

PLANT AND PEST MANAGEMENT IN AQUAPONICS



D. Allen Pattillo • Aquaculture Extension Specialist
Department of Natural Resource Ecology and Management

Plant Functions in Aquaponics

- Enhanced Biofiltration
 >>Surface Area
- Nutrient Uptake
 Ammonia & Nitrate
- Additional Revenue
 Stream
 >75% of total revenue

Hydroponic Units

- Where the plants are grown
- Must maintain moisture and high oxygen concentrations for plant roots
- Options:
 - Floating raft
 - Flood and drain
 - Nutrient film technique
 - Towers
 - Aeroponics



Potential Plant Issues

- Deficiencies
 - Nutrients
 - Light
 - Moisture
- Temperature Stress
- Insect Predation
- Food Safety

All Impact Harvest Yield

Nutrient Deficiencies

Yellowing, reduced growth rates, and reduced flavor quality can be caused by nutrient imbalances



Deficiencies related to source water and feed additives

Use a feeding ration for design calculations

- For a raft hydroponic system the optimum ratio varies from **60 to 100 g/m²/day**.
 - **35% Protein Feed**
- For example:
 - 1,000 g feed per day will fertilize 16.7 m² for a feeding rate ratio of 60 g/m²/day.



Implications of Protein in Feed

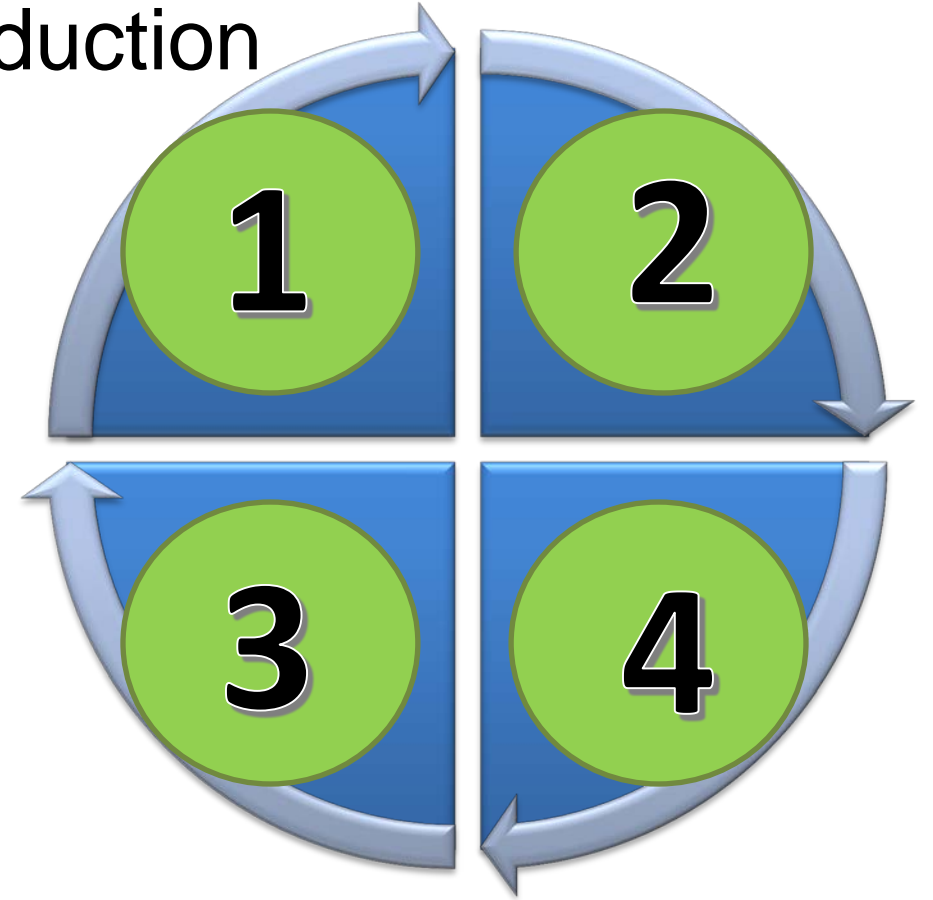
- Higher protein = higher nitrogen
 - Protein is generally ~6.25% nitrogen
 - Nitrogen affects plant growth
 - Leafy greens use more N
 - Fruiting plants need more K
- Protein source relates to sustainability
 - Fish meal vs. plant protein meals



