Aquaculture Development in the 21st Century

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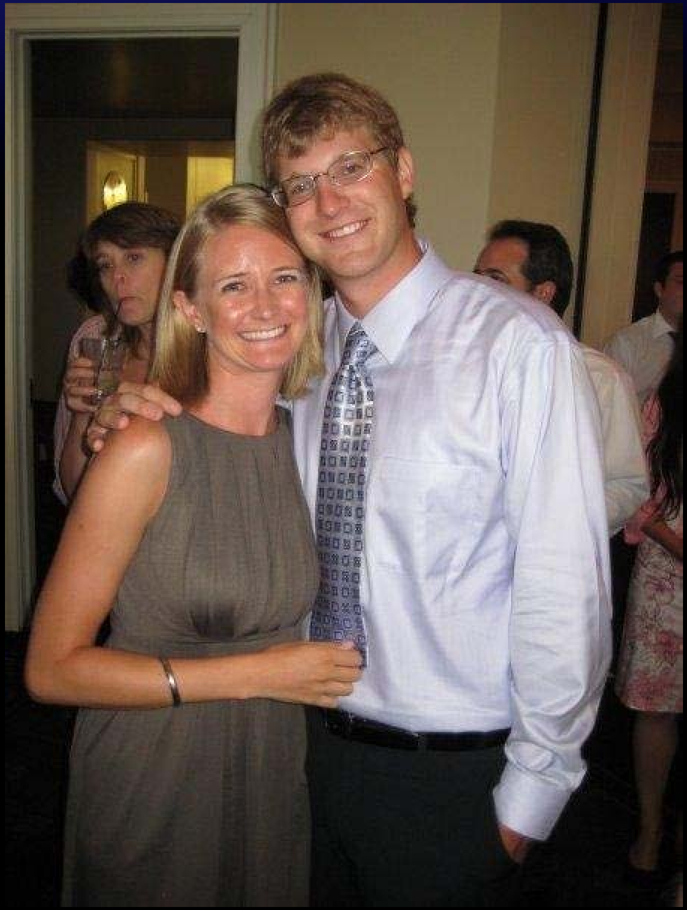
Soil, Water, and Environmental Science

The Faces of the Industry



Agenda

Introduction

Aquaculture in the past, present, and the future

- Past (20th century): Industry development
- Present: R&D, distribution, political reform
- Future (21st century): Strategic and sustainable growth using global models

Agenda

Environment (Towards a sustainable solution)

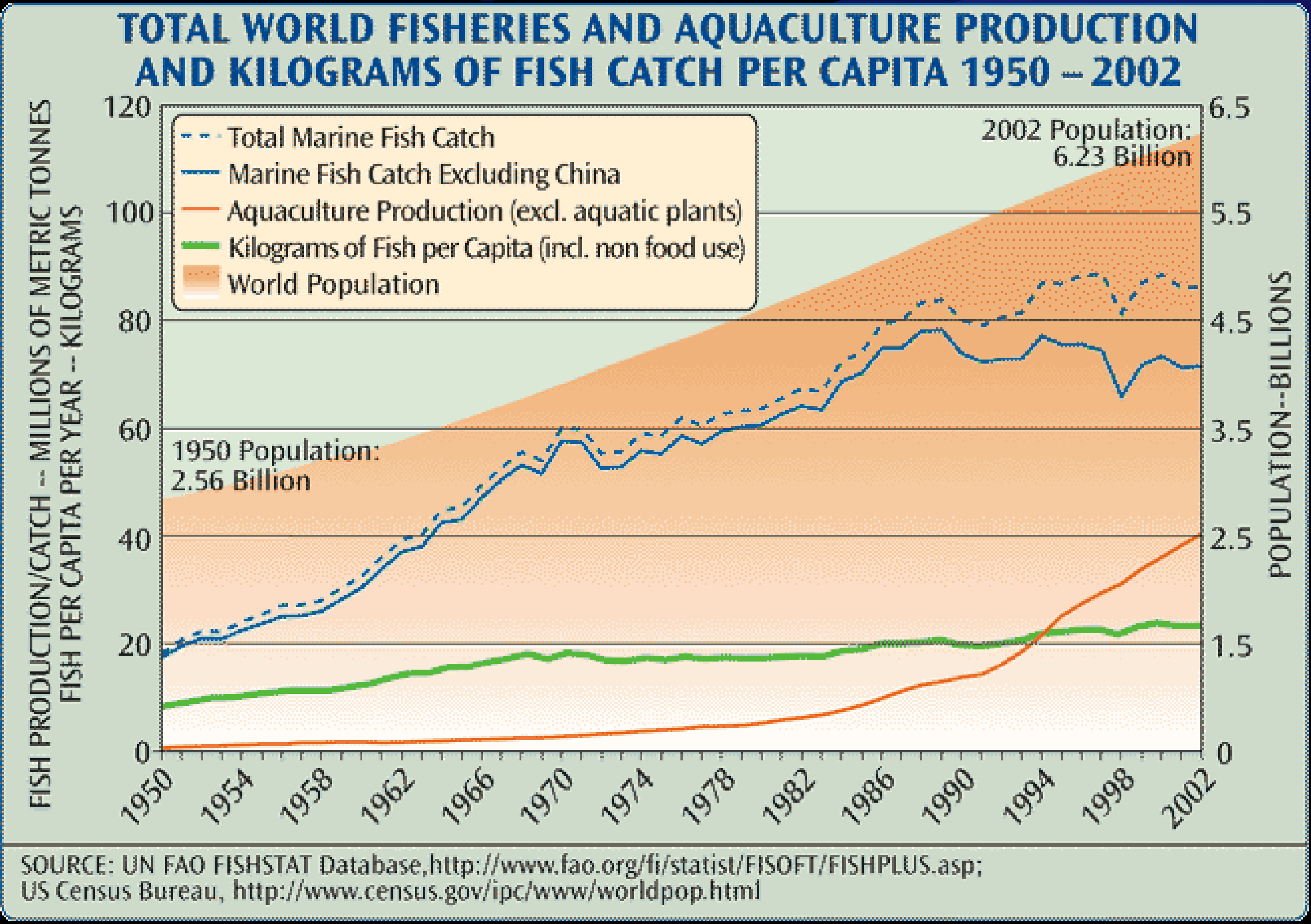
Exp. 1: Tilapia with basil

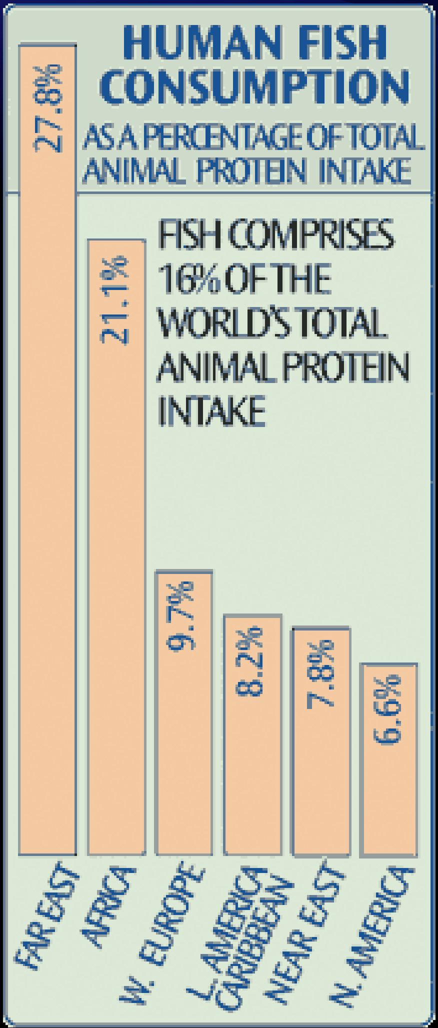
Exp. 2: Tilapia with basil and lettuce

Conclusion:

