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# The Viability of Small Scale Aquaponics in Urban and Rural Underserved Communities

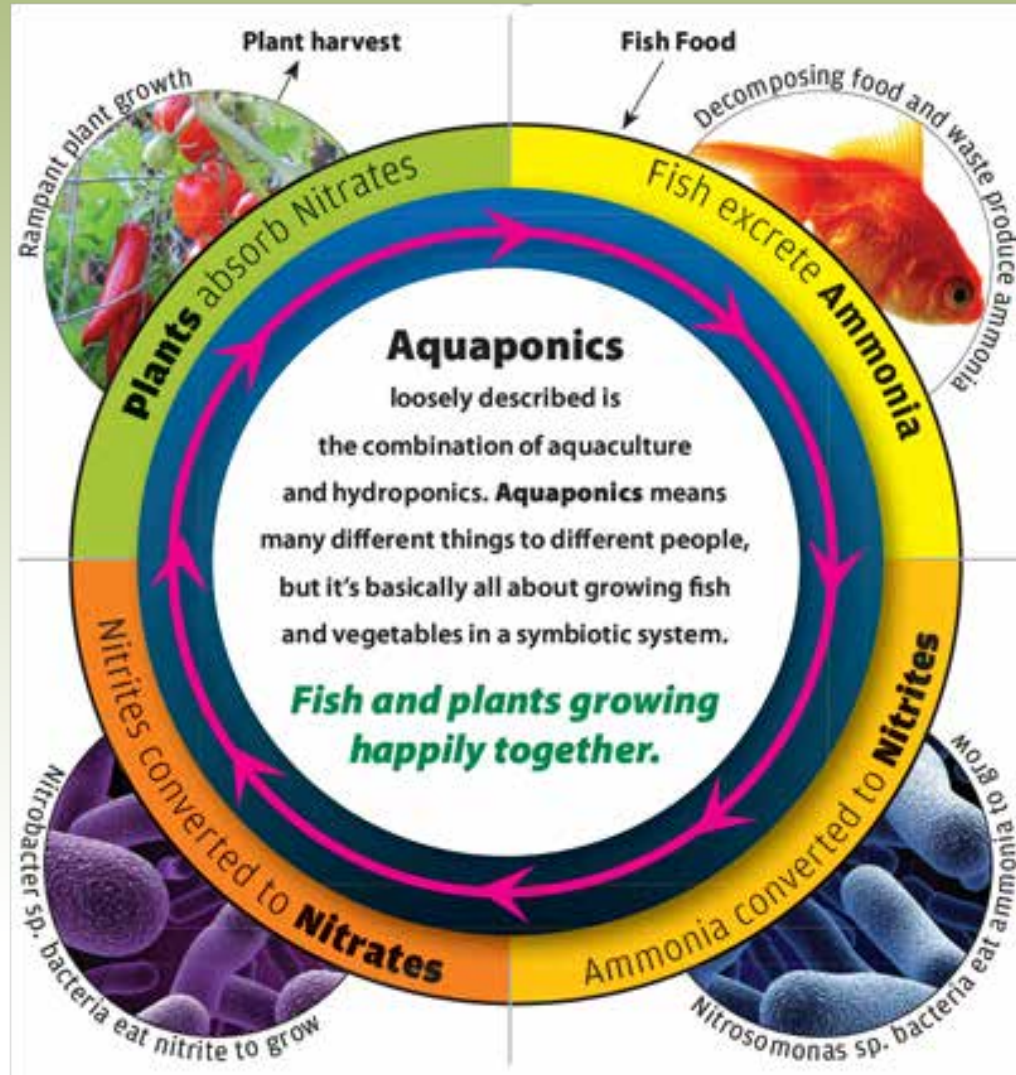
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# My Background

