

A Commercial-Scale Aquaponic System

Developed at the University of the Virgin Islands

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UVI-AES
FARM STORE
TUES-FRI, 9-4
92-4221
FRESH PRODUCE

GROWING
LTHY

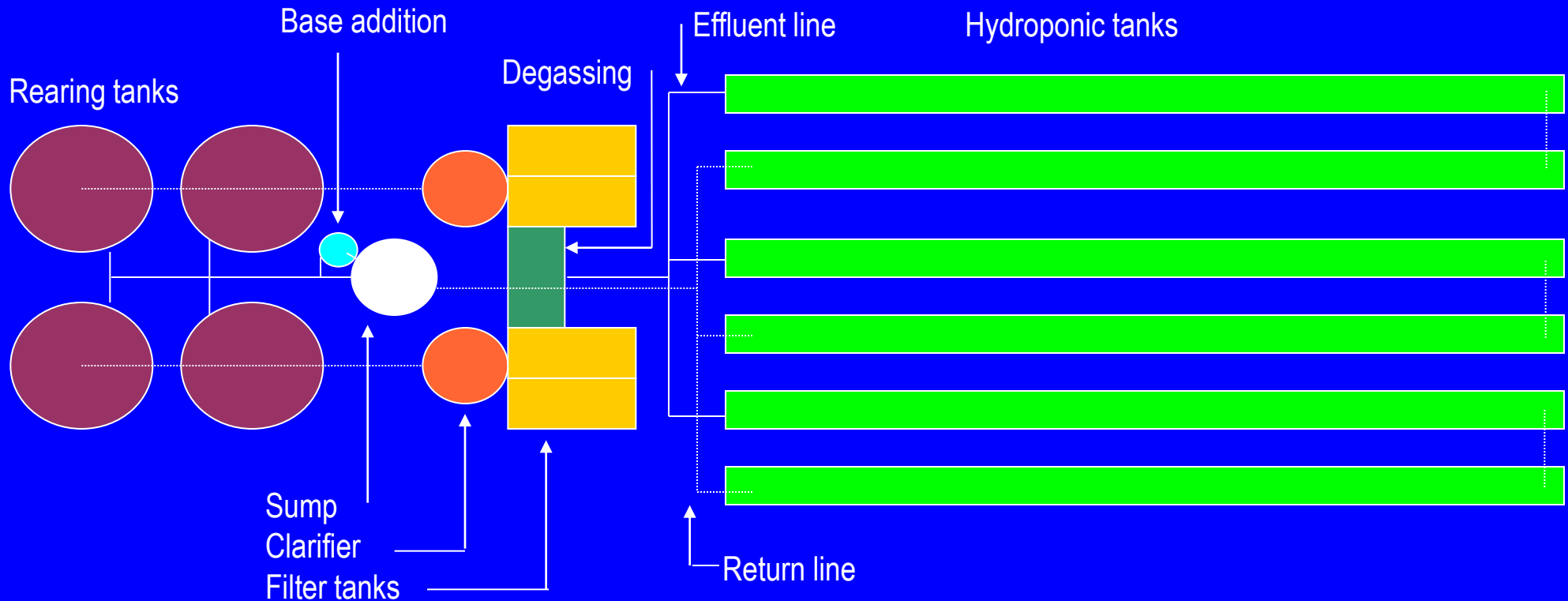
SPRING HOPERS



Advantages of Aquaponics

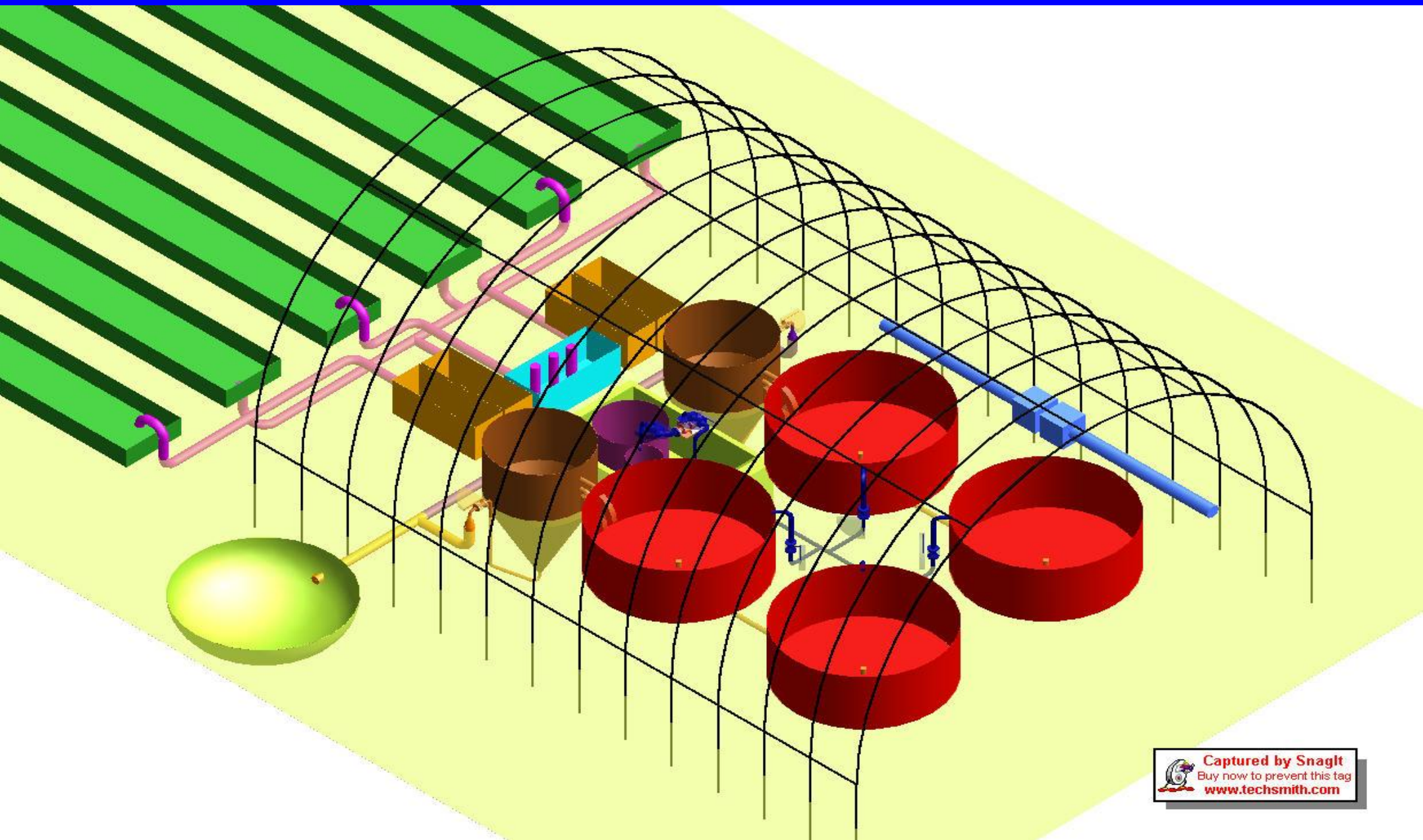
- ◆ Fish provide most nutrients required by plants
- ◆ Plants use nutrients to produce a valuable by-product
- ◆ Hydroponic component serves as a biofilter
- ◆ Hydroponic plants extend water use and reduce discharge to the environment
- ◆ Integrated systems require less water quality monitoring than individual systems
- ◆ Profit potential increased due to free nutrients for plants, lower water requirement, elimination of separate biofilter, less water quality monitoring and shared costs for operation and infrastructure.

System Layout



Total water volume, 110 m³

Land area - 0.05 ha





System Design

- ◆ Four fish rearing tanks, 7.8 m³ each
- ◆ Two cylindro-conical clarifiers, 3.8 m³ each
- ◆ Four filter tanks, 0.7 m³ each
- ◆ One degassing tank, 0.7 m³
- ◆ Six hydroponic tanks, 11.3 m³ each
- ◆ Total plant growing area, 214 m²
- ◆ One sump, 0.6 m³
- ◆ Base addition tank, 0.2 m³
- ◆ Total water volume, 110 m³
- ◆ Land area - 0.05 ha



Treatment Processes

- ◆ Air stones, 22 in each rearing tank, 24 in each hydroponic tank
- ◆ Solids removal, three times daily from clarifier, filter tank cleaning one or two times weekly
- ◆ Continuous degassing of methane, CO_2 , H_2S , N_2
- ◆ Denitrification in filter tanks
- ◆ Direct uptake of ammonia and other nutrient by plants
- ◆ Nitrification in hydroponic tanks and water column
- ◆ Retention time: rearing tank, 1.37 h; clarifier, 20 min, hydroponic tanks, 3 h



























