AquaFish Collaborative Research Support
Program Technical Sessions at
Aquaculture America 2010
San Diego, California, USA
2 – 5 March 2010
Session organizer: Dr. Hillary Egna

Proceedings

Assembled by Amanda Hyman Edited by Jenna Borberg 2017

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







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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.

Acknowledgements

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Disclaimers

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PREAMBLE
2010 AQUAFISH CRSP TECHNICAL MEETING AGENDA
ABSTRACTS AND PRESENTATIONS9
DR. YANG YI – A MEMORIAL9
ADVANCES IN OPTIMIZING POND CULTURE SYSTEMS11
WATER USE EFFICIENCY IN AQUACULTURE
INTRODUCED NILE TILAPIA <i>Oreochromis niloticus</i> HAVE ONLY A MINOR IMPACT ON SMALL INDIGENOUS FISH SPECIES IN STATIC POND ENVIRONMENT OF BANGLDSESH AND NEPAL
POLYCULTURE OF SAHAR <i>Tor putitora</i> WITH MIXED-SEX NILE TILAPA <i>Oreochromis niloticus</i> 15
GROWTH PERFORMANCE OF NILE TILAPIA <i>Oreochromis niloticus L</i> . IN PONDS IN THE PHILIPPINES USING COMBINED FEED REDUCTION STRATEGIES 16
EFFECT OF AGE OF BROODFISH ON THE GROW-OUT PERFORMANCE OF NILE TILAPIA <i>Oreochromis niloticus L</i> . FINGERLINGS IN EARTHEN PONDS
REPLACEMENT OF FISH MEAL BY SOYBEAN MEAL WITH ALPHAGALACTOSIDASE IN DIETS FOR SNAKEHEAD, <i>Channa striata</i>
EFFECT OF THE Microcystis aeruginosa ON THE WATER FLEA Daphnia magna AND THE RED SWAMP CRAYFISH Procambarus Clarkia
FARMING PRACTICES OF SNAKEHEAD (<i>Channa micropeltes</i> and <i>Channa striatus</i>) IN THE MEKONG DELTA OF VIETNAM
TRADE AND CONSUMPTION OF FOOD FISH IN FRESHWATER AREAS OF THE MEKONG DELTA, VIETNAM21
SMALL-SIZED FISH PASTE PRODUCTION TECHNOLOGY IN CAMBODIA'S MEKONG RIVER BASIN
MARKET CHANNEL AND TRADE OF FISH PASTE FROM SMALL-SIZED FISH IN CAMBODIA23
EFFECTS OF DIFFERENT FEEDING METHODS ON PERFORMANCES OF INTENSIVE POLYCULTURE OF WHITE SHRIMP <i>Litopenaeus vannamei</i> AND RED TILAPIA <i>Oreochromis spp.</i>
LESSONS FROM ASIA FOR RICE-FISH CULTURE IN MALI IN WEST AFRICA 25
EFFICIENT POND DESIGN STRATEGIES FOR A VARIETY OF ENVIRONMENTS 26
AQUACULTURE POND CONSTRUCTION GUIDELINES FOR SUSTAINABLE MICROWATERSHED DEVELOPMENT IN UGANDA
PROSPECTS OF AQUACULTURE ENTERPRISES IN POVERTY REDUCTION IN UGANDA
SOURCES AND USES OF MICRO-CREDIT IN POVERTY ALLEVIATION AMONG FISHFARMERS IN OSUN STATE, NIGERIA

PREAMBLE

Session Organizer: Dr. Hillary Egna

We sadly note the death of our dear friend and colleague, Dr. Yang Yi. Yang Yi was an excellent and collaborative researcher, achieved scholar, and a leader in the field of aquaculture. Yang Yi received his B. Sc. in Genetics from Sichuan University, China in 1985 and his M. Sc. and D. Tech. Sc. degrees in Aquaculture from the Asian Institute of Technology (AIT), Thailand in 1992 and 1997. He was a post-doctoral researcher at AIT funded by University of Michigan and the Aquaculture CRSP. He became an assistant professor in 1999, an associate professor in 2003, and chair of the Department of Aquaculture and Aquatic Resources Management in 2005. In August 2007, he was hired as Professor at Shanghai Ocean University, as well as the Director of the Sichuan Aquacultural Engineering and Technology Research Center in Chengdu, part of Tongwei Group, the major feed producer for China. Throughout his career, Yang Yi earned numerous awards, became president of Asian Fisheries Society, and consulted in Egypt, Mali, Indonesia, and many other countries.

In the words of AquaFish Director, Dr. Hillary Egna, "Yang Yi possessed a rare knowledge of aquaculture— a knowledge that cut across disciplinary boundaries, from theory into practice. In my many years in aquaculture and fisheries, I haven't come across many like him, with his depth and breadth of knowledge, his ability to explain complexity, reach out to producers, and mentor students with compassion and purpose. The immensity of his loss—right when he was poised to make even more outstanding contributions—is matched by his profound influence on this next generation of aquaculturists. Yang Yi will be missed for many, many years to come."

On 3 March 2010, researchers assembled in San Diego, California, USA for the AquaFish Technical Session honoring Dr. Yang Yi at Aquaculture America. Chaired by AquaFish CRSP Director, Hillary Egna and co-chaired by Assistant Director, Ford Evans, participants were provided the opportunity to honor the memory of Dr. Yang Yi with talks on research in "Optimizing Small-Scale Aquaculture for the Poor." Jim Diana started with a memorial presentation on Dr. Yang Yi's life and work. With a full day of 27 presentations, the session provided a comprehensive display of the wide range of AquaFish CRSP and ACRSP research over the years.

2010 AQUAFISH CRSP TECHNICAL MEETING AGENDA AA 2010 – San Diego, California, USA

3 March 2010

Wednesday, 3 March 2010

AquaFish CRSP Technical Session (8:30 – 16:30) Optimizing Small-scale Aquaculture for the Poor: A Session in Honor of Dr. Yang Yi

Chair: Dr. Hillary Egna, AquaFish Director and Lead Principal Investigator Co-Chair: Dr. Ford Evans, AquaFish Associate Director

8:30-8:45	DR. YANG YI – A MEMORIAL
	James S. Diana and C. Kwei Lin*
8:45-9:00	ADVANCES IN OPTIMIZING POND CULTURE SYSTEMS
	James S. Diana*, C. Kwei Lin, and Yang Yi
9:00-9:15	WATER USE EFFICIENCY IN AQUACULTURE
	Claude E. Boyd
9:15-9:30	POLYCULTURE OF SAHAR Tor putitora WITH MIXED-SEX NILE
	TILAPA Oreochromis niloticus
	Madhav K Shrestha*, Ravi Lal Sharma, Kamala Gharti, Yang Yi, James S Diana
9:30-9:45	GROWTH PERFORMANCE OF NILE TILAPIA Oreochromis niloticus L.
	IN PONDS IN THE PHILIPPINES USING COMBINED FEED
	REDUCTION STRATEGIES
	Russell J. Borski*, Remedios B. Bolivar, Eddie Boy T. Jimenez, Roberto Miguel
	V. Sayco, and Reginor Lyzza B. Argueza
9:45-10:00	INTRODUCED NILE TILAPIA Oreochromis niloticus HAVE ONLY A
	MINOR IMPACT ON SMALL INDIGENOUS FISH SPECIES IN STATIC
	POND ENVIRONMENT OF BANGLDSESH AND NEPAL
	Amrit Bart *, Sultanul. A. S. Ahmad, James E. Rakocy and James S. Diana
10:00-10:15	EFFECT OF AGE OF BROODFISH ON THE GROW-OUT
	PERFORMANCE OF NILE TILAPIA Oreochromis niloticus L.
	FINGERLINGS IN EARTHEN PONDS
	Remedios B. Bolivar*, Eddie Boy T. Jimenez, Roberto Miguel V. Sayco, Reginor
10 20 10 15	Lyzza B. Argueza, Hernando L. Bolivar, Lourdes B. Dadag, and Russell J. Borski
10:30-10:45	REPLACEMENT OF FISH MEAL BY SOYBEAN MEAL WITH
	ALPHAGALACTOSIDASE IN DIETS FOR SNAKEHEAD, Channa striata
	Tran Thi Thanh Hien*, Ly Vu Minh, Nguyen Hoang Duc Trung, Chong M. Lee
10 47 11 00	and David A. Bengtson
10:45-11:00	EFFECT OF THE Microcystis aeruginosa ON THE WATER FLEA Daphnia
	magna AND THE RED SWAMP CRAYFISH Procambarus Clarkia
11.00 11.15	Liu Liping*, LI Kang, Chen Taoying, Yang Yi, James S. Diana
11:00-11:15	FARMING PRACTICES OF SNAKEHEAD (Channa micropeltes and
	Channa striatus) IN THE MEKONG DELTA OF VIETNAM Le Xuan Sinh* Robert S. Pomerov
	LE XUAN SINNT KODERT S. POMETOV

11:15-11:30	TRADE AND CONSUMPTION OF FOOD FISH IN FRESHWATER AREAS OF THE MEKONG DELTA, VIETNAM
11:30-11:45	Le Xuan Sinh* Robert S. Pomeroy SMALL-SIZED FISH PASTE PRODUCTION TECHNOLOGY IN CAMBODIA'S MEKONG RIVER BASIN
11:45-12:00	Nam So*, Chakriya Norng, Sy Vann Leng, Robert Pomeroy MARKET CHANNEL AND TRADE OF FISH PASTE FROM SMALL- SIZED FISH IN CAMBODIA
12:00-12:15	Nam So*, Sophea Un, Sy Vann Leng, Robert Pomeroy EFFECTS OF DIFFERENT FEEDING METHODS ON PERFORMANCES OF INTENSIVE POLYCULTURE OF WHITE SHRIMP Litopenaeus
12:15-12:30	vannamei AND RED TILAPIA Oreochromis spp. Derun Yuan*, Amararatne Yakupitiyage, Yang Yi, James S. Diana LESSONS FROM ASIA FOR RICE-FISH CULTURE IN MALI IN WEST AFRICA Liu Liping*, Yuan Derun, James H. Bowman, Yang Yi, Héry Coulibaly, Hillary
13:30-13:45	Egna EFFICIENT POND DESIGN STRATEGIES FOR A VARIETY OF ENVIRONMENTS
13:45-14:00	Charles C. Ngugi* and Kwamena Quagrainie AQUACULTURE POND CONSTRUCTION GUIDELINES FOR SUSTAINABLE MICROWATERSHED DEVELOPMENT IN UGANDA Levi L. Kasisira*, Peter Mulamba, Nelly A. Isyagi, John Walakira, and William
14:00-14:15	E. Tollner PROSPECTS OF AQUACULTURE ENTERPRISES IN POVERTY REDUCTION IN UGANDA
14:15-14:30	Hyuha Theodora Shuwu*and Bukenya, James SOURCES AND USES OF MICRO-CREDIT IN POVERTY ALLEVIATION AMONG FISHFARMERS IN OSUN STATE, NIGERIA
14:30-14:45	Omitoyin, S.A *, Sanda O.H USE OF Moringa oleifera and Leucaena leucocephala TO IMPROVE COST EFFICIENCIES IN TILAPIA Oreochromis niloticus FEED
14:45-15:00	Sebastian W. Chenyambuga*, Margaret M. Kibodya, Berno V. Mnembuka, Kajitanus O. Osewe, Rebecca Lochmann and Kwamena Quagrainie TRANSFERRING CICLID CULTURE TECHNOLOGIES TO BRAZIL: YANG YI'S LEGACY
	Maria Célia Portella*, Hillary S. Egna, James R. Bowman, Remedios Bolivar, Wilfrido Contreras, Lourens De Wet, Khalid Salie, Charles Ngugi, Nguyen Thanh Phuong
15:00-15:15	UTILIZATION OF LOCAL FEED INGREDIENTS FOR FRESHWATER AQUACUTLURE
15:15-15:30	Kevin Fitzsimmons*, Pamila Ramotar, Jason Licamele, Michelle Ferman PARTIAL SUBSTITUTION OF FISH MEAL WITH PORK MEAL IN PRACTICAL DIETS FOR THE MAYAN CICHLID Cichlasoma
	urophthalmus JUVENILES Benigno Garc, Carlos A.*, Gabriel Marquez-Couturier, Wilfrido M. Contreras-

Sanchez, Roberto Civera-Cerecedo, Ernesto Goytortua-Bores

15:30-15:45 OPTIMIZING UTILIZATION OF BIVALVE RESOURCES THROUGH COMMUNITYBASED AQUACULTURE, SANITATION AND FISHERIES MANAGEMENT ON THE PACIFIC COASTS OF MEXICO AND NICARAGUA

Haws, M.C.*, Gaxiola-Camacho, E., Rodriguez-Dominguez, G., Hernandez, N., Sandoval, E., Rivas, C., Bravo, J.R., Crawford, B., Supan, J. and Saborio-Coze, A. Maria C. Haws

- 15:45-16:00 DEVELOPMENT OF AN ELEOTRIDAE FISH, DORMITATOR

 LATIFRONS (PACIFIC FAT SLEEPER) FOR AQUACULTURE ON THE
 PACIFIC COASTS ECUADOR, NICARAGUA AND MEXICO

 Haws, M.C*., Elao, R., Ochoa-Moreno, E., Guevara, G., Arriaga, L., RodriquezMontes de Oca, G., Gaxioloa-Camacho, E., Rodriguez-Dominguez, G., Crawford,
 B., and Hernandez, N., and Rivas-LeClair, C
- 16:00-16:15 INDUCED REPRODUCTION OF THE FAT SNOOK Centropomus parallelus IN CAPTIVITY USING GnRH-a INJECTIONS AND IMPLANTS

Marde JesContreras-Garc, Wilfrido M. Contreras-S*, Ulises Hern, Alejandro Mcdonal-Vera and Reynaldo Pati

16:15-16:30 ISOLATION AND CHARACTERIZATION OF BACTERIA FROM BIOFILMS FORMED IN FILTERS USED TO ELIMINATE METHYLTESTOSTERONE FROM INTESIVE TILAPIA MASCULINIZATION SYSTEMS

Rosa M. PadrLucero VUlises Hern, Wilfrido M. Contreras-Sanchez*, Kevin Fitszimmons.

ABSTRACTS AND PRESENTATIONS

Optimizing Small-scale Aquaculture for the Poor: A Session in Honor of Dr. Yang Yi

DR. YANG YI - A MEMORIAL

James S. Diana and C. Kwei Lin*
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USA 48109-1041 jimd@umich.edu

We sadly note the death of our dear friend and colleague, Dr. Yang Yi, who passed away at 2:41 am on 31 July 2009, at the age of 46. Yang Yi was an accomplished scholar, an excellent researcher, and an innovator in the field of aquaculture, especially in applying simple techniques to gain efficiency for small scale farmers with limited incomes. Yang Yi received his B. Sc. in Genetics degree from Sichuan University, China in 1985 and his M. Sc. and D. Tech. Sc. degrees in Aquaculture from the Asian Institute of Technology, Thailand in 1992 and 1997. Yang Yi was a total product of the Collaborative Research Support Program, a long-term project funded by US Agency for International Development. His doctoral work was funded by CRSP projects, and upon completion of his doctorate, he became a faculty member at AIT, seconded by University of Michigan and the Aquaculture CRSP. He became an assistant professor in 1999, an associate professor in 2003, and chair of the Department of Aquaculture and Aquatic Resources Management in 2005. In August 2007, he was hired as Professor at Shanghai Ocean University, as well as the Director of the Sichuan Aquacultural Engineering and Technology Research Center in Chengdu, part of Tongwei Group, the major feed producer for China.

In 1992, Yang Yi began a doctor of technical science program at AIT under supervision of Dr. Kwei Lin. We had been working for some time on projects combining cage and pond culture, with cage culture of pellet-feeding fish in the middle of a pond and open water culture of tilapia, based on the waste products from the cage-culture system. Yang Yi's dissertation work focused on co-culture of tilapia in cages and ponds. His basic premise was that one could grow large tilapia in cages using pellets, grow small tilapia in the open water using waste products to stimulate phytoplankton and zooplankton for tilapia consumption, and balance the two systems so the young fish from the ponds could be stocked in the cages for the grow-out to a large size. The optimum system produced about 19 tons of fed tilapia per hectare of pond per year, with a market size of about 450-500 g; as well 6 tons per hectare per year of tilapia from the open water. Of the nutrients applied, 21% of the nitrogen and 28% of the phosphorus was recovered in fish. The system was a model of efficiency, and led Yang Yi into years of research focusing on improving the efficiency of aquaculture systems, and improving the lot of poor farmers. Yang Yi earned a number of honors during his career.

He was the current president of the Asian Fisheries Society and had been since 2007. He consulted internationally in Egypt, Mali, Indonesia, and many other countries. He published broadly in the major journals in our field and took his research through the full circle of development, data collection, modeling, implementation, and publication. He was a great

example of all the things collaborative research can do. It allowed him to develop his graduate program, which led him to an academic career focused on aquaculture, and eventually to becoming an expert in the field and president of a major society. Aquaculture has grown dramatically since the CRSP was initiated in 1982, and in large part, this growth has been due to the development of remarkable scientists like Yang Yi.

Dr. Yang Yi: A memorial

C. Kwei Lin

Aquaculture and Aquatic Resources Management Program Asian Institute of Technology, Thailand

J.S. Diana

School of Natural Resources and Environment University of Michigan



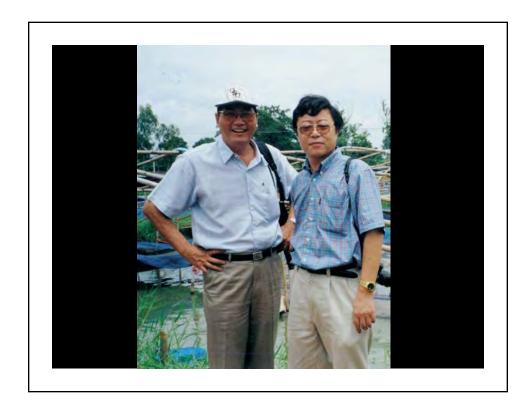








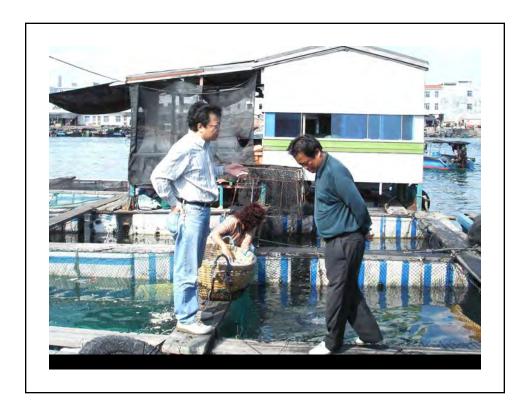
































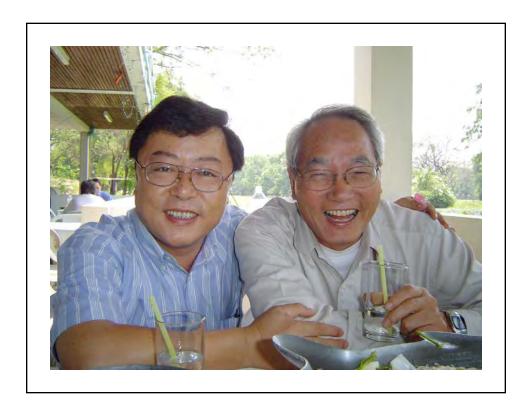












ADVANCES IN OPTIMIZING POND CULTURE SYSTEMS

James S. Diana*, C. Kwei Lin, and Yang Yi School of Natural Resources and Environment University of Michigan Ann Arbor, Michigan, USA 48109-1041 jimd@umich.edu

The focus of the Aquaculture Collaborative Research Support Project in Thailand has been on developing efficient systems for production of tilapia. Early research focused on nutrient balance in semi-intensive ponds, with organic manures and inorganic supplements. Use of chicken manure resulted in high levels of phosphorus and limited levels of nitrogen in the water. Providing nutrients at 4 kg of nitrogen and 1 kg of phosphorus per ha per day yielded optimal primary production and increased tilapia yield (from approximately 4,000 up to 6,200 kg). Harvest included fish approximately 300 g in size in five months of culture, fitting well to the traditional Thai market was for small fish (150-250 g) with fairly low market value. In the 1990s, an export market began for tilapia, and there was a need to grow fish to 500 g, which would allow the export of frozen fillets. Addition of feed in the pond changed the nature of the overall system. In fertilized ponds, critical standing crop was achieved by tilapia at about 35 g, and carrying capacity was reached when the fish were about 350 g. so that feed needed to be added in order to achieve a size near. We next tested the addition of feed and fertilizer to balance nutrient conditions in the ponds, and found that fertilizer helped maintain better water quality, while allowing for full feeding. Since natural feeds could add into tilapia nutrition, it might not be necessary to fully feed tilapia in order to obtain maximum growth. A new experiment was done using fertilized ponds and feed applied at proportions of satiation ration (1.0, 0.75, 0.5, or 0.25). Growth was comparable among the three treatments with 1.0, 0.75 or at 0.5 rations. However, should first feeding occur at stocking or could it be delayed to an advanced size after critical standing crop was exceeded? The final feeding experiment first fed tilapia at 50, 100, 150, 200, or 250 g; growth was comparable with first feeding at 50 or 100 g. Overall, optimal feeding grew much larger fish (500 g in 6 months) and higher yields (20,000 kg per hectare annually). Financial analyses using partial enterprise budgets indicated that fertilizing with a balanced addition was the most profitable fertilizing strategy (\$1,500 per ha per year). First feeding at 100 g and utilizing 50% satiation ration produced maximum economic value (\$6.000 per ha annually). The cage-cum-pond system, developed mainly by Yang Yi, held cages of tilapia in the middle of a pond, where the fish in cages were fed intensively. In the remainder of the pond, tilapia were allowed at large to consume waste feed, as well as phytoplankton and zooplankton produced by the fertilization effect of wastes from the cages. Overall, the sequential development of optimal feeding techniques and cage-cum-pond culture systems has resulted in considerably more efficient growth of tilapia, both for an export market and for local consumption. The system has to be adapted to local conditions of market type, temperature, feed type, fertilizers available, and other conditions. However, the beauty of the cage-cum-pond system is that it can be operated by a small-scale farmer with relatively limited facilities in terms of numbers of ponds or other machinery.

Advances in optimizing pond culture systems

J.S. Diana

School of Natural Resources and Environment University of Michigan

Yang Yi

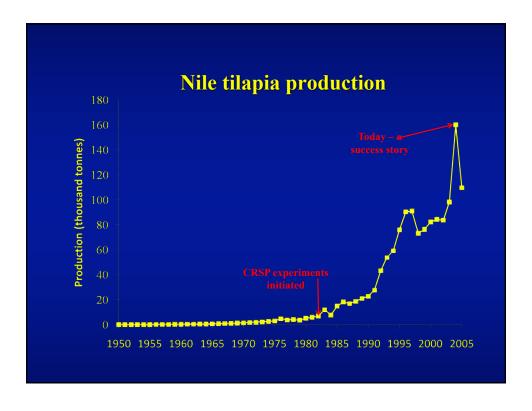
Shanghai Ocean University and Tongwei Company





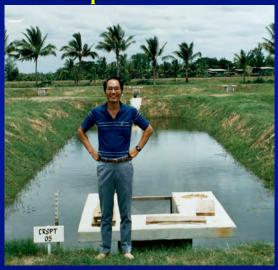
Historic tilapia culture in Thailand

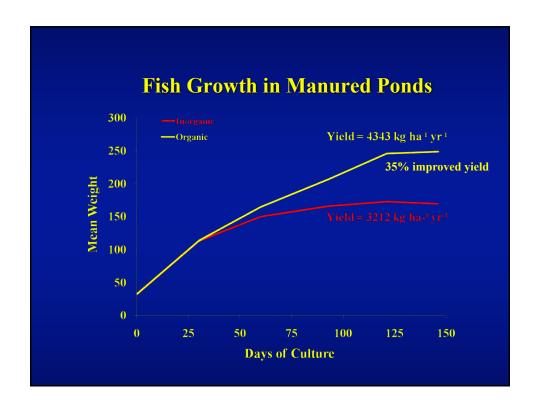
- In early 1980s, tilapia were grown in fertilized ponds mainly using chicken manure at 500 kg ha⁻¹ wk⁻¹
- Sold in domestic markets for local consumption, preferred fish at about 150-250 g size, which could be achieved in about 120-150 days of culture
- Market value for such fish was about \$0.48 per kg

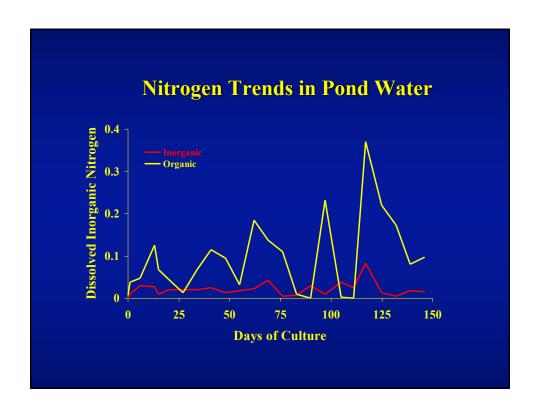


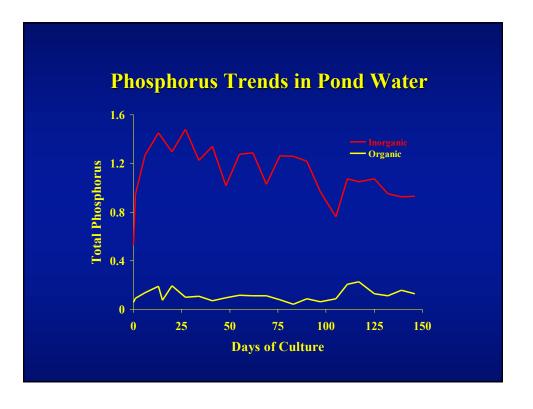
Experiments on semi-intensive culture for tilapia

- Add fertilizer (500 kg ha⁻¹ wk⁻¹ for chicken manure) to stimulate natural production
- Fish at low stocking density (1-2/m²)
- No need for aeration, effluents still may be problem
- CRSP experiments
 - Use small earthen ponds about 220 m²
 - Usually 3-5 replicate ponds per treatment
 - Usually 150 days, or to some set fish size



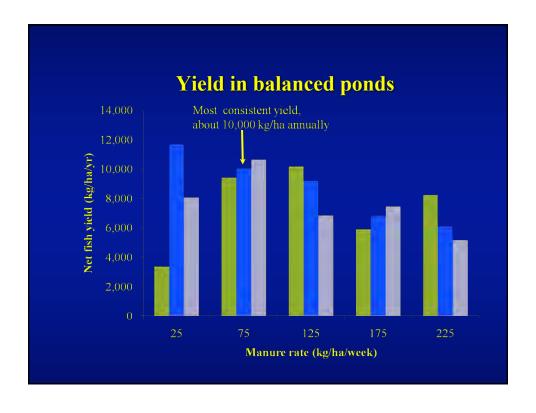






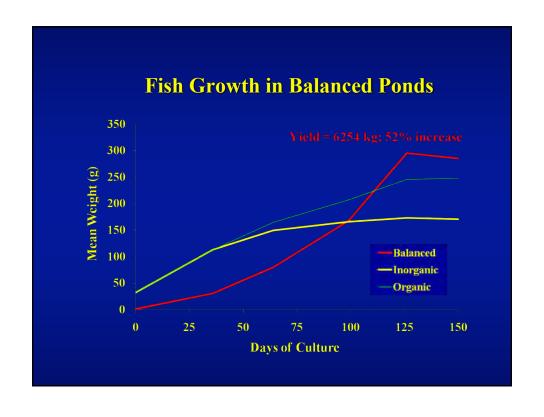
Providing nutrient balance

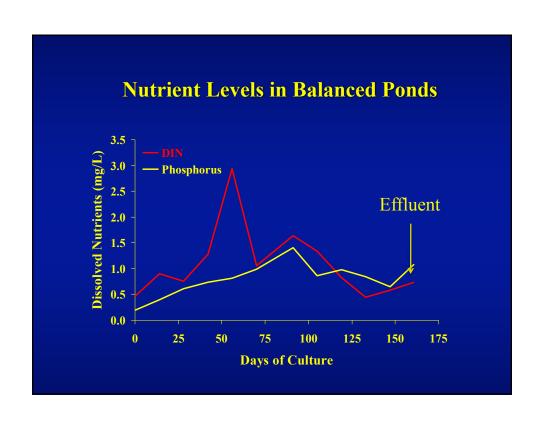
- Phytoplankton element ratios 18C:8N:1P
- Water levels for optimal production may vary due to cycling rates of each nutrient
- Chicken manure has 2.8N:4.5P by weight, with C in excess
- Supplementing N could boost production even though P is the first limiting nutrient
 - Particularly true when high rate of primary production is reached
 - Carbon may be limiting when fertilized with inorganic material, as alkalinity declines



