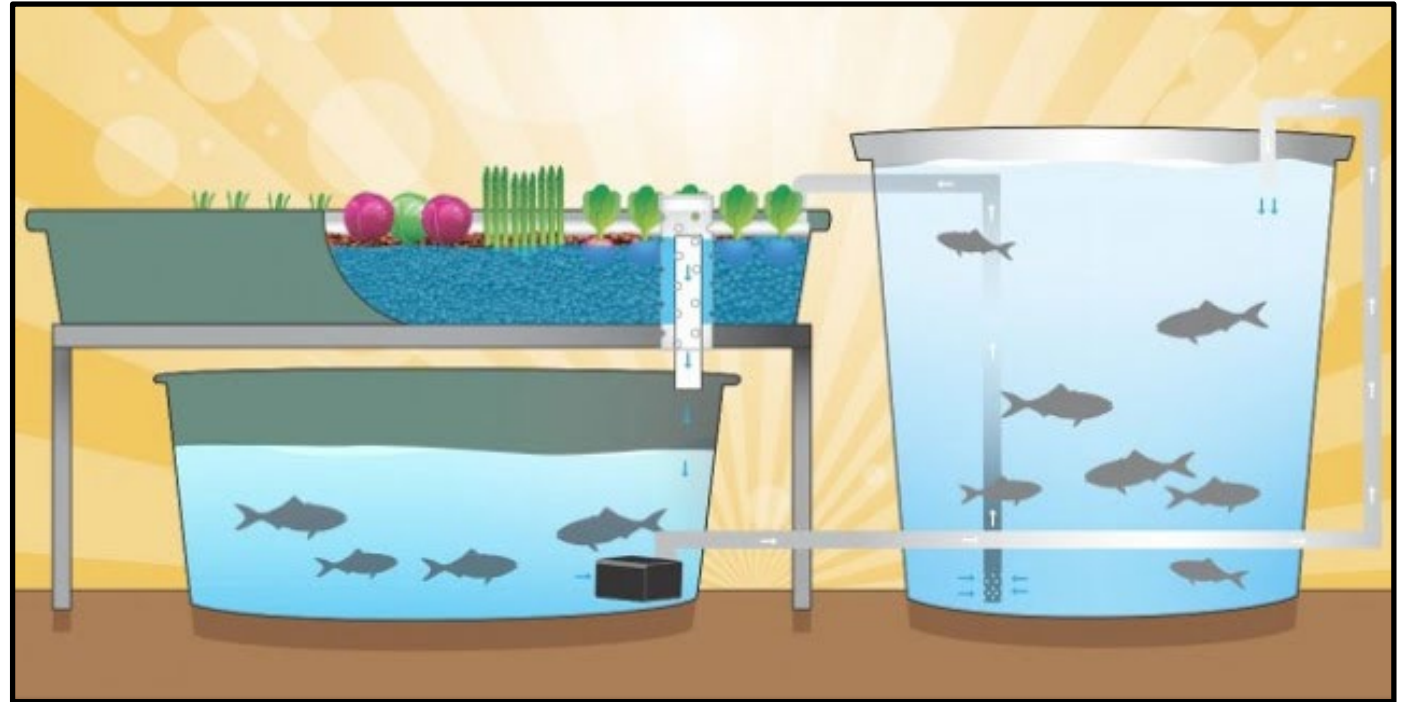


Aquaponics:

Can it help families be more food-secure in Nepal and elsewhere?