Feed Consistently

Feed = Fertilizer

- Multiple rearing tanks, staggered production
 - four tilapia rearing tanks
 - Stock & Harvest every 6 weeks
 - All-in/all-out production (per tank)



Keep Plant Density Consistent

**Plants provide critical
filtration!!**

Single rearing tank with
multiple size groups of plants

- 6-week growout time for plants will require
- Harvest plants weekly or bi-weekly
- restock equal number of seedlings



SOW SEEDS

Week 1

Week 2

TRANSPLANT

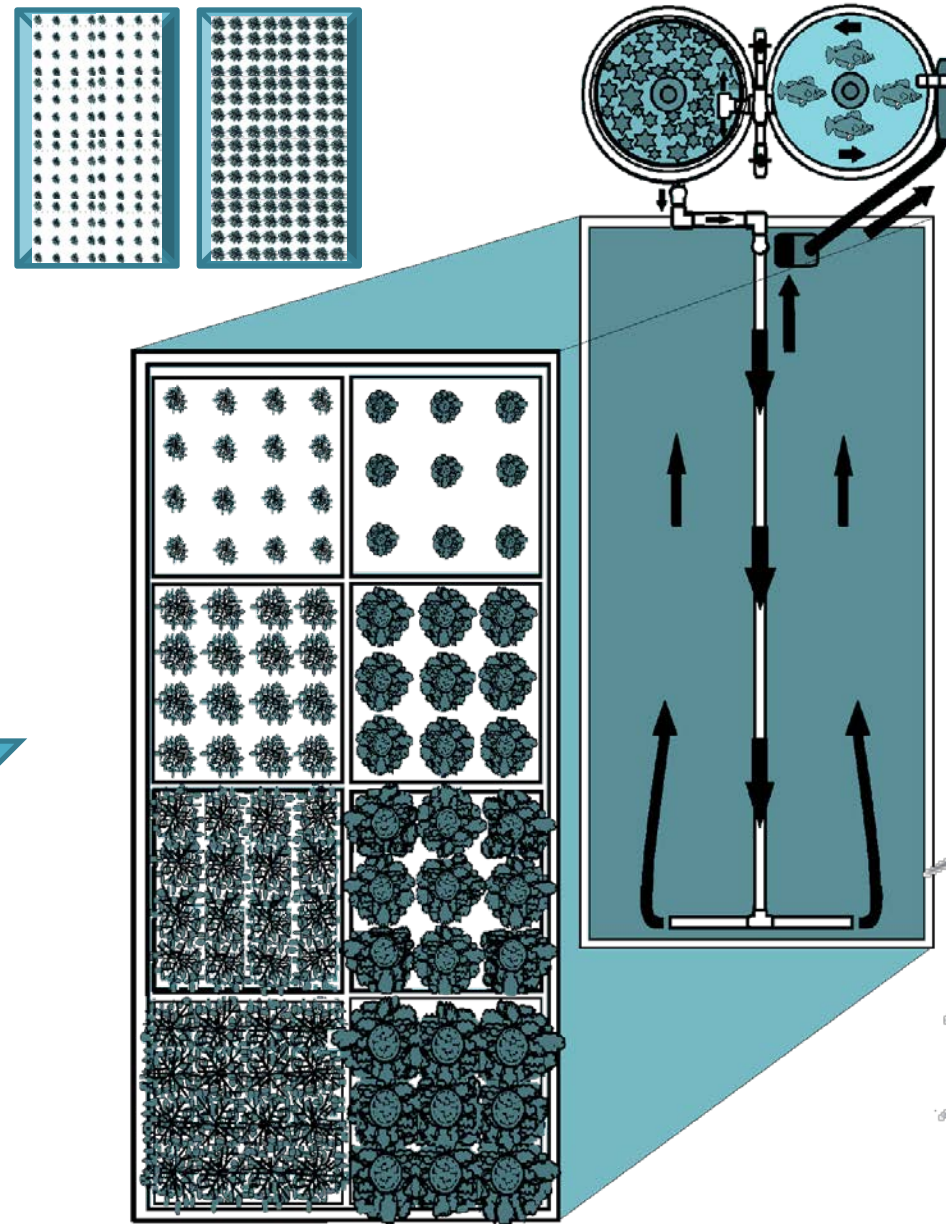
Week 3

Week 4

Week 5

Week 6

HARVEST



Ensure adequate biofiltration

- **Surface Area**

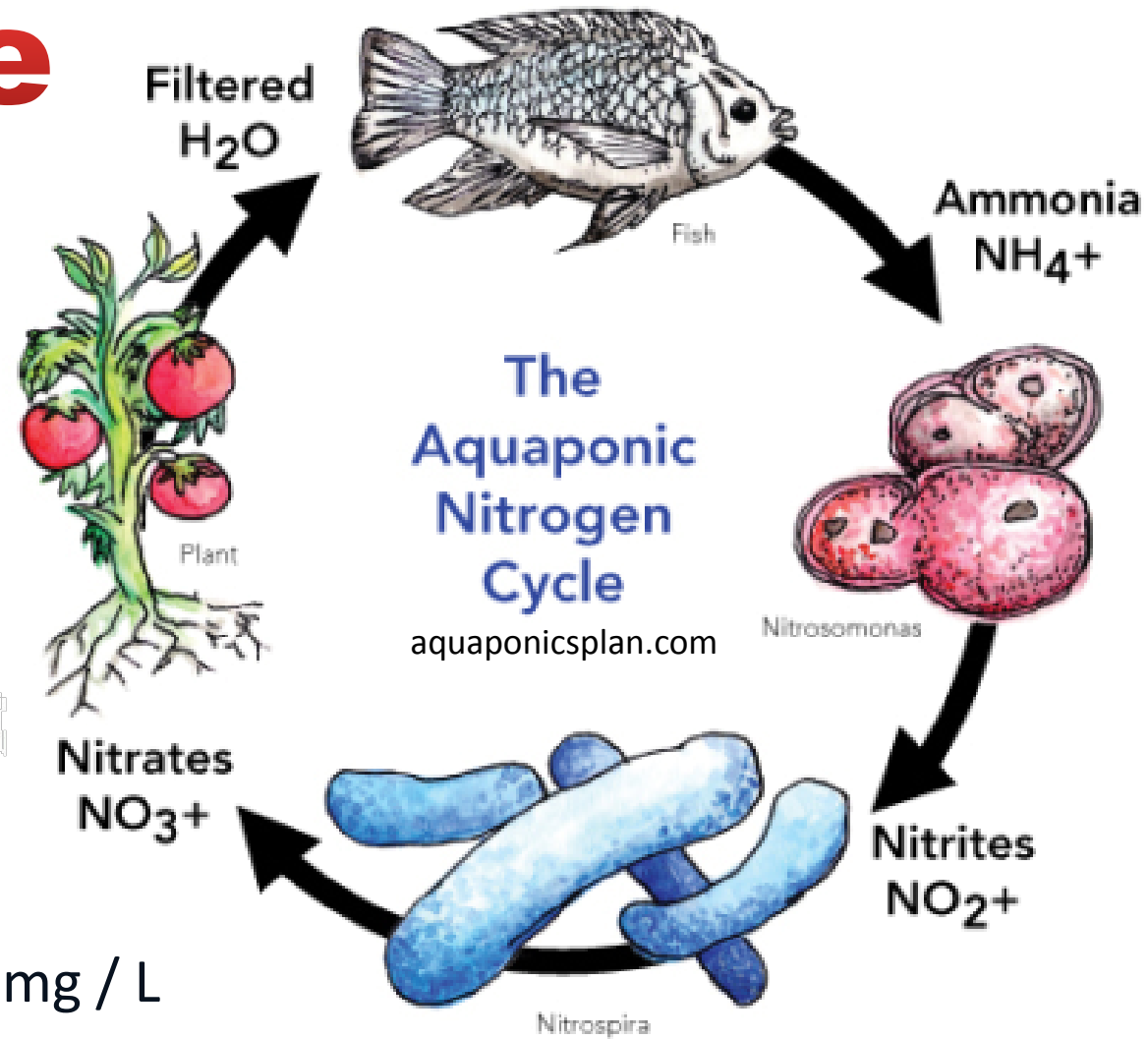
- Living Space for the Nitrifying Bacteria
- Competition for that Space