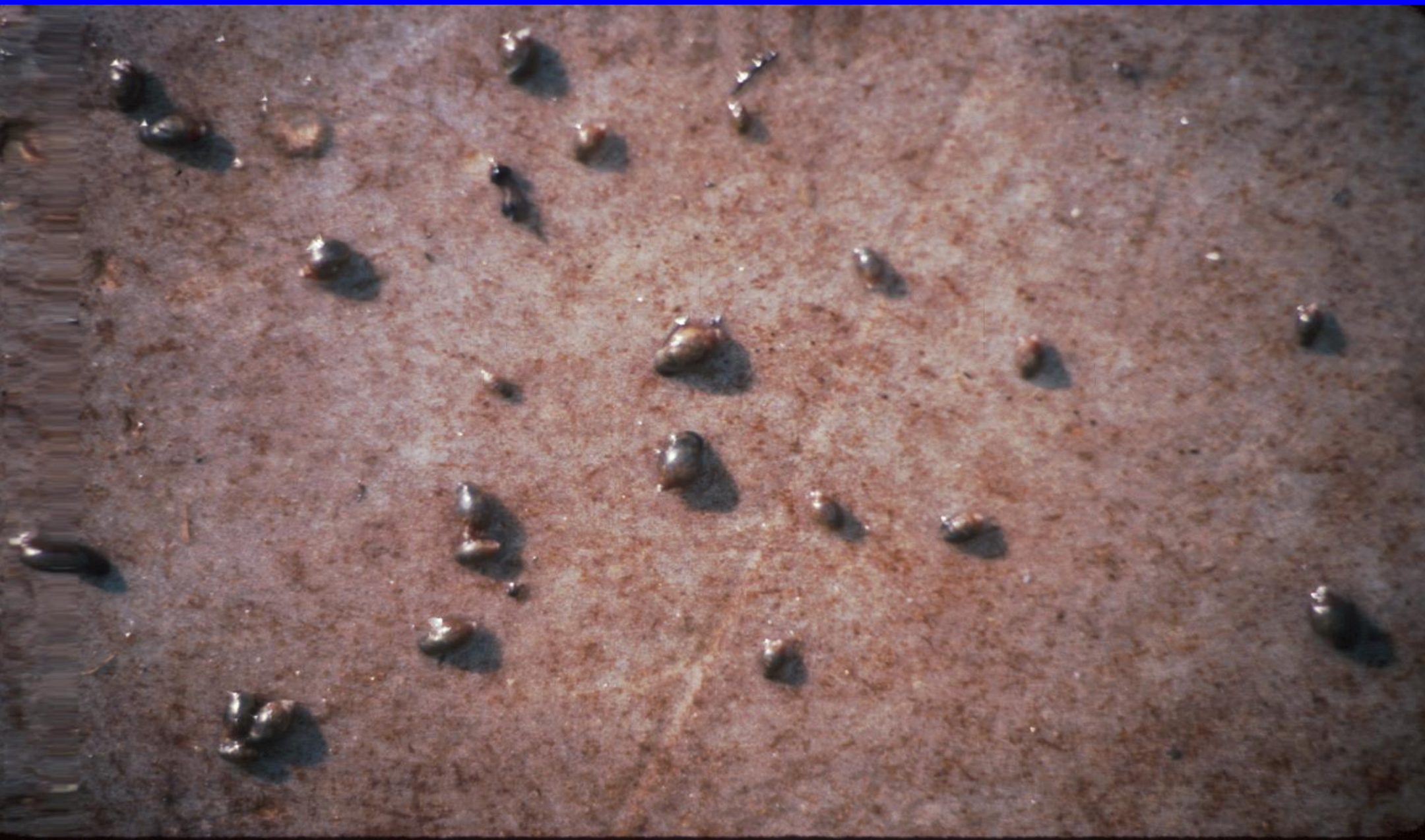
Treatment Characteristics

- ◆ Removal rates using romaine lettuce (g/m²/d):
 - NH₃-N, 0.56
 - NO₂-N, 0.62
 - Total nitrogen, 0.83
 - Total phosphorous, 0.17



Raft Hydroponics

- ◆ Advantages: no tank size limitation, no root clogging, maximum exposure of roots to water, sheets shade and cool water, plants not affected when water pump stops, easy to harvest
- ◆ Disadvantages: roots vulnerable to damage by zooplankton, snails and other organisms (use tetras to control zooplankton and red ear sunfish to control snails)



