



**GoFISH**  
HAWAI'I  
UNIVERSITY OF HAWAI'I

# Introduction to Aquaponics

GoFish Hawai'i

2/11/2024



COLLEGE OF TROPICAL AGRICULTURE  
AND HUMAN RESOURCES  
UNIVERSITY OF HAWAI'I AT MĀNOA



Sustainable and Organic  
Agriculture Program  
College of Tropical Agriculture and Human Resources  
University of Hawai'i at Mānoa



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# Overview: System Design

- Talk: open, domestic, demonstration, commercial and “aquaponic farming”

# Aquaponics Definition

- EU Aquaponics HUB (Palm 2018): ‘Aquaponics is a production system of aquatic organisms and plants where the **majority (> 50%) of nutrients** sustaining the optimal plant growth derives from waste (effluent water, solid and sludge removal) originating from feeding the aquatic organisms’
- Does it matter if you farm aquaponically from this strict definition of aquaponics? No! This distinction has been developed to market the products from aquaponics and develop the industry.

The modern aquaponic operation should be:

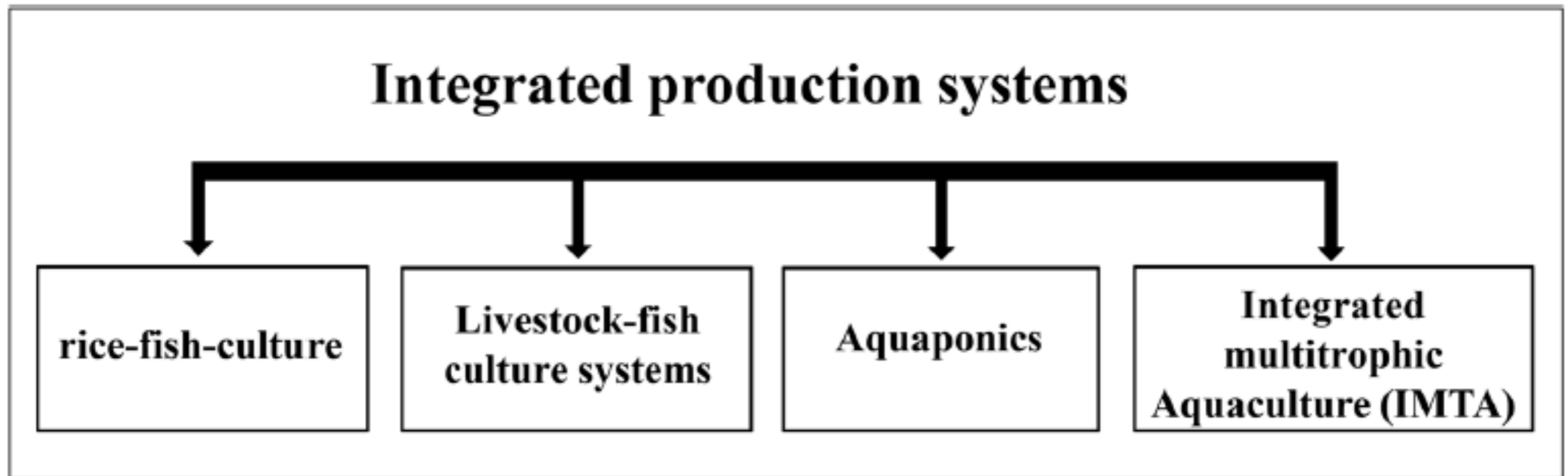
- **Robust**
- **Reliable**
- **Simple**
- **Easy to operate**
- **Requiring minimal labor**
- **Low risk**



# Aquaponic Research Needs

- **Study of various production systems**
- **New fish species into aquaponics**
- **Nutrient cycling**
- **Economic and marketing analysis**
- **Fish feed in aquaponics**
- **Addition of solid waste treatment loop**
- **Anaerobic vs. aerobic sludge treatment**
- **Influence of the aquaponic waste onto the plant performance in comparison to regular farming practices**
- **Food safety studies**
- **Aquaponics microbiome studies**
- **Balance studies and modelling of aquaponic systems**
- **More predictability commercial commercial operations**
- **Development of new methods for water filtration**
- **New scientifically-based designs for commercial aquaponics of small, mid- and large sizes**
- **Economic studies using aquaponic systems based on modern technologies as opposite to backyard aquaponics**
- **PGPM (plant growth promoting microbes)**