Sustainability: Econ., Environ., and Equity

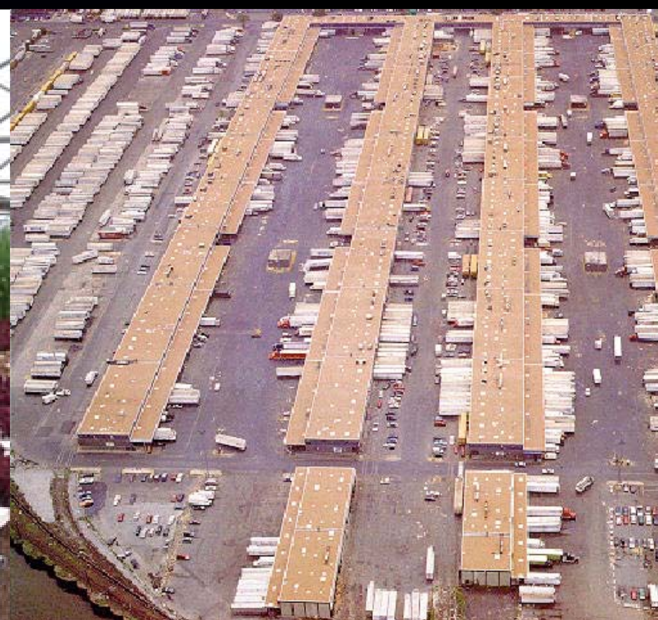
Past: Aquaculture 20th Century





Present: Sustaining Growth

R&D Innovation Distribution Networks Political Reform



Future: Aquaculture 21st Century

Sustainable growth using global models

- Strategic business development
- Sustainable solutions to satisfy domestic and international needs

OPERATIONAL MANAGEMEMENT IN MULTINATIONAL FOOD INDUSTRIES

International Businesses

Why form international arrangements

- Coordinate multi-national supply and global demand
- Hedge seasonal supply-demand markets
- Means of strategic economic development

Development allowing complex arrangements

- Trade liberalization
- IT
- Distribution capacity

Strategic Development

Photos from AwF

Strategic Development

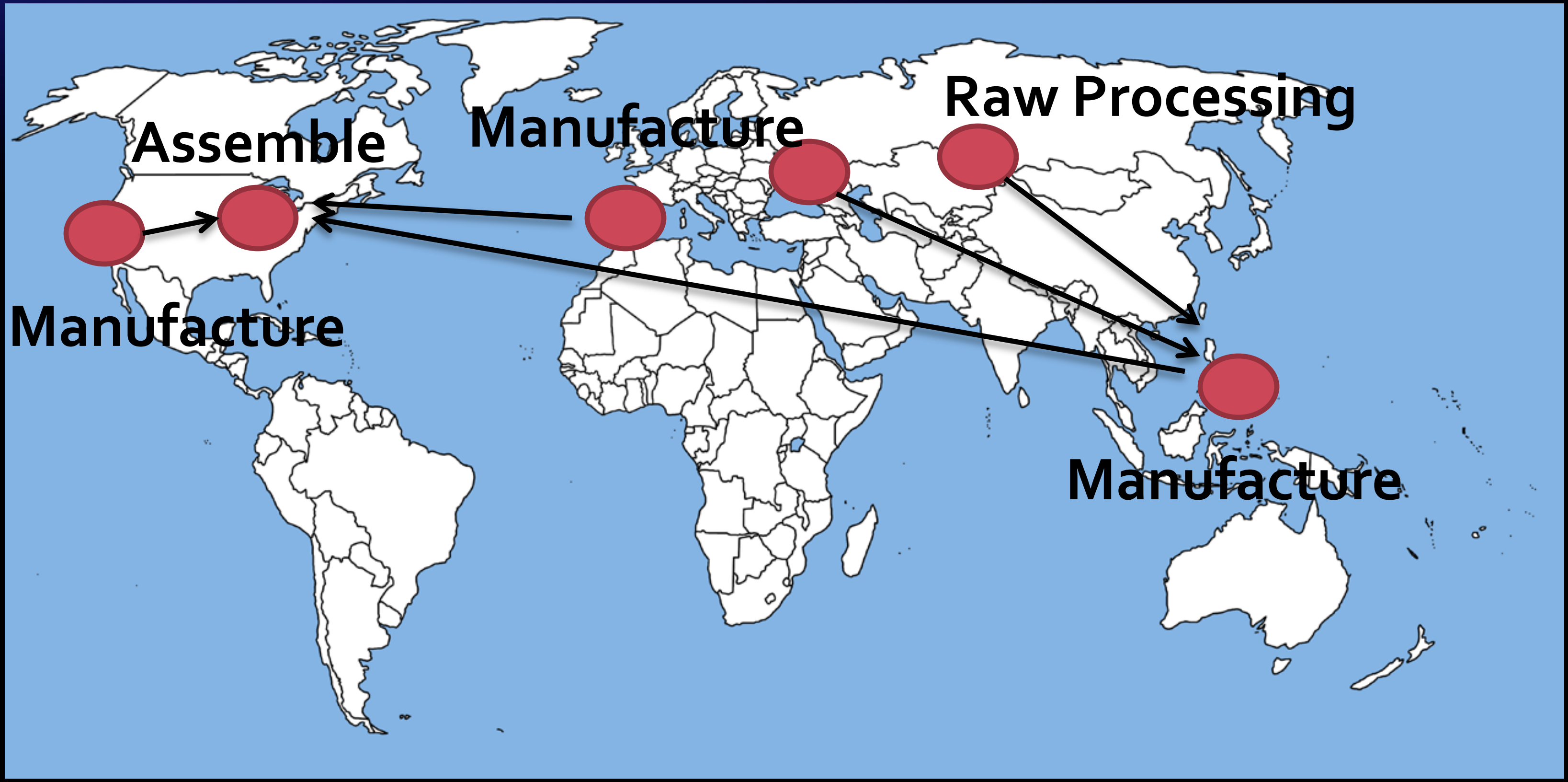
Aquaculture cages in Bay of Manila photos: Reefbase/J. Oliver

Multiplier Modeling

- Keynesian Model
  - Propensity of industry to purchase inputs from local economy versus from the outside economy.
- Tiebout's Model
  - Propensity of firms and households to purchase locally versus from outside economy.
- Location Quotient
  - % of sales outside of home locality