- **Food**

- ammonia or nitrite
- $> 0.07 \text{ mg / L}$

- **Good Living Conditions**

- Dissolved Oxygen going into the biofilter $> 4 \text{ mg / L}$
- pH 7.2 – 8.8
- Alkalinity $> 200 \text{ mg / L as CaCO}_3$



Aeration

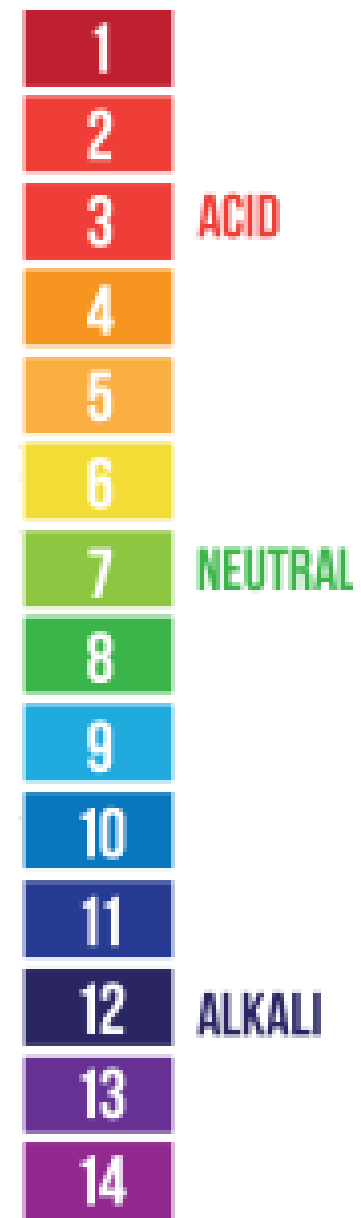
- The fish, plants and bacteria in aquaponic systems require adequate levels of **dissolved oxygen** maximum health and growth.
 - **Maintain DO at >5 mg/liter**



