

# **Aquaponics – Vegetable and Fish Co-Production 2013**

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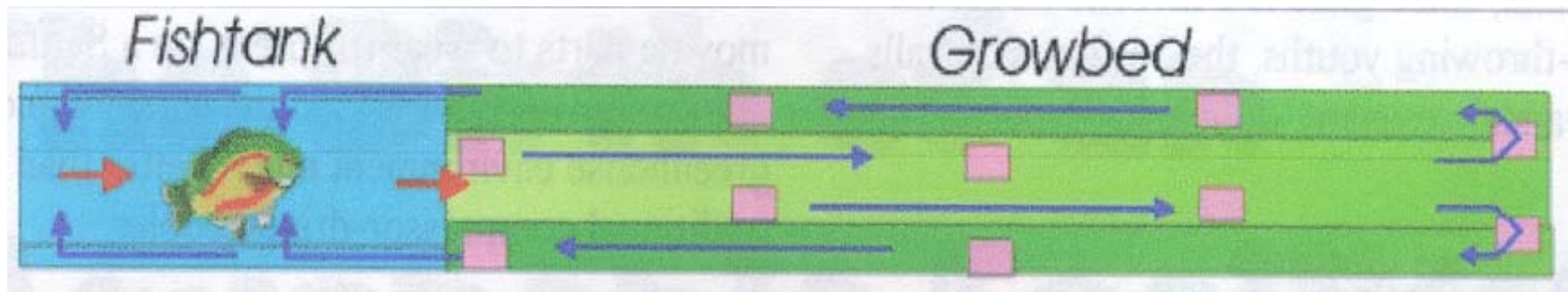
# INTRODUCTION

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- **Sustainable agriculture combines plant and animal production, integrates natural biological cycles, and makes the most use of nonrenewable resources (USDA 1990 Farm Bill).**

# INTRODUCTION

- ❑ Aquaponics is a sustainable system that integrates hydroponic (plant) and aquaculture (animal) systems.
- ❑ Uses natural biological cycles (Nitrification)
- ❑ Conserves nitrogen - fish waste nutrients are taken up by plants reducing fertilizer inputs.



# Aquaponic Systems

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**NFT**



**Floating raft**



**Bench Bed**



# Crop and Fish Choices

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- ❑ Leafy salad crops, herbs, tomato, pepper, and cucumber
  
- ❑ Tilapia, rainbow trout, largemouth bass, yellow perch, bluegill, Barramundi, koi and other ornamental fish



# System Water Quality

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- pH, 7.0 – 7.5
- Oxygen, 5 ppm or greater
- Ammonia, 1 ppm or less
- Sunlight + Nutrient rich water = algae

# Water Quality Measurements

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- pH
- Ammonia
- Dissolved Oxygen
- Soluble Salts
- Alkalinity
- Nitrate



