AquaFish Collaborative Research Support Program Technical Session at Aquaculture America 2009

Seattle, Washington, USA

15 – 18 February 2009

Session organizer: Dr. Hillary Egna

Proceedings

Assembled by Amanda Hyman

Edited by Jenna Borberg

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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.

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Disclaimers

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TABLE OF CONTENTS

PREAMBLE

2009 AquaFish CRSP Technical Session
Aquaculture America 2009 – Seattle, WA, USA
16 February 2009

Session Organizer: Dr. Hillary Egna

On Monday, February 16 2009, researchers assembled in Seattle, WA, USA at the Seattle Convention Center for the AquaFish Technical Session. Dr. Egna chaired a session titled “International Aquaculture Development for the Poor.” There were eleven AquaFish presentations in the afternoon that covered a range of AquaFish research over the years. The well attended session with a captive audience that offered challenging questions and provided insightful feedback. Subsequent Aquaculture America 2009 conference activities offered exposure to a wide range of aquaculture research and provided a number of opportunities for meeting and discussion among all participants.

2009 AquaFish CRSP Technical Meeting Agenda
Aquaculture America 2009 – Seattle, WA, USA

16 February 2009

Seattle Convention Center

<u>Monday, February 16, 2009</u>

AquaFish CRSP Technical Session (13:30-16:30)
International Aquaculture Development for the Poor

Chair: Dr. Hillary Egna, AquaFish Director and Lead Principal Investigator

13:30-13:45	**Eye Color as A Predictor of Social Dominance in Nile Tilapia *Oreochromis niloticus*** Emmanuel M. Vera Cruz*, Reggie May L. Bero, Remedios B. Bolivar and Russell J. Borski
13:45-14:00	**Grow-out performance of Nile Tilapia *Oreochromis* niloticus Fingerlings from Different Hatching Systems** Remedios B. Bolivar*, Eddie Boy T. Jimenez, Roberto Miguel V. Sayco, Reginor Lyzza B. Argueza, Hernando L. Bolivar, and Russell J. Borski
14:00-14:15	**Strategies of Nile tilapia *Orechromis niloticus* Pond Culture for Small-scale Farmers** Yang Yi* and James Diana
14:15-14:30	**Alternative Feeding Strategies to Improve Milkfish Production** Evelyn Grace T. de Jesus-Ayson* and Russell J. Borski
14:30-14:45	**Use of Freshwater Low Value Fish for Aquaculture Development in Cambodia's Mekong River Basin** So Nam*, Eng Tong, Souen Norng and Kent Hortle
14:45-15:00	**What is the Effect of Different Indispensable Amino Acid Imbalanced Diets on Tropical Fish Pacu *Piaractus mesopotamicus*?** Rodrigo Takata, Maria C. Portella*, Thiago M. de Freitas, Karolina Kwasek and Konrad Dabrowski
15:00-15:15	**Concentration of Organic Material in Oyster *Crassostrea corteziensis* Growing Waters at Boca de Camichin, Nayarit, Mexico** Maria C. Haws*, Guillermo Rodriguez Dom Omar Calvario Martinez, Laura Edith Corona Osuna and Eladio Gaxiola Camacho
15:15-15:30	**Outreach, Acceptance, and Success of Pond Aquaculture in Promoting Rural Economy and Social Stability** James Diana*
15:30-15:45	**Catfish *Clarias gariepinus* Fingerlings as Bait for Lake Victoria Commercial Fisheries** Charles Ngugi* and Kwamena Quagrainie

15:45-16:00 Evaluating Pond Aquaculture Effluents through Biological Assessment of Fish and Benthic Macroinvertebrate Assemblages in Receiving Streams
Emmanuel A. Frimpong*, and Steve Amisah

16:00-16:15 Development of Small-scale Aquaculture: Trout Farming Systems in the Western-cape Province of South Africa
Henk B. Strander*

16:15-16:30 Effect of Temperature on the Growth and Survival of Nile tilapia *Oreochromis niloticus* Fry Reared in Hapas
Remedios B. Bolivar, Eddie Boy T. Jimenez, Roberto Miguel V. Sayco, Reginor Lyzza B. Argueza, Hernando L. Bolivar* and Russell Borski

AquaFish CRSP Technical Session: International Aquaculture Development for the Poor

Eye Color as A Predictor of Social Dominance in Nile Tilapia *Oreochromis niloticus*

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Heterogeneous fish growth is a common phenomenon in cultured fish populations. Variation in individual growth rates may be attributed in part to social interactions and the formation of feeding hierarchies. Breeding is also largely driven by social behavior and an understanding or ability to predict dominance may contribute to breeding programs. Fish in a stable dominance hierarchy may be classified as dominant, subordinate, or intermediate in status.

It has previously been shown that eye color pattern in Nile tilapia is a consequence of a fish's relative position in the social hierarchy. However it is still an open question if this physiological difference can also be a cause of social status. To evaluate this, 40 all-male juvenile *Oreochromis niloticus* of similar size and with no apparent differences in social history were isolated for 10 days and were used in a social pair study. Eye color pattern of each fish was observed and recorded several times during the isolation period, during an aggressive encounter and after the social interaction settled. Eye color change was marked by fractional changes of the color of the iris and sclera around the pupil which was transformed into scores ranging from 0/8 (no darkening) to 8/8 (total darkening).

Results of the study demonstrated that the ability to win a fight for social dominance can be predicted using the fish's eye color. Fish with darker eye color pattern are most likely to win the contest for social dominance. In addition, during an aggressive encounter, shifts in the eye color pattern were observed in both the subsequent dominant and subordinate fish. This change in eye color patterns in both fish served as a signal to the opponent to indicate preparedness to fight. When the social interactions had settled, dominant and subordinate fish shifted their eye color patterns to a paler and darker configuration, respectively. The eye darkening in the subordinates served as a social signal for social submission.

EYE COLOR AS A PREDICTOR OF SOCIAL DOMINANCE IN NILE TILAPIA *Oreochromis niloticus*

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Introduction

- Heterogeneous fish growth is a common phenomenon in cultured fish populations
- Variation in individual growth rates attributed in part to:
  - social interactions
  - formation of feeding hierarchies
- Fish status in a stable dominance hierarchy classified as:
  - dominant
  - subordinate, or
  - intermediate
- In Nile tilapia the eye color pattern is a consequence of fish's relative position in the social hierarchy (Volpato et al., 2003, Vera Cruz & Brown, 2007)
- Can eye color pattern prior to the interaction predicts the outcome of contest for social dominance?

Experimental fish

- Seventy five 3-wk old all-male Nile tilapia (mean wt = 0.87 g) was obtained from the Phil-Fishgen, CLSU, Science City of Muñoz Nueva Ecija
- Maintained in a rectangular tank (2 x 1 x 1 m) receiving continuous flow of water for around 3 months

- Fed four times a day (2 % BW)

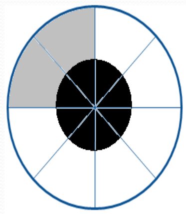
Isolation

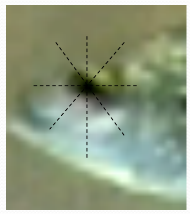
- Weight & length of each fish were obtained

- Isolation of 40 fish for 10 days

Monitoring of eye color pattern (ECP)

- ECP was monitored for six days
- ECP was measured by quantifying the darkened area between the iris & sclera; from zero (no darkening) to eight (total darkening)
- The eye was divided into 8 equal parts using 4 imaginary diameter lines





- 2/8 or 2 3/8 or 3

Social interaction

- ECP was recorded prior to the interaction
- After 10 days of isolation, fish were size-matched for the later pairing with maximum size difference of 17.74% (mean = 2.32%±2.09)
- Fish were individually marked by cutting the lower (with darker ECP) or upper (with paler ECP) part of the caudal fin
- To prevent the effect of place familiarity, the fish in a pair were introduced at the same time in a new environment (30x15x 30 cm aquarium)

Data gathered

- The period from time of the introduction up to the time of first agonistic attack
- Number of pairs that interacted
- Duration of social interaction
- The change in ECP
- Social status of each fish after the interaction

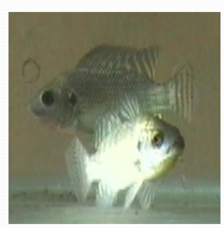
RESULTS

Duration of time before observance of first attack

- This time duration corresponds to the duration of familiarization to the new environment of at least one individual in a pair
- The mean was 4.97 min (±0.69) & only one pair exceeded 10 min
- Fish can adapt to the new environment as early as 2.17 minutes.

Prior to interaction

- Circling at each other, provoking the other fish to start the interaction
- Fins of both fish were erected indicating that they are ready to fight



During the interaction

- Biting directly at each others mouth

- Biting at the caudal part of the opponent

- Biting at body part of the opponent

After the interaction

- Subordinate retreating during attacks of dominant

resulting social ranks

	Eye color pattern					
		During the encounter				
Fish pair	Before the encounter	Early part	Middle part	Late part	After the encounter	Dominant individual
1 & 13	1, 2	2, 8	8, 2	8, 8	8, 8	13
2 & 11	2, 2	8, 8	8, 8	8, 2	1, 8	2
3 & 5	3, 7	8, 8	2, 8	8, 2	8, 2	5
4 & 37	1, 8	0, 0	2, 6	2, 2	8, 2	37
6 & 15	3, 7					NI
7 & 22	3, 8	8, 8	2, 8	8, 0	8, 0	22
9 & 36	2, 4	0, 8	6, 8	2, 8	8, 2	36
14 & 21	1, 4	8, 2	8, 4	8, 4	8, 4	21
17 & 16	2, 3	2, 2	8, 8	8, 0	8, 2	16
18 & 10	2, 7	2, 6	8, 0	8, 6	8, 6	10
19 & 8	6, 8	8, 8	2, 8	7, 8	8, 2	8
25 & 20*	6, 8	8, 2	8, 8	8, 8	2, 8	25
23 & 29	7, 7.5	6, 8	4, 8	0, 8	8, 2	29
24 & 39	6, 8					NI
26 & 38*	3, 7	4, 8	2, 8	2, 8	2, 8	26
27 & 31	2, 6	6, 6	8, 8	0, 2	8, 2	31
32 & 33	4, 8	8, 8	2, 2	2, 8	8, 2	33
34 & 30*	0, 4	8, 8	8, 2	0, 8	0, 8	34
40 & 12	4, 8	8, 8	8, 8	8, 8	8, 2	12
35 & 28	2, 7	8, 8	2, 8	8, 2	8, 2	28

NI – no interaction

Social interaction

- 18 of the 20 pairs interacted
- In this 18 pairs, 14 (77.78%) fish with darker ECP prior to pairing became dominant
- Frequency difference was highly significant (Binomial test, *P* = 0.009)
- It is important to note that during the start of the social conflict in all the 18 pairs, the opponents with paler ECP were the ones that initiated the encounter & they were the ones that first bit & chased the opponent

Duration of interaction

Group	Number of pairs (n)	Mean duration of interaction (min)	ECP difference
Short Interaction (< 5 min)	4	4.24±0.14	5.25±0.63
Long Interaction (> 5 min)	14	9.29±0.52	2.66±0.43
ANOVA		*P* = 0.001	*P* = 0.008

Change in ECP of competing individuals during and after the encounter as compared to their ECP prior to the encounter

Part of the social encounter	Pairs with the following change in ECP (%)			
	Pale-Paler: Dark-Darker	Pale-Darker: Dark-Darker	Pale-Darker: Dark-Paler	Pale-Paler: Dark-Paler
Early part	11	61	11	17
Middle part	33	39	22	6
Late part	28	17	55	0
After the encounter	22	6	72	0

In dominant fish, any change in ECP after the interaction was either towards paler or darker than the original ECP while for subordinate fish it was only for darker

Conclusions

- Tilapia with darker ECP before the interaction has a greater possibility to win the fight
- Subordination increased the ECP patterns of the fish after pairing
- In dominant fish, any change in ECP after the interaction was either towards paler or darker than the original ECP
- Shorter duration of social encounter is needed for the establishment of dominance hierarchy in pairs having greater difference in ECP prior to social encounter.

Recommendations

Further investigations on the ECP of fish is needed to answer the ff. questions:

1. Is ECP of the fish consequences of prior social (dominance or subordination) experience or is it a coping style used as a flexible behavioral strategy?
2. Is the degree of change in ECP after the interaction compared to the original ECP prior to interaction caused by the level of stress (i.e aggressive encounter) received during the interaction?
3. What are the factors influencing the change in ECP in both opponents during the early stage of the conflict?

Funding for this research was provided by the

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Thank you

Grow-out Performance of Nile Tilapia *Oreochromis niloticus* Fingerlings from Different Hatching Systems

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Tilapia hatcheries in the Philippines use various techniques in fry production that includes ponds, hapas and tanks. This study was conducted to evaluate the growth performance of Nile tilapia (*Oreochromis niloticus* L.) fingerlings in earthen ponds that were produced from three hatching systems, artificial incubation units, hapas and ponds. Treatments used in the study were based on the source of the fry. Treatments were the following: I -artificial incubation-hatched fry, II - hapa-hatched fry, III - pond-hatched fry and IV - combination of hatched fry by stocking 33.3% from each hatching source. Each treatment was replicated three times. Twelve (12) 500 m2 ponds were used for rearing and each was stocked at 4 fish m-2 or 2000 fingerlings pond-1. Fingerlings for treatments I, II, III and IV had an average body weight of 0.292 g, 0.308 g, 0.320 g and 0.307 g, respectively. The average body length measured were 2.56 cm, 2.63 cm, 2.66 cm and 2.50 cm for Treatments I, II, III and IV, respectively. Analysis of variance showed no significant difference among groups with respect to initial size.

After four months of rearing in ponds, final weight and length did not differ among treatments (P>0.05). Total harvested fish per replicate per treatment were counted for determination of percentage survival. Treatment IV had the highest survival with 59.30% followed by Treatment II with 58.63%, Treatment I with 56.63% and Treatment III with 56.30% survival. There were no significant differences in survival among groups. Artificial incubation-hatched fry had the highest extrapolated yield (kg/ha) with 3890.67 kg/ha followed by hapa-hatched fry with 3797.49 kg/ha, combination of hatched fry with 3488.96 kg/ha and pond-hatched fry with 2995.15 kg/ha. However, these differences were not statistically insignificant. It is concluded that fingerlings reared from different hatching systems (artificial incubation units, hapas and ponds) do not significantly affect final length and weight, survival and yield of Nile tilapia during pond growout.

GROW-OUT PERFORMANCE OF NILE TILAPIA (*Oreochromis niloticus* L.) FINGERLINGS FROM DIFFERENT HATCHING SYSTEMS

AQUACULTURE AMERICA 2009

February 15-18, 2009

Washington State Convention Center

Seattle, Washington

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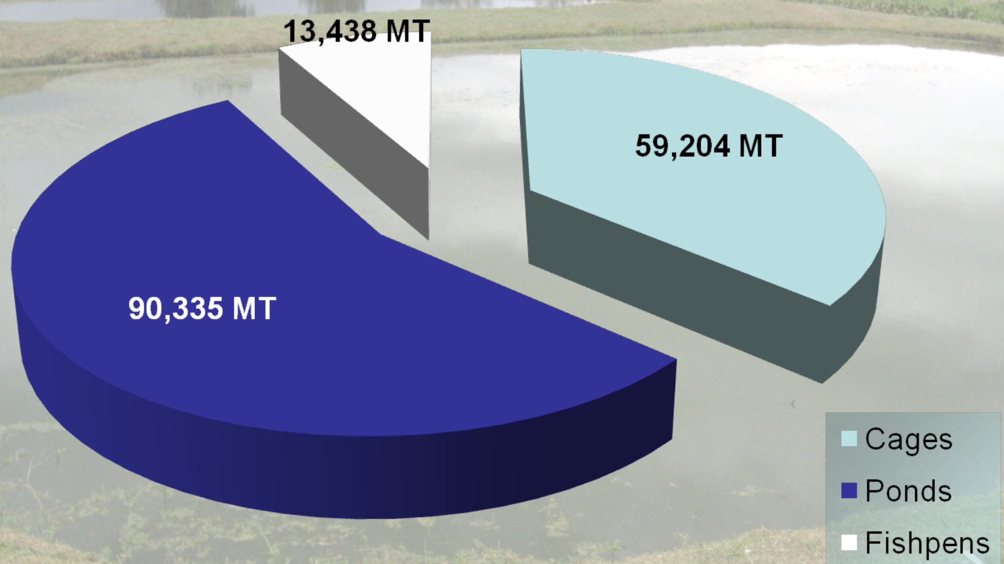
INTRODUCTION

- Tilapia is one of the most important cultured species in aquaculture
- In the Philippines, the aquaculture sector has intensified tilapia farming for food security and enhanced productivity

Tilapia Production in the Philippines (2005) by Major Types of Culture System



Species Cultured

- Tilapia production in the Philippines increased due to the development of genetically improved tilapia strains such as GIFT, FaST, GMT, BFAR-GET ExCEL, GENOMAR and others

Hatching Systems

- Tilapia farmers believe that fingerlings from artificial incubation unit have lower survival, smaller size and generally of poor quality
- On the other hand, fingerlings from hapas and ponds are bigger in size, with high survival and generally of good quality

OBJECTIVE OF THE STUDY

To evaluate the grow-out performance of sex-reversed tilapia produced from different hatching systems

MATERIALS AND METHODS

<u>Experimental Units</u>

Twelve (12) 500 m^2 earthen ponds

<u>Treatments</u>

I – Artificial incubation unit
II – Hapas
III – Ponds
IV – Fry from the different sources

Treatments were replicated three (3) times

MATERIALS AND METHODS

- Sex-reversed GIFT strain of Nile tilapia fingerlings produced from different hatching systems were used

- Ponds were prepared by draining, elimination of unwanted species and drying of pond bottom

MATERIALS AND METHODS

- Each pond was stocked at 4 fish m^{-2} or 2,000 fish $pond^{-1}$

- Feeding of the fish was done twice a day, seven days a week based on the feeding rates obtained from the feeding guides of two feed companies

MATERIALS AND METHODS

- **Management of Ponds**
  - Weekly application of inorganic fertilizer was done
    - Urea (28 kg N/ha/wk) and
    - Ammonium Phosphate (5.6 kg P/ha/wk)
  - Replenishment of pond water due to seepage and evaporation
  - Weekly monitoring of dissolved oxygen concentration, water temperature and Secchi disk visibility depth

MATERIALS AND METHODS

Fish Sampling

Fish sampling was done twice a month wherein length and weight of the samples were obtained

Sexing of Fish

Manual sexing was done in determining the sex of the fish after the four-month culture period

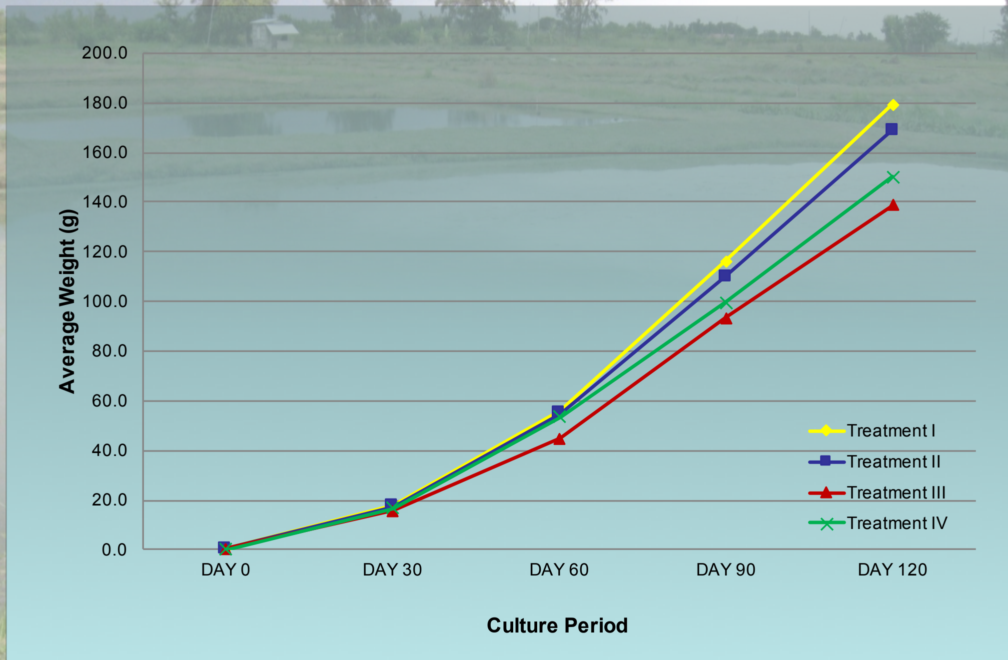
MATERIALS AND METHODS

Statistical Analysis

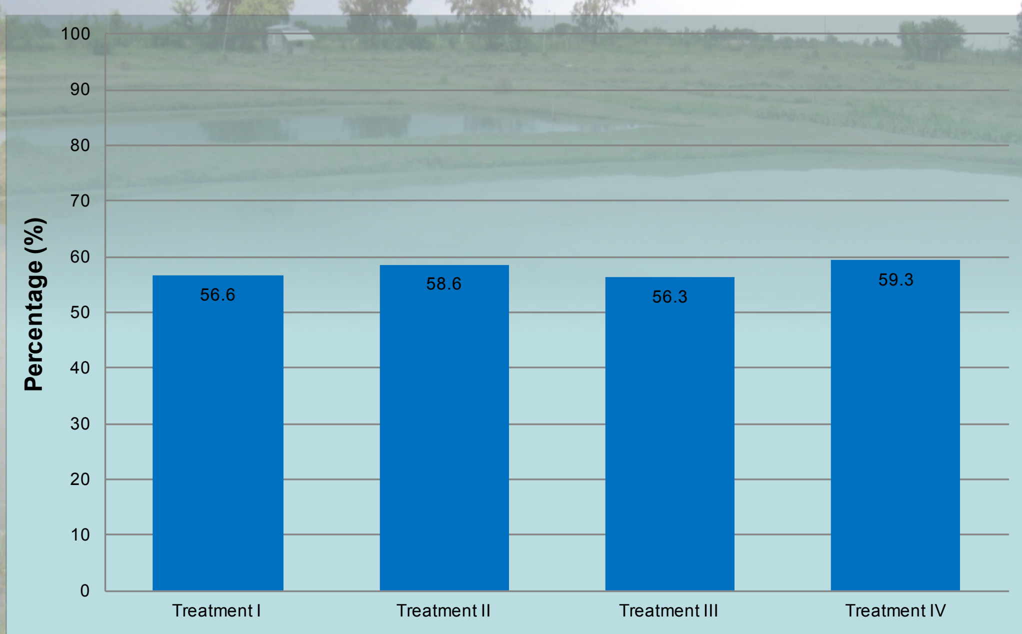
Data analysis was done using Analysis of Variance (ANOVA) in Randomized Complete Block Design (RCBD). The Least Significant Difference was used for the comparison of means.

RESULTS AND DISCUSSION

Growth pattern of fish



Survival



Note: Analysis of variance showed no significant difference among treatments (P>0.05)

Growth performance of the fish

Performance	Treatments			
	I	II	III	IV
Initial Mean Weight (g)	0.292 ± 0.011	0.308 ± 0.014	0.320 ± 0.017	0.271 ± 0.005
Final Mean Weight (g)	179.256 ± 42.260	168.945 ± 48.582	138.871 ± 17.271	150.042 ± 14.730
Daily Gain in Weight (g day^{-1})	1.492 ± 0.352	1.405 ± 0.405	1.155 ± 0.144	1.248 ± 0.122
Specific Growth Rate (%)	5.333 ± 0.221	5.235 ± 0.263	5.058 ± 0.150	5.264 ± 0.070
Survival (%)	56.6 ± 8.121	58.6 ± 15.065	56.3 ± 22.471	59.3 ± 1.744

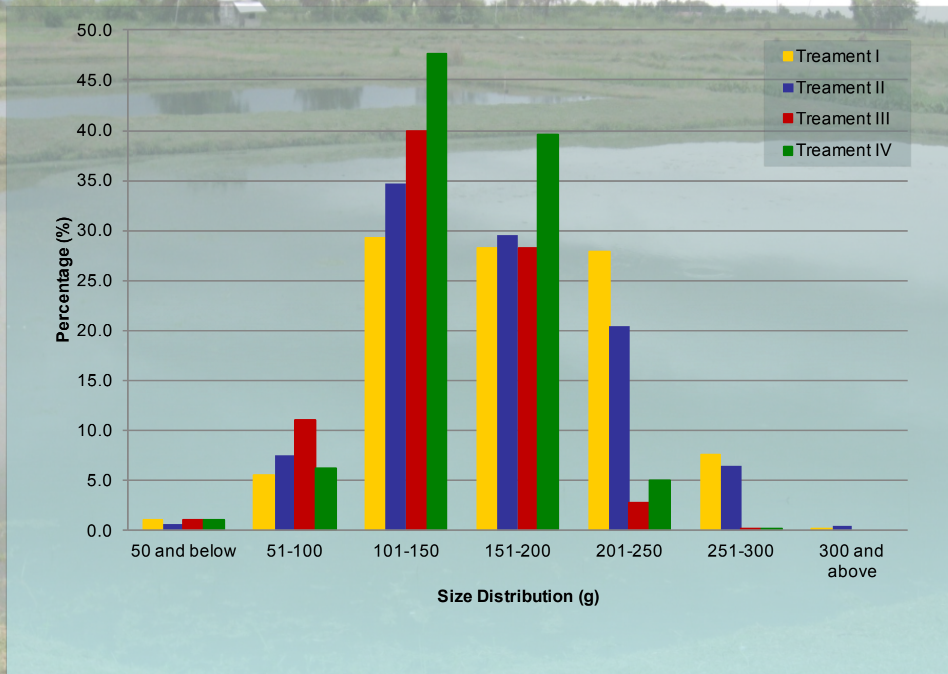
Note: Values are means ± standard deviation

Production performance of the fish

Performance	Treatments			
	I	II	III	IV
Extrapolated Feed Consumed (kg ha^{-1})	7055 ± 1258.6	6820 ± 1420.5	5853 ± 123.7	6497 ± 375.2
Feed Conversion Ratio	2.0 ± 0.153	2.1 ± 0.153	2.1 ± 0.252	2.2 ± 0.115
Gross Fish Yield (kg $pond^{-1}$)	194.533 ± 30.276	189.874 ± 37.698	149.757 ± 43.220	174.448 ± 9.381
Extrapolated Gross Yield (kg ha^{-1})	3890.7 ± 605.5	3797.5 ± 754.0	2995.1 ± 864.4	3489.0 ± 187.6

Note: Values are means ± standard deviation
Treatment means are not significantly different at 5% level of significance

Size distribution of harvested fish



Average water quality parameter

Treatment	D.O. (mg/L)	Temperature (ºC)	SDVD (cm)	Pond Depth (cm)
I	4.72	30.1	33.0	98.7
II	4.71	30.2	33.3	99.7
III	4.55	30.1	33.0	99.3
IV	4.63	30.2	35.7	99.3

Note: Treatment means are not significantly different at 5% level of significance

Simple Cost and Return Analysis

ITEMS	TREATMENTS			
	I	II	III	IV
Gross Return (USD)	4,993.41	4,873.80	3,843.98	4,477.86
Cost (USD)				
Fingerlings	385.03	385.03	385.03	385.03
Commercial Fertilizers				
Ammonium Phosphate	78.65	64.33	57.20	71.45
Urea	146.71	120.02	106.71	133.33
Commercial Feeds	3,773.26	3,647.06	3,129.41	3,473.80
Total Cost	4,383.65	4,216.43	3,678.35	4,063.60
Net Returns (USD)	609.76	657.37	165.63	414.26

Assumptions	
Stocking Density	4 pc m^{-2}
Price of fingerlings	USD 0.01 pc^{-1}
Price of Commercial fertilizers	
Ammonium Phosphate	USD 0.77 kg^{-1}
Urea	USD 0.78 kg^{-1}
Price of Commercial Feeds	USD 0.53 kg^{-1}
Price of Marketable Tilapia	USD 1.28 kg^{-1}

Note:
US$ 1.0 = PhP 46.75

SUMMARY

- The experiment was conducted to evaluate the growth performance of sex-reversed tilapia produced from different hatching systems
- Data on fish weight, length, size distribution, FCR, yield and survival were gathered
- Low survival is due to the fluctuating weather condition during the conduct of the study

SUMMARY

- Treatment I had the highest gain in weight and gross yield
- Treatment IV had the highest percent survival
- Treatments I and II produced fish under the different size ranges including the largest size
- There were no significant differences on growth, survival, size distribution as well as net profit among treatments

CONCLUSION

- It is concluded that the hatching systems (artificial incubation unit, hapas and ponds) had no significant differences in terms of growth performance, survival, size distribution and net profit
- Therefore, any of the hatching systems can be used for tilapia grow-out with positive production returns

Funding for this research was provided by the

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Strategies of Nile tilapia *Oreochromis niloticus* Pond Culture for Small-scale Farmers

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Different strategies for Nile tilapia (*Oreochromis niloticus*) culture in ponds with a series of progressive inputs were compared. The sequential experimental stages to increase fish production through intensification were: 1) triple superphosphate (TSP) only; 2) chicken manure only; 3) chicken manure supplemented with urea or urea and TSP; 4) urea and TSP; 5) continually supplemental feeding; 6) staged supplemental feeding; 7) feeding alone.