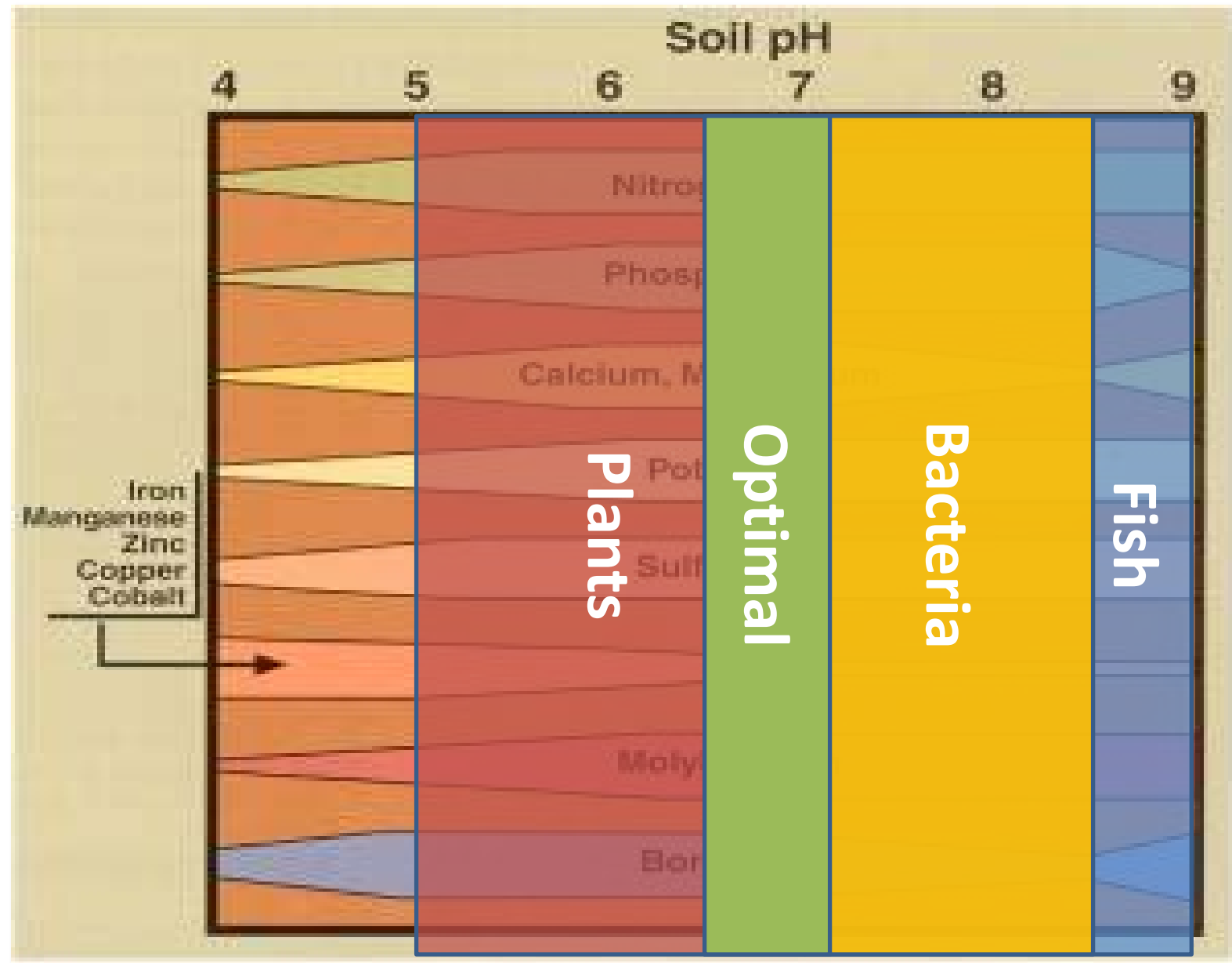
Control pH

Affects All Biological Processes

- Nitrification
 - >pH 7.5 ideal
 - Stops < 6.0
- High pH plants display nutrient deficiencies
- High pH ammonia toxicity



Optimal
pH 6.5
to 7.2



Nutrient Supplementation

Fish feed provides 10 out of 13 macro and micro nutrients

- **Iron**
 - Chelated Iron (EDTA)
- **Calcium**
 - Agricultural Limestone
 - Calcium Carbonate (CaCO_3)
 - Hydrated Lime
 - Calcium Hydroxide ($\text{Ca}(\text{OH})_2$)
 - Calcium Chloride (CaCl_2)
- **Potassium**
 - Muriate of Potash
 - Potassium chloride (KCl)
 - Potassium Hydroxide (KOH)



Be careful with aggregates

- Organic solids may tend to clog aggregates such as pea gravel, sand and perlite
 - Creates anaerobic conditions (low DO)
 - Kills plant roots
 - Kills beneficial bacteria
 - Can be mitigated by adding worms to aggregate substrate to process organics