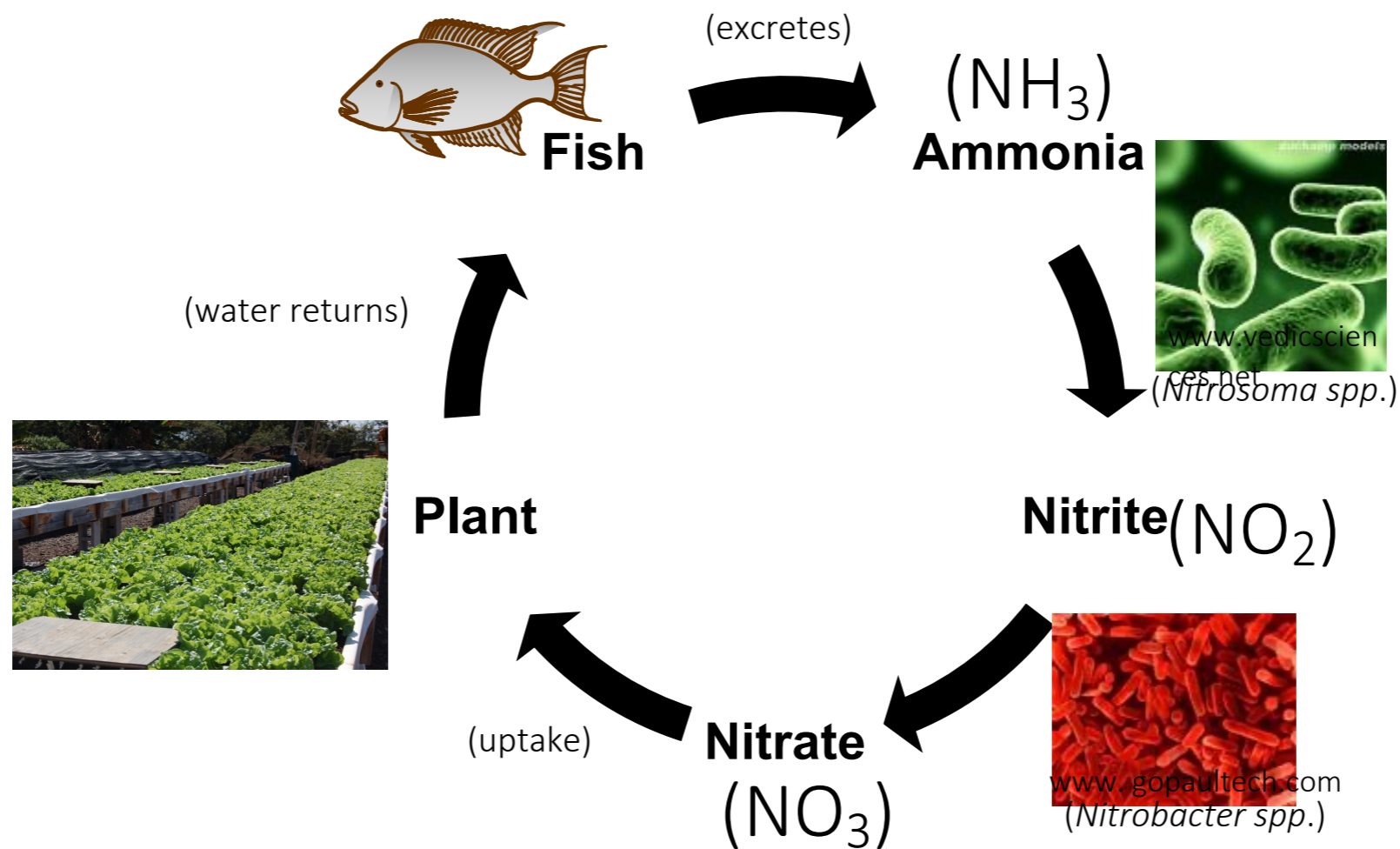
# Integrated Aquaculture: Two or More Linked Farming Systems, One of Which is Aquaculture



**Fig. 1** Overview of integrated production systems, rice-fish culture and livestock-fish culture systems, aquaponics, integrated multitrophic aquaculture (IMTA)

Aquacult Int (2018) 26:813–842  
<https://doi.org/10.1007/s10499-018-0249-z>

# Nitrogen Transformation in an Aquaponic System



# System Design: Types of Aquaponic Systems

- **Ebb and flow (reciprocating)**
  - Hydroponic support media (gravel, clay balls, cinder, etc.) “box of rocks”
- **Raft aquaponics**
  - Polystyrene sheets
- **Nutrient Film Technique (NFT)**
  - Rain Gutters
  - PVC pipe
- **Three Components**
  - Rearing tank
  - Biofilter
  - Hydroponic component

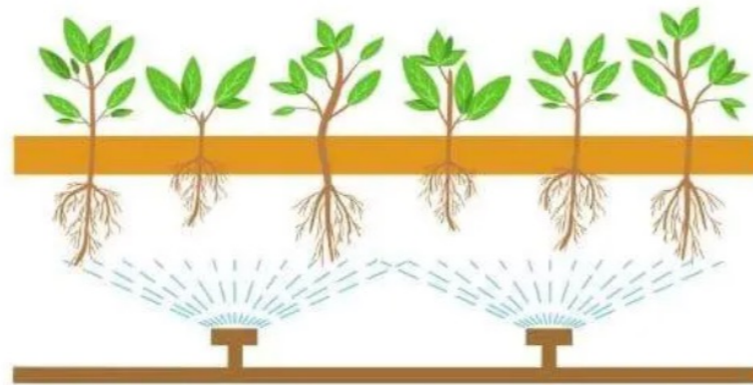


UVI



# Aquaponic Aeroponics

## Aeroponics



## Deep Water Culture



## Drip System



## Nutrient Film Technique



<https://gardeniaorganic.com/high-pressure-vs-low-pressure-aeroponics-compared/>

# Bumina/Yumina



<https://diskanak.bogorkab.go.id/yumina-bumina-beternak-ikan-sekaligus-sayuran-dan-buah/>

# Biofilter Consists of Two Components

- **Biological Filtration**

- Bacteria need some type of media to cling to in order to complete nitrification process (biofilm)
- The more surface, the more efficient the process
- Examples of biological filtration media:
  - Matala mats
  - Kaldnes Media
  - Pea Gravel
  - Lava Rock

- **Mechanical Filtration**

- Solids must be removed from the system
- Nutrients (N,P,K) can be recovered from sludge by aerobic mineralization
- Examples of mechanical filtration:
  - Circulation Pumps
  - Swirl separators
  - Drum Filters
  - Filter Socks
  - Cleaning of media beds