Balanced addition

- Yield up to 10,000 kg/ha/yr
- Fish grew from 3 g to about 130-250 g in 147 days
- Highest and most reliable yield at 75 kg manure
- Variable results at 25 kg
 - Some ponds reached low alkalinity
- Lower yields at 175-225 kg manure inputs
 - Ponds began to have lower water quality



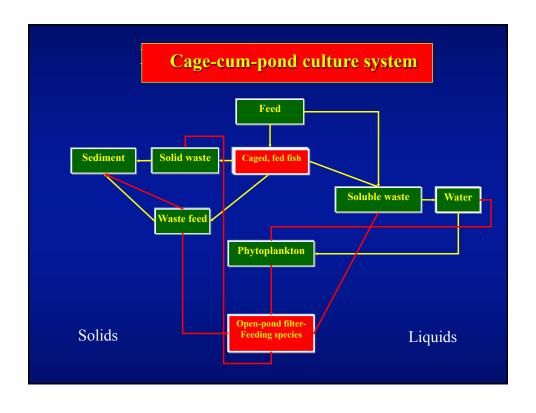


Discharge management

- · Harvest fish by nets
 - Usually incomplete at best
- Sequentially drain to control sediments and water loss
 - Can damage fish being harvested in limited water left
 - Hard to control well
- Use water drained from harvest pond to fill ponds
 - Probably most reliable and efficient
 - Requires some infrastructure to recapture drained water, such as settling pond, retaining pond, and pumping back to new pond
 - May need to treat water to control disease or fish population

Integrated cage-cum-pond culture

- Cages
 - high-valued fish species
 - high protein diets
- Open pond
 - filter-feeding fish species
 - natural foods





Cages (~4 m³) submerged in ponds



Catfish-tilapia cage-cum-pond results

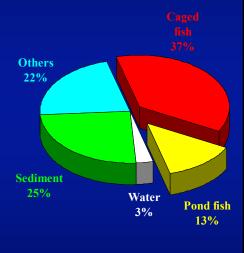
Performance measures	Treatment A		Treatment B	
	Caged catfish	Open-pond tilapia	Caged catfish	Open-pond tilapia
Water volume (m ³)	3.2	220	3.2	220
Cage no./pond	1		2	
Stocking				
Density (fish/m ³)	275	2	275	2
Total no. (fish)	880	440	1760	440
Mean wt. (g/fish)	14.3	7.0	15.0	6.7
Harvest				
Survival (%)	95.8	90.5	87.5	69.8
Mean wt (g/fish)	273.8	179.2	270.2	297.2
Net yield (t/ha/year)	26.1	8.1	46.9	10.3
Gross yield (t/ha/year)	27.6	8.5	50.0	10.6
FCR	1.94		2.24	
Waste loading rate (kg/ha/d)	3.71	3.71 N and 1.01 P		6 N and 2.20 P
Fish density (kg/m ³)	72.1	0.3	65.0	0.41
Overall density (kg/m³)	1.37	1.37)
Nutrient recovery rate (%)	13%	13% N and 17% P		% N and 5% P

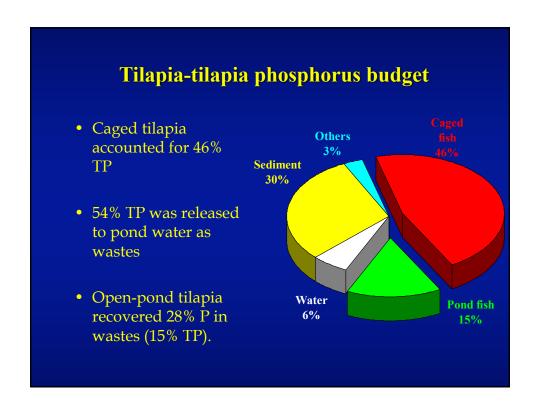
Optimized tilapia-tilapia cage-cum-pond results

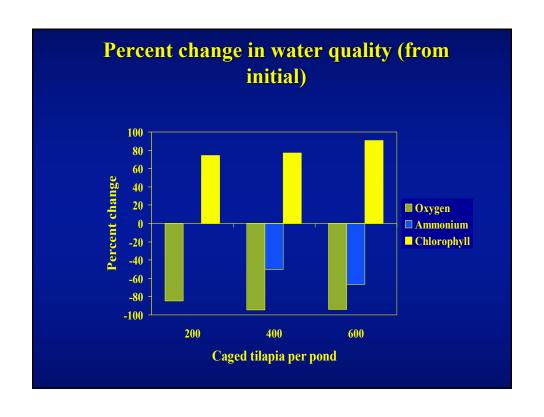
Performance measures	Caged tilapia	Open-pond tilapia
Water volume (m ³)	4	330
Stocking		
Density (fish/m ³)	50	1.4
Total no. (fish/pond)	400	462
Mean wt. (g/fish)	124	16
Large tilapia : small tilapia ratio	1:1.2	
Harvest		
Survival (%)	98.8	92.0
Mean wt (g/fish)	456	124
Net yield (t/ha/year)	18.2	6.2
Gross yield (t/ha/year)	24.9	7.1
FCR	1.22	
Total net yield (t/ha/year)	24.4	
Total gross yield (t/ha/year)	32.0	
Waste loading rate (kg/ha/d)	1.75 N and 0.37 P	
Fish density (kg/m ³)	44.7	0.16
Overall density (kg/m ³)	0.70	
Nutrient recover rate (% of fish waste)	21% N and 28% P	

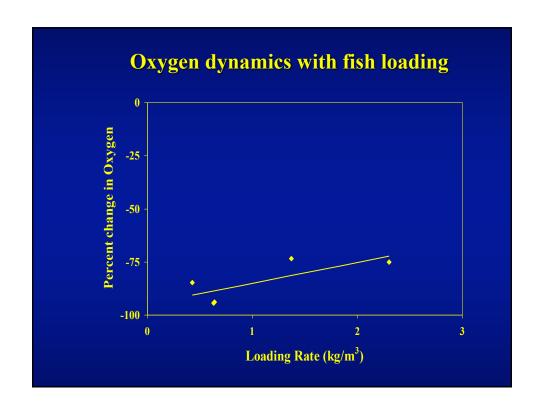
Tilapia-tilapia nitrogen budget

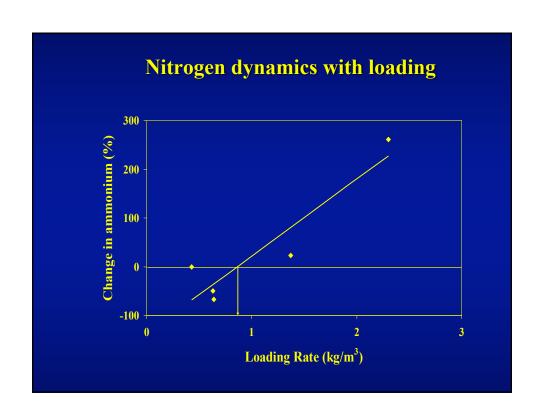
- Caged tilapia accounted for 37% TN;
- 63% TN was released to pond water as wastes;
- Open-pond tilapia recovered 21% N in wastes (13% TN).

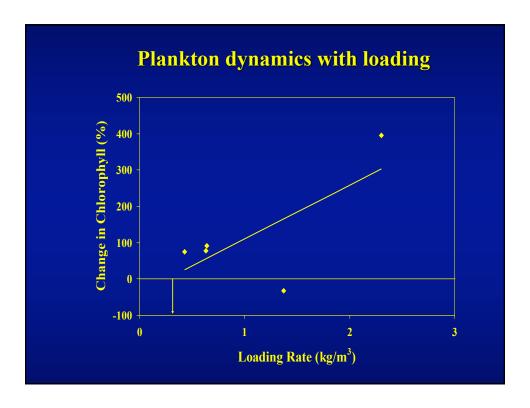












Advances in optimization

- Balance of nutrients important
- Harvest techniques can improve
- CCP reuses some wastes for fish growth
- CCP confines costly feed to target species
- CCP improves effluent quality
- CCP suitable for small-scale farmers especially those with only one pond

Target of System Must Be the Users



WATER USE EFFICIENCY IN AQUACULTURE

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Total water use in aquaculture is greater than consumptive water use, because water from production units is discharged downstream. Consumptive water use in aquaculture is defined as reduction in downstream flow plus groundwater taken from wells. Fish production typically requires total water use to 4 to 8 m³ /kg fish in embankment ponds and 8 to 16 m³ /kg fish in watershed ponds. Typical values for corresponding consumptive water use are 2 to 4 m3 /kg fish and 1 to 2 m³ /kg fish, respectively. Water use in agriculture often is determined as the amount of water used in producing a product but not contained in the product – this water is called virtual or embedded water. Virtual water includes three fractions (colors): green (rainwater evaporated during production); blue (water from wells or irrigation canals evaporated during production); gray (water polluted during production). The concept is promoted by several environmental organizations, and it could be used in aquaculture. In pond fish production, green and blue water is around 2 to 4 m3 /kg – similar to consumptive water use. All water discharged from culture units is gray water, and virtual water use essentially equals total water use. Consumptive water use in raceways is low because evaporation is a minor loss and nearly all inflowing water passes downstream. Virtual water use equals total water use because discharge contains wastes. In cage culture, consumptive water use is limited to water in harvested biomass. Virtual water use consists almost entirely of the gray fraction, and it seems impossible to estimate the volume of this fraction other than considering that cages pollute the entire water body into which they are installed. Aquaculture systems do not discharge highly polluted water. and aquaculture effluents do not seriously impair receiving water for most other uses. It seems more reasonable to evaluate water use efficiency for aquaculture systems based on consumptive water use rather than virtual water use. Aquaculture effluents can be considered separately from consumptive water use allowing a better assessment of water pollution potential than possible by classifying them as gray, virtual water.

Water Use Efficiency in Aquaculture

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Proposed Definitions of Freshwater Use in Aquaculture (Boyd 2005)

Total Water Use – All water entering ponds or production units.

Consumptive Water Use – All freshwater withdrawn from wells and amount of reduction caused in runoff entering streams.

Total Water Use for Selected Species According to the Definition

Total water use = Precipitation + Runoff + Seepage in + Management additions + Water in biomass

Catfish (ponds) 1,200 to 10,000 m³/t

Tilapia (cages) 667 m³/t

Trout (raceways) 16,000 to 120,000 m³/t Shrimp (ponds) 20,000 to 100,000 m³/t

Hydrologic Equation

Inflows = Outflows $\pm \Delta$ Storage

Inflows Outflows

Precipitation (P) Evaporation (E)

Runoff (R) Seepage (S)

Additions (wells, Harvest biomass (B)

streams, reservoirs, Releases (water exchange,

etc.) (A) draining, etc.) (D)

Overflow (OF)

 $P + R + A = E + S + B + D + OF \pm \Delta Storage$

Water in Harvested Biomass

Fish and most other culture species are about 75% water

$$1,000 \text{ kg} \cdot 0.75 = 750 \text{ kg} = 0.75 \text{ m}^3$$

$$\frac{0.75 \text{ m}^3}{10,000 \text{ m}^2/\text{ha}} = 0.000075 \text{ m or } 0.0075 \text{ cm/mt}$$

Assumptions for Calculations

Hydrologic data

P = 150 cm/yr E = 130 cm/yr R = 60 cm/yr S = 100 cm/yr B = negligible (omitted)

Pond data

- Pond area = 1 ha
- Water depth = 1.5 m
- For embankment pond, watershed area negligible
- For watershed pond, watershed: pond area ratio = 10:1
- Storage capacity below drain ≤ 10 cm

Water Use Calculation for Embankment Pond

Fill (well water)150 cmEvaporation130 cmPrecipitation150 cmSeepage100 cm(Δ Precipitation130 cm)Overflow20 cm

Water addition [(E + S) - Δ P] 100 cm Total outflow (S + OF + D) 270 cm Normal outflow without pond 60 cm

Total water use: $A_F + A_{WL} + P = 400 \text{ cm}$

Consumptive water use: $A_F + A_{WL} = 250$ cm

Virtual Water

The water used in production of goods and services is called virtual water or it may be termed embedded water, embodied water, or hidden water. For example, a tonne of wheat grain contains only about 100 L of water, but it takes around 1,300 m³ of water to produce 1 tonne of wheat grain.

Agricultural products are a major source of virtual water in international trade. About 16% of total water use worldwide is virtual water in exported products.

Color of Virtual Water

Green – volume of rainwater that is lost to evapotranspiration during production of a crop or product.

Blue – volume of surface or groundwater that is lost to evaporation or evapotranspiration during production of a crop or product.

Gray – volume of water that is polluted during production of a crop or product.

Virtual Water in Embankment Pond Example

Green = E ×
$$\frac{P}{A_F + A_{WL} + P}$$
 = 130 × $\frac{150}{400}$ = 48.75 cm

Blue = E ×
$$\frac{A_F + A_{WL}}{A_F + A_{WI} + P}$$
 = 130 × $\frac{250}{400}$ = 81.25 cm

$$Gray = S + OF + D = 20 + 100 + 150 = 270 cm$$

Water Use Calculation for Watershed Pond

Runoff 600 cm Evaporation 130 cm
Precipitation 150 cm Seepage 100 cm
Overflow 370 cm

Pond outflow (S + OF + D) 620 cm Normal outflow without pond 660 cm

Total water use: R + P = 750 cm

Consumptive water use = Normal overflow without pond – pond outflow = 40 cm

Virtual Water in Watershed Pond Example

Green = E
$$\times \frac{P}{P + RO} = \frac{150}{750} = 26 \text{ cm}$$

Blue = E ×
$$\frac{RO}{P + RO}$$
 = 130 × $\frac{600}{750}$ = 104 cm

$$Gray = S + OF + D = 100 + 370 + 150 = 620 cm$$

Water Use	m^3/ka) in Ponds	*
vvaler USE	(III-/Kg) III Pullus	

	Total	Consumptive
Embankment	8	5
Watershed	15	0.8

		Virtual			
	Green	Blue	Gray	G	
+B+G					
Embankment	0.98	1.62	5.4	8	
Watershed	0.52	2.08	12.4	15	

*Production = 5,000 kg/ha.

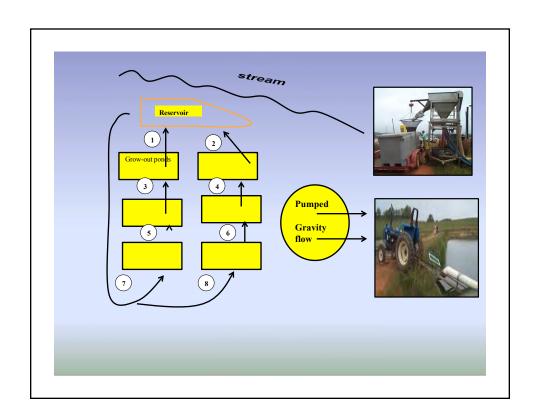
- Verdegem and Bosma (2009) estimated that total water withdrawal for freshwater aquaculture averaged 16.9 m³/kg – 429 km³/ yr or 3.6% of global, annual, renewable freshwater supply. This estimate was based on average production of about 3,000 kg/ha.
- Verdegem and Bosma recommended improving water use efficiency by increasing production.

Methods for Improving Water Use Efficiency

- Provide storage volume in ponds to prevent overflow following heavy rains.
- Install seepage reduction measures.
- Reduce water exchange.
- Reuse water where possible.
- Increase production levels through use of aeration.



Illustration of storage volume to maintain rainfall into ponds



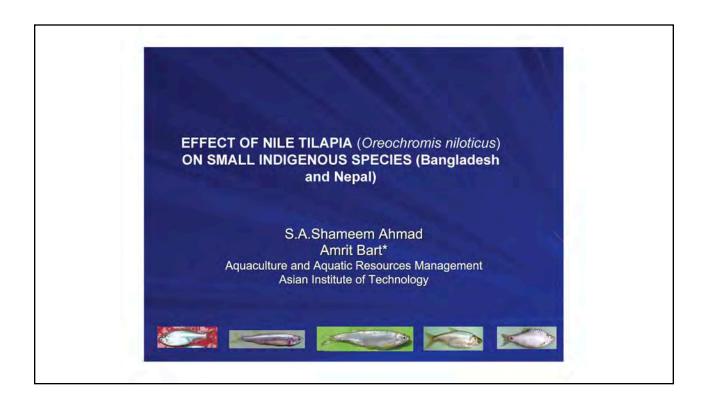
INTRODUCED NILE TILAPIA OREOCHROMIS NILOTICUS HAVE ONLY A MINOR IMPACT ON SMALL INDIGENOUS FISH SPECIES IN STATIC POND ENVIRONMENT OF BANGLDSESH AND NEPAL

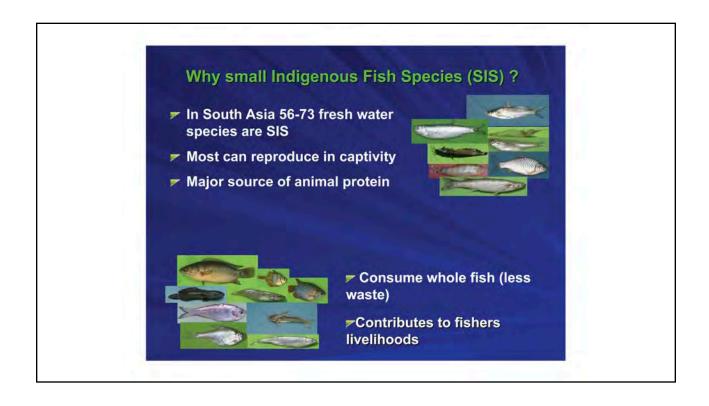
Amrit Bart*, Sultanul. A. S. Ahmad, James E. Rakocy and James S. Diana Asian Institute of Technology in Vietnam (AITVN); B3, UTC, Box 46, Hanoi, Vietnam bart@ait.asia

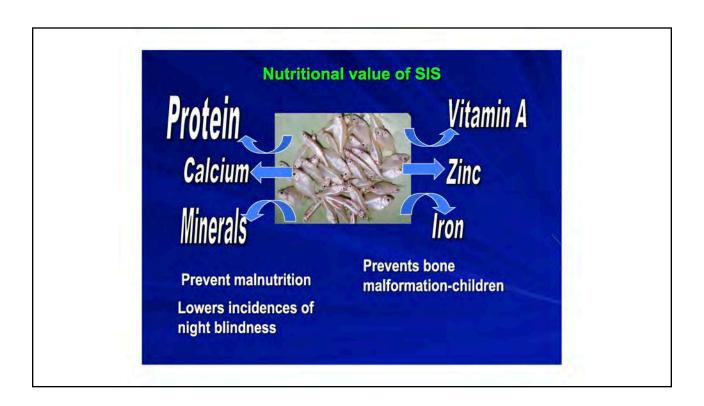
Two experiments were conducted to assess the impact of mixed-sex and male mono-sex Nile tilapia (Oreochromis niloticus) on small indigenous fish species (SIS) of Bangladesh and Nepal. Both experiments were conducted in small earthen ponds over 21-month period in Bangladesh experiment and 14 months in Nepal experiments. Treatments were mixed-sex tilapia with SIS, mono-sex male tilapia with SIS and SIS without tilapia (control) for both experiments. No nutritional inputs were applied after stocking. All species reproduced during the experimental period except faketa in Nepal experiment. Mixed sex tilapia reproduced greater number than SIS and tilapia numbers at harvest were the highest in mixed sex treatment compared with SIS in both treatments. There were lowest numbers of total SIS in mixed-sex tilapia treatment than in the mono-sex treatments and control. In the mono-sex tilapia treatments, SIS numbers and harvest biomass were similar to the control in both experiments. At harvest, tilapia biomass in mixed sex and mono-sex treatments was higher than all three SIS species combined in both experiments. In the aggregate, there was reduction in SIS (numbers and biomass) in mixed sex tilapia treatment than mono-sex and control. Gut content analysis and electivity index (Ivlev index) in both experiments indicated that all fish species fed selectively. In both experiments, Schoener's index also revealed that overall dietary overlap was greater between SIS and tilapia in presence of mixed sex tilapia than the mono-sex tilapia treatments. Significant interspecies dietary overlap between the Nile tilapia and SIS and among SIS in both experiments reflects competition exits in both experiments. Both studies suggested a low negative effect of Nile tilapia on indigenous species because no indigenous species was lost (except faketa) from treatments ponds and a healthy population of SIS was found to reproduce in the experimental ponds.

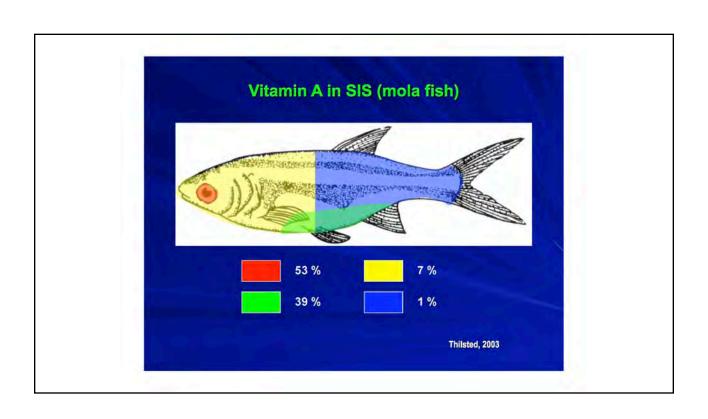
Table. Mean (±SE) number (fish/100 m²) and biomass (g/100 m²) of SIS and Nile tilapia (*Oreochromis niloticus*) in mixed-sex, mono-sex and without tilapia treatments at harvest in Bangladesh and Nepal Experiments.

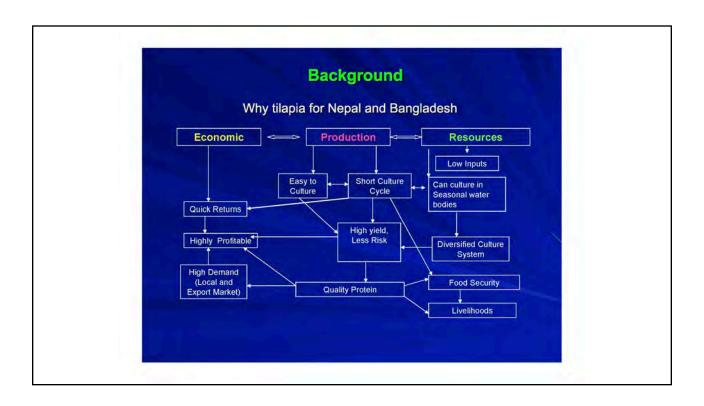
	At	Γ	Treatments (at har	eatments (at harvest)			
Parameters	stocking	Mixed-sex tilapia	Mono-sex tilapia	Without tilapia			
Bangladesh Experiment							
No. of mola	14	221±22 ⁶	399±33a	358±46 ^a			
Biomass of mola	9.62	238.33±24.34 ⁰	496.33±57.44 ^a	424.63±62.61 ^a			
No. of chela	14	94±8°	157±6 ⁰	238±7 ^a			
Biomass of chela	10.22	162.50±8.85°	234.57±19.17 ⁰	421±38.62 ^a			
No. of punti	14	100±7	304±116	308±43			
Biomass of punti	63.56	1009.67±153.10 ^t	1399.67±247.31a	2052.50±157.50 ^a			
No. of tilapia	14	451±25 ^a	14±0.0 ⁰	-			
Biomass of Tilapia	71.68	7201±330	6387±438	-			
Total number of SIS-only	42	415±25°	861±110 ^a	905±85 ^a			
Total biomass of SIS- only	83.3	1410±121 ⁰	2130 ±290 ^{ao}	2840 ± 140^{a}			

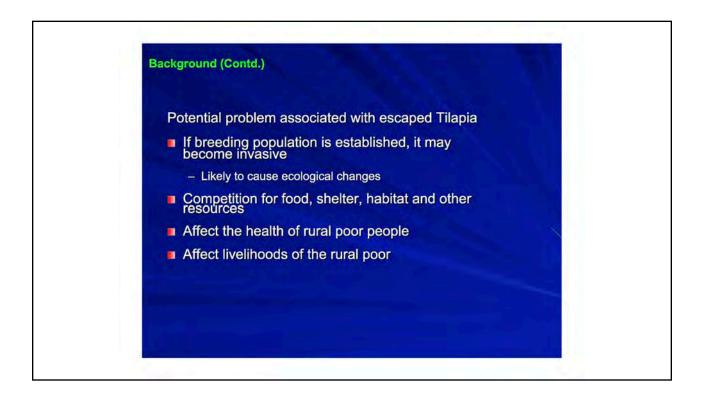












Rationale

"Populations of many indigenous small fish species (SIS) have declined due to the invasion of Oreochromis niloticus in water bodies of Bangladesh" (IUCN Biodiversity Conference, 1999)

based on anecdotal evidence and survey data (Ameen, 2000, Canonico et al. 2005)

no experimental study to date on the effects of Nile tilapia on indigenous species

Rationale (Contd.)

We wanted to know:

"Does introduced tilapia pose a real threat to Biodiversity and the Ecology?"

This is not easy to answer because:

- ❖ Laboratory/controlled experiment is difficult
- * The study need long period
- ❖ Interpretation of laboratory study could be misleading

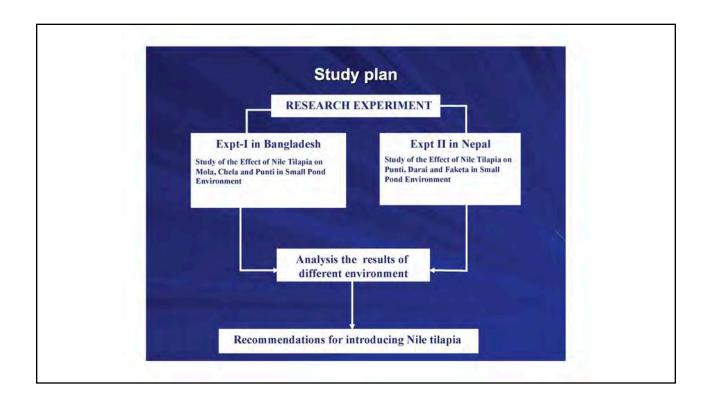
Research Questions

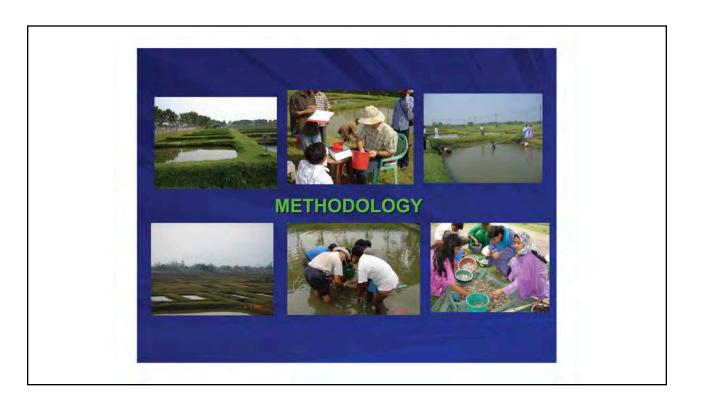
Do introduced tilapia compete with SIS?