- Top Ranked U.S. Navy Officer and Enlisted Member
- B.S. degree in Management Information Systems
- Former Head of Talent Acquisition TD Ameritrade
- Built first Aquaponics/Hydroponics Systems in 1999
- University of Arizona Greenhouse Crop Production and Engineering Course
- Cornell University Aquaculture Design and Engineering
- Center for Rural Affairs – Board of Directors
- Urban Agriculture Planning and Execution
- Board of Directors Center for Rural Affairs

# What is Aquaponics?

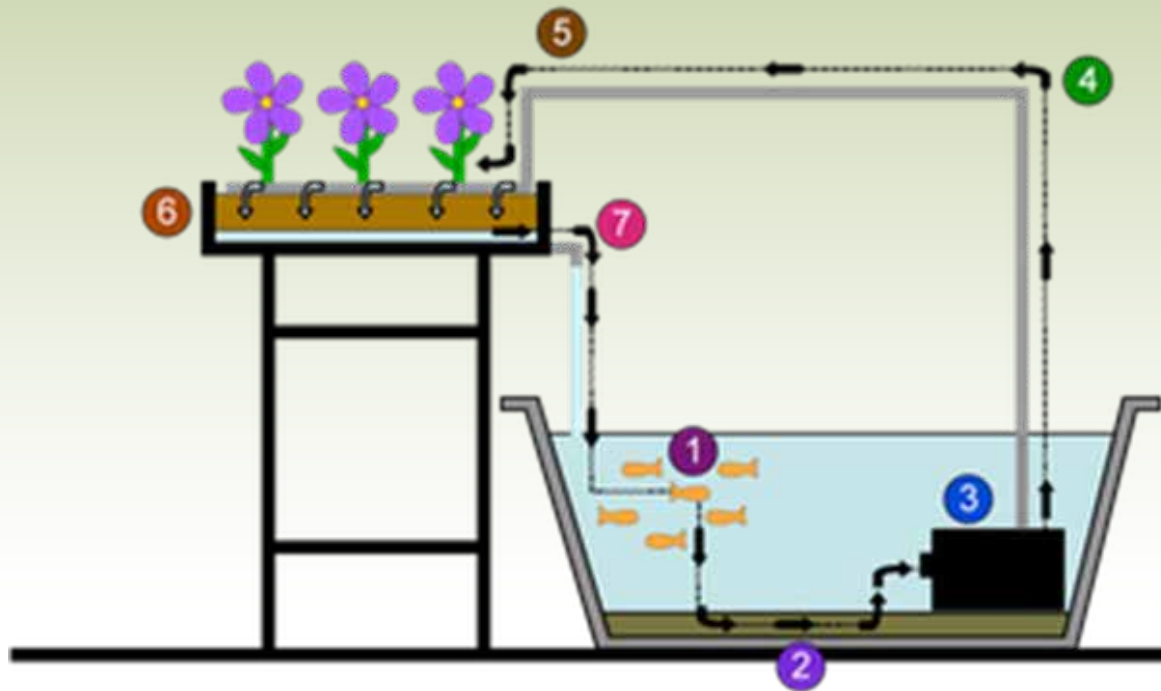


# Advantages

- Uses only approximately 10% of the water required for traditional farming
- No soil required for growing plants
- Year round production
- No pesticides
- Faster growing, high quality vegetables
- Can harvest plants 7-10 days sooner
- Plants can be spaced closer together due to constant nutrient replenishment
- Closed system. No discharge into streams, lakes, etc.