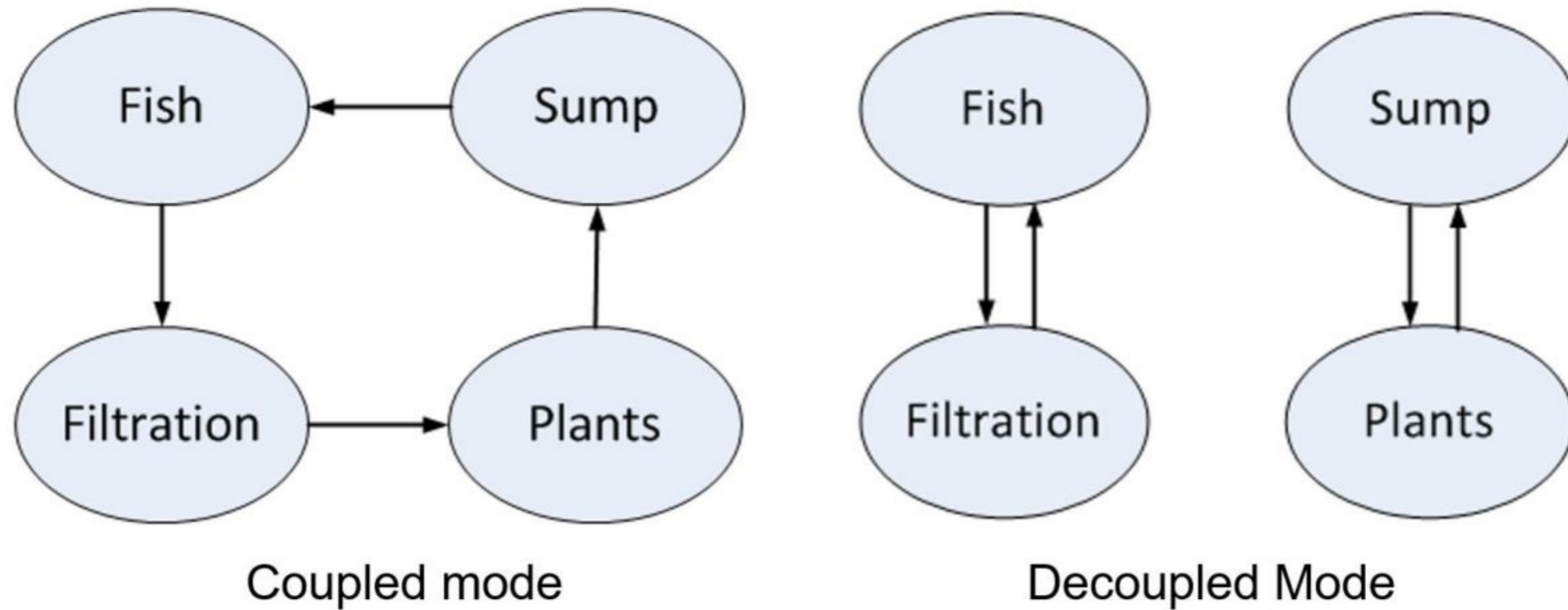
# Systems Scaling

- Open (pond)
- Domestic (backyard)-one pump, tank, grow bed
- Demonstration (retail)-more pumps, tanks, grow beds, staggered production
- Commercial-max output of fish and plants, high investment and management skill needed, greenhouse, multiple rearing units with staggered production, solids removal, power backup, biosecurity, water monitoring
- "Aquaponic Farming"