The results showed that the choices of input regimes with increasing economic gains are: 1) fertilizing ponds with moderate loading of chicken manure; 2) fertilizing ponds with chicken manure supplemented with urea and TSP; 3) fertilizing ponds with urea and TSP; 4) fertilizing ponds initially with urea and TSP in combination of supplemental pelleted feed at 50% satiation level at later stage of grow-out cycle.

Keywords: Nile tilapia, pond culture, fertilization, feeding

STRATEGIES OF NILE TILAPIA (*Oreochromis niloticus*) POND CULTURE FOR SMALL-SCALE FARMERS

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Aquaculture Collaborative Research Support Program

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Introduction

- Tilapia culture in Asia is both spreading and intensifying;
- Aquaculture CRSP has developed various grow-out strategies to increase production;
- Economic research in aquaculture is often neglected by aquaculturists.

Objectives

- To assess Nile tilapia grow-out strategies in ponds developed by Aquaculture CRSP;
- To recommend the appropriate strategies to small-scale farmers with various resources and financial ability

Methods

- Conducted basic economic analyses of input costs (excluding facility and labor cost) and output revenues
- Compared relative profitability of various strategies by: total production cost; gross revenue; net revenue; unit cost and R/C ratio
- Sensitive analysis to evaluate effects of changes in cost of inputs and outputs

Culture conditions

- Pond size: 200-400 m^2; water depth: 1m
- Stocking density : 0.88-9 fish/m^2
- Culture period : 5 months
- No water exchange
- Extrapolated yield (kg/ha/year) from two 5-month cycles/year
- Different input regimes

Experimental Stages

Stage	Chicken manure (kgDM/ha/week)	Urea (kg/ha/week)	TSP (kg/ha/week)
1. TSP only			8 P_2O_5 or 17.8 TSP/ha/month
2. CM only	125; 250; 500; 1,000		
3. CM with urea and TSP	44; 100; 200	supplemented N : P = 5 : 1	
	25; 75; 125; 175; 225	Supplemented to 28 N N : P = 4 : 1	Supplemented to 7 P N : P = 4 : 1
4. Urea and TSP		14 N or 28 N	22.4 P or 7 P

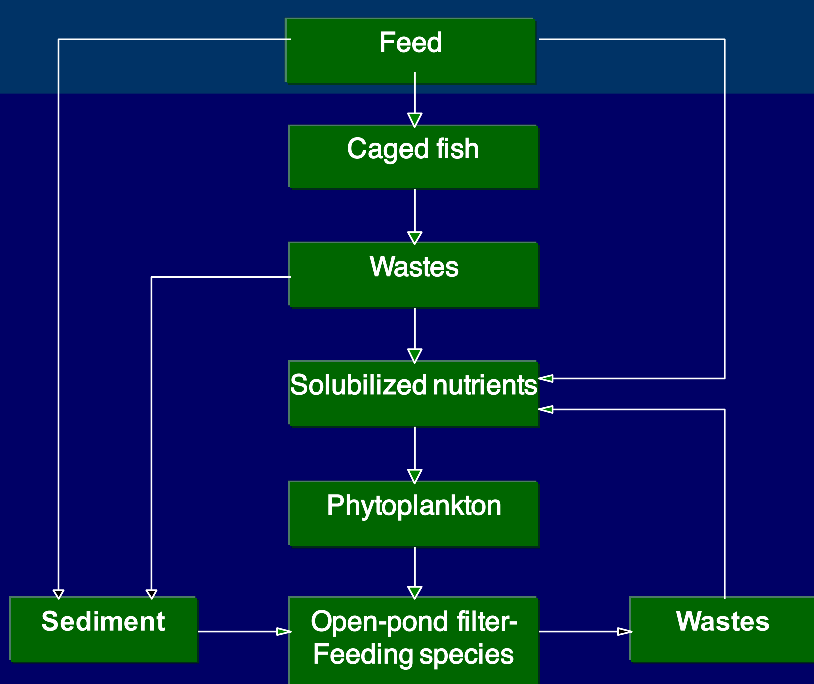
Experimental stages

Stage	Urea (kg/ha/week)	TSP (kg/ha/week)	Feed (% satiation)	Fish size (g)
5. Continue suppl. feeding	28 N	7 P	25%; 50%; 75%	
	or adjust weekly based on waste content			
6. Staged suppl. feeding	28 N	7 P	50%	50; 100; 150; 200; 250
7. Feeding alone			100%	

Developed Strategies

Technologies	Nutrient inputs	Gross yields (kg/ha/yr)
CM alone	CM: 125 – 1,000 kg DM /ha/wk	2,900 - 4,000
CM+Urea+TSP	CM: 25 - 225 kg DM /ha/wk supplemented with urea and TSP to give 28 kg N and 7 kg P /ha/wk	4,200 - 7,600
Urea+TSP	Urea and TSP: 28 kg N and 7 kg P /ha/wk	4,500 – 7,100
Continually supplemental feeding (Urea+TSP+Feed)	Urea and TSP: 28 kg N and 7 kg P /ha/wk Feed: 25, 50, 75% satiation starting from beginning	12,100 - 31,330
Staged supplemental feeding (Urea+TSP+Feed)	Urea and TSP: 28 kg N and 7 kg P /ha/wk Feed: 50% satiation starting from 50, 100, 150, 200 and 250 g	11,900 – 19,600
Feed alone	Feed: 100% satiation	18,00 – 19,600
Cage-cum-pond	Fattening in cages and nursing in open water	20,000-25,000

Integrated cage-cum-pond culture system



Integrated cage-cum-pond culture system

Developed Strategies (2)

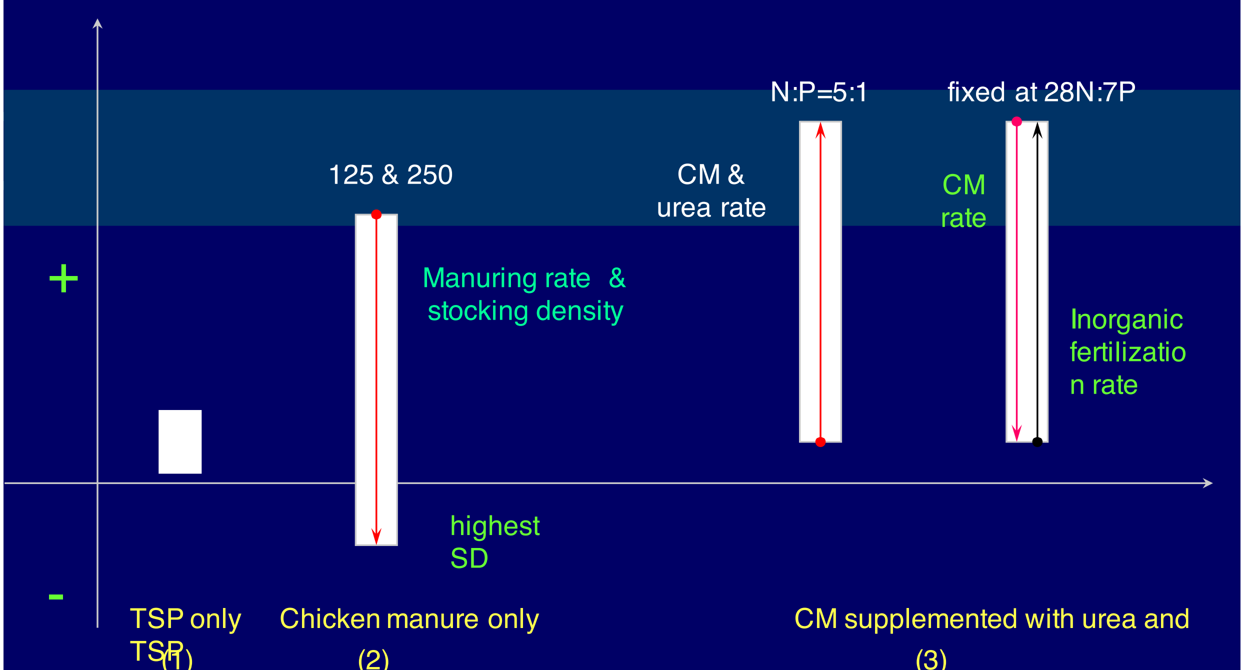
Technologies	Gross Yield (kg/ha/yr)	Net Yield (kg/ha/yr)	Net return (US$/ha/yr)
CM alone (125 kg/ha/wk)	2,965	2,502	1,117
CM+Urea+TSP (75 kg CM, 28 N+7P)	7,578	7,271	1,955
Urea+TSP (28 N+7 P)	7,110	6,439	1,733
Continually supplemental feeding (Urea+TSP+0.5 Feed)	18,374	17,714	1,551
Staged supplemental feeding from 100-150g (Urea+TSP+0.5 Feed)	19,539	18,952	5,029
Feed alone	19,574	18,901	-2,198
Cage-cum-pond	25,214	19,179	6,578

Results

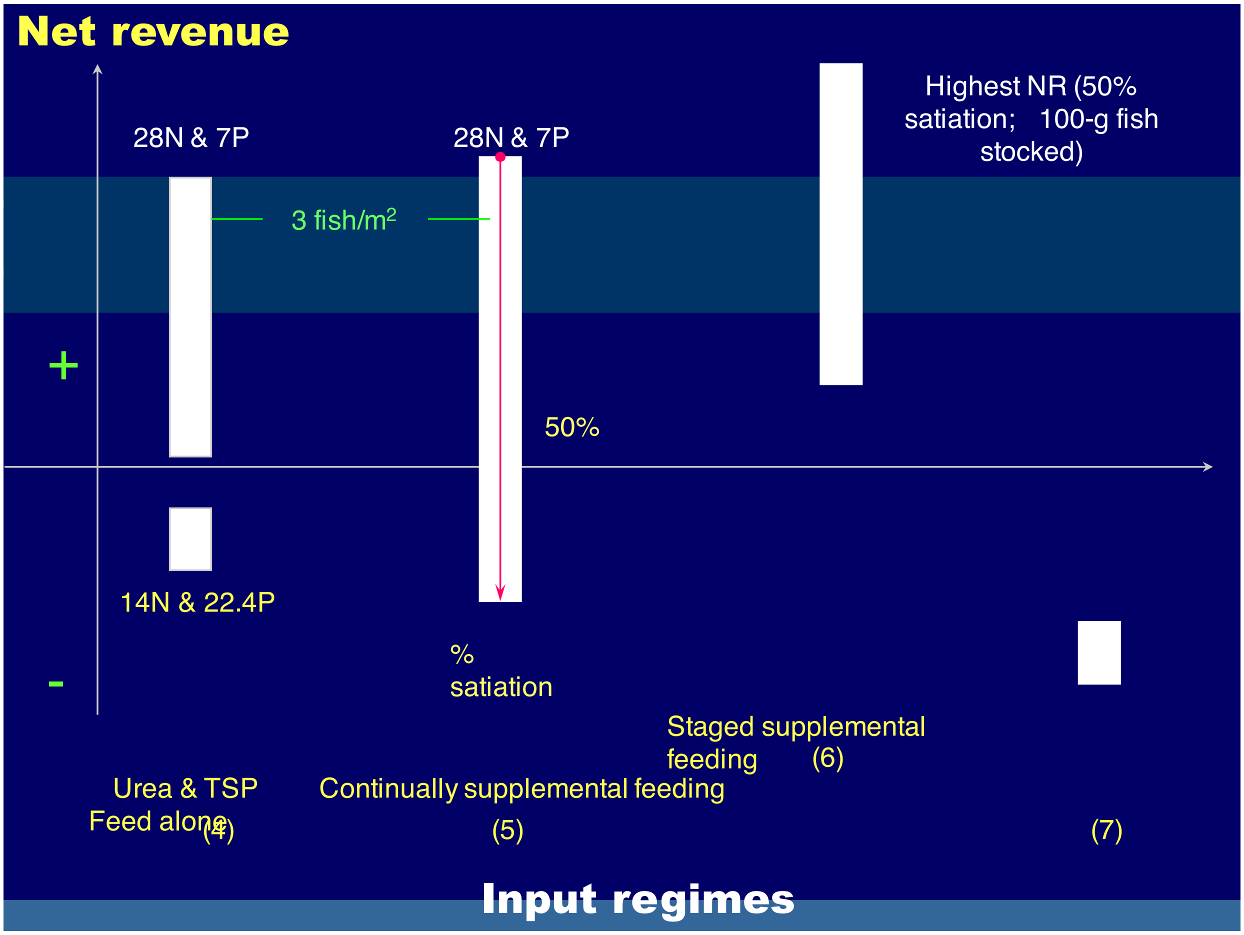
- 26 out of 34 tested input regimes had positive net revenue
- Return/Cost ratio ranged from 4.7 to 0.8, decreasing with increased inputs and stocking density
- Unit cost ranged from 0.12 to 0.74 US$/kg net fish yield

  (lowest in aged chicken manure only and highest feed only)

Net revenue



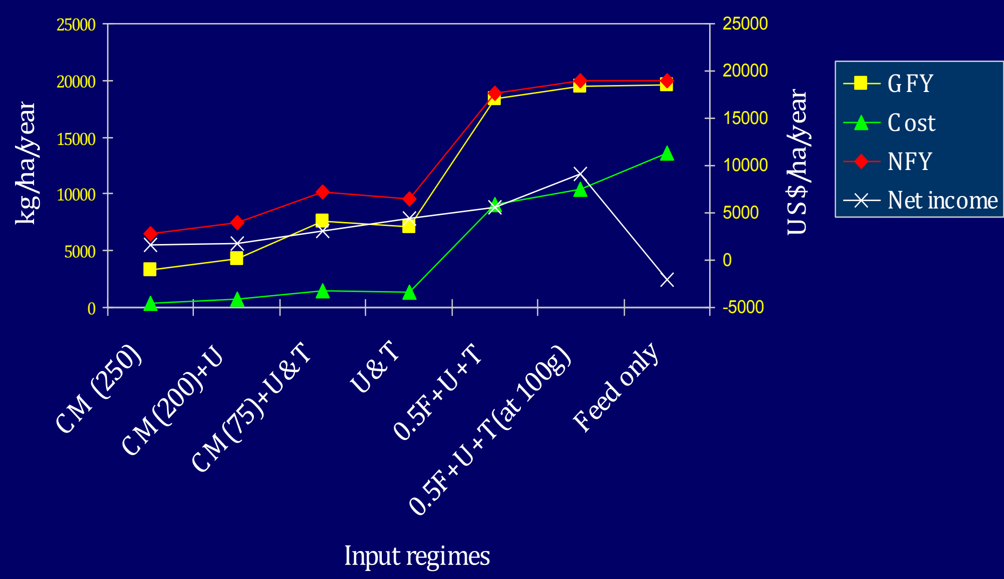
Input regimes



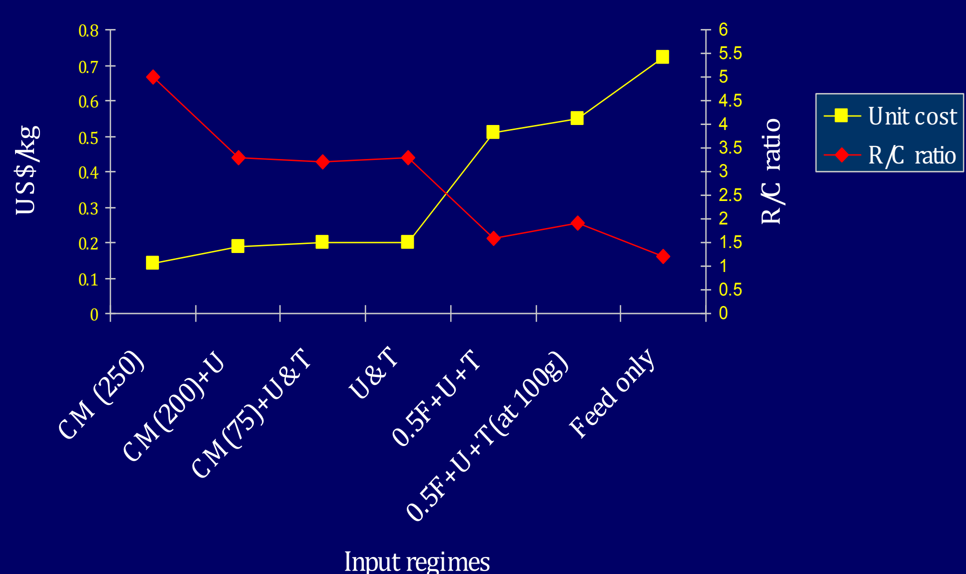
Relation between input cost and net revenue

- Net revenue increases with increased input costs and
- Net revenue decreases when input costs are further increased with increased intensification

Yield, cost and net income



Unit cost and Return/cost ratio



PRODUCTION COST ANALYSIS

- Analyzed for the input regime with the highest net revenue at each stage
- "TSP only" and "Chicken manure only" had lowest total production cost (fry cost>50%)
- Inorganic fertilizers accounted for large proportion of production cost in the stages without feed
- Feed cost was >85% and 96% with supplemental feeding and feed alone, respectively

Sensitivity analysis

- **The most sensitive factors to net revenue:**
  - **Market price of fish, and**
  - **Price of pelleted feed**
- **Price of chicken manure was the least sensitive factor for the regimes with CM**
- **Price of fish fry was the least sensitive factor to all strategies without CM, except for 'TSP only'**

Discussion

Œ Progressively greater inputs produce greater net revenue, but high costs limit applicability of some strategies for small-scale farmers;

❷ Low-input strategies are more attractive to poor farmers with on-farm inputs or limited financial ability;

❸ Richer farmers can apply ‘supplemental feeding’ for higher net revenue;

Discussion

❹ Lower rates of CM (125 & 250 kg/ha/week) achieved highest net return, compared to that found by Green et al. (750 & 1,000kg);

❺ ‘Continually supplemental feeding’ strategies may have positive net return if fish were cultured to the size of > 500g;

‘ Further research is needed to fine-tune ‘supplemental feeding’ and to develop low-cost pelleted feed.

Conclusions

These analyses provide the guidelines as input regimes for Nile tilapia production to small-scale farmers depending on their

+ available resources and
+ financial ability

Recommendations

Recommended strategies are:

Œ Fertilize ponds with chicken manure at 125 or 250 kg(DM)/ha/week

❷ Chicken manure at 75kg(DM)/ha/week supplemented with Urea and TSP to bring 28kgN and 7kgP/ha/week

❸ Fertilize ponds with urea and TSP at the above N and P rates

Recommendations

- Fertilize ponds with using urea and TSP at the above N and P rates with supplemental pelleted feed at daily rations of 50% of satiation levels but starting at 100 g size.

- Integrated Cage-cum-Pond culture system.

Alternative Feeding Strategies to Improve Milkfish Production

Evelyn Grace T. de Jesus-Ayson* and Russell J. Borski
Aquaculture Department, Southeast Asian Fisheries Development Center, Tigbauan, Iloilo, Philippines (email: edjayson@seafdec.org.ph)

In the Philippines, cage culture of milkfish in marine environments is increasing. The practice uses high stocking densities, with significantly greater inputs of artificial feeds which more often than not, has led to excessive feeding and consequently excessive nutrient loading in receiving waters, exacerbating problems with pollution. These could have contributed to occurrence of periodic fish kills in areas of marine milkfish culture clusters.

Sixty percent of milkfish farming expenses are attributable to feed costs. A series of experiments were conducted in an attempt to develop alternative feeding strategies that will reduce feed inputs without compromising growth and resulting production. In the first experiment, growth was compared in milkfish fed daily, on alternate days and on alternate 2-week or 4-week starvation and refeeding cycles in a tank environment provided with flow-through water system. Results show, that milkfish fed on alternate days do not grow as well as milkfish that are fed daily. Feed restriction for 2 weeks followed by 2 weeks of refeeding elicited a compensatory growth response such that average body weight (ABW) of fish was not significantly different from ABW of fish fed daily. Another experiment compared growth of fish given a ration equivalent to 10% of BW (usual practice) or 7.5% of BW. Results show no significant effect on growth or final ABW or biomass. Thus, a lower feeding ration can be given to milkfish without compromising yield. Results of the tank experiments will be tested in a simulated cage environment in order to refine the feeding strategy and will be verified in actual marine cage and brackishwater pond production systems.

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Southeast Asian Fisheries Development Center
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Alternative Feeding Strategies to Improve Production of Milkfish in the Philippines

Evelyn Grace T. de Jesus-Ayson
SEAFDEC AQD, Philippines

and

Russell J. Borski
North Carolina State University

Background

- ✓ Milkfish is the Philippines' #1 foodfish; it is the #1 aquaculture product
- ✓ Milkfish farming was traditionally done in brackishwater ponds
- ✓ Farming practices have expanded to pens and cages in lakes and other freshwater bodies
- ✓ Intensive farming in pens and cages in coastal waters and channels started in the 90s and is increasing fast because of high profitability

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Problems

- ✓ Unregulated construction of fish pens and cages resulting to congestion
- ✓ Overstocking
- ✓ Overfeeding: high FCR, high feeding and production costs
- ✓ Pollution and deteriorating environmental conditions
- ✓ Mass fish kills

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Challenges

- ✓ High feed inputs
- ✓ Negative environmental impact

Compensatory growth – a period of growth that exceeds normal growth rates after animals are alleviated of certain growth stunting conditions

OBJECTIVES

- To examine whether milkfish exhibits compensatory growth
- Identify feeding strategies that will result in compensatory growth response in milkfish
- Exploit natural compensatory growth mechanism to improve production efficiency
    - Lower feed inputs
    - Reduce environmental impact

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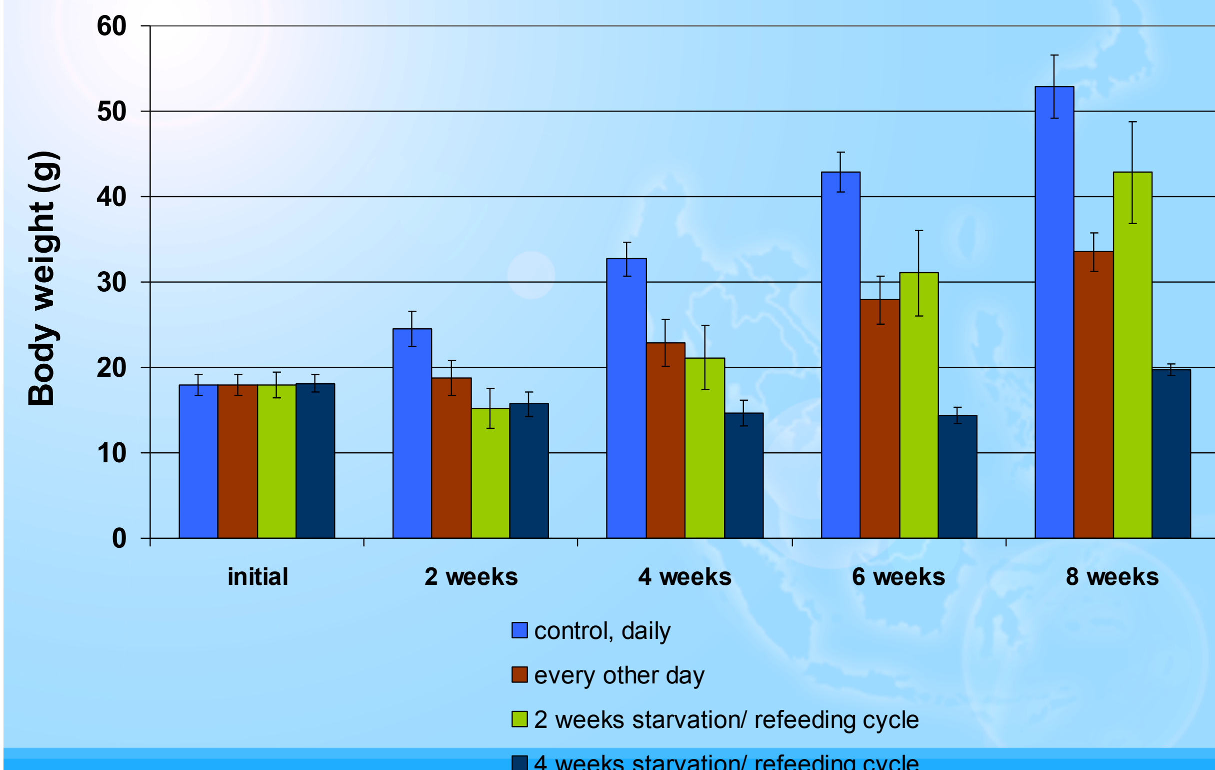
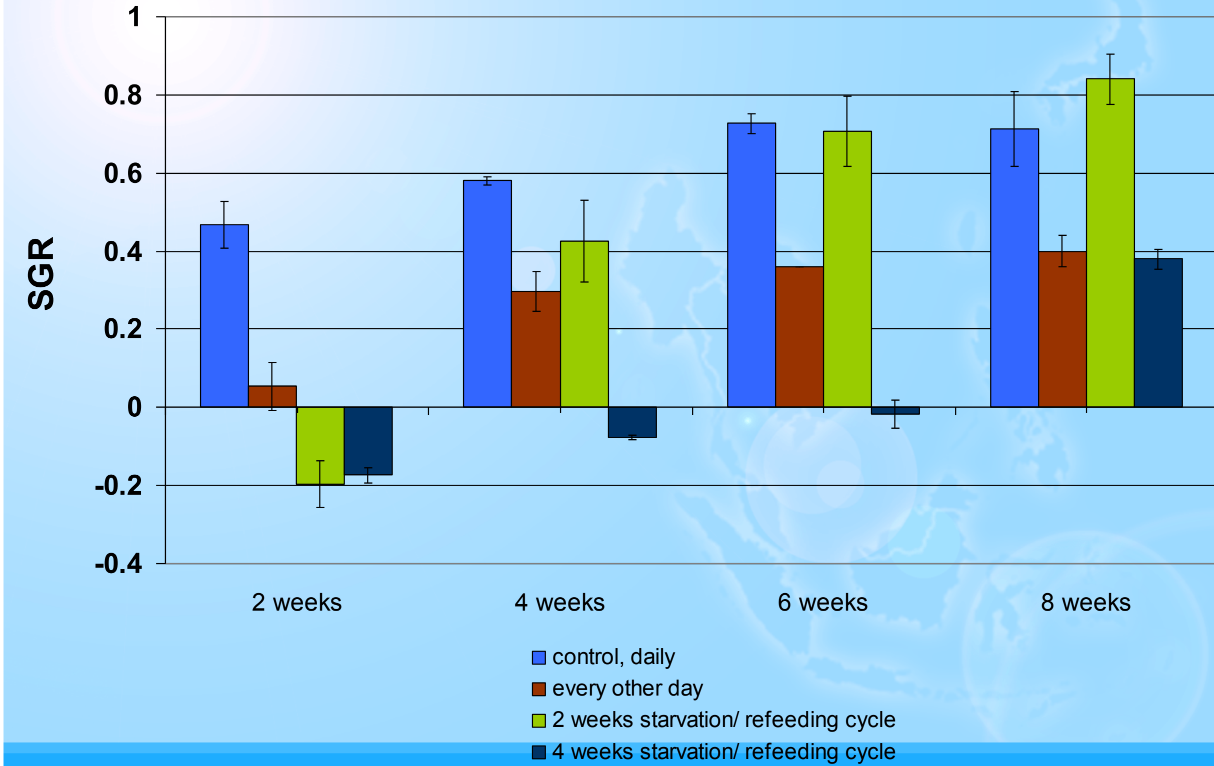
Feeding Scheme