# Aquaponics Nitrogen Cycle

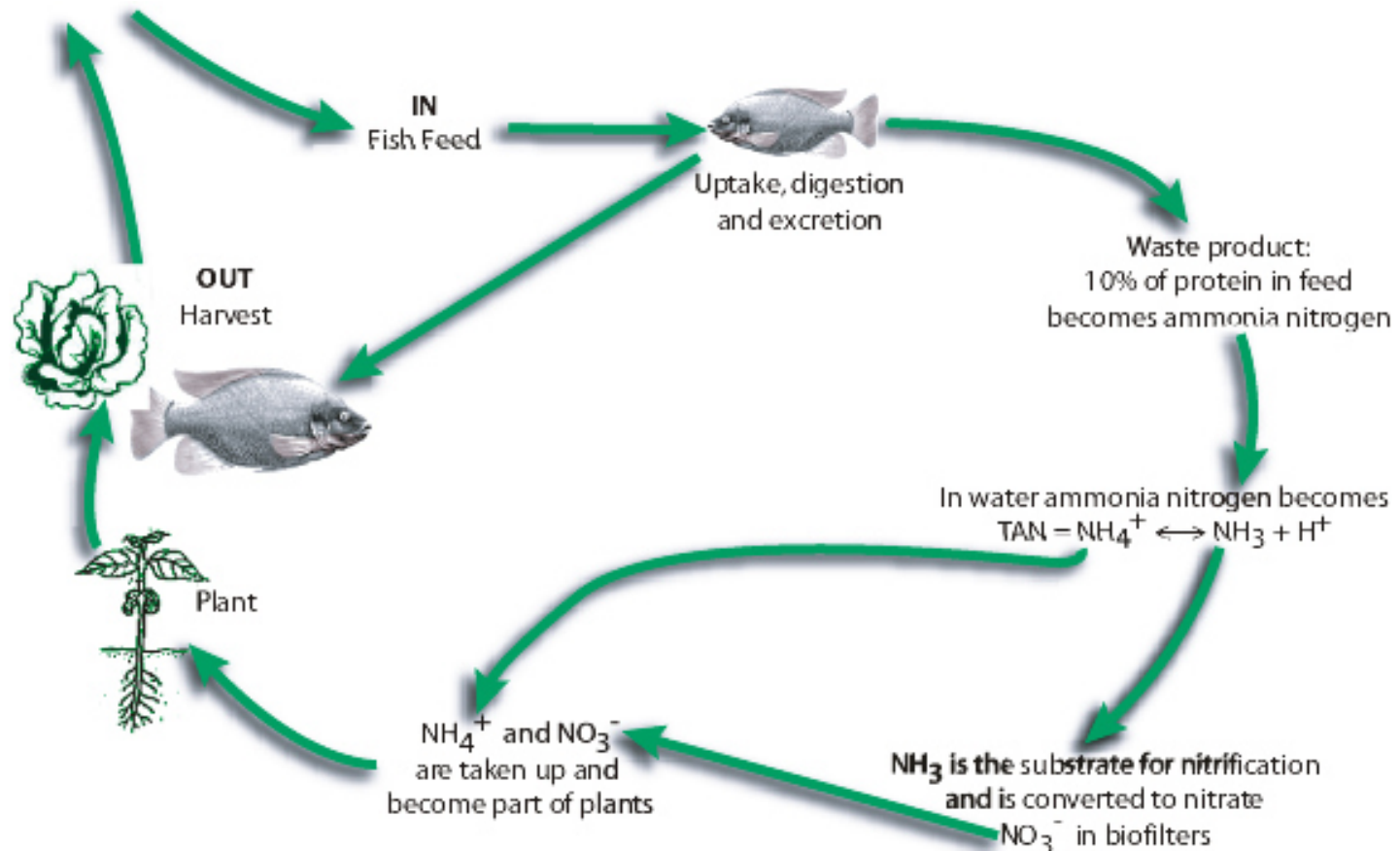


Figure 1. Nitrogen cycle in aquaponics.

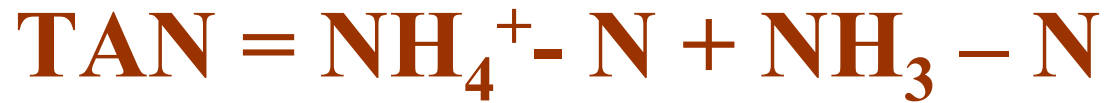


# Nitrogen from Fish Feed

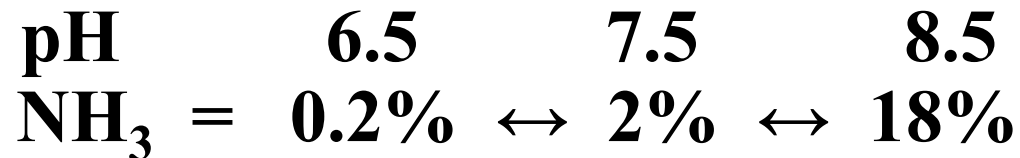
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- **In aquaculture, the generation of NH<sub>3</sub>-N in recirculating water through fish waste is based on the fish feeding rate:**
- **$P \text{ TAN} = \frac{F \times PC \times 0.092}{T}$**
- **F = feed weight, PC = % protein content of the feed, T (time) = 1 d.**
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- **1 kg of fish feed with 30% protein will produce 27.6 g of N in 1 d**
- **Or 10% of the protein in the feed becomes nitrogen in the water!**