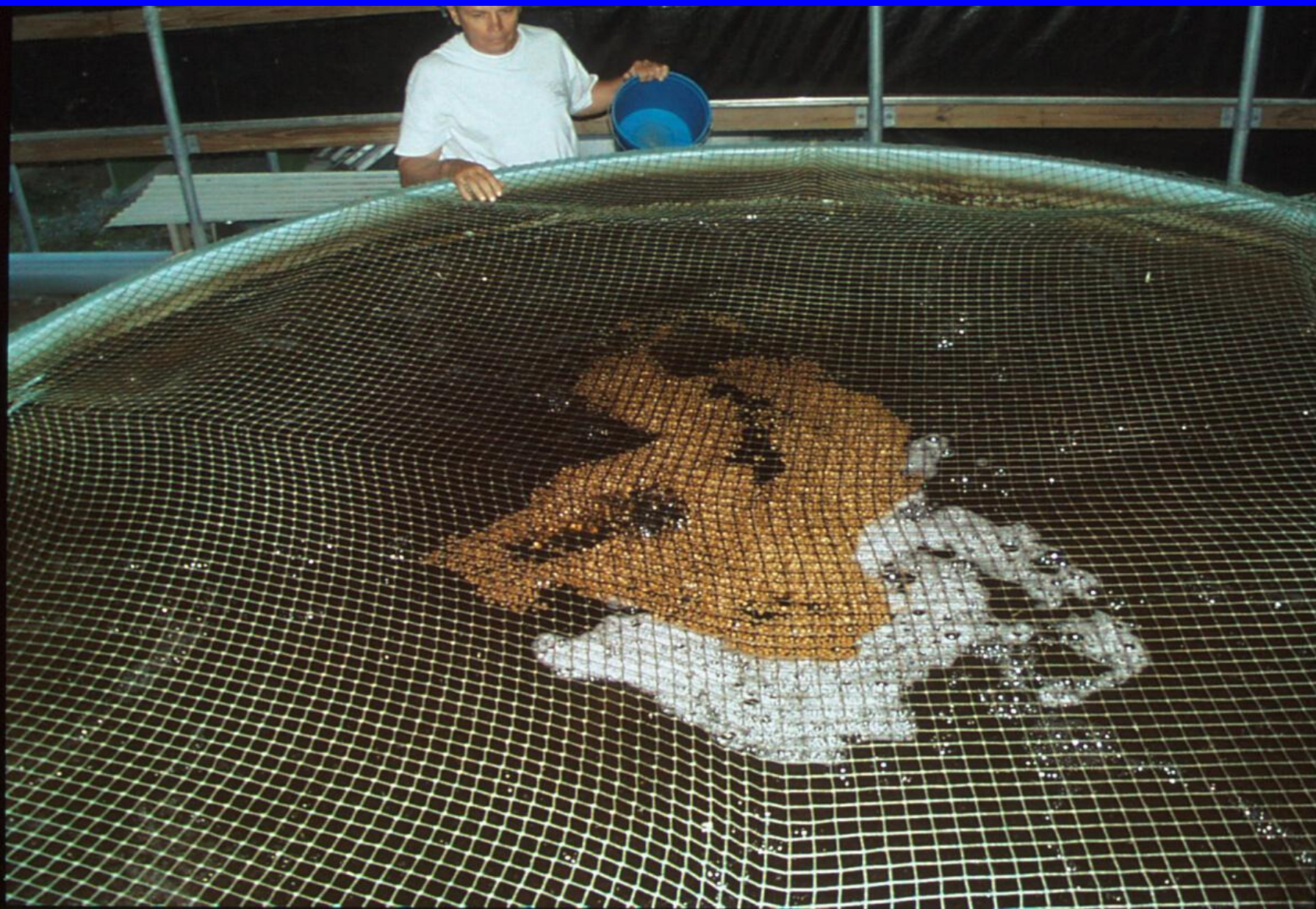


Important Principles

- ◆ Optimum feeding rate, 60 - 100 g/m² plant area/day prevents nutrient accumulation or deficiency
- ◆ Slow removal of solids increases mineralization
- ◆ Frequency of filter tank cleaning controls nitrate levels through denitrification
- ◆ Treatment capacity of hydroponic tanks is equivalent to 180 g of feed/day/m² of plant area