- Daily feeding, 10% of BW
- Feeding every other day, 10% of BW
- 2-week alternate starvation and refeeding cycles, 10% of BW
- 4-week alternate starvation and refeeding cycles, 10% of BW

Experimental Set-up

- 1-ton fiberglass tanks provided with flowing seawater
- 3 replicate tanks per treatment
- 100 fish/tank (initial BW ranging from 15.31 to 20.86g)
- Sampling every two weeks





Summary

✓ Milkfish seems to exhibit compensatory growth mechanism(s). A 2-week starvation and refeeding cycle results in final body weights comparable to the control group fed daily

✓ Feeding every other day result in lower growth rates compared to daily feeding

✓ A 4-week starvation and refeeding cycle resulted in poor growth performance compared to control

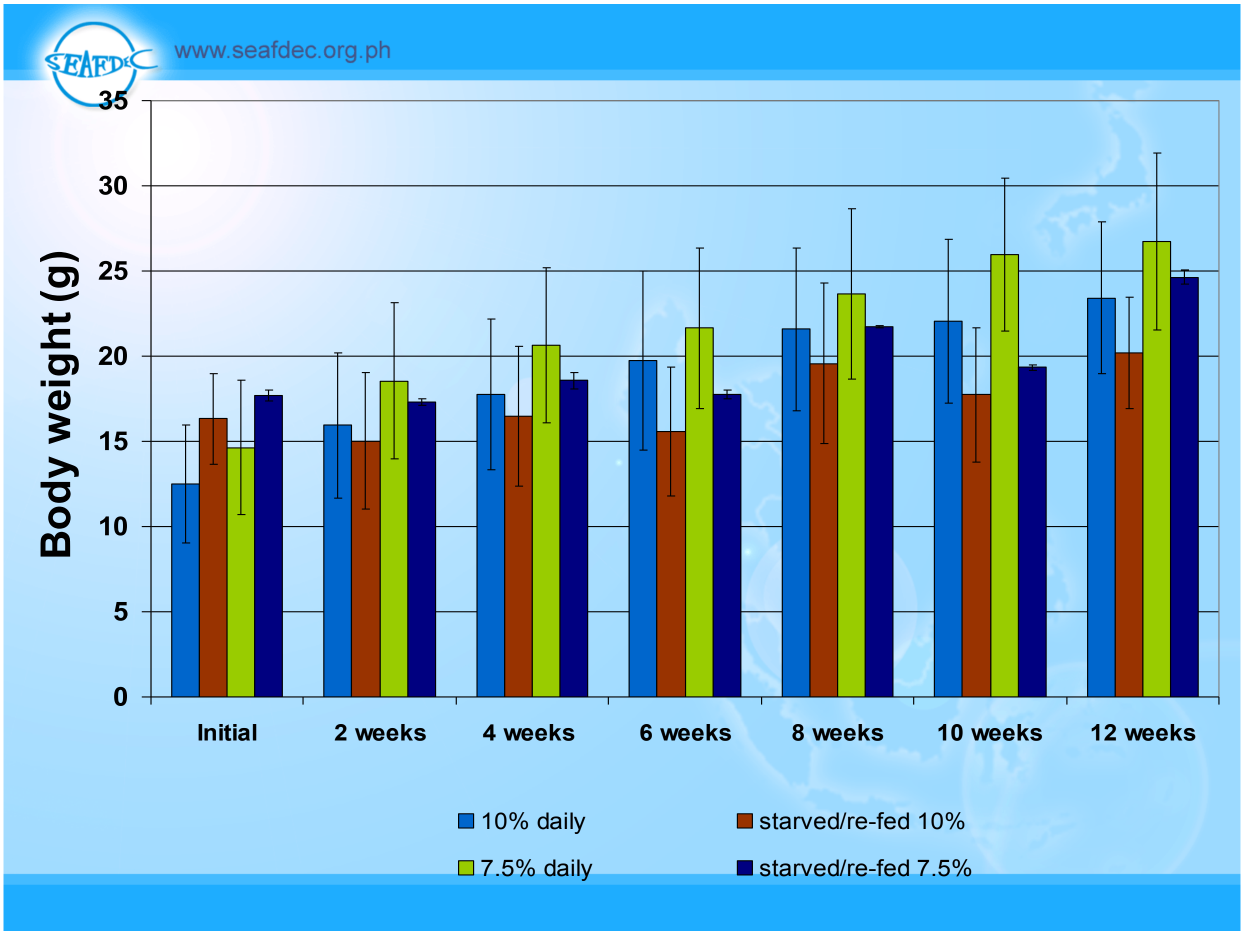
Question: Can feeding be reduced further?

Experimental Set-up

- 1-ton fiberglass tanks provided with flowing seawater
- 3 replicate tanks per treatment
- 100 fish/tank (initial BW ranging from 12.51 to 16.33g)
- Sampling every two weeks

Feeding Scheme

- Daily feeding, 10% of BW
- 2-week alternate starvation and refeeding cycles, 10% of BW
- Daily feeding, 7.5% of BW
- 2-week alternate starvation and refeeding cycles, 7.5% of BW



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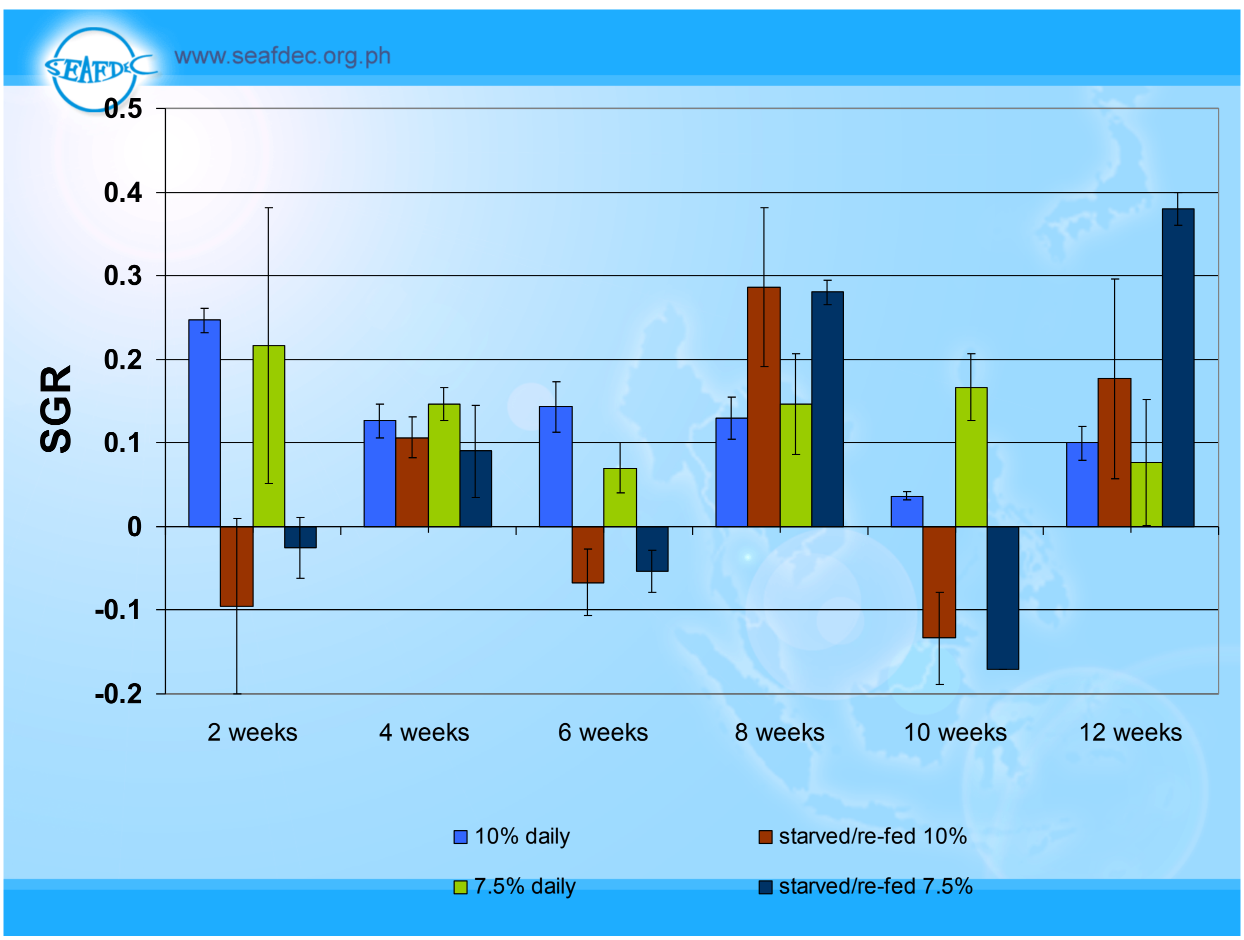
Body weight (g)
35
30
25
20
15
10
5
0
Initial
2 weeks
4 weeks
6 weeks
8 weeks
10 weeks
12 weeks
10% daily
starved/re-fed 10%
7.5% daily
starved/re-fed 7.5%



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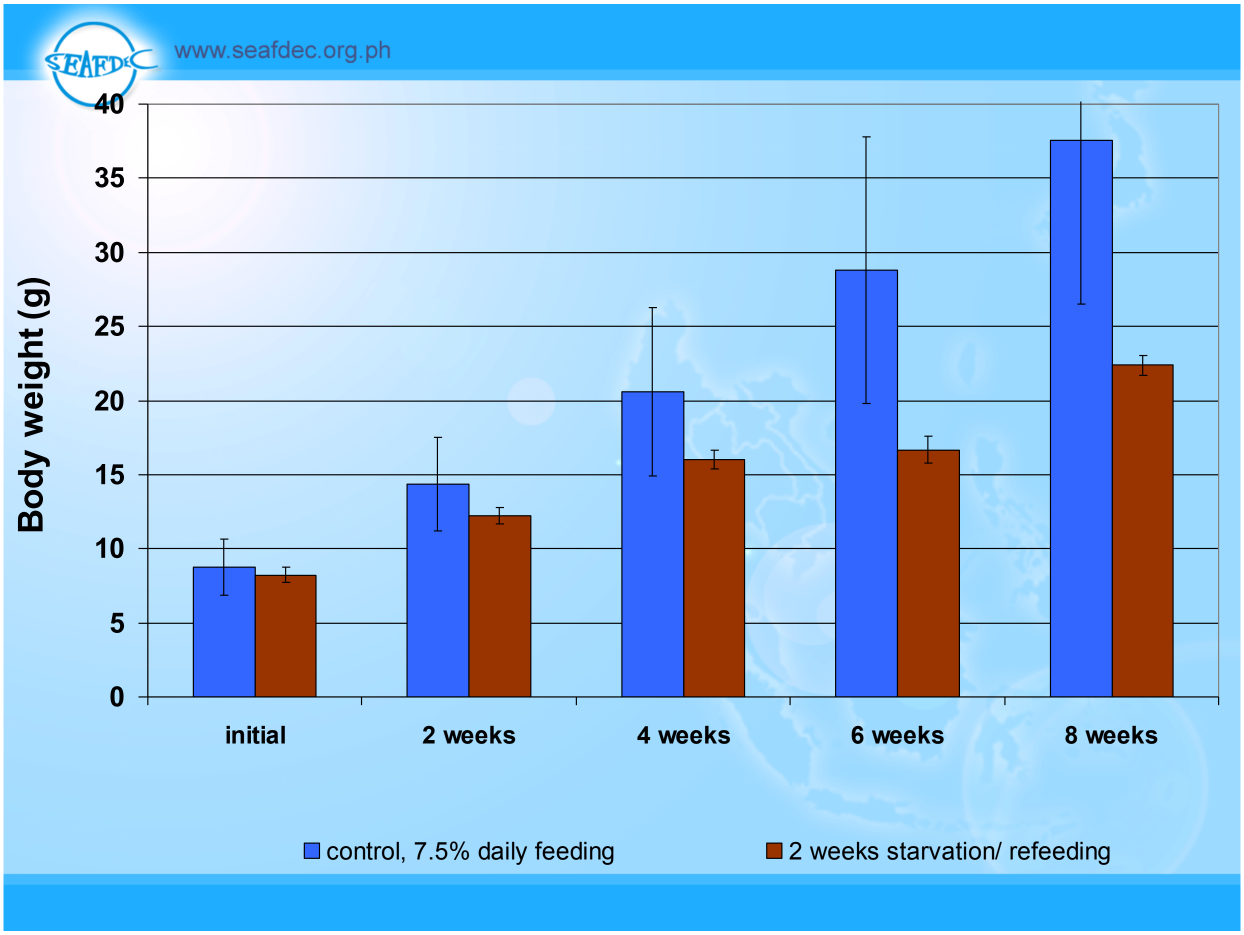
SGR
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
2 weeks
4 weeks
6 weeks
8 weeks
10 weeks
12 weeks
10% daily
starved/re-fed 10%
7.5% daily
starved/re-fed 7.5%

Summary

- ✓ Milkfish given a daily ration of 7.5% of its body weight grow as well as fish fed a daily ration of 10% of its body weight
- ✓ Results of the present experiment also validate results from the previous experiment that growth in fish subjected to 2-week starvation and refeeding cycles is comparable to that of fish fed daily

We wanted to validate the result of the tank experiments in a simulated cage set-up

- ❖ 2 x 2 x 1m cage set in a 500-ton tank provided with flowing seawater
- ❖ 100 fish/cage (initial BW 7.88-10.10g)
- ❖ Feeding: 7.5% BW daily or 2-week starvation and refeeding cycle (7.5%)
- ❖ 2 replicate cages per treatment



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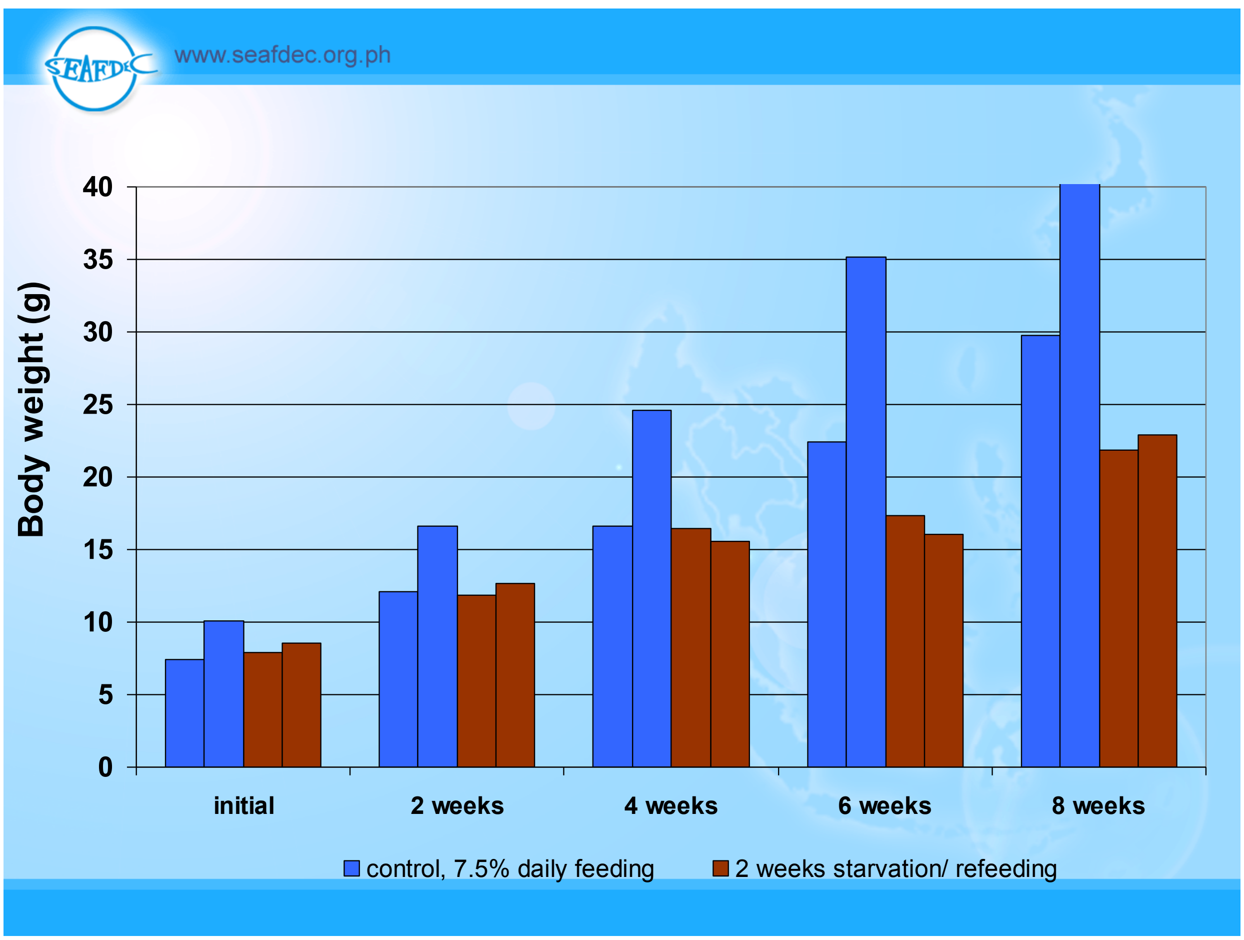
Body weight (g)
40
35
30
25
20
15
10
5
0
initial
2 weeks
4 weeks
6 weeks
8 weeks
control, 7.5% daily feeding
2 weeks starvation/ refeeding



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Body weight (g)
40
35
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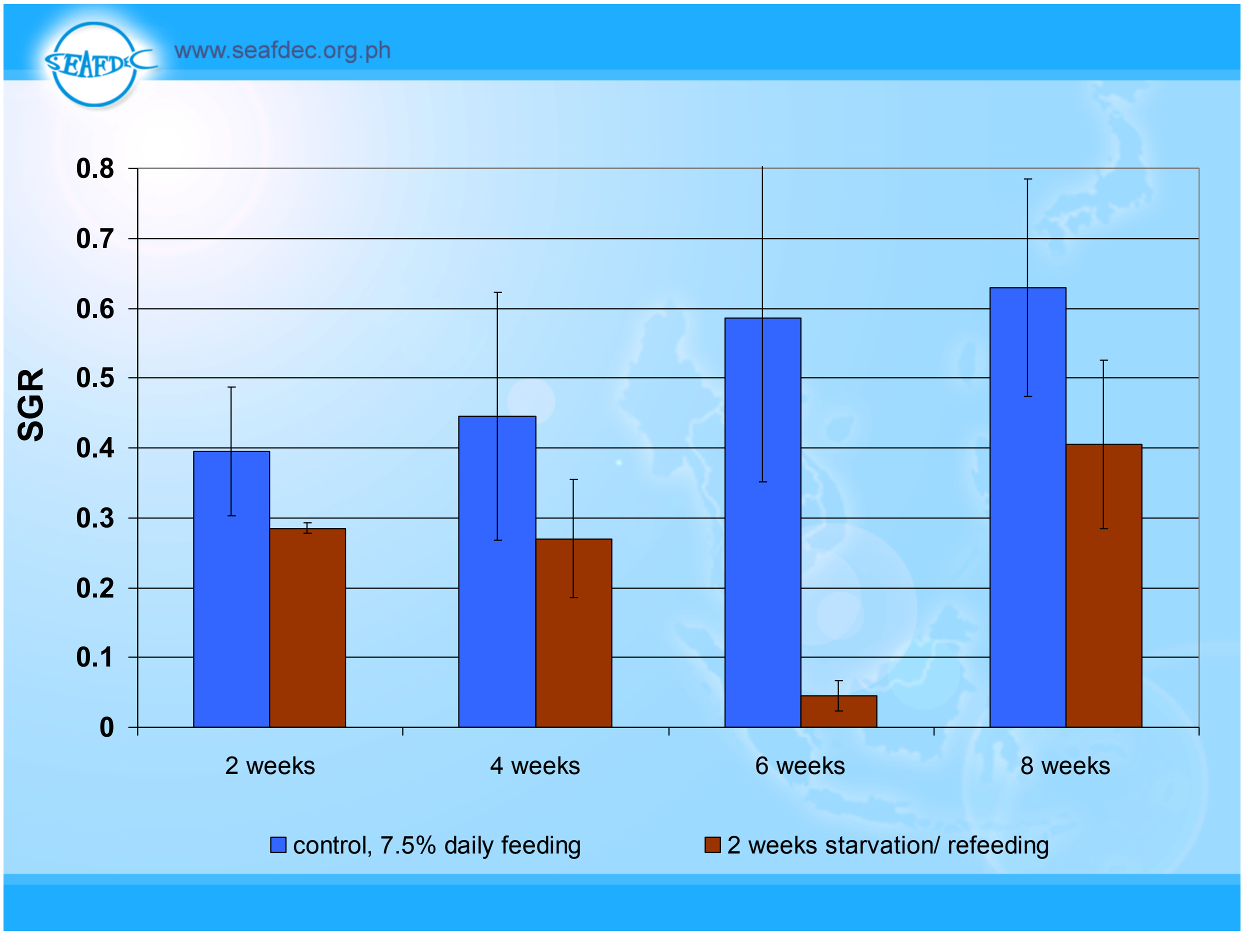
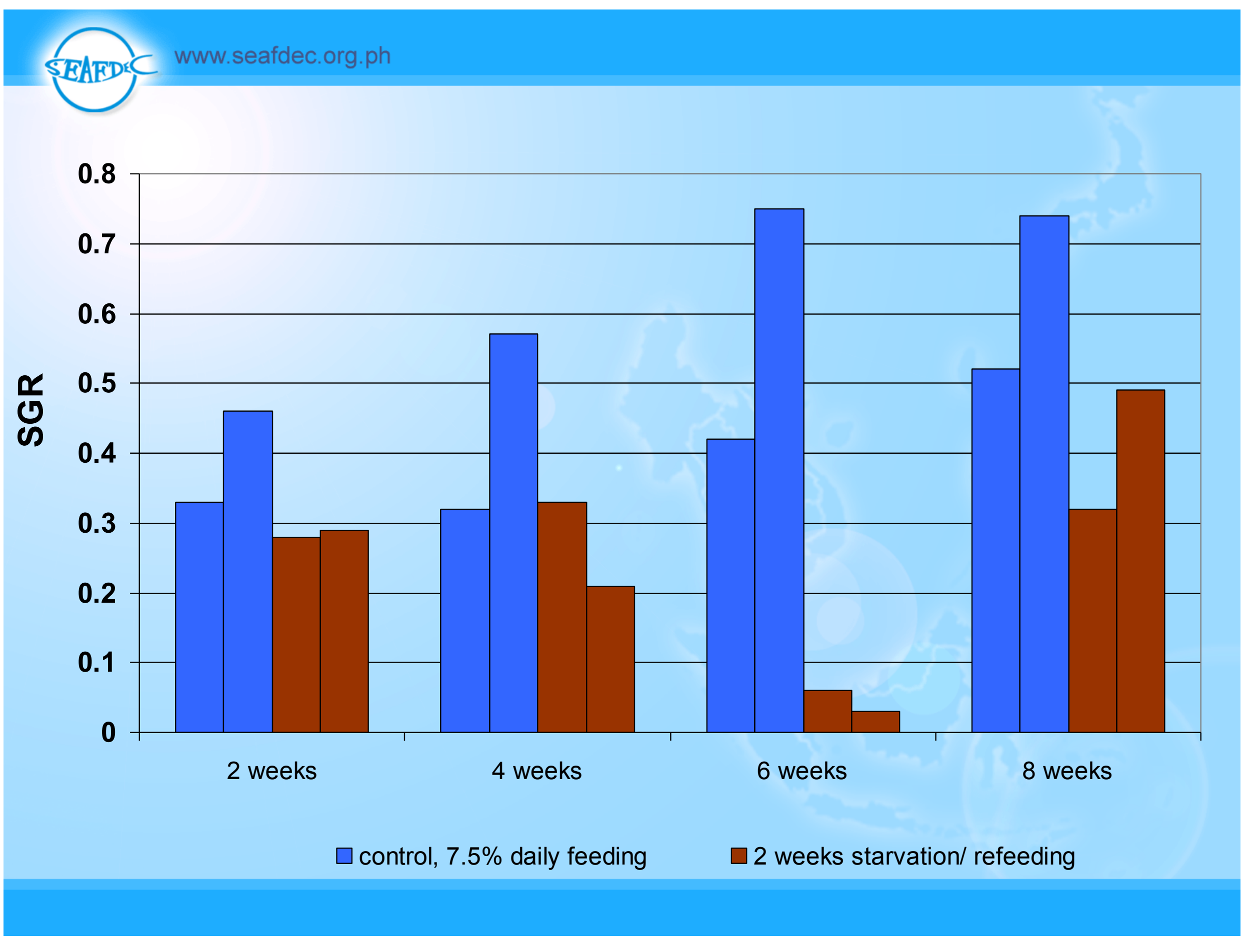
initial
2 weeks
4 weeks
6 weeks
8 weeks
control, 7.5% daily feeding
2 weeks starvation/ refeeding


www.seafdec.org.ph
SGR
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2 weeks
4 weeks
6 weeks
8 weeks
control, 7.5% daily feeding
2 weeks starvation/ refeeding


www.seafdec.org.ph
SGR
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2 weeks
4 weeks
6 weeks
8 weeks
control, 7.5% daily feeding
2 weeks starvation/ refeeding

Summary

- ✓ Milkfish subjected to 2-week starvation and refeeding cycles did not grow as well as fish fed daily
- ✓ Milkfish subjected to 2-week starvation and refeeding cycles did not exhibit a marked compensatory growth response probably because they did not reach a catabolic state
- ✓ Milkfish which are filter feeders, most probably fed on the plankton population in the rearing water during the period when they were "starved"

Implications

- ✓ Reduced feed inputs
- ✓ Reduced feeding costs
- ✓ Higher profit margins
- ✓ A more affordable milkfish
- ✓ Reduced negative environmental impact

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- Validate the results of the tank experiments in marine cage as well as brackishwater pond production

Igang Marine Station Mariculture Park

Dumangas Brackishwater Station

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Thank you!

