AquaFish Innovation Lab Technical Sessions at Aquaculture America 2014

Seattle, Washington, USA

11 February 2014

Sessions organized by Dr. Hillary Egna

Proceedings

Assembled by Amanda Hyman
Edited by Jenna Borberg

2017

AquaFish Innovation Lab Management Office
Oregon State University
Strand Agriculture Hall
Corvallis, OR USA 97330

Program activities are funded in part by the United States Agency for International Development (USAID) under CA/LWA No. EPP-A-00-06-00012-00 and by participating US and Host Country institutions.

The mission of the AquaFish Innovation Lab is to enrich livelihoods and promote health by cultivating international multidisciplinary partnerships that advance science, research, education, and outreach in aquatic resources. Bringing together resources from Host Country institutions and US universities, the AquaFish Innovation Lab emphasizes sustainable solutions in aquaculture and fisheries for improving health, building wealth, conserving natural environments for future generations, and strengthening poorer countries' ability to self-govern.

Acknowledgements

The AquaFish Management Entity acknowledges the contributions of researchers and the support provided by participating US and Host Country institutions. The editors acknowledge the contributions of Ford Evans, Kat Goetting, Stephanie Ichien, and Briana Goodwin.

Disclaimers

This publication may be cited as:

AquaFish Innovation Lab. April 2017. AquaFish Technical Sessions at Aquaculture America 2014. AquaFish Innovation Lab, Oregon State University. Corvallis, Oregon, USA.

AquaFish Innovation Lab
College of Agricultural Sciences
Oregon State University
Strand Agriculture Hall
Corvallis, Oregon 97330-1643 USA

Table of Contents

PREAMBLE

2014 AquaFish Technical Sessions AA
2014 – Seattle, Washington, USA 11
February 2014

Session Organizer: Dr. Hillary Egna
Organizing Committee: Jenna Borberg and Stephanie Ichien

On 11 February 2014, AquaFish Innovation Lab held two special sessions at the World Aquaculture Society's Aquaculture America 2014 conference in Seattle, Washington, USA. Eight presentations were made in the morning session titled "Low Cost Feed and Input Solutions for Small-scale Aquaculture in Developing countries," and twelve presentations were given in the afternoon session titled "Low-cost Solutions for Sustainable Small-scale Aquaculture in Developing Countries." These sessions covered research on sustainable aquaculture for small-scale farmers, featuring numerous current and past AquaFish participants from around the globe. The morning and the afternoon sessions were a success with a captive audience that offered challenging questions and provided insightful feedback. These sessions at Aquaculture America were valuable for not only the AquaFish community, but also other aquaculture researchers worldwide who strive to find practices to decrease the cost of inputs while still producing valuable products.

2014 AquaFish Technical Sessions Agenda
AA 2014 – Seattle, Washington, USA

11 February 2014

<u>Tuesday, 11 February 2014</u>

AquaFish Technical Session 1 (10:30-12:30)
Low-Cost Feed and Input Solutions for Sustainable Small-Scale Aquaculture in Developing Countries

Chair: Kevin Fitzsimmons, AquaFish Co-PI

10:30-10:45 **EFFECT OF DIFFERENT FERTILIZATION AND FEEDING SYSTEMS ON WATER QUALITY AND GROWTH PERFORMANCE IN NILE TILAPIA Oreochromis niloticus**
Madhav K. Shrestha*, Nelson Pokhrel, Narayan P. Pandit and James S. Diana

10:45-11:00 **TESTING INDUCTION OF PERIPHYTON GROWTH AS A LOW-COST POSSIBILITY FOR SUSTAINABLE SMALL-SCALE TILAPIA CULTURE IN YUCATAN, MEXICO**
Martha Hernández, Eucario Gasca-Leyva, and Ana Milstein*

11:00-11:15 **EFFECT OF DIFFERENT FEEDING REGIMES ON GROWTH AND PRODUCTION PERFORMANCE OF AIR-BREATHING STINGING CATFISH, SHING *Heteropneustes fossilis* AND MAJOR CARPS IN POND POLYCULTURE**
Md. Abdul Wahab*, Md. Nazmush Sakib, and Russell J. Borski

11:15-11:30 **ALTERNATE DAY FEEDING IS MORE COST EFFECTIVE THAN DAILY FEEDING FOR CULTURE OF MILKFISH IN BRACKISH WATER PONDS AND SEA CAGES**
Russell J. Borski* and Evelyn Grace T. de Jesus-Ayson Department of Biological Sciences

11:30-11:45 **EFFECT OF FEEDING LEVEL AND FREQUENCY ON PERFORMANCE OF *Oreochromis niloticus* FED DIETS CONTAINING MORINGA LEAF MEAL AND SUNFLOWER SEED CAKE**
Nazael A. Madalla*, Omary D. Kitojo, and Sebastian W. Chenyambuga

11:45-12:00 **MOBILIZATION AND RECOVERY OF ENERGY STORAGE IN NILE TILAPIA SUBMITTED TO FASTING AND REFEEDING**
Caroline Nebo*, Maeli Dal Pai Silva, and Maria Célia Portella

12:00-12:15 **EFFECTS OF FERTILIZATION AND FEEDING LEVEL ON THE PRODUCTIVITY OF TILAPIA POND CULTURE IN GHANA**
Daniel Adjei-Boateng*, Collins Duodu Prah, and Regina E. Edziyie

12:15-12:30 **ENHANCEMENT OF POND PRODUCTIVITY OF TILAPIA POND CULTURE IN GHANA**
Julius O. Manyala*, Kevin Fitzsimmons, Charles C. Ngugi, Josiah Ani, and Henry Lubanga

AquaFish Technical Session 2 (13:30-15:00)
Low-Cost Solutions for Sustainable Small-Scale Aquaculture in Developing Countries

Chair (absent): Dr. Hillary Egna
Co-Chairs: Jenna Borberg, AquaFish Assistant Director of Research
Stephanie Ichien, AquaFish Monitoring and Evaluation Manager

13:30-13:45 **PRODUCTION PERFORMANCE OF DEDHUWA *Esomus danricus* IN MONOCULTURE AND POLYCULTURE WITH CARP IN CHITWAN, NEPAL**
Sunila Rai*, Sunil Poudel, Jiwan Shrestha

13:45-14:00 **SUSTAINABLE STRATEGY FOR CONTROLLING FISH DISEASE CONDITIONS USING BANANA *Musa sp.*LEAF EXTRACTS IN UGANDA**
John Walakira*, Joseph Molnar, and Edith Nankya

14:00-14:15 **ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI**
Dr Héry Coulibaly* Fishery of Mali, Boureima

14:15-14:30 **PROFITABILITY AND ADOPTION OF TWO POND AQUACULTURE BEST MANAGEMENT PRACTICES IN GHANA**
Yaw B. Ansah* and Emmanuel A. Frimpong

14:30-14:45 **USING ON-FARM EXPERIMENTS TO UNTANGLE THE CAUSES OF LOW PRODUCTIVITY OF TILAPIA *Oreochromis niloticus* GROWN IN PONDS IN GHANA**
Emmanuel A. Frimpong*, Yaw B. Ansah, Steve Amisah, and Daniel Adjei-Boateng

14:45-15:00 **ESTIMATING THE ACTUAL AND POTENTIAL PRODUCTION CAPACITY OF AQUACULTURE PONDS IN GHANA**
Iris Fynn* and Emmanuel Frimpong

15:00-15:15 **AN ECOLOGICAL APPROACH TOWARDS OPTIMIZING POND-SPECIFIC FERTILIZATION EFFICIENCIES FOR SEMI-INTENSIVE AQUACULTURE**
Christopher F. Knud-Hansen

15:15-15:30 **STOCKING DENSITY ANALYSIS OF TWO SMALL INDIGENOUS SPECIES, PUNTI *Puntius sophore* AND DEDHUWA *Esomus danricus* TO IMPROVE SUSTAINABILITY OF TYPICAL SIX-SPECIES LARGE-CARP CULTURE SYSTEMS IN RURAL NEPAL**
Bailey A. Keeler*, James S. Diana, and Madhav Shrestha

15:30-15:45 **ENVIRONMENTALLY FRIENDLY CAGE CULTURE: A SUCCESSFUL MODEL OF SMALL-SCALE AQUACULTURE FOR LIVELIHOOD OF FISHING COMMUNITIES IN NEPAL**
Jay D. Bista*, Madhav K. Shrestha, Surendra Prasad, and Narayan P. Pandit

15:45-16:00 **EVALUATION OF THE FUNCTIONING OF FARM DAMS IN CATCHMENTS IN THE STELLENBOSCH AREA OF SOUTH AFRICA**
Khalid Salie, Claude E. Boyd, Neelia du Buisson, Bernard Snyman

16:00-16:15 **AQUACULTURE PROCUCT DEVELOPMENT AND MARKETING INNOVATIONS FOR SUSTAINABLE SMALL-SCALE**

AQUACULTURE IN KENYA
Kwamena Quagrainie, Charles Ngugi, Judy Amadiva and Sammy K. Macaria

16:15-16:30 **LOW COST PRODUCTION SYSTEMS FOR TROPICAL GAR *Atractosteus tropicus***
Wilfrido Contreras-Sanchez*, Alejandro Mcdonal-Vera, Ulises Hernández-Vidal, and Sergio Hernandez-Garcia

AquaFish Technical Session 1: Low-Cost Feed and Input Solutions for Sustainable Small-Scale Aquaculture in Developing Countries

Effect of different fertilization and feeding systems on water quality and growth performance in Nile tilapia *Oreochromis niloticus*

Madhav K. Shrestha*, Nelson Pokhrel, Narayan P. Pandit and James S. Diana
Agriculture and Forestry University (AFU), Chitwan, Nepal madhavshrestha1954@gmail.com

Feed is the major input that increases production cost in aquaculture. Production system that decreases feed cost and optimizes productivity has to be explored. An experiment was conducted in 12 earthen ponds of 150 m^2 size for 120 days at the Institute of Agriculture and Animal Science (IAAS), Nepal to assess the effect of fertilization and feeding combinations on growth, production in Nile tilapia (*Oreochromis niloticus*) and water quality in production system. The experiment was conducted in a completely randomized design (CRD) with 3 treatments and 4 replications. The treatments were: fertilization only (T_1); fertilization + half feeding (T_2); full feeding (T_3). All-male Nile tilapia fingerlings of about 6.0 g size were stocked in all ponds at the density of 1 fish/m^2. The $T_1$and T_2 ponds were fertilized weekly @ 4 kg N and 1 kg P/ha/day using di-ammonium phosphate (DAP) and urea, whereas no fertilizers were applied for T_3 ponds. The T_2 and T_3 ponds were fed twice a day between 9-10 am and 3-4 pm, with a commercial pellet feed (25.0% crude protein) at 1.5 and 3.0% of body weight per day, respectively. Feed rations were adjusted fortnightly based on sampling weights. At harvest, the mean weight, daily growth rate and survival of Nile tilapia were not significantly different among treatments ($p>0.05$). The gross fish yield and net fish yield were significantly higher in fertilization + half feeding system (T_2) than sole fertilization system (T_1) and sole feeding system (T_3) ($p<0.05$). The cost per kg fish production ranged from NRs 95.1-150.0, which was significantly lower in fertilization + half feeding system (T_2) than sole feeding system (T_3) ($p<0.05$). There were no significant differences in dissolved oxygen, transparency, total alkalinity, total phosphorous and total Kjeldahl nitrogen among treatments ($p>0.05$). However, the soluble reactive phosphorous and chlorophyll-a were significantly higher in fertilization + half feeding system (T_2) than in sole feeding system (T_3) ($p<0.05$). This study demonstrates that fertilization supplemented with half feeding is more productive and economic than sole fertilization or full feeding system in mono-sex Nile tilapia culture.

TABLE 1. Growth performance of Nile tilapia in different treatments during the experimental period of 120 days. Data based on 150 m^2 water area. Mean values with same superscript in the same row are not significantly different (P>0.05).

Parameter	Treatments		
	T_1	**T_2**	**T_3**
Total stock number	150	150	150
Average stock weight (g/fish)	6.2±0.1 ^{a}	6.3±0.0 ^{a}	6.1±0.1 ^{a}
Total harvest number	42.3±11.0 ^{a}	65.3±8.4 ^{a}	52.8±2.3 ^{a}
Average harvest weight (g/fish)	246.0±97.5 ^{a}	343.2±64.3 ^{a}	248.7±26.3 ^{a}
Daily growth rate (g/fish/day)	2.0±0.8 ^{a}	2.8±0.5 ^{a}	2.0±0.2 ^{a}
Gross fish yield (kg/crop)	8.4±0.9 ^{a}	21.4±1.9 ^{b}	13.0±1.0 ^{a}
Net fish yield (kg/crop)	7.7±0.9 ^{a}	20.7±1.8 ^{b}	12.4±1.0 ^{a}
Cost per kg fish production (NRs)	125.4±9.6 ^{ab}	95.1±5.2 ^{a}	150.0±13.2 ^{b}

Effect of Different Fertilization and Feeding Systems on Water Quality and Growth Performance in Nile Tilapia *Oreochromis niloticus*

Madhav K. Shrestha[1], Nelson Pokhrel[1], Narayan P. Pandit[1*] and James S. Diana[2]

[1]Agriculture and Forestry University (AFU), Chitwan, Nepal

[2]University of Michigan, USA

Introduction

- Feed is the major input that increases production cost in aquaculture.
- Production system that decreases feed cost and optimizes productivity has to be explored.
- Combination of proper feeding and fertilization regimes might be an effective way to decrease feed cost and increase productivity.
- The objective of the present experiment was to assess effect of different feeding and fertilizer system on production and water quality of Nile tilapia.

Materials and Methods

Location: IAAS Fish Farm, Rampur, Nepal

Duration: 120 days

Experimental unit: 12 earthen pond of 150m^2

Species: All-male Nile Tilapia

Stocking density: 1 fish/m^2

Treatments: 3

Replications: 4

Experimental design: CRD

Treatments:

T$_1$: Fertilization only

T$_2$: Fertilization + half feeding (1% of BW)

T$_3$: Full feeding (2% of BW)

- **Feed/Feeding rate:** 30% CP pellet @ 2% body weight, twice a day
- **Fertilization rate:** weekly @ 4 kg N and 1 kg P/ha/day using di-ammonium phosphate (DAP) and urea

Measured parameters

- Growth and production
- Water quality
- Economics

Results

Growth parameters

Parameter	Treatments		
	Fertilization only	Fertilization + Half feeding	Full feeding
Total stock number	150±0.0[a]	150±0.0[a]	150±0.0[a]
Average stock weight (g/fish)	6.2±0.1[a]	6.3±0.0[a]	6.1±0.1[a]
Total harvest number	42.3±11.0[a]	65.3±8.4[a]	52.8±2.3[a]
Average harvest weight (g/fish)	246.0±97.5[a]	343.2±64.3[a]	248.7±26.3[a]
Daily growth rate (g/fish/day)	2.0±0.8[a]	2.8±0.5[a]	2.0±0.2[a]

Production

Parameter	Treatments		
	Fertilization only	Fertilization + Half feeding	Full feeding
Extrapolated GFY (t/ha/year)	1.67±0.18[a]	4.27±0.37[b]	2.60±0.21[a]
Extrapolated NFY (t/ha/year)	1.55±0.18[a]	4.15±0.37[b]	2.47±0.21[a]
SIS/Weed fish harvested (t/ha/year)	0.2±0.1	0.1±0.0	0.1±0.0

Water quality

Parameter	Treatments		
	Fertilization only	Fertilization + Half feeding	Full feeding
Water temperature (^oC)	25.3±0.0[a] (11.1-31.6)	25.5±0.0[a] (10.5-32.2)	25.4±0.2[a] (10.1-32.7)
Dissolved oxygen (mg/L)	5.4±0.5[a] (0.6-14.0)	4.5±0.7[a] (0.7-16.2)	4.3±0.2[a] (0.6-9.8)
pH	7.8 (7.0-9.7)	8.1 (7.5-9.7)	6.9 (5.8-8.8)
Secchi disk depth (cm)	26.0±1.6[a] (15.0-55.0)	27.5±0.4[a] (15.0-75.0)	27.7±0.5[a] (15.0-65.0)
Total alkalinity (mg/L $CaCO_3$)	114.6±3.8[a] (61.9-251.2)	155.9±22.0[a] (68.7-269.3)	161.6±21.3[a] (89.6-231.4)

Water quality (contd ….)

Parameter	Treatments		
	Fertilization only	Fertilization + Half feeding	Full feeding
Soluble reactive phosphorous (mg/L)	0.6 ± 0.0^{b} (0.1-1.2)	0.6 ± 0.1^{b} (0.1-1.3)	0.2 ± 0.0^{a} (0.1-0.6)
Total phosphorous (mg/L)	1.5 ± 0.1^{a} (0.3-4.3)	1.3 ± 0.1^{a} (0.2-4.7)	0.9 ± 0.3^{a} (0.1-4.6)
Total ammonium nitrogen (mg/L)	0.8 ± 0.0^{b} (0.0-2.5)	0.5 ± 0.0^{a} (0.1-1.2)	0.5 ± 0.1^{a} (0.1-1.3)
Nitrite nitrogen (mg/L)	0.09 ± 0.01^{b} (0.00-0.83)	0.04 ± 0.01^{a} (0.00-0.12)	0.03 ± 0.00^{a} (0.00-0.16)
Total kjeldahl nitrogen (mg/L)	1.2 ± 0.2^{a} (0.2-1.8)	1.3 ± 0.3^{a} (0.2-2.5)	0.9 ± 0.2^{a} (0.2-1.4)
Chlorophyll-a (mg/m^3)	54.1 ± 4.8^{b} (0.9-162.2)	58.0 ± 5.6^{b} (0.5-295.8)	20.1 ± 2.6^{a} (0.5-70.8)

Economics

Parameter	Treatments		
	Fertilization only	Fertilization + Half feeding	Full feeding
Variable costs (NRs/pond/month)	946±0	1953±75	1818±162
Gross return (NRs/pond/month)	1548±180	4147±369	2473±209
Gross margin (NRs/pond/month)	602±180	2194±295	656±247
Extrapolated gross margin (NRs in 1000/ha/year)	120 ± 26^{a}	438 ± 39^{b}	131 ± 29^{a}
Cost per kg fish production (NRs)	125.4 ± 9.6^{ab}	95.1 ± 5.2^{a}	150.0 ± 13.2^{b}

Summary and Conclusion

- Fertilization supplemented with half feeding is more productive and economic than sole fertilization or full feeding system in mono-sex Nile tilapia culture.

Funding for this research and travel was provided by the

AQUAFISH INNOVATION LAB

USAID FROM THE AMERICAN PEOPLE

OSU Oregon State

AQUAFISH INNOVATION LAB

The AquaFish Innovation Lab is supported in part by United States Agency for International Development (USAID) Cooperative Agreement No. EPP-A-00-06-00012-00 and by contributions from participating institutions.

This presentation is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government. Mention of trade names or commercial products in this presentation does not constitute endorsement or recommendation for use on the part of USAID or AquaFish. The accuracy, reliability, and originality of the work presented are the responsibility of the individual authors.

Thank You

Testing induction of periphyton growth as a low-cost possibility for sustainable small-scale tilapia culture in Yucatan, Mexico

Martha Hernández, Eucario Gasca-Leyva, and Ana Milstein*
Agricultural Research Organization, Fish and Aquaculture Research Station Dor, M. P. Hof Ha Carmel, 30820, Israel. anamilstein@agri.gov.il

In Yucatan aquaculture is not a common practice. The rural population perceives fish culture as an activity compatible with their agriculture production ways, and as a potential food and income source. The high cost of commercial feeds is one of the main problems limiting fish culture development in the region. The installation of substrates in the water column to promote periphyton development on them as natural food for Nile tilapia *Oreochromis niloticus*, a priori looks like a low-cost technology possibility for small-scale tilapia culture appropriate for the rural population of Yucatan.

Since there is no previous experience in periphyton-based aquaculture under Yucatan conditions, we first tested periphyton growth on cheap locally abundant substrates: corn cane, corncob, corn leaf, bamboo cane, guano stick, plastic bottle. Guano stick showed the best periphyton growth and longer durability than the other organic substrates.

Experiments on tilapia growth were carried out in tanks filled with well water without aeration or water renewal. Treatments were 'with' and 'without' substrates, guano sticks and plastic bottles providing an underwater hard surface area equivalent to 80% of the tank surface. Under inorganic fertilization without fish feed inputs, in the tanks with guano sticks tilapia weight and biomass at harvest were significantly lower than in tanks without substrates. This seems to be due to some substance from the guano sticks that negatively affected the fish. When under the same conditions (inorganic fertilization without fish feed inputs) plastic bottles were used as substrate, tilapia performance was similar with and without substrates. This discards the use of guano sticks and would indicate that inducing periphyton growth even on appropriate substrates would not have an advantage for tilapia culture, which throws out our a priori assumptions.

However, in all the experiments performed tilapia performance was poor in all tanks, with and without substrates, with inorganic fertilization and with comercial feed. This led us to search for a more general phenomenon that might be affecting tilapia growth, like the high alkalinity of the well water characteristic of Yucatan. High alkalinity affects chemical reactions and biological processes, so that photosynthesis leads to very high pH in still water exposed to direct sunlight. Thus, our next step will be to search for a cheap way to reduce alkalinity (like liming is used to increase it, or renewing water periodically) and then test again induction of periphyton growth as a low-cost possibility for sustainable small-scale tilapia culture under Yucatan conditions.

Dr. Ana Milstein

Agricultural Research Organization-ARO
Aquaculture Department

Fish & Aquaculture Research Station, Dor
M.P. Hof HaCarmel
30820 ISRAEL

Phone: +972 4 6390651
Fax: +972 4 6390652
E-mail: anamilstein@agri.gov.il
http://www.agri.gov.il/en/people/610.aspx

AQUACULTURE AMERICA 2014
Seattle, 9-12 Feb - 2014

Testing Induction of Periphyton Growth as a Low-Cost Possibility for Sustainable Small-Scale Tilapia Culture in Yucatán, Mexico

Martha Hernández[a], Eucario Gasca-Leyva[a], and Ana Milstein[b]

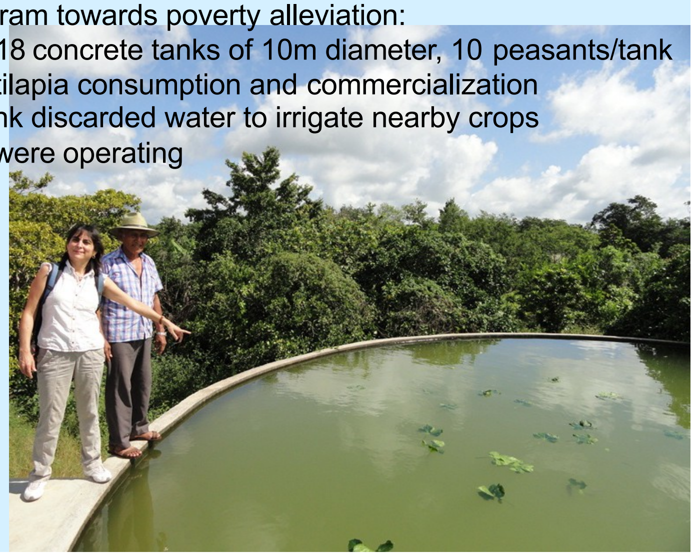
[a] Departamento de Recursos del Mar. Centro de Investigación y de Estudios Avanzados del IPN -CINVESTAV, Mérida, Yucatán, MÉXICO

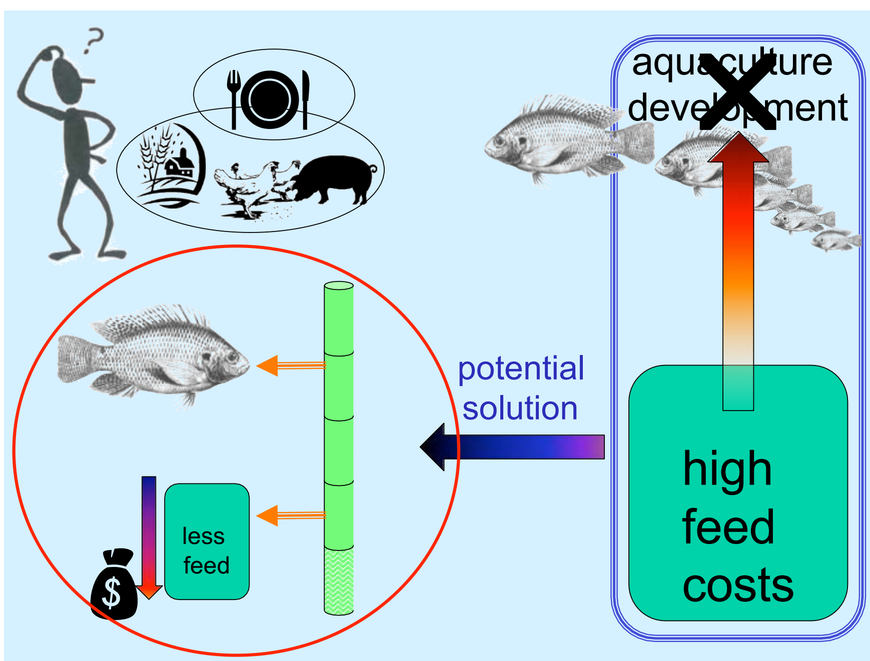
[b] Agricultural Research Organization, Fish and Aquaculture Research Station Dor, ISRAEL

Aquaculture in Yucatan

Not developed.
National program towards poverty alleviation:
2001-2002: 118 concrete tanks of 10m diameter, 10 peasants/tank
- foster tilapia consumption and commercialization
- use tank discarded water to irrigate nearby crops

2008: only 5 were operating





Periphyton based aquaculture ponds in Ivory Coast

Periphyton based aquaculture ponds in Bangladesh

At CINVESTAV - Mérida :

test of periphyton growth on cheap locally abundant substrates:

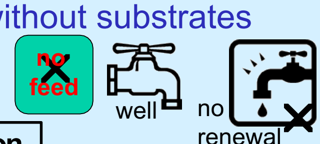
corn cane, corncob, corn leaf, bamboo cane, guano stick, plastic bottle.

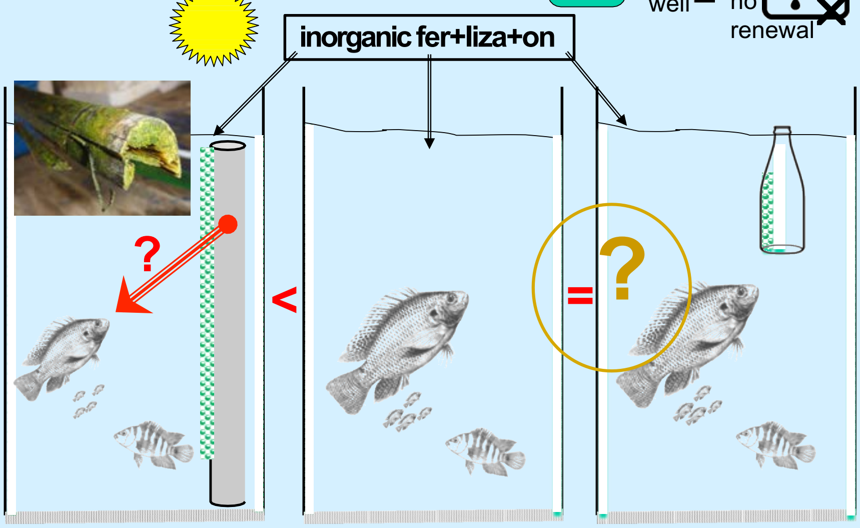
best periphyton growth & longer durability

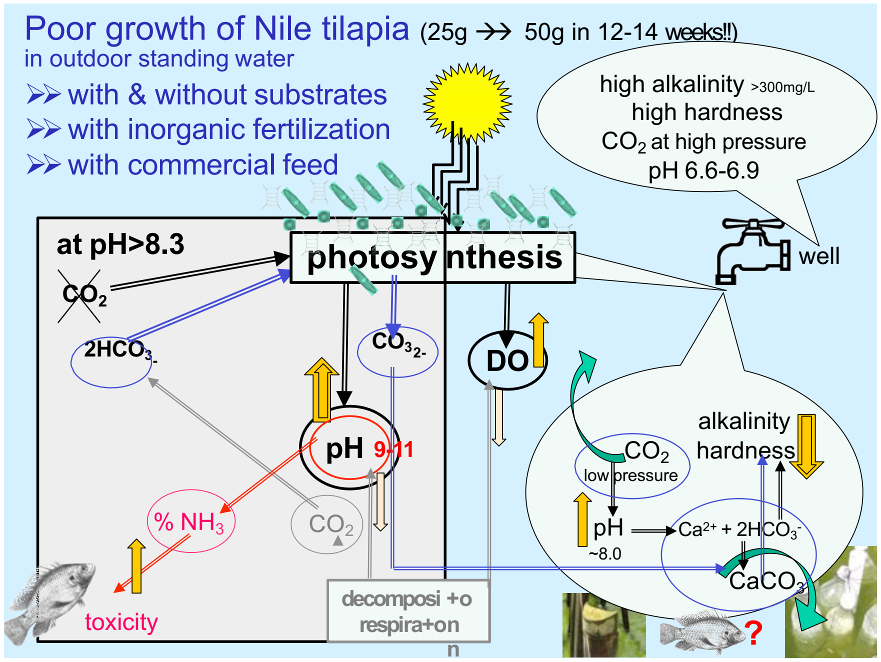
Tests of Nile tilapia growth with & without substrates

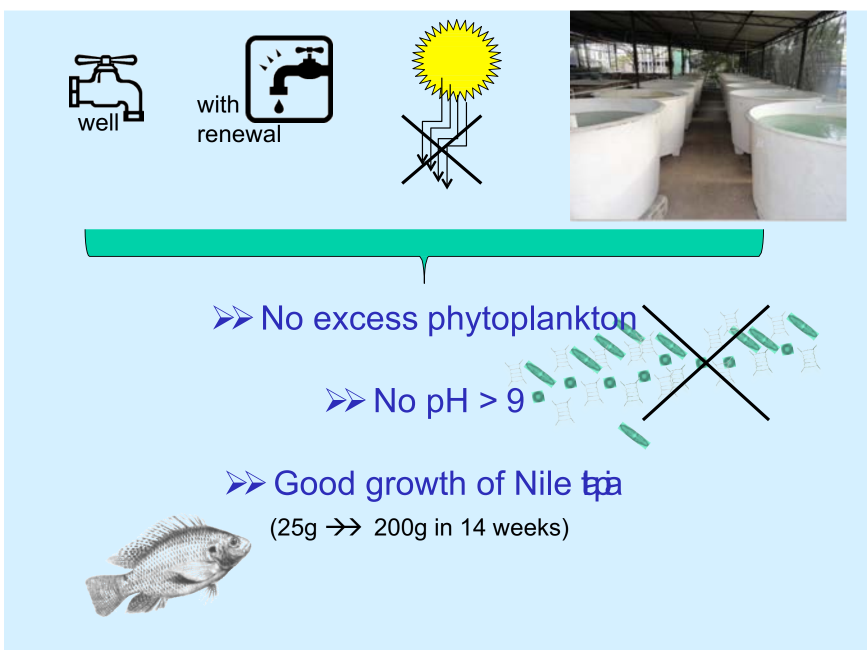
(underwater area = 80% of surface area)

(Mayan cichlid stocked to control wild spawning)






Poor growth of Nile tilapia (25g → 50g in 12-14 weeks!!)
in outdoor standing water
with & without substrates
with inorganic fertilization
with commercial feed
high alkalinity >300mg/L
high hardness
CO2 at high pressure
pH 6.6-6.9
well
at pH>8.3
photosynthesis
CO2
2HCO3-
CO32-
DO
pH 9-11
% NH3
CO2
toxicity
decomposition
respiration
CO2
low pressure
alkalinity
hardness
pH
~8.0
Ca2+ + 2HCO3-
CaCO3
?


well
with
renewal
No excess phytoplankton
No pH > 9
Good growth of Nile tilapia
(25g → 200g in 14 weeks)

Our challange:

To find ways to control pH in alkaline waters

- suitable for Yucatáns' small-scale farmers,

and that at the same time
- allow enough photosynthesis for periphyton growth

Effect of different feeding regimes on growth and production performance of air-breathing stinging catfish, shing *Heteropneustes fossilis* and major carps in pond polyculture

Md. Abdul Wahab*, Md. Nazmush Sakib, and Russell J. Borski
Department of Fisheries Management Bangladesh Agricultural University Mymensingh, Bangladesh wahabma_bau2@yahoo.com

The stinging catfish or shing (*Heteropneuestes fossilis*) is a high value, micronutrient dense, air-breathing fish that has a strong capacity to tolerate poor oxygen environments. Because of this, the culture of shing has grown substantially over the past decade in Bangladesh. Feed constitutes almost 80% of the total variable costs of producing shing, so methods to reduce feed inputs can provide significant benefits, particularly if fish are polycultured with carps that rely primarily on natural pond productivity rather than direct consumption of formulated feeds for their growth. A study was carried out at the Fisheries Field Laboratory at Bangladesh Agricultural University to evaluate the effects of reduced feeding regimes on the growth and production of major Indian carps, rui (*Labeo rohita*) and catla (*Catla catla*) in pond polyculture with shing over a 120-day growout period. The experiment comprised three treatments in nine ponds (100 m^2 area, 1.5 m depth) each stocked with an equivalent number of carps (catla, 20 and rui, 80) and shing (500); with full feeding daily (T1), half feeding daily (T2), and full feeding on alternate days (T3). All ponds were fertilized weekly (N:P = 2.0:0.5). Commercial pelleted feed was applied according to current culture practices (20% down to 5% body weight of shing) either daily (T1) or on alternate days (T3) at full ration level or at half-rations daily (T2; 10% down to 2.5% bw of shing). Pond water temperature, TDS, conductivity, total alkalinity, pH, dissolved oxygen, ammonia-nitrogen, phosphate-phosphorus and chlorophyll-a did not differ among treatments ($p > 0.05$), while transparency was reduced in T1. No significant effect of treatment on survival rates was observed among the three species. Specific growth rates (SGR) of rui and catla did not vary significantly among treatments, but SGR was slightly reduced for shing in T3 relative to T1. No difference in shing SGR was observed between the T1 and T2 groups. The mean harvest weight of shing was similar in T1 (full feeding) and T2 (half feeding) groups, while both were higher than T_3(alternative day full feeding) fish. The apparent combined feed conversion ratio (FCR; feed applied to body weight gain) was lower in T2 and T3 relative to T1. The production of each (of three) species was higher in T1 than the T2 and T3 groups. The combined net production for the three species was 3,300 kg/ha for T1, 2,136 kg/ha for T2, and 2,440 kg/ha for T3. Despite the higher net production of fish in T1, the benefit-to-cost ratio (returns - investment) was better for T2 (3.34) and T3 (2.97) than for T1 (2.55). This is largely due to the lower costs of feed associated with 50% feed reduction strategies. Thus, despite lower production levels, daily feeding at half ration levels was the most cost effective strategy.