- Is the recruitment of SIS reduced?
- Is the population structure altered?
- Is there dietary overlap?

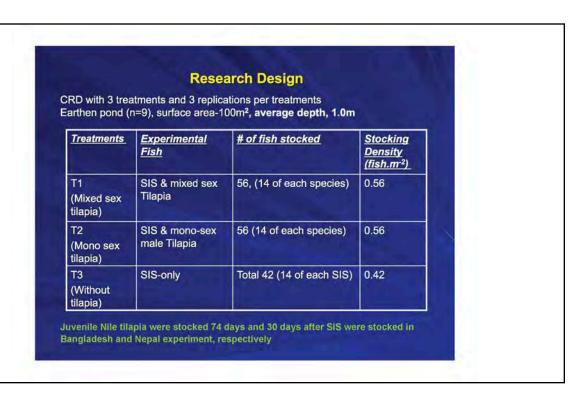
Is the important limnological factors altered as a result of introduction?

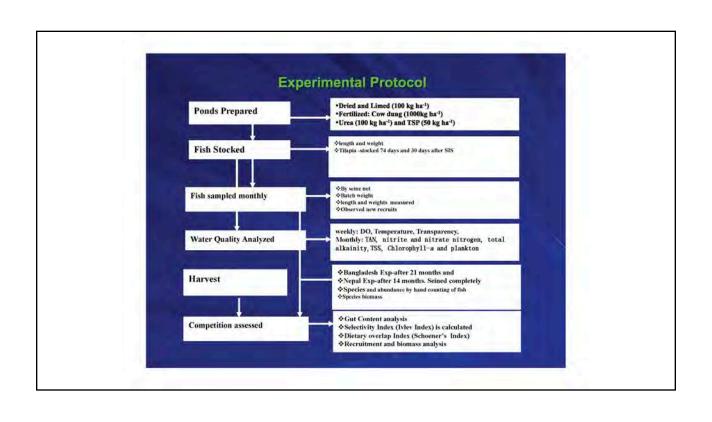


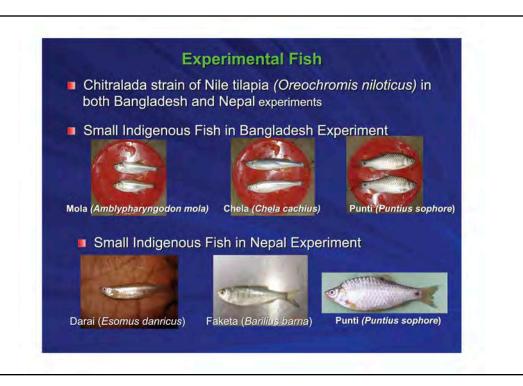




Expt No.	Name of Experiments	Experimental Sites	Experimental Fish	Experiment Duration
	The effect of Nile tilapia on SIS in static pond environment in Bangladesh	ACRSP-sites, BAU, Bangladesh	Mola, Chela, Punti and Nile tilapia	Dec 2004- Sept 2006
	The effect of Nile tilapia on SIS in static pond environment in Nepal	ACRSP-sites, Institute of Agriculture and Animal Science (IAAS), Nepal	Darai, Faketa, Punti and Nile tilapia	Jun 2005- July 2006 (14-mo)







Assessment of Competition

Gut Content, Selectivity and Dietary Overlap

- At the end of experiment, 20 fish was randomly removed from each replication for Gut Analysis, Dietary Overlap & Selectivity Index
- Estimation of Electivity Index (Ivlev , 1961)

$$E = \frac{Pg - Pw}{Pg + Pw}$$

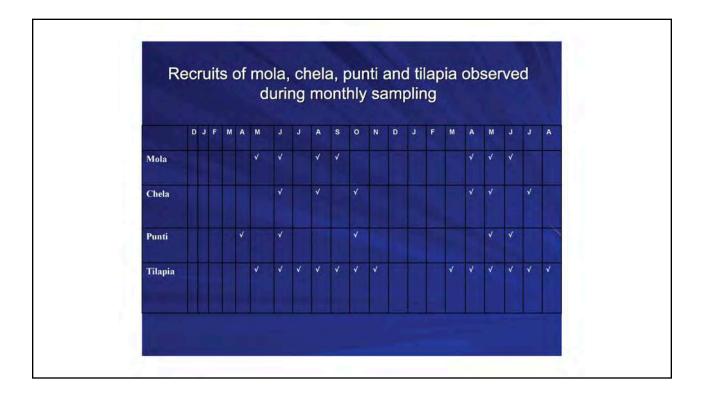
E is the Dietary Overlap Index

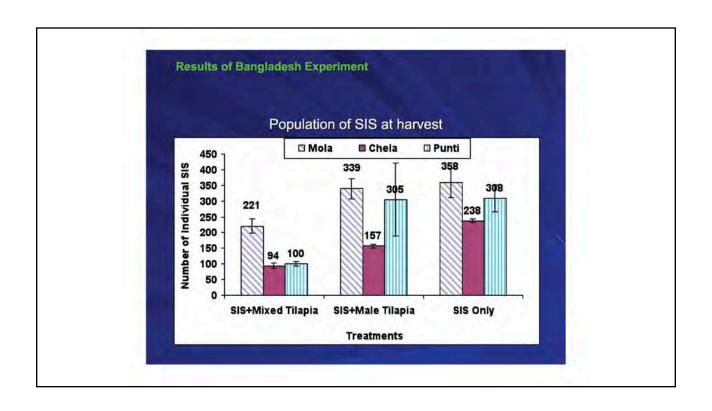
Estimation of Dietary Overlap (Schoener's Index, 1970)

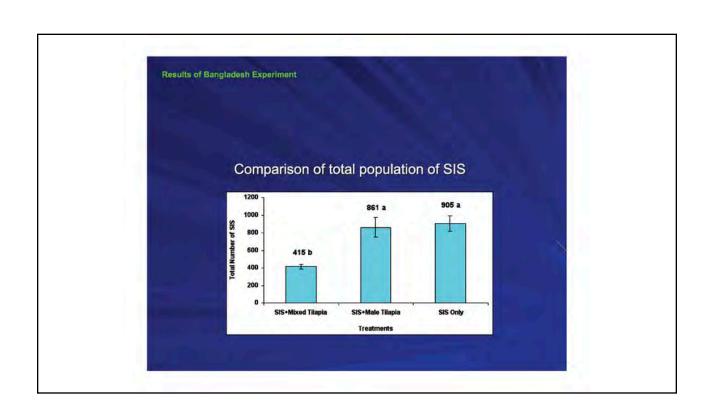
$$\alpha = 1 - 0.5 \left(\sum_{i=1}^{n} [Pxi - Pyi] \right)$$

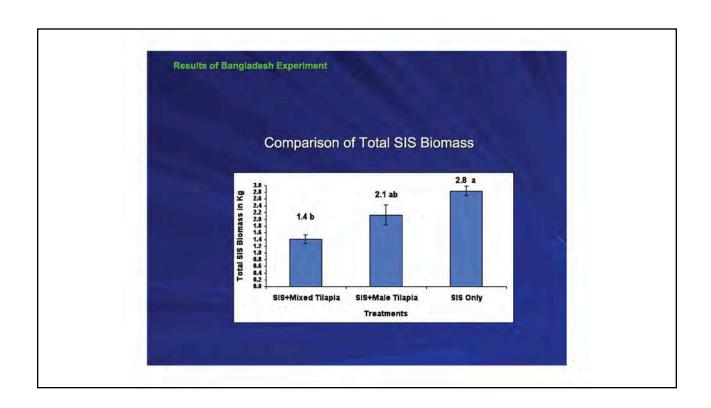
α is the Dietary Overlap Index

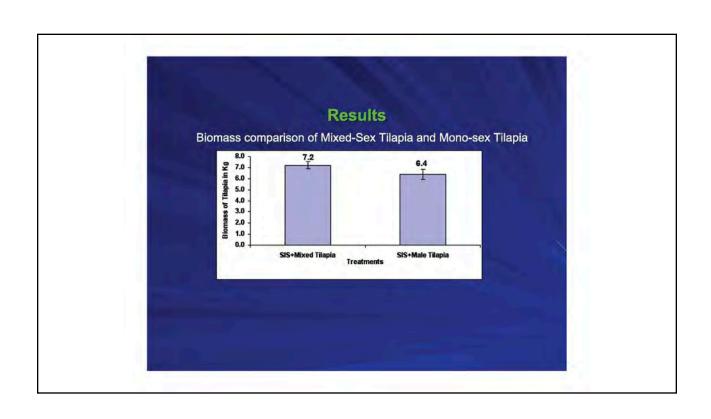


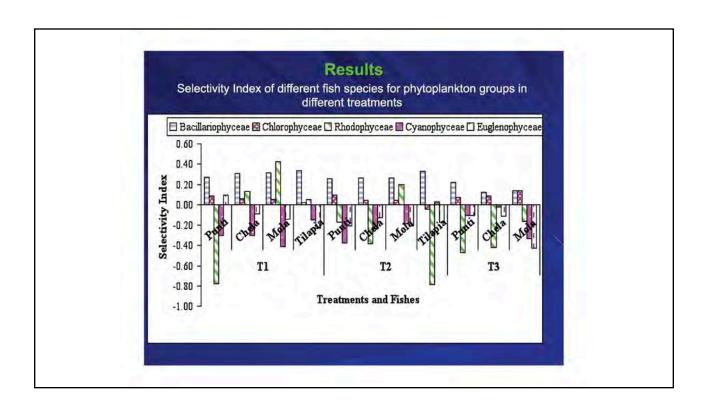


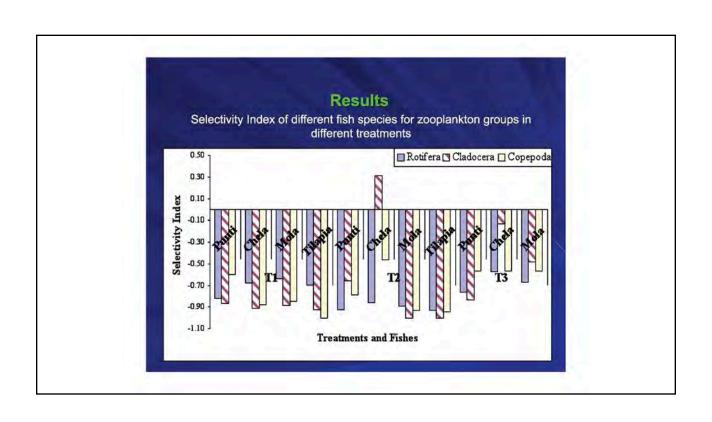












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Schoener's Index of Dietary Overlap Among Different Fish Species

Fish				Trea	ments			
LISII	Mix	ed-sex Til	apia	Mon	o-sex Til	apia	Without	Tilapia
	Punti	Mola	Chela	Punti	Mola	Chela	Punti	Mola
Mola	0.69		-	0.58	-	-	0.52	
Chela	0.70	0.65	-	0.57	0.55		0.54	0.51
Tilapia	0.79	0.75	0.70	0.64	0.65	0.66		-

Summary of Bangladesh Experiment

- Lower number of SIS and biomass when stocked with mixed sex tilapia
- Mono-sex had minimal effect on SIS
- Recruitment and biomass of chela was affected in both mixed sex and mono-sex treatment
- Recruitment and biomass of mola was also reduced in mixed sex tilapia
- Mixed sex treatment had no effect on recruitment of punti but biomass was reduced

Findings of Bangladesh Experiments

- Gut content analysis and Selectivity Index (Ivlev's Index)-
 - SIS and Tilapia were not only selective, but also selected for similar species of phytoplankton and zooplankton
- Biologically Significant interspecies dietary overlap (Schoener's Index) was found between Nile tilapia and SIS and among SIS



Summary of Nepal Experiment

- Lower recruitment of total SIS and biomass in both mixed-sex and mono-sex tilapia
- Mono-sex male tilapia had no negative effect on the number and biomass of darai and faketa
- Recruitment and biomass of punti was lower in both mixed and mono-sex treatments
- Recruitment and biomass of darai was also lower mixed sex treatment

Findings of Nepal Experiment

- Similar to the previous experiment, gut content analysis and Selectivity Index (Ivlev's Index)- SIS and Tilapia were selective feeders
- Biologically Significant interspecies dietary overlap (Schoener's Index)- between Nile tilapia and SIS, and among SIS

Conclusion

- Introducing tilapia did not eradicate SIS over several generation. In fact, SIS reproduced several times during the experimental period.
 - This suggests low drastic effect on biodiversity and ecology of introducing tilapia in certain environments
- Introducing tilapia (mixed sex) reduced the relative number and biomass of some SIS over multiple generations. Moreover, they selected similar food types (dietary overlap).
 - This suggests potential for competition
- A follow up study over longer period with varying level of input could improve this study.



POLYCULTURE OF SAHAR TOR PUTITORA WITH MIXED-SEX NILE TILAPA OREOCHROMIS NILOTICUS

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Sahar (*Tor putitora*) was cultured with Nile tilapia to control the tilapia recruitments in ponds. Two experiments, first in on station and second in on farm were conducted to assess Sahar to tilapia stocking ratio on recruitment control and growth of mixed-sex Nile tilapia, and to verify it in farmer's pond. On station experiment was conducted in 100 m² size earthen ponds at Institute of Agriculture and Animal Science, Chitwan and on farm experiment was conducted in farmer's ponds at Kathar, Chitwan, Nepal. On station experiment had four treatments with three replicates each: Tilapia monoculture (T1), 1:16 Sahar to tilapia ratio (T2), 1:8 Sahar to tilapia ratio (T3), and 1:4 Sahar to tilapia ratio (T4). The stocking density of tilapia was 2 fish/m². The ponds were fertilized weekly using diammonium phosphate (DAP) and urea at the rate of 0.4 g N/m² /day and 0.1 g P/m² /day. Tilapia was fed with a locally made pellet feed (27% crude protein) at the rate of 2% body weight once a day on an alternate day when it attained 100 g size. On farm experiment had 3 treatments with 3 replicates each. Treatments were: Tilapia monoculture (T1), 1:33 Sahar to tilapia ratio (T2), 1:16 Sahar to tilapia ratio. Ponds were fertilized fortnightly with DAP and urea at similar rate as on station experiment.

Results of on station experiment showed increased harvest size when Sahar were stocked with tilapia compared to tilapia monoculture. The number of recruits was decreased with increasing stocking density of Sahar indicating it preys on tilapia recruits. Thus, the result demonstrated that stocking of Sahar controls tilapia recruitments in mixed-sex Nile tilapia pond culture system and provide environment for better tilapia growth and production. Stocking of 1:16 Sahar to tilapia ratio showed overall better performance (Table 1). On farm results showed significantly higher growth of tilapia in 1:33 stocking ratio of Sahar to tilapia compared to tilapia monoculture (Table 2).

Table 1: Stocking and harvest size of tilapia and tilapia recruitments (Mean \pm SE).

		T	reatment	
	T1	T2	Т3	T4
Stocking size (g)	11.6 ± 0.2	11.3 ± 0.1	11.5 ± 0.4	11.1 ± 0.4
Harvest size (g)	$92.4 \pm 2.6 \text{ b}$	112.0 ± 6.0 a	$106.6 \pm 7.4 \text{ ab}$	$103.1 \pm 1.6 \text{ ab}$
Recruitment (no/pond)	$324 \pm 40 \text{ a}$	$169 \pm 74 \text{ b}$	$89 \pm 15 \text{ b}$	$69 \pm 32 \text{ b}$

Table 2: Stocking and harvest size of tilapia in on farm experiment (Mean \pm SE).

	Treatment			
	T1	T2	T3	
Stocking size (g)	10.5 ± 0.0	9.6 ± 0.0	8.9 ± 0.9	
Harvest size (g)	$138.0 \pm 10.7 a$	$190.0 \pm 2.0 \text{ b}$	$169.3 \pm 9.3 \text{ ab}$	



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Aquaculture 2010, March 1-5, 2010, San Diego, California, USA

Introduction

- Sahar Tor putitors is a high valued indigenous river fish of Nepal.
- It is in threat and declining from natural habitats and needs immediate conservation.
- Production of this fish through farming in ponds may help to conserve and decrease fishing pressure in natural waters.
- Nile tilapia has been considered an ideal species for small farmers
- Proper management of mixed-sex tilapia culture can provide regular seed and save seed cost.
- Predatory habit of Sahar is an opportunity to control tilapia recruitment by co-culture with mixed-sex Nile tilapia.





Objectives

- Assess proper stocking ratio of Sahar to Nile tilapia for recruitment control.
- Compare growth and production of Nile tilapia in monoculture and in polyculture with sahar.
- Assess and compare economic returns between monoculture and polyculture.
- Disseminate research outcomes to farmers, government research and development/extension organizations

Materials and Methods

- 1. On station experiment at IAAS Fish farm
- Experimental Unit: 100 m² earthen pond
- Treatments:
 - Tilapia monoculture at 2/m² (control)
 Sahar with tilapia at 1:16 ratio
 Sahar with tilapia at 1:8 ratio
 Sahar with tilapia at 1:4 ratio
- Experimental period: 14 October 2007 to 10 June 2008
- Design: CRD with 3 replications/treatment



Materials and Methods

- 2. On farm verification at framers, pond at Kathar, Chitwan
- Pond size 90-131 m²
- Treatments
 - Tilapia monoculture at 2/m² (control)
 Sahar with tilapia at 1:33 ratio
 Sahar with tilapia at 1:16 ratio
- Experimental period: 15 February to 19 July 2009
- Design: CRD with 3 replications/treatment

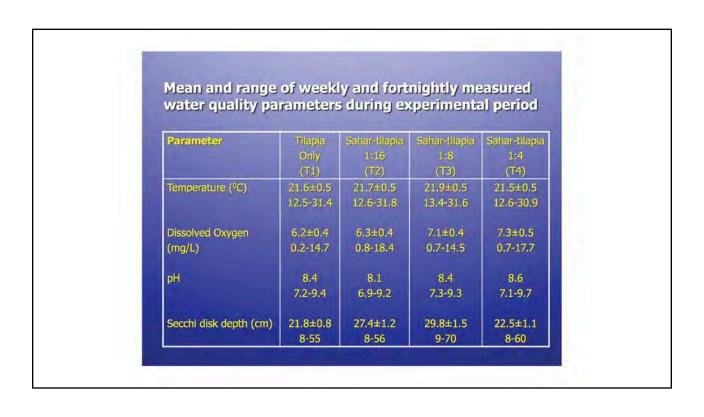
Materials and Methods

- Pond input:
 - Pond fertilization with Urea and Di-ammonium phosphate at 0.4 g N and 0.1 g P/m²/day (weekly in on station and every two weeks in on farm).
 - 27% CP pellet feed at 2% BW of tilapia, when it attained 100 g once in an alternate day in on station experiment. No feeding in on farm trial.
- Fortnightly water quality analysis and monthly fish growth sampling
- 3. Workshop for outcome dissemination
 - One-day workshop at IAAS, Rampur

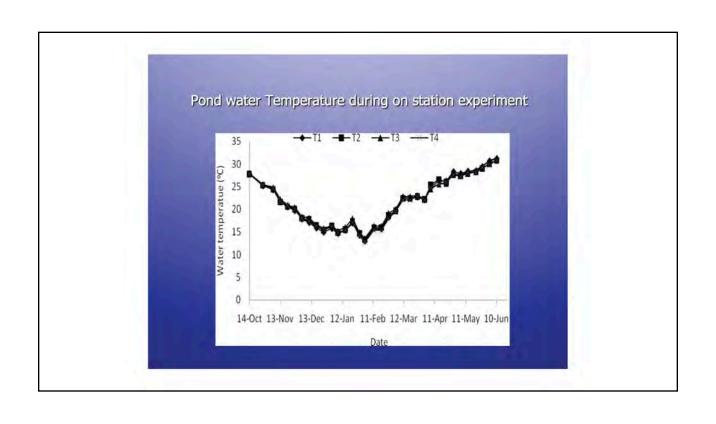
Stocking and harvest siz	On statio	esults in experime		e tilapia (Mea
± SE) Parameter	Tilapia Only (T1)	Sahar-tilapia 1:16 (T2)	Sahar-tilapia 1;8 (T3)	Sahar-tilapia 1;4 (T4)
Stocking size (g)	11.6±0.2	11.3±0.1	11.5±0.4	11.1±0.4
Harvest size (g)	92.4±2.6 b	112.0±6.0 ª	106.6±7.4 ab	103.1±1.6 ab
Growth rate (g/d)	0.33±0.0 b	0.42±0.0 a	0.39±0.0 ab	0.38±0.0 ab
Survival (%)	56.0±2.3	70.1±5.0	56.8±7.1	63.8±8.5
Recruitment (#/pond)	324±40	169±74	89±15	69±32

Results..... On station experiment Parameter Sahar-tilapia Sahar-tilapia Sahar-tilapia 16.3±0.3 Stocking size (g) 109.4±1.5 a 91.1±1.9 b 82.9±0.4 ° Harvest size (g) Growth rate (g/d) 0.37±0.0 ª 0.31±0.0 b 0.27±0.0 ° 56.4±6.7 49.3±5.8 39.3±5.3 Survival (%)





Water Quality						
Parameter	Tilapia	Sahar-tilapia	Sahar-tilapia	Sahar-tilapia		
	Only	1:16	1:8	1;4		
	(T1)	(T2)	(T3)	(T4)		
Total Alkalinity (mg/L)	111±2	104±2	105±2	104±1		
	79-152	67-134	74-145	86-135		
Chlorophyll a (µg/L)	78.8±8.8	58.1±6.8	46.9±5.4	78.4±9.8		
	5.3-315.4	2.7-240.6	2.0-200.5	2.7-291.4		
TAN (mg/L)	0.10±0.0	0.09±0.0	0.10±0.01	0.08±0.0		
	0.01-0.3	0.01-0.32	0.01-0.35	0.01-0.26		
SRP (mg/L)	0.16±0.01	0.12±0.01	0.13±0.01	0.13±0.01		
	0.0-0.42	0.0-0.37	0.0-0.37	0.0-0.37		



Results On farm trial

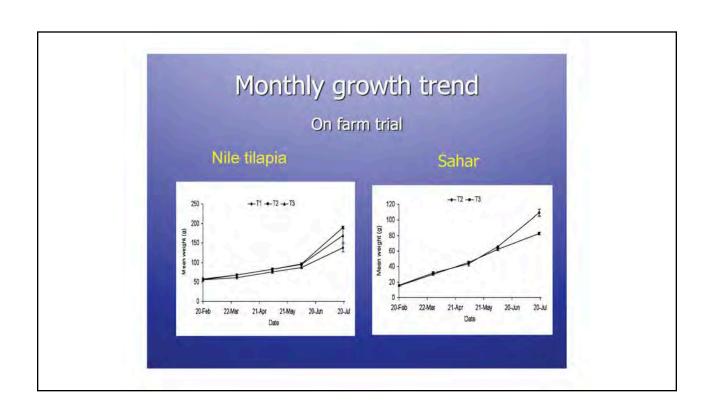
Harvest size, growth, survival and Net yield of Nile tilapia (Mean \pm SE).

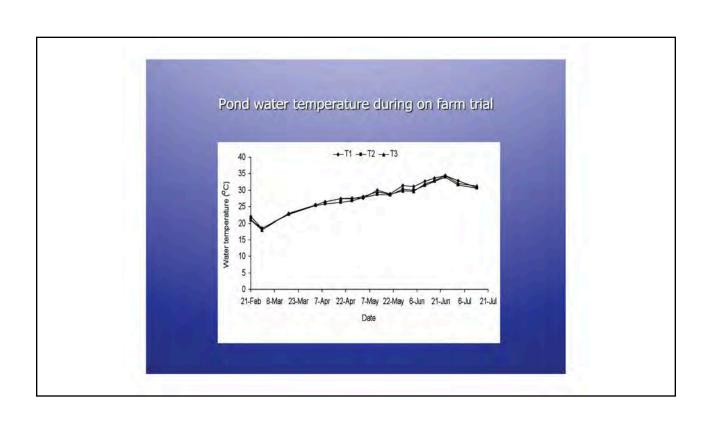
Parameter	Tilapia only (T1)	Sahar-tilapia 1:33 (T2)	Sahar-tilapia 1:16 (T3)
Stocking size (g)	55.3±3.1	57.4±1.7	55.7±1.4
Harvest size (g)	138.0±10.1ª	190.0±2.0 b	169.3±17.8 ab
Growth rate (g/d)	0.55±0.08 a	0.87±0.01 b	0.75±0.11 ab
Survival (%)	92.9±1.7	95.0±0.8	95.1±2.6
Net yield (t/ha/yr)	2.91±0.54 a	4.82±0.01 b	4.22±0.76 b
Recruitments (count/m²)	13.2±4.0 a	8.0±1.4 a	3.9±0.3 b

Results

Harvest size, growth, survival, yield of sahar and combined total yield of tilapia and sahar (Mean ± SE).

Parameter	Tilapia only (T1)	Sahar-tilapia 1:33 (T2)	Sahar-tilapia 1:16 (T3)
Stocking size (g)		15.7 ± 0.2	15.1±0.5
Harvest size (g)		109.5±4.5 °	82.5±1.7 ^b
Survival (%)		92.9±4.1	88.9±11.1
Net yield (t/ha/yr)	Die-	0.11±0.01	0.15 ± 0.03
Total yield	2.91±0.54 ª	4.93±0.01 b	4.37±0.74 ab





Economics of the tilapia monoculture and sahar-tilapia polyculture

Gross Return (NRs/100 m² pond)

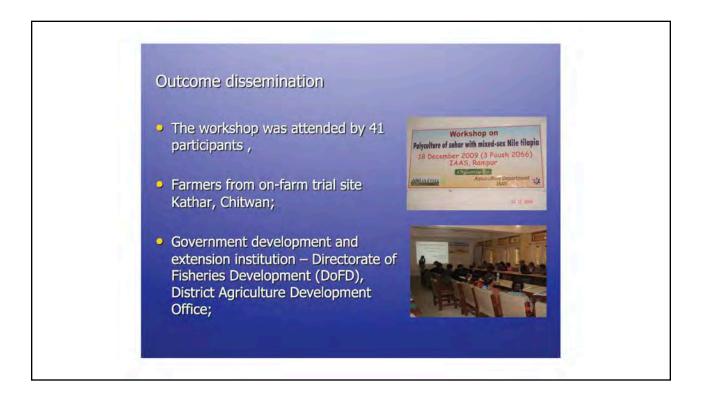
	Price	Tilapia monoculture	Sahar-tilapia polyculture (1:33)	Sahar-tilapia polyculture (1:16)
Adult tilapia Sahar	140 250	3,595 ± 304	5,049 ± 24 158 ± 15	4,532 ± 571 237 ± 33
Tilapia recruits	0.5-2.0	685 ± 203	899 ± 184	867 ± 61
Total		4,281 ± 504	6,107 ± 193	5,636 ± 598

Economics

Variable Cost (NRs/100 m2 pond)

	Price	Tilapia monoculture	Sahar-tilapia Polyculture (1:33	Sahar-tilapia polyculture (1:16)
Lime	15.0	75.0	75.0	75.0
Tilapia fingerling	5.0	100.0	100.0	100.0
Sahar fingerling	10.0		70.0	130.0
DAP	35.0	134.8	134.8	134.8
Urea	18.0	93.1	93.1	93.1
Labor	100.0	200.0	200.0	200.0
Cost of working capital	(10%)	150.3	157.3	163.3
Total		1653.2	1730.2	1796.2
	المرساء			

Gross Margin (1,000 NF	Rs)		
	Tilapia monoculture	Sahar-tilapia polyculture (1:33)	Sahar-tilapia polyculture (1:16)
Gross Margin (NRs/pond)	2.6±0.5 ª	4.4±0.2 b	3.8±0.6ª
Gross Margin (NRs/ha)	262.8 ±50.4 a	437.6±19.3 b	384.0 ±59.8 ab



Outcome dissemination.....