# Total Ammonia Nitrogen



**pH Determines Ammonia Equilibrium in Water**



# The Dichotomy of pH Optima for 3 Organisms

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**Hydroponic  
Plants = 5.5-6.5**

**Aquaculture = 6.5-8.5**

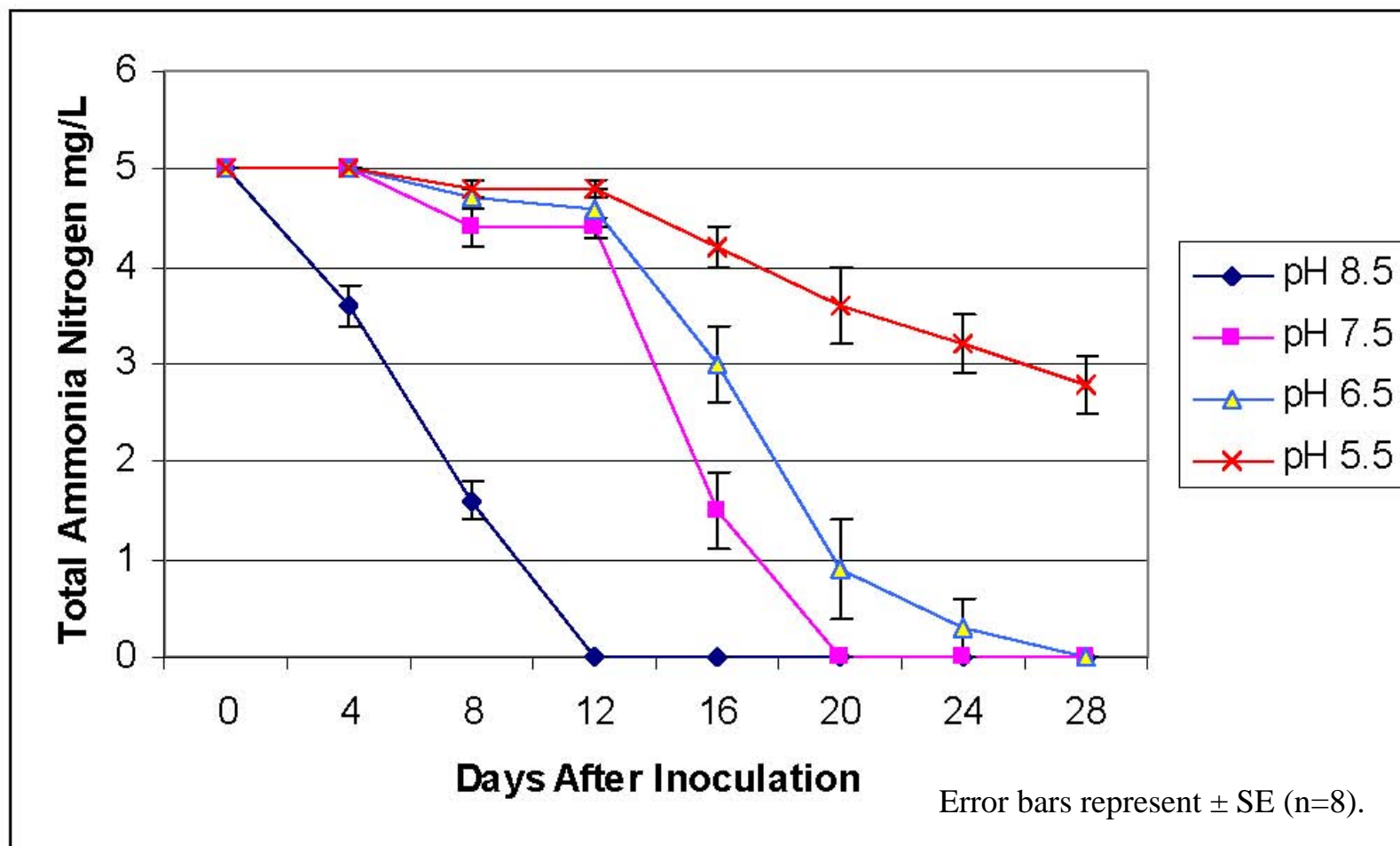
**N. Bacteria = 7.5-9.0**

# NITRIFYING BACTERIA

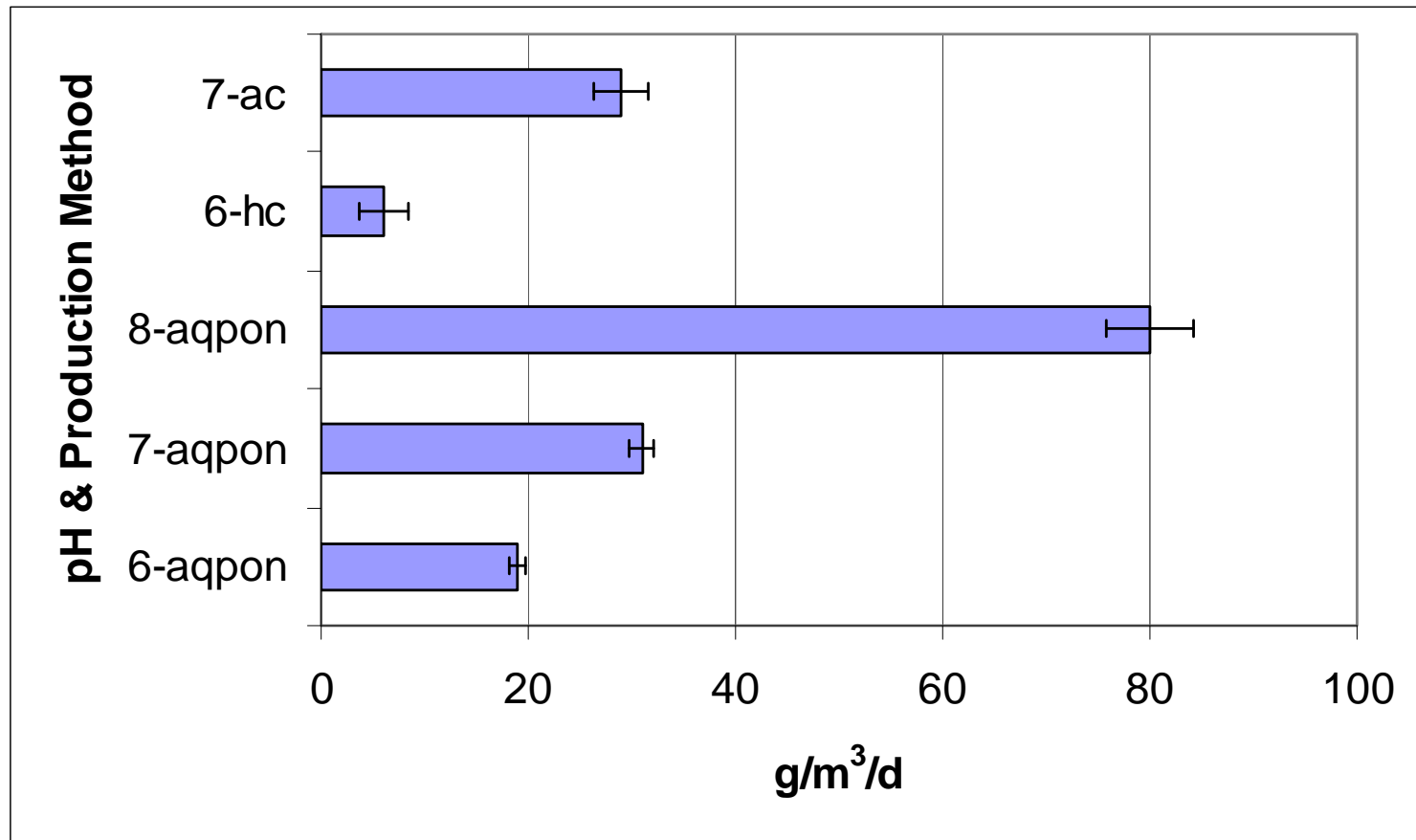
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- **Nitrification maintains water quality by oxidation of ammonia to nitrate (*Nitrosomonas sp.* + *Nitrobacter sp.*)**
- **$\text{NH}_3 + 1\frac{1}{2} \text{O}_2 \rightarrow \text{NO}_2^- + \text{H}^+ + \text{H}_2\text{O}$  Eq 1**
- **$\text{NO}_2^- + \frac{1}{2} \text{O}_2 \rightarrow \text{NO}_3^-$  Eq 2**
- **Measure substrate loss, product accumulation**