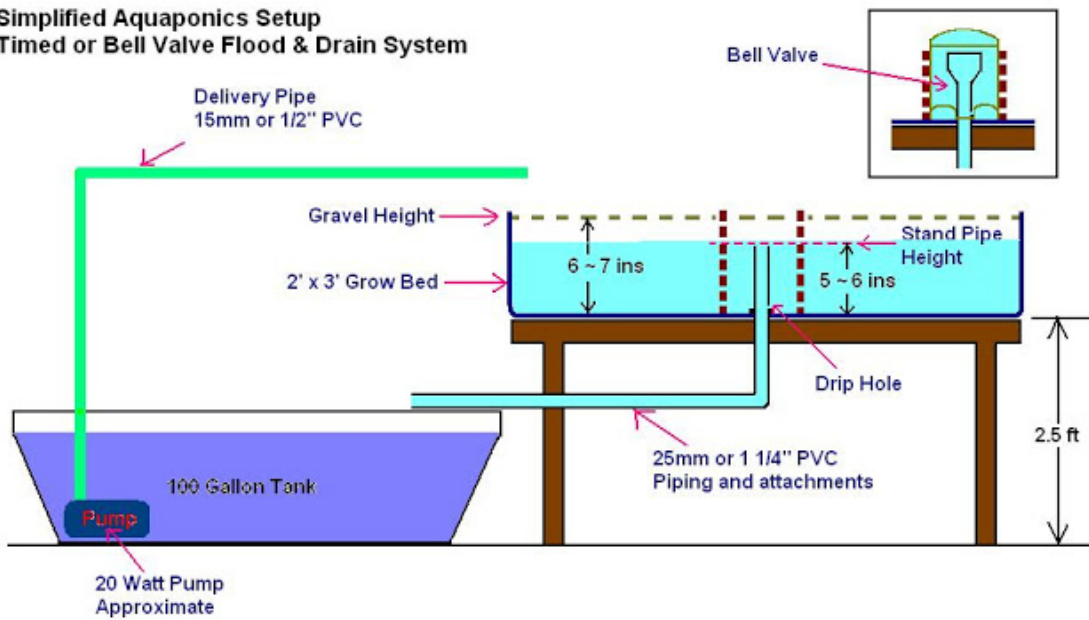
# Basic System

Basic system consists of a tank, pump, plumbing, grow bed, grow media, plants, fish and light source.



# Basic System Overview

## Simplified Aquaponics Setup Timed or Bell Valve Flood & Drain System



<http://affnan-aquaponics.blogspot.com>



# Aquaponics Commercial System Design

- Fish Tanks
- Plumbing
- Filtration
- Grow Beds





# What Grows Well?

- Lettuce
- Basil
- Other Herbs
- Cucumbers
- Tomatoes
- Cabbage
- Peppers



\*\*Heavy feeders (Tomatoes, Cucumber, etc.) require a well stocked system.

# The Fish

- Tilapia
- Bluegill
- Trout
- Gold Fish
- Bass

## Tilapia

1. Grows rapidly (7-9 months to full growth)
2. Tolerant of poor water conditions
3. Feed to weight conversion of approx. 1:1
4. Good Filets
5. Excellent protein source



# How Much Can We Grow?

- Depends on the size of the system and type of plants we are growing.
- Typically, can grow 10% - 15% more plants than what grows in the same size traditional plot. Can get up to 30% more production with intensive system.
- Standard 4'x4' growing bed will hold 30 – 40 heads of lettuce with approximately 35 – 45 days to maturity. Longer maturity dates may occur in winter due to low light conditions.

# System Types

- Flood and Drain – Normally used for Backyard systems
- Nutrient Film Technique (NFT)
- Floating Raft or Deep Water Culture



# Floating Raft

- Also known as Deep Water Culture
- Plants grow in net pots placed in Styrofoam sheets that float on top of the water.
- Must aerate the water and keep water very clean
- Need approximately 10-12 inches of water

