of Bell Peppers
Fish Waste Water Irrigation System with Storage/Settling Tanks for Melons Raised on Plastic Covered Sand Beds
Trickle Irrigation of Watermelons
Local Marketing of Hybrid Aquaponic Produce