- Vernon Byrd
(byrdv2@gmail.com)
- University of the Nations, Kona
Hawaii campus, USA
and
- Kathmandu University, Nepal



From Kentucky State University

Youth With a Mission University of the Nations, Kona, Hawaii, USA Science and Technology

To Know God and Make Him Know





Kathmandu University Environmental Science



The Issue: Food Security (having regular access to affordable, adequate food)

- Urban Migration
- Food Vulnerable
 - shipping
 - price fluctuation
 - seasonal shortage
 - quality

Issues that cause (at least) seasonal shortages



Flooding (even normal monsoon)



No rain (dry season or draught)



Loss to pests and inadequate storage



Temperature extremes

Other issues
that affect
food security

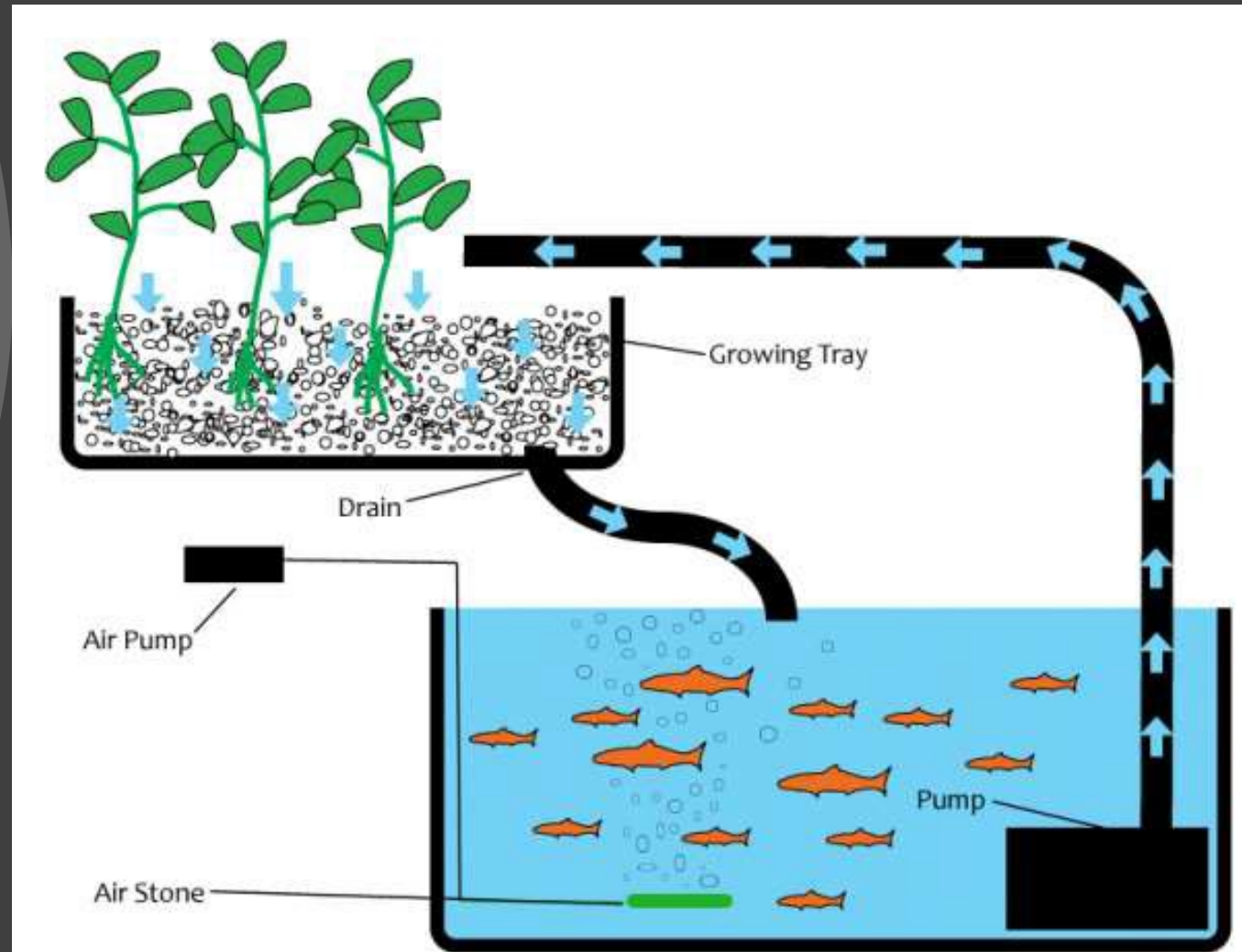
Ability to Grow

- Available land for growing
- Lack of knowledge
- Available labor

What is Aquaponics?