Production Management

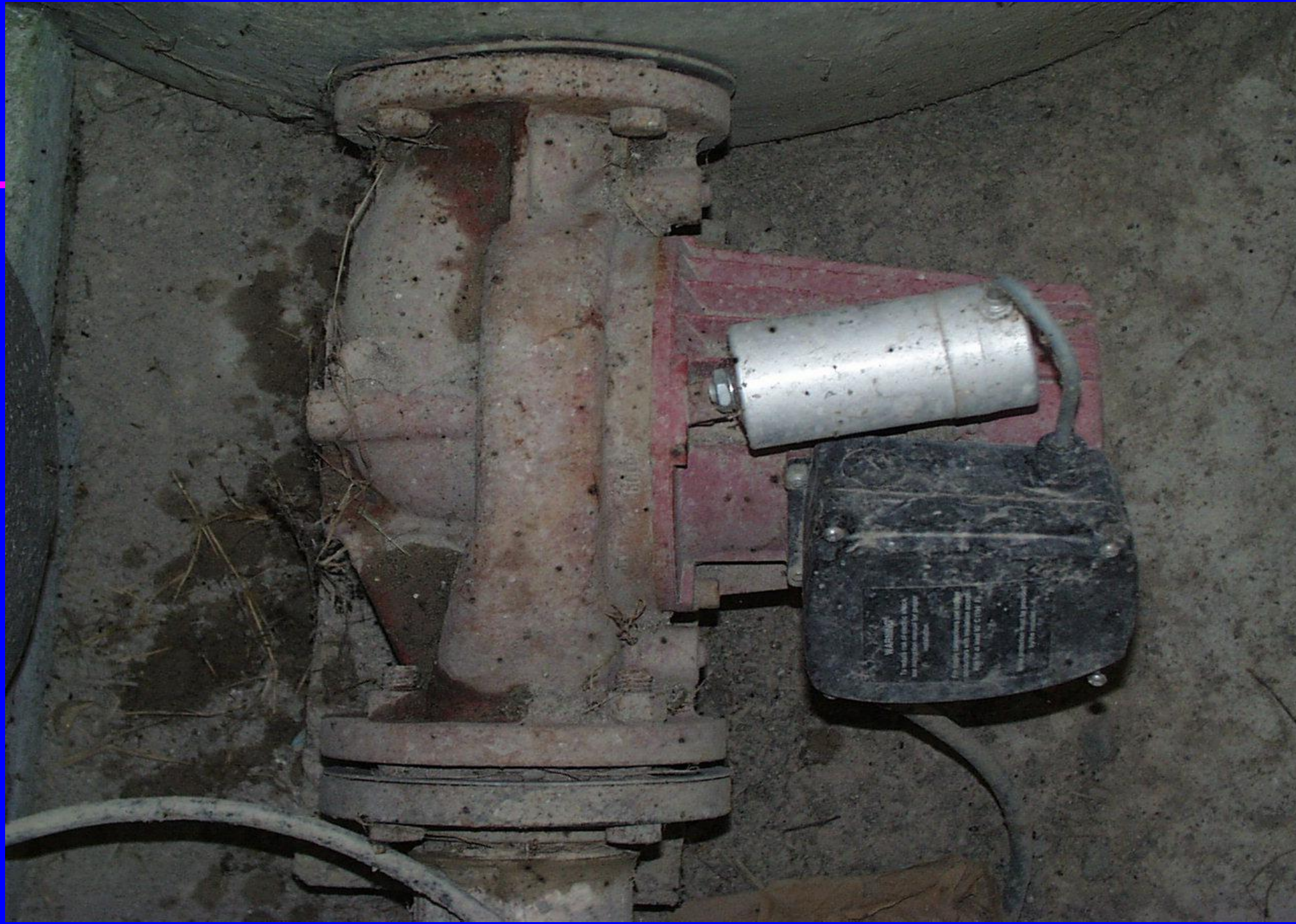
- ◆ Feeding: three times daily *ad libitum*
32% protein, floating, complete diet
- ◆ Stagger fish production, 24 week cycle, harvest every 6 weeks
- ◆ Stagger plant production
- ◆ Use biological insect control
- ◆ Monitor pH daily, maintain pH 7.0 by
alternate and equal additions Ca(OH)_2 and KOH
- ◆ Add chelated iron (2 mg/L) every 3 weeks
- ◆ Add makeup water daily, about 1.5% of system volume











WARNING
To avoid an electric shock,
do not touch the metal parts
of the actuator when the power
is on.

CAUTION
The actuator is not to be used
as a support for the valve.
The valve must be supported
by its own structure.

Energy Consumption

- ◆ One blower for fish and degassing, 1.12 kW
- ◆ One blower for hydroponics, 0.75 kW
- ◆ One water pump, 0.37 kW
- ◆ Total energy consumption, 2.24 kW





Production

- ◆ Tilapia - 5 mt annually , 580 kg every 6 weeks, 160 kg/m³/yr
- ◆ Stocking rate: Niles, 77 fish/m³; reds, 154 fish/m³
- ◆ Leaf lettuce - 1,404 cases annually, 24-30 heads/case, 27 cases/week
- ◆ Basil – 5 mt annually
- ◆ Okra – 2.9 mt annually

