EFFECT OF DIFFERENT FEEDING REGIMES ON GROWTH AND PRODUCTION PERFORMANCE OF AIR-BREATHING STINGING CATFISH, SHING (*Heteropneustes fossilis*) AND MAJOR CARPS IN POND POLYCULTURE

M. A. Wahab[1], M. N. Sakib[1] and Russell J. Borski[2]

[1]Department of Fisheries Management
Bangladesh Agricultural University,
Mymensingh, Bangladesh

[2]Department of Biological Sciences,
North Carolina State University,
Raleigh, NC USA

NC STATE UNIVERSITY

AQUAFISH
INNOVATION LAB

Background

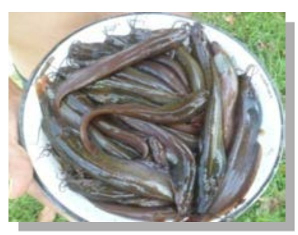
➢➢Following success of pangasius ca0ish aquaculture, Bangladesh has begun culture of three local air–breathing fishes, shing (*Heteropneuestes fossilis)*, magur (*Clarias batrachus*) and koi (*Anabas testudineus*) in intensive pond systems

➢➢Shing recognized for its excellent taste, has high iron content, market value is very high ($6–7 at farm gate)

➢➢Feed cost for air–breathing fishes is high due to high inputs

➢➢This causes environmental deterioraHon, olen leading to mass mortality and economic loss

➢➢Farmers are looking for alternate farming opHons, preferably low input carp -air–breathing fish polyculture



Objec'ves

- ➢➢To evaluate the effects of reduced feeding regimens on growth and producHon of major carps (*Labeo rohita* and *Catla Catla*) and sHnging ca0ish (*Heteropneustes fossilis*) in polyculture
- ➢➢To compare the water quality/environmental parameters in response to three feeding regimes
- ➢➢To assess economic returns from different feeding management protocols

Materials and Methods

Study area and duraHon:

- ➢➢ On-staHon trial carried out at the Fisheries Field Laboratory, Bangladesh Agricultural University, Mymensingh, Bangladesh
- ➢➢ Three treatments in 9 ponds (3x3)
- ➢➢ Pond area 100 m^2 and 1.5 m depth
- ➢➢ The trial was carried out for 120 days from April to August 2013

Treatment Groups

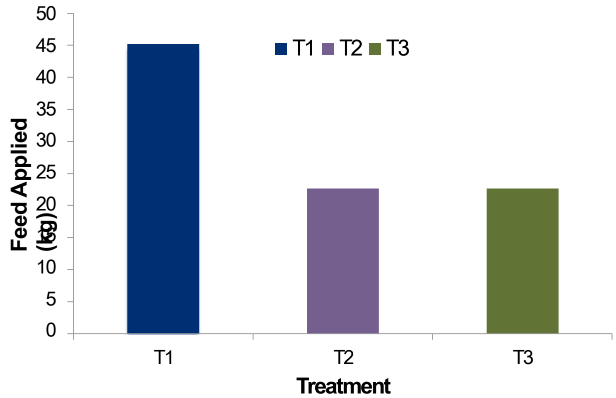
	Treatment 1	Treatment 2	Treatment 3
Stocking			
Rui (*Labeo rohita*)	80	80	80
Catla (*Catla catla*)	20	20	20
Shing (*Heteropneustes fossilis*)	500	500	500
Fer'liza'on	2:0.5 (N:P) weekly	2:0.5 (N:P) weekly	2:0.5 (N:P) weekly
Feeding	Full fed daily	½ Fed daily	Full fed on alternate day

Feed Applica'on

Feeding regimes (% bw) of Shing (T_1 as farmers pracHce), commercial pelleted feed

Month	T_1 Full fed daily	T_2 Half fed daily	T_3 Full fed at alternate day
April	20%	10%	20%
May	15%	7.5%	15%
June	10%	5%	10%
July	5%	2.5%	5%

Feed used per treatment



Water Sampling

- Water samples were collected weekly
- Temperature, transparency, pH, DO were measured on the spot
- Total alkalinity was measured by HtraHon
- NO_3-N, NO_2-N, NH_3-N, PO_4-P, TDS, conducHvity & Chlorophyll-a - measured by DR-4000, a direct reading spectrophotometer in the Water Quality & Pond Dynamics Lab

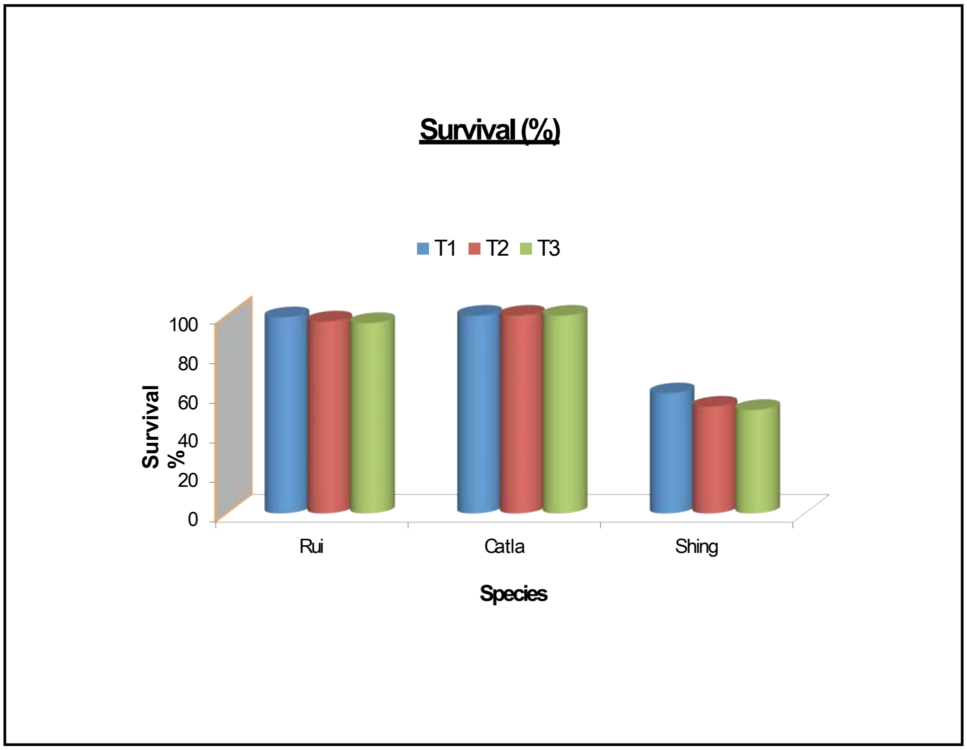
Water Quality Parameters

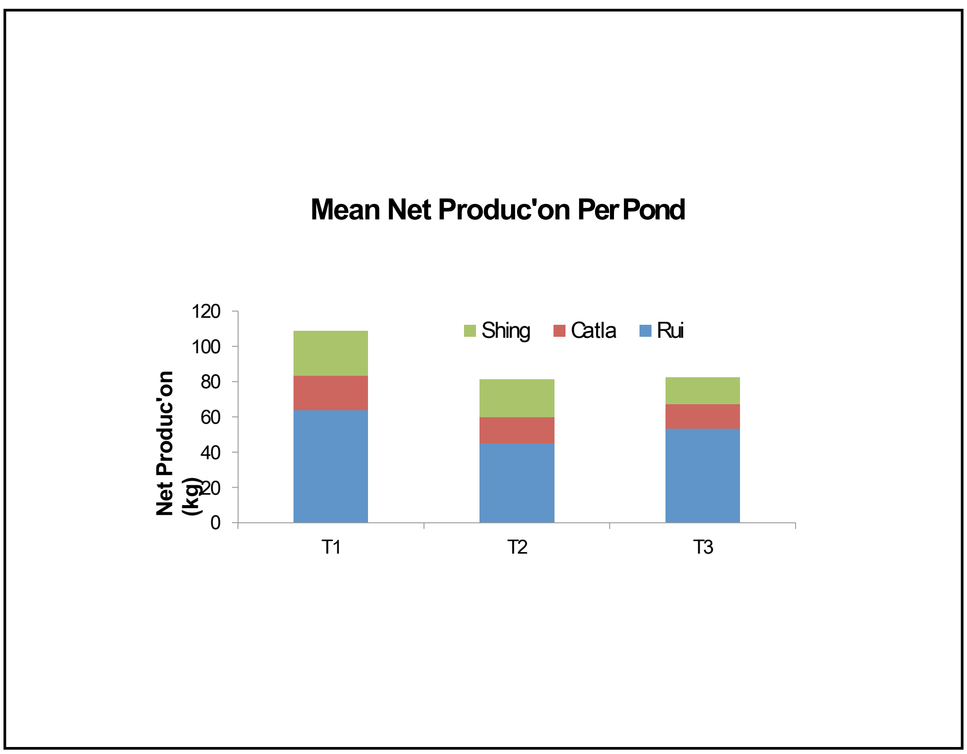
Parameters	T_1	T_2	T_3
Air Temperature (°C)	30.15 ± 0.20	30.15 ± 0.20	30.15 ± 0.20
Water Temperature (°C)	30.88 ± 0.28	30.98 ± 0.25	31.06 ± 0.26
Transparency (cm)	37. 25 ± 1.28[a]	38.12 ± 1.34[a]	44.44 ± 1.61[b]
DO (mg l^{-1})	5.23 ± 0.24	5.15 ± 0.22	5.49 ± 0.23
pH	8.51	8.43	8.32
Alkalinity (mg l^{-1})	110 ± 5.95	110 ± 4.81	107 ± 4.58
Nitrate–nitrogen (mg l^{-1})	0.05 ± 0.009[ab]	0.03 ± 0.003[b]	0.07 ± 0.019[a]
Nitrite–nitrogen (mg l^{-1})	0.03 ± 0.007[b]	0.03 ± 0.007[b]	0.058 ± 0.01[a]
Ammonia–nitrogen (mg l^{-1})	0.47 ± 0.06	0.42 ± 0.04	0.43 ± 0.05
Phosphate– phosphorus (mg l^{-1})	1.16 ± 0.12	1.20 ± 0.11	1.33 ± 0.13
TDS (mg l^{-1})	87.02 ± 5.70	88.35 ± 5.67	90.82 ± 5.14
ConducHvity (µScm^{-1})	159.14 ± 10.5	163.89 ± 11.10	171.82 ± 8.30
Chlorophyll–*a* (µg l^{-1})	49.57 ± 6.45	53.90 ± 6.26	52.84 ± 5.39

T1 = 100% Ration Daily
T2 = 50% Ration Daily
T3 = 100% Ration Alternate Day

Growth Assessment

- Shing fishes were caught by using bamboo cylinders
- Rui and catla were caught by seine net
- Length and weight were measured using a scale & electrical balance


Survival (%)
T1
T2
T3
100
80
60
40
20
0
Survival %
Rui
Catla
Shing
Species


Mean Net Produc'on Per Pond
120
100
80
60
40
20
0
Net Produc'on (kg)
Shing
Catla
Rui
T1
T2
T3

Growth and Produc'on of Rui

Characters	Treatments		
	T_1	T_2	T_3
Mean stocking weight (g)	15.95 ± 2.05	15.95 ± 2.05	15.95 ± 2.05
Mean harvesHng weight (g)	265 ± 1.26[a]	193 ± 2.59[c]	232 ± 4.20[b]
Mean weight gain (g)	249 ± 1.26[a]	177 ± 2.60[c]	216 ± 4.20[b]
Survival (%)	99.16 ± 0.83	97.08 ± 1.81	97.50 ± 1.44
SGR	2.34 ± 0.04	2.07 ± 0.10	2.21 ± 0.14
Total ProducHon (kg)	63.76 ± 1.75[a]	45.25 ± 3.86[b]	53.51 ± 5.54[b]

Growth and Produc'on of Catla

Characters	Treatments		
	T_1	T_2	T_3
Mean stocking weight (g)	18.2 ± 1.23	18.2 ± 1.23	18.2 ± 1.23
Mean harvesHng weight(g)	325 ± 3.87[a]	243±5.05[b]	229±2.59[c]
Mean weight gain (g)	307 ± 3.87[a]	225 ± 5.05[b]	211 ± 3.72[c]
Survival (%)	100	100	100
SGR	2.39 ± 0.10	2.13 ± 0.16	2.09 ± 0.12
Total ProducHon (kg)	19.52 ± 1.34[a]	14.63 ± 1.75[b]	13.78 ± 1.29[b]

Growth and produc'on of Shing

Characters	Treatments		
	T_1	T_2	T_3
Mean stocking weight (g)	2.05 ± 0.56	2.05 ± 0.56	2.05 ± 0.56
Mean harvesHng weight(g)	27.91 ± 0.70[a]	26.20 ± 1.47[ab]	19.55 ± 2.38[b]
Mean weight gain (g)	25.86 ± 0.70[a]	24.15 ± 1.47[ab]	17.50 ± 2.38[b]
Survival (%)	60.80 ± 2.15	54.06 ± 2.47	52.40 ± 2.04
SGR	2.17 ± 0.02[a]	2.12 ± 0.04[ab]	2.05 ± 0.09[b]
FCR	1.76	1.06	1.47
Total ProducHon (kg)	25.45 ± 0.56[a]	21.19 ± 0.27[b]	15.25 ± 0.79[c]

Combined Produc'on Results

Characters	Treatments		
	T_1	T_2	T_3
Combined Net ProducHon (kg ha^{-1})	3300 ± 164[a]	2136 ± 118[b]	2440 ± 215[ab]
Combined Feed Conversion RaHo (FCR)	1.36 ± 0.07[a]	0.96 ± 0.11[b]	0.96 ± 0.13[b]

Economical Analysis

Items	Treatments		
	Daily full feeding T_1	Daily half feeding T_2	Alternate day full feedingT_3
Financial Inputs (per ha)			
Lime	1000	1000	1000
Urea	4440	4440	4440
TSP	1260	1260	1260
Feed	241,310	120,655	120,655
Rui	20550	20550	20550
Catla	5137	5137	5137
Shingi	16466	16466	16466
Labour & Land rental cost	10000	10000	9000
Total Cost	300,164	179,509	178,509
Bank Interest (12% annually)	36019	21541	21421
Total Investments	336,184	201,050	199,930
Financial Returns			
Rui	293976	208632	246716
Catla	102857	77064	72632
Shingi	460893	382896	276047
Total Returns	857,727	668,592	595,390
Return Cost Ra˚o	2.55[b]	3.33[a]	2.98[a]

Summary and Conclusion

- ➢➢All water quality parameters did not differ between groups, except for transparency, NO_3-N and NO_2-N, which showed only slight variaHon
- ➢➢Total producHon of Rui, Catla & Shing was highest in T1 (full daily feeding) than T2 (half daily feeding) and T3 (full alternate day feeding)
- ➢➢ Combined producHon of all fish was greatest in T1
- ➢➢ The combined FCR, however was lower in T2 and T3 than in T1
- ➢➢Daily half feeding with ferHlizaHon was economically more profitable than either daily full feeding or alternate day full feeding
- ➢➢Overall, SHnging ca0ish Shing and carps can be cultured together and both may complement each other in keeping the pond environment clean and making opHmum uHlizaHon of natural food and commercial feed inputs

Funding for this research was provided by the

AquaFish Innovation Lab

USAID FROM THE AMERICAN PEOPLE

OSU Oregon State

AquaFish Innovation Lab

The AquaFish CRSP is funded in part by United States Agency for International Development (USAID) Cooperative Agreement No. EPP-A-00-06-00012-00 and by US and Host Country partners.

Alternate day feeding is more cost effective than daily feeding for culture of milkfish in brackishwater ponds and sea cages

Russell J. Borski* and Evelyn Grace T. de Jesus-Ayson
Department of Biological Sciences North Carolina State University Raleigh, North Carolina, USA russell_borski@ncsu.edu

The herbivorous milkfish (*Chanos chanos*) grows in salinities ranging from fresh water to full-strength seawater. It is the largest finfish aquaculture industry in the Philippines with 350,000 MT produced annually. Much of the production is moving away from traditional brackish water pond systems to culture in sea cages, where fish are grown more intensively with substantively greater feed inputs to the environment. Feeds constitute 50-60% of total production costs for milkfish. This study evaluated the effects of alternate day feeding as a potential cost containment strategy for production of milkfish in both brackish water ponds and sea cages. Studies were undertaken at aquaculture facilities of the Southeast Asian Fisheries Development Center (SEAFDEC) in the Philippines. Milkfish fingerlings were stocked at 0.5 fish/m^2 in 700 m^2 brackish water ponds or in triplicate 5x5x3 m floating cages at 35 fish/m^3 for culture in coastal marine waters. Fish were fed either daily or on alternate days with SEAFDEC formulated feeds initially at 7.5% of body weight/day given over four feedings per day. The amount of feed was reduced as the fish gained weight. Fish were cultured for 12 weeks in brackish water ponds and 14-18 weeks in the sea cages. Survival rates of fish grown in brackish water ponds under alternate day feeding (93%) were similar to that of fish given a daily feeding regimen (84%). Average body weight (ABW) of fish on alternate day feeding was slightly less (275.79 ± 19.5 g) albeit insignificant from that of fish fed daily (324.31 ± 17.13 g). The harvested biomass was similar among treatment groups (daily feeding, 99 kg; alternate day feeding 94 kg). The apparent feed conversion ratio (FCR), however, was substantially lower in fish subjected to alternate day feeding (1.50) than that of fish fed daily (3.41). Results show a 56% savings in feed associated with raising milkfish on alternate day feeding with little impact on total yield.

For studies with sea cages, fish survival rates were similar between alternate day (89%) and daily (83%) feeding groups. The duration of culture for stocks fed on alternate days was longer and the ABW at harvest was smaller compared to stocks fed daily, indicating fish fed on alternate days grew at a lower rate. However, the total harvested biomass (615 ± 42.36 kg, alternate day; 629.67 ± 6.01, fed daily) and estimated value of the harvest was similar between the two groups. On the other hand, the amount of feed consumed and the corresponding cost of feeds were significantly lower in stocks fed on alternate days compared with stocks that were fed daily. The apparent FCR was lower in the alternate day (2.25 ± 0.15) relative to daily (3.2 ± 0.06) feeding groups. This resulted in savings in feed cost of 31.74% in the alternate-day fed group. Collectively, these results suggest that alternate day feeding provides a significant cost savings over the traditional management approach of feeding milkfish on a daily basis in both brackish water ponds and sea cages. Considering similar findings were observed with tilapia pond culture, the cost-containment approach of feeding on alternate days may prove generally useful for the culture of herbivorous fishes.

Alternate Day Feeding is More Cost Effective than Daily Feeding for Culture of Milkfish in Brackishwater Ponds and Sea Cages

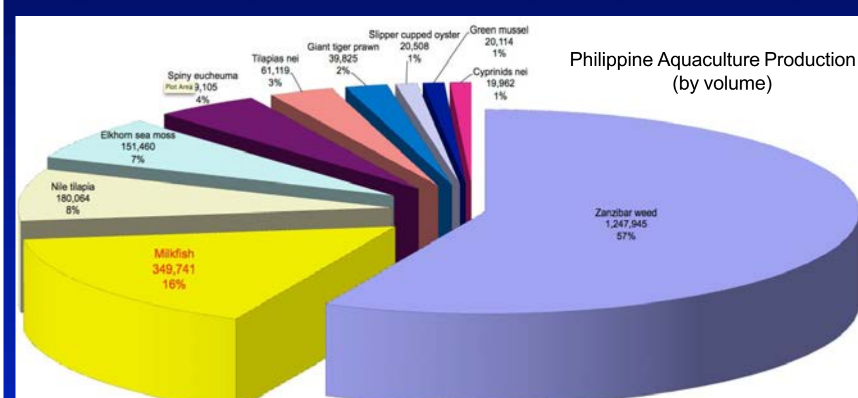
Russell J. Borski
Department of Biology, North Carolina State University, Raleigh, NC USA

Evelyn Grace T. de Jesus-Ayson
Southeast Asian Fisheries Development Center – Aquaculture Department, Tigbauan, Philippines

Aquaculture America
Feb 9-12, 2014, Seattle WA USA

Milkfish (*Chanos chanos*) Production

- Euryhaline herbivore grown throughout Asia
- Philippines largest producer
- Philippines: #1 foodfish by volume, #1 aquaculture product by value



Milkfish (*Chanos chanos*) Production in the Philippines

- Traditionally produced in brackishwater ponds
- Intensive culture in cages in coastal marine environments and pens in freshwater growing rapidly – more profitable

	1996	2000	2005	2010
Total Milkfish Production	150,182	209,994	289,152	349,435
% total aquaculture production	23	30	22	19
Brackishwater ponds, pens	139,372	186,599	219,906	219,443
% of total milkfish production	93	89	76	63
Freshwater cages and pens	10,779	14,523	25,277	42,788
% of total milkfish production	7	7	9	12
Marine Cages and Pens	31	8,872	43,969	87,199
% of total milkfish production	0	4	15	25

Problems

Uncontrolled expansion/ intensification of aquaculture activities

↓

Congestion

Overstocking

Overfeeding: high feeding & production costs

↓

Pollution
Eutrophication
Harmful Algal Blooms →

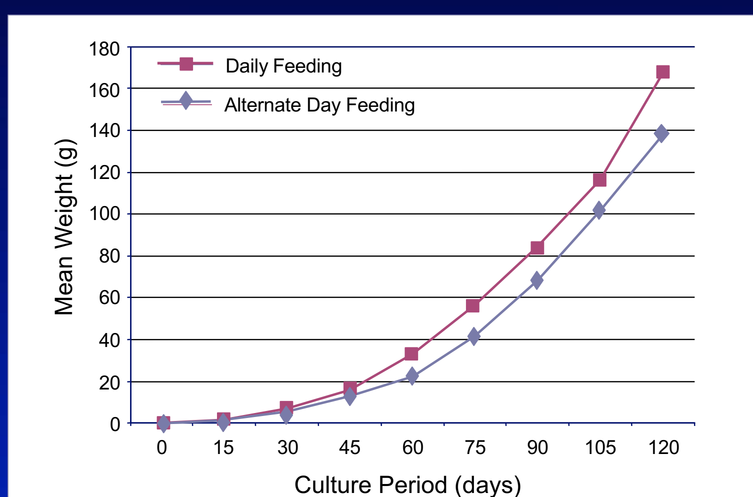
Challenge to Intensification of Milkfish Culture

- Greater dependency on commercial feeds
- 50-60% of production costs due to feed
- Low feed efficiency (FCR >3.0)
- Negative environmental impact

Goal: Reduce Feed Input Costs

- Can limit amount of feed
- Reduce cost of feed

Previous Findings - Alternate Day Feeding is Effective in Nile Tilapia



Bolivar et al. 2006 NAJA

On-Farm Performance of Nile Tilapia Fed Daily and on Alternate Days

Performance	Daily Feeding	Alternate Day Feeding
Final mean weight (g)	167.3 ± 53	137.8 ± 72
Mean daily weigh gain (g)	1.39 ± 0.44	1.15 ± 0.60
Extrapolated gross yield (kg)	2,994 ± 808	2,807 ± 857
Feed conversion ratio	2.2 ± 0.73	1.0 ± 0.34
Survival (%)	55.3 ± 20	63.4 ± 26
Quantity of feeds (kg ha^{-1})	6,331 ± 1,088	2,689 ± 601

OBJECTIVES

- Evaluate if alternate day feeding is as effective as daily feeding in growout of milkfish in brackish water ponds and sea cages
- Can strategy improve production efficiency?

Milkfish Brackish Water Preliminary Study

Brackish water ponds

- pond area - 700 m^2
- stocking density - 0.5 fish/m^2
- supplemental feeding daily (control) or every other day (alternate day), duplicate ponds
- SEAFDEC feed - CP 30%, CF 8-9%
- fed 4x daily or alternate days (6 – 3% ABW/day)
- 3 month culture

Feeding Rate

Our previous work found daily feeding rate can be reduced by approx. 25% relative to industry practices

Industry Rate

Average Body Weight (grams)	Feeding Rate (% of Biomass)
5 to50	10
51 to 125	8
125 to 199	6
200 to 250	5.5
251 to 300	5
300 to 400	4
400 to 500	3.5 to 3
>500	2.5

Experimental Rate

Average Body Weight (grams)	Feeding Rate (% of Biomass)
< 50	7.5
50 to 100	6
100 to 150	5.5
150 to 200	5
200 to 250	4.5
250 to 300	4
300 to 350	3.5
350 to 400	3
400 to 500	2.5
>500	2

Milkfish Alternate Day Feeding Brackishwater Ponds – Preliminary Study

	Daily Fed	Alternate Day Fed
Initial ABW (g)	67.0 ± 5.6	67 ± 7.5
Final ABW (g)	351 ± 25	304 ± 25
Weight Gain (g)	284 ± 31	237 ± 17
Daily Growth Rate (g/day)	3.38 ± 0.37	2.83 ± 0.21
Survival (%)	76.9 ± 19.0	88.0 ± 9.3
Actual Biomass Harvested (kg)	89.7 ± 29.8	92.5 ± 5.6
Total Feed Applied (kg)	314.7 ± 8.12	160.8 ± 2.1*
FCR	3.70 ± 1.14	1.74 ± 0.08
Total Feed Cost (PhP)	8498 ± 219	4342 ± 57*
Savings on Feed Cost (PhP)		4156
Savings on Feed Cost (%)		48.9%

Milkfish Brackish Water - Study 2

Brackish water ponds

- pond area - 700 m^2
- stocking density - 0.5 fish/m^2
- supplemental feeding daily (control) or every other day (alternate day), triplicate ponds
- fed 4x daily or alternate days (6 – 3% ABW/day)
- 4 month culture

Milkfish Alternate Day Feeding Brackishwater Ponds – Study 2

	Daily Fed	Alternate Day Fed
Initial ABW (g)	72.12 ± 6.0	66 ± 2.2
Final ABW (g)	324 ± 17	276 ± 20
Survival (%)	83.9 ± 6.9	92.6 ± 3.82
Actual Biomass Harvested (kg)	99 ± 10	95 ± 4
Total Feed Applied (kg)	327 ± 8	141 ± 12*
FCR	3.41 ± 0.37	1.50 ± 0.14*
Total Feed Cost (PhP)	8818 ± 216	3804 ± 57*
Savings on Feed Cost (PhP)		5014
Savings on Feed Cost (%)		57%

Milkfish Marine Cages

Marine Cages

- 6- 5 x 5 x 3 m cages
- Density - 35 fish/m^2
- Feeding: daily (control) or every other day (alternate day), triplicate cages
- Fed 4x daily: (7.5 – 3% ABW per day)
- 4.5 -5.5 mo. culture

Milkfish Alternate Day Feeding
Marine Cages – Study 1

	Daily Fed	Alternate Day Fed
Initial ABW (g)	55.64 ± 8.09	50.52 ± 4.23
Final ABW (g)	310 ± 4.51	303 ± 40.71
Weight Gain (g)	254 ± 11.79	253 ± 36.77
Culture Period (day)	130 ± 8.09	151 ± 6.74
Daily Growth Rate (g/day)	1.95 ± 0.19	1.70 ± 0.29
Survival (%)	90.23 ± 5.73	90.37 ± 2.16
Actual Biomass Harvested (kg)	704 ± 76	682 ± 79
Total Feed Applied (kg)	2474 ± 159	1659 ± 133*
FCR	3.59 ± 0.42	2.46 ± 0.17
Total Feed Cost (PhP)	61845 ± 3963	41472 ± 3325*
Savings on Feed Cost (PhP)		20373
Savings on Feed Cost (%)		32.9%

Milkfish Alternate Day Feeding
Marine Cages – Study 2

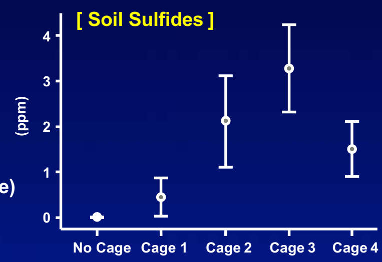
	Daily Fed	Alternate Day Fed
Initial ABW (g)	29.55 ± 6.02	31.76 ± 6.15
Final ABW (g)	303 ± 4.51	277 ± 8.65
Weight Gain (g)	273 ± 1.67	245 ± 10.28*
Culture Period (day)	135 ± 12.66	170 ± 5.55
Daily Growth Rate (g/day)	2.06 ± 0.20	1.44 ± 0.04*
Survival (%)	83.12 ± 1.27	88.69 ± 3.65
Actual Biomass Harvested (kg)	630 ± 6.01	615 ± 42
Total Feed Applied (kg)	2015 ± 37	1375 ± 10*
FCR	3.20 ± 0.06	2.25 ± 0.15*
Total Feed Cost (PhP)	54408 ± 994	37119 ± 274*
Savings on Feed Cost (PhP)		17289
Savings on Feed Cost (%)		31.7%

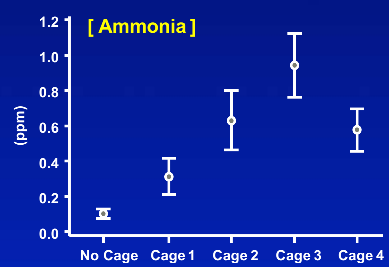
Marine Cages – Water/Sediment Quality

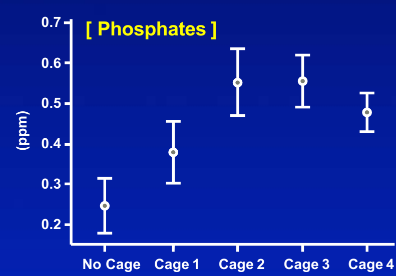
Water/Soil quality declines with feeding intensity

Different Cage Areas

No Cage: No Culture
Cage 1: Intermittent Feeding
Cage 2, 3: Daily Feeding (Industry Practice)
Cage 4: Experimental Feeding

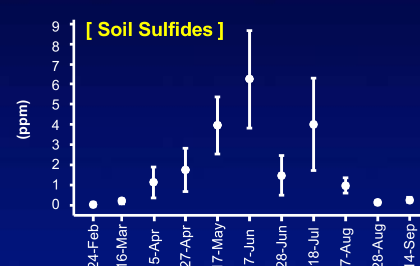


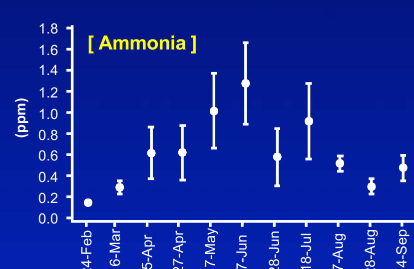


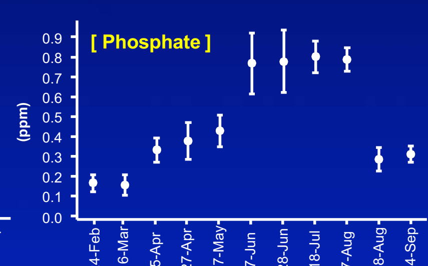


Marine Cages – Water/Sediment Quality

- Water/sediment quality de[illegible] with culture activity
- A fallow period between culture activities can help restore environment







Conclusion

- For both pond and sea cage culture, alternate day feeding produces fish of similar yield as daily feeding with 30-50% less feed, and an improvement in feed conversion
- Can be easily adopted – no complicated procedures
- Can lead to considerable profit to farmers (15-25%)
- The feeding strategy is environmentally desirable - reduces organic loading
- Alternate day feeding is a useful strategy for the culture of herbivores/omnivores generally?

Funding for this research was provided by the

AquaFish Innovation Lab

USAID FROM THE AMERICAN PEOPLE

OSU Oregon State

AquaFish Innovation Lab

The AquaFish CRSP is funded in part by United States Agency for International Development (USAID) Cooperative Agreement No. EPP-A-00-06-00012-00 and by US and Host Country partners.

Effect of feeding level and frequency on performance of *Oreochromis niloticus* fed diets containing moringa leaf meal and sunflower seed cake

Nazael A. Madalla*, Omary D. Kitojo, and Sebastian W. Chenyambuga
Department of Animal Science and Production, Sokoine University of Agriculture, Box 3004, Morogoro, Tanzania, nmadalla@gmail.com

A study was conducted for 90 days to assess the effect of feeding level and frequency on growth performance and feed utilization of *Oreochromis niloticus*. Three feeding levels i.e. 1, 2.5 and 5% of body weight, and two feeding frequencies (daily and skip a day) were tested. The experimental diet contained 28.41% crude protein mainly from *Moringa oleifera* leaf meal and sunflower seed meal. *O. niloticus* fingerlings with average weight of 9.3 ± 0.12 g were stocked at a density of 3 m^{-3} in 18 concrete tanks each with surface area of 7.06 m^2 and depth of 1 m. The experiment design was 3 × 2 factorial with the feeding levels and frequencies as factors randomly assigned to the tanks in triplicates. Weight and feed intake was recorded fortnightly for whole of experiment duration which was 90 days. Both feeding levels and frequencies had significant effect (P<0.05) on average daily gain (ADG), specific growth rate (SGR), daily feed intake (DFI), feed conversion ratio (FCR) and protein efficiency ratio (PER) as shown in Tables 1 & 2. There was a significant interaction between feeding level and frequency.

Findings from this study suggests that diets with moringa leaf meal and sunflower seed cake as major sources of protein should be fed to *O. niloticus* daily at 5% of body weight for better growth and feed utilization.

Table 1: Effects of feeding level on tilapia performance (Mean ± SE, n=3)

Variable	Feeding level		
	5%	2.5%	1%
ADG (g fish^{-1} day^{-1})	0.27±0.04^a	0.16±0.01^b	0.10±0.02^b
SGR (% day^{-1})	1.35±0.11^a	0.96±0.05^b	0.69±0.08^c
DFI (g fish^{-1} day^{-1})	0.72±0.13^a	0.30±0.04^b	0.12±0.02^c
FCR	2.61±0.20^a	1.96±0.28^b	1.08±0.07^c
PER	1.39±0.11^a	2.00±0.29^b	3.32±0.20^c

Table 2: Effect of feeding frequency on tilapia performance (Mean ± SE, n=3)

Variable	Feeding frequency	
	Daily	Skip
ADG (g fish^{-1} day^{-1})	0.20±0.04^a	0.15±0.02^a
SGR (% day^{-1})	1.09±0.12^a	0.90±0.10^b
DFI (g fish^{-1} day^{-1})	0.51±0.13^a	0.25±0.06^b
FCR	2.25±0.29^a	1.52±0.20^b
PER	1.85±0.29$_a$	2.62±0.31^b

^{a,b,c} Different superscripts in the same row indicate significant difference (p<0.05)

Effect of feeding level and frequency on performance of Nile tilapia (*Oreochromis niloticus*) fed diets containing Moringa leaf meal and sunflower seed cake

Nazael Madalla, Omary Kitojo, Hegi Shighulu,
and Sebastian Chenyambuga
Department of Animal Science and Production,
Sokoine University of Agriculture,
Morogoro, Tanzania

Introduction

- Nile tilapia, *Oreochromis niloticus*, is the most popular fish for aquaculture in Tanzania and worldwide due to its better growth performance, ability to grow on a wide range of diets, ability to reproduce readily in captivity and good carcass characteristics compared to other tilapia species.