- National research institutions Nepal Agricultural Research Council (NARC), Fisheries Research Division, Fisheries Research Center;
- Academic institution IAAS Directorate of Research, Aquaculture Department
- Director of DoFD and Director of Livestock and Fisheries NARC have shown positive response to have verification trial in their respective farms and to up scale in mass scale.



Conclusions

- Sahar tilapia polyculture at 1:16 to 1:33 ratio provided best results in growth of tilapia.
- Inclusion of Sahar enhanced harvest size of tilapia by 19-38%, growth rate 36-58%, tilapia yield 45-66% and total yield 50-69% compared to tilapia monoculture.
- Increasing Sahar stocking, decreased tilapia recruitment linearly showing Sahar controls recruitments.
- It also maintained required amount of tilapia fry for next stocking.
- Gross margin in sahar-tilapia polyculture increased by 46-67% compared to tilapia monoculture.





GROWTH PERFORMANCE OF NILE TILAPIA OREOCHROMIS NILOTICUS L. IN PONDS IN THE PHILIPPINES USING COMBINED FEED REDUCTION STRATEGIES

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Feed constitutes 60-80% of production costs of tilapia. Therefore, strategies that reduce the amount of feed consumed without negatively impacting growth of fish can enhance production efficiency of tilapia farming. Previous pond studies in the Philippines show that 1) delayed onset of supplemental feeding by either 45-days or 75-days in fertilized ponds, 2) feeding at a subsatiation level of 67%, or 3) feeding on alternate days saves on feed cost without significantly reducing production of Nile tilapia in growout ponds. We examined the utility of combined feeding delay and reduction as an additional feeding option for tilapia farmers to reduce costs. On farm trials with six cooperators evaluated the effects of standard 100% daily feeding (Treatment I) versus a feeding regimen consisting of 60 days delayed feeding, 30 days alternate day feeding and then 30 days full feeding on a daily basis but at a sub-satiation level of 67% (Treatment II).

Each farmer-cooperator provided one pond each for the standard and reduced feeding regimen. Twelve (12) ponds in Central Luzon, Philippines ranging from 586 - 1,280 sq m were stocked with sex-reversed Nile tilapia fingerlings of the GIFT strain at 4 fish m-2. Fingerlings were stocked at the same initial weight (0.35 g) and similar initial lengths (0.10 and 0.11 cm for Treatments I and II, respectively).

Following four months of culture, fish under the reduced feeding strategy had an average final body weight of 118.05 ± 13.91 g (mean \pm standard deviation), total length of 17.1 ± 1.08 cm, specific growth rates (SGR) of 4.86 ± 0.12 %, feed conversion ratio (FCR) of 2.4 ± 0.83 and mean survival rate of 32.1 ± 23.50 %. Control fish under a standard feeding protocol obtained a mean final body weight of 149.82 ± 33.14 g, total length of 18.6 ± 1.50 cm, SGR of 5.04 ± 0.17 %, FCR of 2.7 ± 1.10 and survival rate of 47.9 ± 22.32 %. Except for survivorship, there were no significant differences in parameters between the control group and the group raised under the combined delayed and reduced feeding strategy. The total amount of feed consumed was ~55% less in fish under the reduced feeding strategy than fish fed at typical levels. Collectively, these results suggest that a combination of delayed and reduced feeding ration has the potential to reduce production costs through lower feed consumption without significantly altering fish growth in pond raised tilapia.

Growth Performance of Semi-Intensive Culture of Nile Tilapia (*Oreochromis niloticus*) in Ponds Under Combined Feed Reduction and Subsatiation Feeding Strategies

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World Aquaculture Society
March 1-5, 2010, San Diego CA USA



Typical Farm Budget fo	or Tilapia Pond C	Culture (PhP)
Gross Income		643,854
Less: Cash costs		
Fingerlings	37,801	
Feed	262,400	63%
Fertilizer	5,417	
Diesel	42,652	
Hired labor	19,718	
Non-cash cost	49,088	
Total Costs		417,076
Net Income		226,778
Price/kg of tilapia	40	
Production cost/kg of tilapia	26	
Profit margin	35%	

Feed Reduction Strategies

➤ We showed that either delayed onset (75 day), alternate day feeding or 67% satiation feeding reduced feed costs without significantly impacting fish yield (Bolivar et al. 2006)

Objectives

- Evaluate if combined delayed feeding, alternate day feeding and 67% satiation feeding might provide further cost benefits
- Evaluate if 50% satiation feeding might provide an additional feed reduction and cost containment strategy for farmers

Semi-Intensive Culture System

- ➤ The production of fish using natural food, through pond fertilization, or pond fertilization and supplemental feeding
- ➤ This system is a means of producing fish, through low production inputs

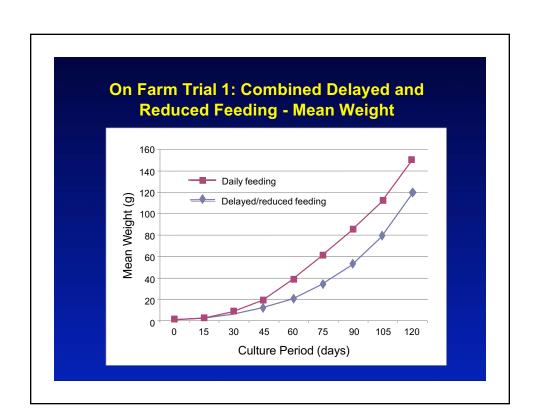


Methodology

- > Two on-farm trials were conducted on the evaluation of tilapia feeding strategies
- ➤ Six farms participated on each on-farm trial
- Two ponds from each farm were made available for each study - one pond per treatment
- ➤ Ponds were fertilized with inorganic fertilizers at the rates of 28 kg N + 5.6 kg P ha⁻¹ wk⁻¹

Methodology

- ➤ Ponds were stocked with sex-reversed Nile tilapia fingerlings at a density of 4 fish/ m²
- ➤ The fish were fed with supplemental feeds at the rate of 20% biomass/day down to 3% fish biomass/day towards the end of the experiment
- ➤ Culture period lasted for 120 days
- > Fish sampling and water quality monitoring were done every two weeks
- > Statistical Analyses: Pairwise t-Test

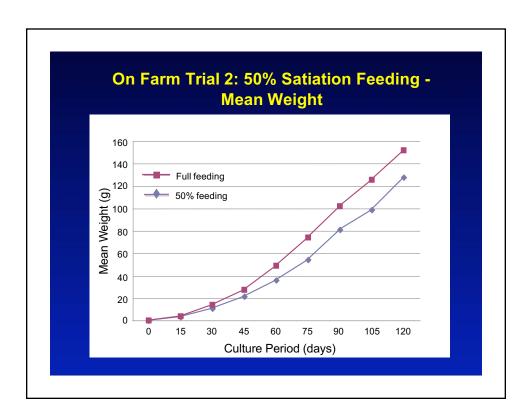


Summary - Trial 1

- ➤ Growth performance of fish was lower in the combined delayed/reduced feeding strategy group, although not significant relative to the control group
 - Lower growth performance may have been due to initial delayed feeding
- Survival was generally low in both groups, but significantly more so in the combined delayed/reduced feeding strategy group
 - Presence of predators in ponds and extreme weather conditions may have contributed

Summary - Trial 1

- ➤ The combind delayed/reduced feeding stategy group had 56% lower feed consumption
- Gross yield was significantly lower in the combibned delayed/reduced feeding strategy group



Conclusions

- ➤ Limiting the initial delayed feeding to 30-45 days rather than 60 days might prove more effective when using a combination of delayed and reduced feeding protocols
- ➤ 50% feeding satiation produced fish of similar yield and resulted in 100% improvement in feed conversion
- ➤ The feeding strategies tested were environmentally desirable reduces organic loading in the ponds

Conclusions

- > These protocols can be easily adopted
- > They can leads to considerable profit due to feed cost reduction

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COLLABORATIVE RESEARCH
SUPPORT PROGRAM







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EFFECT OF AGE OF BROODFISH ON THE GROW-OUT PERFORMANCE OF NILE TILAPIA OREOCHROMIS NILOTICUS L. FINGERLINGS IN EARTHEN PONDS

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Grow-out tilapia farmers are encouraged to intensify their production through the use of good quality fry/fingerlings that could produce higher yield of tilapia. However, some tilapia farmers consider that younger broodfish produce better quality seed in terms of growth and survival. Therefore, this study was conducted to investigate the effect of age of broodfish on the grow-out performance of Nile tilapia (Oreochromis niloticus L.) fingerlings in earthen ponds. Twelve (12) 500 m2 ponds were stocked with sex-reversed Nile tilapia fingerlings of the GIFT strain. Each pond was stocked at 4 fish m-2. Four treatments with three replicates are applied as follows: Treatment I – fingerlings produced by 8 month-old broodfish, Treatment II – fingerlings produced by 1 year-old broodfish, Treatment III – fingerlings produced by 2 year-old broodfish and Treatment IV – equal combination of fingerlings from the three different ages of broodfish. After 120 days of culture fish were harvested, weighed and counted. Gross yield, final weight and length of fish, and survival rates were measured. Duncan Multiple Range Test (DMRT) was used for the comparison of means.

The extrapolated gross yield per hectare showed that Treatment IV had the highest gross yield with 4472.7 + 619.1 kg ha-1 followed by Treatment III with 4045.3 + 1039.8 kg ha-1, Treatment II with 3719.3 + 365.5 kg ha-1 and Treatment I with 3667.3 + 689.3 kg ha-1. The treatments were not significantly different at 5% level of significance. The highest average final weight of 191.25 + 33.56 g and total length of 20.5 + 1.09 cm was seen in fish produced from 2 year-old broodfish (Treatment III). Treatment IV had an average final weight and total length of 182.41 + 33.46 g and 20.2+ 1.12 cm, respectively, followed by Treatment I with average final weight of 162.86 + 28.55 g and average final length of 19.5 + 1.15 cm and Treatment II with average final weight of 160.21 + 1.32 g and average final length of 19.4 + 0.17 cm. There was no statistically significant difference in terms of final mean weight and total length. In terms of survival rate, Treatment IV obtained the highest survival with 70.0 + 14.1 % followed by Treatment I with 61.3 + 22.9 %, Treatment II with 61.0 + 8.0 % and Treatment III with 53.8 + 4.6 %. Again, statistical analysis showed no significant difference among treatments (P>0.05). It is concluded that broodfish ranging from 8-24 months could be used for the production of Nile tilapia of the GIFT strain with no deleterious effects on fingerling growth and survival.

Effect of Age of Broodfish on the Growout Performance of Nile Tilapia (Oreochromis niloticus L.) Fingerlings in Earthen Ponds AQUACULTURE 2010 Town and Country Resort and Convention Center San Diego, California, USA March 1-5, 2010

Researchers (Philippines): Remedios B. Bolivar, Eddie Boy T. Jimenez, Roberto Miguel V. Sayco & Reginor Lyzza B. Argueza Freshwater Aquaculture Center/College of Fisheries, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines Collaborating Researcher: Hernando L. Bolivar GIFT Foundation International Incorporated, CLSU Compound, Science City of Muñoz, Nueva Ecija, Philippines US Lead Principal Investigator: Russell J. Borski North Carolina State University, Raleigh, NC, USA

Introduction

- With several tilapia strains available in the field, many farmers often select the best and most efficient strain to attain profitable production
- Despite the genetically improved strains of tilapia, some farmers perceive that younger broodfish produce better quality seed in terms of survival and growth as compared to older broodfish

Objectives of the Study

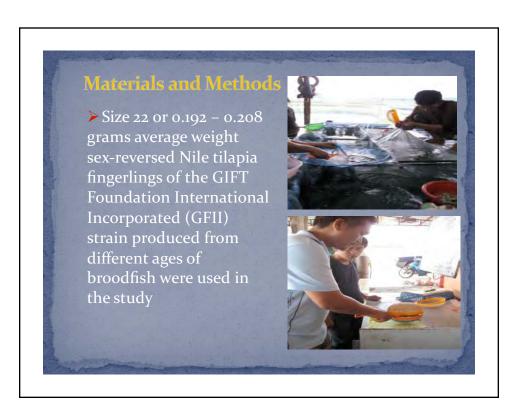
The objectives of the study were to compare the growth performance of sexreversed Nile tilapia fingerlings produced from different ages of broodfish and assess the yield and survival after 120 days of grow-out culture period

Hypothesis

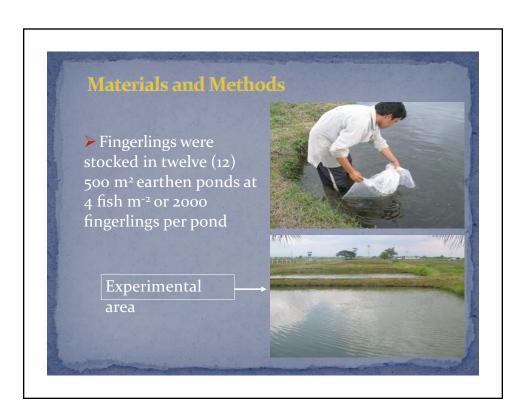
The hypothesis of this study was that there will be no effect of broodfish age on growout performance variables in Nile tilapia cultured in earthen ponds

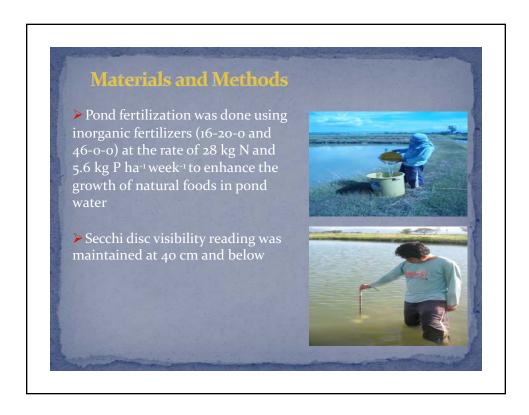
Materials and Methods

- ➤ There were four (4) treatments replicated three
- (3) times
- > Treatments were as follows:
 - I. sex-reversed Nile tilapiaproduced from 8-month old broodfish
 - II. sex-reversed Nile tilapia produced from 1-year old broodfish
 - III.- sex-reversed Nile tilapia produced from 2-year old broodfish
 - IV combination of sex-reversed Nile tilapia produced from different ages of broodfish











- samples were measured monthly for weight and length using cast net method as a sampling device to check the growth of the fish stocks
- > At the end of the culture period, 10% of the total fish stock were sampled for individual weight and length and the rest of the harvested fish were counted and bulk weighed





Materials and Methods

- Water quality parameters such as dissolved oxygen and water temperature were monitored weekly starting at 9 o'clock in the morning
- Data on air temperature, amount of rainfall (mm) and photoperiod (min) were gathered from a local weather station located in the university

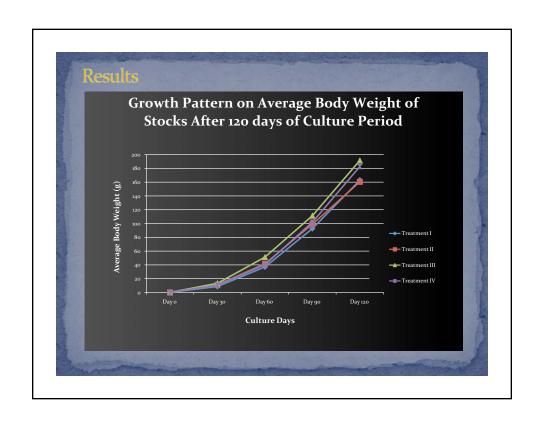


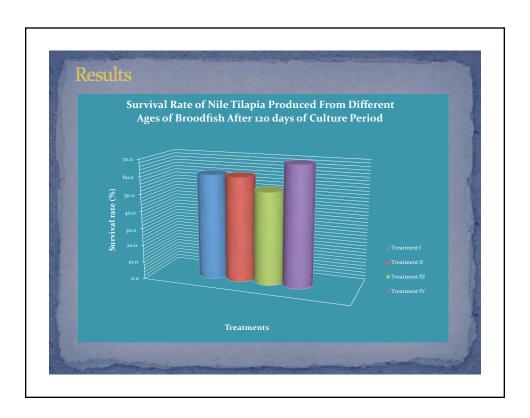
Materials and Methods

- After 120-days of culture period, all data gathered were analyzed by analysis of variance (ANOVA) in Randomized Complete Block Design (RCBD)
- Comparison among treatment means were done using the Duncan's Multiple Range Test (DMRT)



ages of brood		1 C 1	gs produced f	
Parameters	Treatment	days of culture Treatment II	Treatment	Treatment IV
Initial Average Body Weight (g)	0.20	0.20	0.21	0.20
Final Average Body Weight (g)	162.85 <u>+</u> 28.5	160.40 ± 1.3	191.46 <u>+</u> 33.6	182.61 ± 33.5
Daily Gain in Weight (g/day)	1.36 ± 0.24	1.34 <u>+</u> 0.01	1.59 <u>+</u> 0.28	1.52 ± 0.28
Survival Rate (%)	61.3 <u>+</u> 22.9	61.0 ± 8.2	53.8 <u>+</u> 4.6	70.0 <u>+</u> 14.1
Extrapolated Yield (kg/ha)	3667.3 <u>+</u> 689.3	3719.3 <u>+</u> 365.5	4045.3 <u>+</u> 1039.8	4472.7 <u>+</u> 619.1
Extrapolated Feed Consumed (kg/ha)	5353.2 ± 172	5506.7 ± 169	6315.4 <u>+</u> 747	5692.5 <u>+</u> 590
Feed Conversion Ratio	1.5 <u>+</u> 0.4	1.5 <u>+</u> 0.1	1.6 ± 0.2	1.3 <u>+</u> 0.1





		weekiy over	i 120 days ct	ılture perioc	l.
Parameters		Treatmen t I	Treatmen t II	Treatmen t III	Treatmen t IV
DO (mg/l)	Mean	4.24	4.27	4.31	4.31
	Min- Max	1.77 8.13	1.74 8.71	1.67 10.10	2.01 8.36
Water Temp (°C)	Mean	30.3	30.3	30.3	30.4
	Min- Max	28.0 34.2	27.34 34.2	27.9 34·3	28.0 34·4
Secchi Disc Visibility (cm)	Mean	34.6	33.6	33.3	31.9
	Min- Max	22.3 70.0	22.3 76.7	21.3 80.0	20.0 76.7

Simple cost and return analysis of Nile tilapia produced from different ages of broodfish after 120-days of culture period (US\$/ha)

	Treatment I	Treatment II	Treatment III	Treatment IV
Gross Return	4783.48	4851.30	5276.52	5833.91
Costs		STAR WALL		1334 300
Fingerlings	373.91	373.91	373.91	373.91
Commercial Feeds	3124.96	3219.79	3691.24	3324.67
Commercial Fertilizers	41.62	41.62	41.62	41.62
	THE REAL PROPERTY.	7-8-5-63		THE PARTY
Total Costs	3540.49	3635.32	4106.77	3740.20
	A STATE OF THE PARTY OF THE PAR			SE SER
NET RETURN	1242.99	1215.98	1169.75	2093.71

Assumptions

Price of tilapia fingerlings: \$0.0093/pc

Price of commercial feeds:

Fry mash - \$0.625/kg

Starter - \$0.603/kg

Grower - \$0.578/kg

Price of commercial fertilizers:

Ammonium phosphate (16-20-0) - \$0.404/kg

Urea (46-o-o) - \$0.382/kg

Price of marketable size tilapia: \$1.304/kg

Conclusion

• It is concluded that the growth parameters measured in this experiment, survival and yield of Nile tilapia cultured in earthen ponds were not significantly affected by the age of broodfish





REPLACEMENT OF FISH MEAL BY SOYBEAN MEAL WITH ALPHAGALACTOSIDASE IN DIETS FOR SNAKEHEAD, CHANNA STRIATA

Tran Thi Thanh Hien*, Ly Vu Minh, Nguyen Hoang Duc Trung, Chong M. Lee and David A. Bengtson

Culture of snakehead, Channa striata, is a rapidly growing industry in the Mekong River in Vietnam and Cambodia, but relies largely on trash fish for feed. In order to make the industry more sustainable, we seek to develop snakehead diets based on fish meal and plant proteins. Soybean meal can replace up to 30% of fish meal in the diet without addition of phytase or 40% of fish meal with the addition of phytase (Hien, 2009). In this experiment, we tested a control diet of fish meal against diets in which soybean meal replaced fish meal at several levels (50, 60, or 70% replacement), with appropriate essential amino acid (EAA) additions so that all diets matched the EAA profiles of fish meal. The soybean replacement diets were supplemented with phytase and alphagalactosidase. All treatments were done in triplicate. The experiment began with snakehead juveniles that averaged 3.8 g in size and lasted for 8 weeks. Growth of the fish on diets with 50% or 60% replacement of fish meal with soybean meal with phytase and alphagalactosidase was statistically indistinguishable from those fed the control fish meal (0% replacement) diet, but diets with 70% fish meal replacement yielded statistically poorer growth. Thus, soybean meal can replace up to 60% of fish meal in the diet with the addition of phytase and alpha-galactosidase.



REPLACEMENT FISH MEAL BY SOYBEAN MEAL WITH FISH SOLUTION FEEDING ATTRACTANT OR ALPHA-GALACTOSIDASE IN SNAKEHEAD (Channa striata) FINGERLINGS DIETS

Tran Thi Thanh Hien (1), Tran Thi Be (1)
David A. Bengtson (2), Chong M. Lee (2),

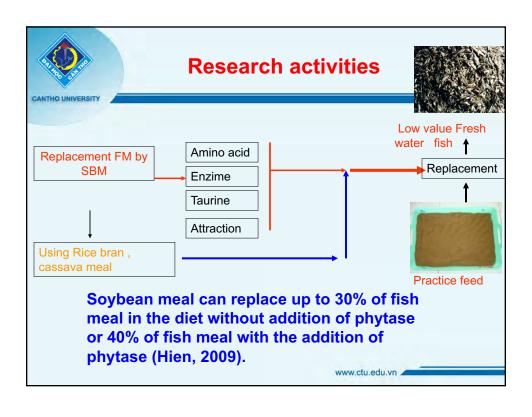
- (1) Cantho University, Vietnam
- (2) University of Rhode Island, US

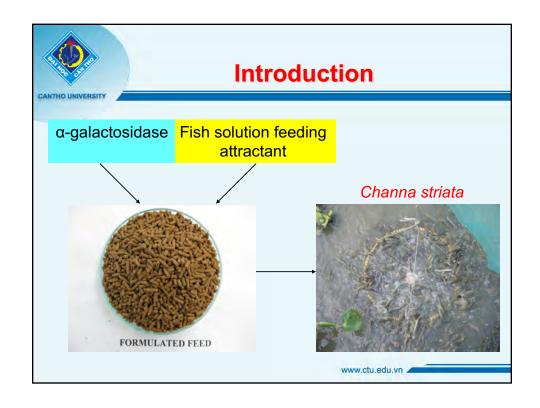
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Objective

The objective of the study is to increase the effect on using soybean meal in Channa striata diets

Two experiments

- Experiment 1: Replacement of FM protein with SBM protein and supplementary α-galactosidase in diets
- Experiment 2: Replacement of FM protein with SBM protein and supplementary fish Solution feeding attractant in diets

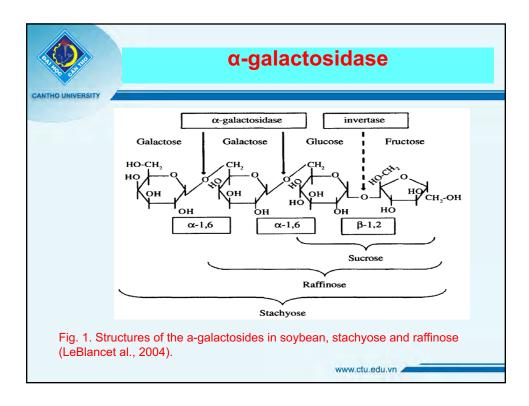
www.ctu.edu.vn



α-Galactosidase

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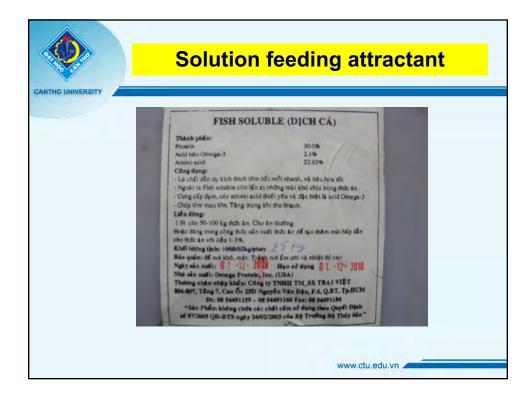
- The enzyme α -D-galactoside galactohydrolase (EC 3.2.1.22), also named α -galactosidase or a-gal, catalyzes the hydrolysis of α -1,6-galactosidic bonds, releasing α -D-galactose.
- α-Galactosidases are applied in biocatalytic processes to improve products destined to human nutrition and also as component in animal diets to increase digestibility and reduce the fermentation of nondigestible oligosaccharides.
- α-Galactosidases are widely distributed in microorganisms (fungi, yeasts and bacteria) plants and animals (Said & Pietro, 2004).