# Classical Aquaponics Systems: Coupled (1 loop)

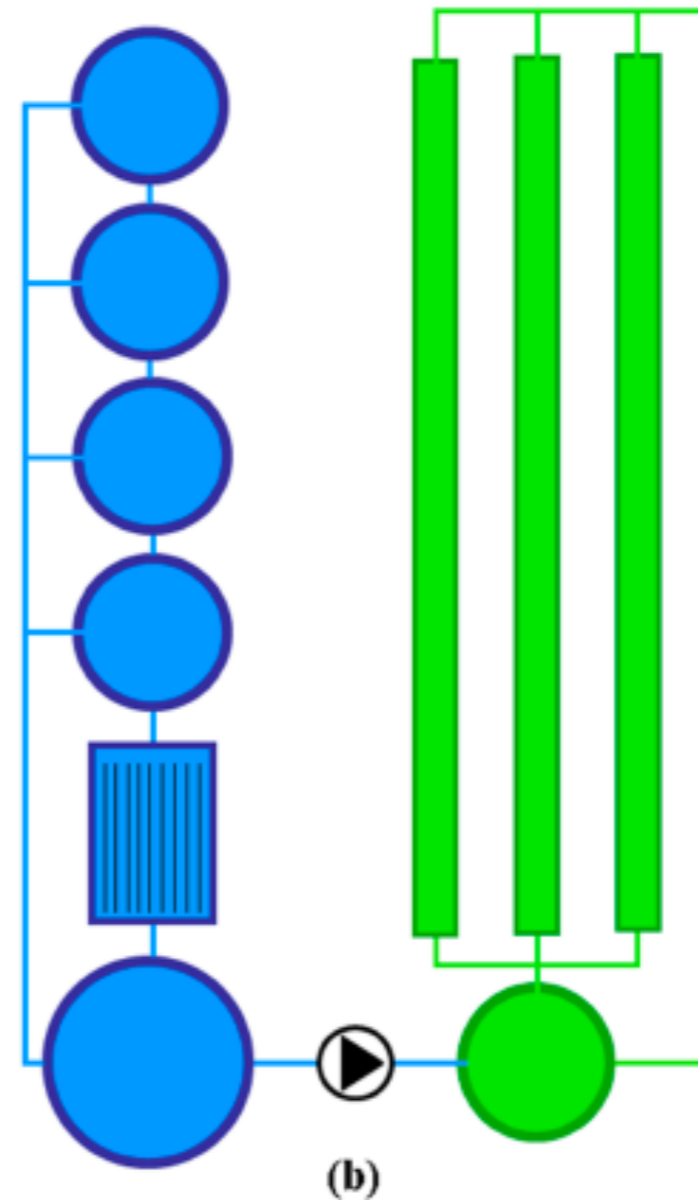
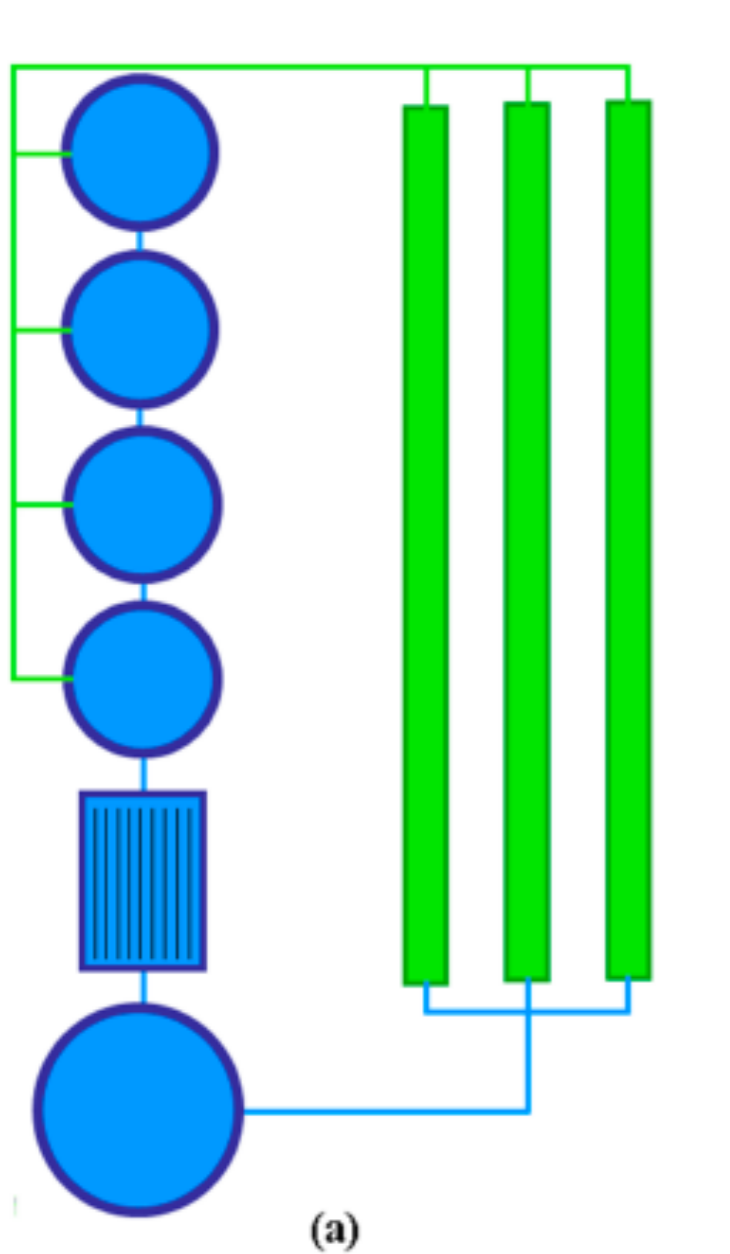
- Need compromise between living components
  - This limits scale
    - Small systems-coupled
    - Large systems-decoupled
- The addition of supplemental fertilizers or pH adjustments often results in intentionally created suboptimal conditions for fish, plants and microbes

# System Design



<https://www.theaquaponicsource.com/aquaponic-system-decoupling/>

# Coupled vs Decoupled



Monsees H, Kloas W, Wuertz S (2017)  
Decoupled systems on trial: Eliminating  
bottlenecks to improve aquaponic processes. PLoS  
ONE 12(9): e0183056. [https://doi.org/10.1371/  
journal.pone.0183056](https://doi.org/10.1371/journal.pone.0183056)