## Water pH Affects TAN Loss From Recirculating Tanks With Perlite Biofilters Inoculated With Nitrifying Bacteria



# Biofilter Performance as measured by TAN Removal





# Soluble Salts

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- ❑ Plants need balanced nutrition which can nearly be supplied by fish waste
- ❑ Recirculating vs. intermittent nutrient application
- ❑ Leafy salad crops & herbs vs fruiting crops





# **‘Fitness’ Cucumber Fruit Yield (kg/plant)**

## **Response to pH and Production Method**

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	<b>E. Mkt.</b>	<b>T. Mkt.</b>	<b>T. Cull</b>
<b>6.0-aqpon</b>	<b>1.52 a</b>	<b>3.64 a</b>	<b>0.44 a</b>
<b>7.0-aqpon</b>	<b>1.32 a</b>	<b>4.12 a</b>	<b>0.33 a</b>
<b>8.0-aqpon</b>	<b>0.67 b</b>	<b>3.54 a</b>	<b>0.33 a</b>
<b>Contrast</b>	<b>L**</b>		
<b>6.0-hc</b>	<b>1.57 a</b>	<b>3.63 a</b>	<b>0.53 a</b>

# System Sizing

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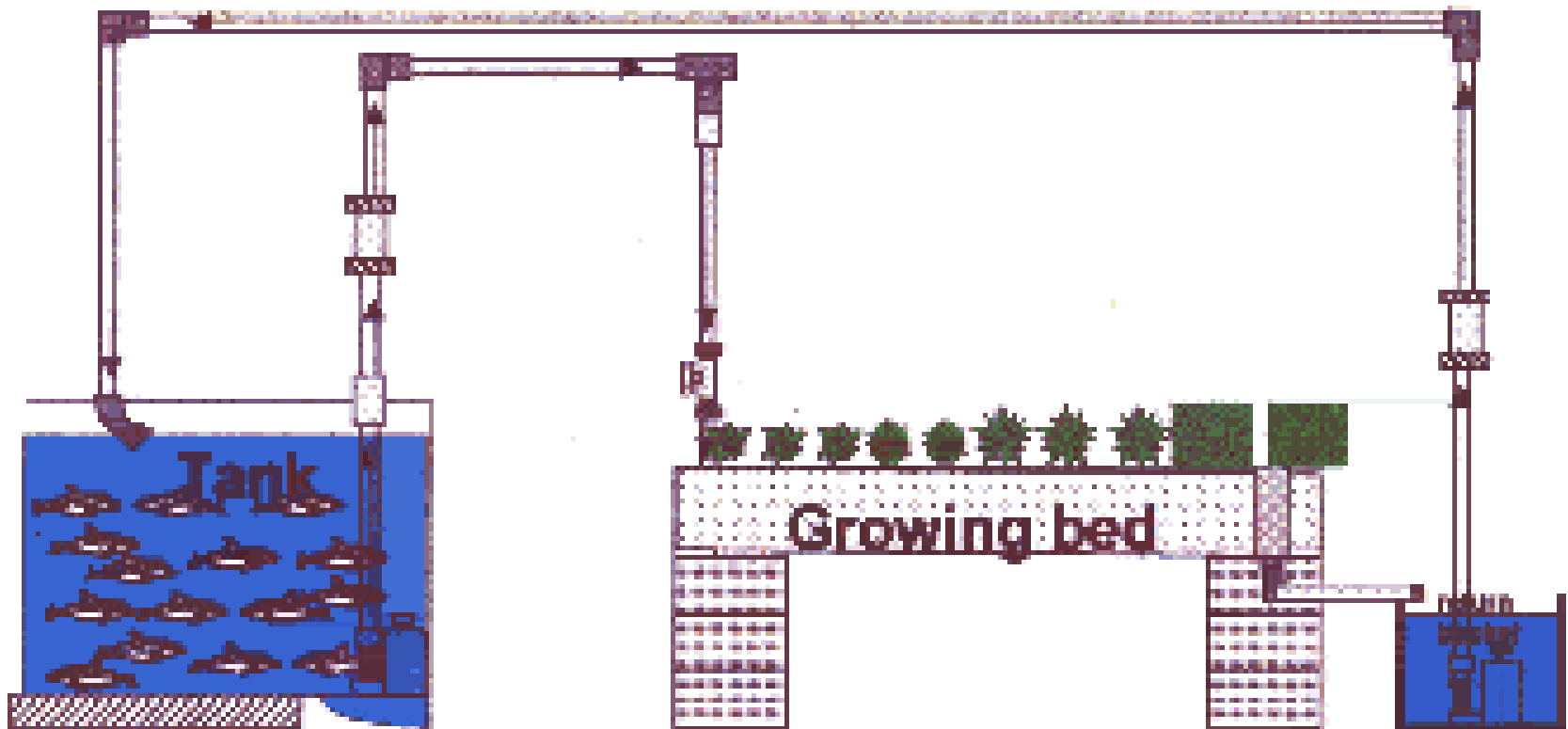




# Basic System

S&S Aquafarms

## Simplified Basic System Set-up



# Aquaponics - Application

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- Target pH should be between 7.0 – 8.0
- It depends on ammonia level (2ppm) and condition of fish and plants – I-4 Rush Hour
- Foliar or root feed plants to overcome deficiencies
- Reduce feeding and or increase water discharge and replacement to lower ammonia