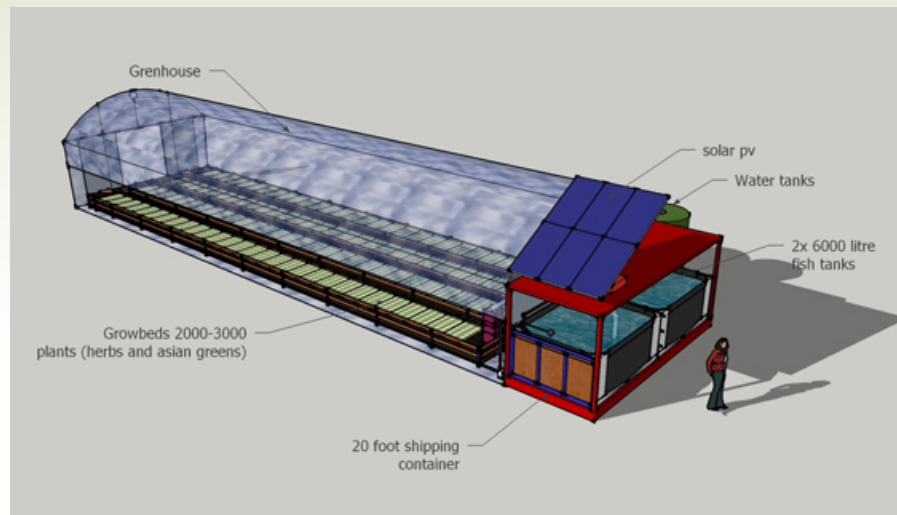


# Nutrient Film Technique (NFT)

- Plants grow in net pots that sit in material very similar to rain gutter
- Holes are drilled in the gutters to hold the net pots
- Plants receive nutrient via a thin stream of water from the fish tank that runs beneath the roots
- Power outage is a risk to the plants
- Requires additional filtration



# Designs Based Upon Available Space/Funds



# Small Scale Expectations

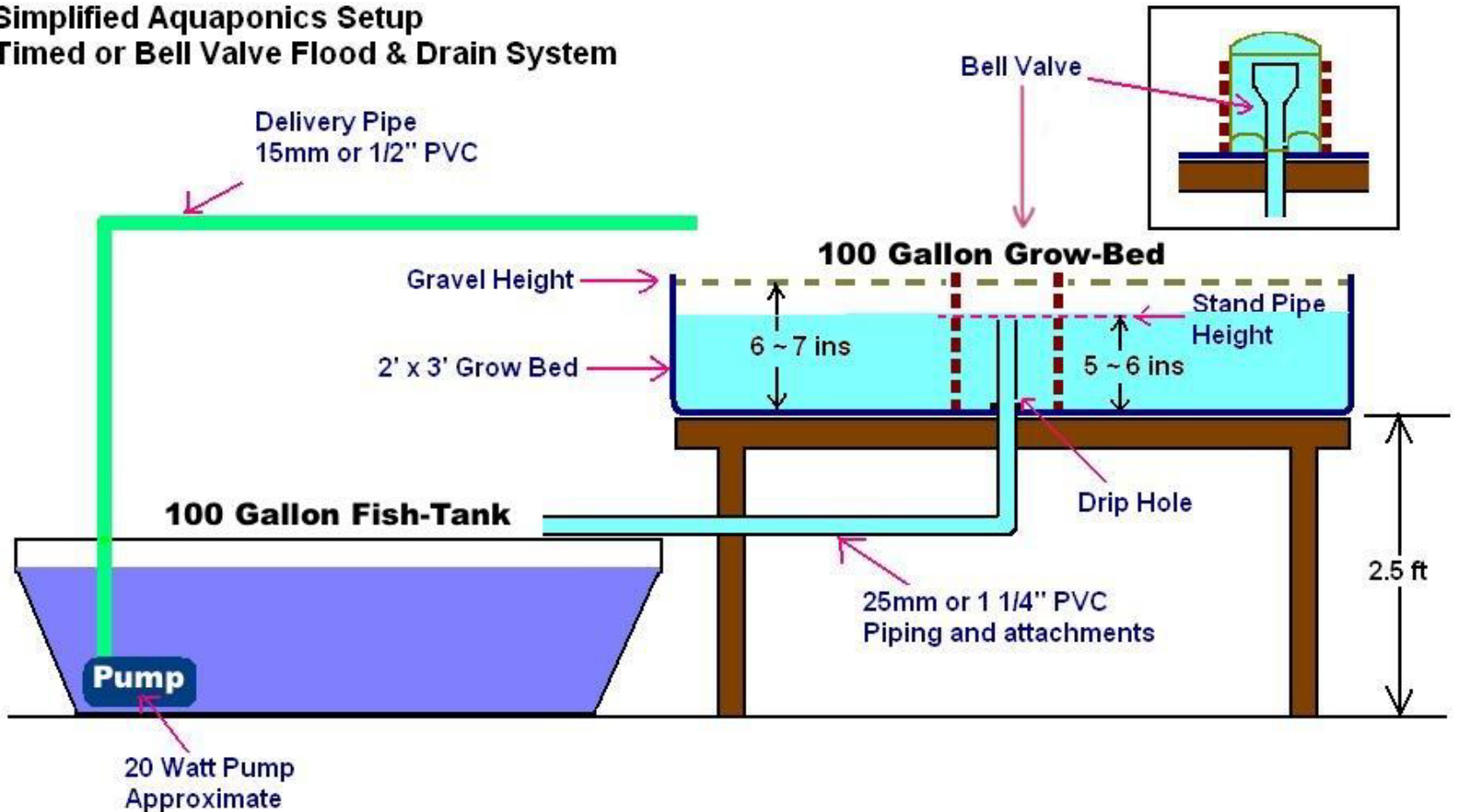
- 1500sqft of grow space
- 1500 gallons of fish tank
- 11,000 gallons of total system volume
- Approximately 500lbs of fish
- 40,000 heads of lettuce per year