# Open Pond Aquaponics



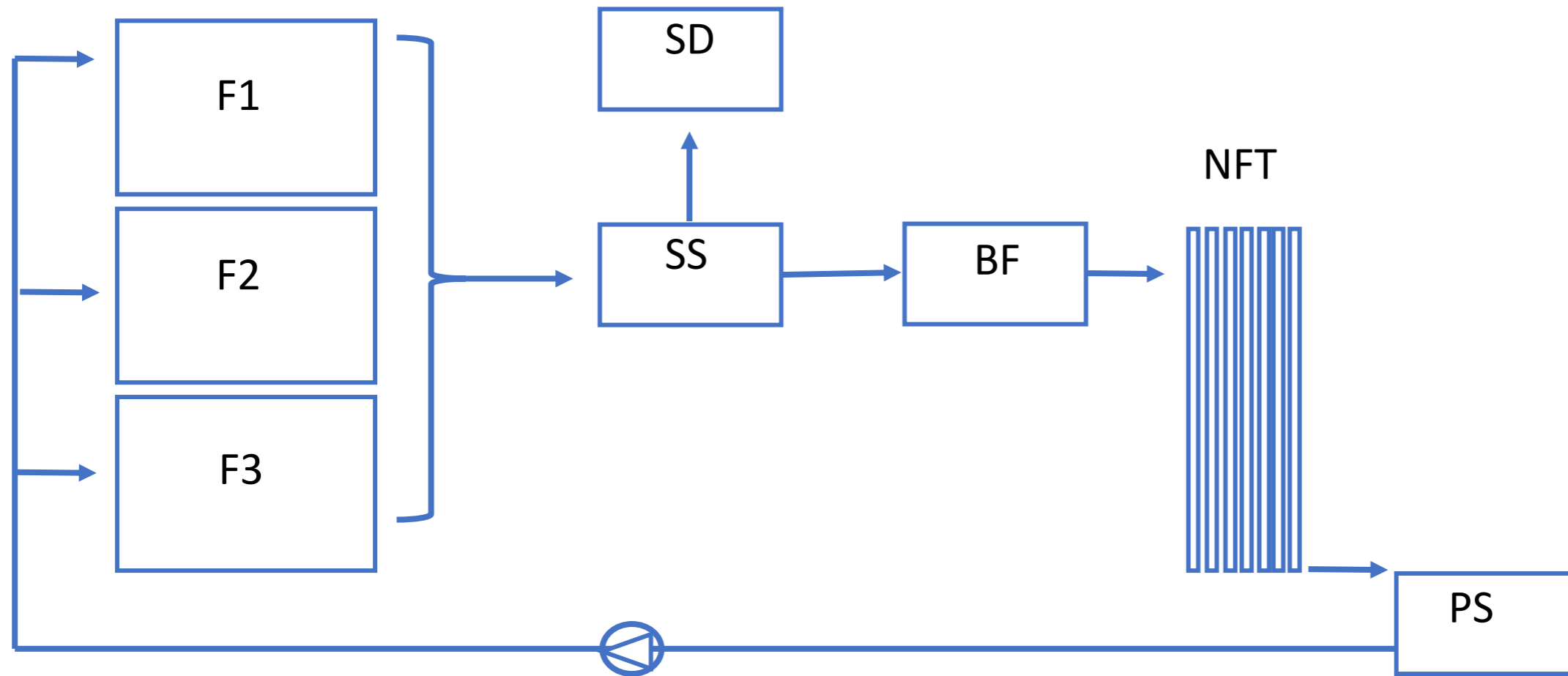
<https://www.permaculturenews.org/2014/10/14/worlds-largest-aquaponics-project-chinas-third-largest-aquaculture-lake/>



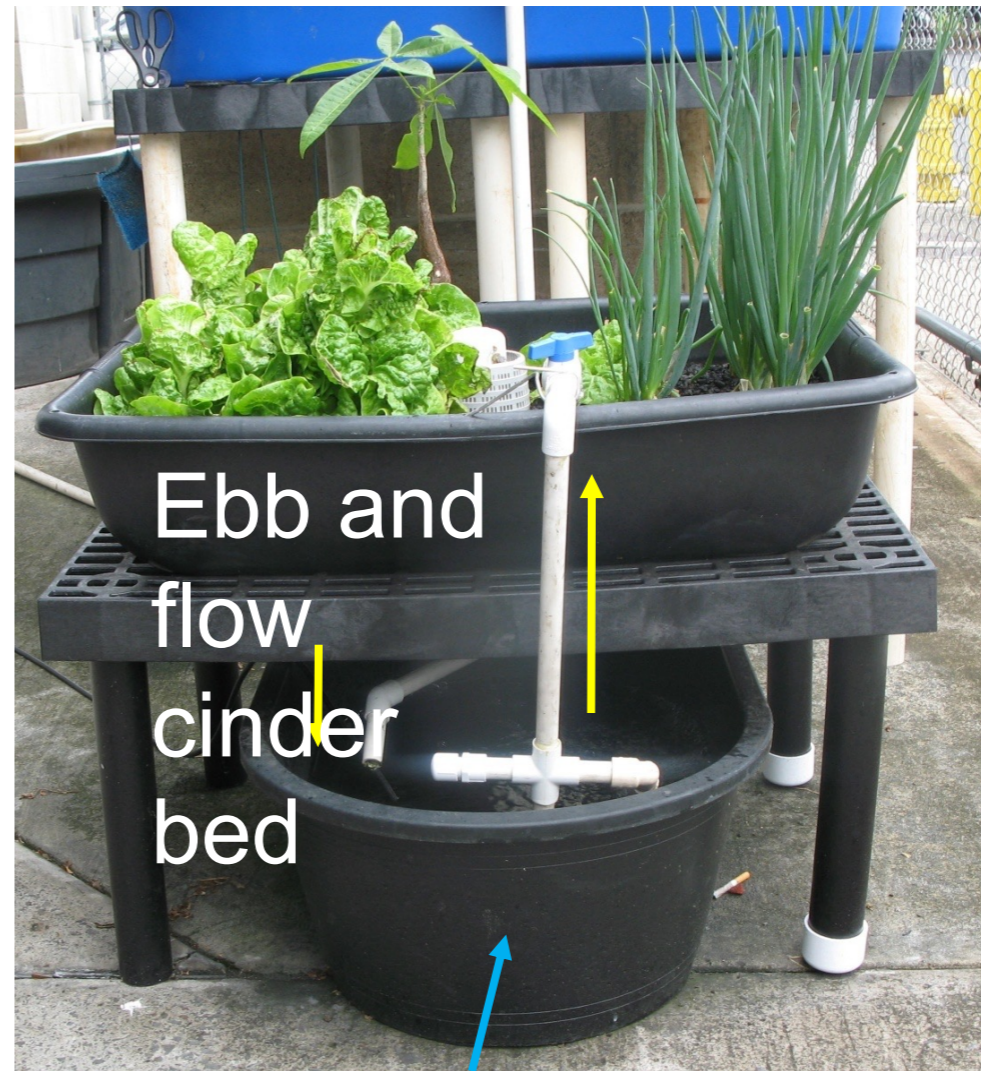


FT-Fish Tank  
SS-Solid separator  
SD-Solid discard  
BF-Biofilter  
PS-Pump sump