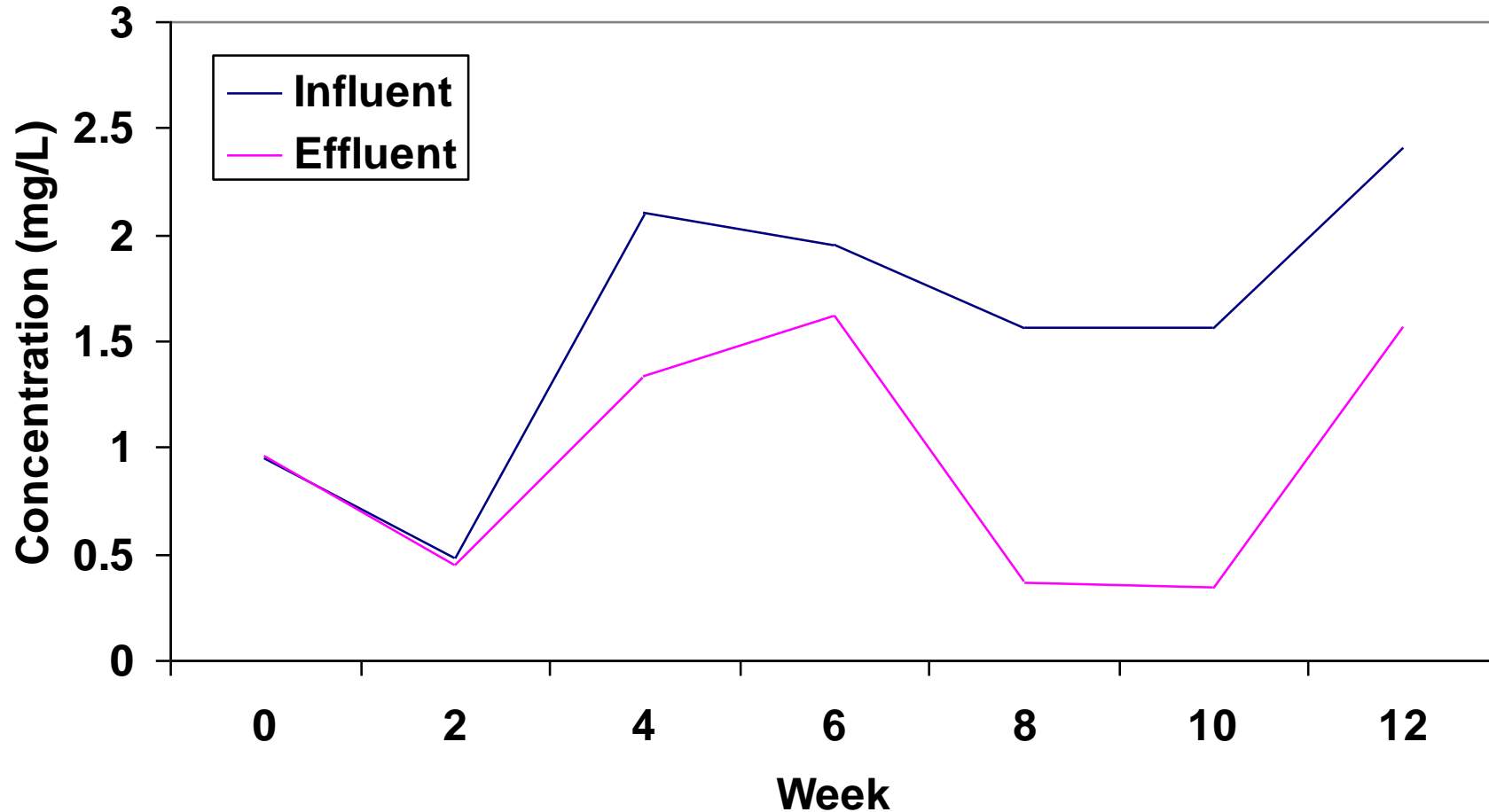




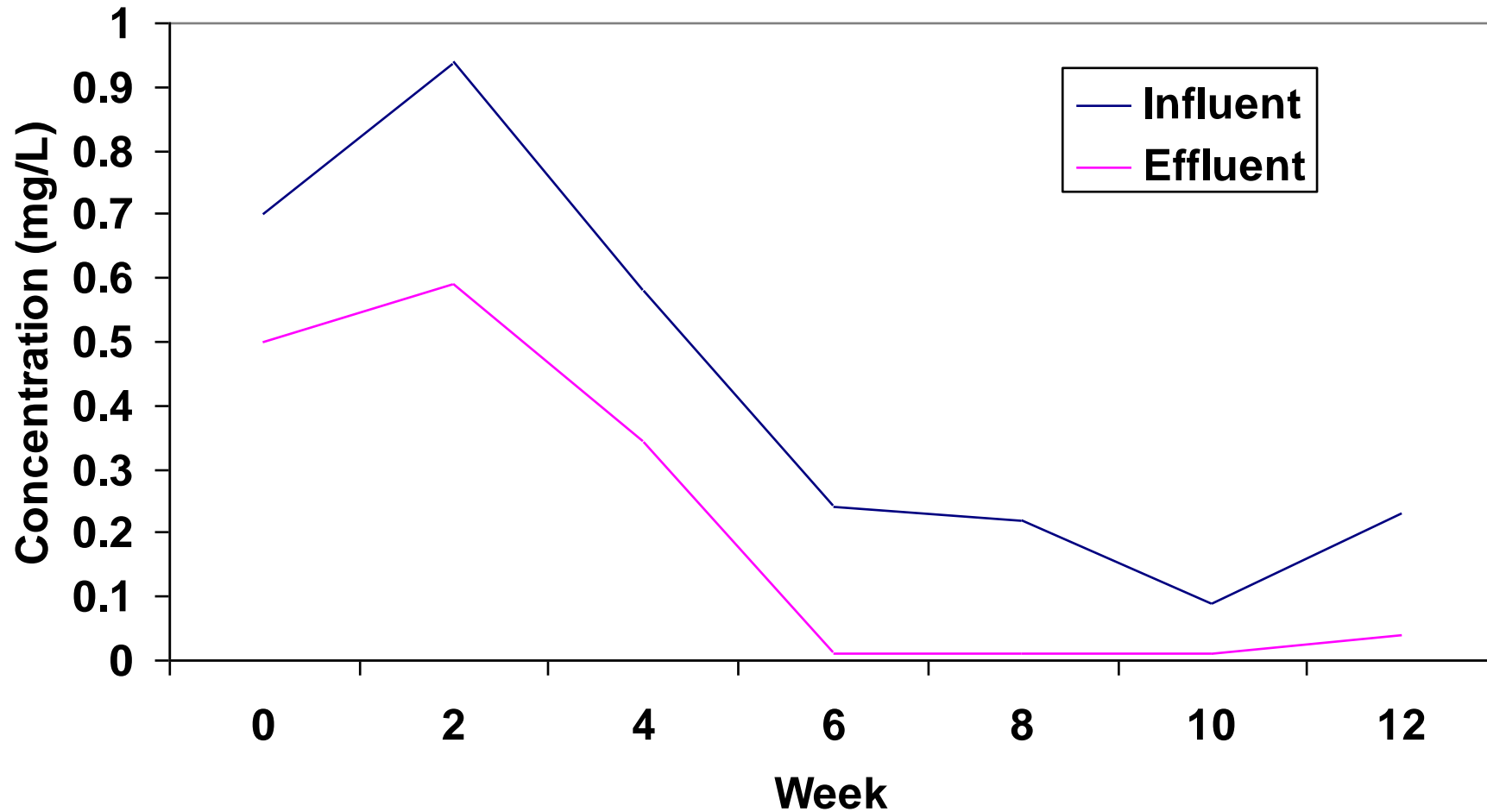




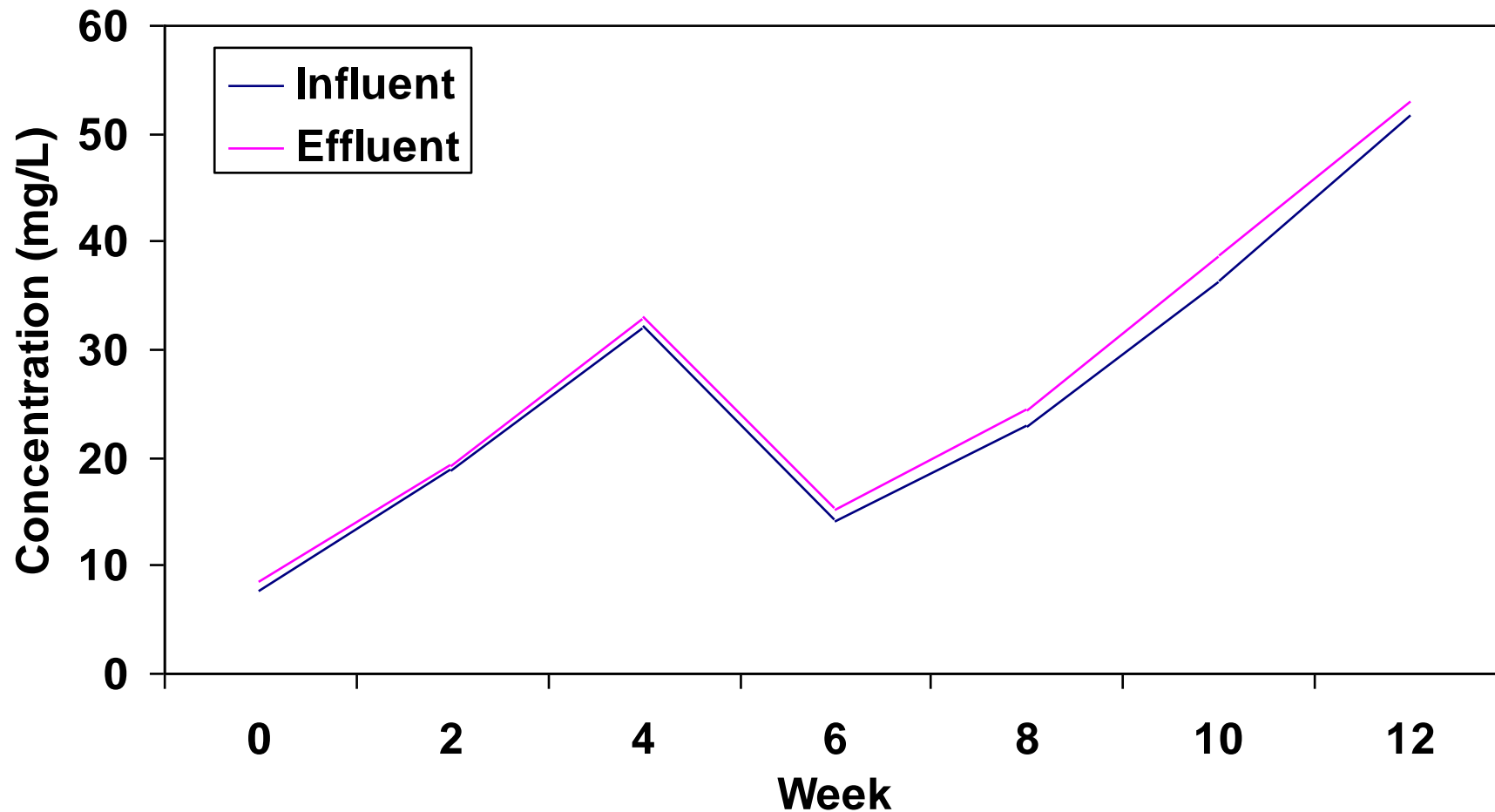
TAN: Hydroponic Tank Influent and Effluent



Nitrite-Nitrogen: Hydroponic Tank Influent and Effluent



Nitrate-Nitrogen: Hydroponic Tank Influent and Effluent



Macro-nutrients: Hydroponic Tank

Influent and Effluent

| Parameter (mg/L) | Influent (mean) | Effluent (mean) |
|--------------------|-----------------|-----------------|
| TAN | 1.58 | 0.95 |
| NO ₂ -N | 0.43 | 0.21 |
| NO ₃ -N | 26.34 | 27.51 |
| Total Phosphate | 16.35 | 15.86 |