- One of the problems that make tilapia farming unprofitable is low productivity due to imbalance of energy and protein in the fish diets commonly used by small-scale farmers.

- Fish farmers use naturally available feeds (maize bran, kitchen leftovers, and vegetables) to feed the cultured fish.

- These are of low quality and fish reared on these feeds are unable to meet their maintenance and production requirements, especially for protein.

- Feeding low quality feeds prolongs the time to reach the market weight and consequently leads to production of poor quality fish and low profitability of fish farming.

- For several decades, fishmeal and soybean have been used as the main sources of protein in fish feeds.

- However, the limited supplies due to competition with humans and livestock and the high prices of fish meal and soybean make them unaffordable to small-scale fish farmers in developing countries.

- In order to enhance aquaculture production, improve food security and reduce the level of poverty in rural areas, a search for cheap, good quality and locally available feedstuffs is required.

- *Moringa oleifera* is the most useful trees as feed supplements to animals as their leaves are highly nutritious with excellent palatability, digestibility and balanced chemical composition of protein and minerals.
- However, there is limited information on the feeding value of *Moringa oleifera* leaf meals as protein supplements in tilapia feeding.
- The use of Moringa leaf meal can lower feed costs and hence increase the profitability of fish farming enterprises.

- In fish farming 40% of costs of production is contributed by feed.
- In order to avoid unnecessary cost of feed, the correct amount of feed and frequency of feeding must be determined before starting to feed.
- This study was carried out to establish feeding strategies that minimize feed wastage and deterioration of water quality and ensure profitability.

Objectives

- To compare the effect of substituting soybean meal with sunflower seed cake and Moringa Leaf Meal on growth performance, feed conversional ratio and survival rate of cultured *Oreochromis niloticus*.
- To determine the appropriate feeding level (1%, 2.5% and 5% of body weight) which promotes high growth performance of *Oreochromis niloticus*.
- To determine the feeding frequency (daily vs skip a day feeding) which supports high growth rate of *Oreochromis niloticus*.

Materials and Methods

- The study was conducted at the Aquaculture unit, Sokoine University of Agriculture.
- Nile tilapia (*O. niloticus*) fingerlings were obtained from Kingolwira Fish Farming Centre.
- Eighteen round concrete tanks of about 7 m^2 and 1 m depth each were used.
- Nile tilapia fingerlings were stocked at a stocking density of 3 fingerlings/m^2.

- Two experiments were carried out.
- The first experiment compared the effect of substituting soybean meal with sunflower seed cake and Moringa Leaf Meal and established the best inclusion level of Moringa Leaf Meal in the diet of *Oreochromis niloticus.*

- Nine diets were formulated. Diets 1, 5 and 6 contained sunflower seed cake, Moringa Leaf Meal and Soybean meal as the sole sources of protein in the diets, respectively.

- In diets 2, 3 and 4 sunflower seed cake was replaced with Moringa leaf meal at the levels 25, 50 and 75 %, respectively.
- In diets 7, 8 and 9 soybean meal was replaced with Moringa leaf meal at the levels 25, 50 and 75%, respectively.
- The diets were allocated randomly to the experimental ponds.
- The fish were at 5% of their body weight for 90 days.
- Body weight and length and water quality parameters were measured every two weeks.

Table 1: Proportions of the feed ingredients in the formulated diets

Ingredients	Diets								
	1	2	3	4	5	6	7	8	9
SFSC (%)	84	66	41	21	0	0	0	0	0
SBM (%)	0	0	0	0	0	25	24	20	13
MOLM(%)	0	22	41	63	80	0	7	20	39
MB (%)	10	6	12	10	14	69	63	54	42
SFO (%)	3	3	3	3	3	3	3	3	3
WM (%)	2	2	2	2	2	2	2	2	2
Mineral (%)	1	1	1	1	1	1	1	1	1

Table 2: Chemical composition of formulated diets used to feed the fish

	Diets								
Parameter	1	2	3	4	5	6	7	8	9
DM%	97.17	95.91	94.73	93.44	92.40	96.89	96.52	95.79	94.71
CP%	20.01	20.47	20.02	20.31	20.03	20.11	20.46	20.47	20.12
Fat%	13.98	12.23	11.35	9.73	8.85	16.30	15.38	16.43	14.05
CF%	33.83	31.61	27.74	25.10	21.92	15.83	16.33	17.32	18.79
Ash%	6.54	7.14	7.50	8.05	8.37	5.06	5.19	5.76	6.59
GE kJg^{-1}	14.42	14.34	14.71	14.73	13.87	17.86	17.54	17.97	17.02

- The best diet from experiment 1 was used in experiment 2 and adjusted to contain 28.33% crude protein and 15.6 MJ/kg feed.
- The second experiment assessed the effects of feeding levels at 1%, 2.5% and 5% of body weight and feeding frequency (alternate day feeding and daily feeding).
- The main sources of protein were *Moringa oleifera* leaf meal and sunflower seed cake mixed in equal proportions.

Table 3:Proportions of the feed ingredients in the formulated diets expt 2

Ingredient	Percent (%)
Moringa oleifera leaf meal	34.5
Sunflower meal	34.5
Hominy meal	12
Fish meal	13
Sunflower oil	3
Wheat flour	2
Mineral premix	1

Table 4 : Chemical Composition of the diet

Parameter	Percentage (%)
Dry matter	91.32
Crude protein	28.41
Crude fibre	17.14
Ether extract	4.06
Ash	8.38
GE (KJ/kg)	15.65

- Fingerlings weighing between 9 and11g were stock in 18 concrete tanks, each tank with 21 fingerlings.
- Three levels of feeding were used; 1%, 2.5% and 5% of fish weight and two feeding regimes; daily feeding and skip a day feeding.
- After every two weeks, fish were weighed in each tank and the amount of feed given was adjusted accordingly.

Parameters measured

- Survival rate – death recorded as it occurred
- Body weight, length and width were measured at the start of the experiment and then at 2 weeks intervals.
- Water quality parameters: pH, temperature and dissolved oxygen –were measured at weekly intervals.

Data analysis

- The data were analyzed using General Linear Model procedure of SAS.
- The diets were used as fixed effect and the initial body weights were used as the covariate. The dependent variables were final body weight, weight gain, growth rate, specific growth rate and FCR.
- The chi-square test was used to analyze the data on mortality rate.

Results

- In experiment 1 the type of diet affected ($P<0.05$) final body weights, body weight gain, average daily gain, specific growth rate, body length and width.
- The fish on diet 3 (50% SFSC and 50% MOLM) had significantly higher average final body weight (28.08 g), body weight gain (23.03 g), growth rate (0.27 g/d) and specific growth rate (2.27), total body length (11.02 cm) and width (3.45 cm) compared to the fish fed other diets.

Table 5: Least squares means for growth performance parameters of *Oreochromis niloticus* fed different diets (Expt 1)

Parameter	Diets								
	1	2	3	4	5	6	7	8	9
FBw	16.10[d]	19.99[c]	28.08[a]	21.58[b]	19.47[c]	20.53[b]	19.60[c]	17.80[d]	16.73[d]
BwG	10.05[b]	14.94[b]	23.03[a]	16.53[b]	14.42[b]	15.48[b]	14.55[b]	12.75[b]	11.68[b]
ADG	0.13[c]	0.17[c]	0.27[a]	0.19[b]	0.17[c]	0.18[c]	0.17[c]	0.15[c]	0.13[c]
SGR	1.53[a]	1.53[a]	2.27[a]	1.87[a]	1.80[a]	1.84[a]	1.66[a]	1.70[a]	1.54[a]
FCR	2.78[a]	2.62[a]	2.24[a]	2.75[a]	2.73[a]	2.99[a]	3.21[a]	3.44[a]	3.08[a]
FTL	9.29[c]	10.06[c]	11.02[a]	10.30[b]	9.95[c]	10.17[b]	9.92[c]	9.73[c]	9.54[c]
FWd	2.82[c]	3.06[c]	3.45[a]	3.15[b]	3.11[b]	3.12[b]	3.03[c]	2.99[c]	2.96[c]

- In experiment 2 the fish fed at the feeding level of 5% of body weight had higher ($P \leq 0.05$) final body weight, weight gain, average daily gain, specific growth rate, average feed conversion ratio and survival rate while those fed at 1% feeding level had the lowest values.
- The fish under daily feeding regime had higher ($P \leq 0.05$) final body weight, weight gain, average daily gain, specific growth rate and average feed conversion ratio than those under skip a day feeding regime.
- The survival rate did not differ significantly ($P > 0.05$) between the two feeding regimes.

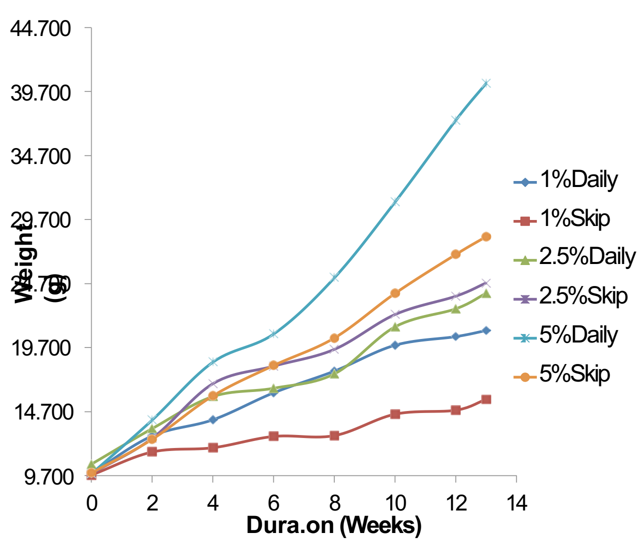


Figure 1 : Growth performance of Nile tilapia under different feeding levels and frequencies

Table 6: Effect of feeding regime on growth performance, feed utilization and survival of Nile tilapia

Parameter	Feeding regime					
	5% Daily	**5% Skip a day**	**2.5% Daily**	**2.5% Skip a day**	**1% Daily**	**1% Skip a day**
FBW (g)	40.37^{a}	28.38^{b}	23.96^{bd}	24.77^{b}	21.04^{bc}	15.67^{cd}
BWG (g)	30.51^{a}	18.47^{b}	13.35^{bd}	14.90^{b}	11.15^{bc}	5.92^{cd}
ADG (g/d)	0.34^{a}	0.21^{b}	0.15^{bd}	0.17^{b}	0.12^{bc}	0.07^{cd}
SGR	1.55^{a}	1.16^{b}	0.90^{c}	1.02^{bc}	0.83^{c}	0.53^{d}
FCR	2.97^{a}	2.25^{b}	2.59^{ab}	1.34^{c}	1.20^{c}	0.97^{c}
SURV. (%)	98.41^{a}	93.65^{a}	82.54^{a}	90.48^{a}	87.30^{a}	84.13^{a}

Conclusions

1. Moringa leaf meal is better than sunflower seed cake as a protein source in Nile tilapia diets.
2. Diet containing a mixture of Moringa leaf meal and sunflower leaf cake in equal proportions promotes higher growth rate of Nile tilapia than soybean meal.
3. Daily feeding at the level of 5% of body weight promotes higher growth rate.
4. Feeding at the level of 5% of body weight and skipping a day results into better growth performance compared to daily feeding at 2.5% level

Acknowledgement

➢➢We are grateful for the financial support provided by USAID, through AquaFish Collaborative Research Support Program (CRSP).

Mobilization and recovery of energy storage in Nile tilapia submitted to fasting and refeeding

Caroline Nebo*, Maeli Dal Pai Silva, and Maria Célia Portella
UNESP, Univ Estadual Paulista, Centro de Aquicultura, Jaboticabal, SP, Brazil.
portella@caunesp.unesp.br

Physiological responses caused by starvation affect fish metabolism and essential metabolic processes are maintained at the expenses of endogenous energy reserves, resulting in changes and progressive depletion of body tissues. The aim of this study was to evaluate the carcass composition in Nile tilapia juveniles (chitralada Thai strain) during periods of fasting and refeeding.

Juveniles (body weight 26.37 ± 3.77g) were randomly stocked into 32 tanks in 150 liters with a continuously flowing water and constant aeration. Four treatments and three replicates were established: FC (control treatment fed daily), F1 (one week of fasting and ten weeks of refeeding), F2 (two weeks of fasting and ten weeks of refeeding), F3 (three weeks of fasting and ten weeks of refeeding). Fish were fed to apparent satiation with commercial diet (32% crude protein), three times a day (9, 14 and 17h). At the beginning of the experiment and during periods of fasting (1, 2 and 3 weeks) and after 10 weeks of refeeding, fish were anaesthetized with benzocaine (0.1 g/L), weighted and carcass samples (n=8 fish per treatment) were taken for analysis of lipid, crude protein, ash and moisture. The data were analysed by the software Statistical Analysis System (SAS 9.1). The means that showed significant differences between treatments were compared by Tukey test, at 5% of significance.

The results indicated that during periods of fasting in F1, F2 and F3, fish presented intense mobilization of body lipid. However, after 10 weeks of refeeding in F1, F2 and F3, the content of lipid in the body increased, and F3 was higher compared to FC. Percentages of moisture in carcass were higher during fasting in F1 and F3 than in FC treatment, but, after refeeding, only F3 changed in relation to FC control treatment. Ashes in F1, F2 and F3 treatments were higher than in FC, but after 10 weeks of refeeding no differences were found among the treatments. Crude protein did not differ among the treatments during the periods of fasting and after the refeeding. In conclusion, this study showed that lipid reserves in Nile tilapia juveniles are affected by food restriction, however, after refeeding fish recovers and the body composition equals to the control treatment (FC).

Table 1 – Effects of fasting and refeeding on carcass composition of Nile tilapia juvenile. Mean values (±dp) of body mass (g), lipid, crude protein, ash and moiture were determined in % total dry matter basis. FC (control treatment fed daily), F1 (one week of fasting and ten weeks of refeeding), F2 (two weeks of fasting and ten weeks of refeeding), F3 (three weeks of fasting and ten weeks of refeeding).

Weeks of Fasting/Refeeding	**Treatments**	**Body mass (g)**	**Lipid (%)**	**Crude Protein (%)**	**Ash (%)**	**Moisture (%)**
1-WF	FC	40.10 ± 1.05 a	5.25 ± 0.51 **a**	13.05 ± 0.46 **a**	3.87 ± 0.22 **b**	78.49 ± 0.64 **b**
	F1	30.00 ± 1.08 b	3.89 ± 0.82 **b**	13.05 ± 0.62 **a**	4.12 ± 0.27 **a**	80.06 ± 0.98 **a**
2-WF	FC	48.50 ± 0.84 a	6.00 ± 0.85 **a**	12.85 ± 0.75 **a**	3.49 ± 0.44 **b**	79.24 ± 2.02 **a**
	F2	29.40 ± 066 b	3.06 ± 0.47 **b**	12.50 ± 0.92 **a**	4.36 ± 0.23 **a**	79.68 ± 1.46 **a**
3-WF	FC	53.60 ± 2.71 a	6.25 ± 0.36 **a**	12.97 ± 0.65 **a**	3.63 ± 0.27 **b**	79.38 ± 1.19 **b**
	F3	28.70 ± 0.66 b	2.72 ± 0.58 **b**	12.71 ± 0.55 **a**	4.44 ± 0.25 **a**	82.28 ± 1.45 **a**
10-WR	FC	136.30 ± 9.12 a	6.80 ± 1.98 **a**	13.42 ± 0.63 **a**	3.64 ± 0.28 **a**	77.00 ± 1.60 **a**
	F1	119.00 ± 1.95 b	7.16 ± 1.48 **a**	13.72 ± 0.65 **a**	3.64 ± 0.34 **a**	77.04 ± 2.10 **a**
	FC	125.60 ± 10.46 a	7.21 ± 0.58 **a**	13.07 ± 0.75 **a**	3.41 ± 0.15 **a**	78.15 ± 1.14 **a**
	F2	100.40 ± 3.04 b	6.89 ± 0.47 **a**	13.40 ± 0.67 **a**	3.46 ± 0.45 **a**	77.83 ± 1.46 **a**
	FC	163.90 ± 33.62 a	6.35 ± 0.92 **b**	13.57 ± 0.84 **a**	3.55 ± 0.40 **a**	77.91 ± 1.89 **a**
	F3	119.20 ± 6.47 b	7.77 ± 0.89 **a**	13.83 ± 0.39 **a**	3.91 ± 0.18 **a**	76.05 ± 1.32 **b**

Means followed by the same letter did not differ by Tukey test (P>0.05).

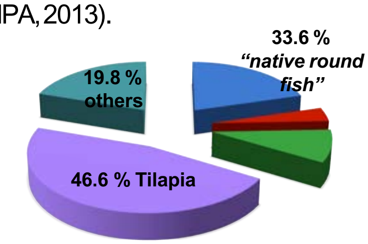
São Paulo State University
Faculty of Agricultural and Veterinarian Science
Aquaculture Center

Caroline Nebo; Maeli Dal-Pai-Silva; Maria Célia Portella

Seattle
Feb, 2014

INTRODUCTION

In Brazil, Tilapia is the first most important fish culture with producCon 253.824,1 ton in 2011 (MPA, 2013).



- ✓✓ Resistance to disease;
- ✓✓ Fast growth;
- ✓✓ Ability to growth of wide range of natural and arCficial feeds;
- ✓✓High tolerance to adverse environmental condiCons and overcrowding;
- ✓✓ Acceptance by a wide range of consumers due the quality of meat;

Feeding Strategies

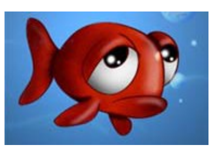
In Brazil, the costs of feed is around 40 to 75% of the total producCon costs.

Tilapia can be produced at low cost, but for this it is necessary to explore your ability to consume natural foods and adopt appropriate strategies of culCvaCon.

PotenLal

Compensatory growth

Feeding Strategies



Food restriction

Natural

- Food limitation;
- Migration;
- Reproduction;

Culture condiLon

- Stressor;
- Pathogens;
- Water quality;
- Temperature fluctuations;

Refeeding

Compensatory growth

THE PROJECT- **Morphology and Expression of Genes Related to Muscle Growth and Atrophy During FasLng and Refeding of Nile Tilapia Juveniles.**

OBJECTIVE: To invesCgate the morpho–physiological characteristcs and the expression of genes related to atrophy (MuRF–1 and MAFbx), and muscle growth (MyoD, Myogenin, MyostaCn and IGF–1) in Nile Clapia juveniles submi\ed to different periods of feed restricCon and refeeding.

CURRENT STATUS: experiment was carried in Brazil in 2012; samples for physiological (glucose, triglycerides, colesterol and total protein), morphological (measurement of muscle fiber diameter), and body composiCon were taken and analyzed as well as growth performance results.

Currently, we are studying the gene expression at Hageman Fish Culture Experiment StaCon

OBJECTIVE

The aim of this study is to evaluate the growth performance and body composiCon in Nile Clapia juveniles (*Oreochromis nilo-cus*) during periods of fasCng and refeeding .

Material and Methods

4 treatments X 8 replicates

➢➢32 tanks, 150 L;

➢➢ 32 juvenile/tank;

➢➢Fish were fed to apparent saCaCon with commercial diet (32% crude protein);

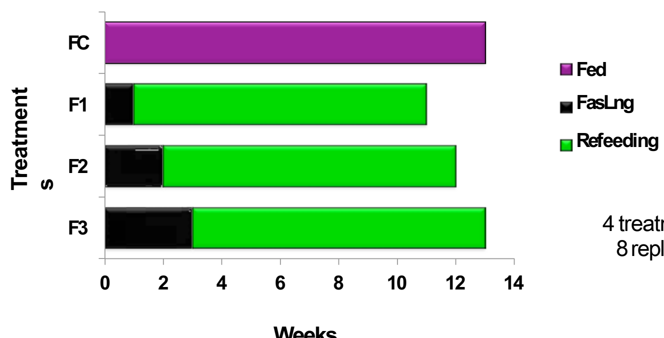
➢➢Feeding 3 Cmes/day: 9am; 2pm and 5pm;

➢➢Temperature : 30.1 ± 0.32 °C;

➢➢Dissolved oxygen: 4.74 ± 0.86 mg/L;

➢➢pH: 7.89 ±0.14;

Experimental design



4 treatments x 8 replicates

FC: control treatment fed daily

F1: one week of fasCng and ten weeks of refeeding

F2: two weeks of fasCng and ten weeks of refeeding

F3: three weeks of fasCng and ten weeks of refeeding

Growth EvaluaLons

At the beginning of the experiment (day 0), ager 1, 2 and 3 weeks with fasCng and ager 10 weeks of refeeding.

- ➢➢Benzocaine (0.1g/L);
- ➢➢ Individually weighed (g) n=8;
- ➢➢Total Length (cm) n=8;
- ➢➢Fat visceral index (FVI);
- ➢➢HepatosomaCc index (HSI);
- ➢➢Survival rate;

IniCal body weight: 26.4 ± 3.8 g;

- ➢➢Diet consumpCon and feed conversion raCo;

Proximate analysis

At the beginning of the experiment (day 0), ager 1, 2 and 3 weeks with fasCng and ager 10 weeks of refeeding.

The carcass samples were collected and frozen –20ºC;

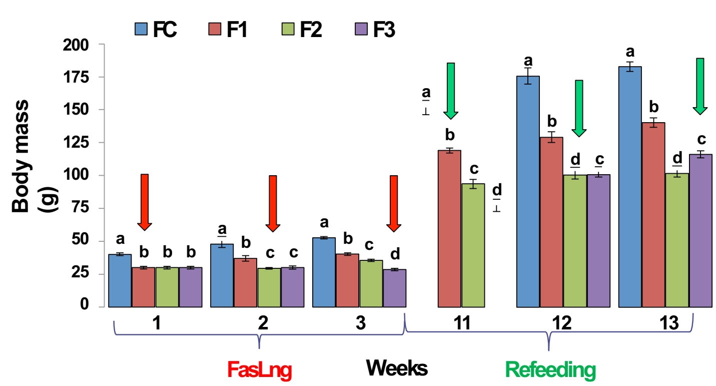
- Crude protein : nitrogen by combusCon (N x 6.25), according Dumas method in LECO analyser;
- Lipid: Soxhlet procedure (AOAC 920.39 Official method);
- Ash: incineraCon in muffle at 600°C;
- Moisture: all samples dried in hot air circulated oven at 105°C;

StaLsLcs

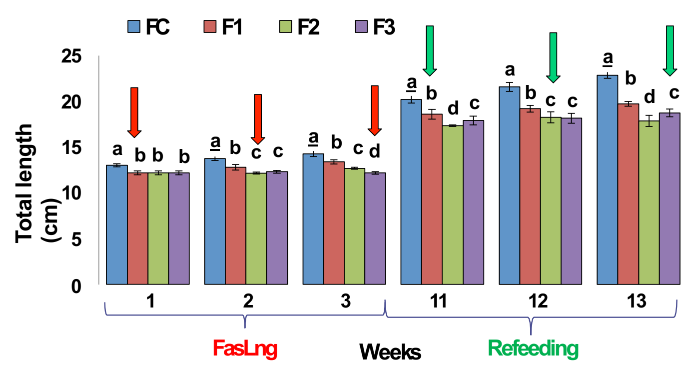
- Body mass, total length, specific growth raCo, survival, hepatosomaCc index, fat visceral index, feed consumpCon, feed conversion raCo and proximate analysis (crude protein, lipid, ash and moisture) data are expressed as means ± sd.

- Differences among treatments were assessed using one way ANOVA and Tukey mulCple range test, at 5% of significance. Data were analysed using the SAS staCsCcal sogware, version 9.0 (SAS InsCtute Inc.).

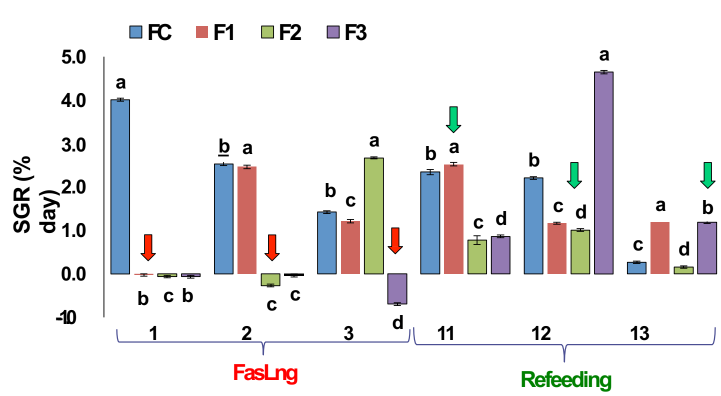
RESULTS



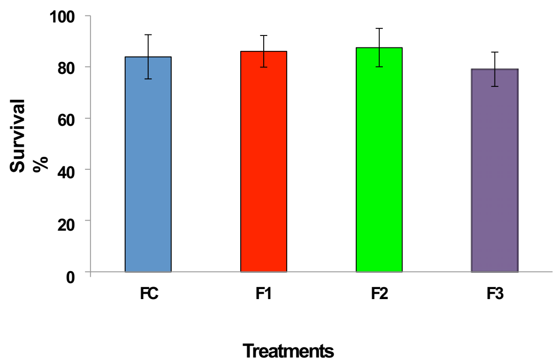
Body mass (g) of juvenile Nile Clapia subjected to periods of fasCng and refeeding.



Total length (cm) of juvenile Nile Clapia subjected to periods of fasCng and refeeding



Specific Growth RaCo of juvenile Nile Clapia subjected to different periods of fasCng and refeeding



Survival rate of juvenile Nile Clapia subjected to different periods of fasCng and refeeding.

Effects of fasCng and refeeding on diet consumpCon (g/fish), feed converCon rate (FCR), hepatosomaCc index (HSI), Fat visceral index (FVI). n=8

Weeks of FasLng/ Refeeding	Treatments[a]	Diet ConsumpLon (g/fish)	FCR	HSI (%)	FVI (%)
	IniLal	-	-	1.37 ± 0.40	0.49 ± 0.29
1WF	FC	6.05 ± 0.30	0.77 ± 0.41	2.60 ± 0.33 [a]	0.52 ± 0.26 [a]
	F1	-	-	1.22 ± 0.19 [b]	0.30 ± 0.11 [b]
2WF	FC	8.68 ± 0.79	1.08 ± 0.60	2.39 ± 0.20 [a]	1.38 ± 0.67 [a]
	F2	-	-	1.08 ± 0.24 [b]	0.35 ± 0.18 [b]
3WF	FC	10.89 ± 1.37	1.43 ± 0.66	3.39 ± 0.39 [a]	1.68 ± 0.31 [a]
	F3	-	-	0.87 ± 0.09 [b]	0.28 ± 0.19 [b]
10WR	FC	15.36 ± 3.84	1.95 ± 1.51	3.17 ± 0.26 [b]	1.67 ± 0.84
	F1	15.48 ± 2.11	1.66 ± 0.56	4.33 ± 0.6 [a]	1.90 ± 0.72
	FC	14.38 ± 6.07	1.44 ± 0.85	3.46 ± 0.85	1.48 ± 0.60
	F	11.27 ± 2.67	0.70 ± 0.17	3.99 ± 0.71	1.89 ± 0.51
	2	11.23 ± 1.29	0.59 ± 0.08	3.09 ± 0.73	1.33 ± 0.52
	F	11.63 ± 3.95	1.78 ± 0.30	3.90 ± 1.05	1.76 ± 0.45
	C				
	F				
	3				

Effects of fasCng and refeeding on carcass composiCon of Nile Clapia juvenile

Weeks of FasLng/ Refeeding	Treatments [a]	Lipid (%)	Crude Protein (%)	Ash (%)	Moisture (%)
	Ini$al	3.74 ± 0.08	12.00 ± 0.31	4.38 ± 0.08	80.64 ± 0.45
1--WF	*FC*	5.25 ± 0.51 a	13.05 ± 0.46	3.69 ± 0.23 b	78.67 ± 0.83
	F1	3.89 ± 0.82 b	13.05 ± 0.62	4.20 ± 0.28 a	80.30 ± 1.73
2--WF	*FC*	6.00 ± 0.85 a	12.85 ± 0.75	3.49 ± 0.44 b	79.33 ± 1.96
	F2	3.06 ± 0.47 b	12.50 ± 0.92	4.36 ± 0.23 a	79.81 ± 1.68
3--WF	*FC*	6.25 ± 0.36 a	13.00 ± 0.69	3.64 ± 0.28 b	79.47 ± 1.25 b
	F3	2.72 ± 0.58 b	12.71 ± 0.55	4.44 ± 0.25 a	82.49 ± 1.27 a
10WR	*FC*	6.80 ± 1.16	13.42 ± 0.63	3.64 ± 0.28	77.15 ± 1.77
	F1	7.16 ± 1.48	13.72 ± 0.65	3.64 ± 0.34	77.03 ± 2.09
	FC	7.21 ± 0.58	13.07 ± 0.75	3.41 ± 0.15	78.19 ± 1.23
	F2	6.89 ± 0.47	13.40 ± 0.67	3.46 ± 0.45	78.07 ± 1.46
	FC	6.35 ± 0.92 b	13.57 ± 0.84	3.55 ± 0.40	77.91 ± 1.89
	F3	7.77 ± 0.89 a	13.83 ± 0.39	3.91 ± 0.18	76.05 ± 1.32

CONCLUSIONS

- Short periods of fasCng (1, 2 and 3 weeks), following to 10 weeks of refeeding had detectable effects on Nile Clapia juvenile growth.
- StarvaCon caused a negaCve effect on SGR, but when food was supplied to fasCng fish the SGR was improved, showing a parCal compensatory growth in body weight at the end of the experiment.
- HepatosomaCc index, fat visceral index and lipid were significantly depleted during fast, showing that lipid was the main source the fish. However, ager 10 weeks of refeeding the fasCng groups of fish now showed these levels equal to the FC (P > 0.05).

CONCLUSIONS

- Body composiCon of Clapia was also affected by fasCng. Lipid was consumed by fish during starvaCon, whereas protein was not uClized during the same condiCons, suggesCng that Clapia conserve their body protein preferenCally rather than conserving lipid during feed restricCon.

IN SUMMARY

This study indicated that juvenile Nile Clapia can tolerate short–term of fasCng by consuming stored lipids to maintain vital body processes, but 10 weeks of refeeding in fasted fish was insufficient to equal growth to fish control group FC.

Acknowledgements

Laboratory of NutriCon of AquaCcOrganisms
Aquaculture Center
UNESP/ Brazil

Fellowships
(2011/08420–3;
2013/13100–3)

Research Grant
(2011/22326–0)

carolnebo@hotmail.com

Effects of fertilization and feeding level on the productivity of tilapia pond culture in Ghana

Daniel Adjei-Boateng*, Collins Duodu Prah, and Regina E. Edziyie
Department of Fisheries and Watershed Management FRNR, KNUST, Kumasi, Ghana E-mail: adjeiboat@yahoo.com

Tilapia pond culture in Ghana is constrained by the high cost of formulated feeds. Fish farmers therefore rely on farm-made feeds that are unbalanced leading to low productivity. This study compared the performance of Nile tilapia cultured in fertilized ponds and fed half the recommended ration of a commercial tilapia feed to fish raised in unfertilized ponds with full ration over a 7-month period. The study was conducted at the research station of the Department of Fisheries and Watershed Management, KNUST, Kumasi, Ghana using 6 ponds of sizes 200 -300m^2. Ponds were dried, limed at a rate of 10kg $CaCO_3$/ 100m^2 and stocked at 2 fish m^{-2} with all-male tilapia fingerlings (20.0 ± 4.0g).Three ponds were fertilized with mono-ammonium phosphate (MAP) and urea at a weekly rate of 2gm^{-2} and 3gm^{-2}, respectively. Fertilization was strictly controlled by phytoplankton abundance through Secchi-disk readings (25 - 30cm). Fertilized ponds received half the ration (3 - 1.5 %) of body weight as feed twice daily whilst the other 3 unfertilized ponds had full ration (6- 3%). Fifty fish were sampled monthly to evaluate growth and adjust the feeding level. The results showed no significant differences in growth between fish fed half ration 202.9 ± 23.7g and full ration 204.6 ± 36.3g. Similarly, the total weight gained (kg), SGR (%/day), and FCR for the half and full ration ponds did not show any differences 101.7 ± 35.6; 101.9 ± 35.0, 2.41 ± 0.77; 2.41 ± 0.76 and 1.16 ± 0.28; 1.11 ± 0.17, respectively. The results of this study indicates that farmers could increase the productivity of their ponds, reduce production cost and increase profit through fertilization and feeding at half ration with formulated feed.

EFFECT OF FERTILIZATION AND FEEDING LEVEL ON THE PRODUC TIVITY OF TILAPIA POND CULTUR E IN GHANA

Daniel Adjei-
-Boateng*, Collins Duodu Prah, Regina E. Ed
ziyie, Steve Amisah

Kwame Nkrumah University of Science and Technology,
Department of Fisheries & Watershed Management,

Current state of Aquaculture in Ghana

- Aquaculture production 30,000t; target of 130,000t in 2018
- 50% deficit in fish supply, fish supply 60% of animal protein
- Over 80% of production from cages
- Pond culture limited by high cost of formulated feed

- Pond culture rely on-farm feeds

- Pond culture rely on-farm feeds

Can pond culture be enhanced?

- BMP studies showed that yields could be almost doubled with formulated feeds

- Shroeder (1980) - natural food account for 50-70% of total available food for tilapia in ponds.
- Green (1992), Diana *et al*., (1994) - tilapia growth in ponds could be significantly improved by:
  - organic & inorganic fertilizers with
  - formulated feeds at reduced ration

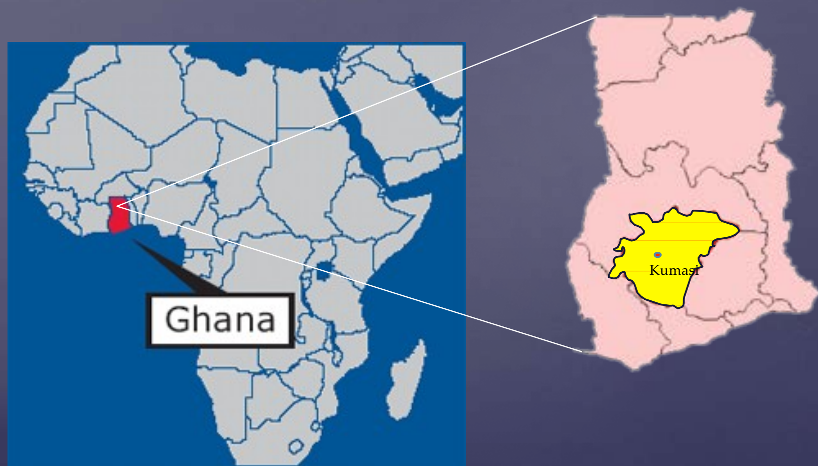
Goal

To optimize formulated feed utilization and maximize gains from natural food sources in tilapia ponds.

objectives

1. Quantify the growth performance of tilapia fed full ration against those in fertilized ponds with half ration .
2. Conduct a cost-benefit analysis of the full and half ration-fertilizer treatment.