# Domestic



# Most Basic Design



Submersible Pump inside of fish tank

# Waimānalo Prototype: Hybrid System Design



# Aquaponic Medicinal Plants



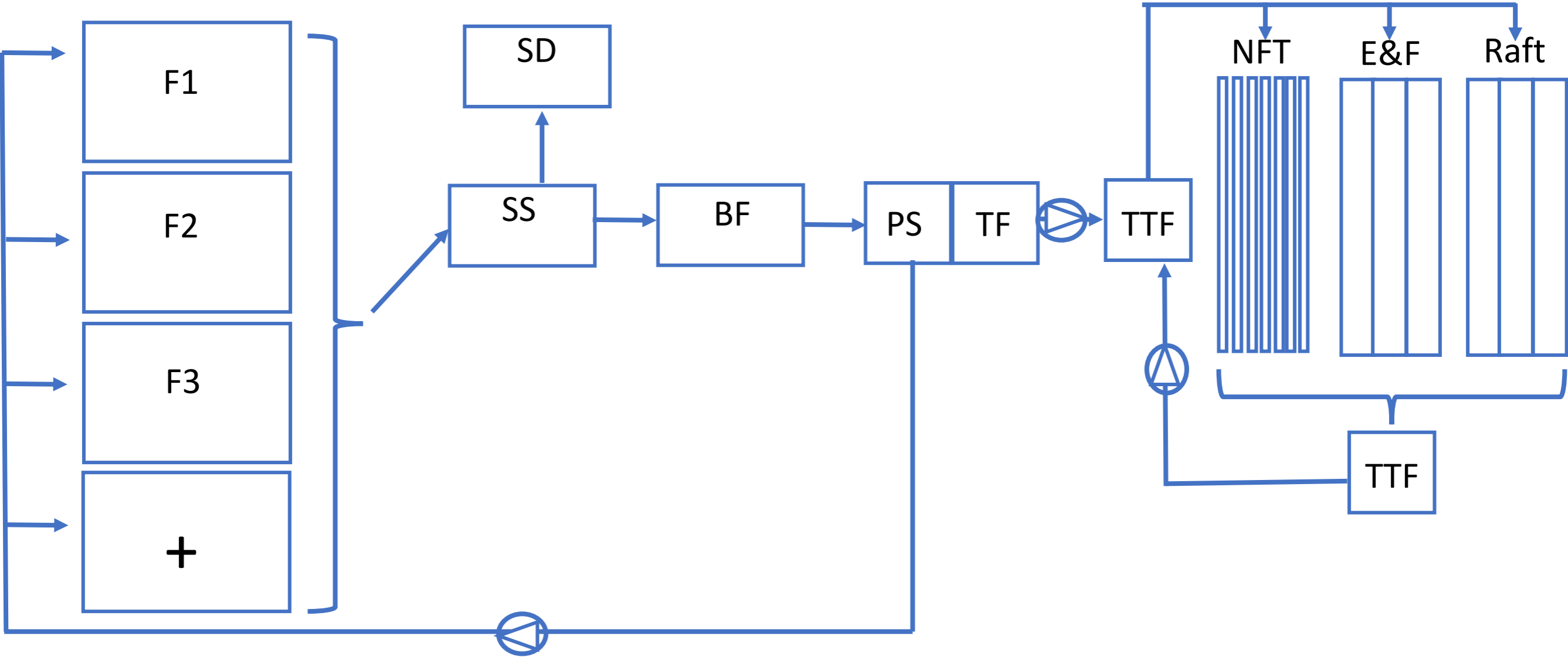
# Barrelponics



[https://www.google.com/search?q=barrelponics&source=lnms&tbn=isch&sa=X&ved=2ahUKEwi217yI0q7tAhWkiTQIHRMLAEwQ\\_AUoAXoECBEQAw&biw=1287&bih=684#imgrc=kf1IZMVNOrYKYM](https://www.google.com/search?q=barrelponics&source=lnms&tbn=isch&sa=X&ved=2ahUKEwi217yI0q7tAhWkiTQIHRMLAEwQ_AUoAXoECBEQAw&biw=1287&bih=684#imgrc=kf1IZMVNOrYKYM)

# Demonstration

- FT-Fish Tank
- SS-Solid separator
- SD-Solid discard
- BF-Biofilter
- TF-Trickle filter
- TTF-Transfer tank (fish water)
- TTP-Transfer tank (plant water)
- PS-Pump sump



# Waimānalo Ag Station



# WCC Static AP System





# Hawaii State Hospital Module



Rearing Tanks

Biofilter  
“Reciprocating  
Ebb and Flow”

Hydroponic  
Component

# Rooftop System



# Rooftop System: IHS Women's Shelter



NFT hydroponic system converted to aquaponics. Producing ~540 heads of lettuce per week now going to support clients of the shelter.