# Flood and Drain

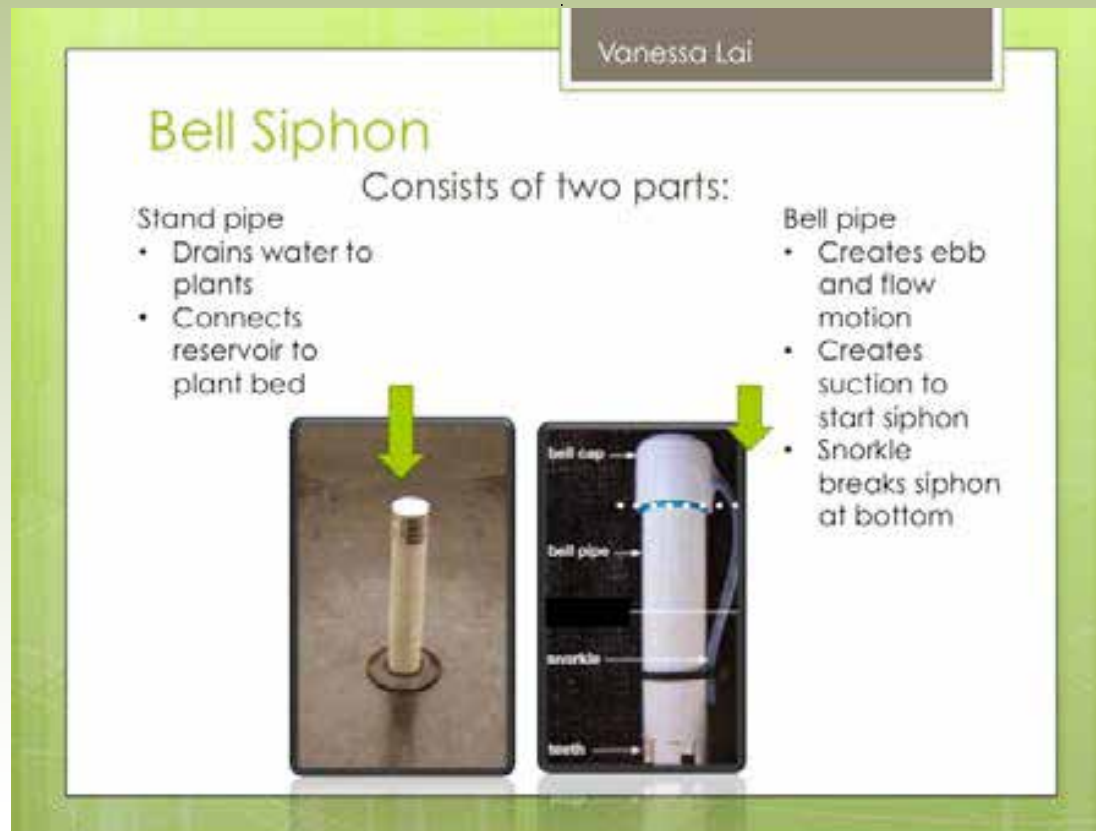
## Simplified Aquaponics Setup Timed or Bell Valve Flood & Drain System