Question: Do other tropical high value marine fish like grouper, also exhibit compensatory growth?

Experimental Set-up

- 1-ton fiberglass tanks provided with flowing seawater
- 20 fish/tank (initial BW ranging from 287-310g)
- One group fed daily at 5% BW; the other group 2-week starvation and refeeding cycles
- Sampling every two weeks

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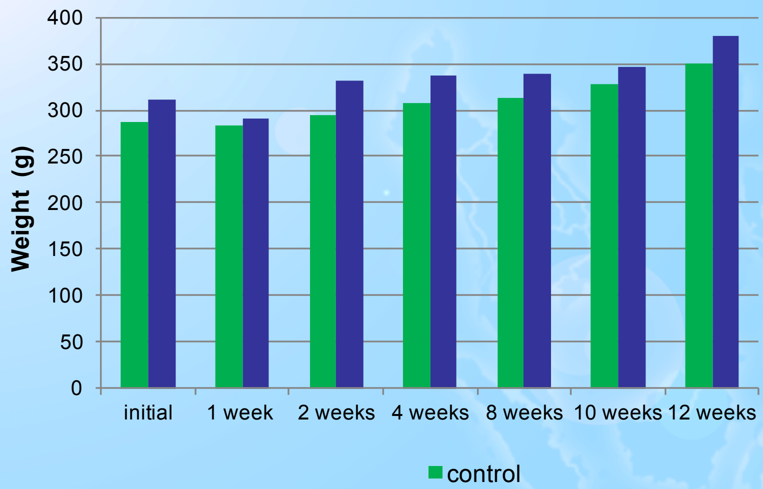
Grouper: 2-week Starvation /Refeeding



Use of Freshwater Low Value Fish for Aquaculture Development in Cambodia's Mekong River Basin

So Nam*, Eng Tong, Souen Norng and Kent Hortle
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Fisheries Administration
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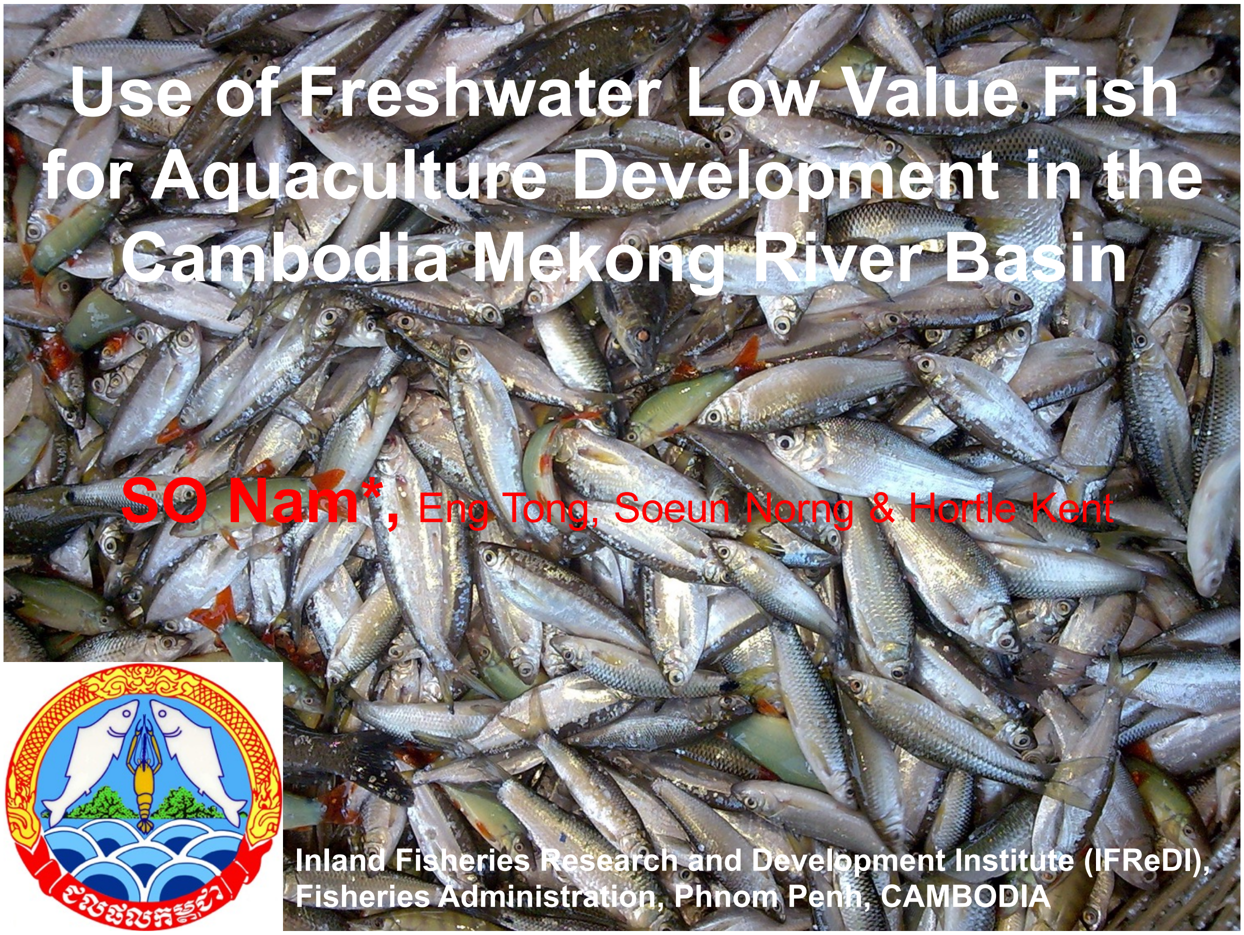
Aquaculture of carnivorous and omnivorous fish species and crocodile in Cambodia is highly dependent on inland fisheries of low value fish for sourcing key dietary nutrient inputs. Thousands of tonnes of low value fish are also used for producing fish and other animal meals and for human consumption.

This study provides clear understanding of the current status of the use of freshwater low value fish in Cambodia. In order to achieve this goal, five specific objectives are developed: (1) To assess technological impacts of use of freshwater low value fish for aquaculture development in Cambodia; (2) To determine approximate quantities or proportions and numbers, to the extent possible, of low value fish species used as direct feed for growing carnivorous and omnivorous fish species and crocodile; (3) To assess socioeconomic impacts of the use of low value fish; (4) To examine actions/strategies to address the identified negative impacts; and (5) To imply for sustainable aquaculture development and fisheries management in the Cambodia's Mekong basin.

In order to achieve the above objectives, primarily field surveys of the main types of aquaculture of carnivorous species (fin fish and crocodiles) and omnivorous species (only fin fish), which are respectively mainly and partially fed with low-marketed value fish, is carried out among local farmers in the four major river branches of the Cambodia's Mekong River basin, with a distance of over 500 km using developed questionnaires.



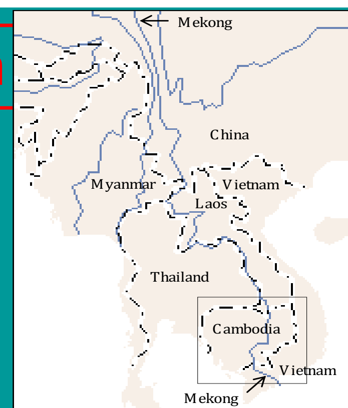
OUTLINE

1. General background of Cambodia
2. The Cambodia Mekong River Basin
3. Fisheries of low valued or small-sized fish
4. Culture systems, species stocked and the use of freshwater low valued or small-sized fish as direct feed
5. Further research questions
6. Acknowledgements

1. General Background of Cambodia

- Total land area = 181,035 km2
- About 86% of the total area is within the Mekong catchment
- Total population = about 13.4 millions (2008)
- Birth rate = 1.48%
- Coastline = 435 km

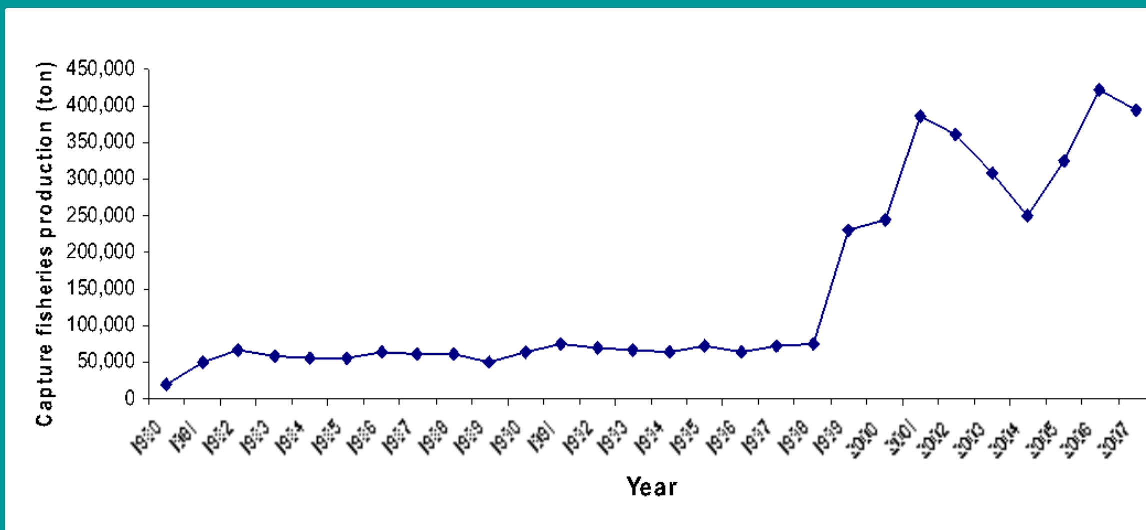
2. Cambodia Mekong River Basin



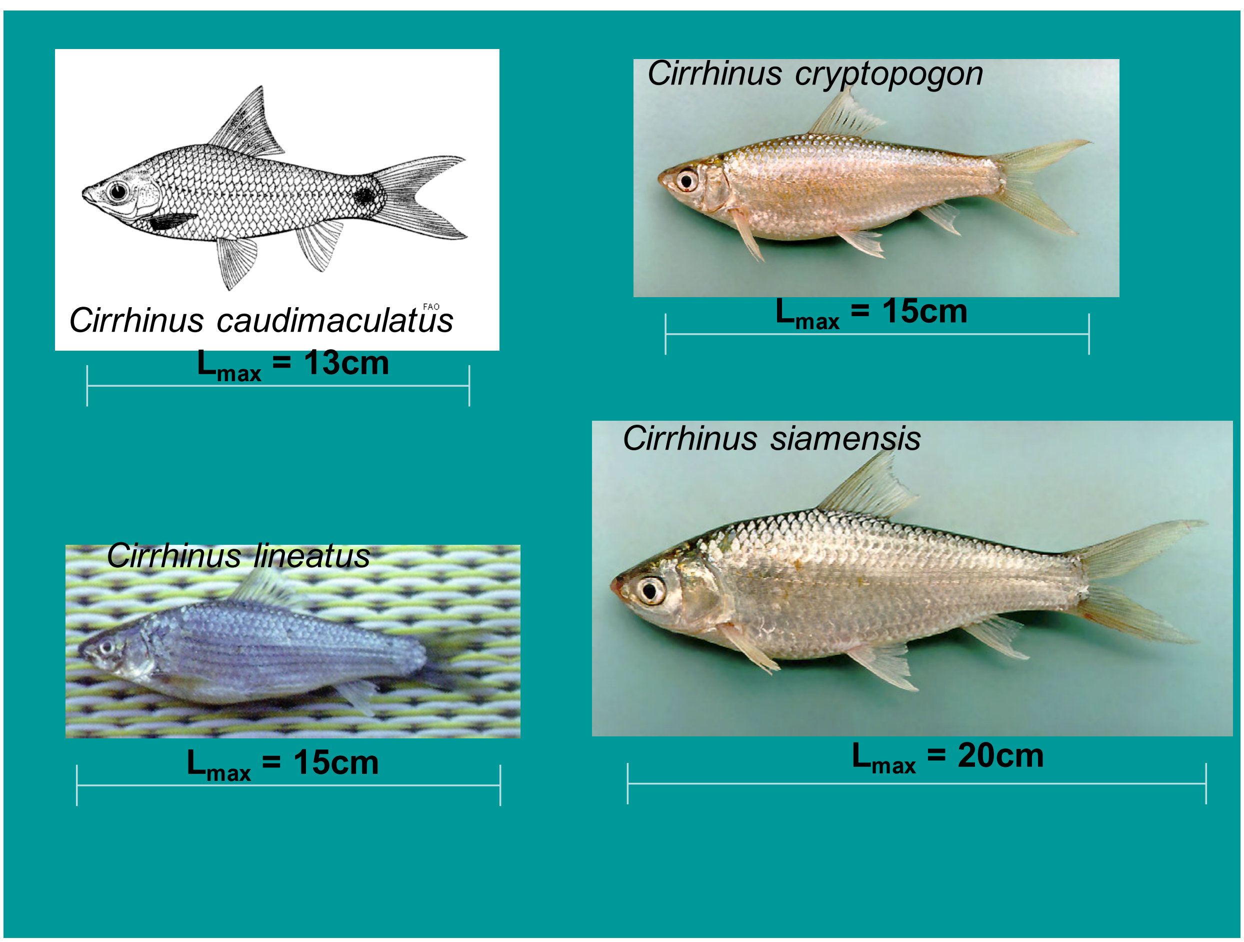
- Floodplain: 40,000 km^2 or 22% = 60%
- Food forests: 22,000 km^2 or 55%
- Wetland: 18,000 km^2 or 45%
- Tonle Sap: 3,000-15,000 km^2 or 8%, the largest and most productive lake in SE Asia

3. Fisheries of low valued or small-sized fish

Trends of Annual Freshwater Capture Fisheries Production




Small-Sized Fish/juvenile of commercially important fish species


Cirrhinus caudimaculatus
Lmax = 13cm
Cirrhinus cryptopogon
Lmax = 15cm
Cirrhinus lineatus
Lmax = 15cm
Cirrhinus siamensis
Lmax = 20cm

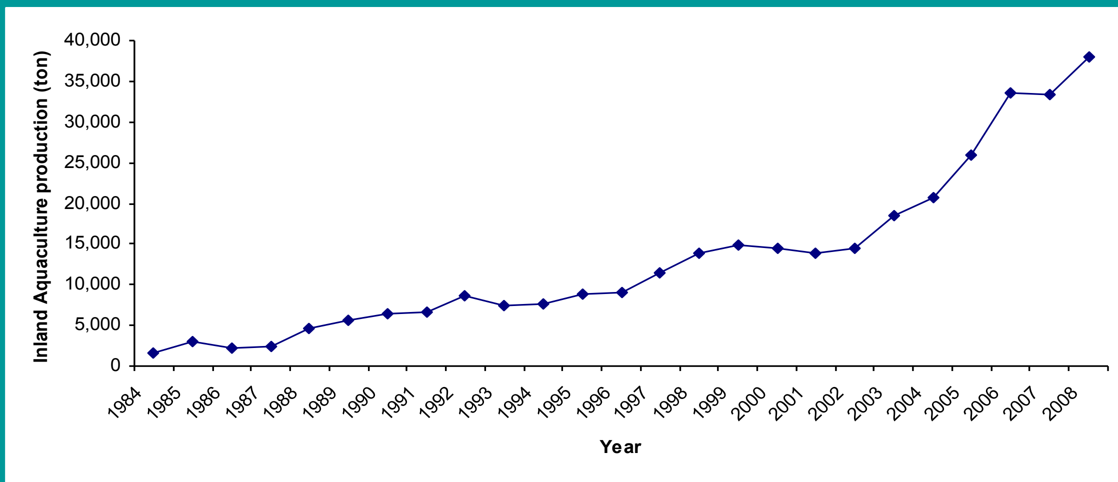

Stationary trawl-net
Seine - net
Fence fishing


Barrage fishing gear


Arrow-shaped fishing gear

4. Culture systems, species stocked, use of freshwater low value or small-sized fish as direct feed

Inland Aquaculture Production in Cambodia



Intensive pond system

Fish species stocked in Intensive pond system

Sutchi catfish

Hybrid catfish

X

Asian catfish

(Clarias batrachus)

African catfish

(Clarias gariepinus)

Use of freshwater low value or small-sized fish as direct feed for intensive fish ponds

		Feed type and feed composition (%)				
Cultured species	FCR	FW fish	D fsih	RB	Kapok	Others*
Clarias batrachus x C. gariepinus	5 (1 – 10)	54	0	44	2	0
Pangasianodon hypophthalmus	5 (3 – 11)	20	2	75	0	3

** Feed including pellet, vegetation plants, kapok flour, red corn and animal slaughter waste.*

Floating wooden cage system

Fish species stocked in cage system

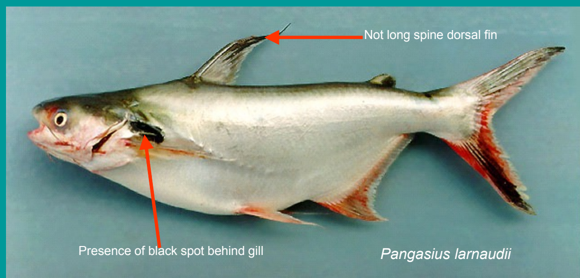
Giant snakehead

Snakehead murrel

Hemibagrus wyckioides

Silver barb

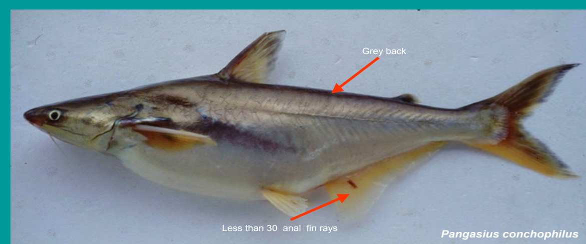
Fish species stocked in cage system



Pangasius larnaudii

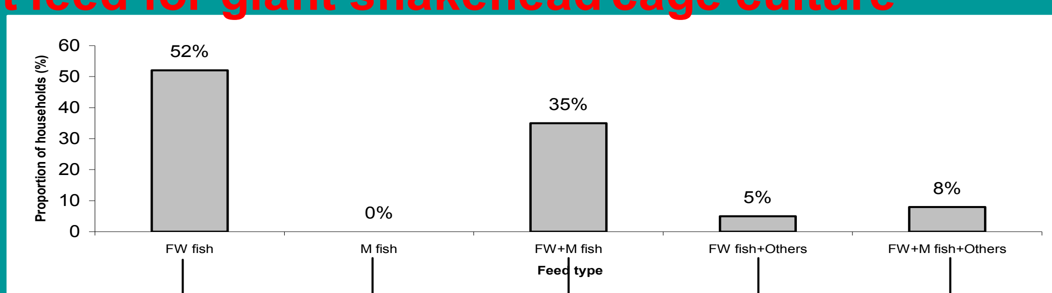
Pangasius bocourti

Pangasianodon hypophthalmus



Pangsius conchophilus

Use of freshwater low value or small-sized fish as direct feed for giant snakehead cage culture



FCR/Feed composition	FW fish	M fish	FW+M fish	FW+Others	FW+M+Others
Average	4	na	5	5	5
Minimum	1	na	2	3	1
Maximum	9	na	10	10	9
FW fish (%)	100	na	73	64	60
M fish (%)	0	na	27	0	23
Others (%)	0	na	0	36	17
- Rodent	0	na	0	22	13
- Amphibian	0	na	0	10	3
- Snake	0	na	0	4	1

Feeding the **giant snakehead *Channa micropeltes*** in the Cambodia's cage culture system. Note: FCR = Feed Conversion Ratio; FW fish = Freshwater fish (i.e. low-market value and small-size fish); M fish = Marine fish (i.e. low-market value); Others = rodent (e.g. mouse/rat) + amphibian (e.g. frog) + snake (water snake).

Use of low value or small-sized fish as direct feed for cage culture

Cultured species	FCR	Feed type and feed composition						
		FW fish	D fish	RB	ASW	V	RC	CW
Hemibagrus wyckioides	5	80	0	0	20	0	0	0
Channa striata	8	100	0	0	0	0	0	0
Pangasius conchophilus	8	19	0	81	0	0	0	0
Pangasius larnaudiei	3	20	5	75	0	0	0	0
Pangasius bocourti	5	26	0	34	0	0	10	30
Pangasianodon hypophthalmus	7	15	0	76	0	9	0	0
Barbodes gonionotus	8	38	0	38	0	24	0	0
Polyculture**	6	26	10	59	0	5	0	0

** Polyculture of *P. hypophthalmus, P. bocourti, P. larnaudiei, P. conchophilus, B. altus and B. gonionotus*

Use of freshwater low value or small-sized fish as direct feed for crocodile farming in Cambodia

Life stage	Feeding rate (kg/head/year)	Feed type and feed composition (%) FW fish	FW shrimp	M fish	Rodent	Snake	Pork/Beef	ASW
Hatchling	34 (10 – 139)	81	12	2	0	0	5	0
Juvenile	62 (23 – 200)	87	0	6	3	3	0	1
Adult	124 (45 – 327)	80	0	5	8	6	0	1

Use of freshwater low value or small-sized fish as direct feed for aquaculture in Cambodia

Feed type	Feed quantity (tonne) Onivorous and carnivorous fish	Crocodile Hatchling	Juvenile	Adult	Total	Grand total
Freshwater fish*	47,262	2,061	3,536	1,735	7,332	54,593
Marine fish	2,617	51	244	108	403	3,020
Dried freswater fish	1,074	0	0	0	0	1,074
Freshwater shrimp	0	305	0	0	305	305
Rice bran	40,590	0	0	0	0	40,590
Rodent	1,832	0	122	174	295	2,128
Amphibian	680	0	0	0	0	680
Snake	262	0	122	130	252	514
Pork/beef	0	127	0	0	127	127
Vegetation plant	2,411	0	0	0	0	2,411
Red corn	610	0	0	0	0	610
Kapok flour	87	0	0	0	0	87
Casava waste	1,570	0	0	0	0	1,570
Animal slaughter waste	1,134	0	41	22	62	1,196
Pellet (manufactured)	87	0	0	0	0	87

* including the small freshwater shrimps *Macrobrachium sp*.

5. Further research questions

1. How is the competition and impacts between use of freshwater small-sized fish for aquaculture feed versus use for human food in Cambodia as well as in other countries of the Mekong River Basin?

2. How many freshwater small-sized fish species, genera and families, and species composition used for aquaculture development and human consumption? How many species and proportion of juvenile of commercially important freshwater fish used as direct feed for aquaculture development?

3. How to Maximize the utilization of low value or small size fish for human consumption through appropriate value added product development?

4. What are the impacts of the ban on snakehead culture in Cambodia?

5. What is the alternative feed or artificial plant protein feed for snakehead aquaculture development?

One photograph figuring out 19 small-sized fish species (Lmax < 25 cm), including juveniles of 3 commercially important fish species!

6. Acknowledgements

Mekong River Commission

Funding for this research was provided by the

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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.


Thank You Very Much
for Your Great Attentions

What is the Effect of Different Indispensable Amino Acid Imbalanced Diets on Tropical Fish pacu *Piaractus mesopotamicus*?

Rodrigo Takata, Maria C. Portella*, Thiago M. de Freitas, Karolina Kwasek and Konrad Dabrowski
Sao Paulo State University - Aquaculture Center. Via Prof. Paulo Donato Castellane, 14884-900 Jaboticabal, SP, Brazil. E-mail: portella@caunesp.unesp.br .

Under practical farming conditions, feed formulations that include plant proteins may result in disproportionate amounts and deficiencies of indispensable (essential) amino acid (IDAA). The pacu, *Piaractus mesopotamicus*, is a native species extensively cultured in Brazil and frequently subjected to disproportionate amounts of IDAA in commercial diets. The present study aimed to investigate how disproportional amounts of IDAA in diets for juvenile pacu affects the growth and survival when IDAA-imbalanced diets are provided in subsequent meals. The experiment was carried out for 56 days. Four isonitrogeneous and isolipidic diets were used: casein-gelatin-based diet (protein control), FAA-based diet (with all indispensable amino acids), (-)Lys diet (devoid of Lys, His, Ile, Phe and Trp and (-)Arg diet (devoid of Arg, Thr, Val, Leu and Met). Amino acids were supplied in the form of L-free amino acids in FAA, (-) Lys and (-)Arg diets. Fish were fed four times per day at 4-hour intervals and the feed schedule (treatment) used were: (-)Lys(-)Arg group, fish were fed 4 meals of (-)Lys, (-)Arg, (-)Lys and (-)Arg diets each day throughout the experiment; (-)Lys(-)Lys group, fish were fed 2 meals of the (-)Lys diet as first two meals in the morning and then 2 meals of the (-)Arg diet in the afternoon; (-)Lys/(-)Arg group, fish were fed four meals of the (-)Lys diet and the (-)Arg diet on alternate days; FAA and Protein diets (controls); fish were fed FAA-based balanced and casein-gelatin based diets, respectively, each day throughout the experiment. Mortality was monitored and moribund fish were removed to avoid cannibalism. Growth performance was assessed by using mean individual weight. Fish fed the protein diet showed the highest ($P<0.05$) growth (1472.9 103.05 mg at the end of the experiment) compared to other treatments and the FAA-based balanced diet (not shown in Fig 1). The (-)Lys/(-)Arg treatment resulted in lower weight ($P<0.05$) in the last two evaluations (48th and 56th experimental day) (Fig.1). The protein-based and FAA-based diets showed higher ($P<0.05$) survival compared to (-)Lys(-)Arg and (-)Lys/(-)Arg diets. The groups that had received IDAA-imbalanced diet in subsequent meals and days have shown similar survival ($P>0.05$). The nitrogen source was of critical importance, with the best result in casein-gelatin fed fish. The supply of IDAA-imbalanced diets in alternate days is not a suitable schedule to support pacu growth compared to an alternate meals schedule. There was no effect on survival.