Solution feeding attractant

- The use of dietary feeding attractants within compound aquafeeds to improve dietary food intake and provide additional nutrients for protein and energy metabolism
 - → minimum wastage and feed efficiency therefore maximized that water pollution will be minimized.
- Betaine, L-alanine, L-glutamic acid, L-arginine, glycine and fish solution are known as dietary feeding attractants for many fish species





- Treatment 1: Fish Meal (FM)
- Treatment 2: SB 50% replacement of FM + α-galactosidase 1%
- Treatment 3: SB 60% replacement of FM + α-galactosidase 1%
- Treatment 4: SB 70% replacement of FM + α-galactosidase 1%

Protein: 45%, Lipid: 10%



Experiment 2: Soybean+ fish Solution

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- Treatment 1: Fish Meal (FM)
- Treatment 2: SB 50% replacement of FM + fish Solution 1.5%
- Treatment 3: SB 60% replacement of FM + fish Solution 1.5%
- Treatment 4: SB 70% replacement of FM + fish Solution 1.5%

Protein: 45%, Lipid: 10%

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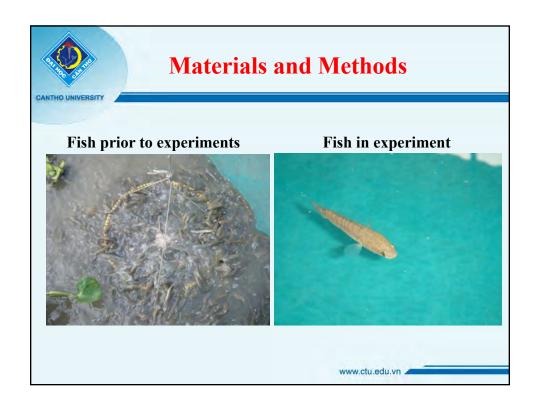


Materials and Methods

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- Initial weight of fish: 2.24–3.79 g
- Stocking density: 30 fish/tank (12 tanks)
- Experimental system: plastic tank system (500 liter each)
- Experimental design: triplicate for each treatment





Materials and Methods

• Experimental conditions:

- Temp: 26.5-27.5°C

- DO: 5-7.6 mg/L and pH: 7.2-7.5

- Feeding frequency: 3 times/day

• Feeding rate: Saturated

• Weight gain: measured initial and 4 weeks, 8 weeks

 Chemical composition of carcass body and feeds analysis (AOAC, 2000)



Statistical analysis

Collected data:

Survival rate (SR)

– Daily Weight gain (DWG)

Feed Intake (FI)

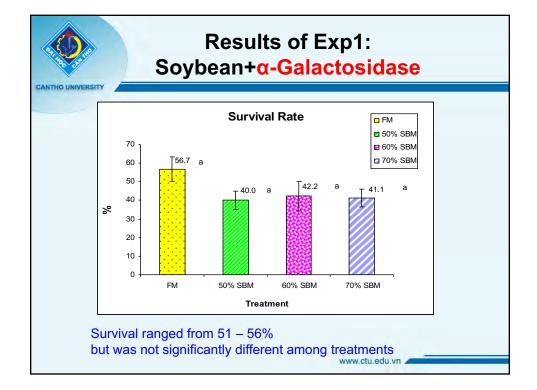
Feed conversion ratio (FCR)

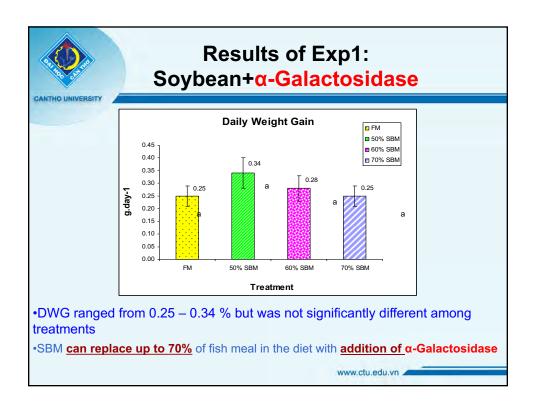
Calculation data

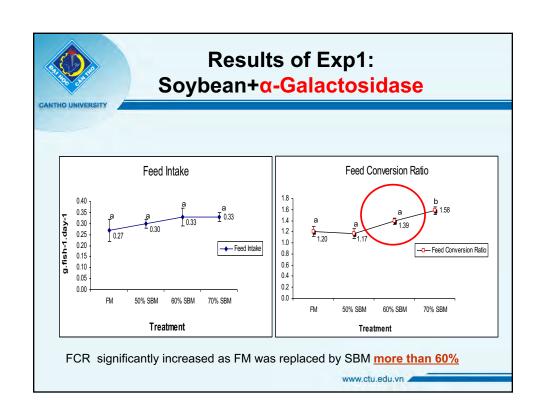
- The cost for feed fish in experiment

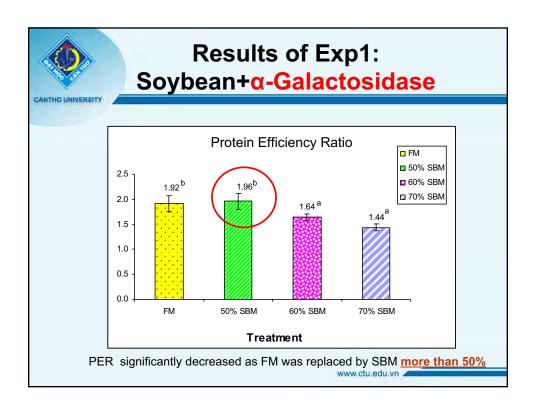
Statistical analysis:

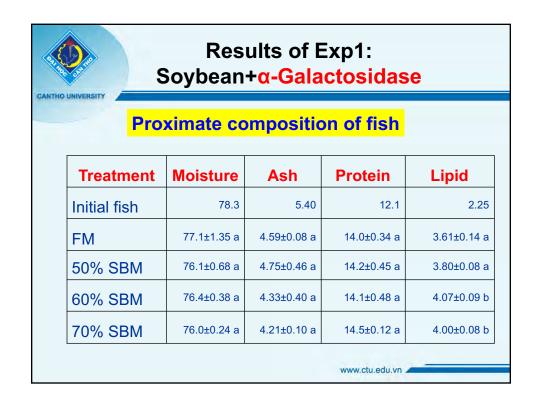
- One-way analysis of variance.
- Duncan's new multiple range test (p<0.05)



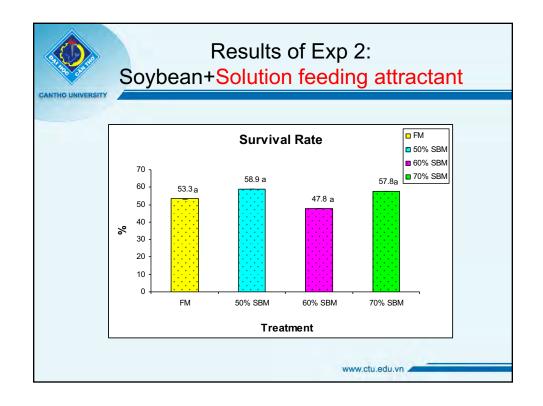


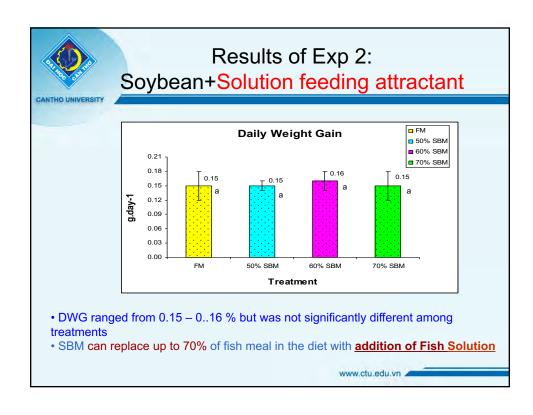


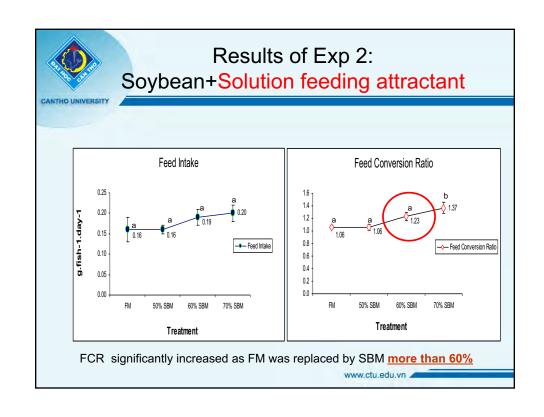


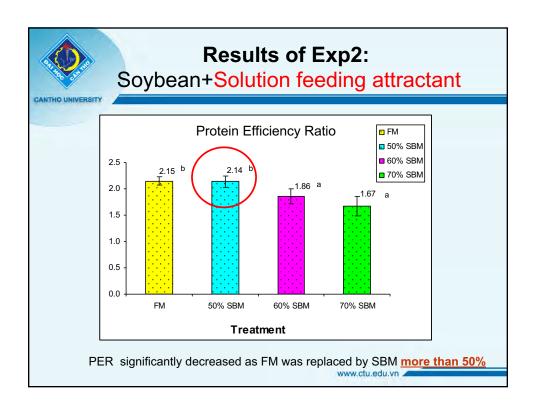


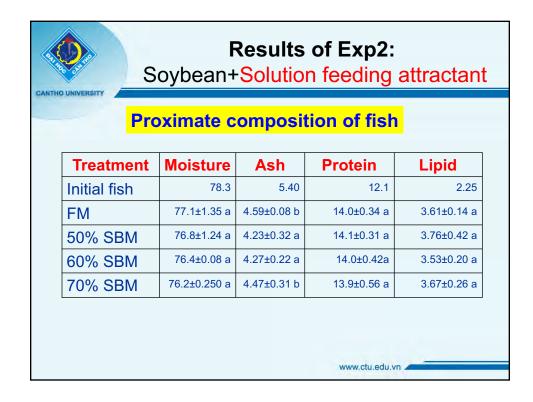
Results of Exp1: Soybean+α-Galactosidase						
Cost/ Kg fish weight gain (USD)	Reduce (%) compare to control					
0.79						
0.71	9.91					
0.82	-4.21					
0.91	-15.3					
	Cost/ Kg fish weight gain (USD) 0.79 0.82					













Results of Exp 2: Soybean+Solution feeding attractant

Diets	Cost/ Kg fish weight gain (USD)	Reduce (%) compare to control
FM	0.70	
50% SBM	0.62	10.5
60% SBM	0.70	-1.05
70% SBM	0.76	-9.41

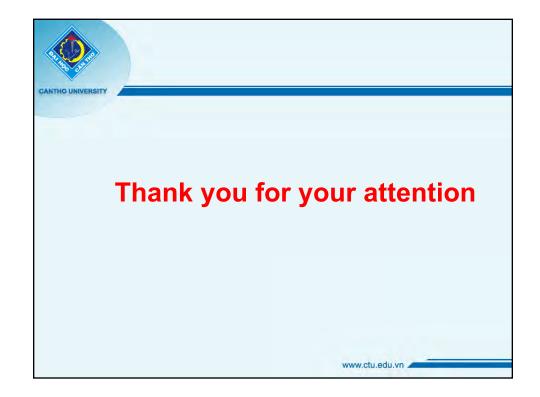
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Conclusion

Soybean meal can replace \underline{up} to 50% of protein fish meal in the diet with the addition of α -galactosidase or fish solution feeding attractant in formulation feed of snakehead







Ingredient composition of the diet - Exp1 (SB+α-Galactosidase)

Ingredients (%)	FM	50% SBM	60% SBM	70% SBM
Fish meal	56.17	27.67	22.18	16.68
Soybean meal	0.00	40.37	48.64	56.72
Rice bran	15.0	15.0	15.0	15.0
Cassava meal	24.15	8.36	5.14	1.90
Vitamine	1.00	1.00	1.00	1.00
Mineral	1.00	1.00	1.00	1.00
Fish oil	2.18	4.22	4.61	5.01
Binder	0.50	0.50	0.50	0.50
Lysine	0.00	0.52	0.60	0.69
Methionin	0.00	0.35	0.41	0.48
Phytase	0.00	0.02	0.02	0.02
α-galactosidase	0.00	1.00	1.00	1.00
Total	100	100	100	100
Proximate composition (%)				
Dry matter	90.99	91.39	91.35	91.03
Crude protein	44.66	44.41	44.75	44.69
Crude lipid	8.96	9.22	9.26	9.10
Crude ash	10.02	8.31	www.ctu.edu.775	7.30



Ingredient composition of the diet - Exp2 (SB+ Solution feeding attractant)

CANTHO UNIVERSITY

Ingredients (%)	FM	50% SBM	60% SBM	70% SBM
Fish meal	56.17	27.67	22.18	16.68
Soybean meal	0.00	40.37	48.54	56.72
Rice bran	15.0	15.0	15.0	15.0
Cassava meal	24.15	7.86	4.64	1.40
Vitamine	1.00	1.00	1.00	1.00
Mineral	1.00	1.00	1.00	1.00
Fish oil	2.18	4.22	4.61	5.01
Binder	0.50	0.50	0.50	0.50
Lysine	0.00	0.52	0.60	0.69
Methionin	0.00	0.35	0.41	0.48
Phytase	0.00	0.02	0.02	0.02
Fish solution feeding attractant	0.00	1.50	1.50	1.50
Total	100	100	100	100
Proximate composition (%)				
Dry matter	90.99	91.18	91.52	91.59
Crude protein	44.66	44.70	44.51	44.59
Crude lipid	8.96	8.15	8.38	8.26
Crude ash	10.02	9.13	www.ctu.edugy74.4	8.27

EFFECT OF THE MICROCYSTIS AERUGINOSA ON THE WATER FLEA DAPHNIA MAGNA AND THE RED SWAMP CRAYFISH PROCAMBARUS CLARKIA

Liu Liping*, Li Kang, Chen Taoying, Yang Yi, James S. Diana College of Fisheries and Life Science, Shanghai Ocean University, Shanghai, 201306, P.R. China, Corresponding author. Tel:+86-21-61900411 E-mail: lp-liu@shou.edu.cn

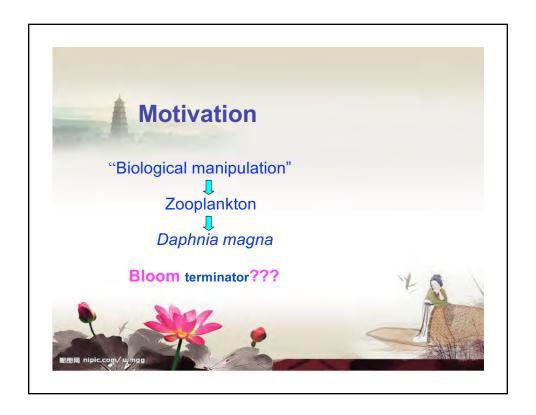
The occurrences of cyanobacteria bloom in many water bodies are abundant, which leads to the possibility of adverse effects on many organisms. The experiments were designed to investigate the harmful effects of Microcystis aeruginosa on Daphnia magna and Procambarus clarkia. The results showed that D. magna could feed on M. aeruginosa, meanwhile M. aeruginosa had adverse impacts on survival of D. magna. When exposed to 1.5×106 , 3×106 , 0.75×107 , 1.5×107 cells·ml-1 of M. aeruginosa for 96h, survival rate of all the treatments were less than 40%, significant lower than 98% in control group. The adverse effect of M. aeruginosa on body length, the time for the first brood, brood numbers, gross fecundity, lifetime and population growth of D. magna were density-dependent. M. aeruginosa also had adverse impacts on survival of P. clarkia. When exposed to 1×107 cells·ml-1 and 2×107 cells·ml-1 of M. aeruginosa for 7 days, survival rates of P. clarkia were 7.69 and 11.53%, respectively, which were significantly lower than that in control group. Through observation of transmission election microscope (TEM), M. aeruginosa was detected to destroy hepatopancreas cellular ultrastructure of P. clarkia, damaged cellular membrane structure and made cell membrane swollen up and broken. Thus, M. aeruginosa had obviously impact effects on life activities of D. magna and P. clarkia.

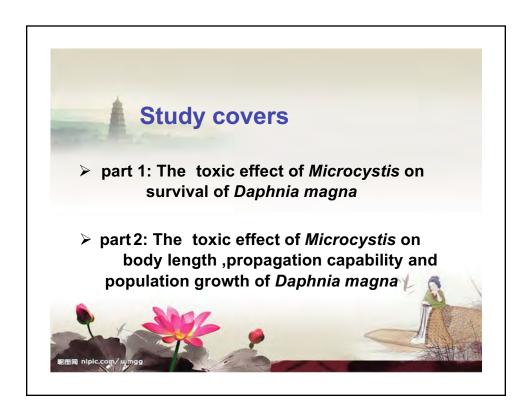
This study was sponsored by the Aquaculture and Fisheries Collaborative Research Support Program of USAID, the Shanghai Rising-Star Program (08QA1405900), the Innovation Program of Shanghai Municipal Education Commission (09YZ277), and the Shanghai Leading Academic Discipline Project (Y1101).





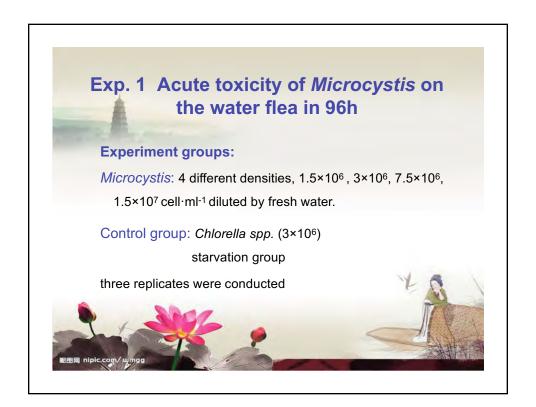












Exp.2 Impacts of *Microcystis* on the growth and reproduction of water flea

Five levels:

Control	3.0×106 cell·mL -1 Chlorella sp. 11ml +1mg/ml yeast solution 1ml
Treatment 1	0.75×10 ⁶ cell·mL ⁻¹ <i>Microcystis</i> 10ml +1mg/ml yeast solution 1ml +3.0×10 ⁶ cell·mL ⁻¹ <i>Chlorella sp.</i> 1ml
Treatment 2	1.5×106cell·mL -1 Microcystis 10ml +1mg/ml yeast solution 1ml +3.0×106 cell·mL -1 Chlorella sp. 1ml
Treatment 3	3.0×10 ⁶ cell·mL - ¹ Microcystis 10ml +1mg/ml yeast solution 1ml +3.0×10 ⁶ cell·mL - ¹ Chlorella sp. 1ml
Treatment 4	7.5×10 ⁶ cell·mL -1 <i>Microcystis</i> 10ml +1mg/ml yeast solution 1ml +3.0×10 ⁶ cell·mL -1 <i>Chlorella sp.</i> 1ml

Exp.3 Impacts of *Microcystis* on the population of water flea

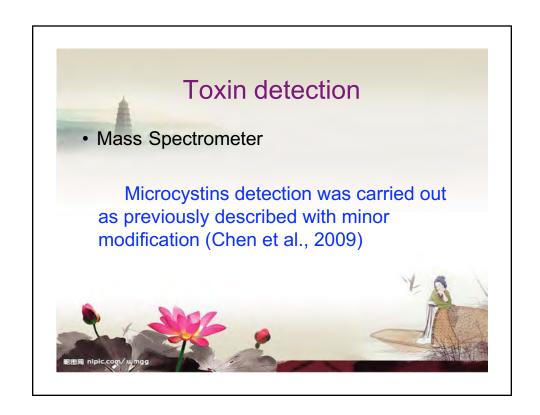
6 different concentrations

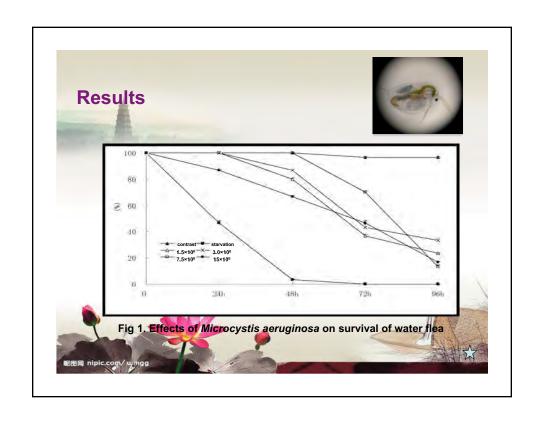
 $0.75 \times 10^6 \text{cell · ml}^{-1}$, $0.5 \times 10^6 \text{cell · ml}^{-1}$, $0.25 \times 10^6 \text{cell · ml}^{-1}$, $0.1 \times 10^6 \text{cell · ml}^{-1}$, $0.05 \times 10^6 \text{cell · ml}^{-1}$, $0.01 \times 10^6 \text{cell · ml}^{-1}$;

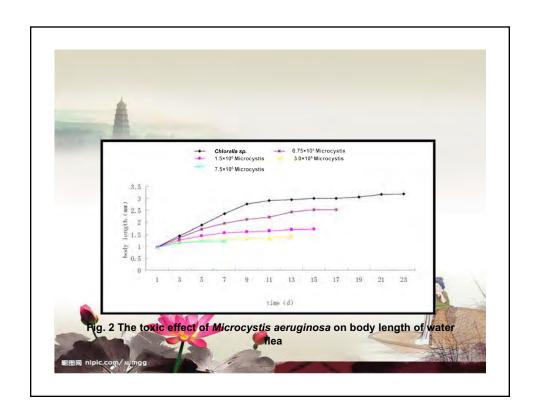
• control: Chlorella sp.

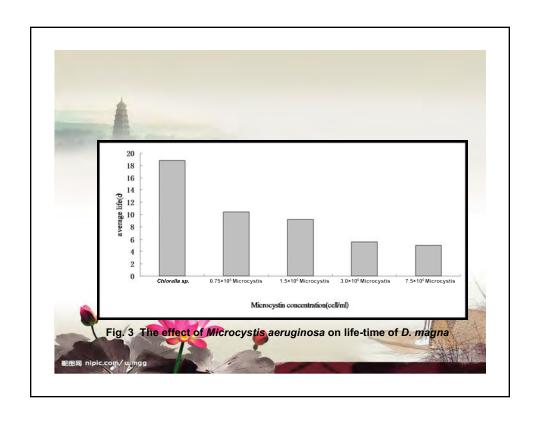
Three replicates



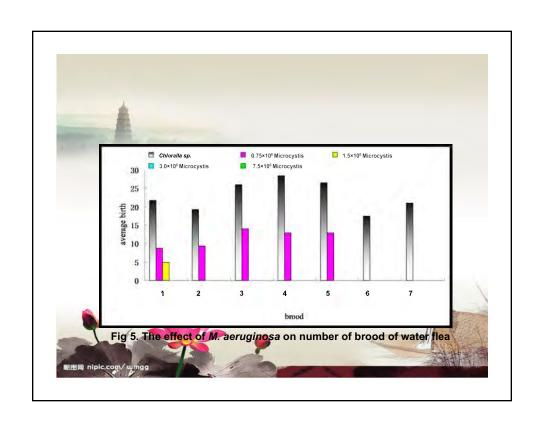


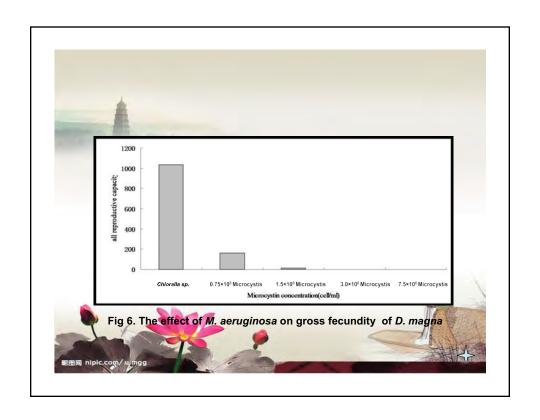


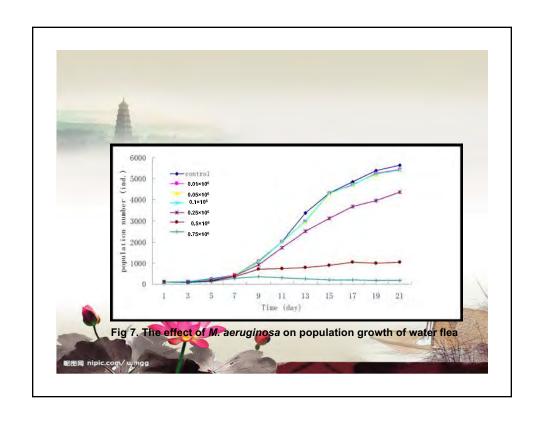


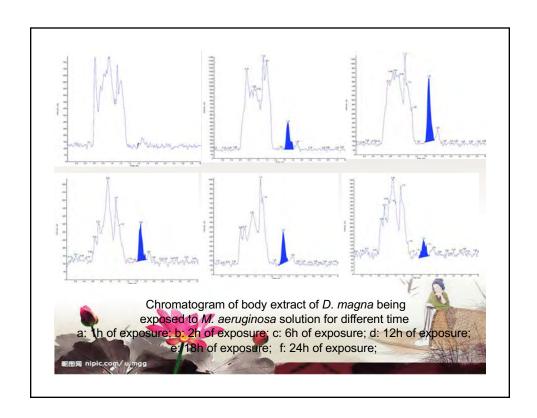




















FARMING PRACTICES OF SNAKEHEAD (CHANNA MICROPELTES AND CHANNA STRIATUS) IN THE MEKONG DELTA OF VIETNAM

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Freshwater fish farming is very common and important in the Mekong Delta of Vietnam. Cage culture of giant snakehead (Channa micropeltes) was started in 1960s, while the farming of common snakehead (Channa striatus) was started in 1990s and has become popular in the flood prone areas of the Delta now. However, the farming of these fish species depends heavily on the exploitation of wild indigenous fishes for feed and the wild fish stock has been rapidly depleted due to many reasons and has caused a number of issues, especially food security for the poor people. To date there has not been much information available on these issues. This paper is based on survey data collected in 2008 and 2009 and aims to provide a better understanding on the situation and to propose a set of solutions for further development of snakehead industry in the Mekong Delta. The results showed that the cultured area or volume and the yield of fish varied strongly by type of farming systems. In order to harvest 1 kg of snakehead fish, about 4.0-5.0 kg of trash fish are used. All of the snakehead farmers used fresh water trash fish in flooding season (September to December), but about 60-70% of total amount of trash fish for snakehead culture were from marine capture, yearly. The major difficulties faced by snakehead farmers are: (1) lack of capital; (2) pollution of cultured area and difficult to treat the fish diseases; (3) unstable price of table fish; (4) increasing price of trash fish. Figure 1: Cage culture of giant snakehead These difficulties have resulted in a decreasing profit and a lower rate of successful farmers. If the cost of self-captured trash fish is taken into account, the rate of successful farmers of giant snakehead in 2008 was 63.6% for crop 1 and 87.5% for crop 2 (in respective percentage of the total number of fish farmers by group). The figures for common snakehead were 46.4% and 66.5%, respectively. Using trash fish for snakehead culture took away the low value sources of animal protein for a large proportion of local community, and put a higher pressure on natural aquatic resources not only freshwater but also marine water ones. The management of this industry should be given more consideration, especially in terms of seed and feed supply, water pollution, market information and marketing of fish products.