# Auto Siphons

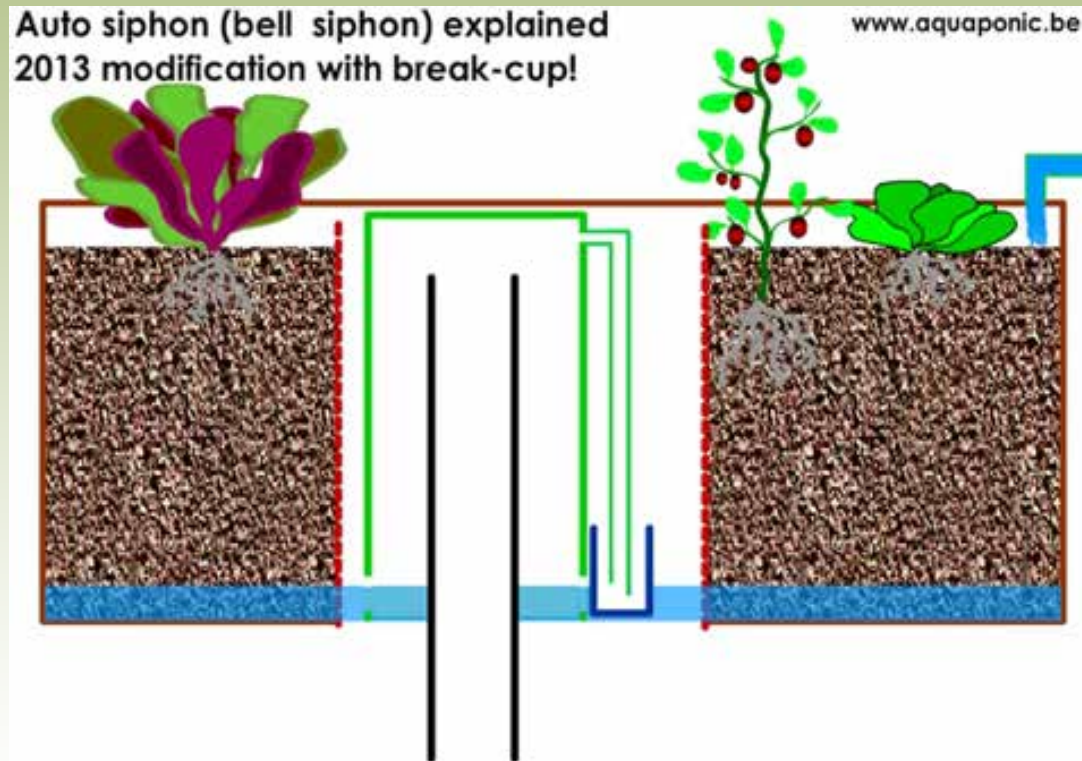
- Used to drain water from media based systems