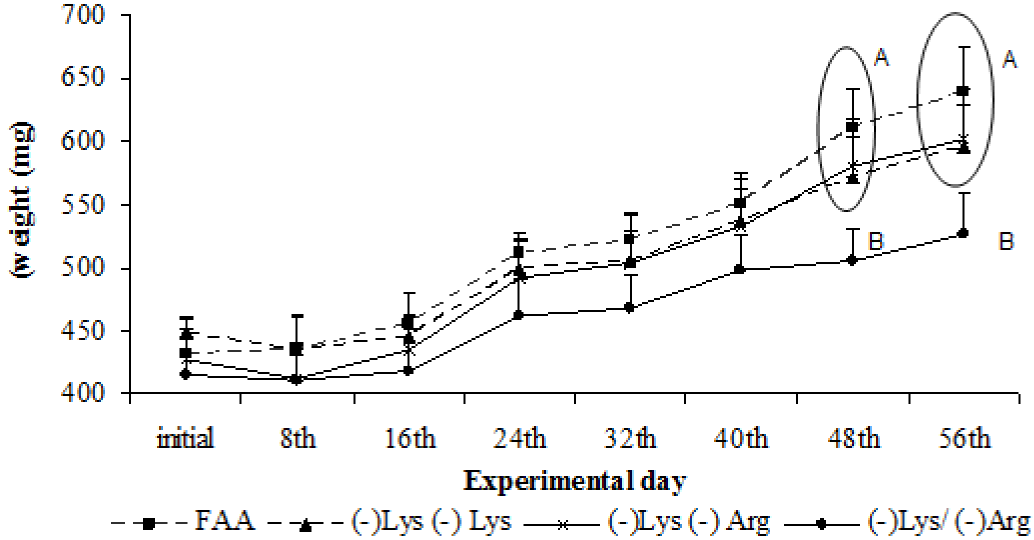

Figure 1. Mean weight of fish during the experiment with the (-)Lys(-)Lys, (-)Lys(-)Arg, (-)Lys/(-)Arg and FAA diets.

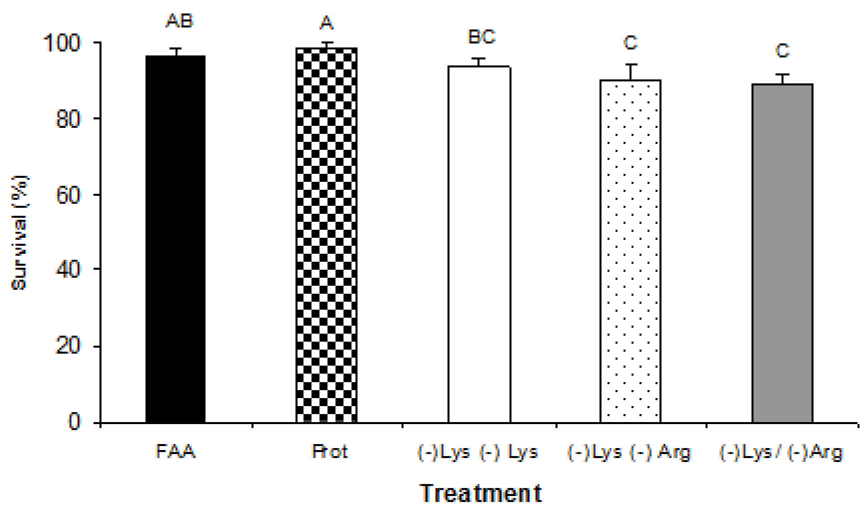

Figure 2. Mean survival of fish at the end of experiment with the (-)Lys(-)Lys, (-)Lys(-)Arg, (-)Lys/(-)Arg, FAA and Prot (casein-gelatin) diets.

WHAT IS THE EFFECT IN TROPICAL FISH PACU *Piaractus mesopotamicus* WITH THE SUPPLY OF DIFFERENT IMBALANCED DIETS IN INDISPENSABLE AMINO ACID?

Rodrigo Takata[1], Maria Célia Portella[1], Thiago M. de Freitas[1], Karolina Kwasek[2] and Konrad Dabrowski[2]

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E-mail: portella@caunesp.unesp.br.

[2] School of Environment and Natural Resources, The Ohio State University, Columbus, OH, 43210, USA.

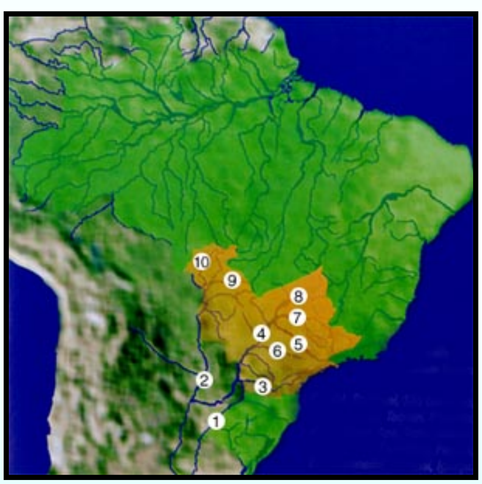
- Species – pacu *Piaractus mesopotamicus*

  Tropical fish – important native from South America

  Originally – Plata Basin

  max. published weight:

  20.0 kg



Brazil, Argentina, Paraguay, Uruguay

Pacu has been studied for more than 30 years in Brazil

- Characteristics of the species:

  Feeding habit → omnivorous (seeds, leaves, fruits, fish carcass)

Larviculture - Intensive rearing (Indoors)

Good results with live food - *Artemia* nauplii.

Jomori et al., 2003, 2007.

Tesser et al. 2005; 2006.

Newly hatched, 4 mm

7.2 mm TL

26mm TL, 241 mg

Larvae around 10 mg are ready to receive formulated diet “Weaning”

Majority of study: Feeding and Nutrition

Behavior and protein utilization	Energy utilization and requirements of AAs	Vitamins and peptides
Feeding behavior *(Dias-Koberstein et al., 2004)*	**Use of non-protein energy source** *(Abimorad and Carneiro, 2007)*	**Effects of lipoic acid and ascorbic acid in plasma free amino acids** *(Terjsen et al., 2006)*
Sources and levels of crude protein *(Fernandes et al., 2000; 2004)*	**Lysine and methionine supplementation** *(Muños-Ramírez and Carneiro, 2002)*	**Physiology effects of free and peptide-based dietary arginine supplementation** *(Tesser et al., 2005)*
Determination of crude protein and gross energy digestibility coefficients of feedstuffs *(Abimorad and Carneiro, 2004)*	**Apparent digestibility of protein, energy and amino acids** *(Abimorad et al, 2008)*	**Use of lipoic acid as potent substance for the prevention of ascorbic acid deficiency** *(Park et al., 2006)*

The new question!

What happens to the fishes supplied with imbalanced diets?

Problems in commercial formulated diet

Lack of studies on nutritional requirements in tropical fishes

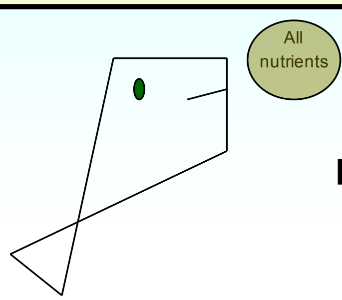
Results

Production of imbalanced formulated diets in practically all nutrients → all phases of development

Mainly indispensable amino acids

One pill, all nutrients

Sometimes it is not true



Nature

Fish eats

Seeds, small fish, ……, fruits, plankton

These foods are not complete in all nutrients by themselves

How fishes growth??

How fishes achieve the nutritional balance in nature??

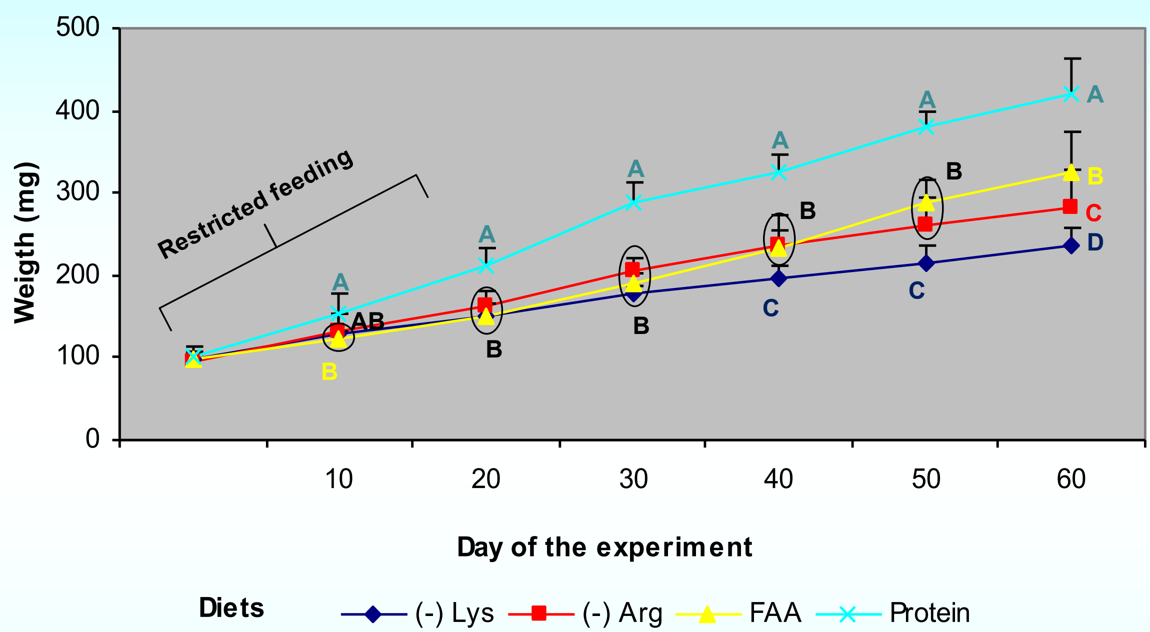
Our project aimed to investigate how disproportional amounts of indispensable amino acid in juvenile pacu diets affect growth, survival and free amino acids (FAA) levels in body tissues and whether fish can recover from IDAA-imbalanced diets when provided IDAA-balanced diets in subsequent meals

1st phase: Long term experiment in which fish were fed balanced Protein based diet, FAA balanced diet and two diets devoid of 5 indispensable amino acids (out of 10 IDAA) → **(-)Arg** (deficiency in Arg, Thr, Val, Leu and Met) or **(-)Lys diets** (deficiency in Lys, His, Ile, Phe and Trp). **Results were presented in Busan (WAS 2008 – CRSP Session)**

2nd phase: We have "switched" (or mixed) of (-)Lys and (-)Arg diets in a series of separate meals to investigate growth, survival and the recovery of FAA in fish body or "compensatory" response, i.e. higher levels of FAA than in control group of fish fed a balanced diet → **preliminary results of growth**

1st phase

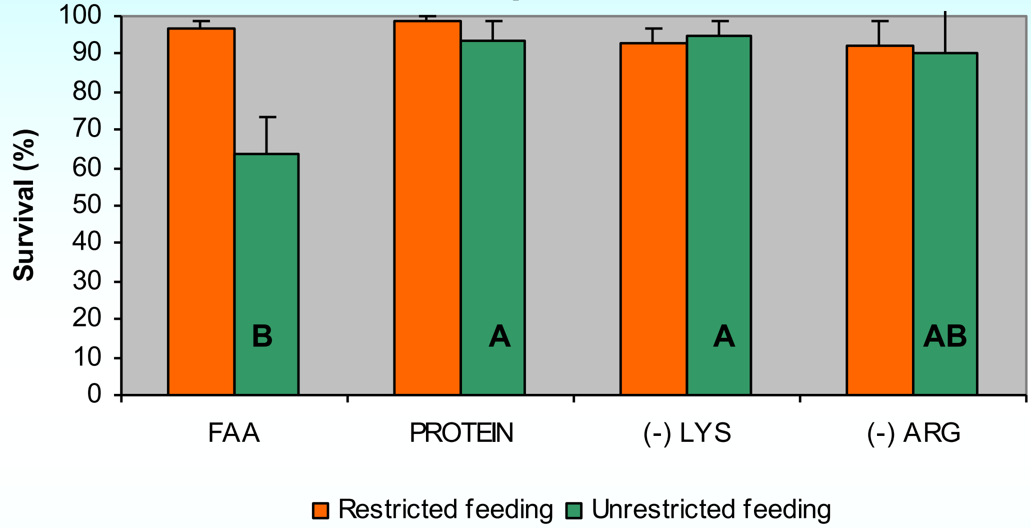
TAKATA, R. et al. (2008) Busan, Korea.



Imbalanced and balanced diets in IDAA are nutritionally inferior to support pacu growth than protein-based diet;

Just after long time (60 days) fish fed IDAA balanced diet has shown better growth in comparison to the IDAA imbalanced treatments.

1st phase



High tolerance in IDAA imbalanced diet when fed for long time (60 days).

The imbalanced and balanced diets in IDAA and protein-based diet do not affect the pacu amino acid profile in postprandial analysis (compared before and 30 minutes after feeding).

MATERIAL AND METHODS

Culture Conditions at the Aquaculture Center Jaboticabal/Brazil

2nd phase

430 mg juveniles

Temperature: 27 ± 0.2

Constant air supply

Initial density: 0.5 fish/L

Water flow-through system: 280mL/min

Dissolved Oxygen: 6.3 mg/L (78.3%)

Restricted feeding rate: 4% biomass

4 meals (8:00 am, 12:00 pm, 4:00 pm, 8:00 pm)

Composition of the four experimental diets for the experiment (g/100g).

Ingredients	Protein	Free AA	(-)Lys	(-)Arg
Casein	29.6	4.5	4.54	4.54
Gelatin	2	2	2	2
Dextrin	23.8	25.6	24.68	26.59
Cellulose	30.1	30.1	30.1	30.1
AA mix*	0	23.3	24.2	22.3
CMC[1]	2	2	2	2
Phosphitan C[2]	0.05	0.05	0.05	0.05
Vitamin mix[3]	2.4	2.4	2.4	2.4
Mineral mix[4]	4	4	4	4
Cod liver oil	3	3	3	3
Soybean oil	3	3	3	3

Free amino acid composition for Free AA, (-)Lys and (-)Arg diets (g/100g).

Free amino acid composition	Free AA	(-)Lys	(-)Arg
L-Lysine HCl	1.529	0	3.058
L-Arginine	1.251	2.502	0
L-Histidine	0.613	0	1.226
L-Threonine	1.258	2.516	0
L-Valine	1.623	3.246	0
L-Leucine	2.128	4.256	0
L-Isoleucine	1.364	0	2.728
L-Methionine	0.923	1.846	0
L-Cysteine	0.135	0.135	0.135
L-Phenylalanine	2.372	0	4.744
L-Tyrosine	0.073	0.073	0.073
L-Tryptophan	0.351	0	0.702
L-Glycine	0.51	0.51	0.51
L-Aspartate	2.658	2.658	2.658
L-Glutamate	2.829	2.829	2.829
L-Serine	1.929	1.929	1.929
L-Proline	0.385	0.385	0.385
L-Alanine	1.365	1.365	1.365
Total AA	23.296	24.25	22.342

- Feeding strategies:
  - T1: Protein (Prot)
  - T2: Free Amino Acid (FAA)
  - T3: (-) Lys (-) Arg
  - T4: (-) Lys (-) Lys
  - T5: (-) Lys/(-) Arg

	odd day				even day			
	8 am	12 am	4pm	8pm	8 am	12 am	4pm	8pm
T1:	Prot	Prot	Prot	Prot	Prot	Prot	Prot	Prot
T2:	FAA	FAA	FAA	FAA	FAA	FAA	FAA	FAA
T3:	(-)Lys	(-)Arg	(-)Lys	(-)Arg	(-)Lys	(-)Arg	(-)Lys	(-)Arg
T4:	(-)Lys	(-)Lys	(-)Arg	(-)Arg	(-)Lys	(-)Lys	(-)Arg	(-)Arg
T5:	(-)Lys	(-)Lys	(-)Lys	(-)Lys	(-)Arg	(-)Arg	(-)Arg	(-)Arg

- Analyses:
  - Weight
  - Biomass gain
  - Survival

- Statistical analyses

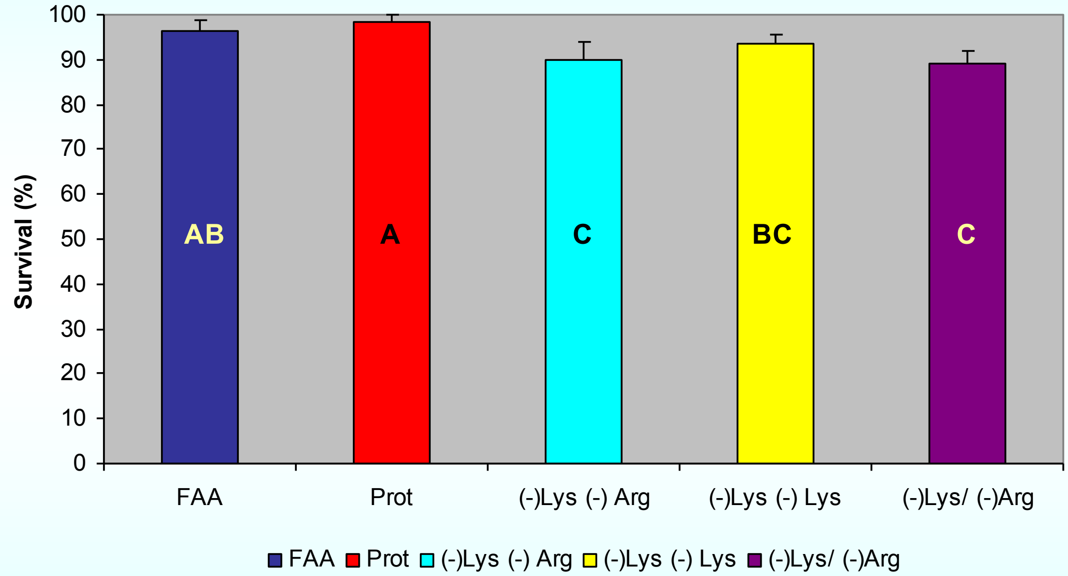
The fish group in one tank were considered as the experimental unit.

Experimental design : Entirely randomized, following a subdivision scheme with 5 treatments and 5 replicates, evaluated in eight periods

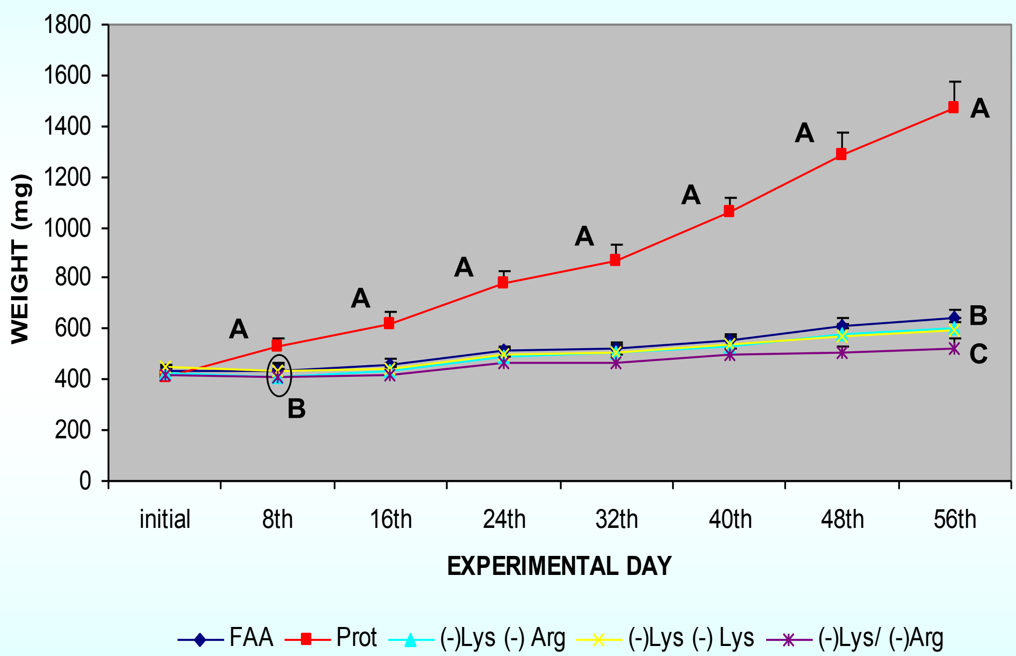
Growth parameters and survival were analyzed among dietary treatments (feeding strategies).

For the analyses of the results was used one-way ANOVA at P= 0.05 All procedure were performed using SAS, version 8.0.

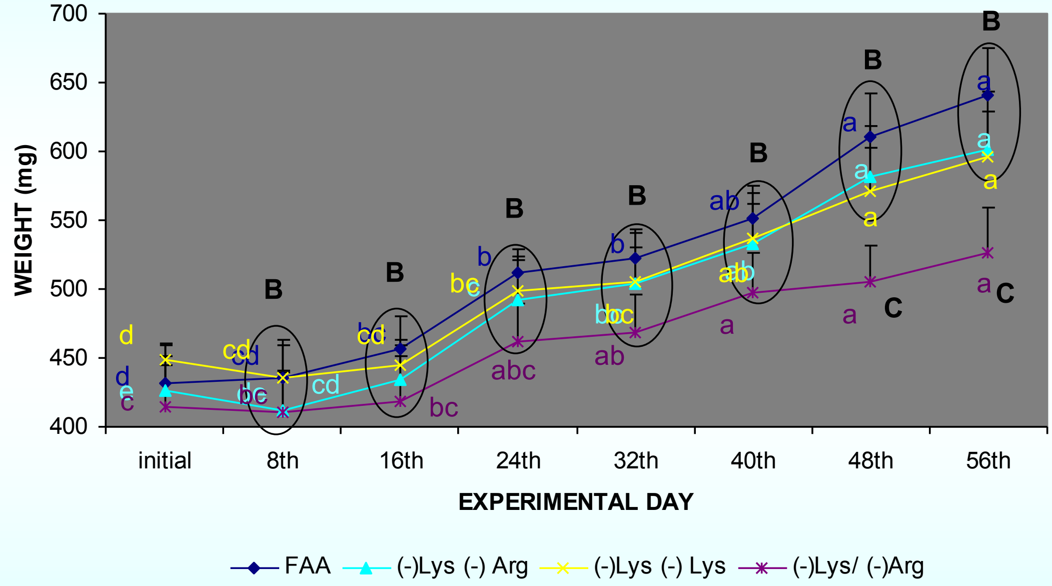
Survival



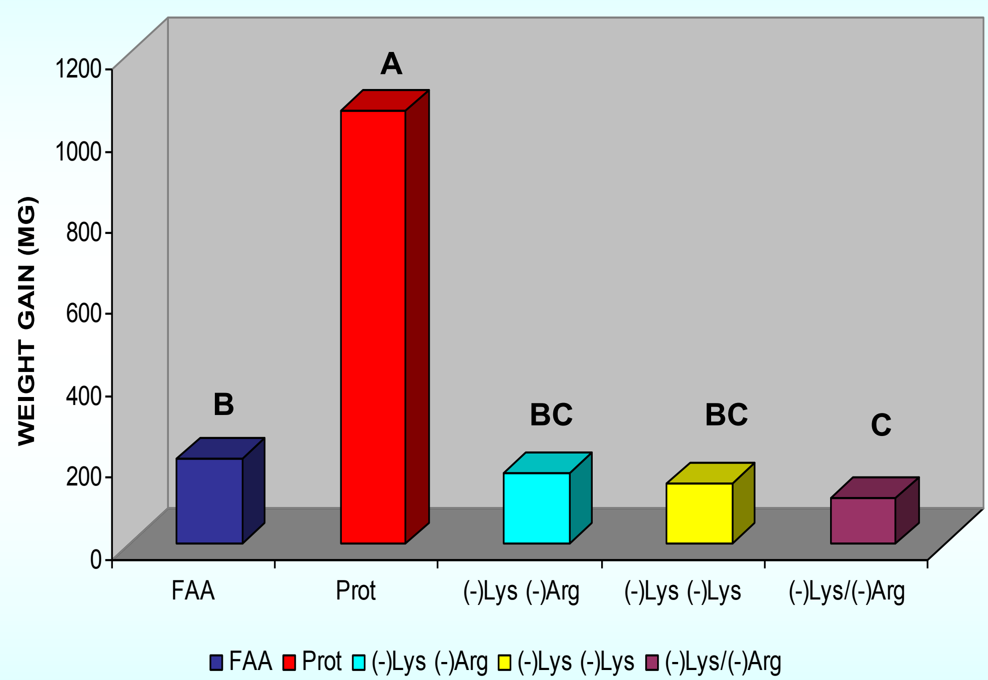
Growth



Growth, focusing in the free amino acid source and feeding strategies



Biomass gain



- The **IDAA balanced diet** and **all switching strategies** were nutritionally **inferior** to support pacu juvenile growth than p**rotein-based** diet;

- The **biomass gain** and individual **weight** of the fish were directly affected by the **nitrogen source**. Better growth was achieved with protein-based source;

- After 56 days, pacu' **survival** was negatively affected by **feeding strategies** and **IDAA-imbalanced diet**. The protein-based treatment appears as the best option for this species;

- The supply of IDAA-imbalanced diets in **alternate days** is not a suitable feeding strategy to support pacu growth compared to alternate meals. However, the survival was not affected.

Current status of the research

Rodrigo Takata working at OSU - CNPq fellow

- Biochemistry analysis

  Free amino acid analysis of body tissues

  High Performance Liquid Chromatography – HPLC

  The Ohio State University - USA

THE OHIO STATE UNIVERSITY

School of Environment and Natural Resources

Supervisor: Dr Konrad Dabrowski

Funding for this research was provided by the

Aquaculture
Collaborative Research Support Program
&
National Council for Scientific and Technological Development / Brazil

CNPq
Conselho Nacional de Desenvolvimento Científico e Tecnológico

USAID
UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

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Concentration of Organic Material in Oyster *Crassostrea corteziensis* Growing Waters at Boca de Camichin, Nayarit, Mexico

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Pacific Aquaculture and Coastal Resources Center, University of Hawaii at Hilo, Hilo, Hawaii 96720 haws@aol.com

The native oyster species, *Crassostrea corteziensis*, has been cultured in the Boca de Camichin estuary in Nayarit, Mexico for over 35 years. Oysters are grown suspended from floating rafts and culture. Recent rapid development without planning or limitation, has led to concern amongst growers as to the carrying capacity of this heavily utilized body of water. A study to estimate carrying capacity has begun. The results of water sampling to determine seston concentrations (Total Particulate Matter-TPM) and the organic fraction of seston (Particulate Organic Matter-POM) are presented here. Water sampling was conducted between February and June, 2008. Three transects were sampled: at the mouth of the estuary, in the central part of the oyster growing area, and the interior estuary area. At each of the transects, measurements were taken at 1.2 m and 2.5 m depth from the center of the estuary channel and close to the two banks. Sampling was repeated at ebb and flood tides.

The concentration of TPM varied from 9.2 in February to 109 in June with a mean of 39.18 The PMO varied between 2.06 in February to 6.59 in March with a mean of 3.82 There was no significant difference in concentrations of TPM nor PMO during the two tidal stages (Table 1). These concentrations are higher than found at another oyster (*Crassostrea gigas*) growing area in Bahia San Quintin in Baja California, Mexico (Garc2004) where the average POM concentration was 1.9 g/ml in an area where 1,913 tons of oysters are produced annually. POM as a percentage of seston (TPM) was lower however, in Boca de Camichin (3.1 to 22.4%) than at San Quintin (17.8 to 25.5%). The higher proportion of POM may influence the oysters' assimilation rate.

References: GarcZ., M. A GonzGF. Ley-Lou and A. Mej2004. Oyster culture potential in the west arm of San Quintin Bay: Current Biomass and preliminary estimate of carrying capacity. Ciencias Marinas 30(1A):61-74.