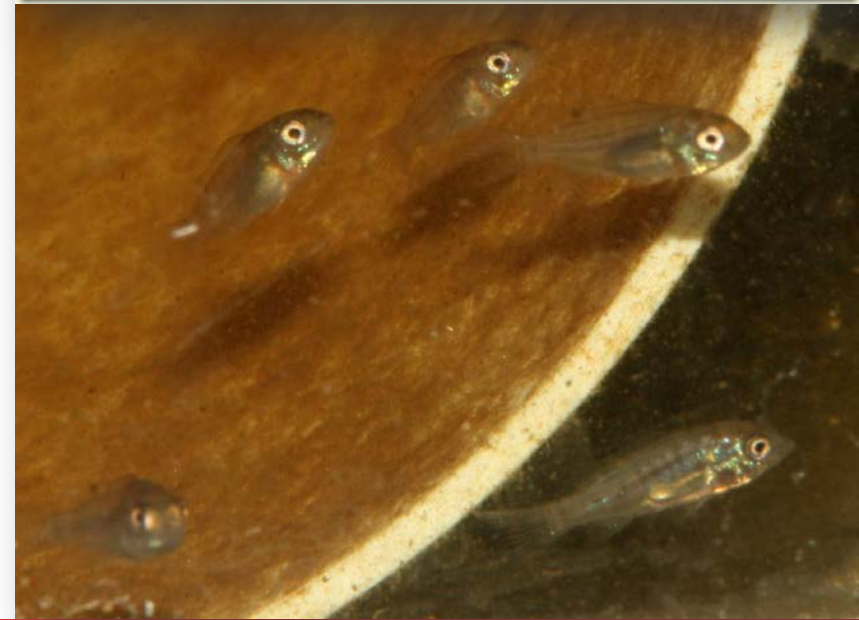
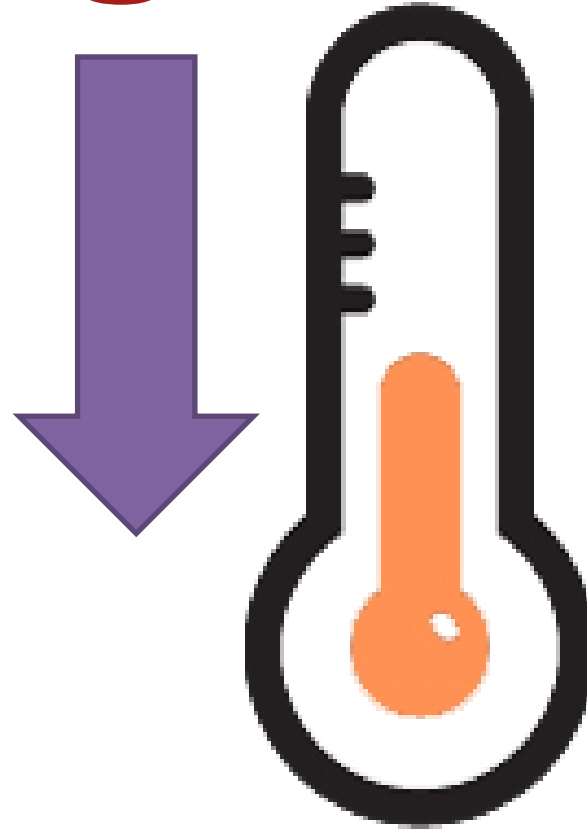
Prevent Biofouling

- Use **oversized pipes** to reduce the effects of biofouling
 - dissolved organic matter promote the growth of filamentous bacteria restricts flow within pipes



Prevent Biofouling

- Spaghetti tubes will likely clog - avoid
- Juvenile tilapia in drain lines reduce biofouling by grazing on bacteria
- Lower water temperatures reduce biofouling



Temperature Matters!

Plan growth cycles for plans based the time of year and the growth requirements of the fish grow in conjunction with market demands!