Aquaponics
combines 2 ways of
growing food:

Aquaculture +
Hydroponics



From Kentucky State University

The Aquaponics Process



Produces fish and plants

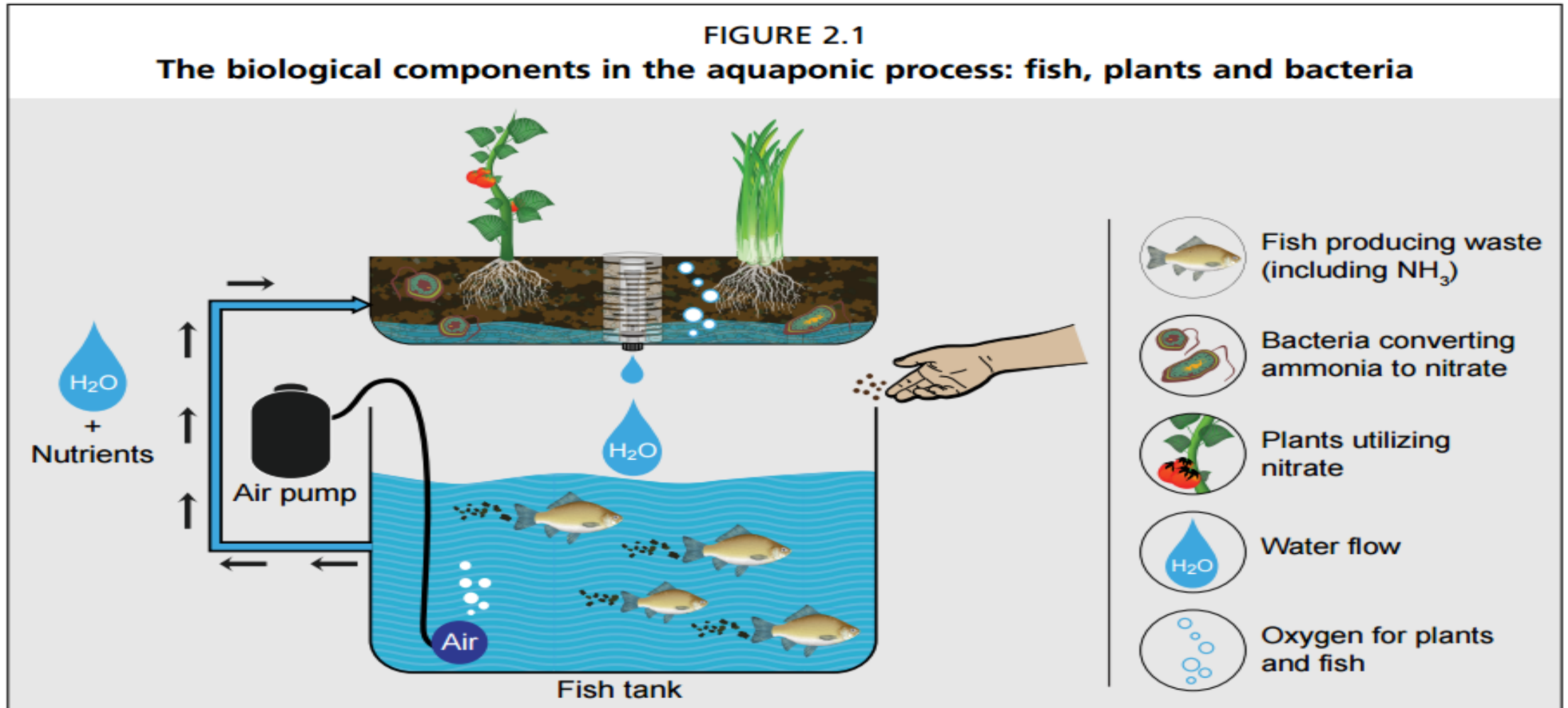


Plant food comes from
fish food through
bioconversion



Water is reused
(recirculated)

How can fish food feed plants?