International Businesses

Example : Car Manufacturing Industry



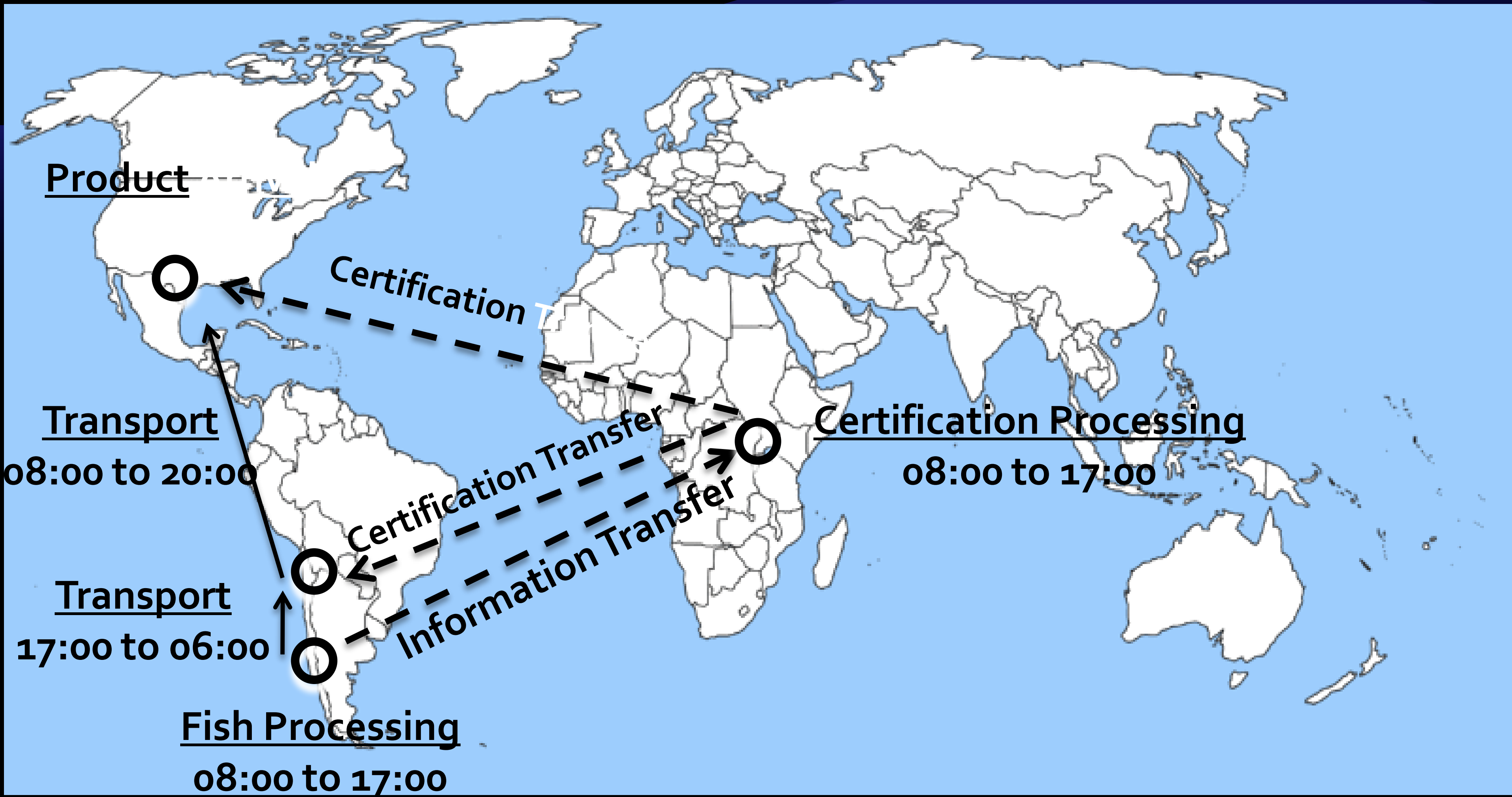
International Businesses

Example : Food System Industry

Tucson: Jan. 1.
12 hrs Central Standard Time .

Country	Local Time	Season
United States (Tucson)	12:00	Winter
Mexico (Mexico City)	11:00	Winter
Chile (Santiago)	13:00	Summer
Uganda (Kampala)	20:00	Winter*

International Businesses

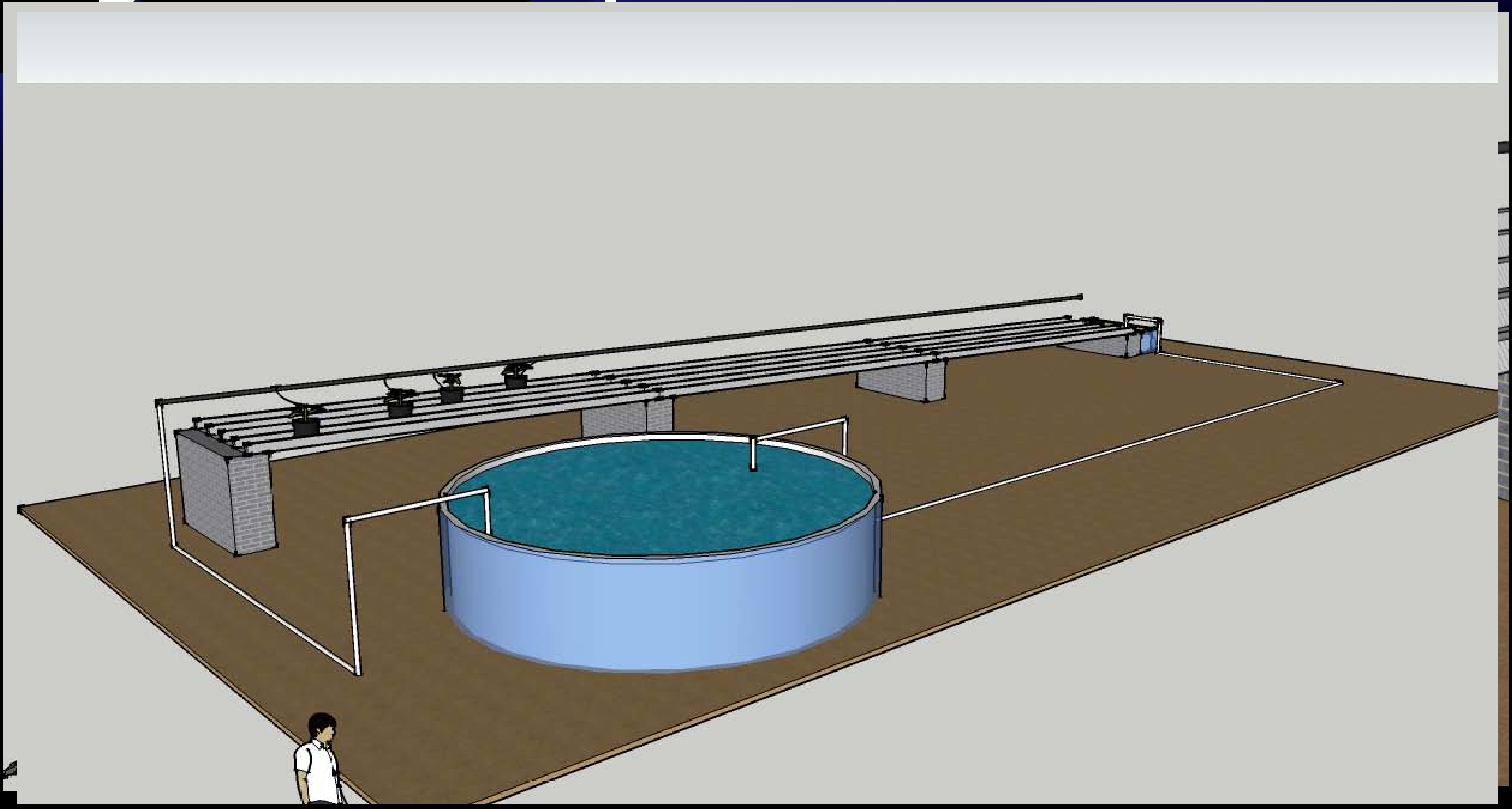


UTILIZING EFFLUENT FROM TILAPIA (*Oreochromis niloticus*) TO GROW Basil (*Ocimum basilicum*) USING RIAA TECHNOLOGY.