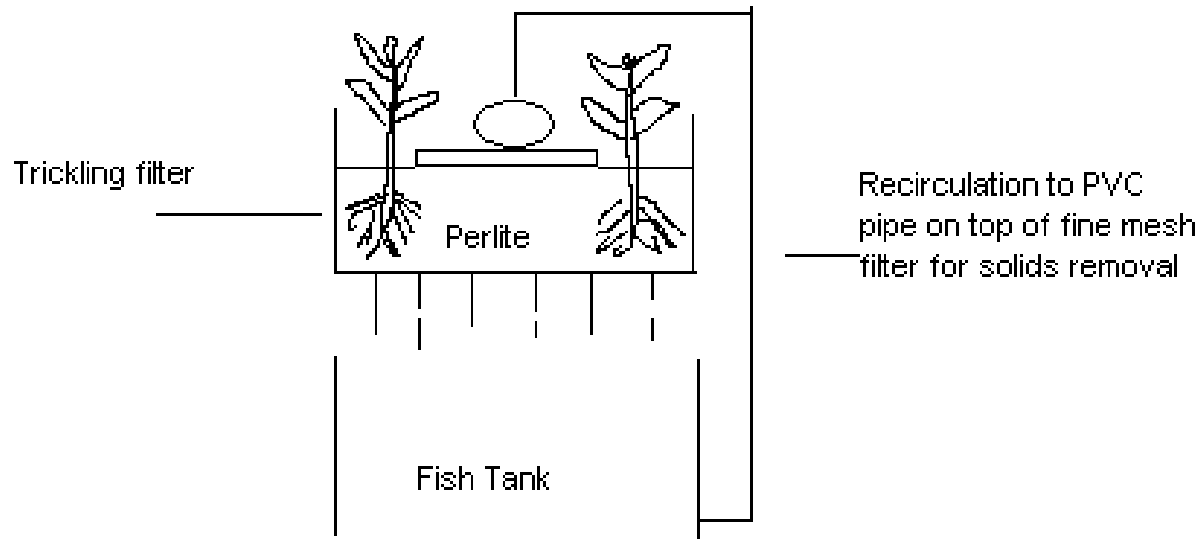
# Aquaponics - Application

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- ❑ A thorough knowledge of the organisms in the system is required for success.
- ❑ Juggles balance between ideal water quality conditions for the growth of fish, plants, and nitrifying bacteria.
- ❑ Aquaponics research is on going

**Stacked System  $\$75/\text{m}^2 + \$25/\text{m}^2 = \$100/\text{m}^2/\text{Time}$ ? Add float system or fill and drain system to increase plant area?**

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# System Sizing – Triple Crop?

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# So Why Aquaponics ?

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- – The Water Budget!
- Plants transpire lg amounts of water (1pt - 6 qt/d/pl).
- Recirculating aquaculture replaces 5 to 10% of system water/day to maintain water quality.
- Potential for zero discharge to the environment

# So Why Aquaponics ?

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- -The Nitrogen Budget!
- Fish produce large amounts of ammonia nitrogen as waste which is harmful
- One plant uses 1 (lettuce) to 20 (tomato) grams of nitrogen per season
- 100 lbs of fish will supply enough nitrogen for 4,050 lettuce plants or 540 tomato plants