Components of Aquaponics Systems

Living	Physical
Fish	Fish Tank
Plants	Grow Beds
Bacteria	Biofilter (bioconverter)
	Water pumps and aeration devices
	Waste management devices

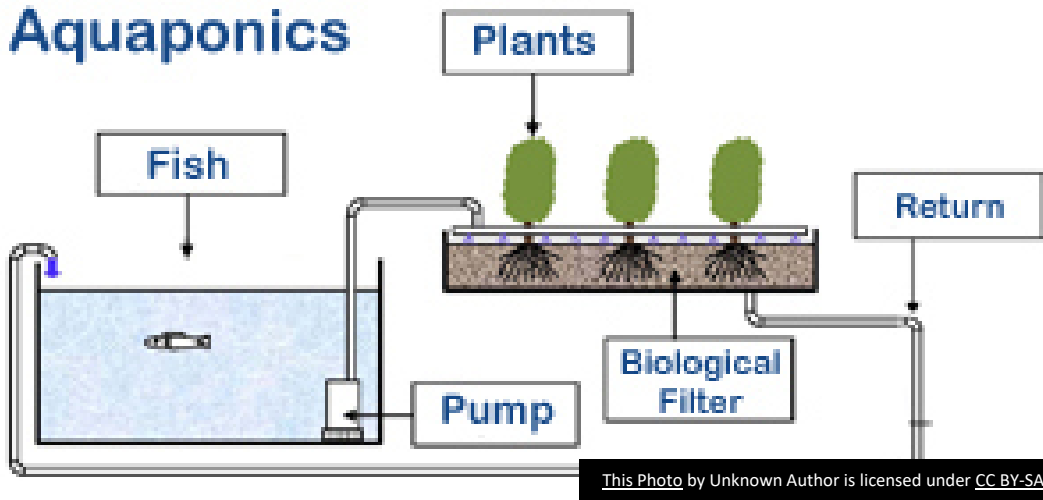
Advantages of Aquaponics



- Can us small space, no soil needed
- Relatively high productivity (high density, rapid growth)
- Fish and plants
- “Organic” by nature (no harmful chemicals)
- Uses relatively-little water
- Not subject to flooding
- No weeding and little added water

Disadvantages of Aquaponics

Aquaponics



- Typically needs electricity
- Initial costs higher than soil garden
- Need knowledge of fish and plants
- Technology fairly-new, limited track record
- Lots of misleading (over enthusiastic) information on internet

Types of Aquaponics Systems

Deep Raft
(Deep Water
Culture)

Media Bed

Nutrient Film
Technique

Aeroponics

Hybrid
(combination)



Deep Water Culture | Floating rafts
of water

Characteristics of Deep Water Culture

- Plant roots are constantly bathed in nutrient – rich water
- Ammonia-oxidizing bacteria and Nitrite-oxidizing bacteria occupy the surfaces of the grow bed and the plant roots
- Changes in water temperatures are buffered by the water volume (compared to NFT for example)
- Oxygen is available mainly as DO supplied by air compressors or other means of perturbation of the water
- May need clarifiers and or solids filters to manage waste



Media Beds

- Brick pieces
- Gravel
- Clay Balls

Characteristics of Media Beds

- Plant roots are typically alternately exposed to nutrient –rich water and air (at least in upper layers) during an ebb and flow cycle
- Nitrifying bacteria occupy the media
- Due to higher biological surface area of media, systems can be smaller than DWC systems without separate biofiltration.
- The media bed acts as both mechanical and biofiltration.
- Most “home” systems are media bed systems



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Nutrient Film

Thin layer of nutrient rich water (plant roots dangle in air and water)

Characteristics of Nutrient Film Technique

- Does not use much water
- Nutrients are concentrated
- Plant roots can take oxygen from the atmosphere
- Need effective clarifiers to avoid clogging tubes
- Subject to temperature fluctuations
- Often used in greenhouses to effectively use space

Aeroponics





Characteristics of Aeroponics

- Roots are misted with fish water
- Oxygen comes from atmosphere
- Excellent use of space
- Need clarified water



Hybrids (Combinations of
other types)



Characteristics of Hybrids

- Can take advantage of strengths of several types
- Particularly improve use of space in controlled environments



Aquaponic technology
can be expressed
many ways



Scales ranging from very
small to very large





There is a growing need and interest in evaluating aquaponics as a possible solutions to food security in cities.