METHODOLOGY



Source: www. wpmaps.org

Figure 1: Map of Africa showing Ghana (red ink) and the Ashanti Region (yellow ink)

METHODOLOGY

Experimental Design

- Study conducted in 6 ponds from Jan. to Aug. 2013.
- Two treatments:
  - Full ration-No Fertilization **(FR)**
  - Half ration-Fertilization **(HR)**

HR	FR	HR
FR	HR	FR

Schematic Diagram of ponds

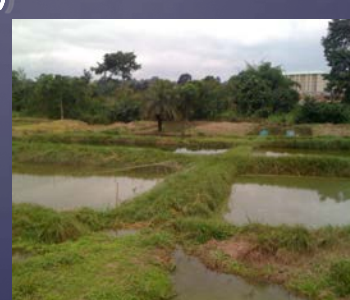


Plate 1: Experimental Ponds at the FRNR fish farm.

Pond preparation

Upper Left: Pond drying

Upper Right: Mud scooping/Dressing

Bottom Left: Pond Liming

Fingerlings and Stocking

Sex-reversed tilapia fingerlings ~ 25g

Stocked at 2 fish per m^2

Fertilizer application

MAP at $2g/m^2$/ weekly

Urea at and $3g/m^2$ /weekly

Feeding

Commercial floating tilapia feed with 30-33% crude protein

Full ration (**FR**) 3-6% bw
Half ration(**HR**) 1.5-3% bw

Feeds were adjusted monthly

Data collection

1. ***Fish sampling***

50 fish sampled monthly to monitor growth and adjust feeding levels.

2. *Growth Parameters*

- Growth performance was assessed using the following indicators:
  - i. Weight gain (g)
  - ii. Specific Growth Rate (%/day)
  - iii. Survival rate (%)

Feed Utilization

- Feed utilization was determined as:
  - i. Feed Conversion Ratio
  - ii. Feed Efficiency Ratio
  - iii. Feed Intake

Cost-Benefit Analyses

An Enterprise budget on the HR and FR treatments

Cost indicators that were considered include:

- ➢➢Fingerlings
- ➢➢Pond preparation/rent
- ➢➢Total Feed used
- ➢➢Labour

Fish Sales

Data Analysis and Presentation

The students t-test was used to test for significant (p<0.05) differences between treatment means for weight gain, FCR, feed intake, expenditure, income and profit.

RESULTS AND DISCUSSION

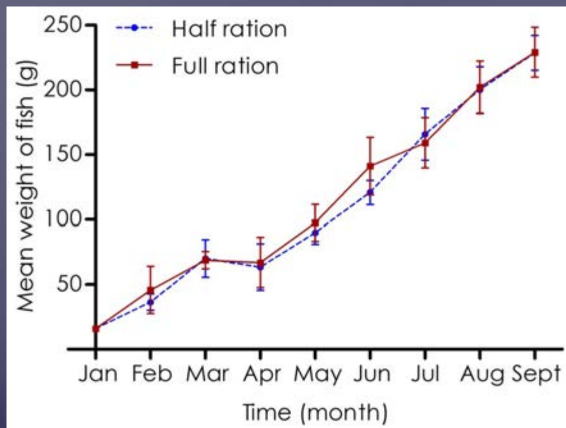


Fig.1: Changes in the growth of Nile tilapia from 6 ponds receiving two treatments.

Table 1: Growth performance and Feed utilization of Nile Tilapia from both treatments after the growth period.

	Parameter							
Treatment	**IW**	**FW**	**WG**	**SGR**	**SR**	**FCR**	**FER**	**FI**
Full Ration	24.99 ± 8.03	229.14 ± 33.50	**204.15 ± 36.30**	1.19 ± 0.23	**62.61 ± 20.34**	**1.11 ± 0.17**	1.36 ± 0.93	0.67 ± 0.46
Half Ration	25.81 ± 8.53	228.73 ± 23.31	**202.92 ± 23.76**	1.20 ± 0.27	**63.87 ± 12.96**	**1.16 ± 0.28**	0.89 ± 0.19	0.63 ± 0.28

Table 2: Total costs and earnings for full ration and half ration treatments after the grow-out period.

ITEM	FULL RATION No. (unit)	Unit price (GH₵)	Total Expense (GH₵)	HALF RATION No. (unit)	Unit Price (GH₵)	Total Expense (GH₵)
Fingerlings (/piece)	1550	0.256	396.8	1550	0.256	396.8
Pond Preparation/Rent	-	-	242.5	-	-	265
Total feed used (kg)	349.26	2.02	705.5	341.77	2.02	691.4
Labor (day)	180	1.5	270.0	180	1.5	270
Total A			**1,614.9**			**1,622.2**
REVENUE (Fish Sales)						
Fish	-	-	**2,212.5**	-	-	**2,253.0**
Profit			**597.6**			**630.8**

CONCLUSION

Farmers could increase the productivity of their ponds;

- through fertilization and feeding at half the ration with formulated feed.
- reduce production cost and increase profit


Thank You
USDA
FAS

Enhancement of Pond Productivity by Organic Manure Fertilization and Supplementary Feeding in Kenya

Julius O. Manyala*, Kevin Fitzsimmons, Charles C. Ngugi, Josiah Ani, and Henry Lubanga
Department of Fisheries and Aquatic Sciences, University of Eldoret, P. O. Box 1125 30100, Eldoret, Kenya manyalajo@yahoo.com

Nine experimental earthen ponds measuring 10x15m were fertilized using organic manure at 4 kg N and 1 kg P per hectare daily for one week before stocking with monosex tilapia at 3 fingerlings m^{-2}. Subsequent fertilization was repeated once a week while feeding was done *ad libitum* twice daily at midday and evening using locally prepared 30% crude protein. Selected water quality parameters were measures at hourly intervals from 08:00 to 16:00 daily with the aim of pond characterization during grow-out and to determine factor loadings for the physical, chemical and biological components of the pond units. The experiments are aimed at assessing the pond productivity under different management regimes and to facilitate designing of production systems and Best Management Practices (BMP). Water samples were collected from 5 cm below the water surface at 14:00 each day for nutrients analysis. Measurements of DO, temperature, conductivity, pH, hardness, TDS, Total phosphates, Total Nitrogen and ammonia were undertaken from February to July 2013 in the pond units under three fertilizer-feed regimes. Results from the study show that temperature increases during the day closely track the increase in the amount of dissolved oxygen in the ponds and that both fertilization and feeding enhance primary productivity. Close similarity (75%) was found between DO and Temperature characteristics of the pond but both compared at only 57% with pH. There was 98% similarity between conductivity and TDS in the three fertilizer-feed regimes. Total phosphorus and total nitrogen had 70.1% similarity in characterizing the treatments and compared favorably with Chlorophyll-a at 66% similarity. Temperature, pH and DO have a high factor loading on primary productivity, the nutrients phosphorus and nitrogen showed high factor loading on plankton biomass while TDS and Conductivity exhibited high factor loading on water quality and hence suitability for grow-out. Chlorophyll-a, pH, Conductivity, Total Dissolved Solids, Total Nitrogen, Total Phosphates, Dissolved Oxygen and Temperature could characterize up to 85% of the variation observed in the three fertilizer-feed regimes. The highest mean temperature of 24.97 was recorded at 14:00Hrs and this corresponded to the highest Dissolved Oxygen of 7.37 mg l-1. Significantly lower temperatures (22.3°C) were observed in fertilizer-feed treatment as compared to feed only treatment (22.8°C). Total phosphorus (0.995 mg l^{-1}) and total nitrogen (1.3735 mg l^{-}1) were significantly higher in fertilizer -feed regime ($F_{0.05,2,429}=5.05$; $p=0.007$ and $F_{0.05,2,594}=26.14$; $p<0.0001$ respectively). Total dissolved solids was significantly higher in the feed regime (258.76 NTU) as compared to fertilizer (243.51) or fertilizer-feed treatment (242.99) ($F_{0.05,2,594}=4.70$; $p=0.009$) while chlorophyll-a was 0.018, 0.029 and 0.032 mg l^{-1} in the respective treatments ($F_{0.05,2,429}=85.06$; $p<0.0001$). This study has shown that a combination of organic manure fertilization and ordinary/local feeds are suitable for sustaining suitable pond conditions for the growth of tilapia. Practices that promote effective seasoning and sustained nutrient levels such as fertilizer-feed are recommended for medium level management of tilapia grow-out in earthen ponds in Kenya.

ENHANCEMENT OF POND PRODUCTIVITY BY ORGANIC MANURE FERTILIZATION AND SUPPLEMENTARY FEEDING IN KENYA

Julius O. Manyala*, Kevin Fitzsimmons, Charles C. Ngugi, Josiah Ani, and Henry Lubanga

**Department of Fisheries and Aquatic Sciences, University of Eldoret, P. O. Box 1125 30100, Eldoret, Kenya*

10th -13th February 2014, Seattle, USA

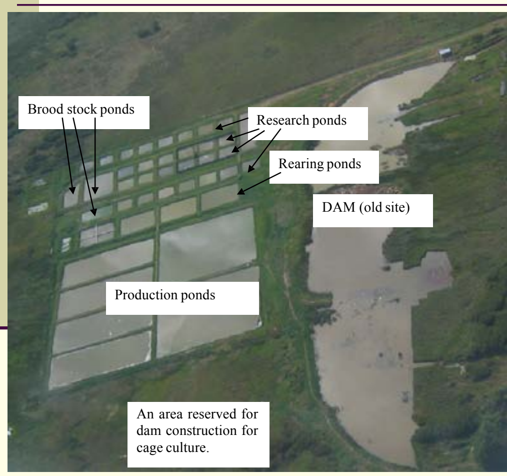
INTRODUCTION

- **Physical Characteristics (pond morphometry)**
  - Pond depth
  - Evaporation rate
  - Seepage rate
  - Water temperature
- **Chemical Characteristics:**
  - Dissolved oxygen
  - Phosphorus
  - Various forms of nitrogen
  - pH and alkalinity
  - Dissolved and suspended solids
- **Biological Characteristics:**
  - Phytoplankton production (primary production or the phytoplankton standing crop)
  - Bacterial production, though usually never measured

OBJECTIVES

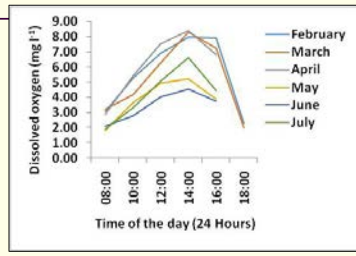
- Evaluate ponds at each research site for their:
  - Physical
  - Chemical, and
  - Biological characteristics/during a grow out
- Stocked ponds with monosex tilapia (Jewlet Farms)
  - Stocking density = 2 m^{-2}
  - Fertilization at 4 kg N and 1 kg P per hectare
  - Local organic nutrient sources once a week
- To determine the ability of each research site to complete these measurements

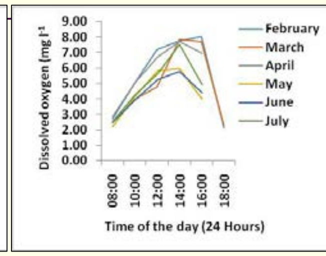
EXPERIMENTAL DESIGN

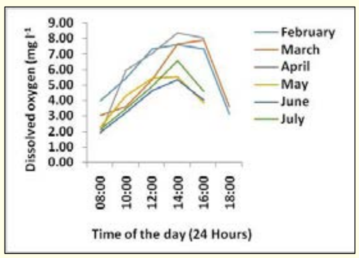


- University of Eldoret fish farm showing the research ponds for the pond experiments
- Measurements made from February – June 2013 = 102 Sets for each weekly parameter
- Size=100 m^2 each

DISSOLVED OXYGEN VARIATION





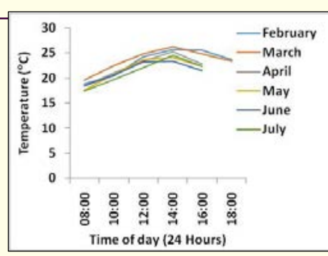


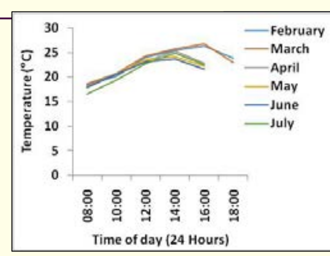
Top Left:
- Mean values for replicates for feed only treatment

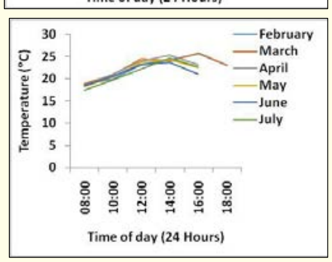
Top Right:
- Mean values for replicates for fertilizer only treatment

Bottom Left:
- Mean values for replicates for feed+fertilizer treatment

TEMPERATUREVARIATION







Top Left:
- Mean values for replicates for feed only treatment

Top Right:
- Mean values for replicates for fertilizer only treatment

Bottom Left:
- Mean values for replicates for feed+fertilizer treatment

MEAN VALUES OF WATER QUALITY PARAMETERS

	Feeds	Fertilizer	Fertilizer and feed
pH	7.75	7.82	7.68
Chlorophyll-a (mg l^{-1})	0.01	0.03	0.03
Conductivity (mS cm^{-1})	358.80	278.47	311.38
TDS (NTU)	247.26	184.62	205.12
Total Nitrogen (mg l^{-1})	0.88	1.17	1.10
Total Phosphorus (mg l^{-1})	0.70	0.84	0.85
DO (mg l^{-1})	5.85	5.36	5.51
Temperature (°C)	23.57	23.23	22.81
Ammonia (mg l^{-1})	0.07	0.07	0.05
Alkalinity (mg l^{-1})	291.23	328.97	273.80
CO_2 (mg l^{-1})	57.35	80.83	32.91
Hardness (ppm)	55.40	60.00	48.73

SD OF MEAN VALUES OF WATER QUALITY PARAMETERS

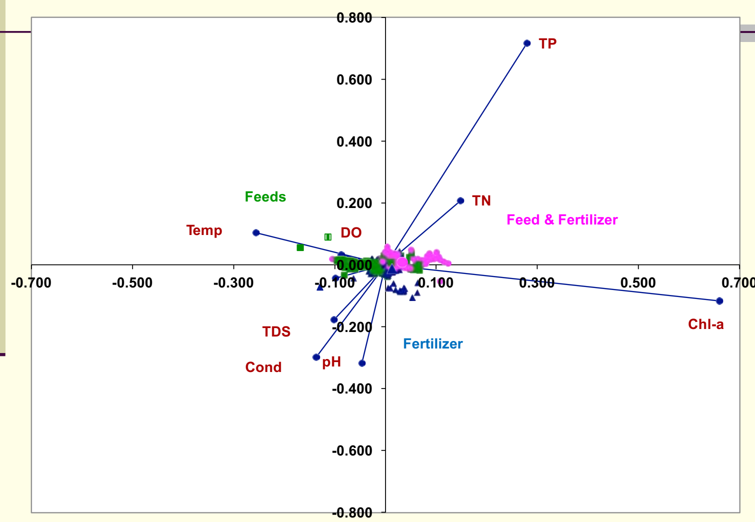
	Feeds	Fertilizer	Fertilizer and feed
pH	0.452	0.332	0.436
Chlorophyll-a (mg l^{-1})	0.007	0.006	0.004
Conductivity (mS cm^{-1})	27.650	24.610	24.970
TDS (NTU)	30.800	15.930	16.180
Total Nitrogen (mg l^{-1})	0.093	0.084	0.072
Total Phosphorus (mg l^{-1})	0.067	0.055	0.044
DO (mg l^{-1})	0.300	0.237	0.327
Temperature (°C)	0.722	0.477	0.433
Ammonia (mg l^{-1})	0.063	0.062	0.041
Alkalinity (mg l^{-1})	88.650	67.380	80.640
CO_2 (mg l^{-1})	33.530	45.630	15.060
Hardness (ppm)	12.830	14.260	4.900

TWO-WAY ANOVA FOR POND WATER QUALITY BY TREATMENT AND TIME

Two-Way ANOVA showing significant variations among treatments and among grow-out time in water quality parameters and mean fish weight from Feb to July 2013 at University of Eldoret experimental fish ponds.

Parameter	Treatment			Months			df_{error}	R^2
	F-statistic	df_1	p-value	F-statistic	df_2	p-value		
pH	5.55	2	0.004	11.70	5	<0.0005	589	0.71
Chlorophyll-a (mg l^{-1})	103.59	2	<0.0005	42.99	4	<0.0005	425	0.89
Conductivity ($\propto$S cm^{-1})	17.79	2	<0.0005	79.70	5	<0.0005	589	0.82
TDS (NTU)	13.1	2	<0.0005	81.16	5	<0.0005	589	0.92
Total Nitrogen (mg l^{-1})	5.91	2	0.003	16.79	4	<0.0005	425	0.77
Total Phosphorus (mg l^{-1})	28.98	2	<0.0005	15.03	5	<0.0005	589	0.78
DO (mg l^{-1})	0.18	2	0.838	80.89	5	0.0005	589	0.41
Temperature (°C)	18.71	2	<0.0005	114.25	5	<0.0005	589	0.91
Ammonia (mg l^{-1})	4.01	2	0.019	27.18	4	0.0005	271	0.81
Alkalinity (mg l^{-1})	8.36	2	<0.0005	13.87	4	<0.0005	271	0.78
CO_2 (mg l^{-1})	34.77	2	<0.0005	5.74	4	0.017	271	0.81
Hardness (ppm)	7.19	2	0.001	6.45	4	0.012	250	0.88
Fish (Mean weight)	183.90	2	<0.0005	1276.2	5	<0.0005	2080	0.76

CCA BETWEEN TREATMENT AND POND WATER QUALITY PARAMETERS



LINEAR DISCRIMINANT FUNCTION FOR TREATMENT GROUPS

	Feeds	Fertilizer	Fertilizer and feed
Constant	-2,436	-2,402	-2,454
pH	64.4	67.7	67.5
Chlorophyll-a (mg l^{-1})	4,485	4,518	4,874
Conductivity (∝S cm^{-1})	4.4	4.4	4.6
TDS (NTU)	-1.2	-1.3	-1.3
Total Nitrogen (mg l^{-1})	1,012	1,043	1,057
Total Phosphorus (mg l^{-1})	-135.6	-142.2	-141.6
DO (mg l^{-1})	55.9	49.3	50.7
Temperature (°C)	77.7	76.3	75.3
Ammonia (∝g l^{-1})	-522	-510.2	-526.2
Alkalinity (mg l^{-1})	-0.1	-0.1	-0.1
CO_2 (mg l^{-1})	-0.2	-0.2	-0.3
Hardness (mg l^{-1})	-0.6	-0.6	-0.6

SUMMAR Y SIFICATION
CLAS

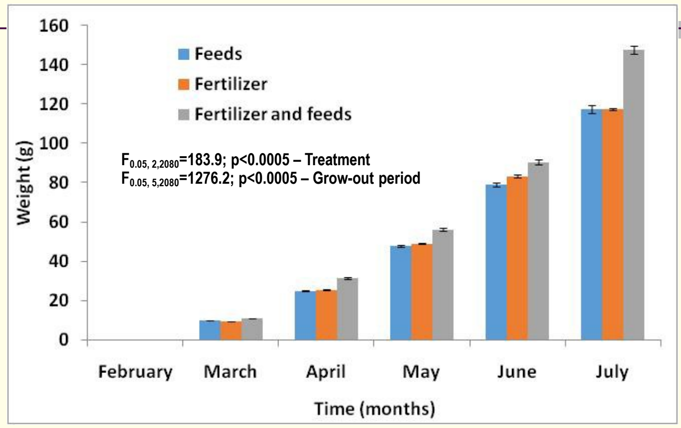
Treatment Group	Feeds		Fertilizer and feed	Total
Feeds	89	Fertilizer 3	2	94
Fertilizer	5	57	16	78
Fertilizer and feed	6	0	61	67
Total N	**100**	**60**	**79**	**239**
N correct	**89**	**57**	**61**	**207**
Proportion	**0.890**	**0.950**	**0.772**	**2.612**

N = 239

N Correctly Identified by Treatment = 207

Proportion Correctly Identified by Treatment = 0.866 (86.6%)

TWO-WAY ANOVA FOR POND WATER QUALITY BY TREATMENT AND TIME



Two-Way ANOVE for treatment ($F_{(0.05), 2, 2080} = 184$; p-value <0.0005) and for grow-out time ($F_{(0.05), 5, 2080} = 1276$; p-value <0.0005) for monosex tilapia stocked in the experimental ponds for 5 months.

CONCLUSIONS/RECOMMENDATIONS

- **Daily variations in temperature and dissolved oxygen followed a typical diurnal productivity cycle**
- **Fertilization and Feeding has synergetic effect on the water quality with reference to nitrates, phosphates and chlorophyll-a and hence is associated with better growth of tilapia in earthen ponds.**
- **Multivariate analysis classified 86.6% of the water quality parameters according to treatment and can be used to classify the ponds according to expected productivity.**
- **Effect of the feed, fertilizer and feed/fertilizer combination was evident on the growth performance of the stocked tilapia.**
- **Results indicate that a combination of fertilization and feeding at the right quantity can influence, explain and enhance tilapia production in earthen ponds**

Funding for this research was provided by the

AquaFish Innovation Lab

The AquaFish Innovation Lab is supported in part by United States Agency for International Development (USAID) Cooperative Agreement No. EPP-A-00-06-00012-00 and by contributions from participating institutions.

This presentation is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government. Mention of trade names or commercial products in this presentation does not constitute endorsement or recommendation for use on the part of USAID or AquaFish. The accuracy, reliability, and originality of the work presented are the responsibility of the individual authors.

AquaFish Technical Session 2: Low-Cost Solutions for Sustainable Small-Scale Aquaculture in Developing Countries

Production performance of dedhuwa *Esomus danricus* in monoculture and polyculture with carp in Chitwan, Nepal

Sunila Rai*, Sunil Poudel, Jiwan Shrestha
Agriculture and Forestry University Rampur, Chitwan Nepal sunilarai@yahoo.com

Small Indigenous Fish Species (SIS) are rich in micro and macro-nutrients. In spite of high nutrient value, their culture potential is often overlooked. Considering this fact, the present experiment was carried out to assess the production performance of Dedhuwa (*Esomus danricus*) in monoculture and polyculture with Carp at Phaphini, Chitwan District. The experiment was carried out in 9 farmers' ponds of 100 m^2 area for 270 days. The experiment included three treatments each with three replicates. Treatments included T_1 (Carp), T_2 (Dedhuwa) and T_3 (Carp+Dedhuwa). The ponds were treated with bleaching powder and lime prior to stocking. The stocking was done with 30 Silver carp (*Hypophthalmichthys molitrix*), 10 Bighead Carp (*Aristichthys nobilis*), 20 Common Carp (*Cyprinus carpio*), 15 Grass Carp (*Ctenopharyngodon idella*), 20 Rohu (*Labeo rohita*) and 5 Naini (*Cirrhinus mrigala*) for each 100 m^2 in T_1 and T_3 while Dedhuwa was stocked at the rate of 300 per 100 m^2 in T_3 and 2,000 per 100 m^2 in T_2. Fish were fed with freshly made dough of rice bran and mustard oil cake (1:1) at the rate of 2% body weight once a day. Result showed that the growth and production of Carp except Bighead Carp was higher ($P<0.05$) in T_3 as compared to T_1 while that of Bighead Carp was higher ($P<0.05$) in T_1 than T_3. This showed that Dedhuwa had positive impact on the growth and production of Carp except Bighead Carp. Total net yield of Carp was higher ($P<0.05$) in T_3 than T_1. Net fish yield was lower ($P<0.05$) in T_2 than T_1 and T_3. Economic analysis showed that T_3 gave higher profit over T_1 whereas T_2 gave loss indicating that Dedhuwa monoculture is not economically viable. To sum up, Carp-Dedhuwa polyculture is suitable for small scale farmers because they can obtain better income and sufficient family nutrition by consumption of this nutrient rich fish.

PRODUCTION PERFORMANCE OF DEDHUWA Esomus danricus IN MONOCULTURE AND POLYCULTURE WITH CARP IN CHITWAN, NEPAL

Sunila Rai, Sunil Poudel, Jiwan Shrestha
Agriculture and Forestry University
Chitwan, Nepal

Vitamin A, Iron and Zinc content in four common Small Indigenous Fish Species (SIS) of Terai, Nepal

SIS	Vitamin A (RAE/100g raw, clean parts)	Iron (mg/100g raw, clean parts)	Zinc (mg/100g raw, clean parts)
Dedhuwa (*Esomus danricus*)	107.5	6.2	4.5
Faketa (*Barilius sp.*)	84.5	1.0	3.6
Mara (*Amblypharyngodon mola)*	685.5	2.4	4.3
Pothi (*Pun7us sophore*)	56.0	3.1	4.2
Carp			
Mrigal (*Cirrhinus cirrhosus*)*	<30	2.5	-
Silver carp (*Hypophthamichyths molitrix*)*	<30	4.4	-

*Roos et al. 2007

Dedhuwa

ObjecEves

- To assess producXon of Dedhuwa in monoculture and polyculture with Carp.

- To compare fish producXon among Dedhuwa monoculture, Carp polyculture and Carp+Dedhuwa polyculture.

- To compare the gross margin among Dedhuwa monoculture, Carp polyculture and Carp+Dedhuwa polyculture.

Materials and Methods

- **Complete Randomized Design (CRD)**

- Three treatments each with three replicaXons
- T_1: Carp only
- T_2: Dedhuwa only
- T_3: Carp + Dedhuwa

Household Income

Household consumption

Experimental Site

Experimental Unit

- Farmers' ponds.
- Average pond size -100m^2.
- Liming @ 500 kg/ha.
- FerXlizaXon using cow dung @ 12 t/ha and urea and DAP @ 47 kg/ha and 35 kg/ha, respecXvely.
- Average water depth -1 m.

Stocking density (No./ha) in different treatments

Species	Carp only (T_1)	Dedhuwa only (T_2)	Carp+Dedhuwa (T_3)
Rohu (*Labeo rohita*)	2,000	--	2,000
Mrigal (*Cirrhinus mrigala*)	500	--	500
Silver carp (*Hypophthalmichthys molitrix)*	3,000	--	3,000
Bighead carp (*Aris7chthys nobilis)*	1,000	--	1,000
Common carp (*Cyprinus carpio)*	2,000	--	2,000
Grass carp (*Ctenopharyngodon idella)*	1,500	--	1,500
Dedhuwa (*Esomus danricus)*	-	2,00,000	30,000
Total	**10,000**	**2,00,000**	**40,000**

Feed and Feeding

- Feed: Mixture of rice bran and mustard oil cake at 1:1 raXo by weight.
- Grass carp: grass, banana leaves etc.
- Feeding: Daily, morning
- Feeding rate: Daily at 2% of total biomass.

HarvesEng

- ParXal harvest of Dedhuwa: ader three months of stocking unXl final harvest.
- ParX al h arves X n g f o r household consumpXon.
- Final harvesXng: Ader 270 days.

AnalyEcal Methods

Water quality analysis

Biweekly sampling, analyses at Aquaculture Department, AFU.

Fish growth performance

Fish growth check: sampling 20% fish, monthly.

Gross margin analysis

Gross margin = Gross return (Rs.) – Variable cost (Rs.)

StaEsEcal analysis

Data of water quality, fish producXon and gross margin among three treatments -One-way analysis of variance (ANOVA).

Dedhuwa producXon between two treatments -Student's t-test

Results

Water quality of ponds (Mean ± S.D.) in three treatments

Parameters	Carp	Dedhuwa	Carp+Dedhuwa
Temperature (°C)	28.4±3.9[a]	28.4±3.9[a]	28.4±3.9[a]
pH	7.6±0.3[a]	7.6±0.4[a]	7.8±0.5[a]
Secchi disk depth (cm)	27±2[a]	32±4[a]	28±1[a]
DO (mg/L)	2.6±0.8[a]	3.7±1.3[a]	3.3±0.9[a]
Total alkalinity (mg/L $CaCO_3$)	124.9±12.9[a]	121.4±18.8[a]	130.5±24.2[a]

ProducEon of Dedhuwa (*Esomus danricus*) (Mean±S.D.) in mono and polyculture

Parameters	Carp	Dedhuwa	Carp+Dedhuwa
IniXal mean wt. (g/fish)	-	2.94±0.10[a]	2.38±0.37[a]
IniXal total wt. (kg/100 m^2)	-	5.88±0.19[a]	0.71±0.11[b]
Final mean wt. (g/fish)	-	2.94±0.26[a]	2.67±0.46[a]
ParXal harvest wt. (kg/100 m^2/270 days)	-	7.18±0.48[a]	2.00±0.06[b]
Final harvest wt. (kg/100 m^2/270 days)	-	0.62±1.42[a]	1.13±1.07[a]
Total harvest wt. (kg/100 m^2/270 days)	-	7.80±0.67[a]	3.13±2.11[b]
Net producXon (kg/100 m^2/270 days)	-	1.92±2.80[a]	2.42±1.21[a]

- Akteruzzaman *et al.* (1990) obtained a yield of 1.2 ton/ha in 6 months with a stocking density of 12500 fish/ha of SharpunX (*Pun7us sarana)* in small, seasonal ponds.

- Kohinoor *et al.* (2001) obtained gross producXon of 805 kg/ ha, 1,120 kg/ha and 509 kg/ha, respecXvely for Mola, Chela and PunX over a period of six months with stocking density of 100,000 fish/ha. FerXlizer and rice bran as a supplementary feed was applied at 3% of the total biomass. Gross producXon was

Total producEon of Carp and SIS (t/ha/yr) in three treatments (Mean±S.D.)

Net Fish ProducXon (t/ha/yr)	Car p (T1)	Dedhuw a (T2)	Carp+Dedhu wa (T3)
Carps (t/ha/yr)	3.21±0.34[a]	-	3.72±0.30[a]
Dedhuwa (t/ha/yr)	-	0.26±0.19[a]	0.33±0.14[a]
Total (t/ha/yr)	3.21±0.34[b]	0.26±0.19[c]	4.05±1.80[a]
AFCR	3.0±0.1[b]	12.4±2.8[a]	3.0±0.2[b]

Gross Margin Analysis

Variables	Treatments Carp	Dedhuwa	Carp+Dedhuwa
Gross Return (Rs./100 m²/270 days)			
Carp	4834±510[b]	0	5587±449[a]
Dedhuwa	-	1482±185[a]	585±217[b]
Gross Return	4834±510[b]	1482±185[c]	6172±272[a]
Variable Cost (Rs./100 m²/270 days)			
Bleaching Powder	93	93	93
Lime	90	90	90
Urea	106	106	106
DAP	158	158	158
Carp Fingerlings	396	0	396
Dedhuwa Fingerlings	-	200	30
Feed	2217±204[b]	567±68[c]	2775±241[a]
Total Variable Cost	3059±205[b]	1213±68[c]	3616±241[a]
Gross Margin (Rs./100 m²/270 days)			
Gross Margin (Rs./100m²)	1775±713[a]	269±220[b]	2556±446[a]

Conclusion

- Dedhuwa monoculture is not viable.
- Carp+Dedhuwa polyculture gave beoer producXon and profit.
- Carp+Dedhuwa polyculture can be one of the means of nutriXonal security and income generaXon for small scale farmers in Nepal.

Acknowledgement

EMBASSY OF DENMARK
DANIDA | INTERNATIONAL DEVELOPMENT COOPERATION

AQUAFISH INNOVATION LAB

Sustainable strategy for controlling fish desease conditions using banana *Musa sp.* Leaf extracts in Uganda

John Walakira*, Joseph Molnar, and Edith Nankya
National Fisheries Resources Research Institute, Uganda. Email:
johnwalakira2003@yahoo.co.uk

Commercialization of aquaculture in Uganda is shifting management practices from subsistence to intensive levels. Small scale fish farmers, like hatchery producers, are adopting new technologies to enhance fish production. However, intensification of production systems is challenged with disease outbreaks that impact negatively on economic returns. Similarly, the common practice of using chicken manure by catfish hatchery farmers to produce zooplankton in nursery ponds is found to be a pathway for disease infections. Use of chemotherapeutants in the food fish industry is becoming less popular especially towards the less resourced farmers. Bio-control strategies are readily available and adaptable. Banana is a major food crop grown in Uganda with many communities deriving livelihoods from it.
Banana leaf extracts are used in a grow-out operation near Kampala city to control disease conditions. Initially, disease episodes caused mortalities ranging 14-100% in Tilapia fry (1-3g) and juveniles (20-50g). With repeated exposures to banana extract solution, the feed conversion ratio (FCR) improved from 3.2 to 0.75-0.87 as well as survival rates (about 85%). Bio-assays using several materials including salt, formalin and banana leaf extract to improve survival rates of catfish larvae were also evaluated. Addition of salt (1 mg/L) and banana leaf extract (3.2 ml/L) improved the survival of African catfish larvae cultured under aquaria conditions. Formalin (400µl/L) treatment had the lowest survival rates.
Results show how banana leaf extracts have a potential to be used in Uganda's aquaculture industry. This is a simple technology which small scale fish farmers can adopt and raw materials are locally available. Future research will focus on evaluating its chemical composition, effects on fish growth performance and its feasibility in aquaculture systems.

SUSTAINABLE STRATEGY FOR CONTROLLING FISH DISEASE CONDITIONS USING BANANA (Musa sp.) LEAF EXTRACTS IN UGANDA

John Walakira[1], Joseph Molnar[2] and Edith Nankya[1]

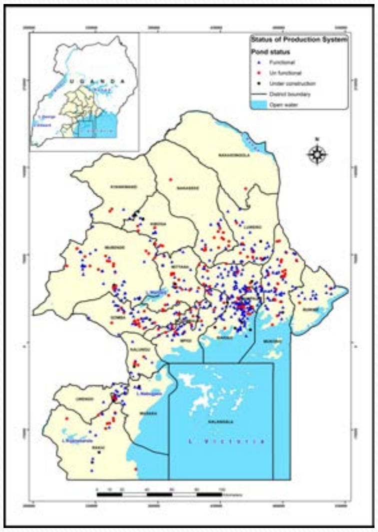
1. National Fisheries Resources Research Institute-Uganda
2. Auburn University , USA

Background

- Aquaculture is increasing and intensifying in Uganda.
- Most farmed fish is Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus).
- production systems: ponds, tanks (hatcheries) and cages.