Background

1) What is RIAA technology?
2) Why are we developing this?
3) Demonstration through experimentation
    a. Combining Tilapia and Barley production
4) Challenges faced
5) Moving forward

Re-circulating Integrated-Agriculture Aquaculture



Goal of This Research

To monitor the efficiency of energy and nutrient transfer in a regulated multi-trophic food chain in order to 1) minimize impact on the environment and 2) maximize the cost-benefit relationships.

Materials and Methods

3 RIAA systems

- 5,000 L Fiber glass swimming pool with 3000 L water
  - Tilapia (*Oreochromis niloticus*)
  - Tilapia mass density maintained @ 3, 6, and 9 kg m^{-3}
  - Adults (500 g) and Juveniles (50 g)
  - Fed 2% body weight per day
- 75 pots with Basil (*Ocimum basilicum*)
  - Sizes: 4 L (one-gallon) and 2 L (½ gallon)
  - Watered daily (15 mins., ~ 1/2 L)
- Add 500 L per week (5%)

Results: Nutrients

Measurements

Fish (n = 10)	Plants (n = 10)	Nutrients (n=3)
Weight (g w^{-1})	Height (cm w^{-1})	Nitrogen
	Seed spikes (#)	Total N
	Root weight (g)	NO_3-N
	Shoot wet weight (g)	NH_4-N
	Seed spike wet weight (g)	Phosphorous
		Total P
		Ortho-P

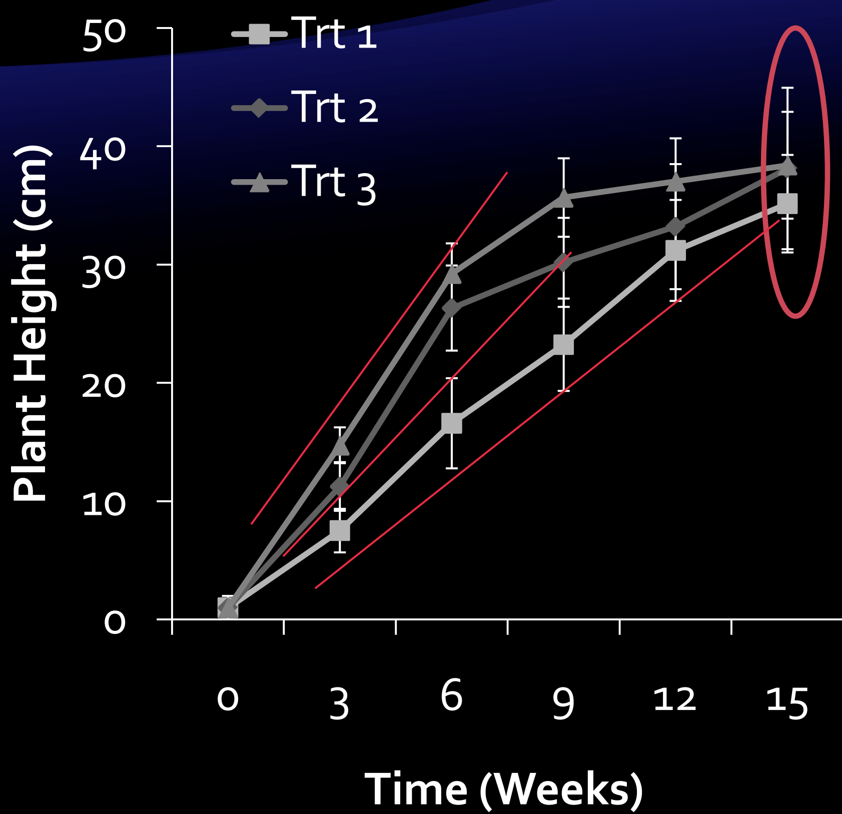
Data compared within and between treatments using General Linear Modeling (SAS 9.1) ANOVA ($\alpha = 0.05$), Duncan's Multiple Range Test students t-test, and Pearson's correlations.

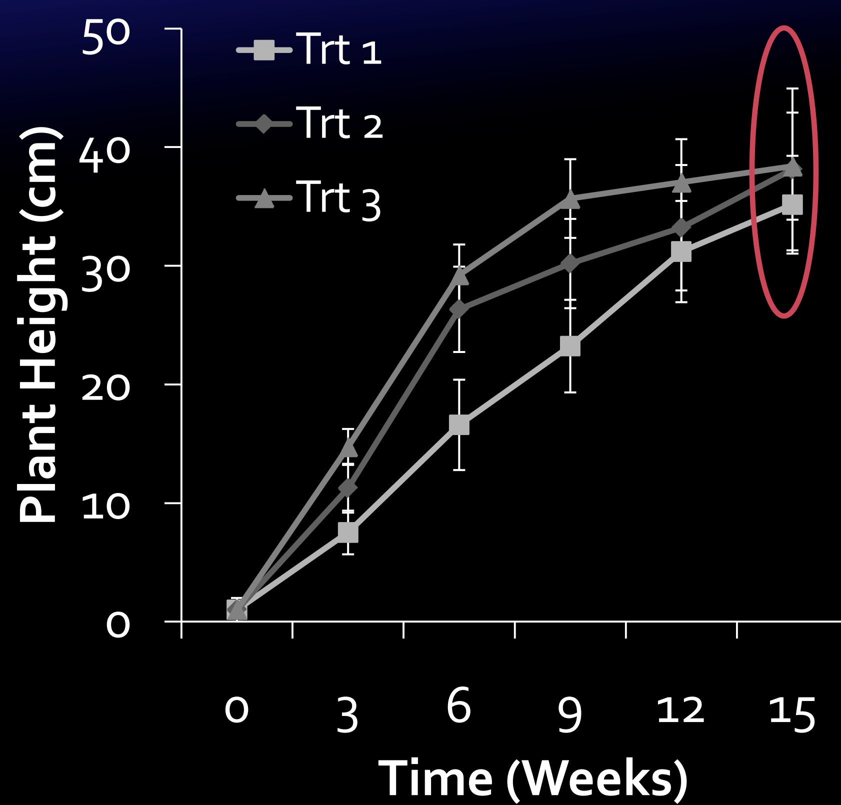
Results: Fish Growth

Juveniles			
Treatment	W_i (g)	W_f (g)	dW/dt (g w^{-1})
1	56 ± 11	73 ± 7	2.0
2	55 ± 11	78 ± 10	1.9
3	62 ± 6	81 ± 7	1.8