# Marketing

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- ❑ USDA wholesale price market reports – do not compete with field grown on the wholesale level
- ❑ Get as close to retail pricing with on-farm sales, high end food stores, restaurants and farmers markets



# Regulations - Aquaponics

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- ❑ Farm food safety audits are currently required by big box stores for vegetables
- ❑ Vegetables may be sold to buyers who do not require the audit
- ❑ Ensure that the vegetable part being eaten does not contact the water

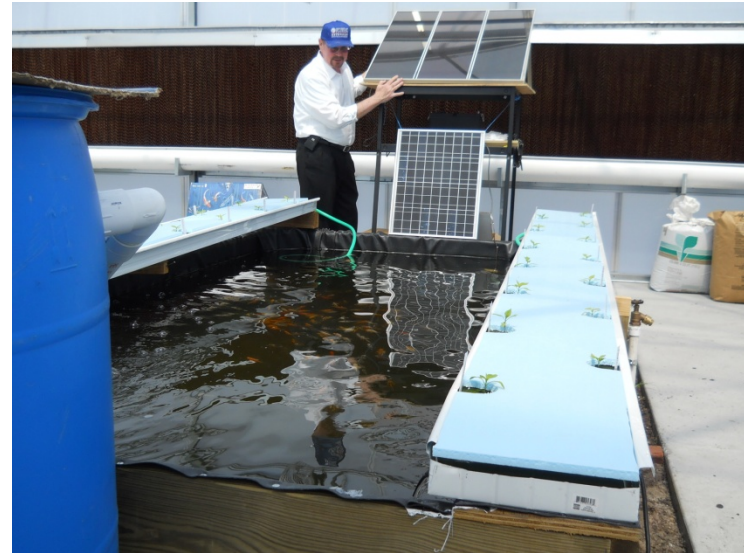
# Regulations - Aquaculture

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- Pond side whole – few
- Blue Tilapia – few, live or dead
- Nile Tilapia – should be dead unless buyer has a license from FDACS Fish & Game
- Any knife or filleted – Many food safety regulations for handling & storage

# Uncertainty, high cost, regulations, do your research!

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# Aquaponic Resources

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- Harbor Branch Oceanographic Institute  
<http://www.fau.edu/hboi/>
- Aquatic Eco-systems, Inc.  
<http://www.aquaticeco.com/>
- Blackwater Creek Koi Farms  
<http://www.koisale.com/>
- Aquasafra, Inc. <http://www.tilapiaseed.com/>