FISH project

GIS of fish farms in central Uganda



68% of fish farm enterprises are $100m^2$ to $2000m^2$

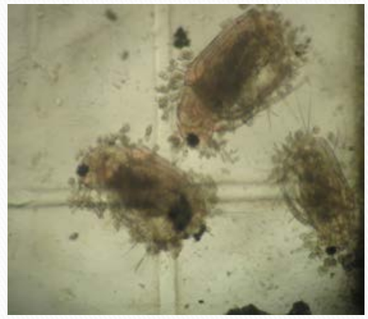
Diseases in Uganda

- Diseases often cause significant economic losses in fish farms.
- Catfish hatcheries are most affected
- Common diseases: bacteria (Columnaris and Aeronomas infections); parasites ('Ich' and digenes); fungal (water moulds), nutrional and stress oriented water quality conditions

Yellow grub (Clinostomum sp) embedded intermuscularly in farmed catfish

Diseases; catfish hatcheries

- Common practice of using chicken manure to produce zooplankton increases the risk of disease transmission.
- Artemia is very expensive (~ 200%)!



Cladocerans infected with Epistylis sp.. Zooplankton produced from organic manure. (Phelps et al)

Brood stocks

- Bacterial infections affecting seed production

Dermal petechial hemorrhages on catfish broodstock

Possible causes

1. Bad management practices
2. Poor or inefficient extension services
3. Lack of information
4. Climate change
5. Lack of policies-unregulated movement of fish across the region

Control strategies used

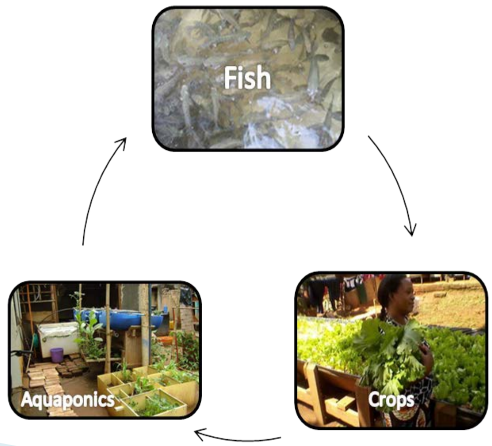
A. Using chemotherapeutants
1. Salt
2. Potassium permanganate
3. Formalin

B. Antibiotics : oxy-tetracycline

C. Using biocontrol agents-plant material

- Banana leaf extracts

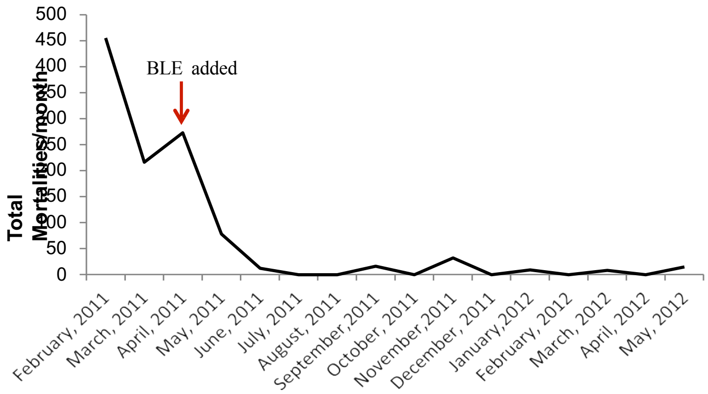
Farmers' Initiative: *Aquaponics Africa* case study



BLE preparation

- Five pieces of dry banana leaves are added in 5-Litres of water.
- The mixture is boiled until the volume reduces to 3-Liters.
- About 8-12 liters of the extract is applied to 2500 L of tank water with fish, under static conditions, for 30-120 minutes.

performance of BLE



Bioassays to enhance (*Clarias gariepinus*) larval production: effects of Formalin, Salt and Banana leaf extracts

a.18 in-door aquaria tanks (25.1 L),

b.Stock rate =183 ± 2 catfish larvae/tanks of 13.39 mg.

c.static conditions with aeration,

d. 10 day experiement

Six treatments (n=3),

i)Pre-exposure of catfish larvae in salt (Non-iodized salt, Sodium chloride, 98.5%) at rate of 3 g/L,

ii) Salt treatment at rate of 3 g/L,

iii)Pre-exposure of catfish larvae to formalin (Formaldehyde, 37-41%) at rate of 400 μL/L, iv) a single formalin (Formaldehyde, 37-41%) treatment at rate of 400 μL/L,

v) single treatment of banana leaf extract at rate of 3.2 ml/L,

vi) control with no treatment.

Each tank was daily fed with 100 ml of zooplankton (prepared from chicken manure. Water quality parameters were monitored, daily.

Results

Parameters	Salt dip	Salt-direct	Formalin dip	Formalin-direct	Banana leaf Extract	Control
Final Body Weight (g)	0.0166±0.0032[a]	0.0097±0.0018[a]	0.0269±0.0051[b]	0.0187±0.0020[a]	0.0210±0.0083[a]	0.0179±0.0062[a]
Weight Gain (g)	0.0032±0.0032[a]	0.0024±0.0023[a]	0.0135±0.0051[b]	0.0054±0.0020[a]	0.0076±0.0083[a]	0.0015±0.0019[a]
Specific Growth rate (%/day)	2.01±1.85[a]	1.56±1.48[a]	6.86±1.83[b]	3.32±1.08[a]	5.82±2.16[b]	0.98± 1.22[a]
Survival (%)	50.63± 9.86[a]	92.71±7.38[b]	33.15±10.46[a]	8.93±7.42[a]	66.67±14.36[a]	44.26±26.03[a]
Condition factor (k)	0.3941±0.0429[a]	0.3464±0.0785[a]	0.6298±0.1330[b]	0.4416±0.0453[a]	0.5725±0.1289[a]	0.3605±0.0848[a]

Results

- Salt (1 mg/L) significantly ($p<0.05$) improves survival of African catfish larvae cultured under aquaria conditions.
- Larvae exposed to banana leaf extracts (3.2ml/L) had good survivals and specific growth rates.
- Formalin treatments had the lowest survival rates despite good SGRs.

conclusion

- Prolonged exposures of un-ionized salt to C. gariepnus larvae improve survivals in aquaria conditions.
- BLE potentially increase production but more research is needed.
- Organic manure can be used for larviculture if risks from disease infection are minimized in systems.

Future research

- Determine the components of BLE and its effects on fish health.
- Synergistic effects of salt and banana leaf extracts will be investigated to determine cost -benefit of this technology.
- Up-scale the technology while addressing farmer's needs.

Opportunities

- Banana products are abundantly available in Uganda.
- gold and silver nanoparticles from BPE are demonstrated to have antimicrobial and antifungal activity (Bankar et al. 2010; Bankar et al. 2010; Jayaseelan et al. 2013).
- BLE/BPE have been tested in fish farms with promising results (Caruso et al., 2013).

Acknowledgement

- Aquaponics Africa
- National Fisheries Resources Research Institute
- AquaFISH Innovation Lab-USAID

Role of collaborating programs in aquaculture development in Mali

Dr Héry Coulibaly*
Fishery of Mali, Boureima
TRAORE; Fishery of Bamako, Seydou TOE Conseiller Technique au Ministère de l'Emploi et de la Formation Professionnelle Cité administrative Bâtiment 8; 1er étage, BP :3298
herycoulibaly55@yahoo.fr

Mali is a country in West Africa with an area of 1,241,238 square kilometers. It has an important hydrographic network in the order of 4,500 km. The hydrography of Mali is essentially constituted by the basins of the rivers (Niger, Senegal and Volta). This hydrographic system maintains a set of natural and artificial lakes. The aquaculture potential is one of the most of West Africa. Before 2005 aquaculture production was estimated at 1300 tons of fish per year.

The constraints to the development of aquaculture were: the low level of training of producers, the low production capacity of fingerlings and the lack of infrastructure for production of the food fish.

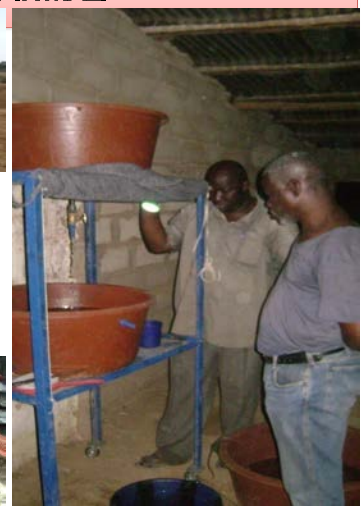
From 2007 to 2010, the National Direction of Fisheries has received support from USAID which has enabled the implementation of AquaFish Collaborative Research Support Program (CRSP) through Oregon State University (OSU). The themes developed by the CRSP-Mali wore on: Pond Culture construction (Bamako), Rice Fish technology (Baguineda), and Fisheries Management (Selingue). The results achieved are: 385 persons trained, the mastery of rice/fish farming, the mastery of the artificial reproduction of wells catfish. CRSP-Mali has helped to strengthen the capacities of support services council of fisheries and of organized producers.

The development of the private production of fingerlings and feed for fish is one of the most important impacts. Mr. Seydou Toe is one of the greatest success stories. It is the first private producer of fingerlings private of Mali. In addition, it has contributed to the dissemination of techniques and technologies learned across the country. Finally he has developed kits of fry production of clarias by artificial reproduction in rural conditions. More than thirty copies of this kit are operating in the regions of Kayes, Koulikoro, Sikasso and Bamako.

Private investors have put in placed fish modern farms with a capacity production of fingerlings nearly 100 000 per year. The most important among them is the Diallo Farm. The unit of manufactures of food for fish has a capacity of 600 TM per year.

Kit for artificial reproduction of clarias of Seydou TOE

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI



Héry COULIBALY
Bouréima TRAO
Seydou TOE

AQUA FISH
COLLABORATIVE RESEARCH SUPPORT PROGRAM

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

- From October 2007 to September 2010 : AquaFish CRSP receive from USAID/Mali an Associate Award
- The project used south–south approach connecJng : Mali, China and Kenya
- Three themes are developed :
- *Theme I: Pond Culture : Bamako*
- *Theme II: Rice-Fish Culture : Baguineda*
- *Theme III: Fisheries Planning : Sélingué*

AQUA FISH
COLLABORATIVE RESEARCH SUPPORT PROGRAM

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

- Project acJviJes were essenJaly:

1. Training sessions on pond construcJon and pond construcJon and management in Mali

AQUA FISH
COLLABORATIVE RESEARCH
SUPPORT PROGRAM

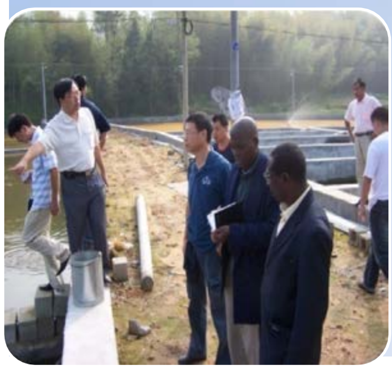
ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

2. Training session in Kenya and Mali on Clarias propagaIon and on farm trial

AQUA FISH
COLLABORATIVE RESEARCH
SUPPORT PROGRAM

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

3. Training Training for technical staff in China on Rice–Fish AdapIve Research



ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

4. Rice–Fish Demonstralons, Baguineda

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

5. Frame survey training in Mali on Lake Sélingué

AQUAFISH COLLABORATIVE RESEARCH SUPPORT PROGRAM

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

- BEFORE THE PROJECT

AQUAFISH COLLABORATIVE RESEARCH SUPPORT PROGRAM

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

The situaJon was :

- A general decline in capture fisheries producJon in Mali,
- Poor technology base, poor adopJon, and very liUle research on species and producJon, condiJons and on post–harvest technologies,
- Inadequate policies on fisheries management and aquaculture development,

AQUA FISH COLLABORATIVE RESEARCH SUPPORT PROGRAM

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

The situaJon was :

- Poor infrastructure and high input costs
- Poor organizaJon of the stakeholders,
- Poor water retenJon of pond soils and water losses in lined or finished earthen ponds,
- Lack of coordinaJon of different partners supporJng the subsector,
- etc

AQUA FISH COLLABORATIVE RESEARCH SUPPORT PROGRAM

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

AFTER PROJECT IMPLEMENTATION

1. DNP become strong to give advices to producers

2. DNP start colaboraJon with US Peace Corps, SwissContact, Winrock InternaJonal, Farmer to Farmer programm, and IICEM on rice fish development in MopJ and Tombouctou

AQUA FISH
COLLABORATIVE RESEARCH SUPPORT PROGRAM

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

AFTER PROJECT IMPLEMENTATION

3. Seydou TOE become the first Private producer of fingerlings and created a kit of arJficial clarias propagaJon with local materials

AQUA FISH
COLLABORATIVE RESEARCH SUPPORT PROGRAM

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

4. Seydou TOE and his team of 15 persons work like and entreprise, building ponds and training producers in clarias propagaJon

AQUA FISH COLLABORATIVE RESEARCH SUPPORT PROGRAM

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

4. More 400 producers and staff are trained in pond construcJon a_er 2010

5. 40 persons are trained in claris propagaJon

6. 33 kits selled by TOE (Sikasso and Kayes)

AQUA FISH COLLABORATIVE RESEARCH SUPPORT PROGRAM

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

7. Ponds and fingerlings producton

	2007	2010	2011	2012
Number of ponds	255	482	700	950
Fingerlings production (clarias)	0	150 000	643 000	1 630 000

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

8. The bigest private producer is Boubacar Daillo’s Farm in Baguineda

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

AQUA FISH
COLLABORATIVE RESEARCH SUPPORT PROGRAM

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

AQUA FISH
COLLABORATIVE RESEARCH SUPPORT PROGRAM

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

AQUA FISH
COLLABORATIVE RESEARCH SUPPORT PROGRAM

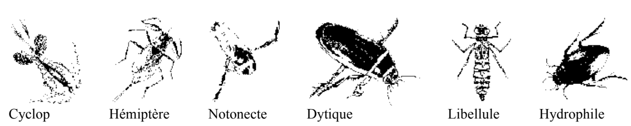
ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

AQUA FISH
COLLABORATIVE RESEARCH SUPPORT PROGRAM

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

(dessins extraits de Éléments d'écologie: Belin)



Source : Carpio

ROLE OF COLLABORATING PROGRAMS IN AQUACULTURE DEVELOPMENT IN MALI

THANK YOU

FOR YOUR ATTENTION

AQUA FISH
COLLABORATIVE RESEARCH SUPPORT PROGRAM

Profitability and adoption of two pond aquaculture best management practices in Ghana

Yaw B. Ansah* and Emmanuel A. Frimpong
Virginia Tech, 113 Cheatham Hall, Blacksburg, VA, USA, yawb@vt.edu

Despite the numerous benefits especially to developing countries from aquaculture, such as increased availability of low-cost, high-quality animal protein, poverty alleviation, increased employment, and foreign exchange earnings, most forms of aquaculture are perceived or known to have some adverse impacts on the environment. The fish farming industry in sub-Saharan Africa has been growing rapidly in recent years, facilitated by development partners. Along with growth and development there is the need to encourage the adoption of environmental best management practices (BMPs) to avoid new and costly environmental regulations, or in the absence of such regulations, degradation of the very environment that would sustain the industry. Considering the relatively dilute nature of effluents from fish ponds, the voluntary adoption of BMPs on these farms seems to be the most viable means of abating the negative impacts on effluent-receiving natural aquatic ecosystems. An important determinant of the voluntary adoption of any new technology by a farmer is his or her perceived relative profitability of the new technology, as compared to the existing technology or technologies been employed on that farm. Therefore, a study of the relative profitability of a new technology could serve as an indirect method of determining the adoption success of that technology in a particular region.

We applied two aquaculture environmental BMPs - pondwater reuse and the use of the relatively more expensive floating feed - to the culture of all-male *Oreochromic niloticus* in ponds on five demonstration fish farms in southwestern and central Ghana. Fish growth data was collected for over five months. We also collected adoption, production and marketing data in a survey we administered in person to 360 pond fish farmers in the study area over a three-year period. We applied the Linear Programming technique to determine the proportion of ponds on a typical farm that will be put under these two BMPs to maximize profits. Simulations were carried out with the General Algebraic Modelling System (GAMS) software.

Preliminary results indicate that under the existing production and marketing parameters, a reduction in the component of total production costs from the recommended feed type of between 10% and 23% will result in partial to full adoption of both BMPs. This reduction in feed costs may be achieved in three ways: reduction in total quantity of feed used while maintaining observed growth rates (increasing FCR), lowering the sale price of the recommended feed type (through subsidies or reduction in feed protein content), and the reduction of the total quantity of feed used in ponds that reuse water.

Further analysis will involve the application of the /Tradeoff analysis/Minimum-data technique to predict the adoption of these BMPs in the study area, based on relative profitability. We also will project actual BMP adoption rates from the three years of survey data, using the logistic adoption model. The results of these three exercises will then been combined to better understand the adoption patterns of the BMPs in the study area.

POND AQUACULTURE BEST MANAGEMENT PRACTICES IN GHANA: To Adopt or not to Adopt

Yaw B. Ansah
Emmanuel A. Frimpong

2/11/2014

Aquaculture

- Positives
  - High-quality animal protein
  - Increased employment
  - Profit for entrepreneurs
  - Foreign exchange earnings
  - Saving wild fish stocks
- Negatives
  - Nutrients (N and P)
  - Biochemical oxygen demand
  - Suspended solids
  - Pathogens
  - Non-native species/strains

Best Management Practices

- Categories:
  - Effluent management
  - Nutrient management

- This study:
  1. Pond water: Reused / new
  2. Fish feed: Floating / sinking

Innovation Adoption

- Relative profitability

More Profitable?

No → Reject

Yes → Adopt

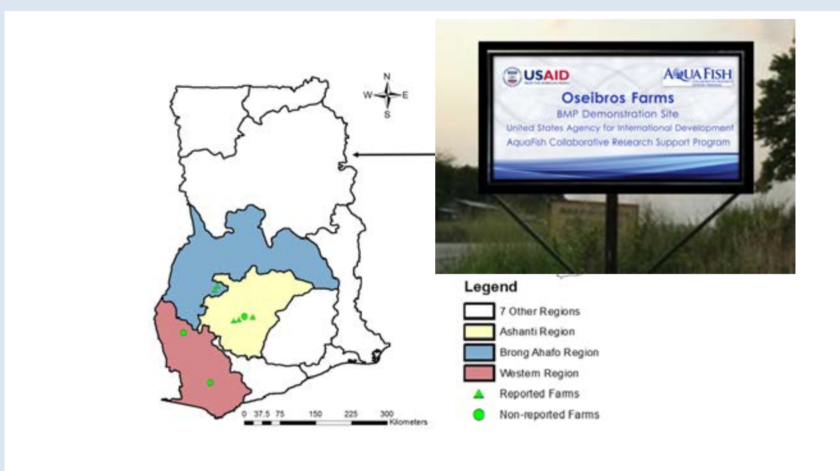
Innovation Adoption

- How do we convince fish farmers?
  - Feed cost / kg

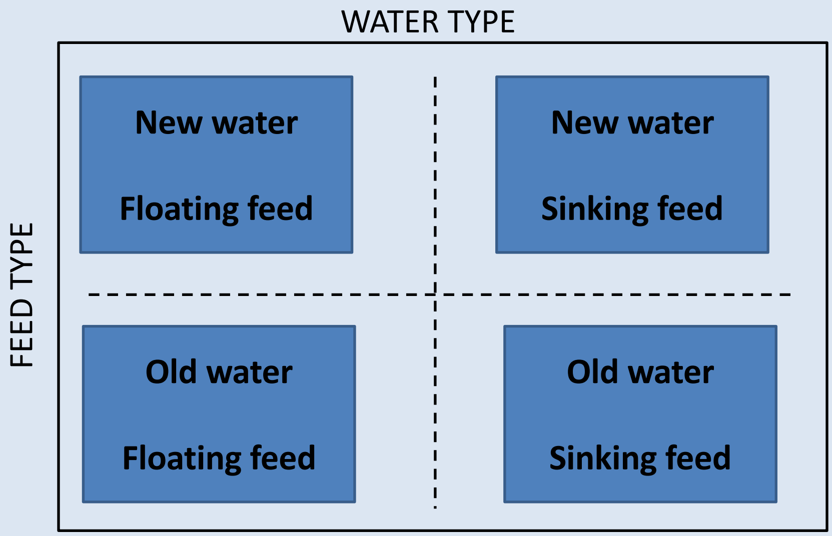
$1.00

$0.13

Study Area



Design

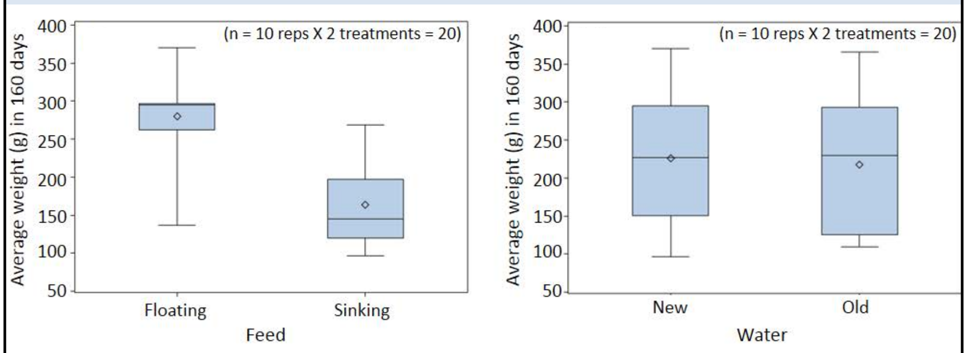


Survey

- Administered in person (2011-2013)
- 363 respondents (pond fish farmers)

Data

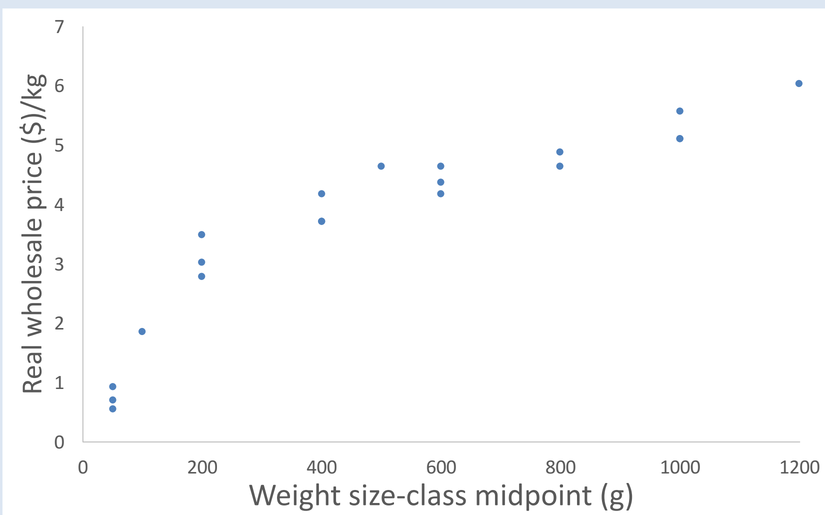
- Fish harvest weight



Frimpong, *et al.*, 2014. Effects of two environmental BMPs on pond water and effluent quality and growth of Nile tilapia, *Oreochromis niloticus*. ***Sustainability***, *6*, 652-675.

Data

- Fish price



Linear Programming Model

$$Maximize\ Z = \sum_{i=1}^{6} p_i\ k_i - \sum_{i=1}^{7} c_i\ l_i,$$

Z = total profits

p = revenue for each BMP combination pond

k = a unique water+feed combination

c = per unit cost of input

l = a production input

- General Algebraic Modelling System software (GAMS)

Linear Programming Model

Constraints:

e.g.,

- Each production cycle:

$$\sum_{i=1}^{4} x_i = n$$

Linear Programming Results

Management Practice	Proportion of Ponds (%)
Cycle 1	
Floating feed	100
Sinking feed	0
Cycle 2	
Floating feed	100
Sinking feed	0

Linear Programming Results

Variable	Value (GHC)
Objective (Profit)	2,321,60
Marginals	
Floating feed Pond	290.20 / cycle
Sinking feed pond	- 948.11 / cycle

Current work

- Enterprise budgets for tilapia farming in Ghana

Item	Description	Unit	Quantity	Price/Unit	Total
Gross receipts					
Tilapia	Live	kg	6199.2	8.750953724	54,2
Total gross receipts		GHC			54,2
Variable costs					
Tilapia fingerlings	Hatchery-raised, all-male	individuals	29520	0.4975	14,6
Fish feed	Pelletized; 30% crude protein	kg	12629.53	2.00	25,2
Fertilizer	Urea	kg	29.52	1	
	Monoammonium phosphate	kg	19.68	6	1
	Chicken manure	kg	49.2	0.15	
Agriculture lime	Lime	kg	623.856	0.8	4
Permanent labor: security, stock, feed, fertilize, harvest		GHC	24	150	3,6
Temporary labor: weed, harvest, levee repair, etc		GHC	32	10	3
Interest on operating capital		GHC	44199.32	0.12	5,3
Total Variable Cost (TVC)		GHC			49,8
Net returns above TVC		GHC			4,4
Fixed Costs		GHC			
Depreciation	Staight-line depreciation (x/time)				
Equipment		GHC			1
Ponds		GHC			1,4
Interest on investment	25%; Equipment & Ponds	GHC			1,8

- Incorporating Risk and Sensitivity analysis
  - Impact of **harvest size** on fish price
  - Impacts of feed type, pond morphometrics, stocking density, and fingerling size on **harvest size**

Future Extensions

- Reduced feeding in reused water ponds
  - Fertilization / Primary production
  - Uneaten feed from previous cycle
  - Lowering feeding rate

Funding for this research was provided by the

AQUAFISH INNOVATION LAB

USAID FROM THE AMERICAN PEOPLE

OSU Oregon State

AQUAFISH INNOVATION LAB

The AquaFish Innovation Lab is supported in part by United States Agency for International Development (USAID) Cooperative Agreement No. EPP-A-00-06-00012-00 and by contributions from participating institutions.

This presentation is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government. Mention of trade names or commercial products in this presentation does not constitute endorsement or recommendation for use on the part of USAID or AquaFish. The accuracy, reliability, and originality of the work presented are the responsibility of the individual authors.

Using on-farm experiments to untangle the cuases of low productivity of tilapia *Oreochromis niloticus* grown in ponds in Ghana

Emmanuel A. Frimpong*, Yaw B. Ansah, Steve Amisah, and Daniel Adjei-Boateng
156 Cheatham Hall Virginia Polytechnic Institute and State University Blacksburg, VA 24061
frimp@vt.edu

Pond-based aquaculture in sub-Saharan Africa has been plagued by low productivity. Many causes of this low productivity in tilapia ponds have been identified, but there is no consensus on the most important causes. To optimally allocate research, development, and extension resources to improve productivity, the multiple tangled causes should be better understood. Factors commonly cited for the problem include low-quality feed, lack of quality fingerlings, poor water quality management, inadequacy of control of reproduction in ponds, and poor stocking practices. Less frequently noted is improper pond construction and maintenance. Using data from on-farm experiments designed to promote wider adoption of selected better management practices (BMPs), the goal of the current study was to quantify the sources of variation in growth of tilapia in ponds, thereby identifying the factors with significant room for improvement.

The study was conducted in three pond aquaculture dominated regions of Ghana on eight farms over two six-month production cycles. Three of the farms participated in both cycles while the other five participated in one cycle. Each farm contributed four ponds for a total of 32 ponds and 44 experimental runs. The two BMPs studied were feed type and water source, combined in a 2 x 2 crossed factorial design. Fingerlings for the first production cycle were obtained from a local hatchery and stocked 3/m^2 at approximately 5g. For the second cycle fingerlings were obtained from a different hatchery, stocked 2/m^2 at approximately 20g, and catfish *Clarias gariepinus* fingerlings stocked at 20% of tilapia density after 10wks to control tilapia populations if sex reversal failed significantly. Feeding was varied from 5% to 2% body weight and fed twice daily and growth was monitored biweekly. Detailed pond morphology measurements were made at the end of the production cycle. We used partial regression analysis to decompose variation in growth among ponds, represented by the average size attained in 160 d.

The regression models accounted for 71.9% of variation (i.e., R^2) in growth. Feed type, source of fingerlings, source of water, control of reproduction, and stocking density accounted for 42.6%. Pond morphology uniquely accounted for only 2.6%, but combined with the other factors to account for a total of 18.3 percent of growth. Farms accounted for 11.0%. Commercial floating feed was the single most important factor accounting for observed growth, whereas the combined effect of fingerling source and control of reproduction followed closely. Many ponds were found to be extremely shallow, leading to true recalculated individual pond stocking densities of 3-17 fish/m^3. Thus, one important pathway by which pond depth mediated growth was through a strong observed negative relationship between stocking density and growth. Tilapia in some deep ponds with commercial floating feed and well controlled reproduction attained fast growth and an uncommon average of 361g in 160d of growout. Future extension needs to emphasize better pond construction, sourcing of good fingerlings, and economical uses of formulated feeds.

USING ON-FARM EXPERIMENTS TO UNTANGLE THE CAUSES OF LOW PRODUCTIVITY OF TILAPIA GROWN IN PONDS IN GHANA

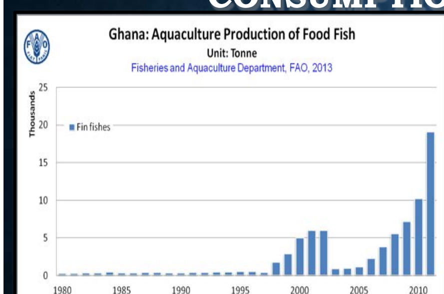
Emmanuel A. Frimpong

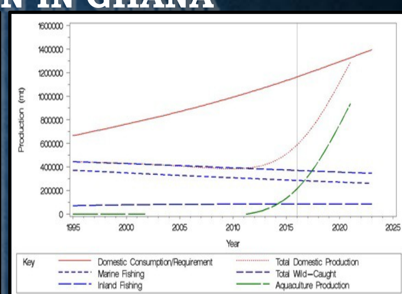
Yaw B. Ansah

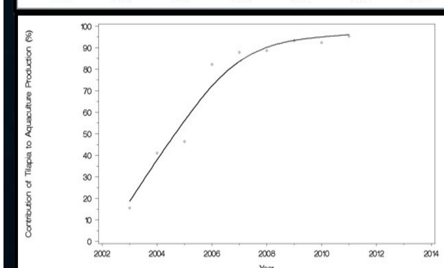
Steve Amisah

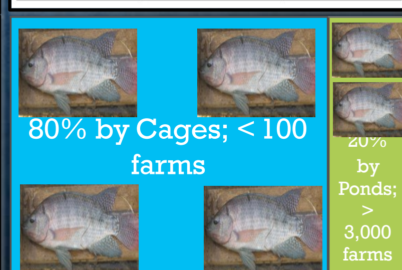
Daniel Adjei-Boateng

AQUACULTURE PRODUCTION & FISH CONSUMPTION IN GHANA









POND PRODUCTIVITY

- Productivity of ponds in Ghana reported at 1,000 – 3,000 kg/ha/yr (avg: 2,500 kg/ha/yr)
- Productivity >10,000 kg/ha/yr without aeration has been demonstrated => Operating well below potential
- Why not put the resources in cage aquaculture development

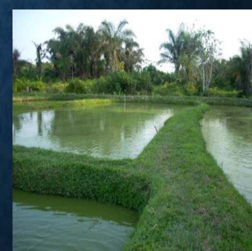
CAUSES OF LOW PRODUCTIVITY

- Low quality /High cost feed
- Low quality fingerlings
- Sub par sex-reversal technology
- Poor water quality management
- Poor stocking practices
- Improper pond construction and maintenance (A hypothesis)

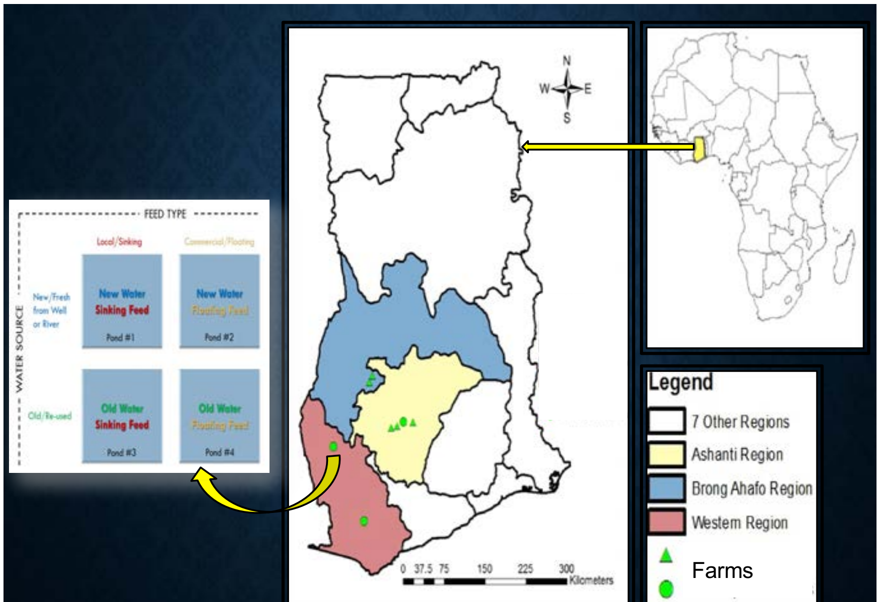
STUDY GOAL

- Decompose the sources variation in pond productivity to better predict how much may be gained by improving pond construction and maintenance in Ghana

Shallow with poor embankments



Deeper with better embankments

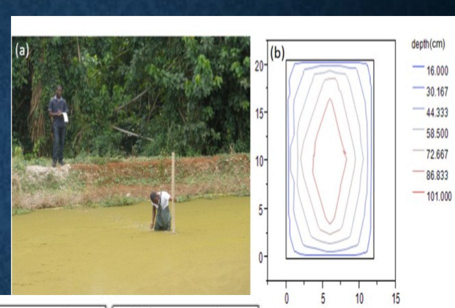


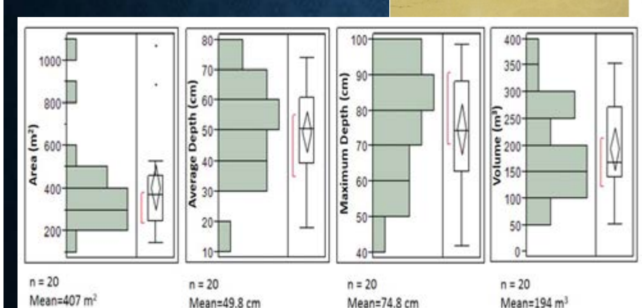
DISCLAIMER! – OPPORTUNISTIC DATA ANALYSIS

Turning unanticipated challenges into oppor

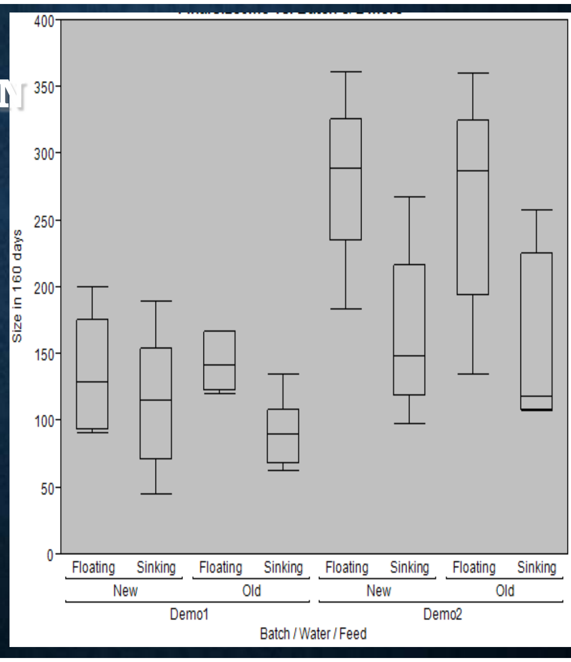
Factor	Demonstration cycle 1	Demonstration cycle 2
O. niloticus strain	Potentially mixed	Akosombo/Volta strain
Stocking density	3/m^2	2/m^2
Control of reproduction	13-27% female; no predator	5-12% female; predator
Size at stocking	2-5g	10-30g
Feed types	Controlled (Sink/ Float)	Controlled (Sink/ Float)
Water sources	Controlled (New/ Green)	Controlled (New/ Green)