# Waiawa Correctional Facility



# Developing Ventures

- Kupu Place Aquaponics
- Hawaii Fish Company



# Vegetables in Aquaponics



Blue berries



Cucumber



Beets



Green onion



Chiso



Cilantro



Tomatoes

# Systems at Mari's Garden



# Dinner in the Garden





# Snip and Serve Salad



# Commercial

FT-Fish Tank

SS-Solid separator

SD-Solid discard

BF-Biofilter

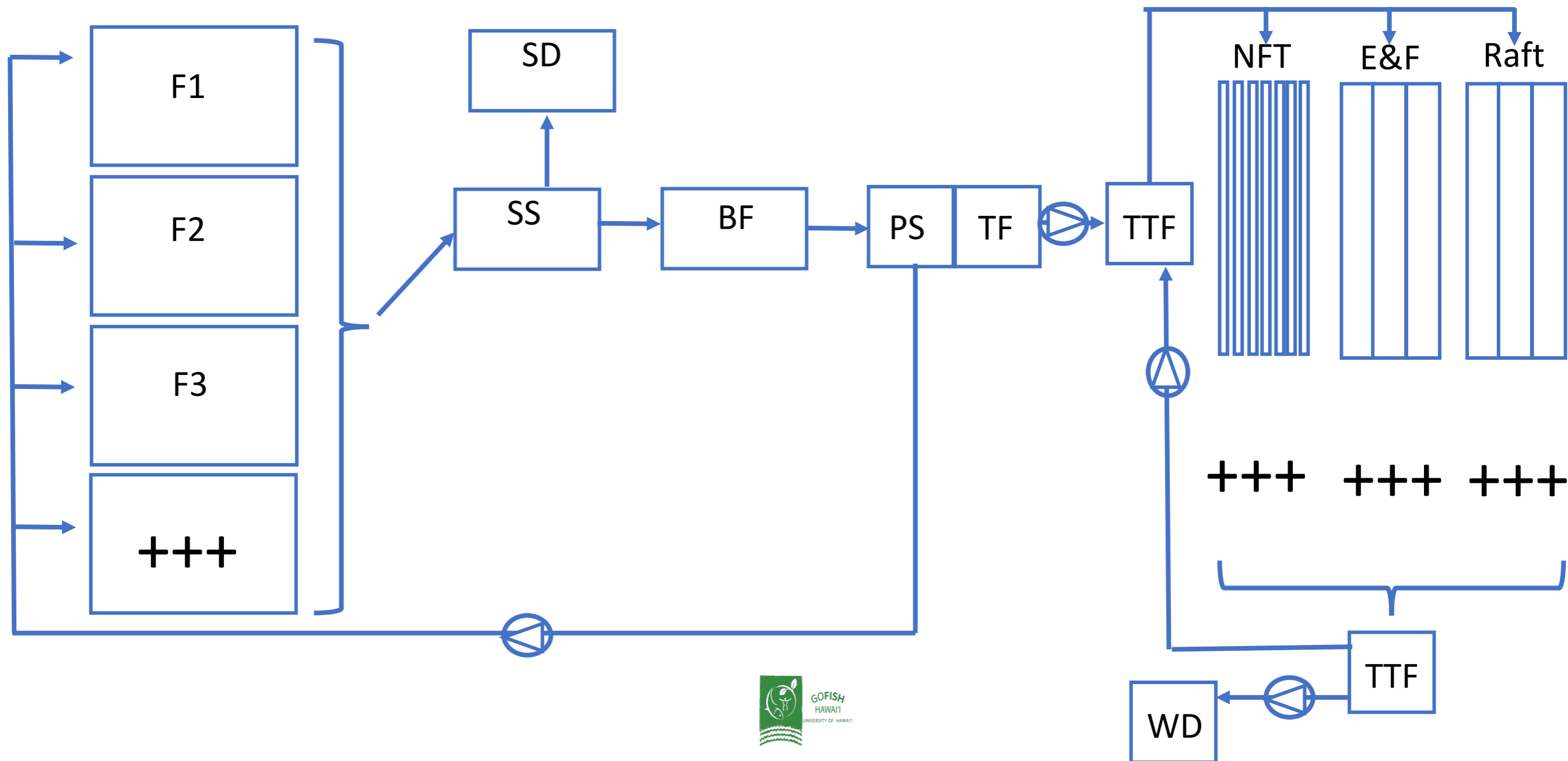
TF-Trickle filter

TTF-Transfer tank (fish water)

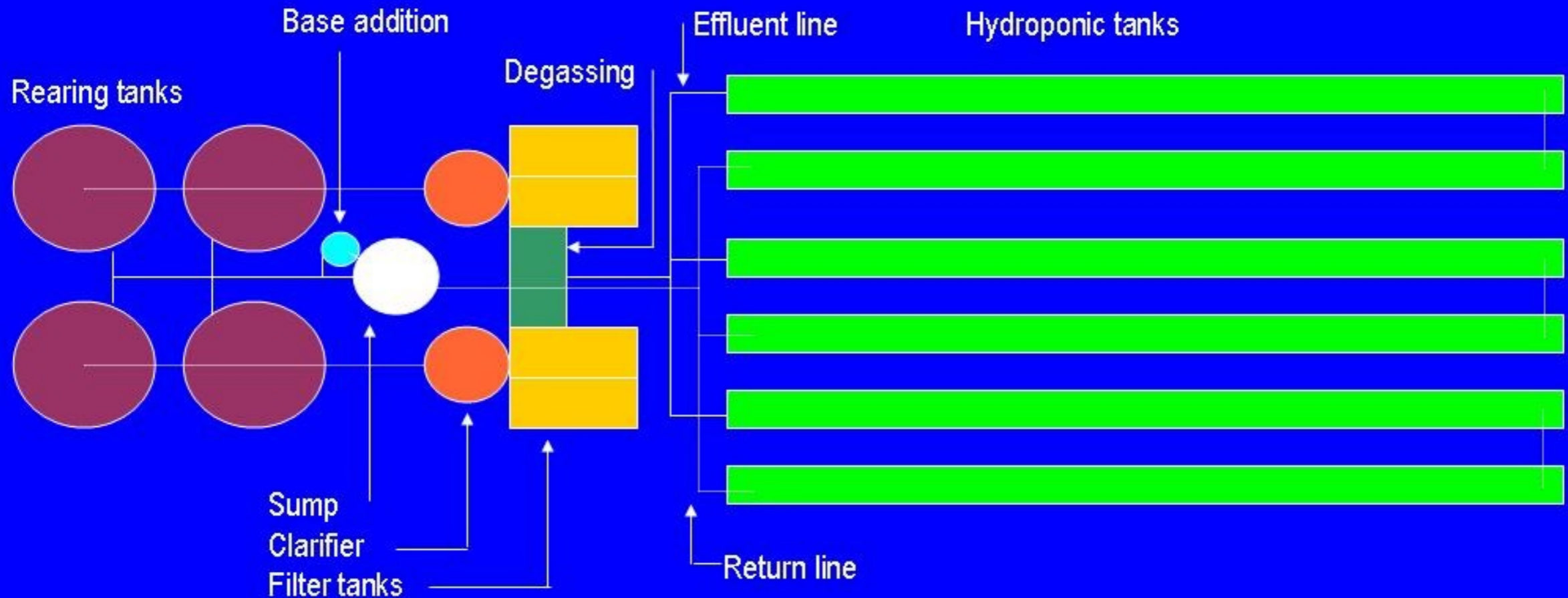
TTP-Transfer tank (plant water)