Air temperature (°F)										
46	50	54	58	62	66	70	74	78	82	86
Parsley										
Chives										
Dill										
			Mint							
			Oregano							
				Cilantro						
					Rosemary					
					Sage					
							Basil			

Supplemental Lighting

- Necessary for winter months and indoor culture
- Efficiency is critical to economic viability
- Light spectrum and photoperiod affects fruiting of plants



HPS vs



LED

Water Quality

Daily Testing

- Dissolved oxygen (DO)
- Temperature
- pH

Twice Weekly Testing

- Total ammonia nitrogen (TAN)
- Nitrite
- Nitrate
- Alkalinity

Twice Monthly Testing

- Phosphorus
- Calcium hardness
- Iron
- Potassium



Pest Issues



Non-Toxic Pest Control

- **Pesticides** must not be used to control insects and plant diseases because many are **toxic to fish** and none have been approved for use in food fish culture.
- **Therapeutants** for treating fish parasites and diseases **may harm beneficial bacteria and vegetables** may absorb and concentrate them.



Cultural Control



Lighted Insect Traps



Sticky Traps

Cultural Control



Insect Screening



Diatomaceous Earth



Parasitic Wasp

Praying Mantis



Lacewing

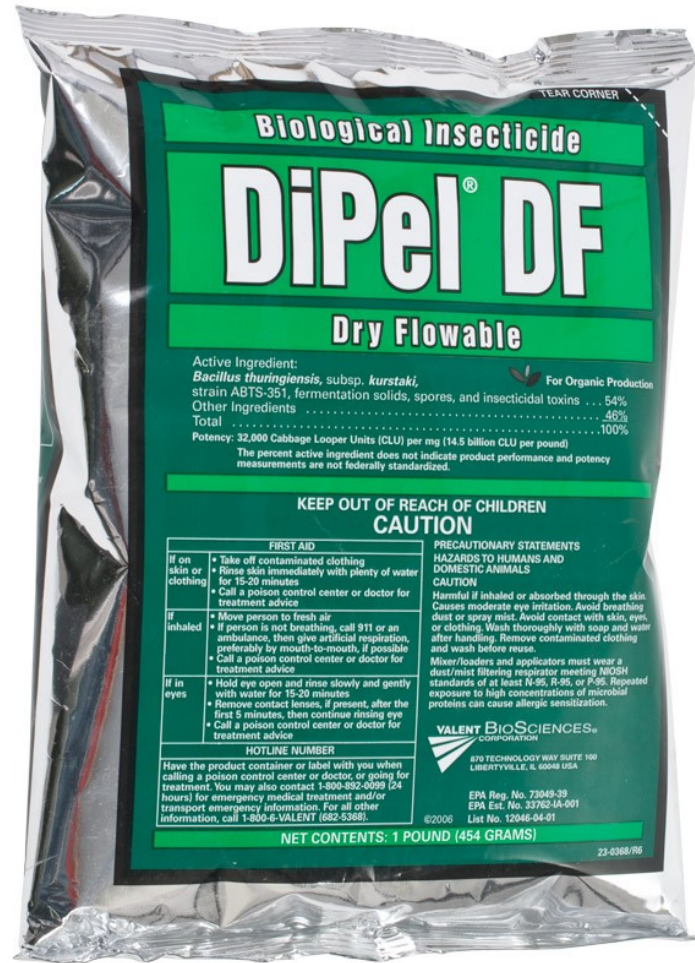
Lady Bug



Biological Control

Non-Toxic Treatments

Bacillus thuringiensis
(Bt) for
Catepillars

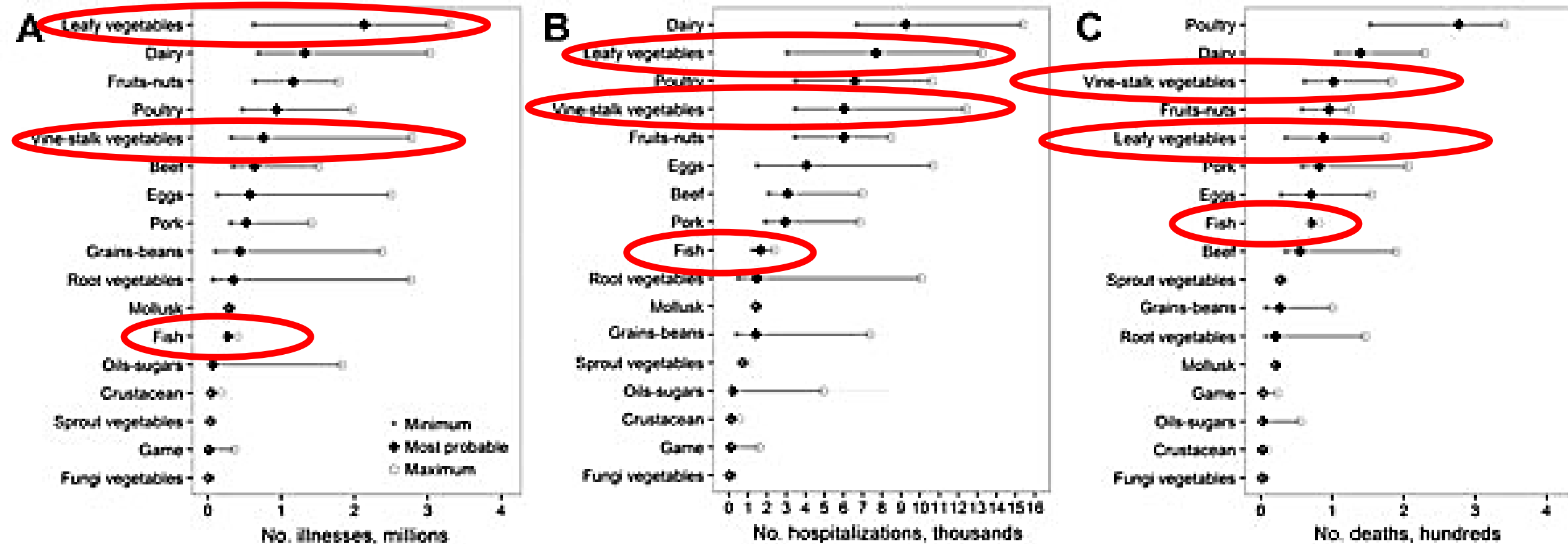


Essential
Plant
Oils



Food Safety Threats

(Greatest to Least)



Why is produce risky?

1. Raw
2. Wrinkly
 - High Surface Area
3. Sticky
 - Covered in Biofilm



Biofilms and Pathogens