Date	TPM µg/ml	POM µg/ml	Tide type
February	9.2 ± 1.01	2.06 ± 0.129	flood tide
March	38.8 ± 2.11	6.59 ± 0.315	flood tide
March	25.47 ± 2.51	4.33 ± 0.256	ebb tide
May	17.5 ± 2.070	2.25 ± 0.215	flood tide
May	18 ± 2.316	3.54 ± 0.328	ebb tide
June	109 ± 17.80	3.42 ± 0.231	flood tide
June	56.3 ± 17.22	4.56 ± 0.282	ebb tide

Table 1. Concentration of seston (TPM) and PMO ± S.E.

CONCENTRATION OF ORGANIC MATERIAL IN OYSTER (*Crassostrea corteziensis*) GROWING WATERS AT BOCA DE CAMICHIN, NAYARIT, MEXICO

Maria C. Haws
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Guillermo Rodriguez Domínguez
Autonomous University of Sinaloa (UAS), Mazatlan, Mexico
Omar Calvario Martine
CIAD, Mexico
Laura Edith Corona Osuna and Eladio Gaxiola Camacho
Autonomous University of Sinaloa (UAS), Culiacan, Mexico

Background

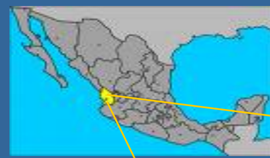
Human Health and Aquaculture: Health Benefits Through Improving Aquaculture Sanitation and Best Management Practices

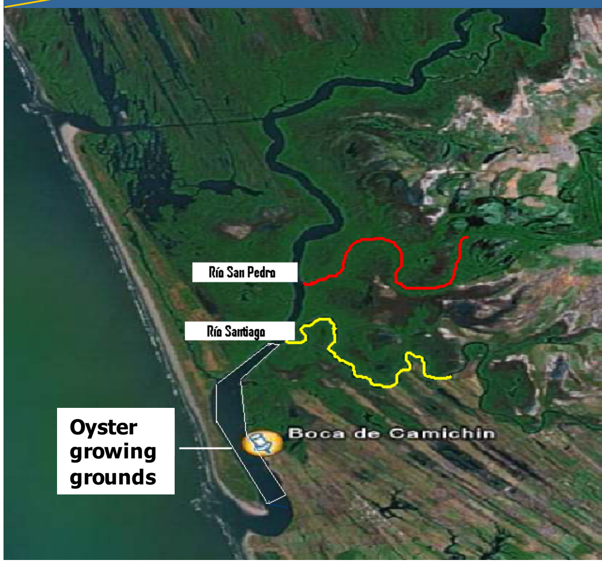
Four year initiative to:

- **Promote bivalve culture using native species**
- **Improve shellfish sanitation**
- **Best management practices**

- **Twelve year initiative to develop integrated coastal zone management programs for major estuaries of Pacific Mexico coast**

STUDY AREA

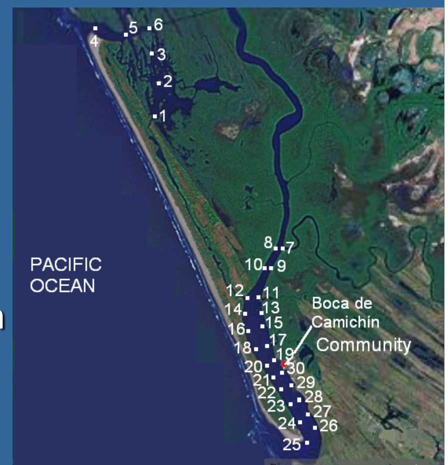




Boca de Camichin

Current status

- As a result of previous water quality sampling for *E. coli* levels, the principal growing area was found to be heavily contaminated
- A neighboring area (Pozo Chino) was found to have acceptable water quality
- Relaying and depuration using Pozo Chino will be initiated as part of the CRSP research
- State agency responsible for shellfish sanitation has committed to beginning the process to classify shellfish growing grounds
- Oyster growing expected to grow rapidly
- Interest in exporting oysters to expanded markets within Mexico and to the U.S.



Crassostrea corteziensis the "pleasure oyster"

- Native species
- High quality, preferred locally over *C. gigas*
- Industry is largely dependent on wild spat collection
- Species is targeted for further development by Mexican government and investors

Issues

- Estuary (growing grounds) is narrow, water flow recently further limited due to blockage of a secondary mouth
- Oyster culture is increasing
- Area is heavily populated and growing
- State authorities may begin water quality sampling at nearby site in order to classify- this may further spur farming expansion

Objectives

- Can a limit for oyster culture volume be estimated using POM levels as an indicator?
- Information could be used by the estuary management committee to place limits on farm size or establishment of new farms

SAMPLING SITES IN OYSTER GROWING AREAS OF BOCA DE CAMICHIN ESTUARY

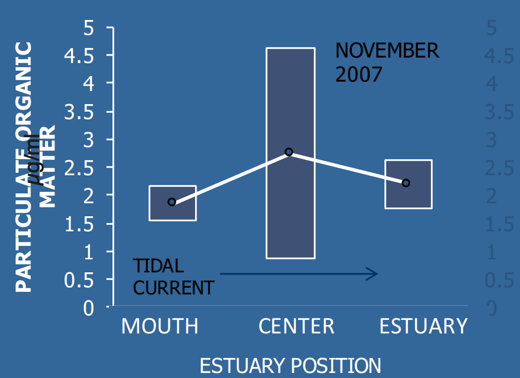
Methods-Sampling

- Three transects were established:
  - 200 m from the estuary mouth ("mouth")
  - 2 km from the mouth in the center of the oyster growing area ("center")
  - 2 km upstream from the main growing area ("estuary")
- Three sampling stations were established along each of the three transects
- Samples were taken from each of the 9 stations at the surface, bottom and mid-water column
- Sampling dates: November 2007, March 2008, May 2008 and June 2008
- With the exception of Nov. 2007, samples were taken on both incoming and outgoing tides

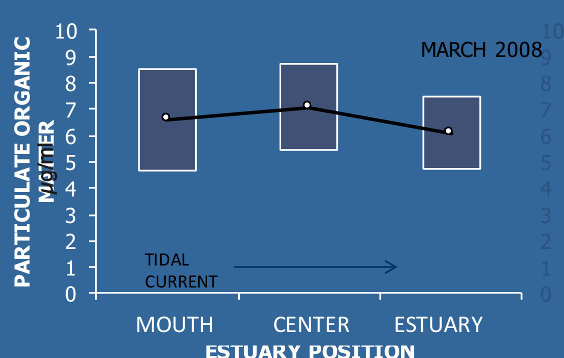
METHOD-SAMPLE ANALYSIS

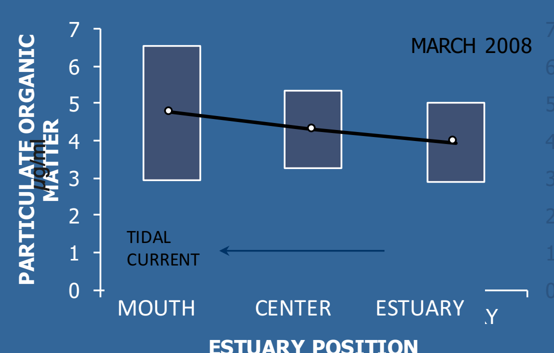
- Water samples of known volume (250-900 ml) were filtered through Whatman GF/C filters (1.2 mm pore size)
- Filters had been previously washed, heated in a muffle oven (4 hrs, 490 ºC) until a constant weight was obtained (±0.01 mg)
- Samples were washed with distilled water after filtration to remove salt residue.
- Samples were stored in individual, aluminum foil envelopes
- Samples were then dried in a conventional oven (72 hours, 65-70 ºC), then cooled in a container with dessicant gel for 1.5 hours.
- Each sample was then weighed to (±0.01 mg). Drying and weighing was repeated until a constant weight was obtained.
- Filters with samples were then heated in a muffle oven (>6 hrs, 490 ºC), cooled and weighed again to obtain the weight of the inorganic matter.
- The difference between the total dried weight and the ashed dried weight was taken as the weight of the Particulate Organic Matter (POM)

RESULTS

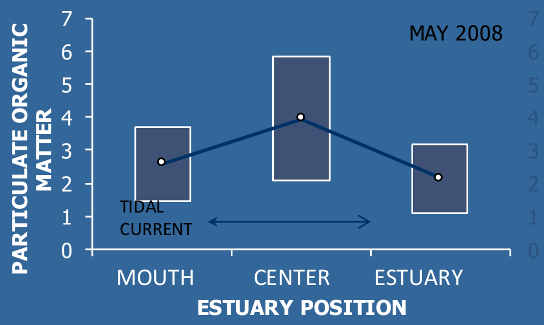


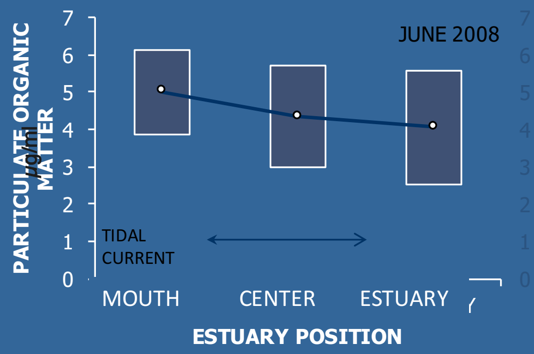
Although POM concentrations tended to be slightly higher near the estuary mouth, there was no significant difference when compared to the two other internal estuary sites, indicating that POM was not being significantly depleted as water moves through the farming area.





RESULTS





In May and June, no significant differences were found for results for incoming and outgoing tides, so results were pooled.

Again, no significant differences were found for POM levels between the three transects.

Results

Average POM concentrations ranged from 2.06 ± 0.12 (November) µg/ml to 6.59 ± 0.31 µg/ml (March)

Boca de Camichin oyster standing stock is ~1800 tons

In comparison, a similar study conducted in Bahia San Quintin (Baja California, Mexico) estimated that POM levels of 1.9 µg/ml were required to maintain a standing stock of 1913 tons harvested per year (García-Esquivel, 2004*)

***García-Esquivel Z., M. A González Gómez, F. Ley-Lou and A. Mejía-Trejo 2004. Oyster culture potential in the west arm of San Quintin Bay: Current Biomass and preliminary estimate of carrying capacity. Ciencias Marinas 30(1A):61-74.**

Conclusion

- Physiological studies of *C. corteziensis* are being completed to allow for a more accurate estimation of carrying capacity
- POM levels suggest that the standing stock of ~1800 tons is not exceeding the carrying capacity
- Caution is indicated pending further results

Funding for this research was provided by the

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OSU Oregon State University

AQUAFISH COLLABORATIVE RESEARCH SUPPORT PROGRAM

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Outreach, Acceptance, and Success of Pond Aquaculture in Promoting Rural Economy and Social Stability

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Aquaculture has importance in promoting a rural economy and social stability in developing nations. The great majority of the worlds aquaculture production comes from developing nations in Asia, where seafood production is important to both the economy and local consumption. While export of seafood generated $42 billion for developing countries in 2006, still 75% of all harvested seafood products were consumed in country. Aquaculture, which produced nearly 50% of the seafood harvest for human consumption, is also important in both economic development as well as local consumption. The purpose of this presentation is to review impacts of three aquaculture systems on social stability and rural economy in Thailand.

The first case, for prawn farming in Thailand, is focused on a local production system used to produce income. Prawn farming in Thailand is mainly done to supply a local market; virtually none of the prawns are exported. Most farmer knowledge is transmitted from farmer to farmer, with limited intervention of government or NGO extension agents. Prawn farmers generally have small farms (averaging 6 ha), yet produce an income of about US $25,000 per year. They use intensive production with aeration, frequent water exchange, and prepared feeds. While they have some problems in culture, 94% prefer prawn farming to their former employment and all would like to make prawn farming more sustainable.

The second case is on tilapia farming in northeast Thailand as adoption of technology for increased food in the home. In this case, considerable extension has been done to promote green pond (HiG) systems. Once again, farms were generally small (5 ha), with mixed farming of tilapia and other crops. Farmers mainly used tilapia to supplement their household consumption, while some also sold surplus fish. People trained in HiG culture, or people who had been included in on-farm trials of HiG, produced higher yields than those who learned of farming techniques from their neighbors. However, all groups valued their fish farming activities and its contribution to their diet.

The final case focuses on shrimp farming and abandonment of shrimp ponds. Shrimp farmers mainly learn their techniques from extension provided by CP, a feed company. Most farmers have a few ponds, lease their ponds, and grow shrimp for export. Pond abandonment, due to disease or market failure, has been a big concern. However, only 14% of ponds had been abandoned, while most were still in use for shrimp, polyculture, fish culture, or had been converted to housing. Farmers and village leaders both agreed that shrimp farming has helped the local economy and provided jobs that are preferred over alternatives of working in factories or salt farms, and they would like to see expansion of local jobs to keep families in their rural areas. Shrimp farming has had a significant impact in the quality of life for rural farmers.

Outreach, acceptance, and success of pond aquaculture in promoting rural economy and social stability

By

James S. Diana, Yang Yi, and many others

University of Michigan and Aquaculture CRSP

Intent of this presentation

- To review our research on local production systems, adoption of technology, and some ecological impacts in Thailand
- Do this by case history:
  - Prawn farming across Thailand as a local production system for main income
  - Tilapia farming in northeast Thailand as adoption of technology for increased food in the home
  - Shrimp farming and abandonment of shrimp ponds, causing ecological impacts and providing local and export consumption and employment

Prawn Methods – Vicki Schwantes

- A structured socioeconomic and technical survey
  - May through July, 2005 in Thailand
- Number of surveys administered per province
  - Initially determined by the average proportion of production (tonnes), number of growout farms, and area of growout farms (rai) within each province



Sources of Training

Information Sources	Percent of Cases
Neighbors	92.9
Government	53.5
Feed and Chemical Suppliers	25.3
Magazine	11.1
Television	4.0

- Only 19% received formal training
- The majority of farmers received information from their neighbors

Water Quality

- Water quality was measured by 43%
- Water treatment during culture was practiced by 41%
- Discharge
  - 90% directly into canal
  - Remaining into fish ponds, settling ponds, or rice fields
- While effluent permits were require

in Chiang Rai and Nakhonsithammar

they were not enforced in either area

Stocking, Feeding, and Producti

- Average stocking density was 17 pcs/m^2
  - 77% stocked below 20 pcs/m^2
- LN Transfer survival significantly related to stocking density ($p < 0.05$, $R^2 = 0.532$)
- Average production was 2,311 kg/ha/yr and ranged from 438-6,380 kg/ha/yr
  - significantly higher for farmers who monitored water quality ($p < 0.05$)
  - production was not related to years of experience, education, training, trend in parasites, harvest method, stocking density

Prawn culture statistics

Table 5. Percentage of prawns transferred from nursing to grow-out ponds, size at transfer, feed conversion ratio, production, and incomes on freshwater prawn farms surveyed in Thailand.

	N	Mean ± SE	Range
Percent Transferred	68	63 ± 3	16 to 99
Size at Transfer (grams)	68	3.2 ± 0.2	0.5 to 9
Feed Conversion Ratio	79	2.1 ± 0.2	0.2 to 8.1
Prawn Production (kg ha^{-1} yr^{-1})	78	2,338 ± 144	438 to 6,381
Net Profit (US\$ ha^{-1} $year^{-1}$)	48	3,918 ± 522	-935 to 14,984
Net Yearly Income (US\$ $year^{-1}$)	48	24,160 ± 6,491	-5,981 to 272,908

Net profit was \$3,918 per ha or \$24,160 per farm – fairly lucrative for Thailand

Table 11. Results of a multiple linear regression model for net profits (US\$ ha^{-1} $year^{-1}$) using management decision predictor variables on monoculture prawn farms surveyed in Thailand (constant = 3,684.167, adjusted R^2 = 0.231).

Management Decision Predictors	Unstandardized Coefficient ± SE	Standardized Coefficient	P value
Stock Directly	3,422.909 ± 1216.264	0.378	0.007
Dolomite Use Throughout Cycle (kg ha^{-1} $year^{-1}$)	0.428 ± 0.186	0.309	0.027
Water Exchange (days $exchanged^{-1}$)	-85.85 ± 42.580	-0.272	0.050

Table 12. Results of a multiple linear regression model for net profits (US\$ ha^{-1} $year^{-1}$) using all predictor variables on monoculture prawn farms surveyed in Thailand (constant = -3,323.189, adjusted R^2 = 0.795).

All Predictors	Unstandardized Coefficient ± SE	Standardized Coefficient	P value
Prawn Production (kg ha^{-1} $year^{-1}$)	2.558 ± 0.217	0.932	0.000
Years of Experience	158.147 ± 43.587	0.260	0.001
Batch Harvest	1457.122 ± 529.054	0.191	0.009
No Aeration	978.961 ± 535.847	0.128	0.075
Feeding Rate (kg ha^{-1} $year^{-1}$)	-0.328 ± 0.063	-0.406	0.000

Evidence of over intensification (feeding and water exchange) affecting net profit

Prawn Summary

- Prawn farming was mainly learned from neighbors, secondly from DOF
- Prawn farming was a primary occupation that provided significant income to locals
- The main problems in prawn farming appear to be related to over intensification, which reduced net profit and caused poor water quality in local area

Tilapia Methods – Fran Tain

- Adoption of HiG technology
- On-Farm Trialists
  - extensive contact with the Thai Department of Fisheries (DOF)
- Training Farmers
  - some formal contact with the Thai DOF.
- Organic Spread Farmers
  - no contact with the Thai DOF.
  - Sample size of 25 interviewees, in each of the 3 groups.
- Five page survey, consisting of 3 sections:
  - Socio-economic background
  - Aquaculture history
  - Attitudes/motivation/relationship to the DOF
- Survey area to include 4 districts in 3 provinces of northeast Thailand

Basic farmer characteristics

- All groups were primarily farmers who grew fish on the side, contributing about 30 minutes per day to fish farming
- 54% of trialists, 16% of trainees, and 28% of spread farmers followed HiG
- Fish raised mainly for home consumption, although 40% raised some fish to sell locally and increased income by 15%

Hypothesis – success = training

Dep Var: PROD_KM2 N: 67 Multiple R: 0.378 Squared multiple R: 0.143

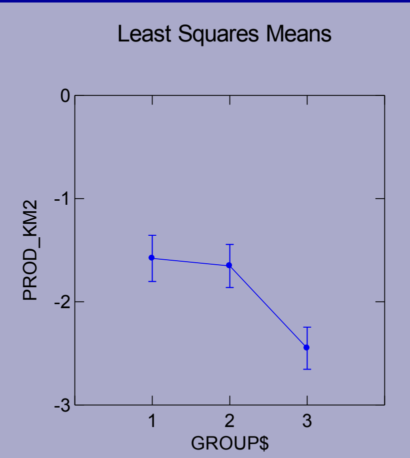
Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
GROUP	10.706	2	5.353	5.349	0.007
Error	64.046	64	1.001		

Durbin-Watson D Statistic 2.359 **Groups 1 and 2 do not have significantly different mean
First Order Autocorrelation -0.208 **Residuals do not violate assumptions of normality or equal variance.

Group 1= Trialists 2,648 kg/ha
Group 2 = Training 2,480 kg/ha
Group 3 = Spread 1,581 kg/ha

Comparably, HiG yields are about 6,000 kg/ha/yr



Factors affecting production

Table 2. Results of regression analyses of socioeconomic variables affecting total fish production

Variable	Coefficient	Standard coefficient	p value
Trialists (p value $< .0000005$, $r^2 = .784$)			
Total income	0.002	0.338	.041
Total land owned	6.668	0.611	.001
Trainees (p value $< .0000005$, $r^2 = .730$)			
Total income	0.001	0.375	.009
Total pond area	0.075	0.583	.0002
Organic spread (p value $= .000011$, $r^2 = .646$)			
Total income	0.001	0.361	.025
Total pond area	0.081	0.550	.001
All farmers (p value $< .0000005$, $r^2 = .652$)			
Total income	0.002	0.391	.00005
Total pond area	0.085	0.506	$< .00005$

Income and farm/pond area important to production

Conclusions

- On-farm Trialists and Training farmers did not have significantly different tilapia production/m^2 in 1997. However, both produced about 62% more fish yield than Organic spread farmers.
  - Brief trainings may be as effective a vehicle for technology diffusion as intensive instruction.
- Receiving HIG technology from non-DOF sources was not as effective as long- or short-term training in promoting high levels of tilapia production.
- Area available for raising fish was constant within groups as having a significant affect on overall tilapia production.

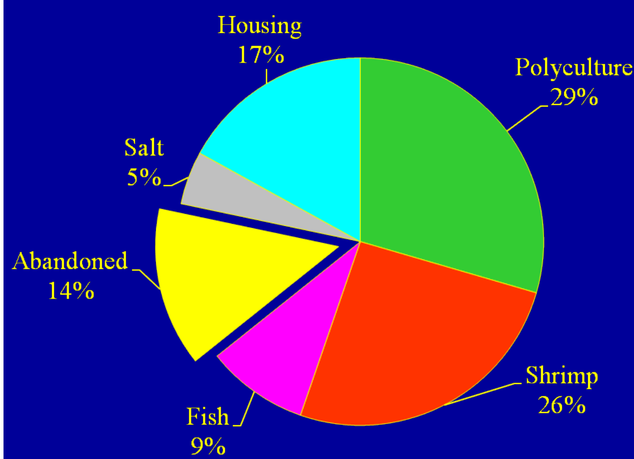
Shrimp study methods - Mindy Clarke

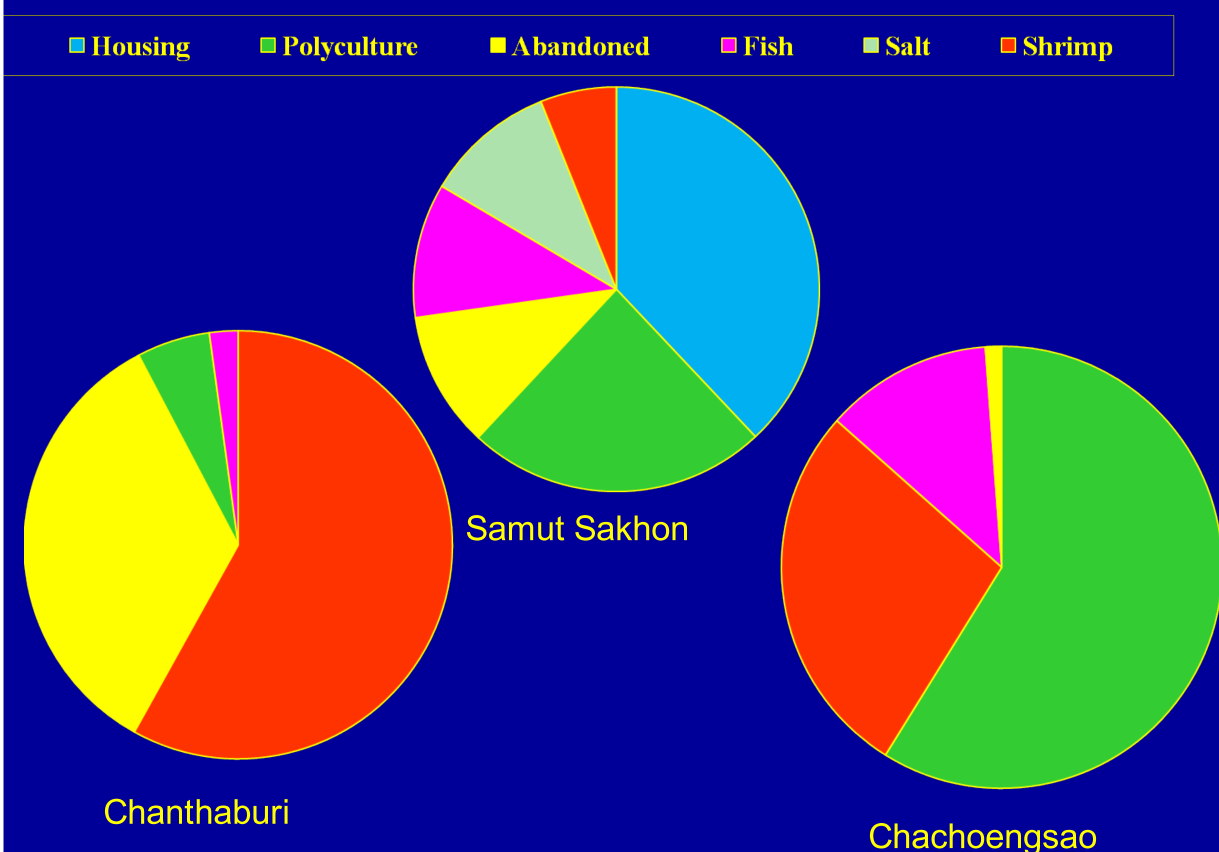
- Quantify extent of pond abandonment
- Determine local concerns about pond abandonment and conversion
- Determine the likelihood of conversion or alternate use of failed ponds
- Evaluate the value of shrimp farming to the local community

Methods

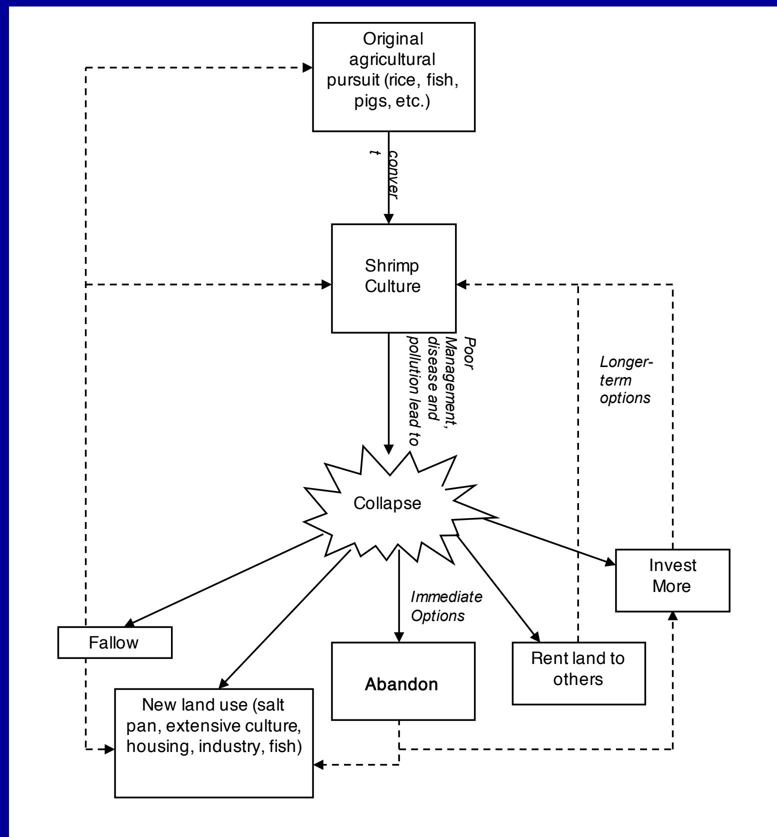
- Analyzed three provinces (Chanthaburi, Chachoengsao, and Samut Sakhon) that varied in proximity to urban center in Bangkok
- Interviewed 109 farmers, 14 head villagers, and 24 other stakeholders (feed suppliers, etc.) on social development of villages over shrimp culture period
- Analyzed spatial extent of current and abandoned ponds in same region, as well as conversions to alternate uses.