QUANTIFYING POND MORPHOLOGY





GROWTH PERFORMANCE



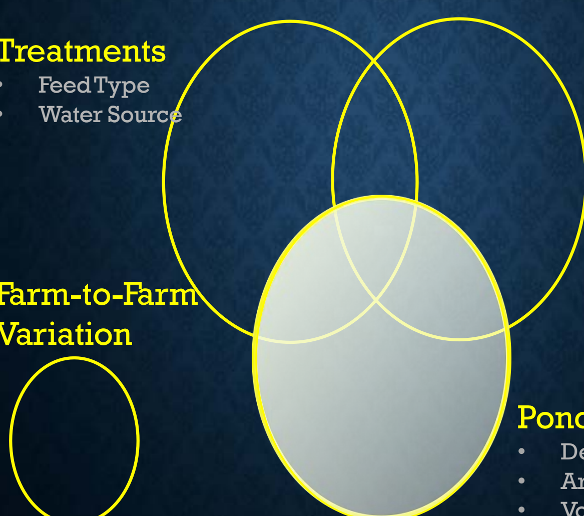
PARTIAL REGRESSION ANALYSIS - CONCEPTUAL

Treatments

- Feed Type
- Water Source

Batch/Cycle

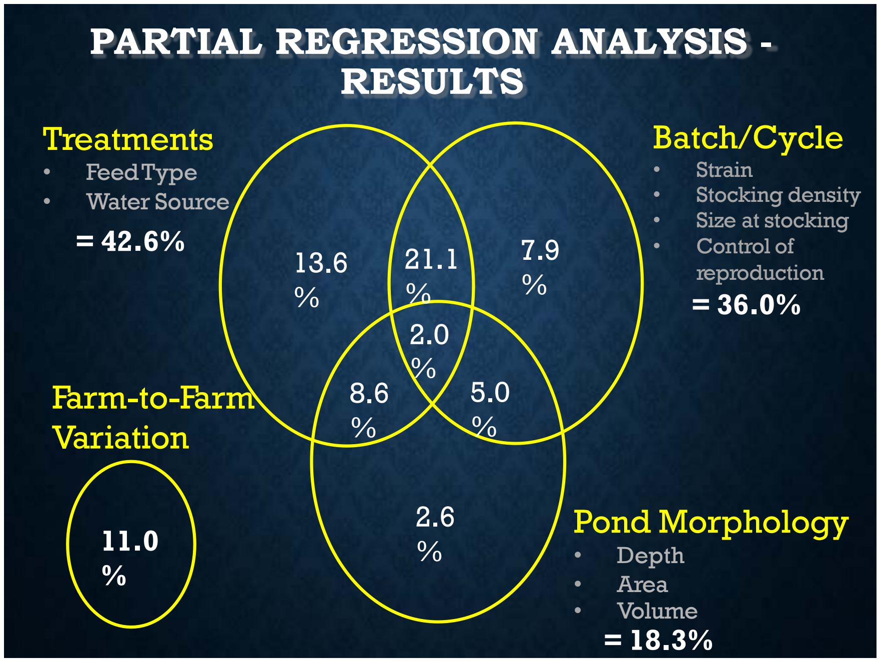
- Strain
- Stocking density
- Size at stocking
- Control of reproduction

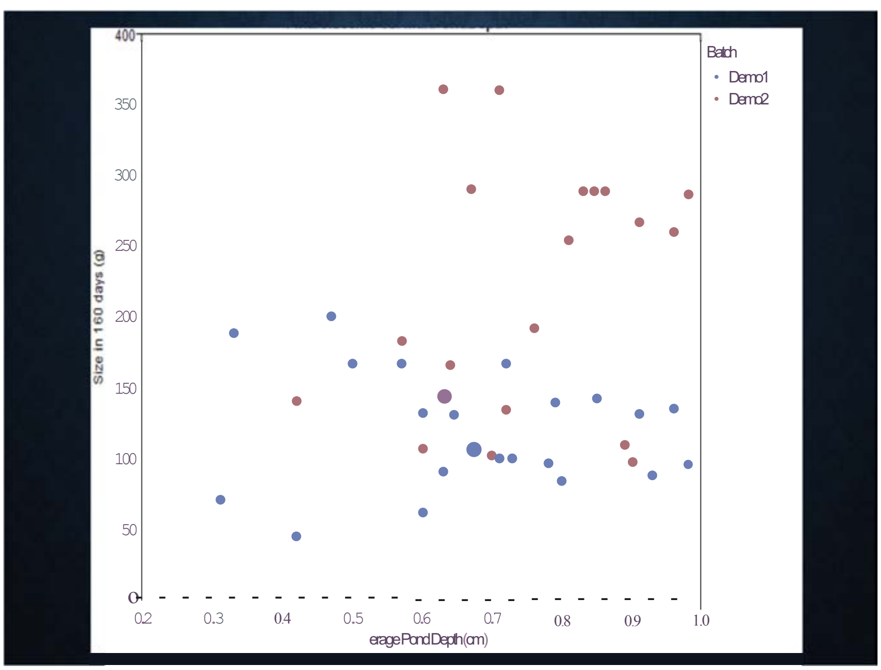


Farm-to-Farm Variation

Pond Morphology

- Depth
- Area
- Volume


PARTIAL REGRESSION ANALYSIS - RESULTS
Treatments
Feed Type
Water Source
= 42.6%
Batch/Cycle
Strain
Stocking density
Size at stocking
Control of reproduction
= 36.0%
Farm-to-Farm Variation
11.0 %
Pond Morphology
Depth
Area
Volume
= 18.3%
13.6 %
21.1 %
7.9 %
2.0 %
8.6 %
5.0 %
2.6 %


Size in 160 days (g)
400
350
300
250
200
150
100
50
0
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
erage Pond Depth (cm)
Batch
Demo1
Demo2

FUNDING FOR THIS RESEARCH WAS PROVIDED BY THE

AQUAFISH INNOVATION LAB

USAID FROM THE AMERICAN PEOPLE

OSU Oregon State

AQUAFISH INNOVATION LAB

The AquaFish Innovation Lab is supported in part by United States Agency for International Development (USAID) Cooperative Agreement No. EPP-A-00-06-00012-00 and by contributions from participating institutions.

This presentation is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government. Mention of trade names or commercial products in this presentation does not constitute endorsement or recommendation for use on the part of USAID or AquaFish. The accuracy, reliability, and originality of the work presented are the responsibility of the individual authors.

Estimating the actual and potential production capacity of aquaculture ponds in Ghana

Iris Fynn* and Emmanuel Frimpong
113 Cheetham Hall, Virginia Polytechnic and State University, Blacksburg, VA 24061
irisfynn@vt.edu

With a current population of over 25,000,000, and a growth rate of 2.3%, there is the need for Ghana to increase agricultural productivity to meet its food demands. Currently a net importer of fish and sea food products, Ghana is reported to have the potential to more than double its current agricultural production. Survey reports of aquaculture production from ponds in Ghana are similarly dismally low, averaging about 2500kg/ha. Sustainable intensification of aquaculture requires a clearer understanding of the gap between current and potential production and the causes of that gap. This study sought to develop a spatial database that includes the key infrastructure required for aquaculture in Ghana and to estimate the current production of Nile tilapia, *Oreochromis niloticus* from earthen ponds and potential production capacity if better management practices were adopted.

With the aid of GPS, the locations of approximately 170 farms in the Eastern, Western, Brong-Ahafo, Central and Ashanti regions, where pond aquaculture is concentrated in the country, were recorded and collated. Morphology was surveyed for a subsample of 160 ponds from these farms along with administering questionnaires to farmers about their management practices. These data were analyzed in conjunction with satellite imagery covering most of the country.
Information from field data, responses to questionnaires, and on-farm experiments provided robust estimates of current and potential total pond production capacity for tilapia in the country for aquaculture development planning. Preliminary results indicate that there may be significantly fewer viable pond-based fish farms in the country than the approximately 3,000 previously reported. However, experiments show that the production from these farms could easily increase fourfold with the adoption of better tilapia strains already available in the country and improvement in management practices.

ESTIMATING THE ACTUAL AND POTENTIAL PRODUCTION CAPACITY OF AQUACULTURE PONDS IN GHANA

Iris Fynn*   Dr. Emmanuel Frimpong
Virginia Tech

Introduction

Introduction

* Fish makes up 60% of the dietary animal protein in Ghana (FC, 2012)
* The volume of fish produced in Ghana(420,000) is less than a half of the total output(880,000) required by the country (FC, 2012)
    * Aquaculture SHOULD make up for the deficit!
* Have aquaculture ponds in Ghana been unproductive or under-reported?

Introduction

* Aim
    * Estimate the actual and potential production capacity of aquaculture ponds in Ghana
        * Consider the key infrastructure required for aquaculture development in the country

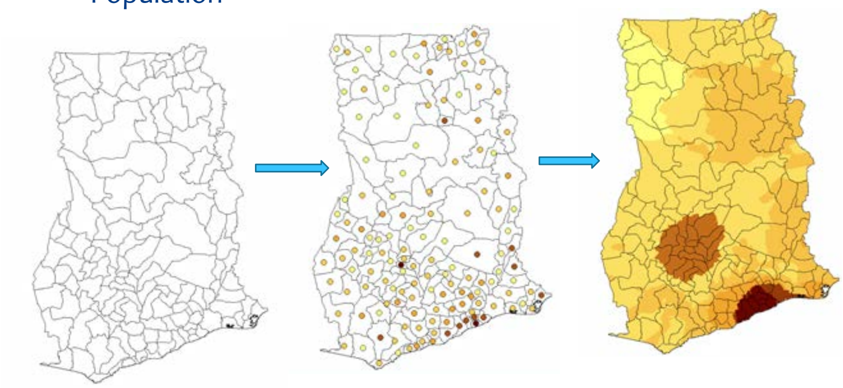
Introduction

* Establish the current location of fish ponds
* Consider the factors that influence the establishment of ponds in Ghana
    * Roads, Soil, Water, Market, Extension
* Deduce the potential of aquaculture given existing conditions

Data Collection

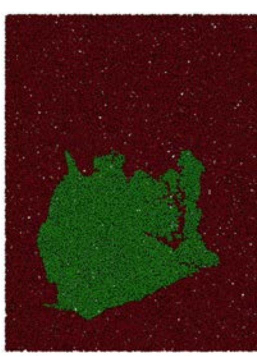
METHODOLOGY

* Population



Methodology

* Different weights attached to districts based on literature and observations

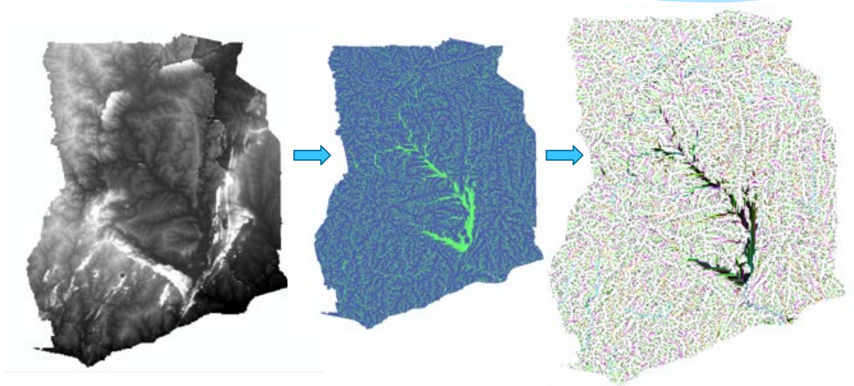


Central	14236	Abura-Asebu-Kwamankese	1.125
Greater Accra	14266	Accra	2.125
Volta	14306	Adaklu Anyigbe	2.5
Ashanti	14197	Adansi North	2.125
Ashanti	14198	Adansi South	2.5
Ashanti	14199	Afigya Sekyere	1.875
Eastern	14249	Afram Plains	1.375
Central	14237	Agona	1.75
Ashanti	14200	Ahafo Ano North	1.625
Ashanti	14201	Ahafo Ano South	2.125
Western	14321	Ahanta West	1.5
Central	14238	Ajumako-Enyan-Esiam	1.25
Volta	14307	Akatsi	1.25
Eastern	14250	Akwapim North	1.5
Eastern	14251	Akwapim South	1.5
Ashanti	14202	Amansie Central	2.5
Ashanti	14203	Amansie East	2.5
Ashanti	14204	Amansie West	2.125
Western	14322	Aowin-Suaman	1.625
Ashanti	14205	Asante Akim North	2
Ashanti	14206	Asante Akim South	2.125
Central	14239	Asikuma Odoben Brakwa	1.625
Central	14240	Assin North	1.75
Central	14241	Assin South	1.75
Brong Ahafo	14218	Asunafo North	2.25
Brong Ahafo	14219	Asunafo South	2.25
Eastern	14252	Asuogyaman	1.125
Brong Ahafo	14220	Asutifi	2.125
Brong Ahafo	14221	Atebubu-Amantin	1.625
Eastern	14253	Atiwa	2.125
Ashanti	14207	Atwima	2.5
Ashanti	14208	Atwima Mponua	2.5
Central	14242	Awutu Efutu Senya	1.5
Brong Ahafo	14222	Berekum	1.75
Western	14323	Bia	1
Western	14324	Bibiani Anhwiaso Bekwai	1.75
Eastern	14254	Birim North	2.25
Eastern	14255	Birim South	2.25
Ashanti	14209	Bosomtwe-Kwanwoma	2.25
Central	14243	Cape Coast	1.125
Greater Accra	14267	Dangbe East	1.5
Greater Accra	14268	Dangbe West	1.5
Brong Ahafo	14223	Dormaa	2.25
Eastern	14256	East Akim	1.875

0=Unsuitable
1=Fairly suitable
2= Suitable
3= Very suitable

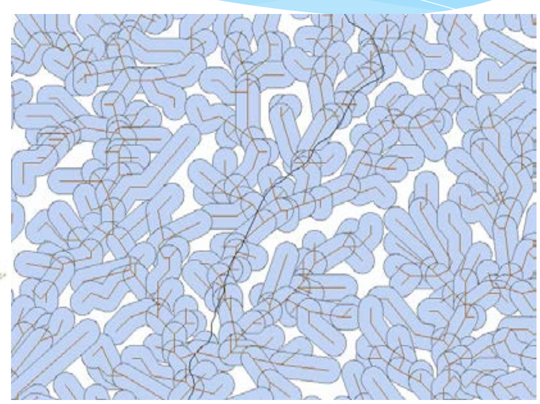
Methodology

* Stream Network



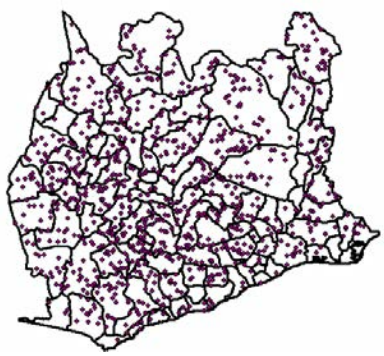
Methodology

* Stream network



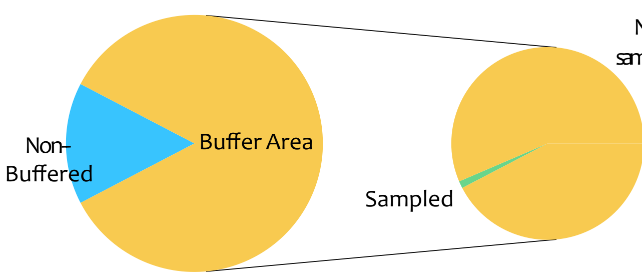
Methodology

Intersect with buffer

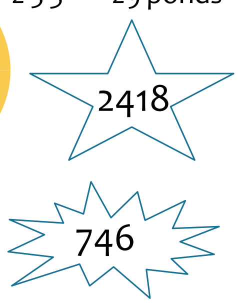


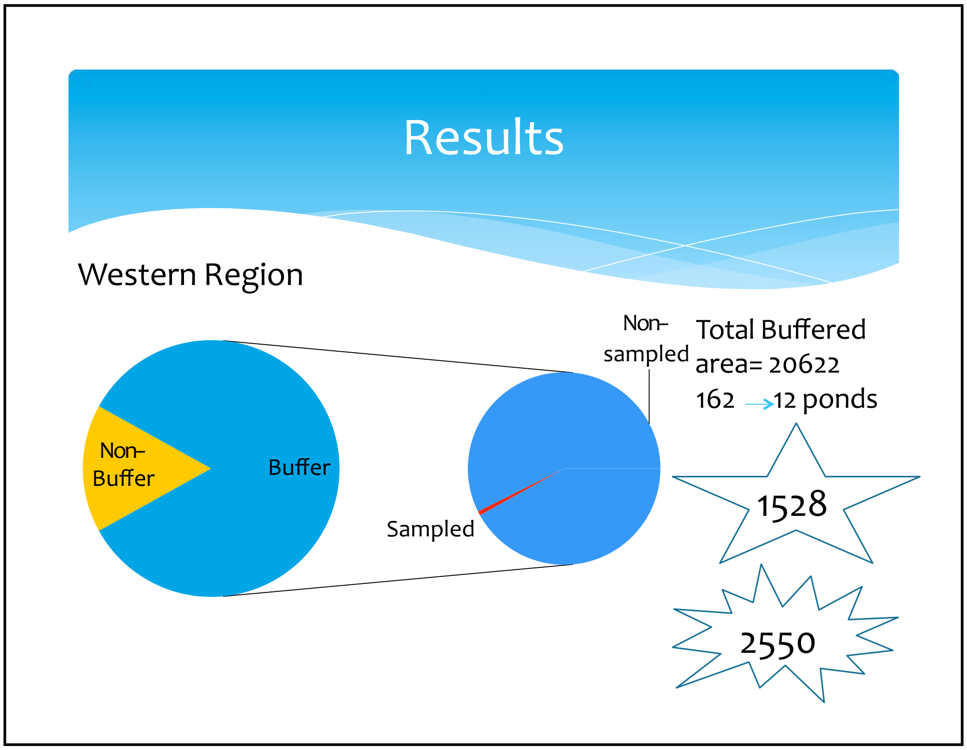
Results

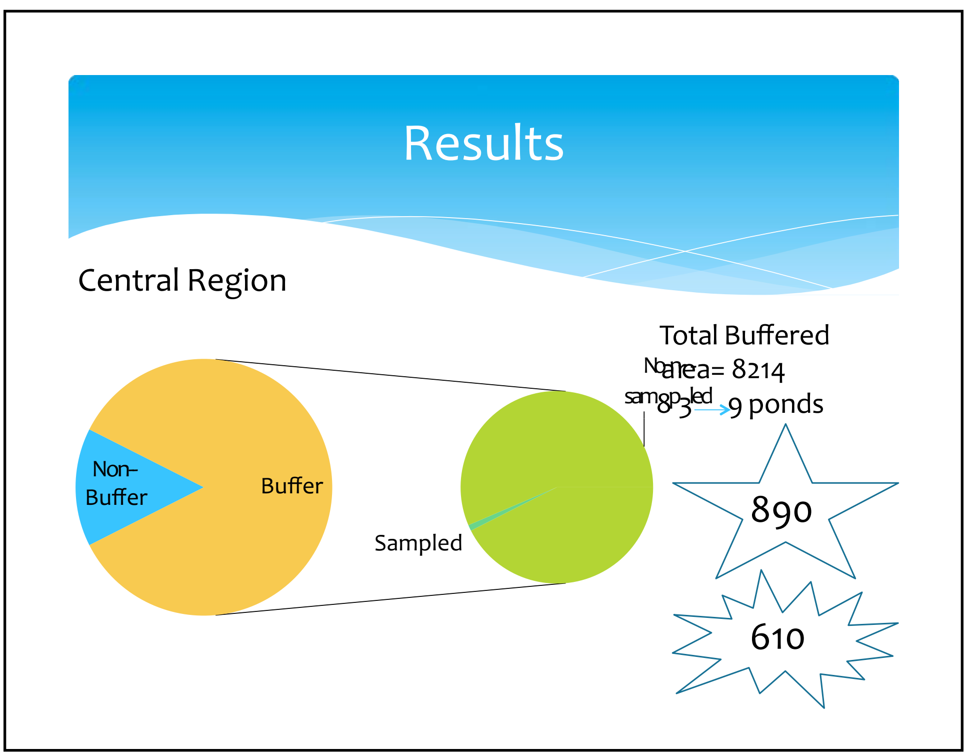
Ashanti Region



Total Buffered
area= 21094
Non-sampled
2353 = 29 ponds

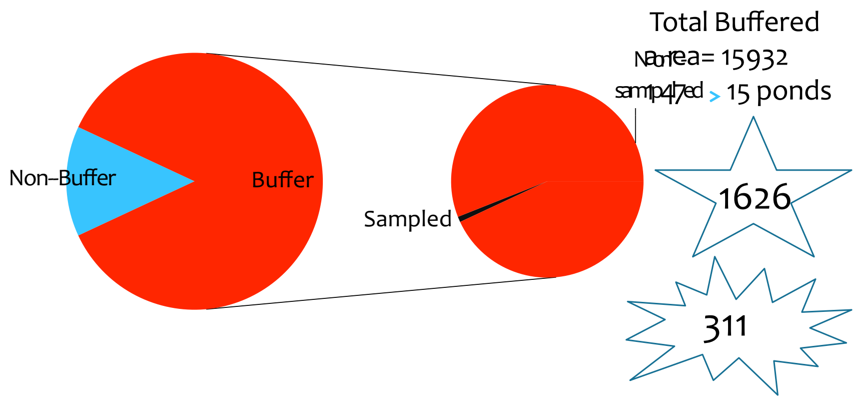



Results
Western Region
Non-Buffer
Buffer
Non-sampled
Sampled
Total Buffered area= 20622
162 → 12 ponds
1528
2550


Results
Central Region
Non-Buffer
Buffer
Non-sampled
Sampled
Total Buffered area= 8214
83 → 9 ponds
890
610

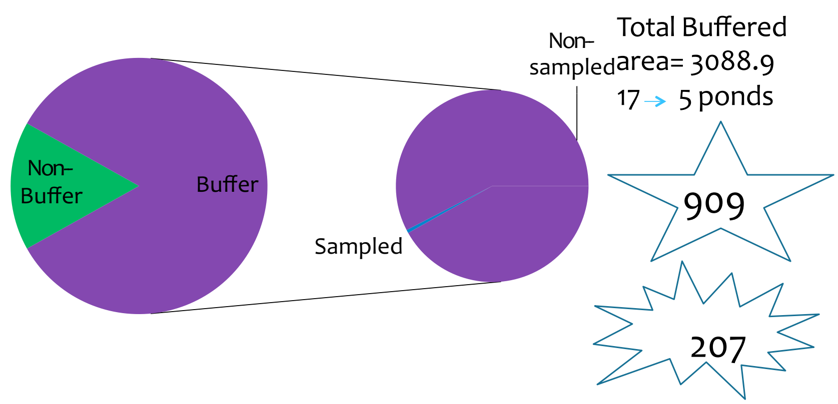
Results

Eastern Region



Results

Greater-Accra Region



Moving forward….

* In Ghana, statistics on production and pond characteristics are based on the area of the fish ponds.

* Volume of ponds will be used as an estimator of the production capacity of ponds since pond volume has an effect on the growth, feeding habits and mortality rates of fish
  - Measurements from randomly selected ponds were taken using AquaFish CRISP procedures

* Production capacity of all farms will then be extrapolated

Conclusion

The number of ponds from the statistical estimates and from field experiment data

+

Analysis on the productivity of the farms

=

Formation of an effective policy that ensures that aquaculture makes up for the 460000 fish deficit in Ghana

THANK YOU

Funding for this research was provided by the

AQUAFISH INNOVATION LAB

The AquaFish Innovation Lab is supported in part by United States Agency for International Development (USAID) Cooperative Agreement No. EPP-A-00-06-00012-00 and by contributions from participating institutions.

This presentation is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government. Mention of trade names or commercial products in this presentation does not constitute endorsement or recommendation for use on the part of USAID or AquaFish. The accuracy, reliability, and originality of the work presented are the responsibility of the individual authors.

An ecological approach towards optimizing pond-specific fertilization efficiencies for semi-intensive aquaculture

Christopher F. Knud-Hansen*

Aquatic Solutions, LLC
Boulder, CO, 80303
E-mail: cknudhansen@att.net

The practical goal of pond fertilization is to stimulate the production of natural foods beneficial for culture organisms by systematically adding essential nutrients to the pond. Most frequently fertilizers are added to supply inorganic nitrogen (N), phosphorus (P), and sometimes carbon (C) to stimulate algal primary productivity, the foundation of the aquatic food web. However, every pond has individual characteristics (e.g., pond depth, source water, age, fertilization history, pond sediments) that can influence the fate of nutrient additions in each pond; this helps explain why what otherwise appears to be similar ponds can produce a wide spectrum of results, even when given identical fertilization treatments. Nevertheless, by incorporating ecological considerations in the fertilization strategy, the farmer can achieve the goal of maximizing production yields while minimizing economic costs on an individual pond basis.

This presentation describes how understanding pond ecological characteristics that influence algal productivity can provide time-specific and pond-specific fertilization requirements, as well as identify cost-effective fertilizer inputs. The centerpiece is the Algal Bioassay Fertilization Strategy (ABFS), a very simple visual algal response technology designed to identify both primary and secondary nutrients limiting algal growth in that pond water at that specific time. If a nutrient is primary limiting, the pond receives the full weekly rate; if the nutrient is secondarily limiting, the pond receives half the weekly rate; and if the nutrient is not limiting, then no additional fertilization is recommended for that time period. The ABFS was developed through PondDynamic/CRSP funding in the 1990s, and was presented at 3-day workshops throughout S.E. Asia in 2002. The ABFS does not require any water chemistry, or even literacy, for the pond's algal community to tell the farmer what they need (and do not need) to grow. Included among results from a 4-month grow-out trial in 400 m^2 earthen ponds comparing: 1) the ABFS, 2) a fixed-recipe approach (30 kg N ha^{-1} $week^{-1}$ and 15 kg P ha^{-1} $week^{-1}$), and 3) recommendations based on a computer model are relative Nile tilapia yields, nutrient uptake efficiencies, and fertilizer costs with each approach.

The presentation concludes with relevant pond-management guidelines (e.g., regarding pond depth and minimizing inorganic turbidity), and the ecologically based recommendations for optimizing pond-specific fertilization for semi-intensive aquaculture. These recommendations include using concentrated nutrient sources rather than manures, fertilizing N according to a fixed-recipe rate, and fertilizing with P and C according to weekly algal bioassay results. Higher, more consistent, and more cost-effective sustainable yields have great benefits for the rural farmer, as well as for research scientists wishing to minimize within-treatment variability when evaluating relative benefits of adding feeds to a fertilized pond system.

An Ecological Approach Towards Optimizing Pond-Specific Fertilization Efficiencies for Semi-Intensive Aquaculture

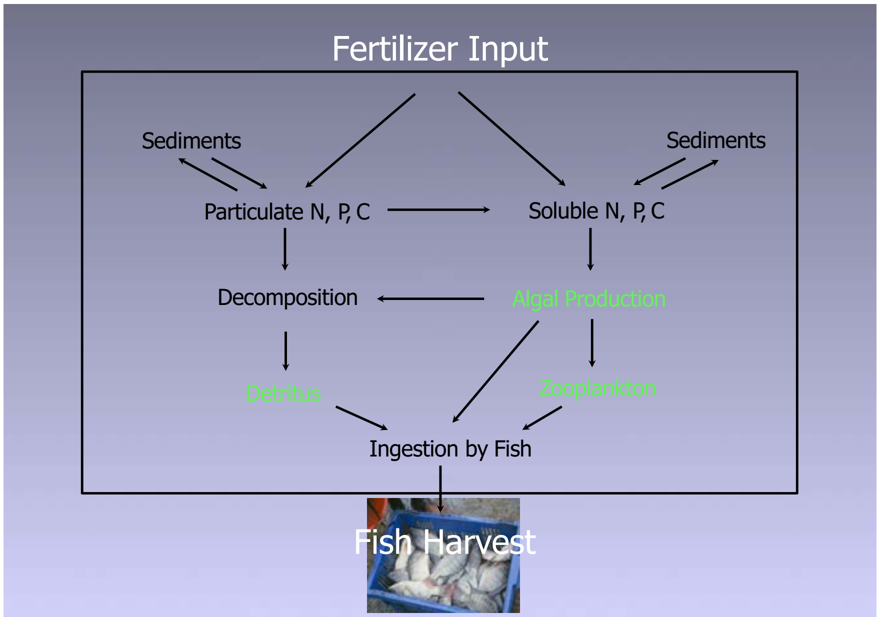
Aquaculture America 2014
Seattle, WA
February 11, 2014

Christopher F. Knud-Hansen, Ph.D.
Aquatic Solutions, LLC
Boulder, CO 80303
cknudhansen@att.net

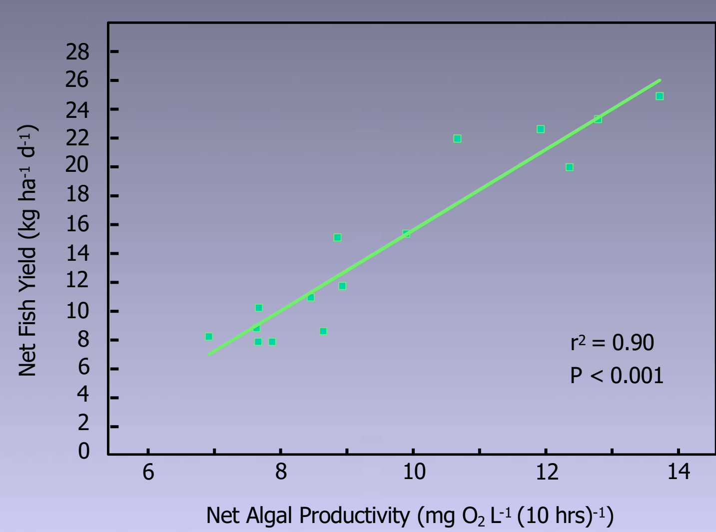
Aquatic Solutions

Pond Fertilization Goals

1. Stimulate algal productivity for natural food production
2. Maximize nutrient and economic efficiencies
3. Minimize environmental degradation



Major ecological pathways in a fertilized culture pond



Tilapia yields increase with algal productivity

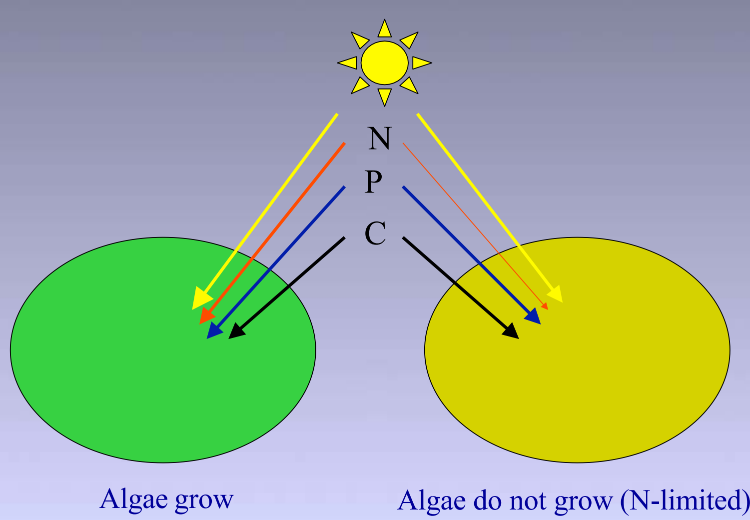

So, how do I get all my ponds this green?


Feed us what we need !!!

Limiting Factors Based on Algal Growth Requirements

- Liebig's Law of the Minimum
  Algal productivity will be limited by the element(s) in least supply relative to algal growth requirements of the algal community
- What do algae need to grow?
  - *Nutrient requirements*
    - phosphorus (P), nitrogen (N), and carbon (C)
    - Hydrogen (H) and oxygen (O)
    - Micronutrients (e.g., iron, manganese, silica, copper, zinc, calcium, magnesium, sodium, potassium, cobalt, sulfur)
  - *Physical requirements*
    - Suitable water temperatures
    - Sufficient light availability

Limitation of algal productivity



Determining Fertilization Rates

- *Pre-determined rates*
  - Fixed fertilization rates
- *Variable rates based on pond-specific measurements*
  - Water chemistry
  - Computer modeling
  - Algal bioassay

Comparing Methods

- Cost, time, and labor needed to determine fertilization rates?
- Does method account for ecological diversity of ponds?
  - How reliably does method predict algal growth?
  - Is there a risk of under or over fertilization?

Fixed, Pre-determined Rates

Advantages:

- simple and routine

Disadvantages:

- ignores ecological variability among ponds:
  - pond depth (stratification and water volume), source water
  - fertilization history (pond age)
  - inorganic turbidity
  - national borders *not* important
- ignores changes in nutrient requirements during grow-out period

Fertilization Rates Based on Pond-Specific Measurements

- Water chemistry
  - not feasible for low-cost aquaculture
- Computer models
  - not feasible for low-cost aquaculture
- Algal bioassay
  - An ecological responsive approach to determine fertilization requirements based on pond-specific nutrient limitation(s)

In other words,

Give the algal community what it needs to grow….