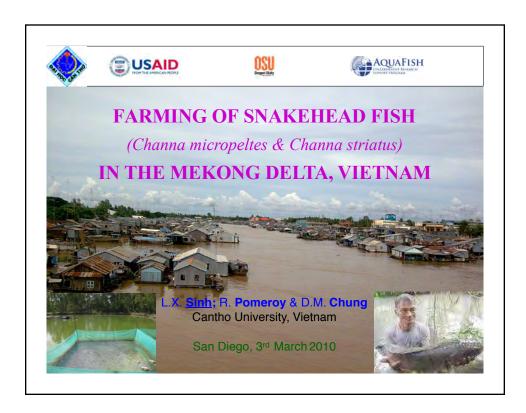
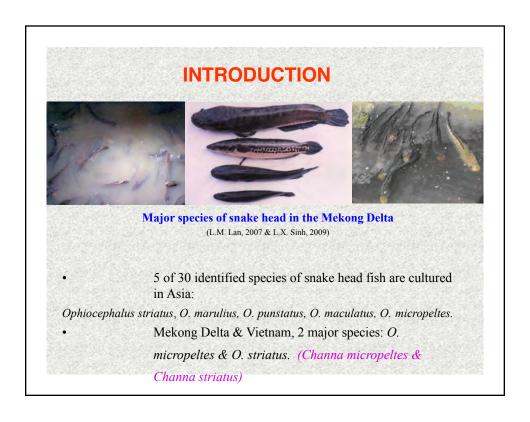
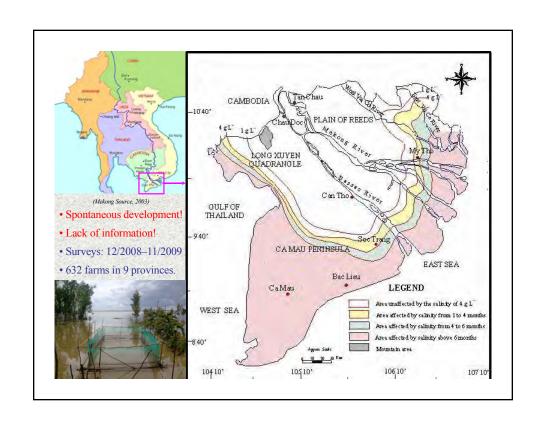


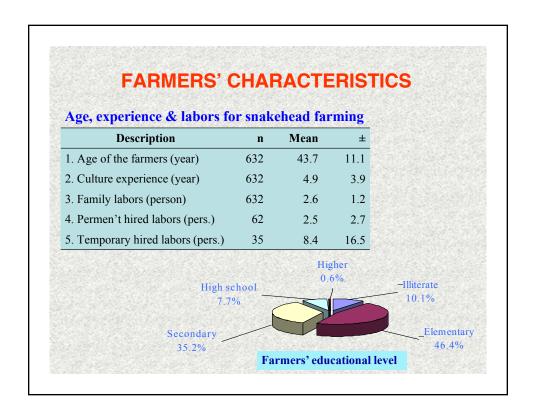
TABLE OF CONTENTS

- 1. INTRODUCTION
- 2. FARMERS' CHARACTERISTICS
- 3. TECHNICAL-ECONOMIC ASPECTS
- 4. FACTORS AFFECTING THE YIELD OF FISH
- 5. FARMERS' PERCEPTION
- 6. CONCLUSIONS





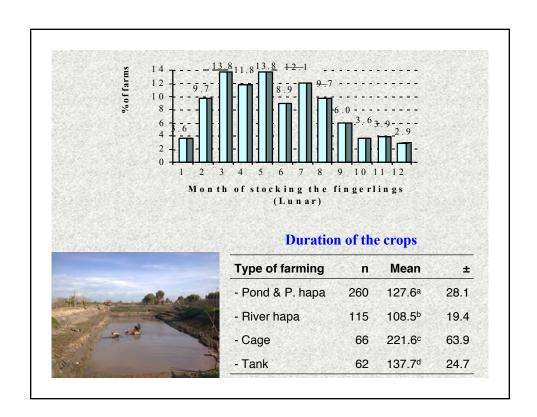


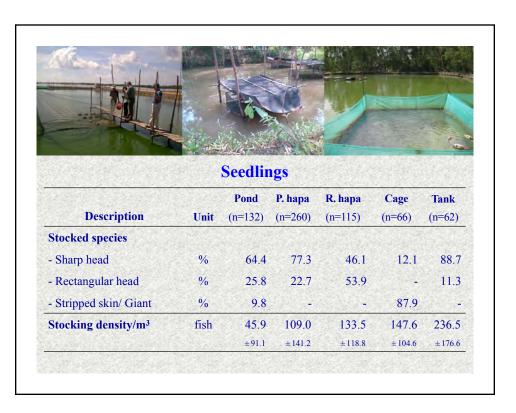


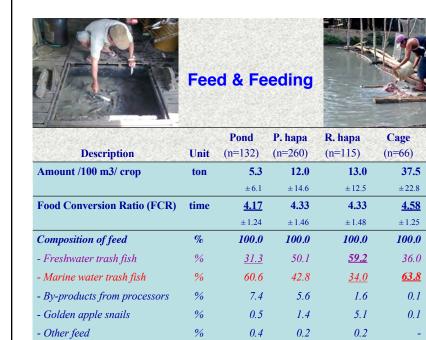
TECHNICAL-ECONOMIC ASPECTS

Design of the system

Description	Unit	Pond (n=132)	P. hapa	R. hapa	R. cage	Tank
Description	Unit	(n-132)	(n=260)	(n=115)	(n=66)	(n=62)
No. of ponds, hapas,	cages/ fa	rm				
+1	%	66.7	43.5	48.7	53.0	64.5
+ 2	%	19.7	33.5	36.5	27.3	21.0
+ 3	%	7.6	11.9	10.4	13.6	6.5
≥ 4	%	6.1	11.2	4.3	6.1	8.1
Cultured Volume	m ³	2925.9	126.0	64.0	260.6	31.8
		±6800,3	±215.8	±66.2	±466.7	±32.3







Tank

(n=62)

30.6

±37.3

4.26

±1.52

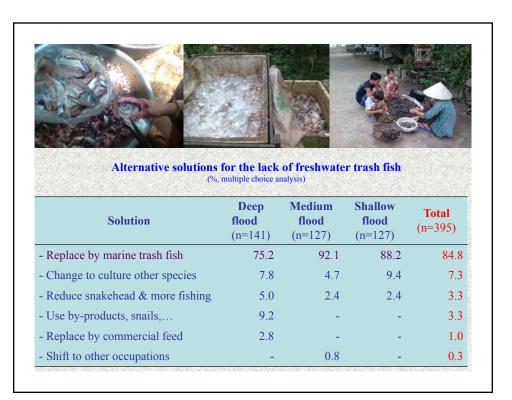
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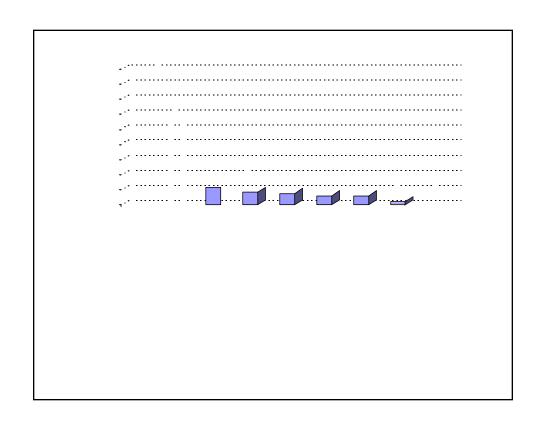
45.5

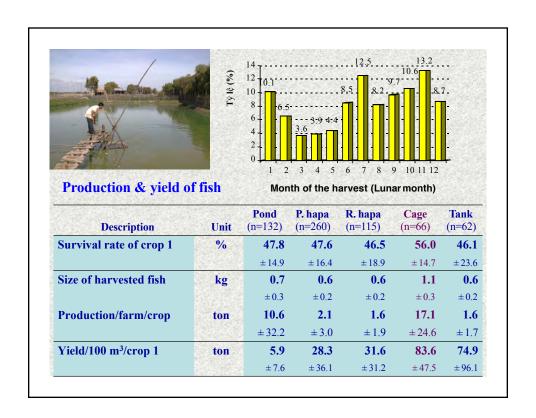
40.4

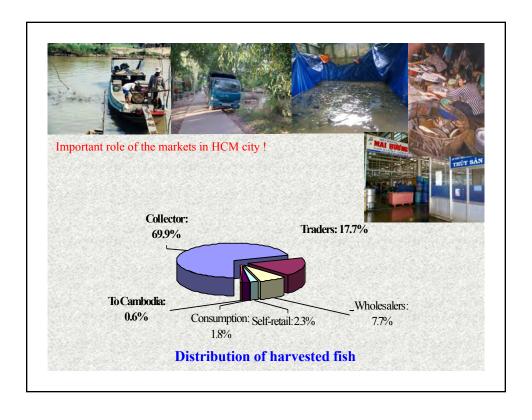
10.5

3.7









		mic indic				
Description	Unit	Pond	P. hapa	R. hapa	Cage	Tank
		(n=132)	(n=260)	(n=115)	(n=66)	(n=62)
A- Including own-captured to	rash fish					
	VND	144.0	731.1	736.1	2252.1	1856.3
1. Total costs/100m ³ /crop	mil.	±186.1	±1182.0	±617.2	± 1365.9	±2129.2
	VND	154.3	700.6	738.5	2430.3	1893.7
2. Gross income/100m³/crop	mil.	±210.5	±1115.1	±841.3	± 1404.7	± 2647.1
	VND	10.3	-30.6	2.4	178.1	37.4
3. Net income/100m³/crop	mil.	± 79.8	±896.8	±443.2	± 886.9	± 1020.3
4. Ratio of NI/TC	%	10.3	1.0	-3.2	17.1	3.4
		± 42.6	± 34.4	±44.4	±53.6	±36.0
5. Rate of successful farms	%	57.6	45.4	38.3	59.1	56.5
B- Exclud. own-captured LV	F (%)	68.9	72.3	60.0	84.8	62.9

FACTORS AFFECTING THE YIELD OF FISH

MULTIPLE REGRESSION ANALYSIS:

 \Rightarrow 5 Xi significantly affected the fish yield at the same time at p<0.05:

- 1. Species: Giant fish had a better yield than Common ones.
- 2. Cultured areas or location: more/deeper flood higher yield & net income.
- **3. Stocking density:** increasing density still could help to increase yield but the highest Net income/Total costs was with 40-80 fish/m³.
- **4. Costs of health management:** still could help to improve the Yield but VND 25,000-40,000 or USD 1.5-2.5/m³/crop => highest Net income and NI/TC.
- 5. Farming techniques: being trained => better yield and net income.

FARMERS' PERCEPTION

Impacts of using the trash fish for farming snakehead fish (%)

Type of impacts	n	Very bad	Bad	Neutral	Good	Very good
- Natural aquatic resources	614	<u>15.1</u>	<u>44.0</u>	40.7	0.2	0.0
- Aquaculture	615	0.0	0.7	10.6	<u>72.0</u>	<u>16.7</u>
- Public water environment	614	<u>6.4</u>	<u>22.6</u>	68.7	2.3	0.0
- Food for the poor	612	0.3	<u>13.1</u>	75.8	7.2	3.6
- Jobs for the community	610	0.0	0.8	12.1	<u>78.2</u>	<u>8.9</u>
- Income of the fishers	607	0.0	0.7	10.2	66.9	22.2



Difficulties in snakehead culture (n=561, multiple choice analysis)

1. Lack of capital	49,7	
2. High mortality by diseases	38,5	
3. Fluctuation of fish price	19,6	
4. Insufficient supply of trash fish	18,7	
5. Lack of knowledge on disease treatment	17,3	
6. Environmental/water pollution	10,3	

NEEDS:

- \Rightarrow Sector management (Planning)
- ⇒ Supply & quality of seed
- \Rightarrow Replacement of feed
- \Rightarrow Marketing of fish
- \Rightarrow Value chain study
- ⇒ Environmental & fish health management.

TRADE AND CONSUMPTION OF FOOD FISH IN FRESHWATER AREAS OF THE MEKONG DELTA, VIETNAM

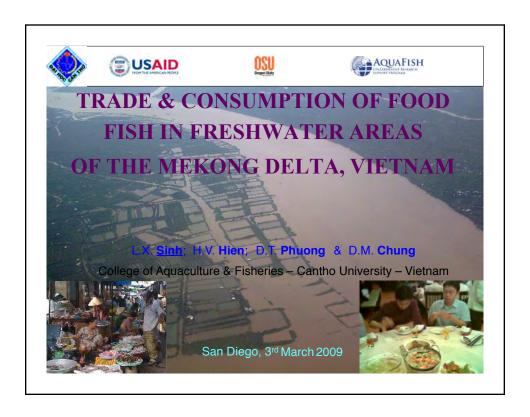
Le Xuan Sinh* and Robert S. Pomeroy College of Aquaculture & Fisheries Can Tho University 3/2 Street, Can Tho City Vietnam. lxsinh@ctu.edu.vn

This study was conducted from January to June 2009 with the aim to describe the situation and to provide a set of solutions for an improvement in both supply and consumption of food fish in the Mekong Delta of Vietnam. Food fish in fresh water areas of the Mekong Delta are mainly supplied via traders. More than 94% of the number of traders are female with the average trading experience of about 12 years. The main sources of information of traders were based on their own experience and consumers. The quality, price, quantity and size of fish were their first priority. The trade of high value marine fish and freshwater fish was reported to increase while that of low value fish was stable. There was 94.7% of the number of traders did not use the contracts due to the flexibility of their trading activities. About 78.1% and 73.9% of them preferred to trade wild fish and freshwater fish, respectively. Among the freshwater fish species traded, snakehead, hybrid catfish and climbing perch were mostly preferred.

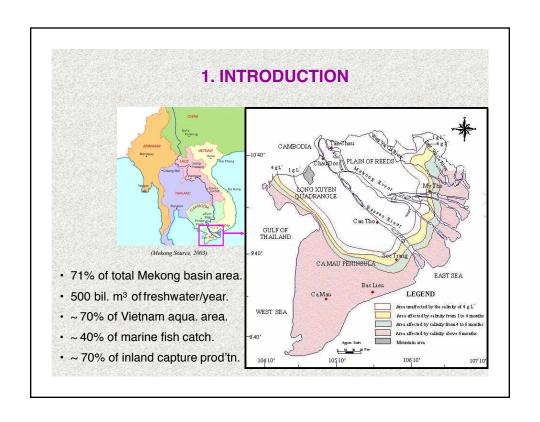
The average size of surveyed households was 4.9 (±1.7), of which 59.9% participated in some fishing activities, especially during the wet season in flood-prone areas. The size of households with fishing activities was bigger than that of non-fishing ones. The purchase of animal protein or red meats shared 63.4% of total expenditures for food. Food fish were from marine and freshwater sources, and from both capture and aquaculture. About 90% and 95% of the total number of households preferred to eat wild fish and freshwater ones, respectively. Local people bought food fish very often and mainly consumed fish in term of fresh type. The amount of food fish consumed per household was almost unchanged while the quality of freshwater fish tended to decrease and the price was increased. In addition, there were seasonal changes in the supply, price and uses of food fish.

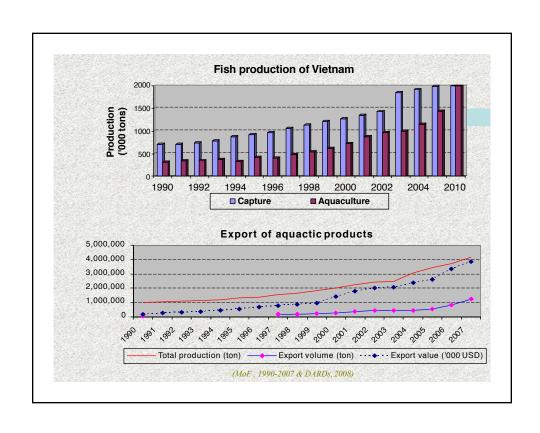


A number of difficulties were reported by the fish traders and consumers. The fish traders looked for more supports on the credit supply, better conditions of fish market places, and a reduction in taxes/fees from different levels of government. The fish consumers suggested for a better management of fishing activities and quality of fish products, as well as a better production or amount of high value fish from aquaculture.



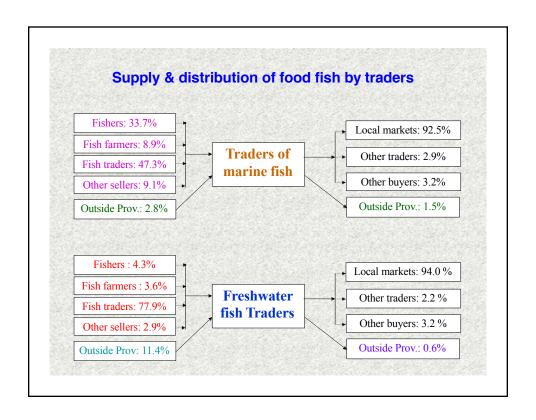








3. TRADERS OF FOOD FISH Village **District Province Total** Description (n1=91)(n2=57)(n3=41)(N=189)1. Total amount of fish traded 45.3 42.8 41.5 38.5 ±32.8 (kg/day) ±51.0 ±42.8 ±45.1 2. Proportion of marine fish (%) 24.6 21.8 22.0 23.1 + Rate of marine LVF (%) 5.7 2.7 2.9 4.2 + Lost of fish in trading (%) 4.1 4.3 7.1 3. Proportion of FW fish (%) 75.4 78.2 78.0 76.9 + Rate of freshwater LVF (%) 31.7 18.5 15.5 24.2 + Lost of fish in trading (%) 4.4 2.3 3.1 •94% are female •12 year experience



Factors affecting the traded amount of food fish:

- 1. No. of trading fish/month (day)
- 2. Contract in trading fish (0-No; 1-Yes)
- 3. Sources of freshwater fish (0-Wild; 1-Cultured)
- 4. Proportion of FW fish/ Total amount of fish traded (%)
- 5. Marketing costs (VND'000/day)



Description	NO (Fishing & Aqua.) (n1=288)	Fishing only (n2=337)	Aquac. only (n3=82)	YES (Fishing & Aqua.) (n4=132)	Total (N=779)
1. Household siez (person)	4.5 ± 1.5	4.8 ± 1.6	5.4 ± 2.0	5.3 ± 1.9	4.9 ± 1.7
2. Net income/HH (VND'000)	96836.0	37382.1	97020.8	59206.2	61542.3
±	539821.4	57124.3	339804.2	66281.0	283892.1
3. Expenditures/mo (VND'000)	1843.4	1416.0	2087.8	1652.2	1658.9
±	1248.8	823.3	1843.3	1192.2	1189.3
3.1. Costs of food (%)	61.4	67.9	52.5	68.2	65.5
±	18.2	18.6	25.2	16.8	18.3
. Share of meat & fish (% of 3.1)	64.4	63.5	45.7	62.6	63.4
±	18.3	17.9	36.4	15.3	17.8
4. Amount of fish/pers/yr (kg)	72,4	143,3	124,2	195,3	129,4
±	99,3	224,3	183,5	275,0	206,5
5. Sources of food fish (%)					
+ Own captured	0.0	63.9	0.0	51.8	44.0
+ Own cultured	0.0	0.0	20.9	14.4	6.4
+ Bought from others	100.0	36.1	79.1	33.8	49.7

Factors affecting the fish consumption per capita:

- 1. Household size (-)
- 2. Living expenditure/pers./month (+)
- 3. % of captured fish kept for HH consumption (+)
- 4. % of cultured fish kept for HH consumption (+)
- 5. % of HVF/ Total food fish (+)
- 6. % of fresh water HVF/ Total FW fish (-)

Buying of fish by value group of fish (N=779)

Description	High value fish	Low value fish
1. No. of days to buy fish (days/time)	3.5	3.4
±	4.3	7.4
2. Amount o money (VND'000/time)	28.9	20.7
\pm	28.4	16.4
3. Amount of fish bought (kg/time)	1.3	1.8
±	2.6	1.7
3.1. Proportion of freshwater fish (%)	83.1	85.0
3.2. Rate of fresh type of FW fish (%)	90.1	86.7

Preferred sources of food fish

(%, multiple choice analysis, N=779)

Type/ Source	High value fish	Low value fish
1. Wild fish	92.3	91.5
2. Cultured fish	7.7	8.5
3. Marine fish	4.7	5.2
4. Freshwater fish	95.3	94.8

5. TRENDS IN THE MARKETS

Trends in consumption of food fish (N=779)

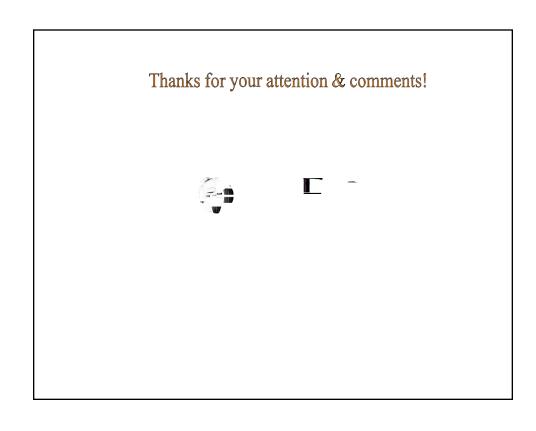
Trend	High value fish	Low value fish
1. Amount of fish (%)		
+ Decreased	15.3	14.8
+ Unchanged	63.3	62.8
+ Increased	<u>21.4</u>	22.4
2. Availability of fish (%)		
+ Decreased	17.6	19.0
+ Unchanged	39.7	39.7
+ Increased	42.6	41.3
3. Convenience in trading (%)		
+ Worse	2.5	8.0
+ Normal	36.5	39.5
+ Better	<u>61.1</u>	<u>59.8</u>

Trends in consumption of food fish (cont...)

Trend	High value fish	Low value fish
4. Size of fish (%)		
+ Decreased	48.8	<u>54.1</u>
+ Unchanged	37.0	39.1
+ Increased	14.2	6.7
5. Quality of fish (%)		
+ Decreased	<u>43.3</u>	43.7
+ Unchanged	43.4	44.4
+ Increased	13.3	11.9
6. Price of fish (%)		
+ Decreased	7.6	6.8
+ Unchanged	14.8	17.4
+ Increased	<u>77.6</u>	<u>75.8</u>

6. CONCLUSIONS

- 1. Domestic markets are not well organized
- 2. Lack of management & information on the marketing of fish
- 3. Traders & retailers play the key role
- 4. Seasonal change in both supply, demand & price
- 5. Substitution bet. wild & cultured fish, and marine & FW fish
- 6. Diversified, but native species are mostly preferred
- 7. LVFs continue to keep an important role
- => More studies on: protection & development of wild fish, marketing of captured cultured fish, value added,



SMALL-SIZED FISH PASTE PRODUCTION TECHNOLOGY IN CAMBODIA'S MEKONG RIVER BASIN

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Fish has long been critical to all Cambodians. It is a major source of nutritious food in the daily diet, a primary source of income and has strong cultural and religious significance. Fish matter a great deal to the millions of people who live on the banks of the country's rivers, particularly those living in and around the Tonle Sap Great Lake. Cambodians are considered one of the highest per capita consumers of freshwater fish in the world (a recent estimate of 52.4 kg per person per year from household surveys, being equal to 81.5% of the total animal protein intake).

There is an abundance of small-sized/low value fish harvested using dai "bag-net" and many of other fishing gears in a short period during the peak fishing season (December – March) along the Tonle Sap and Mekong rivers, and their major tributaries. These fish are typically landed in many (isolated) locations and in a poor condition or severely damaged from the capture methods. During the peak season, thousands of people travel to the Tonle Sap, the Mekong and other waterways to trade rice for fish, to fish themselves, or to buy small-sized/ low-value fish to produce fermented fish paste. Fermented fish paste is excellent food for the elderly or small children. Fish paste is one of fermented fish products, which is preferable and kept for use in all Cambodian houses. Small-sized/low value fish paste is divided into two kinds, boneless and bony fish paste produced by different fermented technologies, have been bought and used by different classes of people. The bony small-sized fish paste, which can also be called low-valued fish paste, is mostly consumed by the poor who have limited income.

This paper provides clear understanding of the processing techniques of fermented small-sized/ low value fish in Cambodia's Mekong basin. The paper will address five specific topics: (1) document both traditional and modern existing technologies of fermentation process of small size fish paste; (2) recommend best management practices of fermented techniques of small sized/low value fish; (3) identify problems and issues relating to small-sized fish fermenting practices and value-added product development; (4) analyze economic aspects of small-size fish paste production; and (5) To imply for maximizing the utilization of small-sized or low value fish paste for human consumption through appropriate value added product development. The data for the paper is based on surveys of interviews with 150 micro-, small-, medium- and large-scale small-size fish fermenting operators in five major provinces of Kandal, Kampong Chhnang, Battambang, Siem Reap, and Phnom Penh located in the four major river branches of the Cambodia's Mekong River basin, with a distance of over 500 km, using standard semi-open questionnaires.









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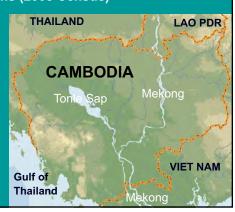
SMALL-SIZED FISH PASTE PRODUCTION TECHNOLOGY IN THE CAMBODIA'S MEKONG RIVER BASIN

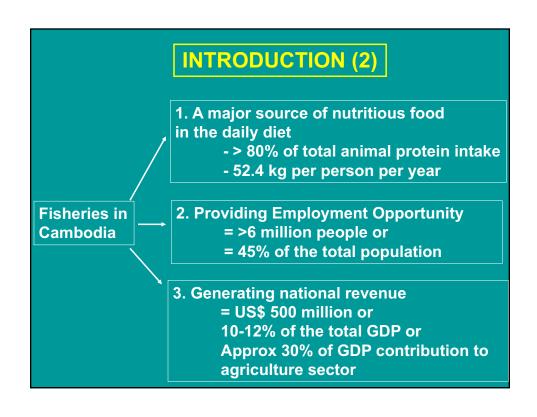
Nam So*, Chakriya Norng & Robert Pomeroy

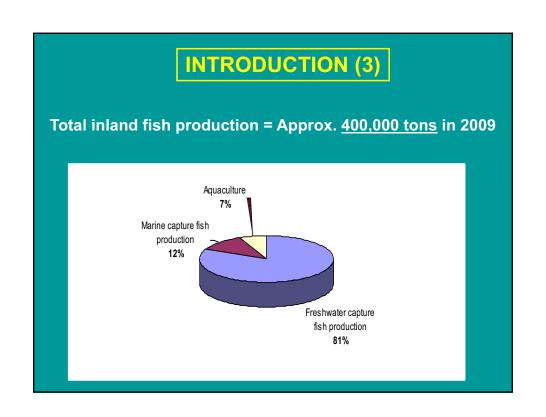
Inland Fisheries Research and Development Institute
Phnom Penh, Cambodia

INTRODUCTION (1)

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



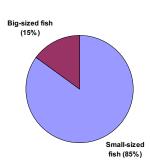




INTRODUCTION (4)

Inland small-sized fish production = <u>Approx. 340,000</u> tons in 2009, including some juvenile of big-sized fish species





So et al. in press

INTRODUCTION (5)

Small-sized fish = Approx. 200 species identified and Lmax of SSF = < 25 cm (So et al. in press)





Cirrhinus siamensis RtIeroltub

L_{max} = 20 cm





Cirrhinus lobatus RtIerolGgÁam Corica laciniata RtIbNþÚlGMe

L_{max} = 15 cm

L_{max} = 7 cm



INTRODUCTION (6)

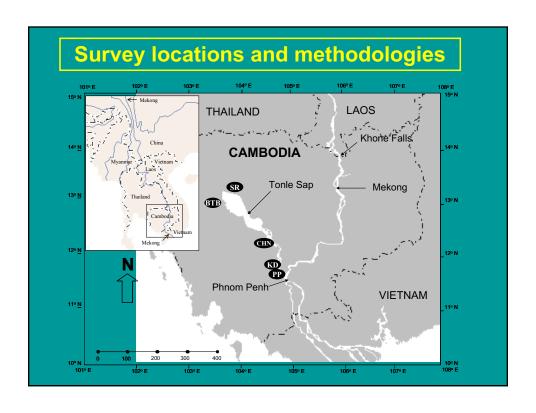
- There is an abundance of small-sized/low value fish harvested in a short period during the peak fishing season (December March) in Cambodia
- These fish are typically landed in many (isolated) locations and in a poor condition or severely damaged from the capture and handling methods.
- During the peak season, several hundreds of thousands of people travel to the Tonle Sap, the Mekong and other waterways to trade rice for fish, to fish themselves, or to buy small-sized/low value fish to produce fermented fish paste.

INTRODUCTION (7)

- Fish paste *(Prohoc)* is one of fermented fish products, which is common, preferable and kept for use in all Cambodian houses.
- Average fish paste (*Prohoc*) consumption rate7 kg/person/year

Objectives

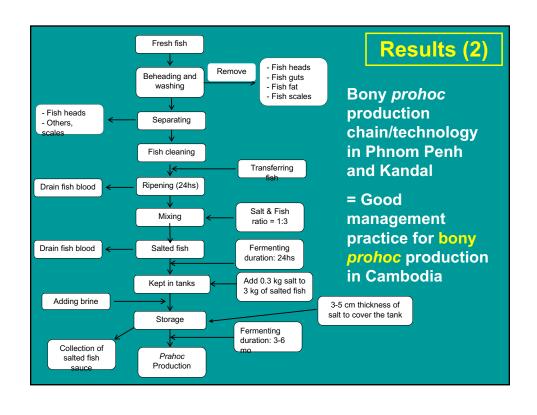
- 1. To document existing technologies of fermentation process of inland small size fish paste (*Prohoc*);
- 2. To recommend best management practices of fermented techniques of prohoc production;
- 3. To analyze economic aspects of prohoc production; and
- 4. To identify problems and issues relating to small-sized fish fermenting practices or *prohoc* production.