Land use in surveyed farms





Abandonment cycle



Uses of land

The number of respondents who indicated each of the following activities as their main source of income from ponds whether active shrimp ponds or ponds converted to other uses. Ponds active in shrimp culture are not counted in the conversion total.

Activity	Chachoengsao*	Chanthaburi**	Samut Sakhon**	Total
Shrimp culture (unconverted)	17	36	4	57
Polyculture	10	3	11	24
Fish (one sp.)	6	2	2	10
Other Aquaculture	2	2	3	7
Rice culture	5	1	0	6
Fruit grove	2	1	2	5
Salt	0	0	3	3
Housing	0	0	3	3
Mangrove	0	0	1	1
Other	4	1	2	7
Conversion Totals	29	10	27	66

Overall survey preferences

Employment Preference	Aggregated Response
1 It is better to work on a farm than work in a factory.	Agree
2 It is better to work in a shop than in a factory	Disagree
3 It is better to work on a farm than in a shop.	Agree
11 Shrimp farmers have a better life than factory workers	Agree
16 It is better to work for someone else than to work your own land	Disagree
17 People with their own land are less subject to economic problems	Agree
18 Shrimp farmers have a better life than salt farmers.	Agree
19 Factory workers have a better life than shrimp farmers	Disagree
20 Salt farmers have a better life than factory workers	Agree
21 The community would be better if there were more employment in factories	Agree
22 The community would be better if more people owned their own land	Agree

Generally a positive impression of the value of shrimp farming to the community

Perceptions of abandonment

Problem Perception	Aggregated Response
23 Have farmers had to change culture practices or leave land?	Yes
24 In your opinion, is there a problem with abandoned shrimp ponds?	No
25 In your opinion is there a problem with under used land?	No

Shrimp conclusions

- Abandonment was common but not dominant, and was not perceived as a problem
- Most people felt shrimp farming had improved their quality of life
- Cycles of shrimp pond use mean that current uses as only certain for now, but can change to other uses easily
- Location had a strong effect on abandonment and on perception of the value of shrimp farming

Overall conclusions

- Prawn farming provided good income and primary source of employment for many farmers, who were happy to work in that field and sold prawns locally
- Tilapia farming provided additional food and limited income to farmers with minimal time needed to care for fish
- Shrimp farming provided good income, added food locally as well as in export sales, and was considered quite good employment compared to alternatives

Funding for this research was provided by the

Aquaculture Collaborative Research Support Program

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Catfish *Clarias gariepinus* Fingerlings as Bait for Lake Victoria Commercial Fisheries

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The artisanal fishery of Lake Victoria, Kenya has been degraded by environmental deterioration, and the stock of catfish in the Lake has been drastically reduced because wild-caught catfish juveniles are used as bait for Nile perch hooks deployed daily in the commercial fisheries industry. There is shortage of catfish bait for fishermen who need bait on a daily basis at an affordable price to be able to continue fishing. Income opportunities therefore exist for current agricultural farmers to diversification into small-pond aquaculture to provide farm-raised catfish fingerlings as alternative supply source of bait for the commercial fisheries on Lake Victoria. The overall objective of the study was to increase catfish fingerling production as bait to reduce overexploitation of indigenous species and conserve the diversity of Lake Victoria Fisheries. This intervention would transform existing and potential small-scale fish farmers into high-yield profitable production groups through technical assistance in propagation, production, general pond husbandry, and marketing.

Preliminary work in 2007 assisted in the formation of farmer clusters; all groups had been registered and opened operational accounts. The Vihiga cluster specifically made far much progress than the other clusters and was able to design and implement a comprehensive propagation programme that resulted into some experienced and new farmers realizing the full potential of fingerling production. Sales for Vihiga cluster for the third quarter of 2007 showed that there was a progressive transformation of baitfish farmers towards commercialization.

A marketing plan that included the current marketing situation, opportunities and threats, and a clearly defined marketing strategy was developed taking into account market demographics, market trends, and market potential for growth. The strengths and weaknesses of the farmer groups, baitfish traders, product offering, financing associated with the marketing channels were analyzed. Results suggest that pricing of baitfish both at source and at end market is dependent on the supply and demand of the baitfish. Demand is determined by the abundance of wild caught Nile perch from the lake. It was found that baitfish is sourced from both the wild and farmed fish farmers. Bait traders are mainly women and operate in organized groups or as individuals depending on the beaches along the Lake.

Some challenges faced included some farmers getting attached to food-size fish and unwilling to sell as bait; lack of funding to purchase feeds and seed by farmers; predation on the farm; volatile baitfish price; and lack of quality feed for *Clarias* fry and fingerlings.

Catfish (*Clarias gariepinus)* Fingerlings as Bait fish for Lake Victoria Commercial Fisheries

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Purdue University, Indiana

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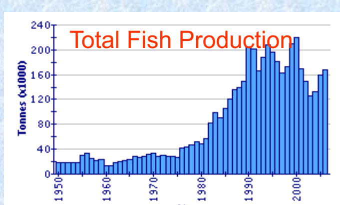
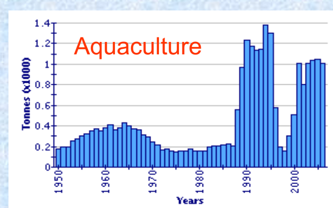
Kenya
Our heritage,
People, Culture,
Agriculture and
Natural Resources

Fisheries Situation in Kenya

- Over 90% of the total fish produced comes from L. Victoria
- Fish supplies - fresh and marine waters appear to be declining in terms of volume and catch-per unit effort





Introduction

- Artisanal fishery of L. Victoria, Kenya has been degraded by environmental deterioration

- Wild-caught catfish juveniles used as bait for Nile perch hooks deployed daily in the commercial fisheries industry; stock has reduced drastically

- Current production is inadequate resulting in destructive fishing and over exploitation of endemic fish species

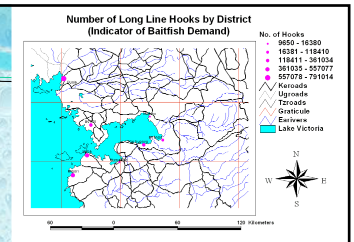
Introduction (2)

- There is shortage of catfish bait for fishermen who need bait on a daily basis at an affordable price to be able to continue fishing.

- Income opportunities exist for current agricultural farmers to diversification into small-pond aquaculture

- Fish Farmers will provide farm-raised catfish fingerlings as alternative supply source of bait for the commercial fisheries on L. Victoria.

Introduction (3)



- **Frame survey (2006) showed 2.5 – 3.0 Million long line hooks**
- **1,000 baits required per day by 3,000 boats**
- **Demand for *Clarias* as bait range from 18-33 m**
- **Price range Kshs 3.00 - 8.00 per bait**

Objectives

Increase catfish fingerling production as bait to reduce overexploitation of indigenous species and conserve the diversity of Lake Victoria Fisheries.

Specificaly to:

- Develop techniques that will assist Fish farmers exploit the emerging catfish bait market
- Make a meaningful contribution to the development of Clarias production by small scale farmers
- Increase farmers income and improve their nutrition status
- Scale up catfish production to commercial levels

Emerging Markets for Catfish

- This intervention will transform existing and potential small-scale fish farmers into high-yield profitable production groups through technical assistance in propagation, production, general pond husbandry, and marketing.

Indicators

- **Number of house hold benefited**
- **Number of individual farmers trained (by Gender)**
- **New technology tied to production, social and management**
- **Volume and value of purchases from small scale holders**

Expected impact

- Concept of working as a group
- Key is commercialize fish farming in the country
- Focus on markets and production targets
- Value chain addition will take this project to the next level
- Case studies will target on beneficiaries

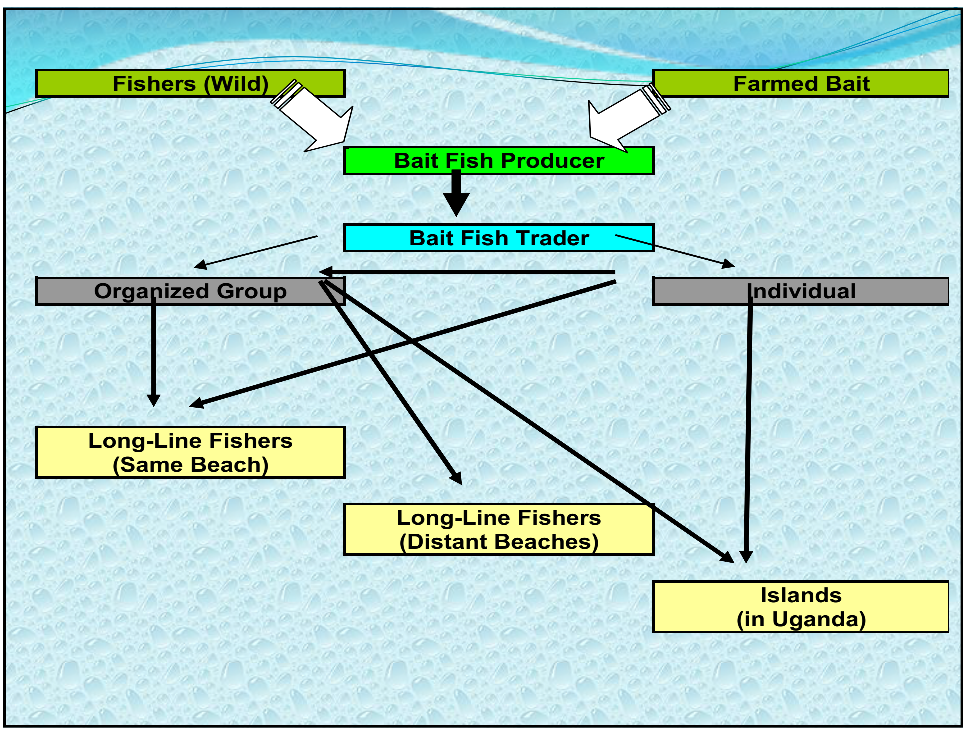
Methodology

- Select Farmers (6 clusters of 10 farmers)
- Identify cluster communities (location)
- Mobilize, sensitize and train them on group dynamics (include individual visit)
- Train farmers on record keeping, catfish production and enterprise budget
- Develop market channels

Bait fish Markets

•A marketing plan that include the current marketing situation, opportunities and threats, and a clearly defined marketing strategy will be developed taking into account market demographics, market trends, and market potential for growth.

•The strengths and weaknesses of the farmer groups, baitfish traders, product offering, financing associated with the marketing channels will be analyzed.



Preliminary study

•Pricing of baitfish both at source and at end market is dependent on the supply and demand

•Demand is determined by the abundance of wild caught Nile perch from the lake.

•Baitfish is sourced from both the wild and farmed fish farmers.

•Bait traders are mainly women and operate in organized groups or as individuals depending on the beaches along the Lake.

Progress made under KBDS funding

- **Base line data collected**
- **Identification of clusters and cluster sites done**
- **Community mobilization done**
- **Catfish Hatcheries Developed**
- **Market survey, strategy, and formalizing linkages between producers and bait fish traders on going**
- **Group dynamics on going - leading to training on catfish production**

Table 1: Quarterly impact indicators and cluster farmers target under KBDS

Indicator	Target	1st Quarter (50%)	2nd Quarter (60%)	3rd Quarter (70%)	4th Quarter (85%)
Farmers trained in technical & Bus. Mgt	40	20	24	28	34
Amount of tilapia produced (Kg Ha^{-1} Yr^{-1})	2,500	1,250	1,500	1,750	2,125
New entrants (Multiplier effect)	30	6	10	20	30
Annual production of Clarias baitfish	33,600,	12,480	16,320	23,000	30,720
Gross income to Clarias baitfish producers	67,200,	24,960,	32,640,	46,000,	61,440,
Number of vendors of farm raised bait fish	18	9	11	13	16
Number of new ponds for baitfish and tilapia production	140	70	84	98	119
Number of women participants	30	15	18	21	26
Number of Farmers sensitized on baitfish production	400	200	240	280	340

Table 2: Leadership structures and filled in positions

Cluster	Registered Name	Leadership position	Member name
Mundika	Bukhayo Self help group	Chair person	Nicholas Wandera
		Secretary	Bernard Taabu
		Treasurer	Sabina Nasirumbi
Matayos	Tumaini Self Help Group	Chair person	Zachary Okello
		Secretary	Loice Nafula
		Treasurer	Peter Mbaye
Funyula	Funyula North Fish Farmers	Chairperson	Peter Omallo
		Secretary	Emmanuel Mbuya
		Treasurer	Nathaniel Ouma
		Marketer	Margaret Mbuya
Vihiga	Bidii Fish Farmers	Chair	George Ambuli
		Vice Chair	Nelson Tika
		Secretary	Daniel Juma
		Treasurer	Emily James

Table 3: **Maximum/minimum pond surface area (m2) and maximum/minimum average pond area per cluster**

Cluster	Minimum Total	Maximum Total	Minimum Average	Maximum Average
Funyula	120	1116	48	528
Matayos	63	351	63	132
Mundika	60	648	60	320
Vihiga	160	2060	127	387

Vihiga Cluster Meeting in Jan 2009

Cluster Performance

•The Vihiga cluster specifically made far much progress than the other clusters and was able to design and implement a comprehensive propagation programme that resulted into some experienced and new farmers realizing the full potential of fingerling production.

•Sales for Vihiga cluster for the third quarter of 2007 showed that there was a progressive transformation of baitfish farmers towards commercialization.

Benefits to fish farmers

- Through technical assistance in propagation, production, and general pond husbandry, small scale fish farmers will learn that improved management can lead to increased production.
- Through assistance in enterprise budgeting and cash-flow analysis, they will learn how to critically examine production methods and business decisions that impact their costing of inputs through output.

Some challenges

- Some farmers getting attached to food-size fish and unwilling to sell as bait
- Lack of funding to purchase feeds and seed by farmers; volatile baitfish price
- Catfish survival to larval stage and predation on the farm
- Lack of quality feed for *Clarias* fry and fingerlings

Funding for this research was provided by the

AQUA FISH

COLLABORATIVE RESEARCH SUPPORT PROGRAM

USAID FROM THE AMERICAN PEOPLE

OSU Oregon State University

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.

Evaluating Pond Aquaculture Effluents Through Biological Assessment of Fish and Benthic Macroinvertebrate Assemblages in Receiving Streams

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Aquaculture is a promising alternative to capture fisheries, especially in developing countries where most capture fisheries are already over-exploited and the value of small streams and headwaters as prime protection for large, downstream productive rivers is often threatened by unsustainable agricultural practices. Some of the most intimate relationships between farmers and streams are found in the use of streams as a source of clean water for filling earthen ponds and as conduits of effluents from ponds. As a supporting system for pond aquaculture, streams are vital to the sustainability of aquaculture industries, but are also directly threatened by harmful effluents in the absence of best management practices.

Developing countries need to develop inexpensive methods for monitoring pond effluent impacts on receiving waters and adopt management practices that maintain the quality of streams to support aquaculture development. This study gives an overview of ongoing research work in Ghana in partnership with Virginia Polytechnic Institute and State University and the Aquaculture and Fisheries Collaborative Research Support Project to develop ecologically-based effluent monitoring protocols for aquaculture.

A vital first step in the development of a biological monitoring protocol is standardization of sampling techniques to collect representative samples of biota. While standardized stream fish and macroinvertebrate sampling is now routinely done is temperate and developed regions (for example, in the United States), tropical streams present unique sampling challenges for biological assessment and little is known about the best way to collect representative samples of tropical stream biota. We present preliminary results of the performance of different configurations of seining and kick-sampling and benthic cores as standard methods for fish and macroinvertebrate sampling, respectively, in tropical streams. Methods for developing assessment metrics based on the two types of biological assemblages will also be discussed. Biological assessment and best management practices provide a viable, low-cost balance to the growth of aquaculture in developing countries

EVALUATING POND AQUACULTURE EFFLUENTS THROUGH BIOLOGICAL ASSESSMENT OF FISH AND BENTHIC MACROINVERTEBRATE ASSEMBLAGES IN RECEIVING STREAMS IN GHANA

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Steve Amisah[2]

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[2]Department of Fisheries & Watershed Management, Kwame Nkrumah University of Science & Technology, Kumasi, Ghana

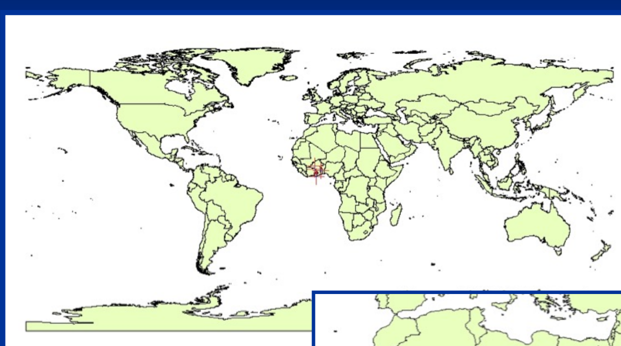
The Issue

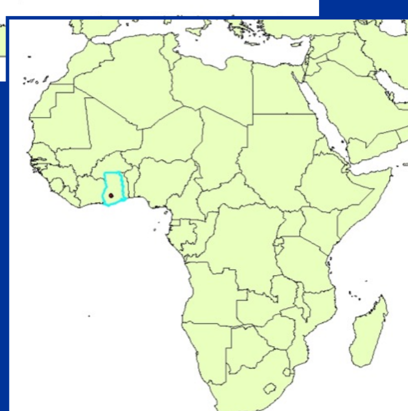
- Aquaculture as a user and polluter of water
  - may be best characterized as 'industrial suicide'
- Aquaculture competes with other water uses and there is a price to pay for growth
- Ghana's fledgling EPA
  - has reactive tendencies toward regulation
  - has limited understanding of aquaculture
- But the industry can be proactive

Overview of Project

- Physico-chemical characterization of pond effluents and receiving waters in Ghana
  - pollution potential (human & ecological)
- Bacteriological assessments (*E. coli* & *strep*)
  - From feeds & fertilizers (human health concerns)
- Biological assessment and monitoring
  - ecological and ecosystem services impacts
- BMP development and training

Location

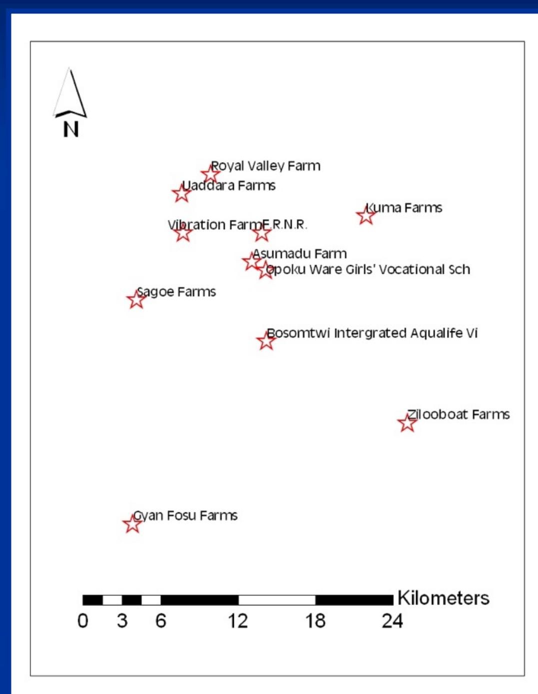




Some Tenets of Biological Assessment

- Biological assemblage composition* reflect habitat condition
  - *measured by guild & functional group performance
- Expectations can be defined for assemblage composition under unimpaired condition
- Different taxonomic groups reflect various scales (spatial & temporal) of perturbations and biotic response

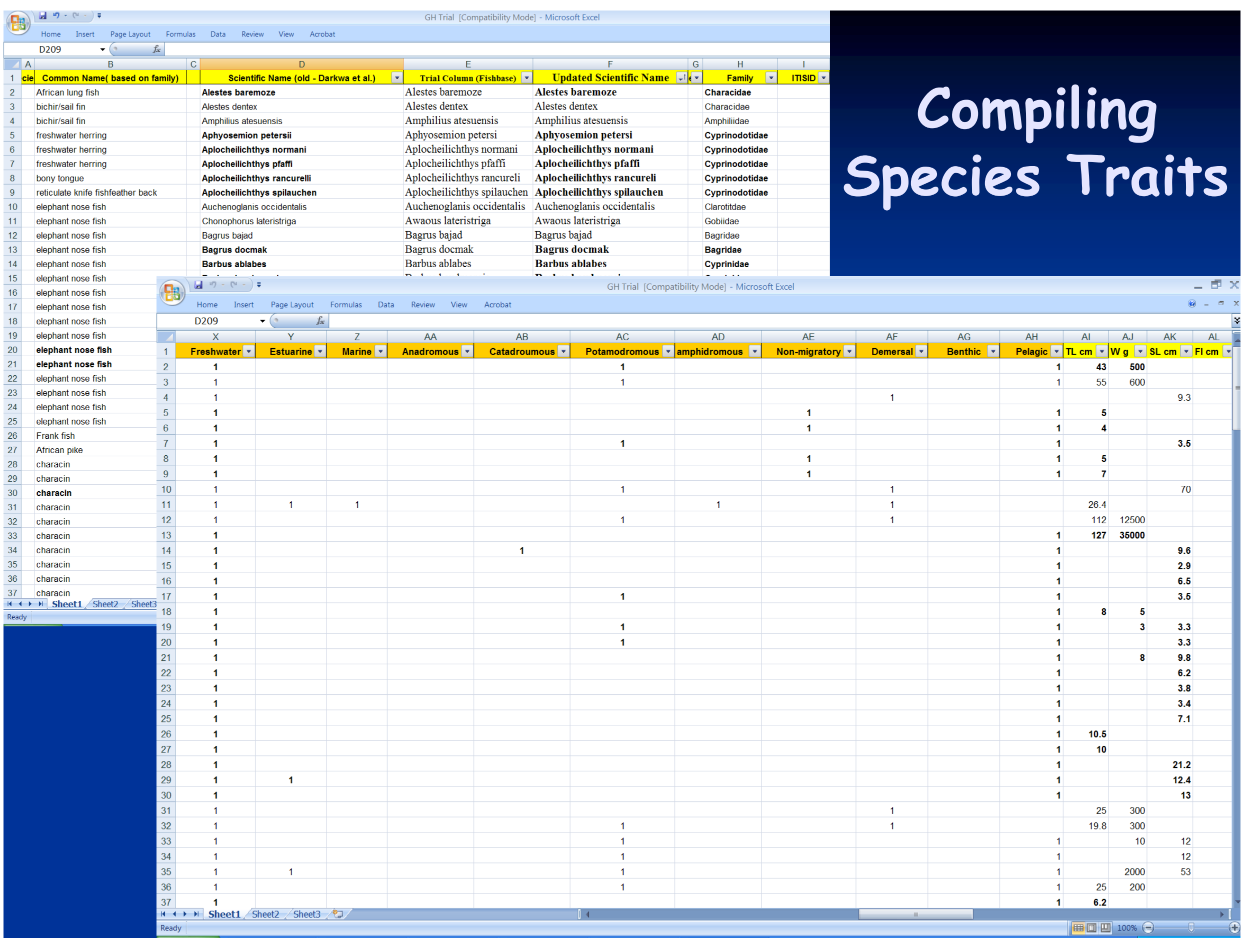
Methods- Sites



Methods- Design

- Pre-stratification of farms??
- WQ and Biological sampling (ongoing)
  - Streams upstream and downstream of farms
  - Paired watersheds
  - Ponds (WQ during draining or stratified in still water
- Minimum 10 farms, 30 ponds, 10 streams + 10 paired streams (mostly already selected)
- Survey for management practices (ongoing)
- BMP development & workshop (May– Sept '09)


Sampling Fish


GH Trial [Compatibility Mode] - Microsoft Excel
Common Name(based on family)
Scientific Name (old - Darkwa et al.)
Trial Column (Fishbase)
Updated Scientific Name
Family
ITISID
Freshwater
Estuarine
Marine
Anadromous
Catadroumous
Potamodromous
amphidromous
Non-migratory
Demersal
Benthic
Pelagic
TL cm
W g
SL cm
Fl cm
Compiling Species Traits

Data

CHARACTERISATION OF POND EFFLUENTS AND BIOLOGICAL AND PHYSIOCHEMICAL ASSESSMENT OF RECEIVING WATERS

Prestratification of Fish Farms

Name of Farm: Gyan Fosu Farms
Address: Gyan Fosu Farms
P.O. Box SE 1331
Suame, Kumasi
Telephone Number (s): 0243321341

Location of Farm: Anwiankwanta	**GPS Readings:**
	North: 06^{0}40.640′ West: 001^{0}30.457′ Elevation:257.039m
Number of Ponds: 13	**Size of Ponds:**
	Pond 1- 1530m^2, Pond 2- 1924m^2, Pond 3- 1845m^2, Pond 4- 2016m^2, Pond 5- 2916m^2, Pond 6- 2880m^2, Pond 7- 2000m^2, Pond 8- 4802m^2, Pond 9- 5194m^2, Pond 10- 5272m^2, Pond 11- 4611m^2, Pond 12- 4140m^2 Spawning pond- 418m^2
Source of Water: Oda River Bawku Stream	**Treatment of Water (if any):** Water quality analysis(nitrate and ammonia)
Fish Species Reared: *Clarias* sp	**Type of Feed Used:** Dizengoff Ghana Limited pelleted feed from Israel
Oreochromis niloticus	
Heterotis sp	
Rearing Cycle: Twice	**Quantity of Feed/Cycle**:
Nature of Receiving Waters	**Operational Methods**
• **Name:** Bawku stream(major)	• **Type of integration and/or culture system:** N/A
Oda River (minor)	
• **Major uses beside aquaculture**	• **Frequency of Discharge:**
Domestic purposes	In the wet season once every month
	Once every two months in the dry season

Water Quality Analysis of Receiving Waters

i. Readings 50-100m Upstream

Parameters	Readings	Parameters	Readings
pH	8.0		
Temperature	26.97^{0}C		
Salinity	0.41 Sal		
Pressure	752.9mmHg		
Conductivity	847µS/cm		
TDS	424mg/L		
DO(mg/L)	4.11		
DO (%)	53.1		

CHARACTERISATION OF POND EFFLUENTS AND BIOLOGICAL AND PHYSIOCHEMICAL ASSESSMENT OF RECEIVING WATERS

Prestratification of Fish Farms

Name of Farm: Kuma Farms
Address:

Telephone Number (s): 0244537144

Location of Farm: Domeabra	**GPS Readings:**
	North: 06^{0}40.640′ West: 001^0.30.113′ Elevation: 254.752m
Number of Ponds: 48	**Size of Ponds**: 3.522ha
	600m^2- 7 Ponds, 1000m^2- 6 Ponds, 200m^2- 6 Ponds, 800m^2- 6 Ponds, 500m^2- 1 Pond, 0.8ha-2 Ponds, 500m^2-3 Nursery Ponds, 0.5m*2m-12 Concrete Tanks, 20m^2-9 Hatchery Tanks
Source of Water: Stream, Wells and Borehole	**Treatment of Water (if any):** Water is filtered before it's pumped into the ponds.
Fish Species Reared:	**Type of Feed Used:**
Clarias sp	Formulated feed
Oreochromis niloticus	Rice bran
Heterotis sp	Copra cake
Snakehead	Dizengoff feed for starters
Rearing Cycle:	**Quantity of Feed/Cycle:**
Nature of Receiving Waters	**Operational Methods**
• **Name:**	• Type of integration and/or culture system:
Spring, Stream and Wells	Intensive integration
• **Major uses beside aquaculture**	• **Frequency of Discharge:**
Domestic purposes	Rainy season full draining (twice in a month)

Water Quality Analysis of Receiving Waters

i. Readings 50-100m Upstream

Parameters	Readings	Parameters	Readings
pH	6.65	DO	4.27mg/L
Temperature	25.31°C		
Pressure	745.9mm/H		
Conductivity	101µS/cm		
TDS	50TDSmg/L		
Salinity	0.05sal		
Oxygen	53.5DO%		

Fish Data

Fish Biota Identification

i. Species 50-100m Upstream

Fish Species	Frequency
Barbus trispilos	2
Oreochromis niloticus	2
Barbus macrops	7

ii. Species 50-100m downstream

Fish Species	Frequency
Oreochromis niloticus	15
Barbus macrops	41
Barbus trispilos	4

Fish Biota Identification

i. Species 50-100m Upstream

Fish Species	Frequency
Oreochromis niloticus	6
Hydrocymus forskalii	1
Brabus macrops	10
Tilapia galileus	2

ii. Species 50-100m downstream

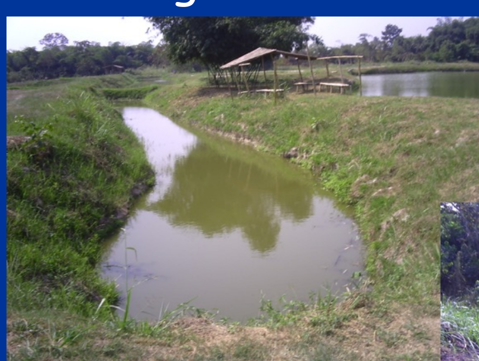
Fish Species	Frequency
Barbus ablabes	1
Barbus occidentalis	21
Alestes baremoze	12
Clarias gariepinus	1
Oreochromis niloticus	1

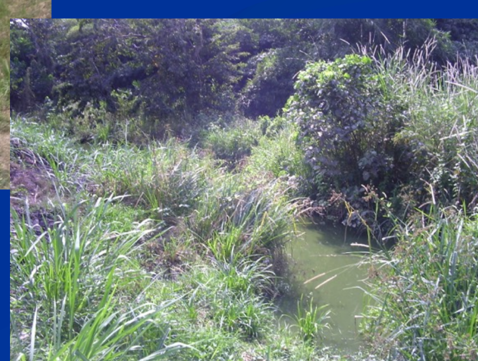
Preliminary Observations

- Seining alone is probably inadequate
  - Additional multiple gear sampling is anticipated
- Multiple gear sampling will require
  - Presence/absence analytical methods
  - A shift from index of biotic integrity (IBI) approach to predictive modeling
- These may also apply to macroinvertebrate analysis

Preliminary Observations (BMP)

- Wide variety of practices exist
- Strong reason not to exclude any farm early



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TAKING OF PHOTOGRAPHS
OF THIS FARM IS PROHIBITED
AQUAFISH
going inseine

Development of Small-scale Aquaculture: Trout Farming Systems in the Western-cap Province of South Africa

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Aquaculture has the potential to contribute towards economic empowerment and social development of disadvantaged rural communities through sustainable utilization of resources. The Division of Aquaculture at Stellenbosch University has launched a Small-Scale Aquaculture Farming Program with the objective to improve the living standards of rural communities, provide opportunities to participate in the regional and national economy, contribute to food security and sustainable utilization of resources. The Program targets disadvantaged rural people with a focus on women. Various role-players including the private sector, government departments and local authorities are participating in the Program.