Adults			
Treatment	W_i (g)	W_f (g)	dW/dt (g w^{-1})
1	449 ± 12	466 ± 10	1.9
2	451 ± 8	466 ± 10	1.9
3	449 ± 13	462 ± 15	1.8

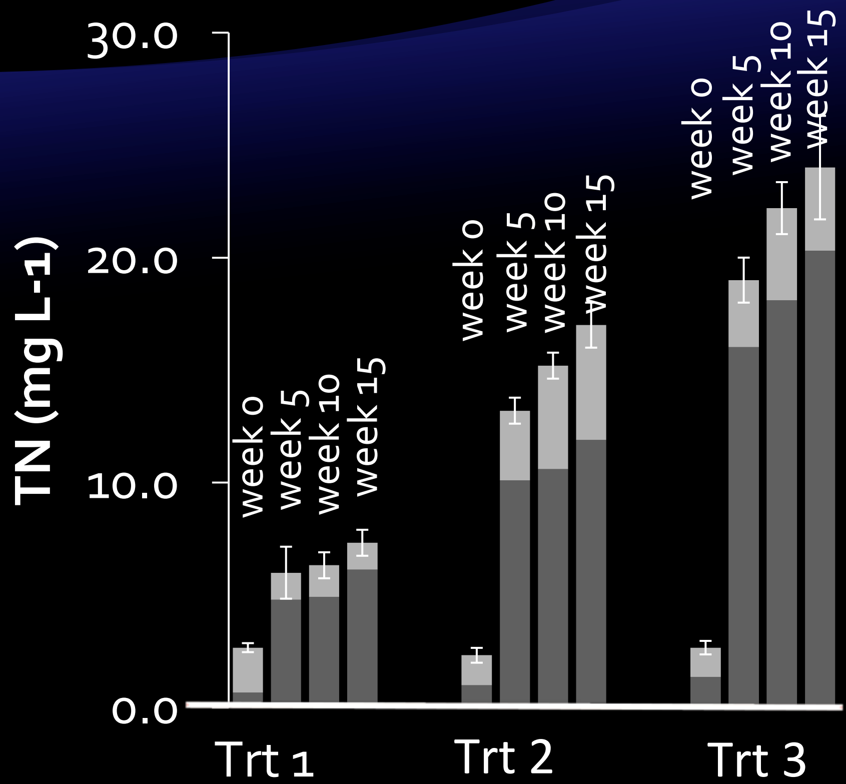
Results: Plant Growth

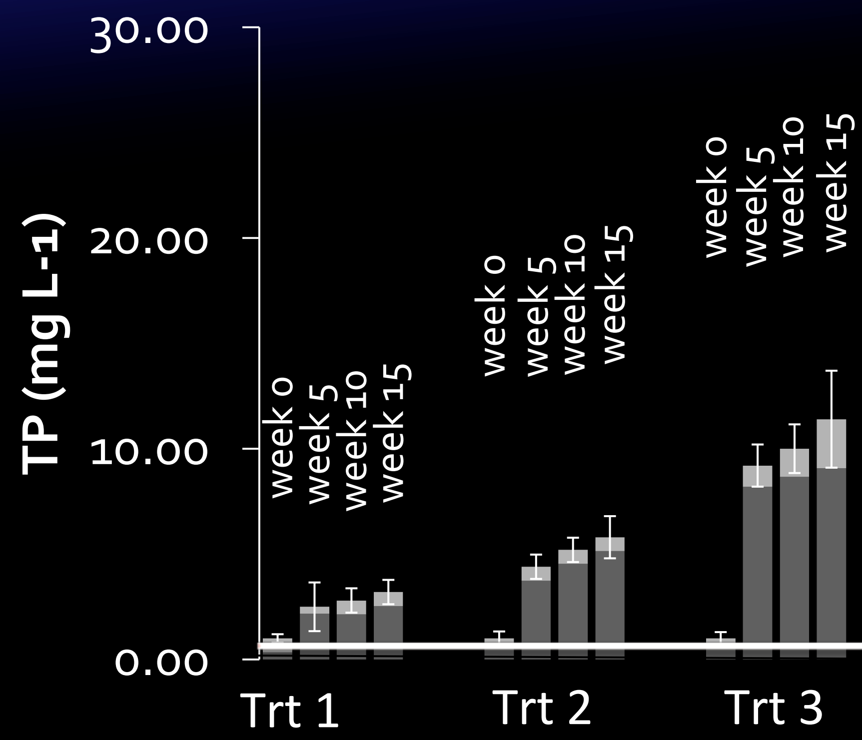




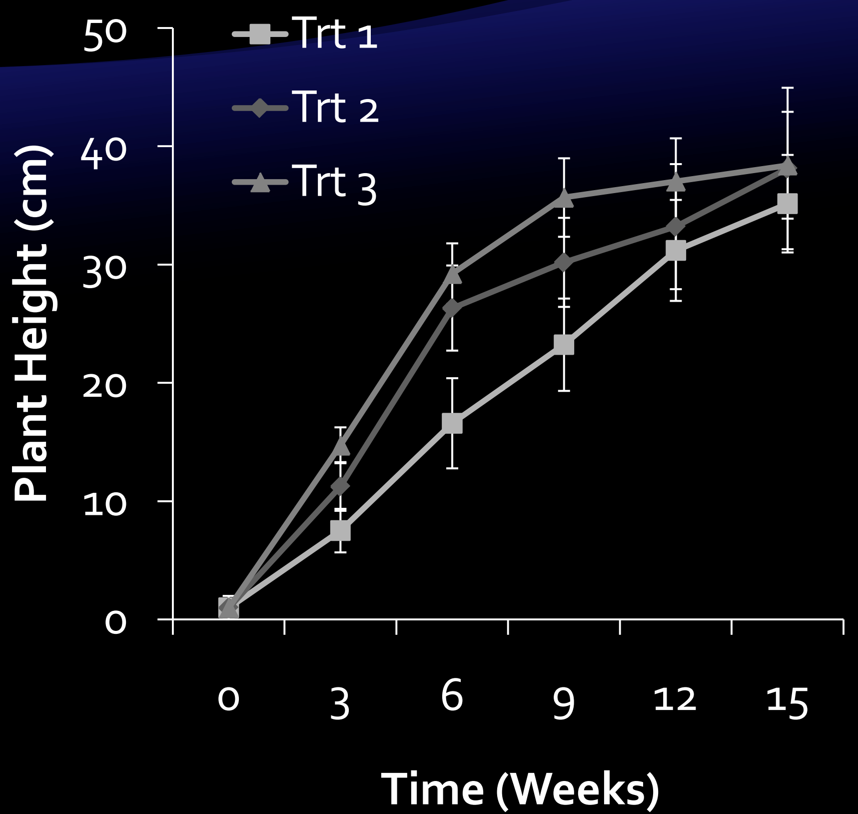
Results: Nutrients

TRT 1 has 3 kg m^{-3}
TRT 2 has 6 kg m^{-3}
TRT 1 has 9 kg m^{-3}

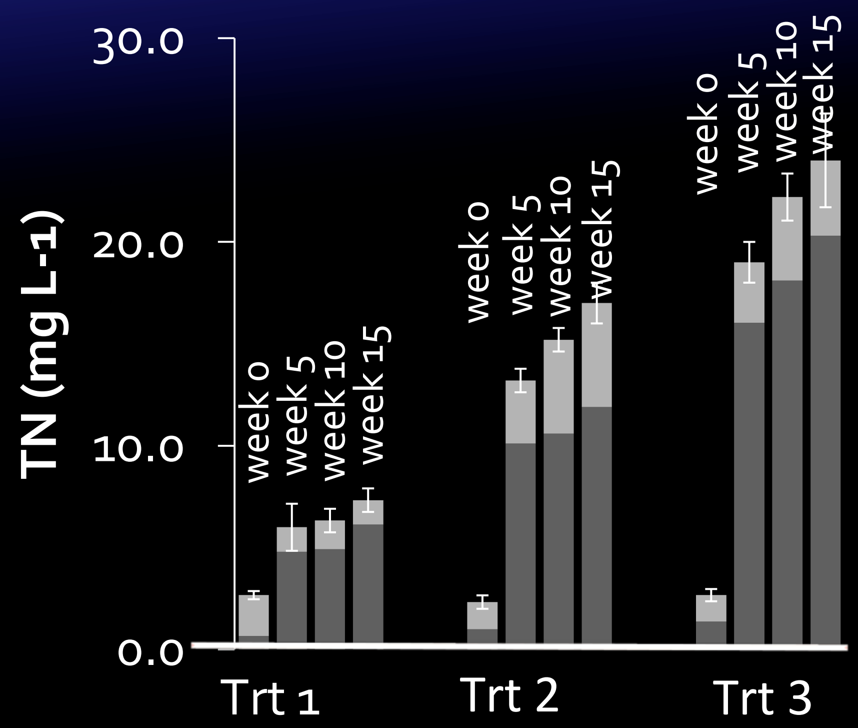




Discussion

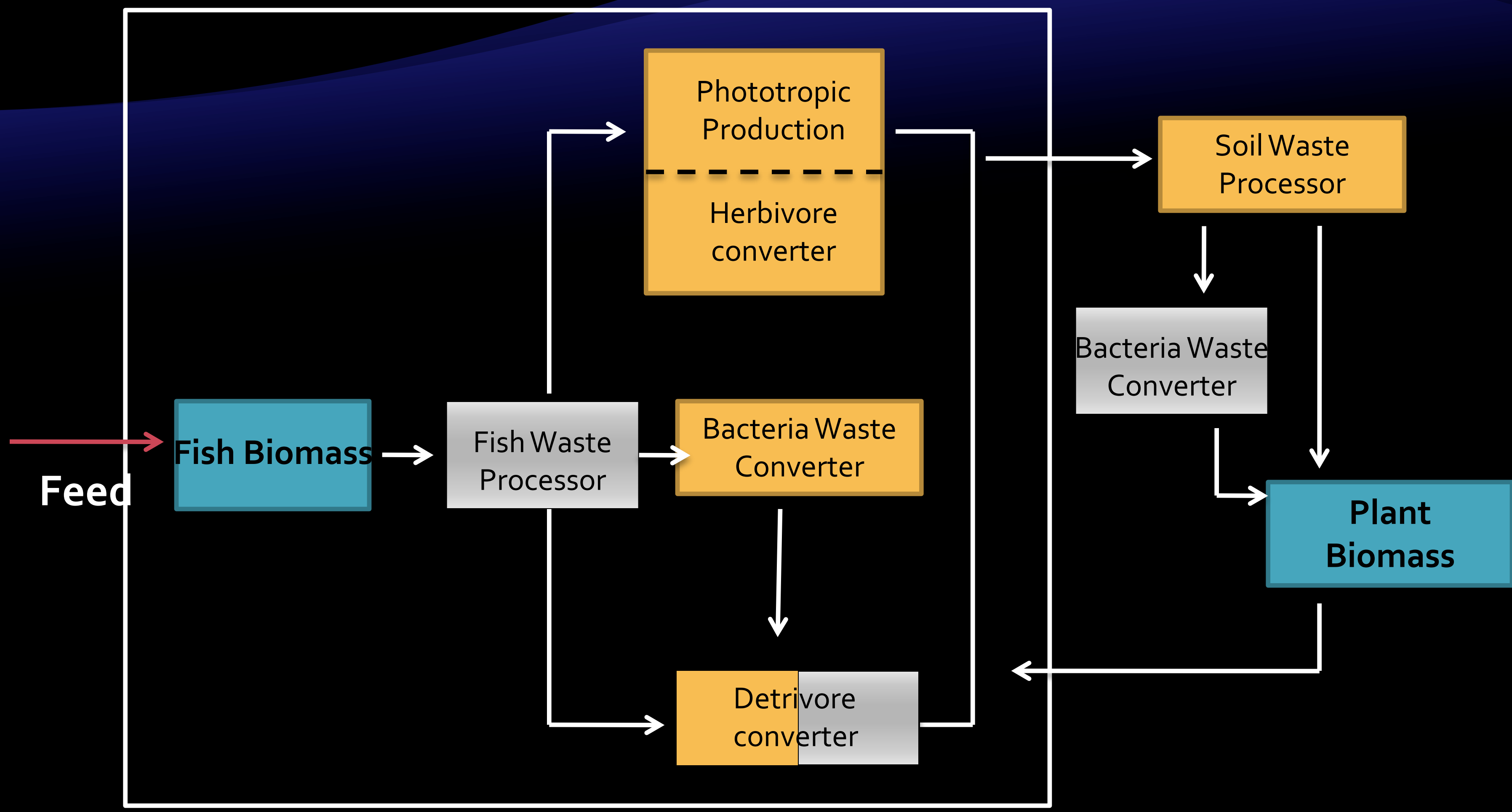


Trt 1
Trt 2
Trt 3
50
40
30
20
10
0
Plant Height (cm)
0
3
6
9
12
15
Time (Weeks)



30.0
20.0
10.0
0.0
TN (mg L-1)
week 0
week 5
week 10
week 15
Trt 1
Trt 2
Trt 3

Discussion


Phototropic Production
Herbivore converter
Soil Waste Processor
Bacteria Waste Converter
Fish Biomass
Feed
Fish Waste Processor
Bacteria Waste Converter
Plant Biomass
Detrivore converter

Discussion: Challenges

Introduction | Economics | Environment | Exp 1 | Exp 2 | Conclusion

Conclusions

- RIAA systems are:
  - Promising but not a magic bullet
  - Economically and environmentally advantageous
  - Robust and implementable

Conclusions

- RIAA systems are:
  - Managing the nutrient regime is challenging albeit critical
  - Well developed plant and fish harvest management could aid in solution

UTILIZING EFFLUENT FROM TILAPIA (*Oreochromis niloticus*) TO GROW LETTUCE (*Lactuca sativa*) and Basil (*Ocimum basilicum*) USING MULTIPLE LEVEL RIAA TECHNOLOGY.