| Ortho-Phosphate | 15.03 | 15.25 |
| Ca | 24.4 | 24.3 |
| Mg | 6.0 | 6.0 |
| K | 63.5 | 64.6 |
| SO ₄ | 18.3 | 18.8 |

Micro-nutrients: Hydroponic Tank

Influent and Effluent

| Parameter (mg/L) | Influent (mean) | Effluent (mean) |
|------------------|-----------------|-----------------|
| Na | 13.7 | 13.7 |
| Cl | 11.5 | 11.5 |
| Fe | 1.3 | 1.3 |
| Mn | 0.06 | 0.05 |
| Zn | 0.34 | 0.34 |
| Cu | 0.03 | 0.03 |
| B | 0.09 | 0.09 |
| Mo | 0.01 | 0.01 |

Other Water Quality Parameters: Hydroponic Tank Influent & Effluent

| Parameter (mg/L) | Influent (mean) | Effluent (mean) |
|------------------|-----------------|-----------------|
| EC | 0.5 | 0.5 |
| TDS | 235.7 | 235.7 |
| TSS | 12.6 | 12.8 |
| Turbidity | 50 | 53 |
| COD | 51.1 | 54.0 |

























Perspective on UVI Aquaponic System

- ◆ The system represents appropriate or intermediate technology
- ◆ It conserves water and reuses nutrients
- ◆ The technology can be applied at a subsistence level or commercial scale
- ◆ Production is continuous and sustainable
- ◆ The system is simple, reliable and robust
- ◆ Management is easy if guidelines are followed