…. nothing more, nothing less

Pond Fertilization
Algal Bioassay Testing
Workshop

Sponsored by:

Pond Dynamics/Aquaculture (now Aquafish)

Collaborative Research Support Program

Oregon State University

Corvallis, OR 97331-1643 USA

http://aquafishcrsp.oregonstate.edu

CRSP is funded through a grant from USAID

Algal Bioassay Method: Step 1

- Collect pond water and put into 8 clear plastic bottles

Algal Bioassay Method: Step 2

- Add nutrient spikes:
  - N, P, C, N+P, N+C, P+C, N+P+C, and one bottle with nothing added (control)

Algal Bioassay Method: Step 3

- Incubate samples for about 3 days under indirect sunlight
  - Mix bottles 1-2 times/day

Algal Bioassay Method: Step 4

- After 2-3 days, visually compare bottles
- Locate results on table and fertilize accordingly

Algal Bioassay Interpretation Table

Table 2. Guide for determining primary (1°) and secondary (2°) limiting nutrient(s) based on algal bioassay results. When visually compared to the control filter color after 2-3 days growth, bioassay responses are indicated by: 0 = algal response similar to control filter, ◐ = partial algal response, and ● = maximum algal response. Corresponding relative nitrogen (N), phosphorus (P) and/or carbon (C) fertilization input requirements are given as: 2 = full amount, 1 = half amount, and 0 = no inputs for that fertilization period. "Other" in line 21 refers to other possible limitations of algal growth such as temperature, light and/or micronutrient availability. See text for further discussion.

	Bioassay Response									Limiting Nutrient		Relative Input		
	Control	N	P	C	N+P	N+C	P+C	N+P+C		1°	2°	N	P	C
1.	0	●	0	0	●	●	0	●	:	N		2	0	0
2.	0	◐	0	0	●	◐	0	●	:	N	P	2	1	0
3.	0	◐	0	0	◐	●	0	●	:	N	C	2	0	1
4.	0	◐	0	0	◐	◐	0	●	:	N	P+C	2	1	1
5.	0	0	●	0	●	0	●	●	:	P		0	2	0
6.	0	0	◐	0	●	0	◐	●	:	P	N	1	2	0
7.	0	0	◐	0	◐	0	●	●	:	P	C	0	2	1
8.	0	0	◐	0	◐	0	◐	●	:	P	N+C	1	2	1
9.	0	0	0	●	0	●	●	●	:	C		0	0	2
10.	0	0	0	◐	0	●	◐	●	:	C	N	1	0	2
11.	0	0	0	◐	0	◐	●	●	:	C	P	0	1	2
12.	0	0	0	◐	0	◐	◐	●	:	C	N+P	1	1	2
13.	0	0	0	0	●	0	0	●	:	N+P		2	2	0
14.	0	0	0	0	◐	0	0	●	:	N+P	C	2	2	1
15.	0	0	0	0	0	●	0	●	:	N+C		2	0	2
16.	0	0	0	0	0	◐	0	●	:	N+C	P	2	1	2
17.	0	0	0	0	0	0	●	●	:	P+C		0	2	2
18.	0	0	0	0	0	0	◐	●	:	P+C	N	1	2	2
19.	0	0	0	0	0	0	0	●	:	N+P+C		2	2	2
20.	●	●	●	●	●	●	●	●	:	None		0	0	0
21.	0	0	0	0	0	0	0	0	:	Other		0	0	0

Fertilization inputs:

1^o Limiting: Full Amount

2^o Limiting: Half Amount

Not Limiting: Nothing

Light Limiting: Nothing

Example: A Nitrogen-limited Pond

Fertilization: N: full amount
P: nothing
C: nothing

Example: Primarily N-limited, Secondarily P-limited

Fertilization: N: full amount
P: half amount
C: nothing

Example: Primarily N-limited, Secondarily P-limited

Fertilization: N: full amount
P: half amount
C: nothing

Issues: Light limitation

From inorganic turbidity

From dense algal biomass

Example: A Light-limited Pond

Fertilization: N: nothing
P: nothing
C: nothing

Example: A Clearwater Pond

Fertilization: N: full amount
P: full amount
C: full amount (if low alkalinity)

Issues: Zooplankton Grazing

Zooplankton grazing should be uniform, but will delay response.
However, tadpoles must be removed….

Comparative analysis of the fixed-input, computer modeling, and algal bioassay approaches (Knud-Hansen et al., 2003)

Design:

- 400 m^2 earthen ponds, 5 replicates/treatment, weekly fertilizations

Results:

- fixed-input gave NFY yields about 20% higher than other methods
  - NFY variability about 2x higher with fixed-input
- N incorporation into fish were nearly identical for all three methods
  - fixed-input used about 20% more N than other methods
  - both algal bioassays and computer model identified N limitation over 90% of the time
- P incorporation into fish for algal bioassay was 2x better than computer model, and 6x better than fixed-input
- fixed-input about 2x more expensive per kg net fish yield

Results from weekly algal bioassays from 5 replicate ponds during 120-day Nile tilapia growout experiment

Limiting Nutrient	Number of Algal Bioassays	
	1° Limiting	2° Limiting
N	62	0
P	4	3
C	1	6
N+P	2	
N+C	9	
P+C	1	
N+P+C	3	
None (light)	8	

Algal Bioassay Fertilization Strategy (ABFS)

- *N input:* fixed-input
  (at about 30 kg N ha^{-1} $week^{-1}$; however, include N in routine algal bioassays to prevent over fertilization)
- *P input:* variable, pond-specific input using algal bioassays
  (full amount = about 10 kg P ha^{-1} $week^{-1}$)
- *C input:* variable, pond-specific input using algal bioassays
  (full amount = about 500 kg $CaCO_3$ ha^{-1} $week^{-1}$; also can use manures to supply inorganic C)
- *Light:* manage ponds to minimize inorganic turbidity
- *Records:* keep pond-specific input/yield records
  (eventually establish pond-specific fixed-input rates)

Algal Bioassay Fertilization Strategy (ABFS)

- *Benefits for rural farmers:*
  - allows *their ponds* to tell farmers what each pond's algal community needs (and doesn't need) to grow
    - maximizes yields while minimizes fertilizer inputs
    - reduces variability between ponds
  - enables farmers to eventually develop their own pond-specific fertilization rates
    - algal bioassays are easy to do with local materials
- *Benefits for aquaculture researchers:*
  - when fertilization is part of a research protocol, the ABFS:
    - standardizes fertilization on outcome instead of inputs
    - reduces within treatment variability

Stocking density analysis of two small indigenous species, punti *Puntius sophore* and dedhuwa *Esomus danricus* to improve sustainability of typical six-species large-carp culture systems in rural Nepal

Bailey A. Keeler*, James S. Diana, and Madhav Shrestha
School of Natural Resources and the Environment University of Michigan Ann Arbor MI, 48109
bailkee@umich.edu

Small indigenous species (SIS) have been added to polyculture ponds in Nepal and been shown to increase the economic and nutritional sustainability for farmers. However, there has been little research on determining an optimal stocking density of these SIS, the resulting production of large carp, and the availability of SIS for household consumption.

Based on surveys conducted while on site, currently farmers do not intentionally stock SIS as they see no benefit to increasing densities above those that enter the system naturally. This research will provide evidence to help fisheries managers better understand SIS potential and advise on optimal pond stocking strategies. Also, SIS have been found in ponds that have been sealed off from outside water sources and not intentionally stocked. This finding highlights their prevalence in the area and the ease with which farmers could intentionally stock them.

Figure 1: SIS Stocking Strategy
The overall goal of this research is to identify an optimal stocking density of SIS within a typical carp polyculture system without significant negative impact on water quality or large carp growth. The project explores the feasibility of adding Punti (Puntius sophore) and Deduwa (Esomus danricus) at various densities to a typical 6-species large carp culture in Nepal (Bighead, Silver, Common, Mrigal, Rohu, and Grass carp). These additions will allow farmers to more efficiently use their pond space, and will increase the economic, nutritional, and environmental sustainability of carp culture. We anticipate that the addition of SIS to this culture system will increase yield by about 10% without reducing carp production or negatively impacting water quality.

Twelve 200m^2 ponds were stocked (August 2013) using 3 treatments and a control (Figure 1). Large carp densities (Figure 2), feed composition, and fertilizer were chosen based on the 'typical' and most common practices in the area under the advice of Dr. Madhav Shrestha, a professor of aquaculture and President of Nepal Fisheries Society (NEFIS). SIS stocking densities were chosen based on a literature review of recommended carp densities, and are widely varied in order to clearly show differential impact(s) and better identify an optimal stocking density.

Figure 2: Large Carp Stocking Strategy
Water quality measurements are being taken taken weekly, diurnal oxygen measurements are taken bi-monthly to estimate primary productivity, and partial harvests are taken monthly to assess carp growth and SIS numbers. During the final harvest (January 2014), ponds will be drained and all fish identified, counted, and measured. Periphyton growth will also be estimated using ceramic tiles.

	Punti (Puntius Sophore)	Deduwa (Esmosus Danricus)
Ponds 6,3,4 (Control)	0/ha , 0/pond	0/ha , 0/pond
Ponds 10,8,2 (Treatment 1)	25,000/ha ,250/pond	25,000/ha ,250/pond
Ponds 12,11,5 (Treatment 2)	50,000/ha ,500/pond	50,000/ha , 500/pond
Ponds 9,7,1 (treatment 3)	75,000/ha ,750/pond	75,000/ha 750/pond

Figure 1: SIS Stocking Strategy

Surface Feeders (50%)			Column Feeders (20%)			Bottom Feeders (30%)		
Species	*%*	*#*	*Species*	*%*	*#*	*Species*	*%*	*#*
Silver	30%	90	Rohu	10%	30	Common	15%	45
Bighead	20%	60	Grass	10%	30	Mrigal	15%	45

Figure 2: Large Carp Stocking Strategy

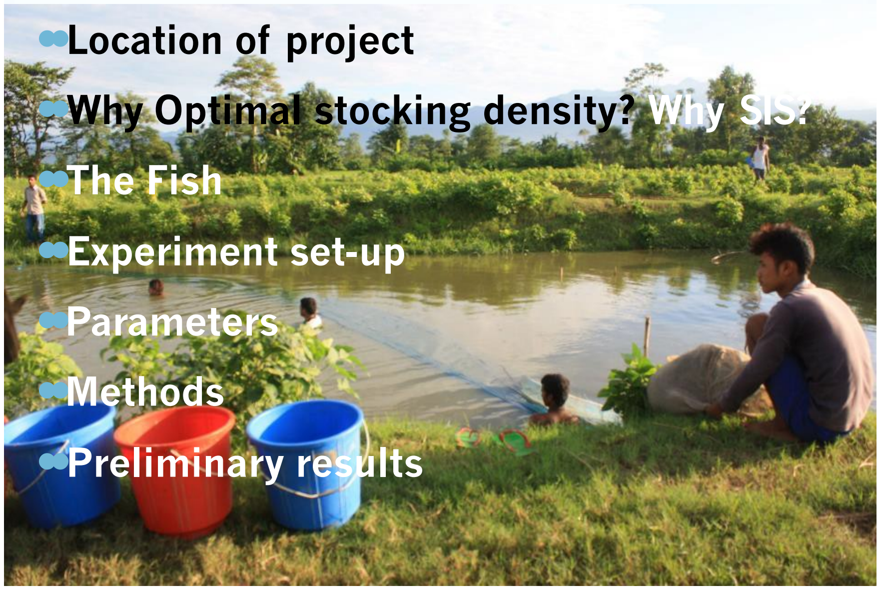
Optimal Stocking Density for Small Indigenous Species within a Large Carp Polyculture System in Rural Nepal

Bailey Keeler

Thesis Title:

Stocking Density Analysis of Two Small Indigenous Species, Punti (*Puntius sophore*) and Dedhuwa (*Esomus danricus*) to Improve Sustainability of Typical Six-Species Large-Carp Culture Systems in Rural Nepal

Overview



- Location of project
- Why Optimal stocking density? Why SIS?
- The Fish
- Experiment set-up
- Parameters
- Methods
- Preliminary results

Geography

Field Site

Kathar, Chitwan

Optimal Density

Both periphyton substrate use and SIS presence have been shown to be beneficial, but work has yet to be done to find an optimal stocking density of SIS. (Azim et al., 2002; Rai et al., 2008; Rai, 2012).

- Overall Goal: Find the maximum stocking density of SIS where neither large carp production nor water quality are negatively impacted. Evaluate the economic viability of intentionally stocking SIS.
- Methods:
  - Optimal Density: Evaluate 3 stocking densities compared to a control to narrow down an optimal stocking density range (25,000/ha, 50,000/ha, and 75,000/ha).
  - Economic evaluation: Surveys

Rational: why SIS?

- Environmental Sustainability
  - Efficient use of pond space.
  - Maintain desirable water quality while increasing production.
- Nutritional Value
  - SIS contain higher nutritional values (vitamin A, calcium, zinc, and iron) per gram than large carp.
  - Known to breed in culture ponds, so can be harvested throughout grow-out season and year.
- Economic Benefit
  - Can have species for household consumption and others for market sales.
  - Further diversify pond products for market.

The Fish

- Large Carp
  - Common (Cyprinus carpio)
  - Silver (Hypophthalmichthys molitrix)
  - Bighead (Hypophthalmichthys nobilis
  - Grass (Ctenopharyngodon idella)
  - Rohu (Labeo rohita)
  - Mrigal (Cirrhinus cirrhosus)






The Fish

- Small Indigenous Species (SIS)
  - Punti (Puntius sophore)
  - Dedhuwa (Esomus danricus)

Periphyton Substrate

- Rohu, Catla, and Common Carp are periphyton feeders.
  - Adding periphyton substrate to ponds will facilitate carp growth and increase carp production.
  - 4.52% of pond surface area.

Experiment Set-up

	Punti (Puntius sophore)	Dedhuwa (Esmosus danricus)
Control (0/ha)	0/pond	0/pond
T250 (25,000/ha)	250/pond	250/pond
T500 (50,000/ha)	500/pond	500/pond
T750 (75,000/ha)	750/pond	750/pond

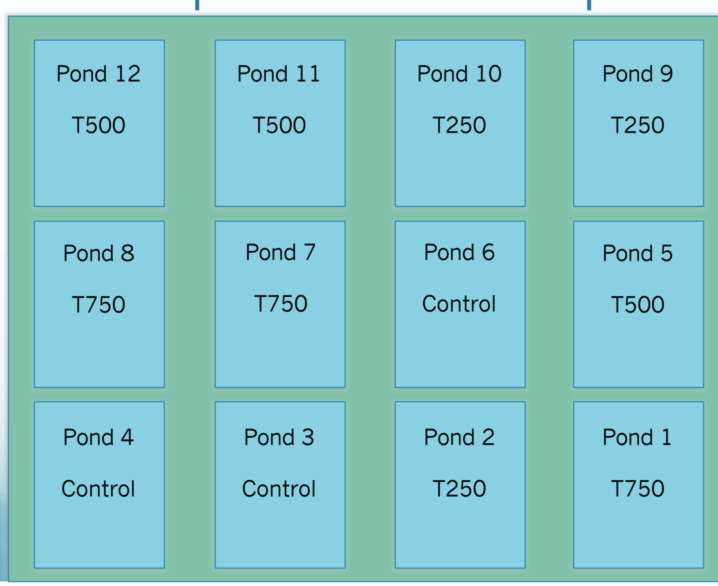
Figure 1: SIS Stocking Strategy

Surface Feeders (50%)			Column Feeders (20%)			Bottom Feeders (30%)		
Species	*%*	*#*	*Species*	*%*	*#*	*Species*	*%*	*#*
Silver	30%	90	Rohu	10%	30	Common	15%	45
Bighead	20%	60	Grass	10%	30	Mrigal	15%	45

Figure 2: Stocking Strategy

- **Feed**: Rice Bran and Mustard Oil Cake (50:50) 6 days/week at 3% body weight (estimated after monthly partial harvests).
- **Fertilize**: DAP (700g/pond) and Urea (950g/pond) once a week.

Experiment Set-up



Experiment Timeline

- Fish stocked in August 2013
- Grow-out period: August 2013 - January 2014 (5 months)
- Caveat: This grow-out period is later in the year than what is typical. Most ponds in Nepal are stocked in the spring (April or May), and then harvested in the fall.

Experimental Parameters

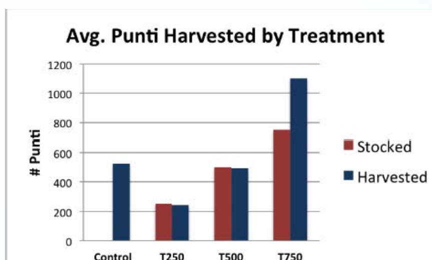
- Water Quality
  - Weekly: DO, pH, temperature, and Secchi disk depth.
  - Bi-Monthly: Diurnal DO measurements to estimate primary productivity
- Fish Production
  - Monthly: partial harvest of fish
    - Species, number, and weight.
- Periphyton Production
  - Estimated in August, 2013 and January, 2014
- Economic Evaluation
  - Surveys

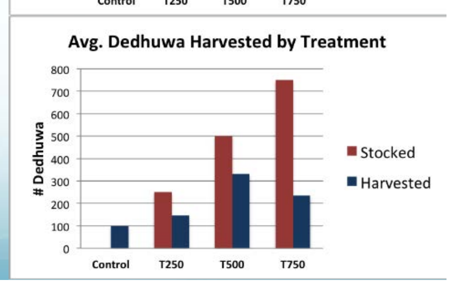
Periphyton Production Estimation

- Randomly chose one pond from each of the 4 treatments.
- Installed 3 tiles in each pond at 25, 50, and 75cm depths.
- Left tiles in ponds for 4-5 days to collect periphyton.
- Pull tiles and scrape periphyton off.
- Strain water out of samples.
- Dry samples in oven
- Take dry weight.

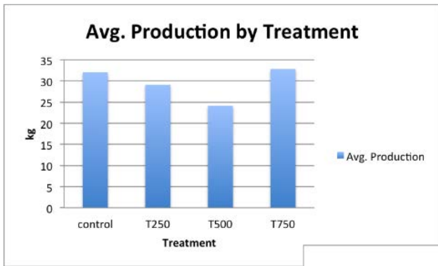
Preliminary Results

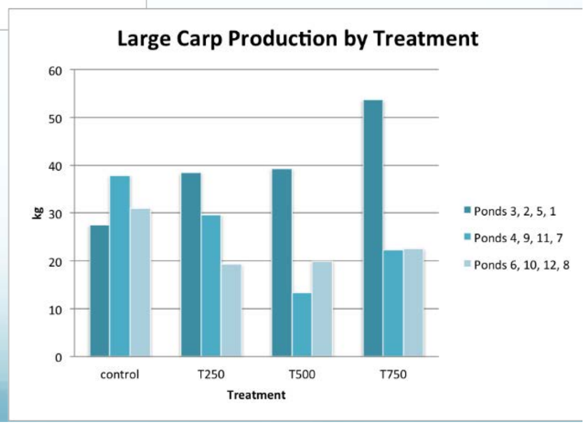
- **Average SIS per treatment after final harvest:**
  - *Control (0/pond stocked):*
    - Punti: 525
    - Dedhuwa: 101
  - *Treatment 1 (250/pond stocked):*
    - Punti: 244
    - Dedhuwa:147
  - *Treatment 2 (500/pond stocked):*
    - Punti: 492
    - Dedhuwa: 331
  - *Treatment 3 (750/pond stocked:*
    - Punti: 1100
    - Dedhuwa: 234



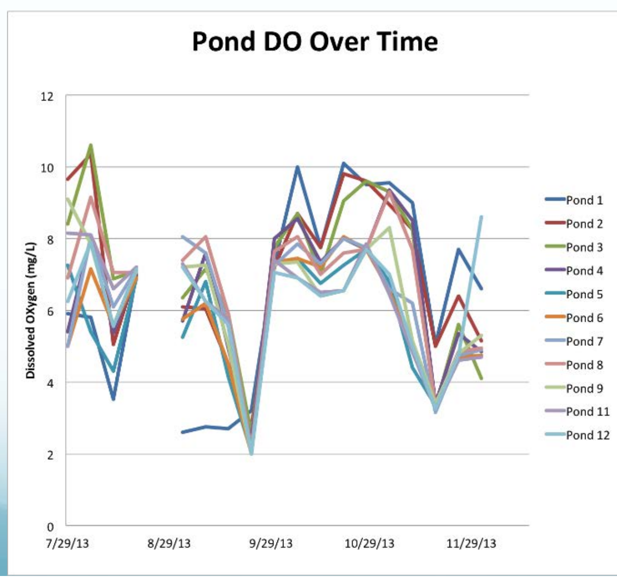


Large Carp Production

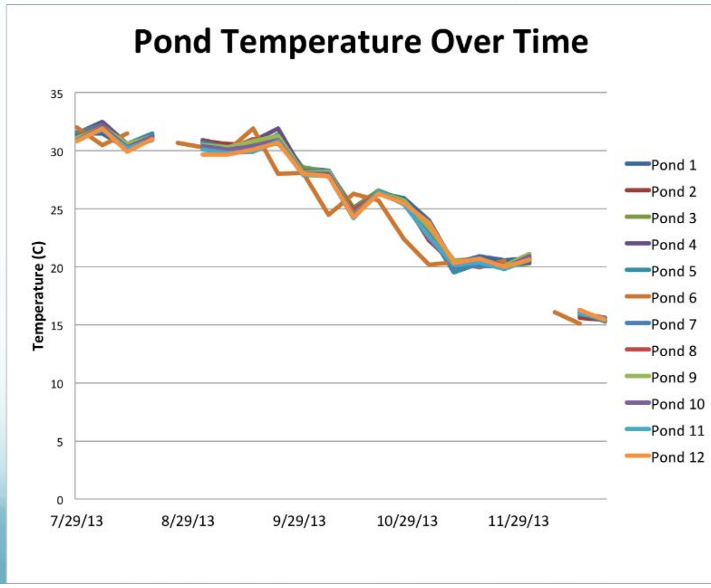




Water Quality



Water Quality



Economic Evaluation

- Method: Interviews
  - Individual farmers, the Kathar Women's Aquaculture Cooperative, a private hatchery, a government hatchery, and a vendor at a local fish market in Bharatpur, Chitwan.
- General results of interviews:
  - Farmers do not currently purposefully stock SIS.
  - Hatcheries do not currently produce SIS
  - People like to eat SIS
  - Large Carp have higher demand at markets
  - People like to produce fish to give/feed to family & friends at religious festivals and other community celebrations.
    - ~80% of fish are consumed at home.
    - ~20% sold to neighbors
  - Large carp purchased at hatchery are seen as an investment and efforts are concentrated on them over SIS.
  - SIS enter ponds through canal connections naturally. Punti are noticed more.

Special Thanks To:

Aquafish/CRSP

The University of Michigan's School of Natural Resources and Rackham Graduate School

Special Thanks (cont)

The Agriculture and Forestry University of Nepal

- Rampur, Chitwan

- Professor Jim Diana -Advisor
- Professor Madhav K Shrestha -Advisor
- Professor Mike Wiley –Thesis Committee Chair
- M. S. Hussain – Field Assistant

Citations

Kadir, A., R.S. Kundu, A. Milstein, and M.A. Wahab. 2006. Effects of silver carp and small indigenous species on pond ecology and carp polycultures in Bangladesh, Aquaculture 261:1065-1076.

Rai, S. 2012. Project Completion Report: Improvement of women's livelihoods, income and nutrition through Carp-SIS polyculture in Terai, Nepal. Institute of Agriculture and Animal Science, Chitwan, Nepal.

Rai, S., Y. Yi, M.A. Wahab, A. Bart, and J.S. Diana. 2008. Comparison of rice straw and bamboo sticks substrates in periphyton-based carp polyculture systems. Aquaculture Research 39:464-473.

Roos, N., M.A. Wahab, M.A.R. Hossain, and S.H. Thilsted. 2007. Linking human nutrition and fisheries: incorporating micro-nutrient dense, small indigenous fish species in carp polyculture in Bangladesh. Food and Nutrition Bulletin.

Wahab, M.A., M.A. Alim, and A. Milstein. 2003. Effects of adding the small fish Punti (*Puntius Sophore* Hamilton) and/or Mola (*Amblypharyngodon Mola* Hamilton) to a polyculture of large carp. Aquaculture Research 2003:149-63.

Environmentall friendly cage culture: A successful model of small-scale aquaculture for livelihood of fishing communities in Nepal

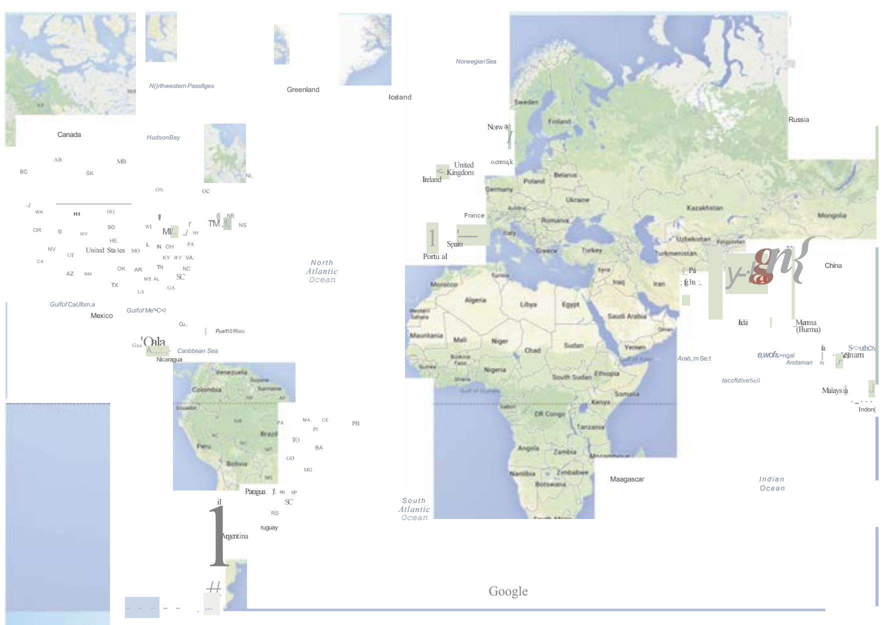
Jay D. Bista*, Madhav K. Shrestha, Surendra Prasad, and Narayan P. Pandit
Fisheries Research Centre, Pokhara, Kaski, Nepal, P. O. Box 274 jdbista@gmail.com

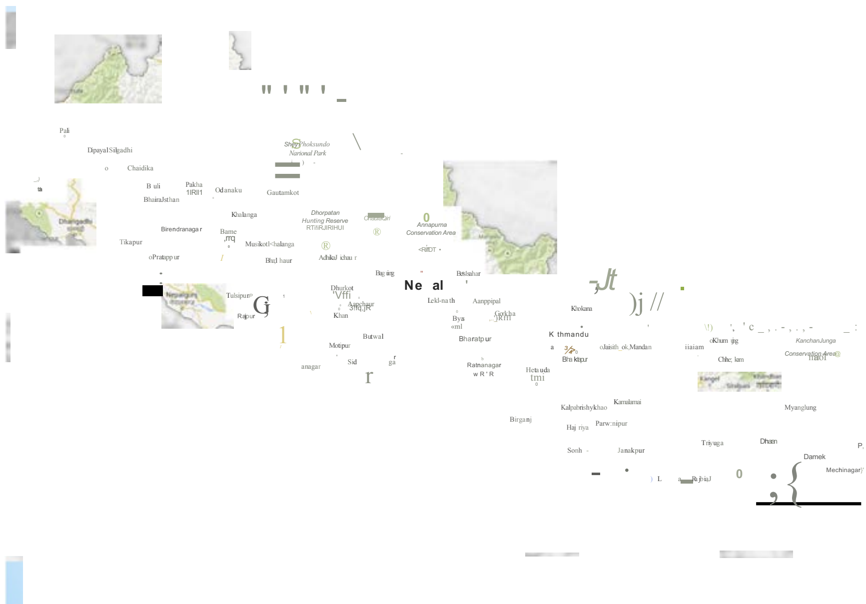
This manuscript presents the current status and future scope of environment friendly small-scale cage fish culture in Nepal, which is practiced mainly with plankton feeder fish, such as bighead carp (*Aristichthys nobilis*) and silver carp (*Hypopthalmichthys molitrix*), in floating cages in natural lakes and reservoirs. The most important feature of this cage culture is absence of external feed to cultivate plankton feeder fish, with the fish subsisting on plankton available naturally in water column. It is popular among the traditional 300 families of fisher community, known as Jalari or Pode, living around lakes of Pokhara valley, and among the families displaced by the construction of hydropower dam in Kulekhani, Makwanpur. In these water bodies, there are over 2,400 cages of approximately 117,350 m^3 with estimated fish production of 250 mt/year. Such a cage fish culture has been in operation since three to four decades in Pokhara and two decades in Kulekhani. The productivity is varied from 1.6 to 4.3 kg/m^3 and contribution to national fish production is about 0.57%. However, its social impact is incomparable as the cage fish culture sustains family job and provides income to buy food and clothing, and to support the education of their children. The cage fish culture in natural lakes in Pokhara valley and Kulekhani reservoir has been appreciated as one of the successful farming model, contributing to mainstreaming the deprived and displaced fisher communities. Since then, the technique has been spread across the country with varying degree of adaptation to local conditions. Inclusion of grass carp (*Ctenopharyngodon idella*), which is famous for utilizing aquatic plants and is a fast grower as well as fetches relatively high market price, is more popular. Recent trend of its adoption suggests that cage culture with grass carp is becoming popular among farmers and possess further adoption potentialities. Small-scale cage fish farming has contributed remarkably to the improvement of living standards of the people, ensuring food security, creating additional jobs and augmenting incomes. This practice is recommended for expansion in other lakes and incoming reservoirs in the country, based on the inclusive doctrine of equal opportunity and sustainable development.

Environmentally Friendly Cage Culture: A successful model of small scale aquaculture for livelihood of fishing communities in Nepal

Jay D. Bista, Tek B. Gurung, Surendra Prasad, Madhav K. Shrestha, Narayan P. Pandit, Md Akbal Husen and Agni Nepal

Fisheries Research Center, Pokhara Nepal






Pokhara

Water Resources




Lakes




Reservoirs

Cage fish culture

- Cage fish culture adopted in Nepal during1975-1980.
- However, cage culture of planktivore carps retains its importance in socio-economically disadvantaged areas.
- Currently, this technique has spread across the country with varying degree of adaptation to local conditions.
- This is the most viable and low cost small scale fresh water aquaculture technology for wetland dependents in Nepal.
- The extensive type of cage culture is one of the eco-friendly intervention.

Significance of cage fish culture practices in Nepal

- Provide alternative livelihood to nearly 45% families of displaced communities in Kulekhani reservoir
- Contribute about 75 % of the annual income of Jalari community of Pokhara
- With the adoption of cage aquaculture the living standard of Jalari community has improved considerably over past three decades.
- Improve women empowerment.
- Women of Jalari and displaced community actively take part in all activities from attending meeting, workshop to fingerling transportation, fish stocking, harvesting and marketing.

Types of cage

- Bamboo cage
- Wooden cage
- Iron wire mesh cage
- Iron frame and netlon cage
- Bamboo frame nylon net cage

Management of Cage Fish Culture

Management practices of cage fish culture in lakes and reservoir

- Cage material: Nylon or polyethylene knot-less floating type
- Cage size: 50 m^3 (5m x 5m x 2m) in general
- Cage frame: Bamboo structure act as frame and float

- Stocking Density: depends on the productivity of lakes and reservoir (10-15 fish/m^3)
- Feeding: No feeding for planktivorous fish but Aquatic macrophytes for herbivorous (Grass carp)
- Growing period: Depends on the productivity of lakes and reservoir (14 to 16 months from rearing to harvesting)
- Harvesting: Partial/Complete



Major fish species for cage fish culture ...

- Silver carp and Bighead carp
  - Feed on naturally available plankton
  - Suitable for extensive type cage fish culture
  - Do not breed in lake and reservoir
- Grass carp
  - Suitable in area with aquatic macrophytes


Cage culture in flood plain wetland

Water quality measurement

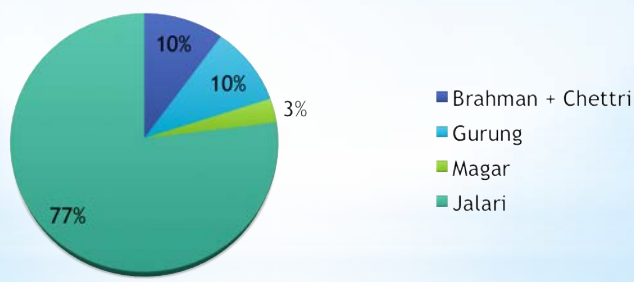
Cages handover to woman group

Interaction and training

Cage Installation in Lake

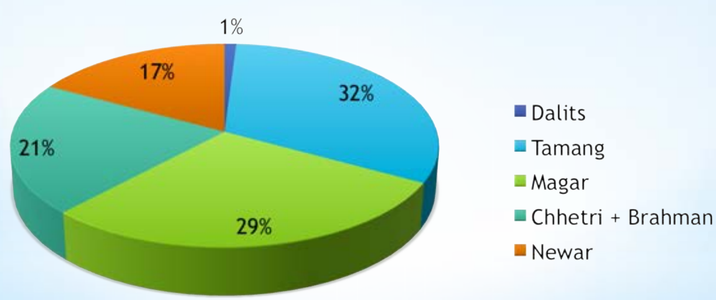
Communities involved in cage fish culture

Pokhara valley lakes communities



Lakes of Pokhara valley = 180

Kulekhani reserviour communities



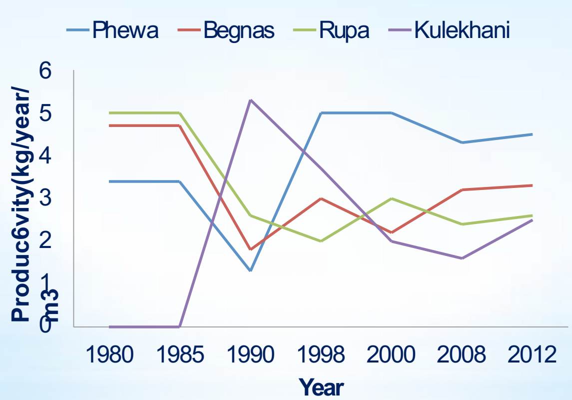
Kulekhani Reservoir= 239

Production and productivity

Table 1. Present status of private sector cage fish culture in Lakes of Pokhara valley and Kulekhani Reservoir, 2008

Location	No. of farmer	No. of cage	Volume (m^3)	Estimated production (mt)
Phewa	90	600	24000	103.2
Begnas	37	120	6000	19.2
Rupa	53	117	5850	14.0
Kulekhani	239	1630	81500	114.2
Total	419	2467	117350	250.6

Productivity trend



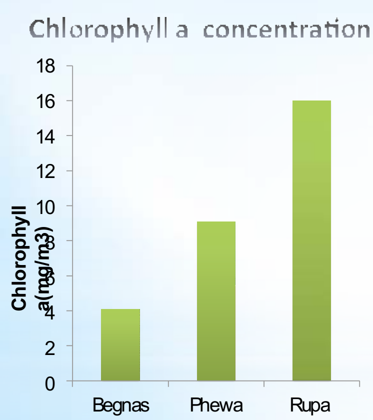
Environmental impact of cage fish culture

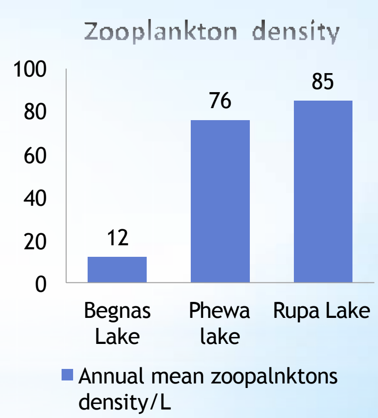
Monthly Lake water sampling and analysis

Physico-chemical variables of Pokhara valley lakes

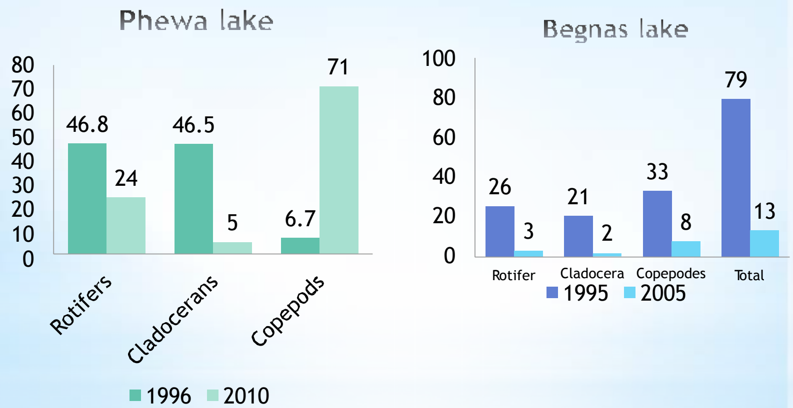
Physicochemical v)	Begnas	Phewa	Rupa
Water temperature(°C)	22.3±4.5	22.7±3.9	22.2±4.8
Dissolved oxygen (mg/L)	5.8±3.0	4.9± 2.9	8.1±2.2
pH	6.7	7.0	6.9
Ammonium (NH_{4+}) nitrogen (mg/L)	0.019±0.036	0.004±0.009	0.010±0.016
Nitrate(NO_3)+ Nitrite(NO_2) nitrogen (mg/ L)	0.031±0.066	0.022±0.039	0.035±0.082
Soluble reacXve phosphorus Po_4P (mg/ L)	0.002±0.002	0.003±0.011	0.002±0.002
Total phosphorus (mg/ L)	0.006±0.005	0.006±0.012	0.011±0.012
Chlorophyll $_a$ (mg/m^3)	**4.1±3.8**	**9.1±9.2**	**16.0±12.1**
Transparency (m)	2.1±0.6	2.3±0.7	0.7±0.3

Present status of plankton in lakes of Pokhara valley





Changes in Zooplankton composition



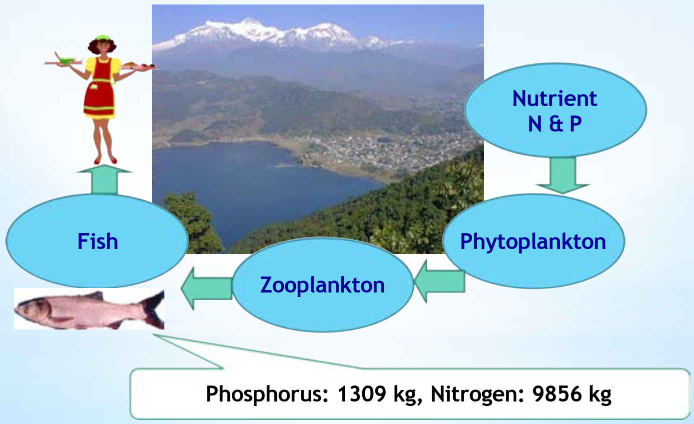
Source: Husen et al.,2012(*Asian Fisheries Science 25 (2012):218-231)*.