Goal of This Research

1) To build upon previous work to evaluate robustness of technology

2) To evaluate 3-D structure food production: advantages and disadvantages and potential cost savings

Materials and Methods

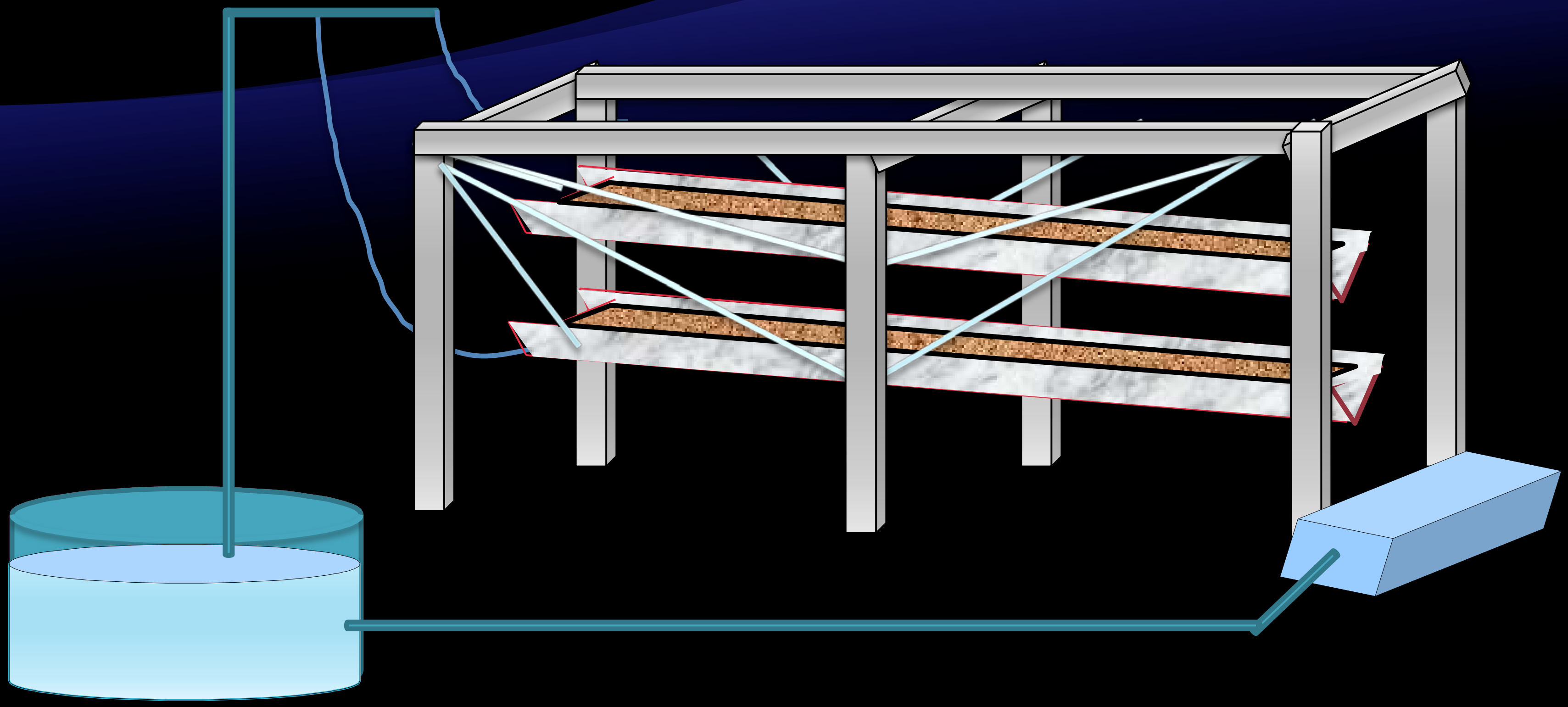
System Design to Test following on plant growth:

- Plant density
- System slope
- Shading levels

Hypotheses:

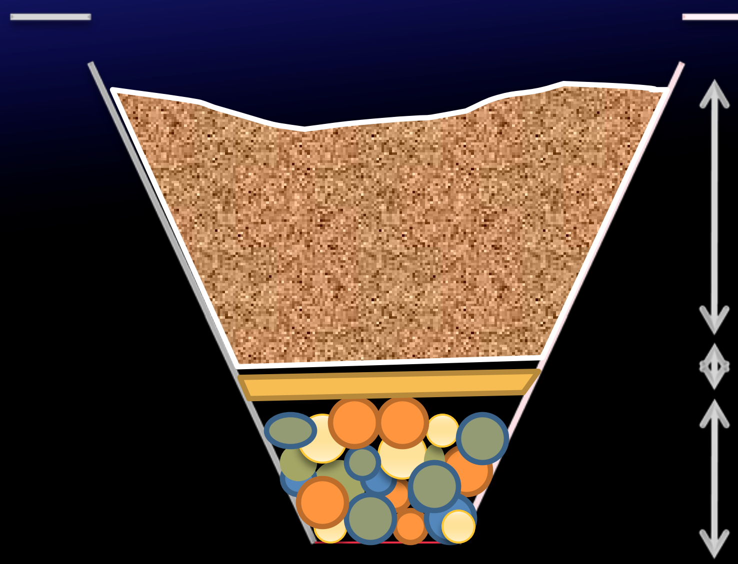
- Lower individual plant growth w/ higher plant densities
- Lower individual plant growth at higher slopes
- Lower individual plant growth in areas w/ more shade

Materials and Methods



Each levels comprised of two 23 m long 20 cm deep rain gutters which were suspended from a steel frame by steel gauge wire.