- Plant matter is coated in a living substance called biofilm that contains beneficial and harmful microbes
- Biofilms are sticky and may harbor pathogens like:
 - *Listeria*
 - *Salmonella*
 - *Aeromonas*

Reducing Food Safety Risks

- Good Agricultural Practices (GAPs)
- Use of water and food sterilization methods
 - Ultraviolet Irradiation
 - Ozone
 - Hydrogen peroxide
 - Others

Plant Harvest

Hollyer et al. 2009. On-farm Food Safety: Aquaponics.
<http://www.ctahr.hawaii.edu/oc/freepubs/pdf/fst-38.pdf>



GOOD HARVESTING TECHNIQUE:
With *washed* hands, or washed hands covered with clean disposable gloves, touch *only* the produce when harvesting.



DO NOT touch the raft or the water underneath the raft during harvesting. That contaminates your hands or gloves with bacteria, which can then contaminate the produce.



For the same reason, **DON'T** touch the root system or growing cup when harvesting.

Plant Harvest

- Rapidly cool plant to food-safe temp. ASAP!
- Clean produce appropriately
- Store plants under proper temps until consumed
- Be aware of regulations associated with processing
- Iowa Department of Inspections and Appeals



Food Safety Resources

- The Ohio State University
 - <http://foodsafety.osu.edu/>
- Iowa State University
 - <http://www.extension.iastate.edu/foodsafety/>
- University of Minnesota
 - www.Extension.umn.edu/foodsafety
- Penn State
 - <http://extension.psu.edu/food/safety>



Contact Info:

D. Allen Pattillo

Aquaculture Extension

515-294-8616

Pattillo@iastate.edu

- www.NCRAC.org
- <http://www.nrem.iastate.edu/fisheries/>