PS-Pump sump

WD-Water discard



# UVI Aquaponic System



Graphic: UVI Aquaculture Program

# Kunia Country Farms



# Auburn University



[https://ocm.auburn.edu/newsroom/news\\_articles/2018/11/071305-aquaponics.php](https://ocm.auburn.edu/newsroom/news_articles/2018/11/071305-aquaponics.php)



[https://ocm.auburn.edu/newsroom/news\\_articles/2018/11/071305-aquaponics.php](https://ocm.auburn.edu/newsroom/news_articles/2018/11/071305-aquaponics.php)

# Urban Organics St. Paul, MN 2013



# Urban Organics R.I.P. 2019



# Dachink Aquaponics 2012-present





# Superior Fresh, Hixton, Wis.



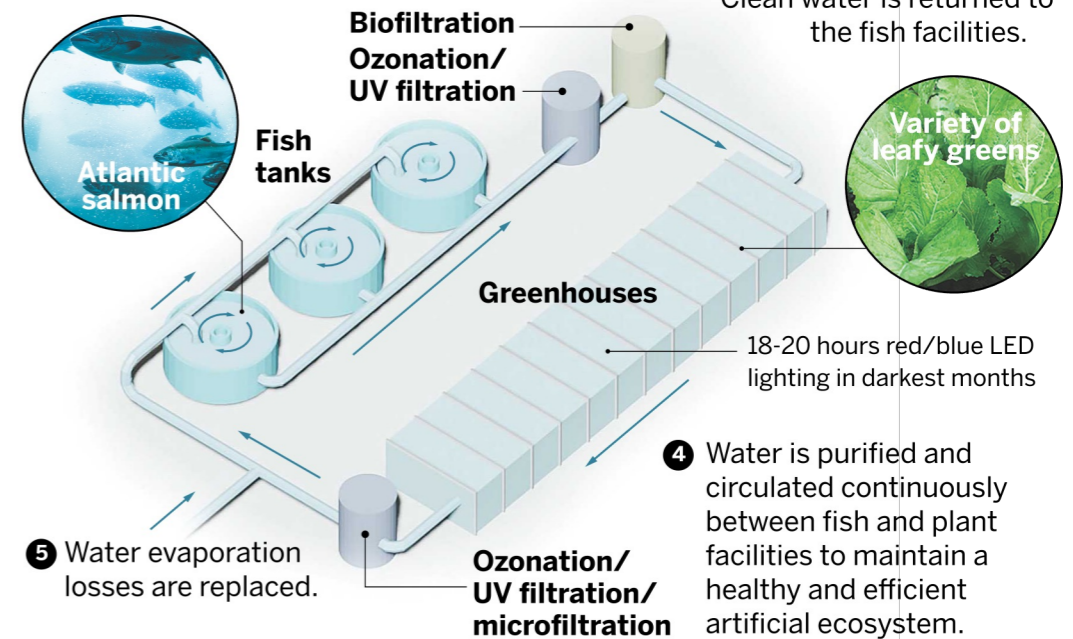
<https://thebl.com/us-news/greenhouse-disrupting-food-systems-with-aquaponics.html>

- Ashley Furniture
- Started 2017
- 6 acres under roof
- 200,000 lbs salmon/year
- 3 million lbs greens/year

## HOW AQUAPONICS WORKS

**Aquaponics is the symbiotic relationship between fish, beneficial bacteria and plants**

- 1 Disease-free Atlantic salmon are hatched on-site and grown to maturity in water circulating at ideal swim speed.
- 2 Water from fish tanks is filtered to remove waste. The waste material is broken down by bacteria.
- 3 The nitrate-rich water is then circulated to greenhouses. Plants are seeded in a "propagation room" and transferred to other pools where they absorb the nutrients as they mature. Clean water is returned to the fish facilities.



Source: Superior Fresh Inc.

MARK BOSWELL • Star Tribune

<https://www.startribune.com/huge-wisconsin-operation-shows-promise-of-aquaponics/568568462/>



# “Aquaponic Farming”






# Reeler

**Fresh Fish  
From Local,  
Small-Scale  
Fishers**

Hours Fresh, Not Weeks Old.



 Reeler




**Reeler**

Location: Kalaheo  
 Delivery options: Pick-up only  
 Availability: 11:00 AM - 10:00 PM (Kalaheo)

**Red Snapper**

1 lb. 10.00

**Subtotal**

1 lb. of Red Snapper 1.7	\$11
Delivery Fee	\$0.00
Tax	\$0.50
<b>Total</b>	<b>\$11.50</b>

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