Family scale variations

Expanded Roof top



Aquaponics on floating building



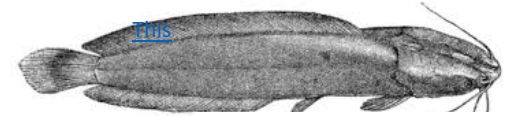
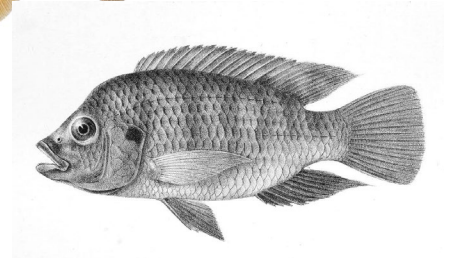
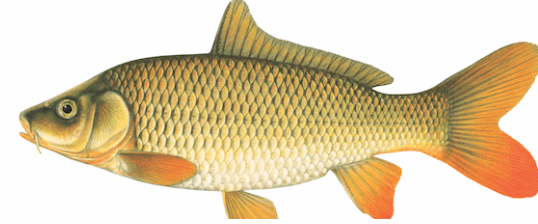
Efficient use of small space



What kinds of things are
grown?

Fish

- Common Carp
- Grass Carp
- Tilapia
- *Clarias* spp. catfish
- Pangas
- Koi



Plants: Leafy greens

rapid turnover,
relatively low
nutrients

LEAFY GREENS



Plants: higher nutrient demands

- Tomatoes
- Peppers
- Cucumbers
- Squash/Bitter Gourd
- Beans



Plants: Others

- Root Crops (in media)
- Starts of larger fruit trees
- Starts of taro
- Flowers



TABLE 28

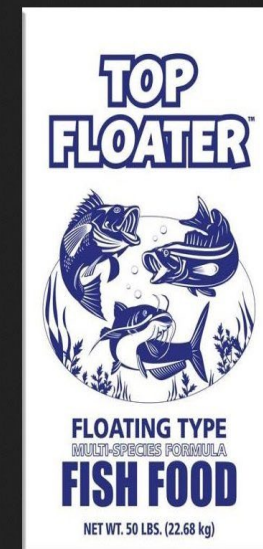
Ingredients and their composition (% inclusion) in manufactured feed in Europe

Ingredients	Reference	
	Waagbø <i>et al.</i> (2001) ¹	Skretting (2001)
	35	30
Fish oil	28	18
Fish ensilage	5	4
Corn and wheat gluten	7	
Vegetable protein		25
Soy products	6	
Soybean oil	3	
Vegetable oil		11
Wheat	12	
Wheat meal		10
Other	4	2

¹ Cited in Aqua Web (2009).

Is the food produced in
aquaponics nutritious?

- Nutrients come from fish food



Nutrients lacking in fish food

Potassium (needed for fruit producing crops, like tomato)

Calcium (used for buffering pH change)

Iron (chelated form to enter plant cells)

How about contamination?

- Since aquaponics systems isolate the plants and fish from contaminated soil and runoff water, which are often the source of farm produce contamination, aquaponics systems appear much more protected from human disease-causing organisms
 - No *E.coli* in aquaponics lettuce (no exposure to mammal feces (Nichols 2009, Maximum Yield). Study in Canada (Crops Diversification Center, Brooks, Alberta)
 - Contaminated water could introduce *E.coli* and other contaminants but these may not persist without additional input of mammal feces.
- This area needs more study (Ljubojevic et al. 2017. Aquaculture Europe Conference)



Food Safety
practices are
similar to other
agriculture
production
methods

Food Safety

So, what about aquaponics as
a technology that can help
people with food security?