# Complete Bell Siphon Systems



# How Does It Work?



# Bell Siphon Installation

- Drill hole for Uniseal or tank adapter
- Insert stand pipe



# Growing Media For Flood and Drain Systems

Pea Gravel, River Rock, Gravel, Clay Balls



Flood and Drain



# Liners

- EPDM Pond Liners are good
- Do not use roofing materials
- Be careful with used tarps (chemicals, paint, etc)





# Air Pumps



# Water Pumps

- Pump should cycle total volume of tank water once each hour
- If pump is on a 15 minute timer, it should be sized to pump total tank volume in 15 mins



# Filtration

- It is important to keep solids to a minimum in the system.
- Biological filtration is the most critical part of the system for ensuring proper water quality and controlling ammonia.
- Media based systems do not need separate filtration components. Can use compost worms in a grow bed.



# Lighting

- Sunlight is best
- Standard Fluorescent Fixtures
- Full Spectrum Fluorescent bulbs work as well
- Some people use LED Lighting or High Pressure Sodium Grow Lights



# Timers

- Control Lights and Pumps



# Basic System Design

- Determine the type of system (Assume media based for this example)
- Determine square foot size of your grow bed
- Use the ratio of 1lb of fish per 1sqft of grow bed space with the grow bed being 1ft deep.
- Calculate fish tank volume using roughly 5-7 gallons of water per pound of fish