Results (1)

Four *prohoc* production scales detected in Cambodia:

Scale	Prohoc	Characteristics
Micro	10 – 50 kg	Household consumption only
Small	50 – 1,000 kg	Both household consumption and Local markets; and no license
Medium	1-50 ton	Local markets, and a license
Large	50 – 1,000 ton	Export markets, trade marks, a license



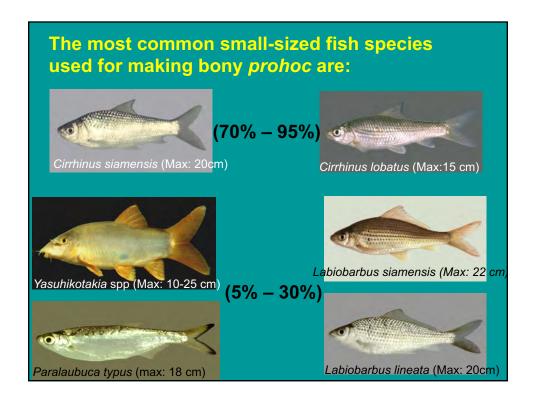


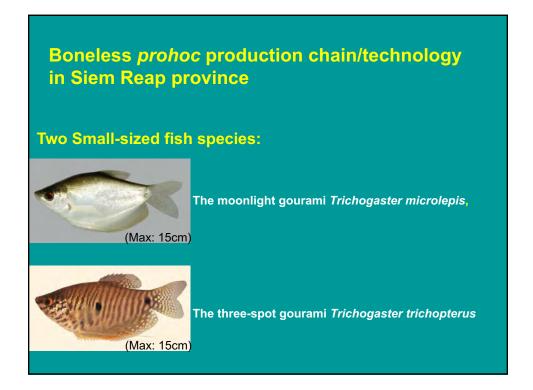


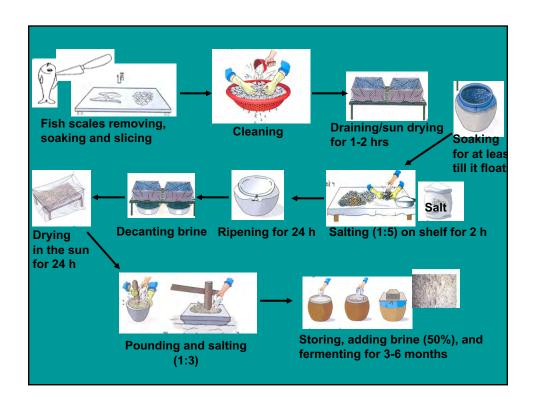














Economic analysis of Prahoc production

Economic Efficiency

Provinces & city

	Micro	Small	Medium	Large
Phnom Penh	0.67	1.10	1.67	1.48
Kandal	0.59	1.06	1.62	1.56
Kampong Chhnang	0.8	1.19	1.12	1.22
Battambang	0.72	1.36	1.37	1.39
Siem Reap	1.87	1.81	2.34	1.57
Total	0.93	1.30	1.62	1.44

Main problems relating prohoc production

- 1. Poor quality and hygiene/sanitation of inland small-sized fish paste due to lack of quality control system in Cambodia leading to fluctuation of demands for export markets and to change in price;
- 2. Increasing price of raw materials such as fresh small-sized fish and salt;
- 3. Lack of good information on domestic and foreign sources of technology and equipments/materials, e.g. non-existing reasonable grading and packaging materials leading to underdeveloped export markets;
- 4. Shortage or lack of working capital to start or expand the business due to a very high interest rate from most of local micro credit intuitions or banks;

- 5. Low level of education and technical skills of the producers;
- 6. Poor research and development infrastructure; and
- 7. Lack of trained human resource in fish processing.

Conclusions

- 1. There are four scales of *prohoc* production in Cambodia. The micro scale has the lowest economic efficiency (EE), while the middle scale has the highest EE, followed the large and small scales.
- 2. Bony *prohoc* production technology is documented in all five surveyed provinces, and the good practice for this technology is detected along the Tonle Sap River of Phnom Penh and Kandal province. It is mostly consumed by the poor who have limited income.
- 3. Boneless *prohoc* production technology is documented in the surveyed provinces, and the good practice for this technology is detected in Siem Reap by using 2 species of small-sized fish: the moolight gourami *Trichogaster microlepis* and the three-spot gourami *Trichogaster trichopterus*. it is sold at a higher price compared to that of bony small-sized fish paste.
- 4. Improving quality and sanitation/hygiene (safety) of *prohoc* is recommended in order to increase demand for export markets

Funding for this research was provided by the







SUPPORT PROGRAM



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MARKET CHANNEL AND TRADE OF FISH PASTE FROM SMALL-SIZED FISH IN CAMBODIA

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Fish has played an important role in ensuring food security in Cambodia. Fish is providing some 82% of the total animal protein intake for the population, while rice constitutes around 75% of the total energy consumption. Besides the protein the fish provide, fish itself also provide income for fishermen and other stakeholders such as fish processors and traders, and has a strong cultural and religious significance.

Fish paste, one kind of fish processed product, is a concentrated form of fermented fish where fermentation has digested the fish to the point where the form of the fish is no longer discernible. Fish paste is typically made from small-sized or low value fish such as the common small cyprinids (Cirrhinus spp.). Preprocessing varies by species, some are used whole, some are headed and cleaned, and fatty species (Cirrhinus spp. in particular) are kneaded or pounded to remove fat. Fish are mixed with salt, after some time liquid is decanted and may be used as fish sauce. The mixture is fermented, typically for three months to one year. Fish paste is also very crucial to Cambodian people due to the fact that they contribute to food availability, especially in the period when fresh fish supply is shortage. Because of its long shelf life, fish paste can be kept and eaten for years round. Moreover, fish paste is presented and traded in all markets in Cambodia and even in some other countries. This paper provides a clear understanding of the current status of the market channels and trade of small-sized or low value fish paste in the Cambodia's Mekong River Basin. The paper will address five topics: (1) an assessment of smallsized fish paste market chain and trade; (2) opportunities for small-sized fish paste markets and trade; (3) problems related to small-sized fish paste marketing and trading; (4) economic efficiency of wholesalers, exporters, traders, and retailers of small-sized fish paste; and (5) recommendations for maximizing the utilization of small-sized or low value fish paste for human consumption through appropriate value added product development.

The paper is based on marketing surveys and interviews of 200 small-sized fish paste retailers, traders, wholesalers, exporters, processing operators and consumers are carried out in five main provinces of Kandal, Kampong Chhnang, Battambang, Siem Reap and Phnom Penh located in the four major river branches of the Cambodia's Mekong River basin, with a distance of over 500 km, using standard forms of semi-open questionnaires.









WAS 2010, 1-5 March 2010, San Diego, CA

MARKET CHANNEL AND TRADE OF FISH PASTE FROM SMALL-SIZED FISH IN CAMBODIA

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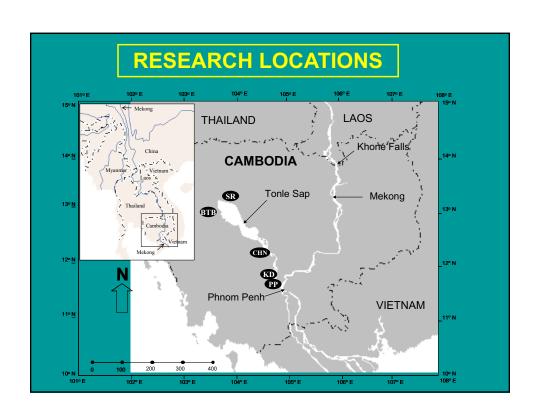
INTRODUCTION

- **Prohoc** (inland small-sized fish paste) is a concentrated form of fermented fish, which it is not paste as commonly understood, but products where fermentation has digested the fish to the point where the form of the fish is no longer discernible.
- **Prohoc** is commonly and preferably kept for use in all houses in Cambodia as direct food or food ingredient, being a national food identity of Cambodia.
- In previous study, technologies used for making both bony and boneless of **prohoc** are well documented and evaluated.

OBJECTIVES

This study was conducted to:

- 1. Identify market channel and trade of *prohoc* in Cambodia;
- 2. Analyze economic efficiency of all relevant stakeholders, including wholesalers, exporters, traders/middlemen, and retailers of *prohoc*; and
- 3. Determine main problems relating marketing and trade of *prohoc* in Cambodia



REARCH METHODOLOGIES

- 150 purposively selected samples of all relevant stakeholders such as processors, exporters, middlemen, wholesalers, retailers and end consumers were structurally interviewed in Phnom Penh city, and Kandal, Kampong Chhnang, Battambang and Siem Reap provinces using six different semi-open questionnaires.
- The collected data were installed and analyzed in SPSS version 12.



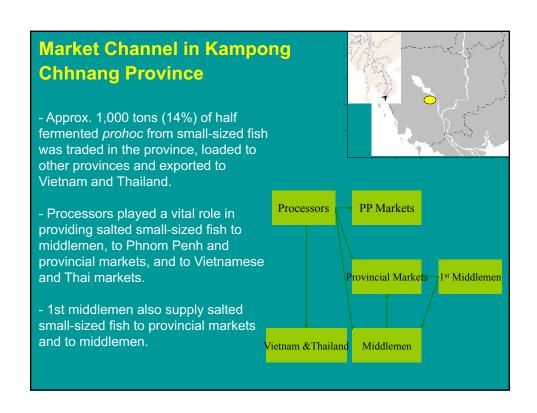


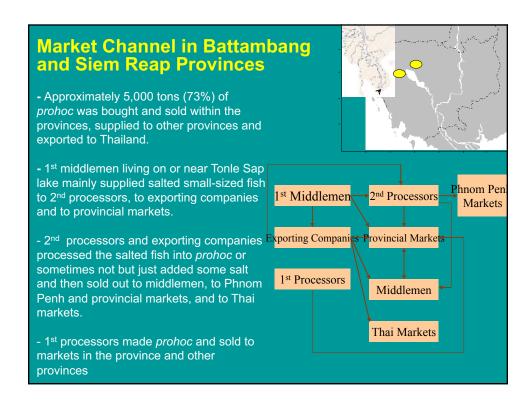




RESEARCH RESULTS







Economic Efficiency (EE) of all stakeholders in the market chain of *prohoc*

Stakeholders	Economic Efficiency (EE)
Middlemen in Phnom Penh capital	1.131
Middlemen in Battambang, Siem Reap, Kampong Chhnang & Kandal provinces	1.052
Exporters	<u>1.327</u>
Wholesalers in Phnom Penh capital	1.092
Wholesalers in Battambang, Siem Reap, Kampong Chhnang & Kandal provinces	1.348
Retailers in Phnom Penh capital	1.084
Retailers in Battambang, Siem Reap, Kampong Chhnang & Kandal provinces	1.193

Main problems relating to prohoc trading

- 1. Lack of good information on domestic and foreign markets, particularly price and demand, causing the large gap between the farm-gate prices and terminal market prices;
- 2. High informal taxes or road taxes, poor government intervention and poor law enforcement of marketing and trade of *prohoc*;
- 3. Non-existing of wholesale markets and distribution centers for *prohoc* production;
- 4. Lack of labor force for transporting prohoc;
- 5. Lack of working capital to start or expand the business due to a very high interest rate from most of local micro credit intuitions or banks; and
- 6. Price instability due to exportation instability resulting from poor quality and unsafe *prohoc* (e.g. use of chemicals to preserve *prohoc*)

Conclusions

- 1. *Prohoc* is not only used for household consumption by the poor in the country but for selling to export markets in Thailand and Vietnam. An estimate of 50% of total *prohoc* produced in Cambodia are domestically consumed, 49% exported to Thailand and 1% to Vietnam.
- 2. Major stakeholders involved in market channels and trade of *prohoc* in Cambodia include: processors, wholesalers, middlemen, retailers and exporters.
- 3. Prohoc market and trade in Cambodia is complicated as it is undertaken through many steps and types of stakeholders who play multiple roles in marketing before it can reach the end consumers, and is different from one province to another province and in accordance to stakeholders' characteristics and small-sized fish species.
- 4. The total amount of *prohoc* produced and traded by each stakeholder is generally increasing from year to year, although the total amount of inland small-sized fish catch is declining, indicating the value added product development is significant.

- 5. An estimate of annual *prohoc* production from the five surveyed provinces of Kandal, Phnom Penh, Kampong Chhnang, Battambang and Siem Reap was approx. 7,200 tons in 2008, increasing from approx. 4,000 tons in 2004.
- 6. The market price of *prohoc* is gradually increasing and varies by season. The average price of *prohoc* was US\$ 1.5 per kilogram in 2008, which is about 4 times higher than the one of fresh small-sized fish (i.e. approx. US\$ 0.4/kg).
- 7. Only **wholesalers** who buy salted small-sized fish for processing and stocking receive the highest economic efficiency.
- 8. The market of *prohoc* cannot be ensured to be expanded due to many encountered problems mentioned above. And
- 9. Hygiene, sanitation, safety, and quality control of *prohoc* production to meet national and international standards should properly be implemented.

Funding for this research was provided by the









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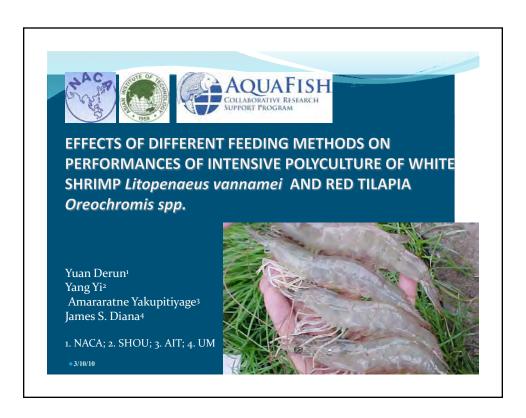
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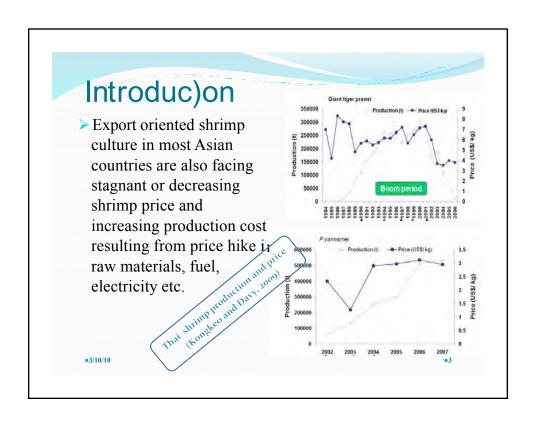
EFFECTS OF DIFFERENT FEEDING METHODS ON PERFORMANCES OF INTENSIVE POLYCULTURE OF WHITE SHRIMP *Litopenaeus vannamei* AND RED TILAPIA *Oreochromis spp*.

Derun Yuan*, Amararatne Yakupitiyage, Yang Yi, James S. Diana The Network of Aquaculture Centres in Asia-Pacific P.O. Box 1040, Kasetsart Post Office, Bangkok 10903, Thailand Email: yuan@enaca.org

An experiment was conducted in 15 cement tanks (2 x 2.5 x 1 m) at the Asian Institute of Technology, Thailand, from April 7 to June 15, 2006 to assess the effects of different feeding methods for intensive polyculture of shrimp (Litopenaeus vannamei) and tilapia (Oreochromis spp.) on shrimp growth, water quality and overall production performances. Shrimp postlarvae of 0.03 g were stocked into the tanks at the density of 60 postlarvae m-1. Red tilapia fingerlings of 47.5 g were stocked into the shrimp tanks four weeks later at the density of 0.8 fish m-2. The experiment followed a 2 x 2 factorial design with shrimp feeding level (satiation or controlled feeding) and tilapia supplementary feeding (with or without) as two factors. All treatment combinations were randomly allocated to the tanks in triplicate with three shrimp monoculture tanks as the control. Shrimp were fed three times a day with shrimp commercial pellets, and tilapia, one time in early morning half hour before shrimp feeding with tilapia commercial pellets. There was no water exchange throughout the experimental period. The mean survival rate of shrimp, ranging from 62% to 70%, was the highest in the tanks with shrimp fed to satiation and tilapia with supplementary feeding, and the lowest in monoculture control tanks (P<0.05). Shrimp grew to 10.3 to 12.3 g in 75 days. The highest yield of shrimp was obtained from the treatment with shrimp fed to satiation and tilapia with supplementary feeding, which was significantly higher than those in treatments with shrimp fed at controlled feeding level and shrimp monoculture (P<0.05), but similar to that in the treatment with shrimp fed to satiation and tilapia without supplementary feeding. Feeding tilapia significantly reduced shrimp FCR (P<0.05), while feeding shrimp at different levels did not significantly affect shrimp FCR. Tilapia growth was very much similar among all treatments except for tilapia in the treatment with shrimp fed at controlled feeding level and tilapia without supplementary feeding, which had a slightly lower growth rate. Most water quality parameters in treatments were similar while control tanks had higher total nitrogen and total phosphorous than others. Shrimp and tilapia together in polyculture recovered much more N and P from feed than shrimp in control. Polyculture with shrimp under satiation feeding and tilapia with supplementary feeding performed the best in terms of profitability. The experiment concluded that production and economic performance of intensive shrimp-tilapia polyculture can be improved through feeding manipulation. Supplementary feeding to tilapia in the system could significantly increase overall production, reduce shrimp FCR, and produce higher net income with less waste nutrient discharge than shrimp monoculture.









Introduc)on

- To adapt to this emerging challenges, culture technology/systems need to be continuously improved:
 - > to increase system productivity and waste assimilating capacity,
 - > to transfer the excessive nutrients in culture systems into harvestable aquatic products,
 - > to avoid uncontrolled effluent discharge, and
 - ➤ to increase economic viability in a dynamic and competitive international environment.

•3/10/10

Introduc)on

> Shrimp polyculture with tilapia as a system alternative to intensive monoculture has been investigated by various researchers.

Introduc)on

- > It has been generally recognized that:
 - ➤ tilapia in such an intensive polyculture system assists shrimp performance by improving and stabilizing the water quality through foraging and cleaning the pond bottom;
 - shrimp in such an intensive polyculture system have similar or improved survival rates and FCR to those in monoculture; and
 - > economic performance could be improved with tilapia as an extra crop.

•3/10/10

Introduc)on

- Research by Yuan etc. (2010) tried to identify the optimal tilapia stocking density in prevailing intensive white shrimp culture system under a restricted feeding regime. It was found that:
 - Red tilapia stocked at 0.4 fish m⁻² and 13.7 g improved productivity, profitability, nutrient utilization and environmental friendliness in comparison with shrimp monoculture;
 - Red tilapia could be stocked at higher density and larger size up to 1.2 fish m⁻² and 42 g respectively to greatly reduce waste nutrient accumulation in culture water without affecting shrimp survival, but economic performance could be negatively affected due to reduced shrimp production.
 - Feed competition was suspected to be the major reason for reduced shrimp growth.

3/10/10

Introduc)on

- The further question askedwas:
 - If the feed competition can be alleviated through feed manipulation, whether can tilapia production be increased while shrimp production is not affected?
- An experiment was therefore conducted in 2006 in Asian Institute of Technology in Thailand:
 - to assess the effects of different feeding methods for intensive polyculture of shrimp (*Litopenaeus vannamei*) and tilapia (*Oreochromis spp.*) on shrimp growth, water quality and overall production performances.

•3/10/10

MATERIALS AND METHODS

- Site: the Asian Institute of Technology, Thailand
- Cement tanks (2.5 x 2 x 1.3 m)
- Water: 20 ppt, 1 m deep, weekly add-up.
- Aeration: 9 spherical airstones in each tank suspended 10 cm above tank bottoms. Aeration was supported by a 2 HP air blower.



MATERIALS AND METHODS

- L. Vannamei post-larvae: 0.03 g, 60 pcs m⁻².
- Red tilapia fingerlings: average at 47.5 g, stocked into the shrimp tanks four weeks later at the density of 0.8 fish m-2.
- 2x2 factorial design with shrimp monoculture as control:
 - Factor 1: shrimp feeding satiation or restricted with commercial shrimp pellets of different sizes, three times daily.
 - Factor 2: tilapia with or without supplementary feeding with tilapia commercial pellets, one time daily in early morning, half hour before feeding shrimp.

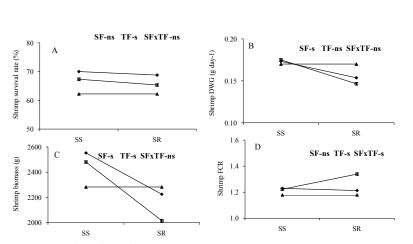
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RESULTS: Shrimp growth performances

	mp feeding	Satiation	Satiation	Restricted	Restricted	
Performances	ipia feeding	with	without	with	without	Control
STOCKING						
Biomas	s (g tank-1)	9.00	9.00	9.00	9.00	9.00
Number (shri	imp tank-1)	300	300	300	300	300
Density (sh	nrimp m-2)	60	60	60	60	60
Mean weight (g	g shrimp ⁻¹)	0.03	0.03	0.03	0.03	0.03
HARVESTING						
Number (shri	imp tank-1)	210±3.21a	202±2.08a	206.33±1.76a	196±1.73ab	186.67±2.73
Biomas	s (g tank-1)	2,553±57.29a	2,480.67±22.81ª	2,225.33±40.96ab	20,16±31.77b	2,283±10.02
Mean weight (g shrimp-1)	12.15±0.11a	12.28±0.16a	11.09±0.06ab	10.28±0.07b	12.23±0.15
GROWTH PERFOR	MANCES					
	veight gain mp-1day-1)	0.17±0a	0.18±0ª	0.16±0ab	0.15±0 ^b	0.17±0a
Surviv	ral rate (%)	70±1.07a	67.33±0.69a	68.78±0.59a	65.33±0.58ab	62.22±0.91
	FCR	1.23±0.01b	1.30±0.02a	1.21±0.01bc	1.34±0.02a	1.18±0.04
•3/10/10						• 12

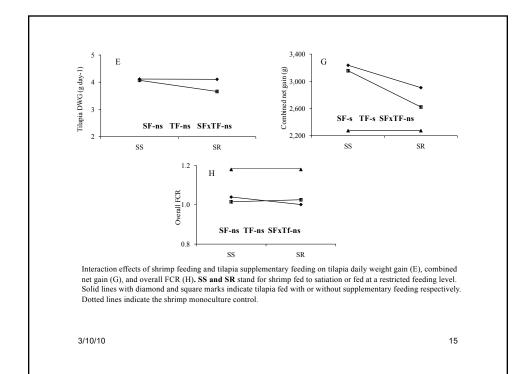
RESULTS: Growth	performances	of 7lania	and c	ombined

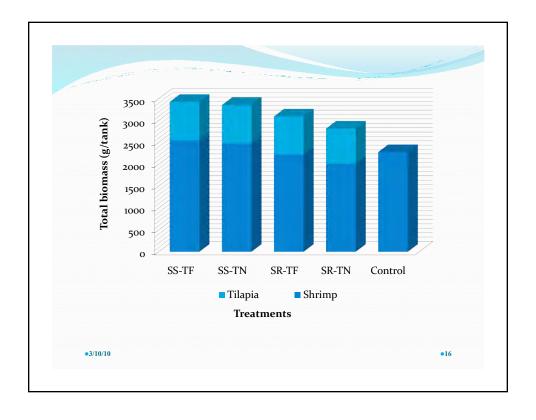
	Shrimp feeding	Satiation	Satiation	Restricted	Restricted	
Performances	Tilapia feeding	with	without	with	without	Control
Stocking		with	without	with	Without	Control
	omass (g tank-1)	100 (5.10)	105 55 10 01	100.55.01		
		188.67±4.26 4	195.67±10.81	183.67±2.4 4	191.33±3.53	
	iber (fish tank-1)	•	· ·	· ·	•	
D	ensity (fish m ⁻²)	0.8	0.8	0.8	0.8	
Mean	weight (g fish1)	47.17±1.06	48.92±2.7	45.92±0.6	47.83±0.88	
Harvesting						
Numl	ber (fish. tank-1)	4	4	4	4	
Bio	omass (g tank-1)	880.33±7.8a	879.33±10.48a	873.67±9.82a	806.33±40.25b	
Mean	weight (g fish-1)	220.08±1.95a	219.83±2.62a	218.42±2.46a	201.58±10.06b	
Growth performa	nces					
Da	aily weight gain					
	(g fish-1day-1)	4.12±0.03a	4.07±0.05a	4.11±0.06a	3.66 ± 0.22^{b}	
COMBINED						
Total bio	mass (g tank-1)	3433.33±64.42a	3360±19.43a	3162.33±20.25a	2822.33±52.1b	2283±10.02
Total net	gain (g tank-1)	3235.67±62.6a	3155.33±28.66a	2906.33±49.45a	2622±48.57b	2274±10.02
	FCR	1.04±0.01b	1.01±0.02b	1.00±0.02b	1.03±0.02b	1.18±0.04a
•3/10/10						•13



Interaction effects of shrimp feeding and tilapia supplementary feeding on shrimp survival rate (A), shrimp daily weight gain (B), shrimp biomass at harvest (C), shrimp FCR (D). **SS and SR** stand for shrimp fed to satiation or fed at a restricted feeding level. Solid lines with diamond and square marks indicate tilapia fed with or without supplementary feeding respectively. Dotted lines indicate the shrimp monoculture control.

3/10/10 14





Overall values of water quality parameters in polyculture treatments measured during the experiment in comparisons with monoculture control.

Shrimp feeding Tilapia feeding	Satiation	Satiation	Restricted	Restricted	
Parameters	with	without	with	without	Control
DO (mg L-1) at dawn	6.00°	6.04bc	6.08ab	6.10ab	6.12a
pH	7.75	7.76	7.75	7.74	7.76
Temp. (°C) at dawn	28.6	28.5	28.5	28.6	28.5
Alkalinity (mg L-1)	109.6	110.7	111.8	108.2	108.3
TAN (mg L-1)	0.32ab	0.31ab	0.33ab	0.31b	0.40a
NO ₃ -N (mg L ⁻¹)	0.22	0.19	0.20	0.18	0.18
NO_2 -N (mg L ⁻¹)	0.05	0.04	0.04	0.04	0.05
TKN (mg L-1)	9.31a	8.32 ^b	7.95bc	7.38 ^{cd}	9.70a
TP (mg L-1)	1.54ab	1.43bcd	1.47bc	1.45bc	1.63a
Chlorophyll a (µg L-1)	147.2ab	138.8 ^b	125.6 ^b	137.2 ^b	164.0a
TSS (mg L-1)	86.5ab	83.3ab	84.6ab	81.0 ^b	89.4a
TVSS (mg L-1)	65.3ab	62.7ab	63.9ab	61.9b	68.6a

•3/10/10 •17

Economic performances

	Shrimp feeding					
	Tilapia feeding	Satiation	Satiation	Restricted	Restricted	_
Parameters	,	with	without	with	without	Control
Revenue						
Shrimp		6.38±0.14a	6.2±0.06a	5.56±0.1ab	5.04±0.08b	5.71±0.03a
Tilapia		0.53±0	0.53±0.01	0.52±0.01	0.48±0.02	0±0
	Total revenue	6.91±0.15a	6.73±0.05a	6.09±0.11ab	5.52±0.08b	5.71±0.03ª
Operation Cost						
Shrimp postlary	vae	0.38±0	0.38±0	0.38±0	0.38±0	0.38±0
Tilapia fingerlir	ngs	0.4±0	0.4±0	0.4±0	0.4±0	0
Feeds		2.6±0.07a	2.56 ± 0.05^{a}	2.24±0b	2.15±0°	2.14±0.08
Electricity		0.4±0	0.4±0	0.4±0	0.4±0	0.4±0
Cost of working	capital	0.3±0.01	0.3±0	0.27±0	0.27±0	0.23±0.01
	Total Cost	4.08 ± 0.07^{a}	4.04 ± 0.05^{a}	3.69 ± 0^{b}	3.59±0°	3.15±0.08
Gross margin (/ta	nnk)	2.83±0.08a	2.69±0.05a	2.4±0.11ab	1.93±0.08b	2.55±0.09

•3/10/10 •18

RESULTS - N Recovery

	Shrimp feeding Tilapia feeding	Satiation	Satiation	Restricted	Restricted	_
Parameters	Thapia recuing	with	without	with	without	Control
Total N input (g)		202.07a	197.03ª	174.64 ^b	165.99°	161.07°
Recovered by:						
Shrimp (g)		67.14a	65.24ab	58.53bc	53.02°	60.04abc
(%)		33.23ab	33.12ab	33.51ab	31.94b	37.37a
Fish (g)		21.13	21.10	20.970	19.35	
(%)		10.47	10.72	12.01	11.66	
Total recovery:						
Amount (g)		88.27a	86.35a	79.49b	72.37°	60.04 ^d
(%)		43.70a	43.85a	45.52a	43.60a	37.37 ^b

•3/10/10

RESULTS - PRecovery

	Shrimp feeding Tilapia feeding	Satiation	Satiation	Restricted	Restricted	_
Parameters		with	without	with	without	Control
Total P input (g)		50.46a	48.51a	43.66ab	40.81b	39.97b
Recovered by:						
Shrimp (g)		5.62a	5.46ab	4.90bc	4.44c	5.02b
(%)		11.13ab	11.25ab	11.21ab	10.87b	12.60a
Fish (g)		3.52	3.52	3.49	3.23	
(%)		6.99	7.26	8.01	7.90	
Total recovery:						
Amount (g)		9.14a	8.97a	8.39a	7.66 ^b	5.02°
(%)		18.12a	18.51a	19.22a	18.77a	12.6b

CONCLUSIONS

- Tilapia in an intensive shrimp tilapia polyculture system had an competitive advantage for food over shrimp. Under restricted feeding condition, tilapia growth seemed less to be affected, while shrimp production and consequently the profit could be significantly reduced.
- Under such a limited feeding condition, supplementary feeding to tilapia, significantly reduced food competition, and sustained a shrimp production comparable to that of monoculture control, so the economic profitability.
- ➤ Under unrestricted feed supply to shrimp, polyculture system maintained a similar or better growth of shrimp, and economic return than monoculture.