The Program has been given a unique opportunity by the private sector to expand its benefits to rural communities, through a long-term market-uptake agreement with Three Streams Smokehouse in Franschhoek. For this, the farmers must produce a quality product according to market standards. A total of 35 additional small farmer projects can be introduced within the framework of the market-uptake agreement.

The successful and sustainable implementation of the Program requires the provision of essential services in the form of business development, support and training. A network of support services that include extension, training, financial, marketing, and legal services are required to ensure effective implementation and sustainability of the small farmer projects.

This Program has proven its ability to make a meaningful contribution to the per capita income and nutritional status of these communities, whilst it also provides a means for the development of human resources.

No presentation provided.

Effect of Temperature on the Growth and Survival of Nile tilapia *Oreochromis niloticus* Fry Reared in Hapas

Remedios B. Bolivar, Eddie Boy T. Jimenez, Roberto Miguel V. Sayco, Reginor Lyzza B. Argueza, Hernando L. Bolivar* and Russell Borski
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In the Philippines, the months of November, December and January are considered as colder months while the months of March, April and May are the warmer months. Observation indicates that relatively higher temperatures result to better growth of tilapia fry. However, the survival rate of tilapia eggs during these months was observed to be lower compared to relatively colder months of the year. A study was conducted to evaluate the growth and survival of Nile tilapia (*Oreochromis niloticus* L.) fry from different hatching systems during colder and warmer months. For each season, fry were produced from artificial incubation units, hapas and ponds. These are the three main hatchery systems used for producing fry in the Philippines.

Growth and survival of fry reared in warmer months (28.6 35.4was significantly higher than the fry reared in colder months (25 32.9Analysis of variance also showed significant difference among treatment with respect to percent survival during the colder months of the study. Comparison of means showed that higher survival of fry was observed in Treatment I compared with Treatments II and IV ($P<0.05$). Analysis of variance also showed significant difference among treatments for final length and weight of tilapia fry, gain in weight, specific growth rate, and percent survival ($P<0.05$) during the warmer months. Comparison of means showed that higher survival of fry was observed in Treatment I compared with Treatments II and IV ($P<0.05$).

EFFECT OF TEMPERATURE ON THE GROWTH AND SURVIVAL OF NILE TILAPIA *(Oreochromis niloticus L.)* FRY REARED IN HAPAS

Remedios B. Bolivar, Eddie Boy T. Jimenez,
Roberto Miguel V. Sayco, Reginor Lyzza B. Argueza,
Hernando L. Bolivar and Russel Borski

Aquaculture America 2009
February 15 – 18, 2009
Seattle, Washington, USA

INTRODUCTION

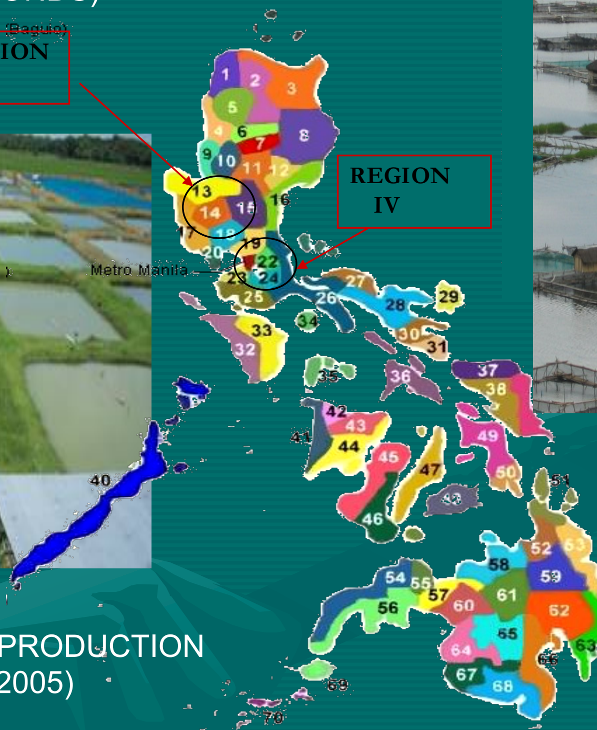
-In the Philippines, the months of November, December and January are considered as relatively colder months while the months of March, April and May are the warmer period.

- Over 2,000 small, medium and large-scale hatchery and nursery operators in the country using different hatching systems for the production of fingerlings, are affected by the changes in temperature.

- Net enclosures (hapas), earthen and concrete ponds, fiberglass/plastic and concrete tanks are some of the common aquacultural facilities utilized by hatcheries for fry production

- Demand of tilapia fingerlings is more than a billion annually

REGION III
72,346.60 TONS (PONDS)
44.38%



REGION IV
53,965.06 TONS
(CAGES)
33.11%

TOTAL TILAPIA PRODUCTION
163,003 TONS (2005)

OBJECTIVE

To evaluate the growth and survival of Nile tilapia *(Oreochromis niloticus L.)* fry from different hatching systems during colder and warmer months.

Treatments

FRY SOURCES

- I – Artificial Incubation- Hatched Fry
- II – Hapa-Hatched Fry
- III – Pond-Hatched Fry
- IV - Combination of Hatched Fry (AI, Hapa and Pond
- Treatments were replicated three times

Place of Study: GIFT Foundation, CLSU,
Science City of Munoz, Nueva Ecija, Philippines

MATERIALS AND METHODS

STOCKING OF BROODSTOCK (GIFT STRAIN)

(1M : 3F)

13 M : 39 F/HAPA

2 FISH/SQ M

CONDITIONING HAPAS

BREEDING HAPAS

Stocking in Hapas

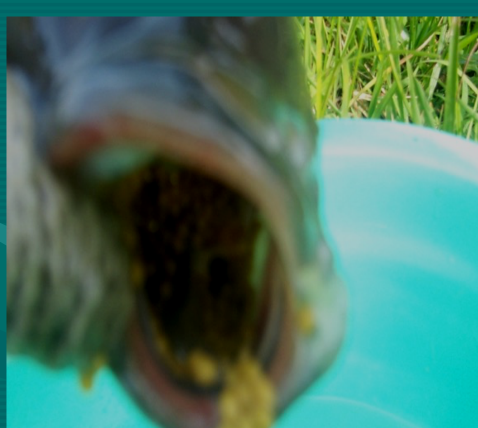
Stocking of broodstocks
in 12 units of hapas
6 hapas for egg collection
6 hapas for fry collection

Synchronized breeding
and collection for the
production of uniform size
and age of fry.

MATERIALS AND METHODS

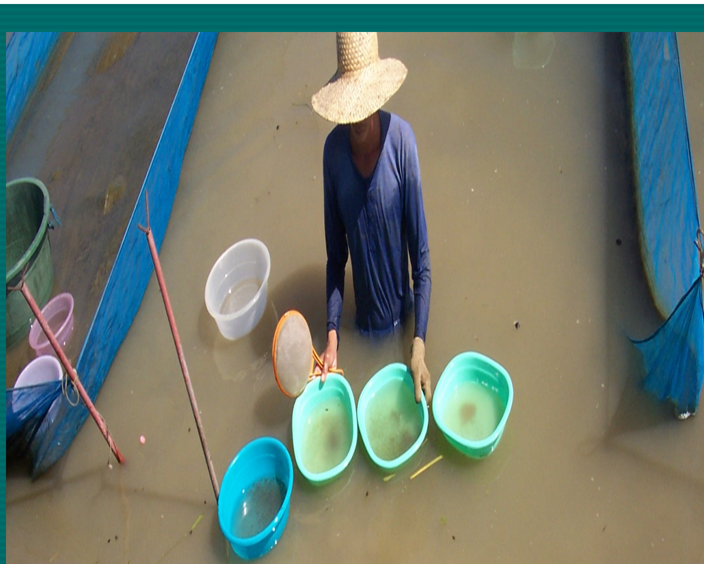
STOCKING OF BREEDERS IN POND AT
2 FISH PER SQ/M (1M : 3F)

Fry Collection in ponds



Egg collection from breeders reared in hapas

Artificial Incubation Unit



Fry collection in hapas

Sampling

Size range - 0.011 g - 0.017 g

Stocking of Fry

850 fry / sq m or
6,800/2x4x1m fine mesh hapa

Feeding

Fry were fed with tilapia fry mash, at a rate of
30% for the first week,
20% for the second week
10% for the third week

Results

Collection and Sampling of Fingerlings from the Nursery Hapas
Data analysis was done following Randomized Complete Block Design (RCBD) using SPSS.

Table 1. Growth Performance of fry during the cold and warm months

Cold Months	I – Artificial Incubation	II - Hapa	III- Pond	IV - Combination
Final Weight (g)	0.072 ± 0.023	0.092 ± 0.030	0.061 ± 0.015	0.061 ± 0.015
Gain Weight (g)	0.058 ± 0.022	0.080 ± 0.030	0.047 ± 0.016	0.052 ± 0.014
Survival (%)	92.03 ± 7.559[c]	65.19 ± 14.409[a]	76.50 ± 4.694[ab]	72.81 ± 3.847[ab]
Warm Months	**I – Artificial Incubation**	**II - Hapa**	**III- Pond**	**IV - Combination**
Final Weight (g)	0.197 014[b]	0.248 ± 0.007[a]	0.209 ± 0.015[b]	0.182 ± 0.023[b]
Gain Weight (g)	0.186 ± 0.014	0.231 ± 0.007	0.196 ± 0.015	0.168 ± 0.023
Survival (%)	93.00 ± 5.553[a]	91.51 ± 1.640[ab]	79.71 ± 3.191[b]	84.76 ± 7.586[ab]

Note: Treatment means with the same letter superscript/s are not significant at 5% level of significance.

Growth

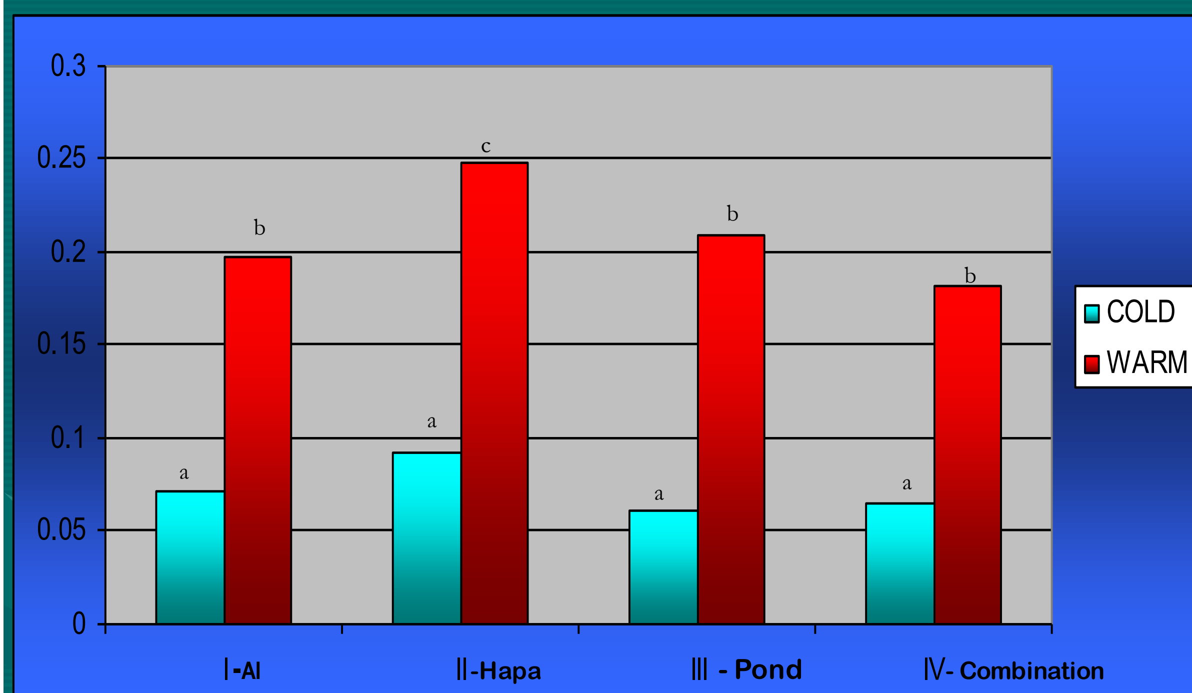


Figure 1. Final weight of fry reared in two seasons

Note: Treatment means with the same letter superscript/s are not significant at 5% level of significance.

Survival

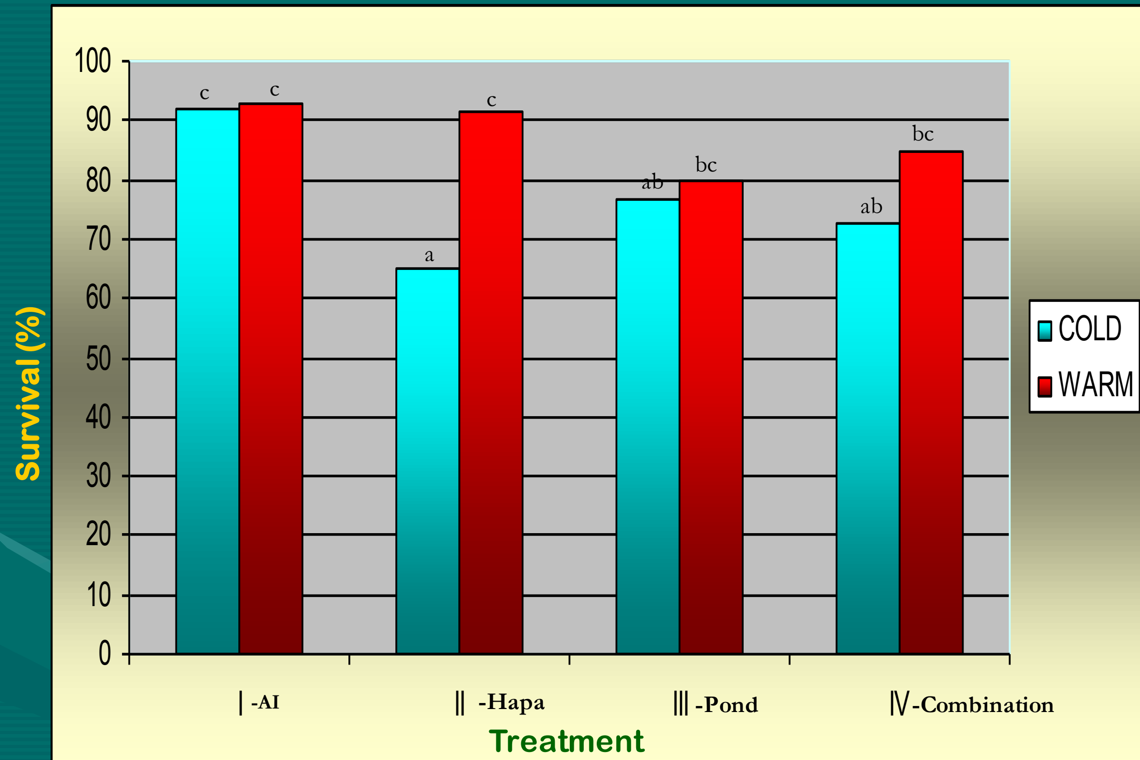
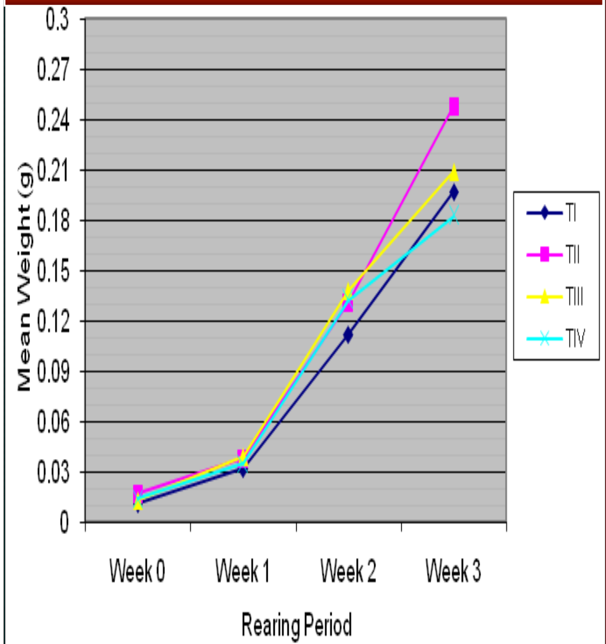


Figure 2. Survival of fry reared in two seasons

Note: Treatment means with the same letter superscript/s are not significant at 5% level of significance.

Size Distribution	SIZE	COLD Total No.	COLD Percentage	WARM Total No.	WARM Percentage
TREATMENTS					
T1 Artificial Incubation Unit	< 0,11 g	16,580	88.31	149	0.80
	S24 (0.11 - 0.18)	2,177	11.60	4466	24.01
	S22 (0.20 - 0.25)	0	0.00	12015	64.60
	S20 (0.30 - 0.35)	17	0.09	1969	10.59
	S17 (0.5 - 0.67)	0	0.00	0	0.00
	S14 (1.3 - 1.6)	0	0.00	0	0.00
T2 Hapa	< 0,11 g	8,986	67.57	221	1.18
	S24 (0.11 - 0.18)	4,033	30.33	1992	10.67
	S22 (0.20 - 0.25)	0	0.00	7563	40.51
	S20 (0.30 - 0.35)	280	2.11	8552	45.81
	S17 (0.5 - 0.67)	0	0.00	341	1.83
	S14 (1.3 - 1.6)	0	0.00	0	0.00
T3 Pond	< 0,11 g	12,486	80.01	475	2.74
	S24 (0.11 - 0.18)	3,042	19.49	2545	14.68
	S22 (0.20 - 0.25)	0	0.00	7225	41.68
	S20 (0.30 - 0.35)	77	0.49	6515	37.58
	S17 (0.5 - 0.67)	0	0.00	575	3.32
	S14 (1.3 - 1.6)	0	0.00	0	0.00
T4 Combination	< 0,11 g	11,541	77.73	759	4.39
	S24 (0.11 - 0.18)	3,269	22.02	2259	13.06
	S22 (0.20 - 0.25)	0	0.00	8461	48.93
	S20 (0.30 - 0.35)	37	0.25	5419	31.34
	S17 (0.5 - 0.67)	0	0.00	394	2.28
	S14 (1.3 - 1.6)	0	0.00	0	0.00



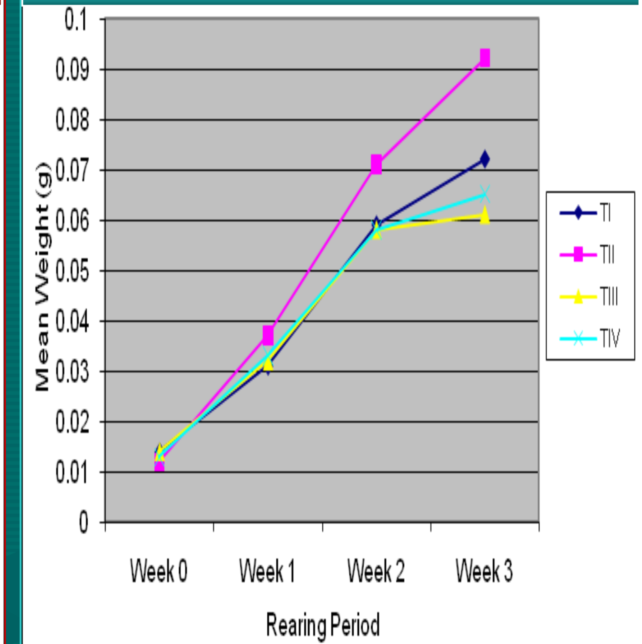
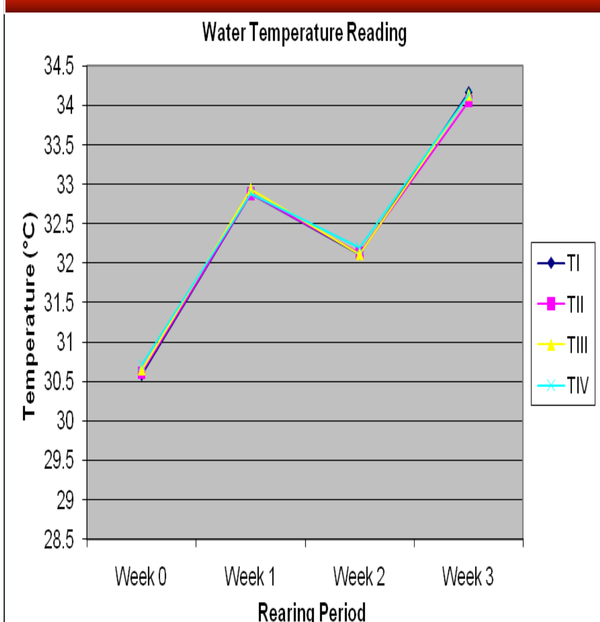


Figure 3. Growth pattern of fry in terms of average body weight during warm season

Figure4. Growth pattern of fry in terms of average body weight during cold season



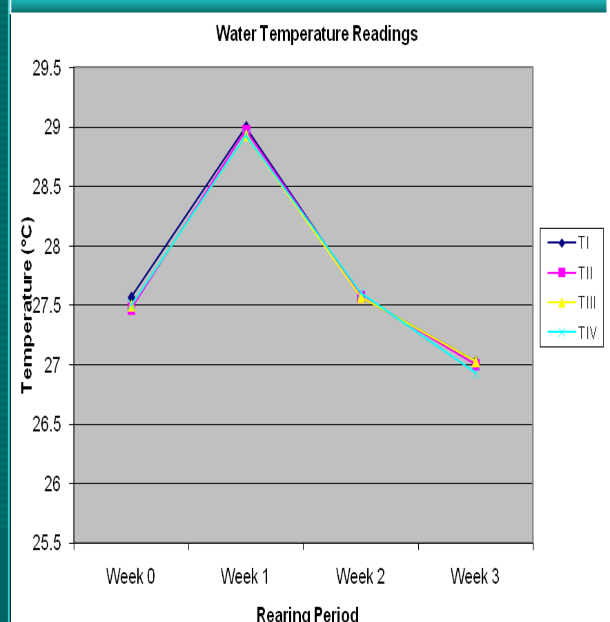


Figure 5. Average Water temperature reading during warm season

Figure 6. Average Water temperature reading during cold season

Ranges (Min-Max)	Treatment			
	I	II	III	IV
D.O. (mg/l) Cold Season	4.81 – 15.04	4.96 – 15.69	5.37 – 15.1	2.82 – 14.94
Temp (°C) Cold Season	25.1 – 32.6	25.1 – 32.7	25.5 – 32.7	25.1 – 32.6
D.O. (mg/l) Warm Season	1.47 – 18.73	1.55 – 16.03	1.59 – 19.56	1.78 – 16.34
Temp (°C) Warm Season	28.5 – 35.7	28.4 – 35.5	28.5 – 35.6	28.5 – 35.5

Figure 7. Water Temperature and Dissolved Oxygen Readings

Conclusion

- Growth of tilapia fry reared in hapas were affected by the season (temperature).

- Fry reared in warm months significantly attained a better growth than fry reared during the cold months.

- Higher percentage (70 – 80%) of fingerlings recovered in warmer months are ready for commercial distribution, while (90%) of fingerlings produced during the cold period are not ready for distribution and needs further rearing to reach the size desired for commercial distribution.

-Survival of fry in hapa was significant between seasons. Pond and artificial incubation raised fry can be utilized during the cold months.

Funding for this research was provided by the

AQUA FISH

COLLABORATIVE RESEARCH SUPPORT PROGRAM

USAID FROM THE AMERICAN PEOPLE

OSU Oregon State University

AQUAFISH COLLABORATIVE RESEARCH SUPPORT PROGRAM

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thank you