## SAMPLE

4'X4' grow bed = 16sqft

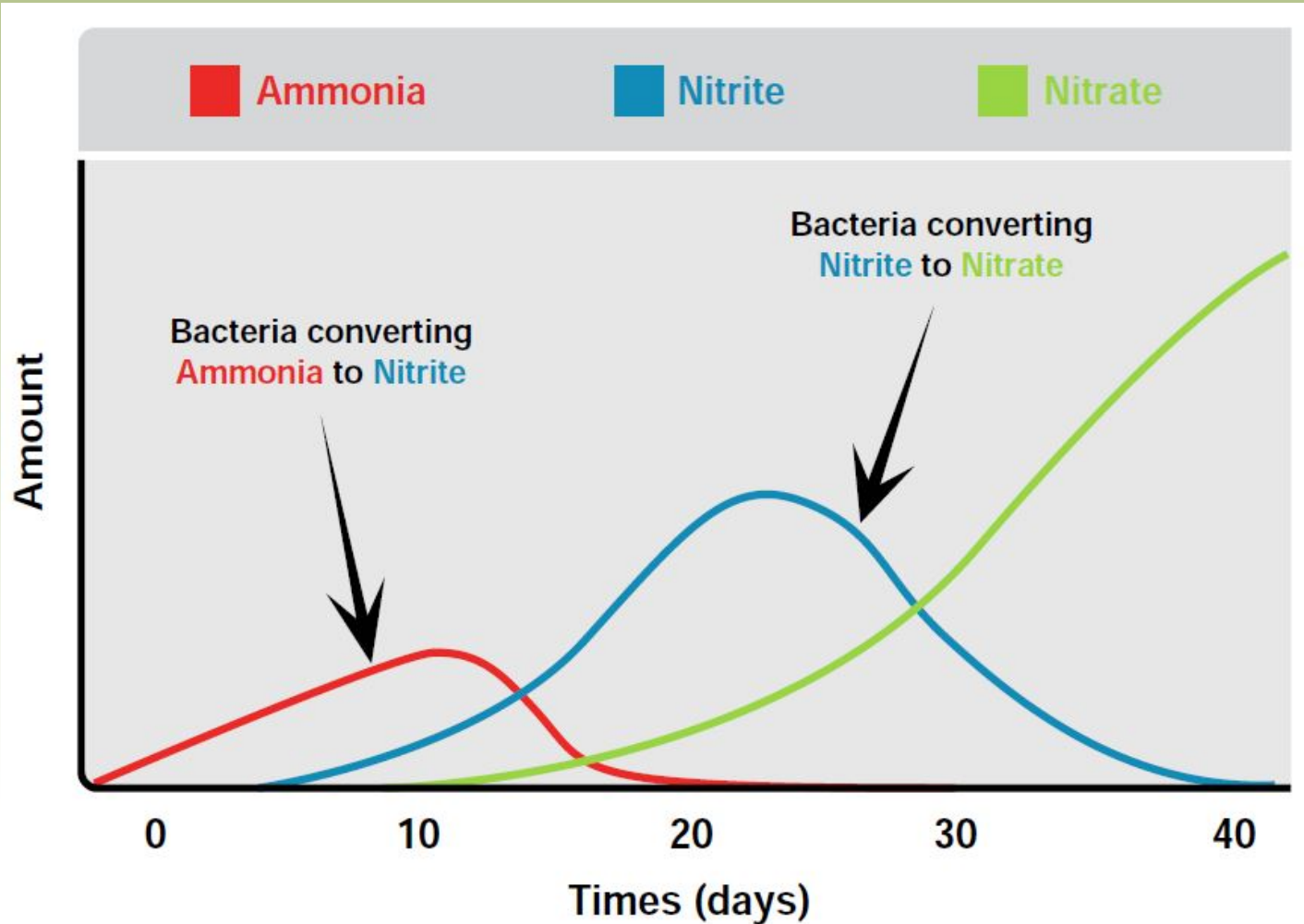
16sqft of grow bed = 16lbs of fish

16lbs of fish requires roughly 80 (16lbs x 5 gallons per lb) gallons of water

# Cycling Your Aquaponic System

- Process of growing enough bacteria to effectively break down the ammonia in the system into useable nutrients for the plants
- Fish Cycling – Add a few fish to the system to provide ammonia and start the process of attracting the beneficial bacteria
- Fishless Cycling – Add ammonia to the system. Benefit is you can add more ammonia to the system without harming any fish
- Can take 4-6 weeks to complete this process

# Cycling Diagram







# Seedling Grow Media

- Coir (Coconut Husk)
- Rockwool
- Rapid Rooter Cubes



# Growing Seedlings

- Lighting is important
- Stand is not necessary
- A window works fine



# Feeding Your Fish

- On average, fish eat about 1.5% of their body weight daily.
- If you have 50 lbs of fish, multiply  $50\text{lbs} \times 1.5\% = 0.75\text{lbs}$  of fish feed daily
- If needed, convert lbs to grams ( $1\text{lb} = 454$  grams)
- $0.75\text{lbs} = 340.5$  grams
- Watch your fish eating to help determine if they are receiving the proper amount of feed
- Commercial Feeds
- Duckweed, Sunflower Cake, Etc.



# Considerations

- Location (Indoors, Outdoors, etc.)
- Type of materials (Liners, Pipes, Frames, etc.)
- Type of fish food as plants receive nutrients from the contents of the fish food
- Access to electricity
- Access to water
- Sunlight (Unless growing indoors)
- Time available to take care of the system
- Budget

# Budgets

- Small Systems >\$1200
- Medium Systems \$1,200 - \$10,000
- Large Systems \$10,000+



# Things To Watch

- Chlorine and Chloramine in municipal water
- Water Quality, Dissolved Oxygen, Solids, Pest Management
- Approximately 25% of feed becomes solid waste
- Have to remove solids before they enter hydroponic portion of system
- Solids can cause anaerobic conditions and affect water quality and nutrient uptake
- Decomposing solids consume oxygen and produce ammonia

# Marketing Options



- Restaurants
- Grocery Stores
- Microgreens
- Salad Greens
- Various Sprouts
- Specialty Crops





# Local Small Farm Options

## Greenfin Gardens



# Wagner South Dakota



# Other Types of Systems



IBC Totes

# Barrel Ponics

- Uses 55 Gallon Food Grade Drums



# Getting Creative

- Using recycled materials
- Food Grade



# Or Just Do This!



# What's Possible?





- \$315,000 EDA Grant
- \$150,000 Farm Credit Services of America Grant





# The Future





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