Materials and Methods

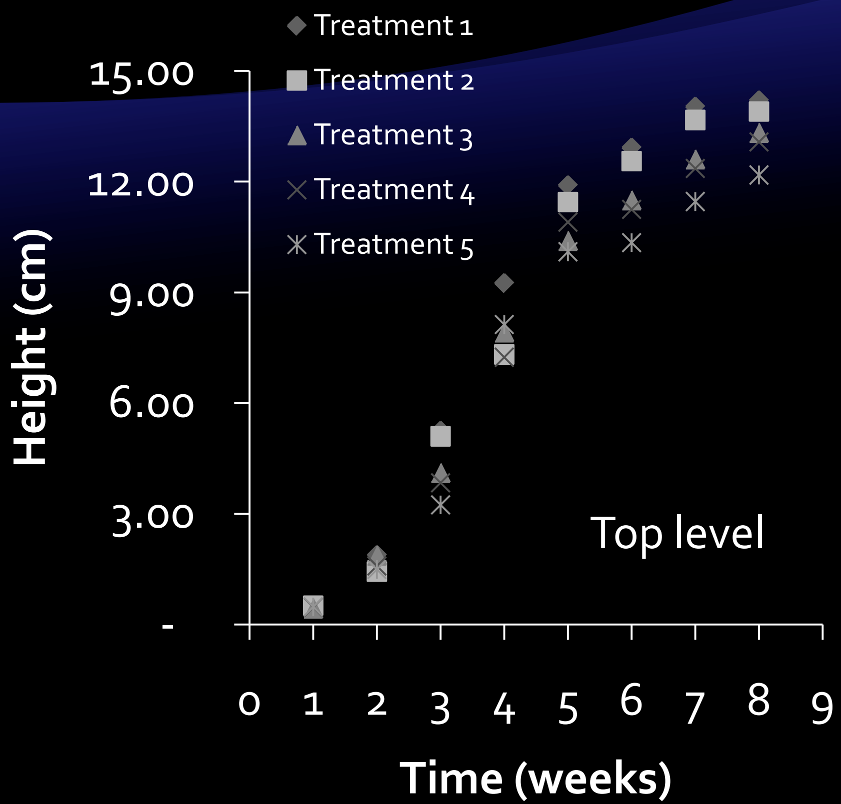


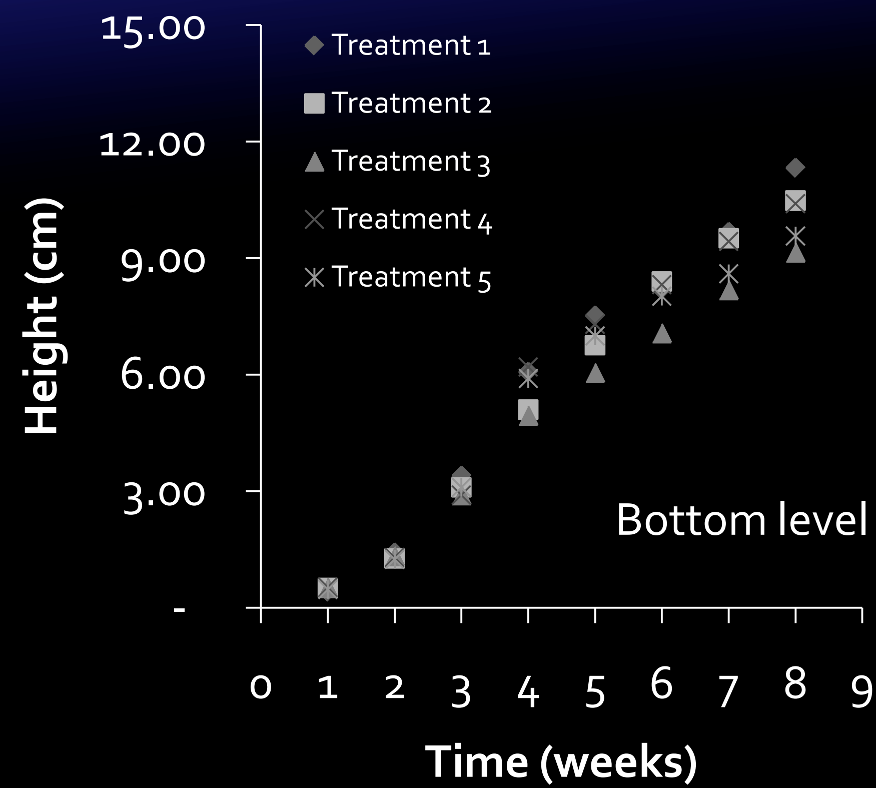
15.25 cm of 3:1 Bleached sand to Sunshine Mix

Geo-textile cloth

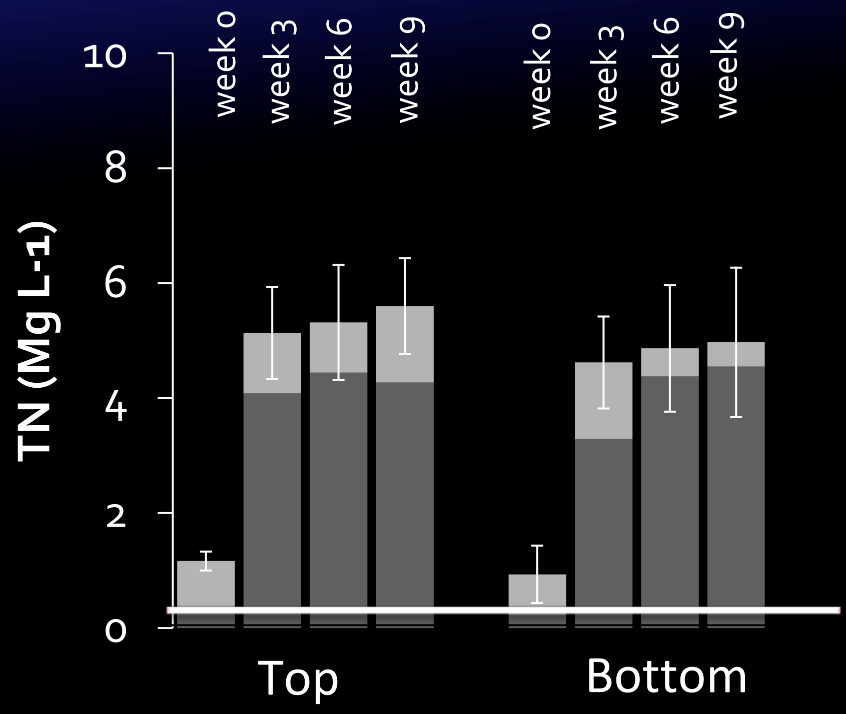
5 cm of 1/8th in course gravel

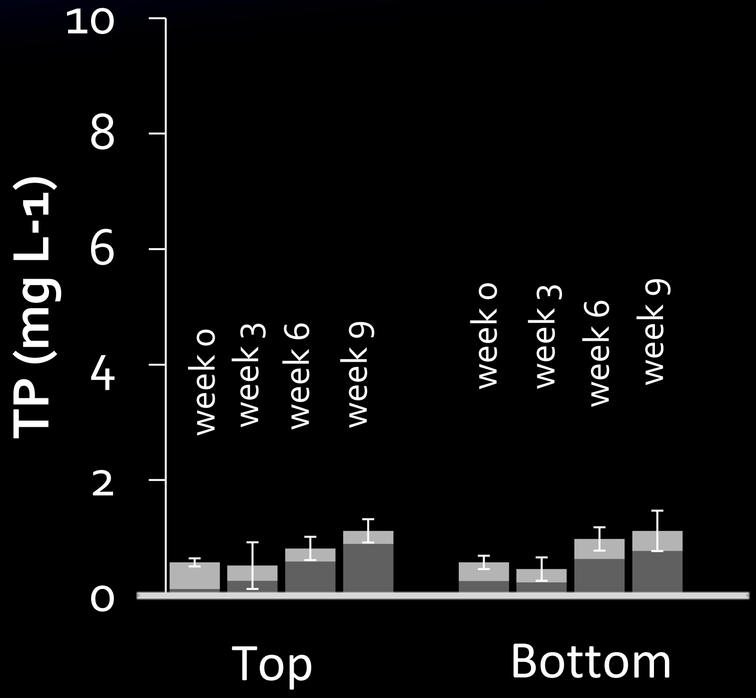
Results: Plant Height Over Time





Nutrients





Introduction | Economics | Environment | Exp 1 | Exp 2 | Conclusion

Conclusions

- MRIAA systems increase growing surface area relative to floor area.
- These systems increase the surface area and volume of soil in which effluent is applied.
- This allows better management control of nutrient regime.

Conclusions

- Strategic business models can be developed internationally using advanced business concepts and techniques
  - These are facilitated by IT, distribution capacity, and political reform.
  - Using economic tools, we can predict where to encourage development of aquaculture operations to have the greatest and most rapid development.

Conclusions

- Sustaining growth will depend on the implementation of sustainable technology which is resource conserving and economically competitive.
- RIAA and MRIAA technology is promising
  - Further assessment of nutrient regime management needed before commercial implementation.

Thank You!