Es6mated removal of nitrogen and phosphorous from cage culture (2012).

Particulars	Fish yield (Mt.)	Phosphorous removed [1] (kg/year)	Nitrogen removed[2] (kg/year)
Lake catch	126	428.4	3225.6
Enclosure	9	30.6	230.4
Cage culture	250	850.0	6400
Total[3]	385	1309	9856

[1]Assuming P content of fish=0.34% of harvested fish
[2]Assuming N content of fish=2.56% of harvested fish
[3]Assumeing P and N addition with fry/fingerlings is not significant

Nutrient and organic matter removal by plankton feeding fish



Fish harvesting

Social Impact on fisher community

Cost-benefit of extensive cage culture (year 2010)

1 US$=100 NRs

Cost variable for 1 cage (50 m3)	Value in NRs.
Initial total cost of cage preparations	15000.0
Annual cost	
A. fixed cost	3000.0
B. Variable cost	
Fish fingerlings	750.0
C. Total Production cost (A+B)	3750.0
D. Total fish production(kg)	150.0
E. Price of fish/kg	300.0
F. Gross revenue (D×E)	45000.0
G. Net profit or Return (F-C)	**41250**
Net profit in US$	410 US$

Socio demographic profile

Indicator	Lakes of Pokhara valley		
	1980	2005	2011
Total HH no	85	130	132
Family size no	4.3	5.1	6.0
Literate %	17.2	46	65.0
High School %	2.1	3.3	6.7
University %	0	2	3.3
Housing land%	62.7	81.3	100
Concrete and tin roof house%	73.0	100	100
Access to portable water%	8.0	100	100
Access to public health service%	10.2	97.6	100
Use of toilet%	0.0	21.8	98.9
Use of cooking gas%	3.4	94.6	97.8
Radio/television/mobile%	5.8	83.2	100
Automobile %	0.0	10.2	6.7
Contribution to HH income (%)	25%	75%	75%

Education	
Literate	65%
High school	15%
University	3.5%

Male: Female
10:7

Fisher children heading to school

Conclusion and Recommendation

- Cage fish culture became promising intervention to improve the livelihood of resource deprived and displaced communities.
- Cage fish farming could be one of the best options for livelihood enhancement to local displaced communities by hydropower and irrigation projects.
- New approaches of cage fish culture should be promoted for improving production and profitability to farmers.
- Development of community level fish seed rearing and supply network is essential to sustain and enhance the productivity of cage fish culture in hill region of the country.

Funding for this travel was provided by the

AquaFish Innovation Lab

USAID FROM THE AMERICAN PEOPLE

OSU Oregon State

AquaFish Innovation Lab

The AquaFish Innovation Lab is supported in part by United States Agency for International Development (USAID) Cooperative Agreement No. EPP-A-00-06-00012-00 and by contributions from participating institutions.

Thanks for your Attention

Evaluation of the functioning of farm dams in catchments in the Stellenbosch Area of South Africa

Khalid Salie, Claude E. Boyd, Neelia du Buisson, Bernard Snyman
Division of Aquaculture, Stellenbosch University, Matieland, 7602
Republic of South Africa
ks1@sun.ac.za

The Western Cape Province in South Africa has a Mediterranean climate with warm, dry summers and wet, cold winters. Commercial farmers of agricultural crops such as grapes, citrus, olives and deciduous fruit are dependent on summer irrigation to maintain water supply for quality produce. However, excessive declines in water level of farm dams caused by withdrawal for irrigation could negatively impact aquaculture in multipurpose water impoundments. Furthermore, aquaculture activities in such impoundments might increase plankton production and the planktonic particles could clog irrigation systems. Changes in water quality caused by aquaculture might also negatively impact use of water for domestic purposes.

The study described events associated with integrated aqua-agriculture systems and explored how small impoundment (farm dams of 300 000 m^3 to 1 500 000 m^3 in volume) mitigate these effects increasing water supply in rural and peri-urban areas. Construction of small impoundments would convert land to aquatic habitat, but overall, the associated effort would probably increase local ecosystem complexity and be beneficial to expanding biodiversity.

The newly-established aquatic habitat gave rise to wetland and marshy areas and could improve and maintain ecological integrity of the lower reaches of the catchment. The study also placed aquaculture in perspective to wider nutrient loading on water resources via agriculture in pesticides and fertilizers.

Aquaculture product development and marketing innovations for Sustainable Small-Scale Aquaculture in Kenya

Kwamena Quagrainie, Charles Ngugi, Judy Amadiva and Sammy K. Macaria*
State Department of Fisheries, Directorate of Aquaculture Development, Kenya
sammacharia@yahoo.co.uk

Aquaculture production in Kenya stands at 48,770 MT, which is about 25% of the total fish production with aquaculture having experienced unprecedented growths of over 300% in the last three years.

AquaFish support in Kenya has big impact in the aquaculture growth in the country and the Kenya Government recognizes aquaculture as one of the key drivers of food security, employment creation and economic growth, and a major instrument for bringing gender parity in the economic sector. Despite the fast aquaculture global growth, aquaculture development in Kenya still faces a lot of challenges; these include weak aquaculture promotion programs and weak marketing systems.

A pilot project in three regions: Western, Rift Valley, and Central in Kenya was started in September 2011 through AquaFish CRSP to enhance profitability of small scale aquaculture operations in the rural areas through adoption of selected aquaculture best management practices (BMPs). The broad objectives of the project are: (1) scaling up innovations from previous ACRSP and AquaFish project successes and (2) accelerating BMP adoption rates in Kenya. The specific objectives of the project are to: (a) provide information on BMP adoption in Kenya, (b) quantify adoption of BMPs, (c) quantify production and financial efficiencies for BMPs adopters versus non-adopters and (d) assess economic benefits of adopting BMPs. Adoptions of the BMPs by some farmers have been very good and they have come up with marketing innovations for aquaculture products.

Farmers have formed groups/clusters and operate under one umbrella organ called the Aquacultural Association of Kenya (AAK). Several such groups of farmers are in operation and include Shama Fish Farmers Group in Central Kenya and Lurambi Farmers Cluster in Western Kenya.

Farmers who have adopted the BMPs formed production clusters that have developed synchronized production plans and established a strong marketing strategy. The innovation involves aquaculture product development, processing and value addition, market development and market outlets for final aquaculture products. The market outlets are strategically located and are operated by vendors who are directly linked to the farmers and to fish buyers and consumers. The farmers have seen their earnings from aquaculture increased by 150% and consumers of aquaculture products rise by 200%.

Aquaculture Product Development And Marketing Innovations For Sustainable Small-scale Aquaculture In Kenya

Sammy K. Macaria* Kwamena Quagrainie, Charles Ngugi and Judy Amadiva
Ministry of Agriculture, Livestock and Fisheries
State Department of Fisheries
Directorate of Aquaculture Development
Kenya

AQUAFISH INNOVATION LAB

PURDUE EXTENSION Making a Difference

HARAMBEE

Introduction

- Aquaculture production in Kenya stands at 48,770 MT, which is about 25% of the total fish production with aquaculture having experienced unprecedented growths of over 300% in the last three years.

Introduction…

- AquaFish support in Kenya has big impact in the aquaculture growth in the country.
- The Kenya Government recognizes aquaculture as one of the key drivers of food security, employment creation and economic growth, and a major instrument for bringing gender parity in the economic sector.

Introduction…

- Despite the fast aquaculture global growth, aquaculture development in Kenya still faces a lot of challenges;
  - **Weak aquaculture promotion programs and**
  - **Weak marketing systems**

The BMPs Project in Kenya

- A pilot project in three regions:
- Western, Rift Valley, and Central in Kenya, was started in September 2011 through AquaFish CRSP to enhance profitability of small scale aquaculture operations in the rural areas through adoption of selected aquaculture best management practices (BMPs).

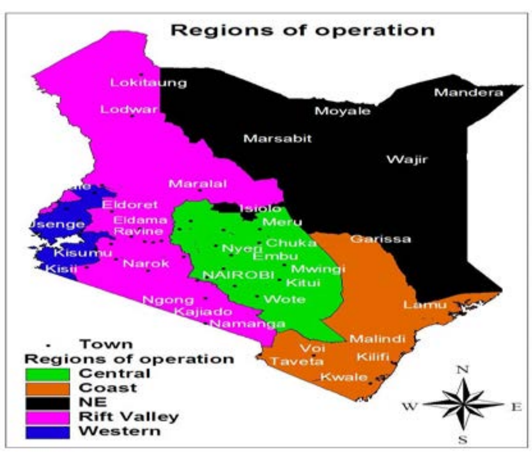
Project Aim

- Its aim was to promote adoption of selected aquaculture BMPs in tilapia production.
  - Use of formulated floating pelleted feed;
  - Reuse of pond water

BMPs Objectives

- The broad objectives of the project were:
- (1) scaling up innovations from previous ACRSP and AquaFish project successes and
- (2) accelerating BMP adoption rates in Kenya. The specific objectives of the project were to:
  - (a) provide information on BMP adoption in Kenya,
  - (b) quantify adoption of BMPs,
  - (c) quantify production and financial efficiencies for BMPs adopters versus non-adopters and
  - (d) assess economic benefits of adopting BMPs

Study Area



Project Activities/Methodology

Promote adoption of the BMPs through;

i. simultaneous deployment of series of workshops at the regional level'
ii. extension follow-ups,
iii. demonstrations of the BMPs on selected farms,
iv. and promoting lateral diffusion through farmer-to-farmer extension activities.

Farmers Workshops




On farm demonstrations



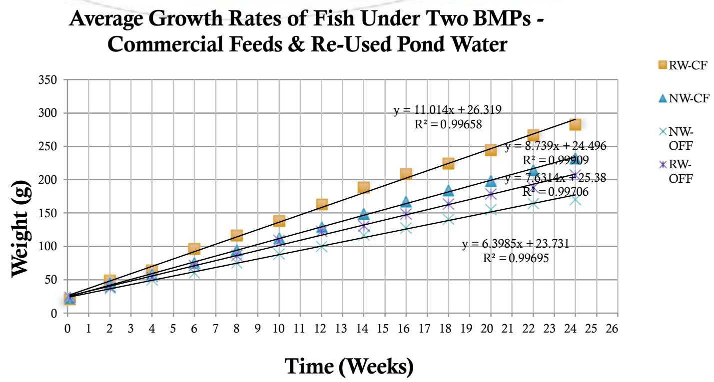


Stocking size 10±3g

- Fish were stocked at 3 fish/m2
- Pond size 100-300 m2
- Production period- 6 months

Farmer-to-farmer extension activities


Results:



Aquaculture Products Development and Marketing Innovations

- Adoptions of the BMPs by some farmers have been very good and have led to increased farmed fish production.
- Farmers have formed groups/clusters and operate under one umbrella organ called the Aquacultural Association of Kenya (AAK).
- Several such groups of farmers are in operation and include Shama Fish Farmers Group in Central Kenya and Lurambi Farmers Cluster in Western Kenya.
- To ensure sustained fish supply, farmers have formed production clusters that have synchronized production plans and established a strong marketing strategy

Innovation…

- The innovation involves aquaculture product development, processing and value addition, market development and market outlets for final aquaculture products.
- Farmers through their clusters develop synchronized production plans, harvesting is done systematically to enable sustainable supply of fish to the market outlets.
- At the market outlet fish undergo value addition, product diversification and product branding.
- The market outlets are strategically located and are operated by vendors who are directly linked to the farmers and to fish buyers and consumers.

Products

Product Branding

Products storage

Product Marketing

Challenges

- High costs
  - Fish collection equipment-cooler containers
  - Fish storage equipment at the marketing outlets
- Competitiveness in finding strategic business locations

Conclusion

- The motivating factor in commercial fish farming is the income from fish sales realized only through strong marketing strategy.
- Farmers are determined to go all way to get their fish to the market and highly appreciate the marketing innovation.

Funding for this research was provided by the

AQUAFISH INNOVATION LAB

USAID FROM THE AMERICAN PEOPLE — OSU Oregon State University — AQUAFISH INNOVATION LAB

The AquaFish Innovation Lab is supported in part by United States Agency for International Development (USAID) Cooperative Agreement No. EPP-A-00-06-00012-00 and by contributions from participating institutions.

Thank you

Low cost production systems for tropical gar *Atractosteus tropicus*

Wilfrido Contreras-Sanchez*, Alejandro Mcdonal-Vera, Ulises Hernández-Vidal, and Sergio Hernandez-Garcia
Laboratorio de Acuacultura, Universidad Juarez Autonoma de Tabasco. Carretera Villahermosa-Cárdenas km 0.5, Entronque Bosques de Saloya, CP 86039 Villahermosa, Tabasco, México. contrerw@hotmail.com

The evaluation of growth performance of the tropical gar, *Atractosteus tropicus*, in different culture conditions has become a priority for new research in aquaculture in southeastern Mexico. During the last years there has been an increasing demand for native species culture in the regional market. A system that is becoming popular in rural areas consists of plastic or PVC circular tanks. To evaluate grow-out of gars, data were recorded from rural facilities located in the biosphere reserve "Pantanos de Centla" in Tabasco, Mexico. Facilities were based on a system including 9m-diameter PVC-lined circular ponds. Two thousand gar fry were stocked in each pond at the initial length of 11.06 cm and weight of 6.34 g. Commercial trout pellets were offered according to fry and juvenile size from 1.5 to 5.5 mm particles. In order to avoid cannibalistic behavior, fishes were classified by size at different times and water quality was maintained by pumping clean water from the river or water reservoirs. Fish weight and length were recorded monthly. Results indicate that tropical gars in this system grow faster than in traditional earthen-ponds and reach marketable size of 41.6 cm and 526.2 g in about 7 months of culture (fig. 1). Future experiments related with water quality and fish density will be necessary to determine profitable culture condition.

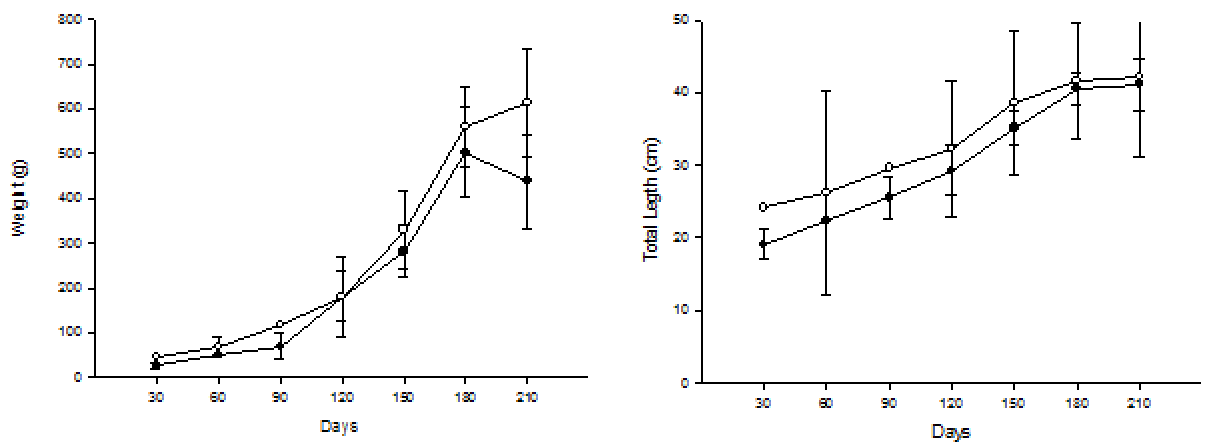


Figure 1. Average growth in weight (A) and Total Length (B) of tropical gar juveniles.

LOW COST PRODUCTION SYSTEMS FOR TROPICAL GAR
Atractosteus tropicus

Wilfrido M. Contreras-Sánchez[1], Ulises Hernández-Vidal[1], Alejandro Mcdonal-Vera, Sergio Hernández –García

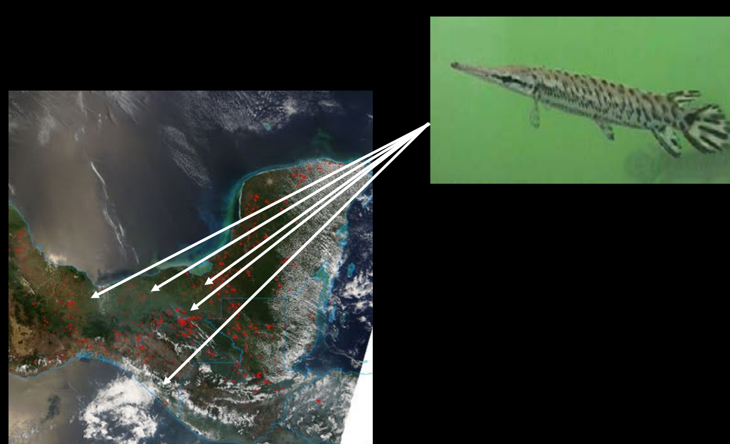
Laboratorio de Acuicultura Tropical DACBiol, UJAT

Project funded by

The tropical gar inhabits rivers, lagoons and wetlands.
The reproduction coincides with the peaks of the flooding season

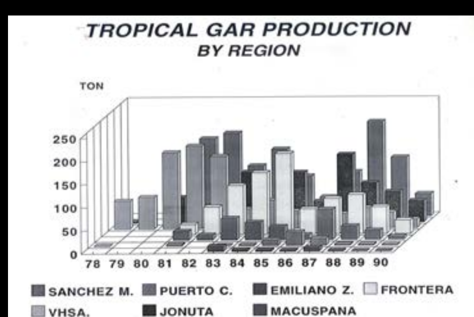
Distribution:
Central America: Southestarn Mexico, Guatemala, Nicaragua, El Salvador and Costa Rica

• Mexico: Veracruz, Tabasco, Campeche and Chiapas



• Value:
Ecological
Economic
Cultural

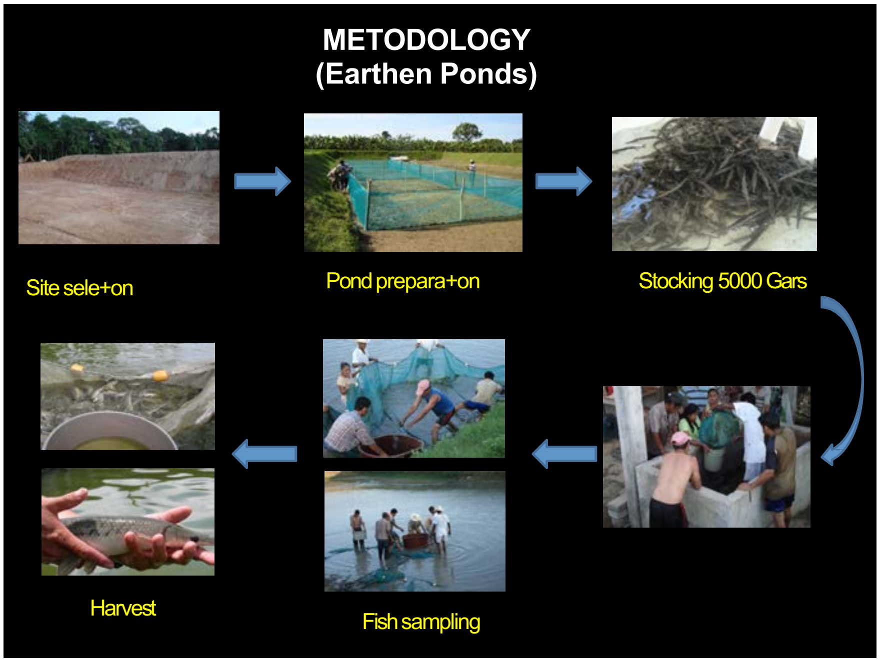
• Status of populations

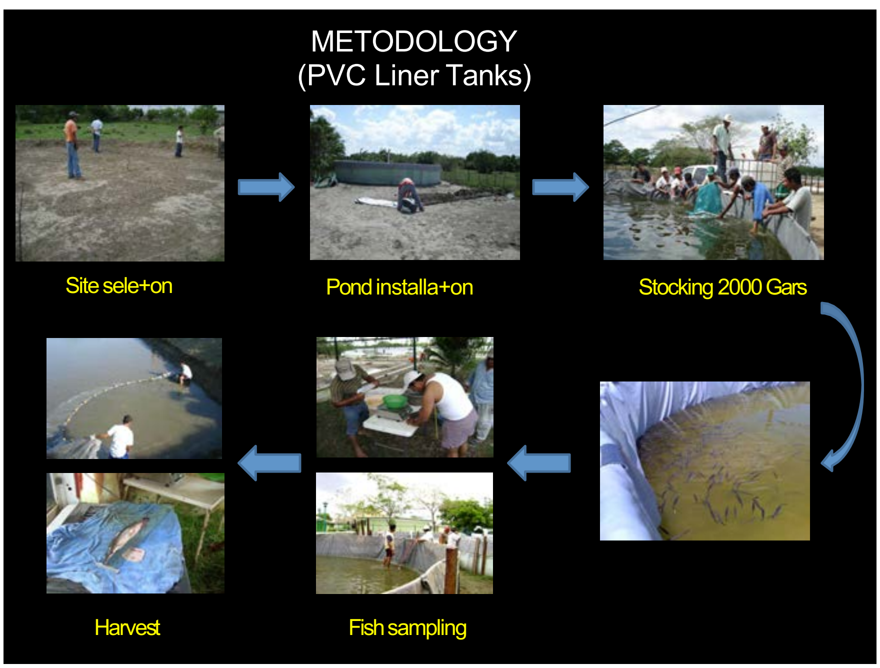


OBJECTIVE

TO ASSESS THE FEASIBILITY OF GAR CULTURE IN EARTHEN & GEOMEMBRANE PONDS

Farm localiza+on


METODOLOGY
(Earthen Ponds)
Site sele+on
Pond prepara+on
Stocking 5000 Gars
Harvest
Fish sampling


METODOLOGY
(PVC Liner Tanks)
Site sele+on
Pond installa+on
Stocking 2000 Gars
Harvest
Fish sampling

Tropical gar culture features

- Two earthen ponds (w/mosquito mesh hapa 3 months) (≈ 500 m^2).
- Three 9 meter diameter PVC lined tanks in each community (≈ 76 m^3), bird net protection.

- Water from Grijalva River, no water exchange. Refilled when needed.
- Water from Usumacinta River, 100% water exchange twice a week.

- Feeding: 3 times/day trout floating pellets (1.5-5.5 mm) to satiation.
- Feeding: 3 times/day trout floating pellets (1.5-5.5 mm) to satiation.

- Stocking 5000 Gars: 11.06 cm LT & 6.34 g (5 fish/m^2)
- Stocking 2000 Gars: 11.06 cm LT & 6.34 g (26 fish/m^3)

Tropical gar culture features

(in earthen ponds only)

- *Ini$al growth period*: 3 months (in hapas)

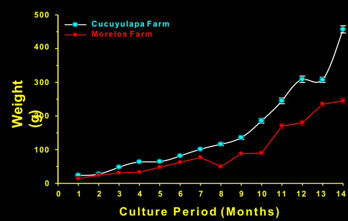
- Juvenile size separa+on adjustment during the period to avoid cannibalism (30-45 days)

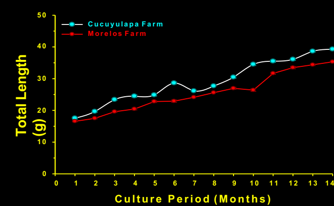
(in both systems)

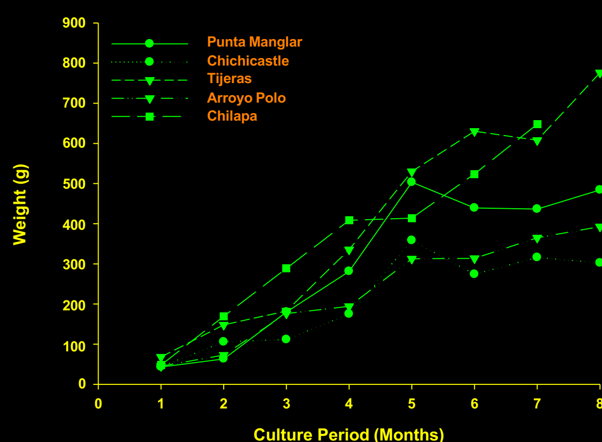
- *Grow-out* period: 7-8 months in PVC tanks and 11 months in earthen ponds;

- Data collection each month (weight and total length)

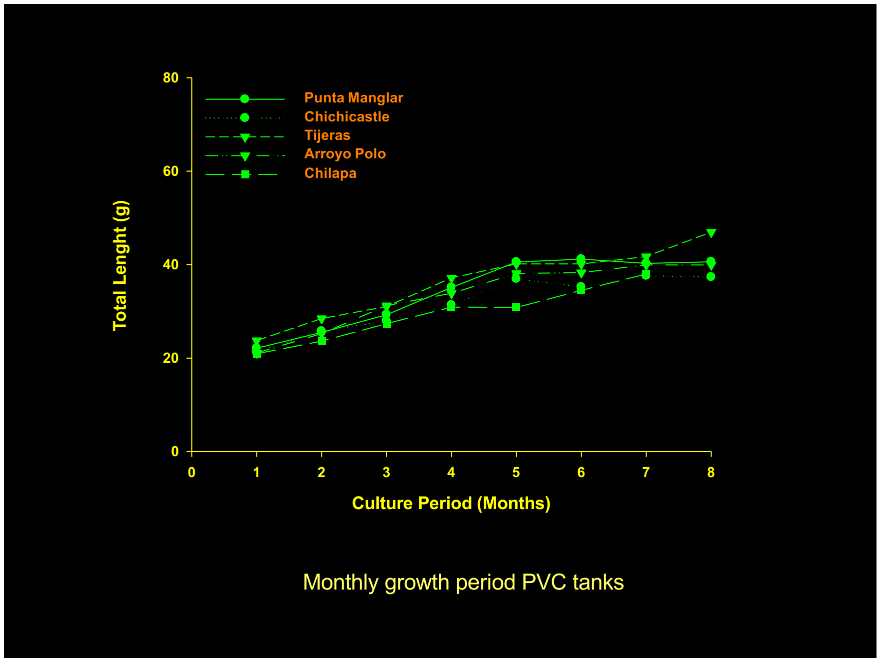
Monthly growth in earthen ponds

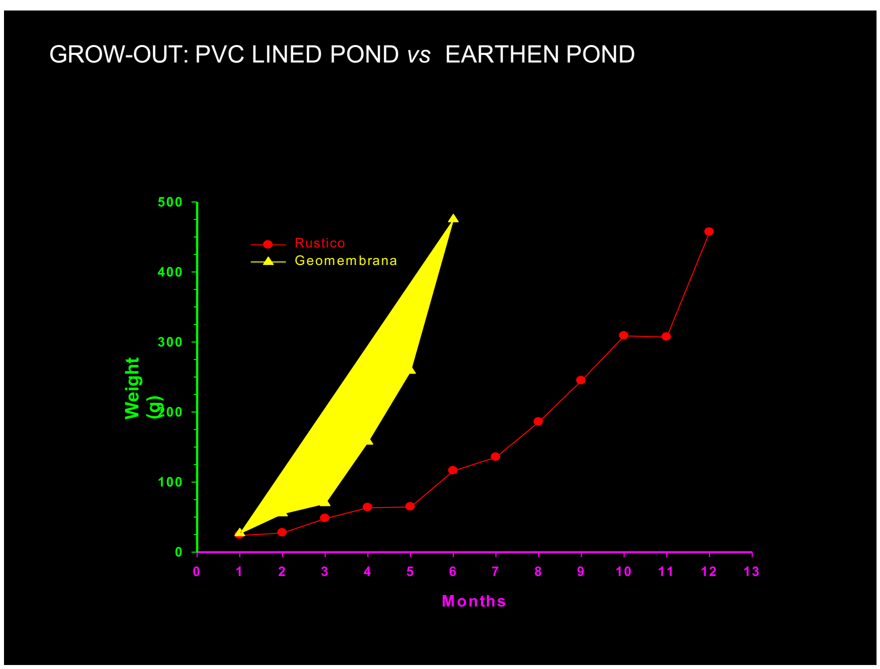






Monthly growth period PVC tanks


Total Lenght (g)
80
60
40
20
0
Punta Manglar
Chichicastle
Tijeras
Arroyo Polo
Chilapa
0
1
2
3
4
5
6
7
8
Culture Period (Months)
Monthly growth period PVC tanks


GROW-OUT: PVC LINED POND vs EARTHEN POND
Weight (g)
500
400
300
200
100
0
Rustico
Geomembrana
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Months

Growth Data from tropical gar in earthen pond culture

Farm	*Initial growth*				
	Initial Weight (g)	Initial length (cm)	Final weight (g)	Final length (cm)	Survival (%)
Cucuyulapa	6.0	11.0	24.2	17.5	43
Morelos	6.0	11.0	14.5	16.5	65

Farm	Final weight (g)	Total Harvest (kg)	Survival (%)	DGR g/day
Cucuyulapa	457.0	1691	74	1.27
Morelos	244.8	869	71	0.68

32-46 % Total

Growth Data from tropical gar PVC-lined tank culture

Farm	Average Weight (g)	Total Harvest (kg)	Survival (%)	DGR g/day
Punta Manglar	504	796	79	2.1
Chichicastle	453	652	72	1.8
Tijeras	555	688	62	2.3
Arroyo Polo	525	787	75	2.1

EXPENSES

EXPENSES		USD	USD	%
Main imputs		EARTHEN POND	PV C TANK S	
Gar Fry		2,083.33	2500.00	30--24
Commercial trout diet		2875.00	5208.00	41--50
Lime & PrevenXve chemicals		127.08	--	2
Other		225.00	--	3
		5310.42	7708.00	
Farm AcXviXes				
Labor		940.00	1750.00	14--17
Pond maintenance		30.00	30.00	0.4
		970.00	1780.00	5
Energy and Farm Use				
Fuel		156.92	300.00	3.0
Electricity		150.00	350.00	2.0
FaciliXes depreciaXon		316.67	400.00	5--4
		623.58	1050.00	
Total expenses		$6,904.00	$10,538.00	100 %

PROFITS

	EARTHEN PONDS USD	PVC TANKS USD
TOTAL INCOME	$8,420.00	$11,945.00
EXPENSES	$6,904.00	$10,538.00
REVENUE	$1,516.00	$1,407.00

POND COST (UNIT)

EARTHEN	PVC
$4,167 USD	$3,333 USD

CONCLUSIONS AND RECOMMENDATIONS

A. tropicus achieves marketable size (>500 g) in seven months of culture period.

A required activity is to separate the fish by size to avoid cannibalism

Recomended to stock bigger size in earthen ponds.

PVC tanks provide better revenues than earthen ponds for Tropical gar aquaculture

Profit is low, but, salaries are part of the earning for the farmer.

Acknowledgements

UJAT

CONACYT

COMISION NACIONAL DE AREAS NATURALES PROTEGIDAS

AQUAFISH

COLLABORATIVE RESEARCH SUPPORT PROGRAM

USAID FROM THE AMERICAN PEOPLE

OSU Oregon State

AQUAFISH COLLABORATIVE RESEARCH SUPPORT PROGRAM

The AquaFish CRSP is funded in part by United States Agency for International Development (USAID) Cooperative Agreement No. EPP-A-00-06-00012-00 and by US and Host Country partners.

The contents of this presentation do not necessarily represent an official position or policy of the United States Agency for International Development (USAID). Mention of trade names or commercial products in this presentation does not constitute endorsement or recommendation for use on the part of USAID or the AquaFish Collaborative Research Support Program. The accuracy, reliability, and originality of the work presented are the responsibility of the individual authors.