Objectives Vary



Family food



Sales (small to large)



Education/Research

Beginning Systems





18-20 cm deep trays each about 1 m x 0.6 m



Hybrid system combine a 1.2 x 2.4 m media bed shown here coupled with two similar-sized deep water culture beds



IBC system with 4 m square grow beds and 1000-liter fish tank



4 deep water rafts (15 m long , 1.2 m wide)



Medium size deep water culture



Dubs.
Jan. 17
B&B - Feb. 6
1013

What about large-scale commercial aquaponics

New industry, not much solid information yet

- Most systems are less than 15 years old

There are systems around the world

- Australia is a leader

University of Virgin Islands System is Model

- James Rakocy
- Wilson Lennard
- Murray Hallam
- Nate Storey



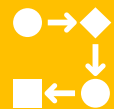
Reported elements for success



Focus of plants, fish are a supplement usually



Sell retail to local restaurants or farmer's markets at premium prices



Do not over build initially



Focus on niche markets, particularly for "off season" fresh produce or flowers

Research

Like for most new technologies, there is an initial research phase for aquaponics

Universities and NGOs in many countries are doing research to evaluate aquaponics

Thousands of individuals are doing “informal” research as they try systems, and this will help develop new approaches but is difficult to evaluate



Bangladesh Agriculture
University

Training

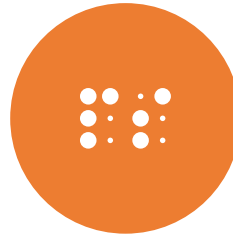
Not much university level training:
Kentucky State University might be only
graduate level course in aquaponics in US

Most training is at community colleges or
businesses (often online)

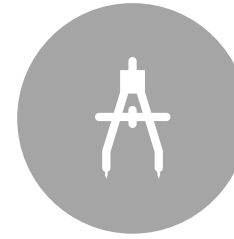
Both can help

Aquaponics: Can it help families
be more food-secure in Nepal
and elsewhere?

Planned Research



REVIEW WHAT
OTHERS ARE
DOING



BUILD FAMILY-
SCALE SYSTEMS IN
KATHMANDU



RECORD WHAT
THEY PRODUCE
AND COSTS



MEASURE AND
EVALUATE
VARIABLES THAT
AFFECT
PRODUCTION



EVALUATE
NUTRIENT DENSITY
OF FOOD
COMPARED TO
SOIL GARDENS



DOCUMENT VALUE
TO FAMILIES

Information Sharing Network



Share knowledge



Share information



Encourage each other

What kinds of
information?

What is being grown

Production/Costs

Problems

Innovations

Just sharing experiences

Acknowledgements:

- James Rakocy: J.E. Rakocy. 2013. Aquaponics: Integrating Fish and Plant Culture. Chapter 19 In Timmons, M.B. and J.M. Eberling (eds). Recirculating Aquaculture. NRAC Publication No. 401-2013. Ithaca Publ. Co. and other publications.
- Murray Hallam: <http://practicalaquaponics.com/blog/>
- Nate Storey: Bright AgroTech. Particularly his “aquaponics academy”
<https://www.youtube.com/user/BrightAgrotechLLC/featured>
https://www.youtube.com/results?search_query=aquaponics+academy
- Travis Hughey: Barrel-ponics (a.k.a. Aquaponics in a Barrel) 2005
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Acknowledgements continued

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- Glen Martinez. <http://www.olomanagardensaquaponics.com/>
- MA Abdus Salam: <https://www.facebook.com/Aquaponics-System-in-Bangladesh-479571739056441/>
- United Nations Food and Agriculture Organization (FAO). Small-scale aquaponic food production. www.fao.org/3/a-i4021e.pdf

Questions?