•3/10/10

CONCLUSIONS

- Combination of shrimp satiation feeding and tilapia supplementary feeding produced best economic performance.
- All polyculture recovered much higher portion of N and P inputs than monoculture, significantly improved total productivity. They were much more ecologically efficiency and environmentally friendly.



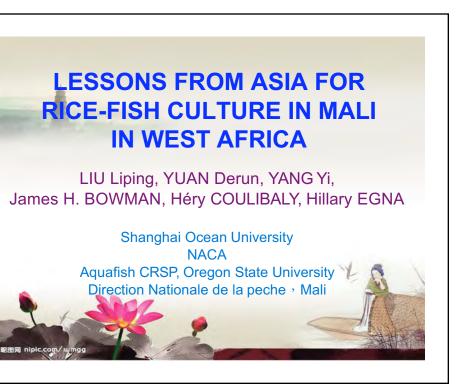


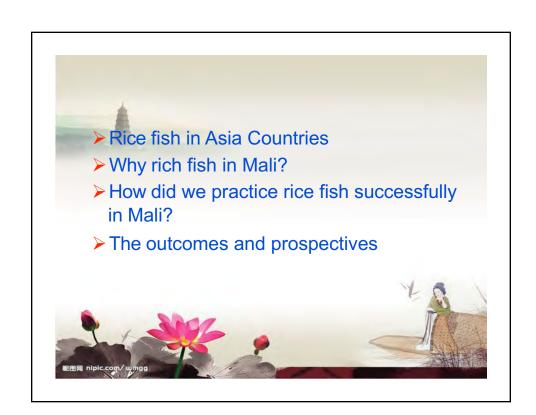
LESSONS FROM ASIA FOR RICE-FISH CULTURE IN MALI IN WEST AFRICA

Liu Liping*, Yuan Derun, James H. Bowman, Yang Yi, Héry Coulibaly, Hillary Egna College of Fisheries and Life Science, Shanghai Ocean University, Shanghai, 201306, China Tel:+86-21-61900411, E-mail: lp-liu@shou.edu.cn

As a traditional technology, integration of fish with rice has great economic, ecological and social benefits. During the past decades, rice-fish culture has been widely encouraged and developed in Asia to increase small-scale farmers' incomes and protect food safety. Cyprinus carpio, Oreochromis niloticus, Barbodes gonionotus, Carassius auratus, Tilapia nilotica etc. are major species cultured in rice field. There is tradition for rice culture and fish culture in Mali, but lack of technical expertise, readily adoptable technology, and extension efforts hindered the two food production sectors from much needed development. Rice-fish culture was recommended by several development agencies as one of the major technological renovations to be adopted in Mali. With the successful implementation of a training course on rice-fish culture for two aquatic engineers from Mali at Shanghai Ocean University in 2008 and demonstration site set-up in June 2009 at Baguineda near Bamako in Mali, monoculture of tilapia and catfish together with polyculture of tilapia and catfish are practiced. The fish is supposed to be harvested in November 2009. Based on preliminary observations, aquatic weeds and harmful insects are controlled, which led to increased enthusiasm of rice production and increased income of the local farmers together with conserved soil and water, therefore opened the frontier for intensification of rice production in lowlands of Mali.

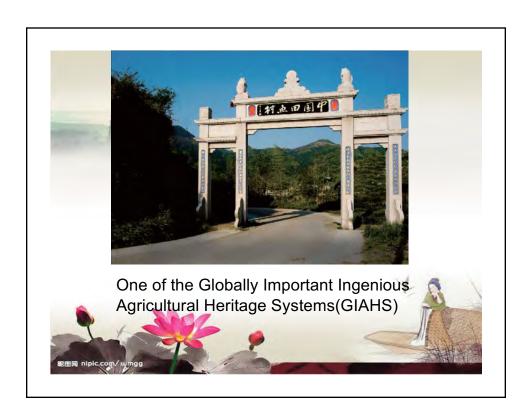
This study was sponsored by the Aquaculture and Fisheries Collaborative Research Support Program of USAID No. 688-A-00-07-00044-00 entitled "Aquatic Resource Use and Conservation for Sustainable Freshwater Aquaculture and Fisheries in Mali".















 During the past decades, rice-fish culture has been widely encouraged and developed in Asia to increase small-scale farmers' incomes and protect food safety.

 The mostly cultured species include carps, tilapia, prawns and crabs.



Why rice fish in Mali?

- Good irrigation systems and excellent water quality
- High fish prices and shortage of fish supply (Tilapia: 1200 CFA, \$ 2.6 per Kg)
- Abundant labors and relatively low wages
- New technology for Malia
- Special benefits of rice F





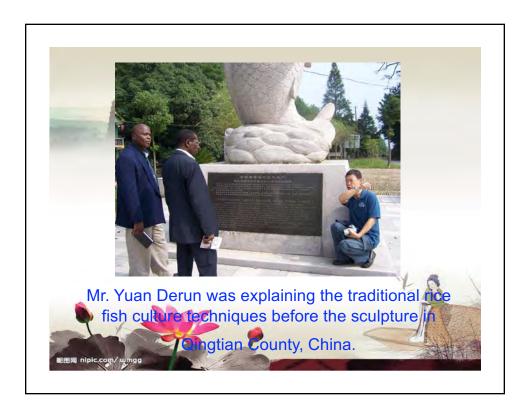


















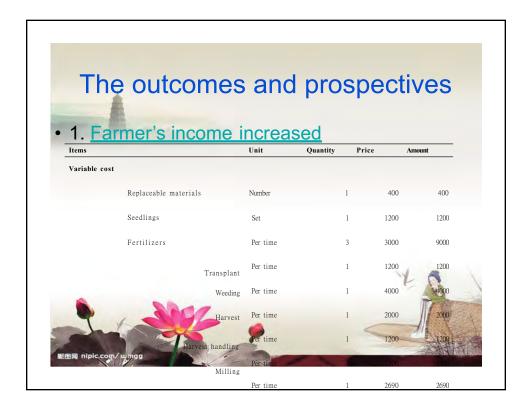






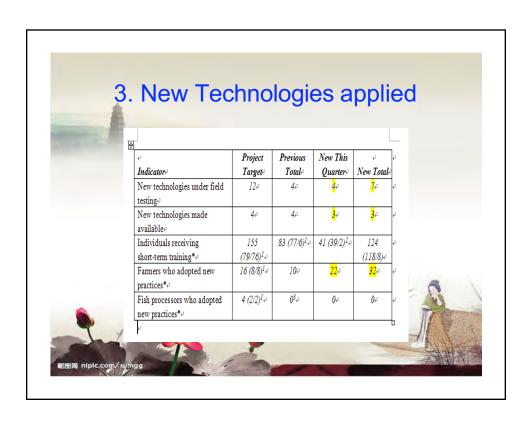
Step 3 Appropriate Post-harvest Technology and BAP training

- A two-day stakeholder workshop on Appropriate Post-harvest Technology was organized.
- The second five days' workshop built training and extension capacity for government extension officers, university teachers and other development workers on rice fish culture techniques.

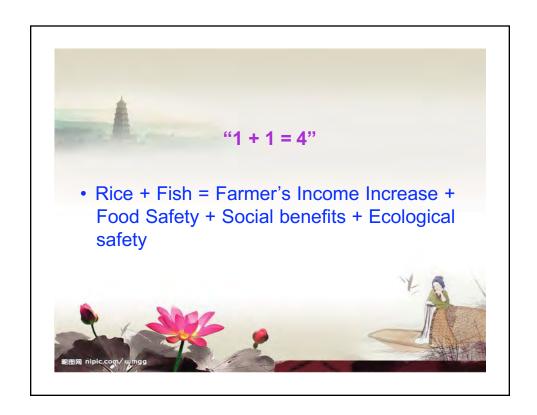
















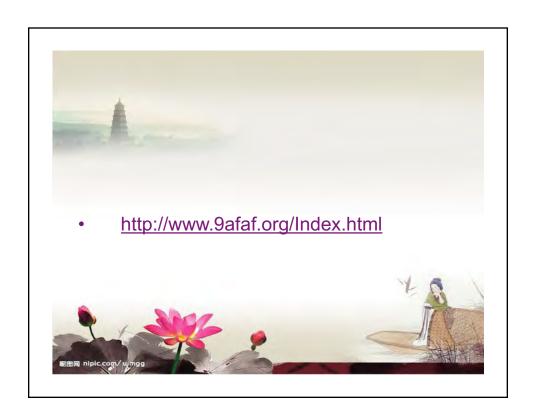


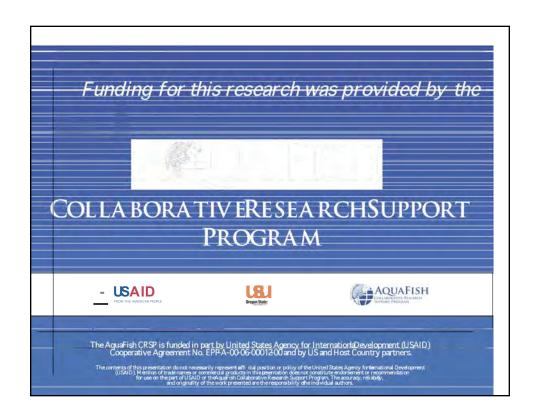


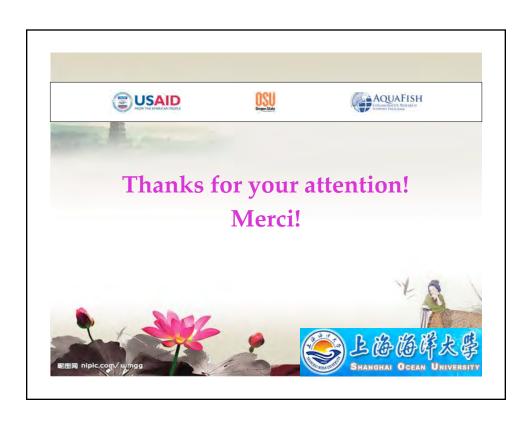












EFFICIENT POND DESIGN STRATEGIES FOR A VARIETY OF ENVIRONMENTS

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Sustainable Aquaculture in Africa depends on good pond design, construction and management Pond should be designed in such a manner as to ensure maximum fish production. Although methods of pond design and construction are based on technologies that are thousand years old it is only in the recent past that new technologies have refined their design. Proper pond design brings numerous benefits such as larger fish, less sediments, clearer water, greatly reduced maintenance expenses and a much more natural environment as well as greater property value. In Africa fish ponds range from fairly small and simple inexpensive dug-outs to more complex and expensive designs. These ponds vary in size but on average famers have ponds ranging from 50 to 1000 m². Environmental and topography varies from region to region and has a primary influence on pond size and design. A properly designed and constructed pond will be easy to manage and will last longer, saving extra work and bringing greater profit.

Efficient pond design strategies for a variety of Environments

Charles C. Ngugi
Kenyatta University, Nairobi, Kenya
and
Kwamena Quagrainie
Purdue University

Optimizing Small scale Aquaculutre for the poor: In honor of Dr. Yang Yi

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Pond construction strategies

- Sustainable Aquaculture in Africa depends on good pond design, construction and management.
- Pond should be designed in such a manner as to ensure maximum fish production.



Pond sizes and construction strategies

- In Africa fish ponds range from fairly small and simple inexpensive dug-outs to more complex and expensive designs.
- These ponds vary in size but on average famers have ponds ranging from 50 to 1000m².

Questions we ask!

- How many fish to stock in a pond?
- What is the surface area of your pond?
- What kind of fish do you want to produce?
- How do you intend to manage the pond;
 Kind of feed and kind of fertilizer to use
- What size do you want to harvest?
- Expected water temperature in your pond?

Examples of stocking levels

Type of Fish	Size	Stocking
Tilapia mixed sex	20-50g	1-2 fish/m2
Tilapia mono sex	20-50g	1-2 fish/m ²
Tilapia fry	1- 4g	10 fish/m2
Catfish Fingerling	5g	2-5 fish /m2
Catfish fry Tank	1-4g	50-150fry/L
Catfish fry Hapa	1-4g	100fry/L

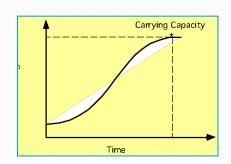
Different management levels

Management you intend	Expected capacity	Number of fish to stock per square meter pond surface			
to practice (See sheets on feeding and fertilizing to find recommended rates).	(kg per 100m ²)	square 150 g	meter po	ond surfa	400g
Composting, grasses and small amounts of manure.	15 kg	1	0.75	0.5	0.38
2. Chemical fertilizers at maximum recommended rate.	25 kg	1.7	1.25	0.83	0.6
3. Manure and feed such as bran.	40 kg	2.7	2	1.3	1
4. Our best management practice: bran at ½ recommended rate plus chemical fertilizer at full-recommended rate.	70 kg total 60 of tiliapa; 10 of Clarias	4.7	3.5	2.3	1.75
5. Pelleted feed at ³ / ₄ ration plus fertilizer to bring total N and P to full recommended rate.	Estimated at 120 kg	8	6	4	3

Fish Production limited by static pond culture limits Consumption (selected countries)

Country	Population (Million)	Fish Production (MT)	Aquaculture (MT)	Fish Per Capita (Kg)
Ethiopia	85	15,000	0.5	2.3
Kenya	40	120,000	4.5	4.7
Rwanda	10	7,800	0.4	2.5
Uganda	33	345,000	7.0	10.0
Tanzania	42	350,000	1.5	8.0

Carrying capacity: the biomass at which production stops; is a function of species, management practice, and environment (ponds have a limit)











Challenges with scarce Resources such as Finance, Land, water, good soil, Climate etc

And how we use available resources!





Proper pond design brings numerous benefits such as larger fish, less sediments, clearer water, greatly reduced maintenance expenses and a much more natural environment as well as greater property value.









Environmental and topography varies from region to region and has a primary influence on pond size and design.







Ponds with different shapes, sizes, as well as slopes depend on environment





Cost Benefit analysis

- Cost of moving one m² soil is US\$ 1.0-1.6 (Kshs 80-120).
- A 300 m² takes 140 man days
- Production per unit now stands at 0.5 Kg fish/m²

















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AQUACULTURE POND CONSTRUCTION GUIDELINES FOR SUSTAINABLE MICROWATERSHED DEVELOPMENT IN UGANDA

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Uganda fisheries sector was in the past only dominated by fish catch from the abundant natural resources (lakes, rivers/streams, wetlands and swamps). The catch fish option is being eroded due to wrong practices of unsustainable fishing. At the same time, a study conducted by the Uganda Fish Processors and Exporters Association (UFPEA) to determine the size and breadth of the local and regional market for farmed fish, revealed a very large market throughout Uganda and regionally. There is also a growing international market especially in the USA and Europe. Consequently, fish farming is currently being sought as household income generating activity and source of proteins. The challenges to the small-scale fish farming are proper pond siting, construction, water management and waste disposal. Many of the ponds are just dug in swampy/wetland areas or micro-watershed concentrated storm runoff areas without proper consideration of guidelines. By reviewing of existing screening tools and prerequisites like preliminary investigations to ascertain minimum water loss through seepage, evaporation, water contamination, sedimentation, our team is developing guidelines on siting ponds to ensure reliable water supply and sustainable ecological existence within the micro-watershed. The construction methods used in Uganda have been reviewed to include manual labor, simple manual machines and earth moving equipment. The effects of construction methods on pond bottom surface compaction and sealing have been examined, with resulting water loss quantification. Recommendations are being drawn with economic consideration as well as water conservation on the appropriate construction method for small-scale fish farmers within a microcatchment. Proper positioning of inlet and outlet are considered and discussed in relation to water management and sustainability.

AQUACULTURE POND CONSTRUCTION GUIDELINES FOR SUSTAINABLE MICROWATERSHED DEVELOPMENT IN UGANDA

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Abstract

Uganda fish farming is currently being sought as a household incomegenerating activity and source of proteins. The water related challenges to small-scale fish farming are proper pond siting, construction, water management and waste disposal. Many of the ponds are just dug in swampy/ wetland areas or micro-watershed concentrated storm runoff areas without proper consideration of guidelines. By reviewing of existing screening tools and prerequisites like preliminary investigations to ascertain minimum water loss through seepage, evaporation, water contamination and sedimentation, guidelines are being developed on siting ponds to ensure reliable water supply and sustainable ecological existence within the micro-watershed. Construction methods have been reviewed to include manual labor, simple manual machines and earth moving equipment. The effects of construction methods on pond bottom surface compaction and sealing are being examined, with resulting water loss quantification. Recommendations will be drawn with economic consideration as well as water conservation on the appropriate construction method for small-scale fish farmers within a micro- catchment. Proper positioning of inlet and outlet are considered and discussed in relation to water management and sustainability.

Introduction

- Overall inadequate or poor reservoir planning and siting of most water harvesting structures for irrigation, livestock watering and aquaculture.
- Most existing water harvesting structures are at different levels of deterioration in terms of their capacity and water quality.
- Most areas in Uganda receive over 1,100mm of annual rainfall and about 18% of the country's surface area is covered with fresh waters in lakes, rivers/streams, swamps and wetlands.
- With proper planning development of water resources, there is sufficient water for agricultural production.

• Water requirement relative rating amongst the five most important factors to commercial fish farming development and operation was about 25% to 27% while for small scale fish farming, it was rated to be of over 51% (Kapetsky and Nath, 1997).

Fisheries sector situa-on in Uganda

- There is continuous depletion of fish in lakes and rivers, which for a long time have been supplying fish internationally and nationally.
- There is also continued decline of fish quality from the water bodies due to poor quality of recharge water.
- International markets like EU have almost taken most of the caught fish, leaving the local demand unsatisfied.
- Fish farming produces fish of very good quality.
- Fish farming is considered as the only option of increasing good quality fish on the local markets.

Uganda Fish ponds

- Most fish ponds are just dug holes in the ground and not constructed.
- Most fish ponds in Uganda suffer from constraints related to:
 - Non leveling
 - Non removal of debris
 - Non compaction
 - Improper slopes
 - Inappropriate locations of inlets and outlets.

Non Leveling

- Difficulty in pond filling and draining.
- Inlet and/or outlet could be under water,
- Poor oxygen circulation because of lack of an appropriate freeboard between the inlet and the water surface.
- Poor water levels: high freeboard and shallow pond water.
- Improper pond nutrient recirculation and waste management.



Non removal of debris

- These rot and can cause settlement of some parts of the water structure resulting into cracks and passages that are potential fish escape and predator curtailer routes.
- Loss of pond water through the passages left behind by rotted debris.
- Need for frequent pond filling.
- Poor water quality management.

Non compac-on

- High water losses through high seepage.
- Collapse/failure of some parts of the structure.
- Potential leakage of pond nutrients & wastes into ground water and possibility of salinity condition of pond soils.
- Improper pond sizing.

Improper slopes

- Potential for flooding of the pond due to non intercepted surface runoff.
- Bank undercutting and caving resulting in enlarged and irregular shaped ponds.

Pond siting

Soil parameters & fish pond suitability (Kapetsky and Nath, 1997)

Soil and terrain		Suitable to moderately	
property	Very suitable	suitable	Unsuitable
Slope (%)	0-2	2-8	>8
Effec:ve soil depth			
(cm)	> 150	75 - 150	<75
Gravel and stones (%)	<40	40 - 80	>80
			Sandy, or clayey with
	Loamy or clayey without swell-shrink &		swell-shrink, or
Soil texture	not organic		organic
Salinity (dS/m)	<4	4-8	>8
pH (H2O; 1:5) fer:lity	7.2 - 8.5	5.5 - 7.2	>8.5
Catclays (sulphate			
toxic, very acidic)	Not present	Not present	Present
Gypsum	Not present	Not present	Present

Addi-onal points to consider

- Locate ponds at area of minimum levee earth fill but with large storage volume.
- Locate ponds in accessible areas.
- Avoid areas of drainage from farmsteads, feedlots, sewage lines, mine dumps and industrial effluent channels that may pollute the pond water.
- In case of dam water supply, consider the possibility of structure failure and sudden overflowing of water.
- Areas of good land scaping (visibility & compatibility with surrounding landscape).



Pond construction methods

- (I) Embankment (Levee) ponds
- (II) Excavated ponds.

Method depends on the available water source and how pond system inlet is positioned:

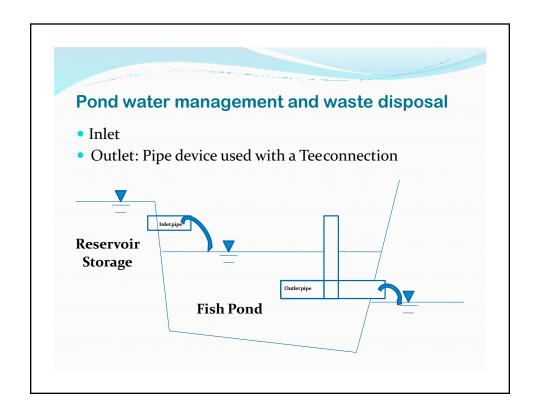
- Harvested water may require a levee to create storage reservoir.
- Diverted stream and wetland water may just require an excavation.

- Earth movers (used):
 - Bulldozers US\$20,000 -30,000
 - Loaders > US\$ 8,000
 - Excavators US\$23,000 30,000
 - Construction per 1,000m² cost is US\$1,250 for 2 days
 - Viable beyond 1000 m².
- Manual labour:
 - Cost is UG Shs. 3,000-4,000 (US\$1.5-2) per m²
 - 35 40 man-days for 100 m²
 - Shovel/spade
 - Wheel barrow
 - Hoe
- Tractor
 - Cost is UG Shs??
 - Disc plough
 - Bucket scoop
 - Scraper & roller



Impact of construction methods on pond bottom surface compaction and sealing

- Compaction and sealing measurements for newly constructed pond will be determined initially.
- Corresponding seepage for the three construction methods will be quantified.
- They will be monitored for trend analyses.
- Possible seepage loss minimization methods determined for different construction methods.



Micro-watershed management & Water quality

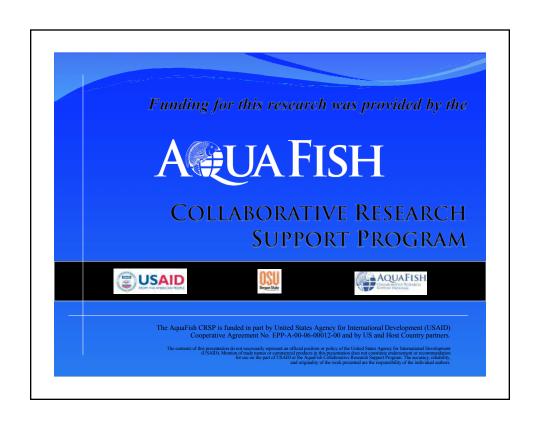
- Interceptor drains to intercept surface runoff from flooding the pond system (MWM).
- Soil and water conservation measures (MWM).
- Filtration of pond inflow water (WQ).
- Draining, de-silting and waste disposal from the pond (WQ)
- Aeration of the pond water (WQ)

Screening tools and prerequisites for preliminary investigations

- Soil-Plant-Atmosphere-Water (SPAW) model (Saxton, 2002)
 - For pond & hydroly analyses
 - For pond simulation
- Spreadsheet screening tool (Tollner, et al., 2004)
 - For site selection from a group of potential sites

Conclusion

- SPAW Model and spread sheet screening tool evaluation using Uganda data will enable identification and development of recommendations for model modifications.
- Modified models will be suitable for multi-purpose water reservoir planning and management of microwatersheds for such reservoirs.
- Guidelines for pond construction in Uganda will be developed for small-scale fish farming.



PROSPECTS OF AQUACULTURE ENTERPRISES IN POVERTY REDUCTION IN UGANDA

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Until recently, most fish farmers in Uganda were poor people in villages who practiced aquaculture for subsistence with ponds of usually less than 500 mC constructed using family labor. These were low or no input production systems, with little or no need for routine management. Those who had some training in the management of ponds usually fertilized their ponds with either chicken droppings or cow dung and any other organic house waste. However, with rising market prices for fish brought about by dwindling supply from capture fish, an excellent opportunity has presented itself for fish farmers to cash in and improve their livelihoods. This paper presents preliminary results of a wider study on "Market Assessment and Profitability Analysis of Aquaculture Enterprises in Uganda". The main objective is to highlight the poverty reduction potential of aquaculture by outlining appropriate policy and institutional environment under which aquaculture can flourish and be more effectively integrated with the poverty reduction and economic growth strategy of the country. To this end, a thorough examination is undertaken of the aquaculture subsector in Uganda along with the important backward and forward linkages and the associated stakeholder activities. Based on these, the paper suggests viable frameworks of interagency (public and private sector) collaboration that would support the promotion of a pro-poor dynamic agribusiness focused aquaculture in Uganda.

PROSPECTS OF AQUACULTURE ENTERPRISES IN POVERTY REDUCTION IN UGANDA

BY

*Ass. Prof. Makerere University ** Ass. Prof. Alabama University A&M

INTRODUCTION

- Close to 1.2 million people are employed in the fisheries subsector as farmers, fish harvesters, boat builders and fish mongers.
- Between 2003 and 2007, the sector contributed on average 14.5% and 23.4% to total and non-traditional value exports, respectively (UBOS, 2008).
- Whereas fish contributes 50% of animal protein intake of the average Ugandan which translates into 10kg per capita per annum.

Introduc1on cont'

- 80% of Ugandans suffer from some form of "malnutrition" and this is linked to limited fish consumption(Kellen, 2006).
- Uganda is rich in aquatic resources with 18% of its surface covered by lakes, rivers and swamps of the 241,038 km sq total area.
- The country has a potential of producing 250,000 metric tonnes annually.

Introduc1on cont.

- However, studies carried out in the country have indicated that this potential is being eroded due to overfishing partly due to treating it as an open access resource(Jagger and Pender, 2001).
- Given a potential role fish can play in the economy, it is imperative that means and ways be found to boost its supply thus aquaculture comes in handy to feel this gap.

Introduc1on cont'

- Aquaculture accounts for 50% of the world's food fish in the world (FAO, 2006) and it is an expanding sector.
- It is estimated that 40 million tonnes of aquatic food will be required by 2030 to maintain the current per capita consumption.
- Aquaculture contributes a modest 6% to fish supply in Uganda and it is in its infancy.

Objectives of the Paper

- To present a review of the aquaculture subsector with the view to highlighting the poverty reduction potential of aquaculture.
- The sub objective is to outline appropriate policy and institutional environment under which aquaculture can flourish and be more effectively integrated with poverty reduction and growth strategy of the country.
- The review is based on existing studies

Aquaculture sub sector: an overview

- Aquaculture may be defined as farming for fish and other aquatic organisms (Edwards, 2000).
- Aquaculture was introduced in Uganda as a non traditional farm technology in 1931, but only set up at Kajjansi experiment station in 1953 (Isyagi, 2007).

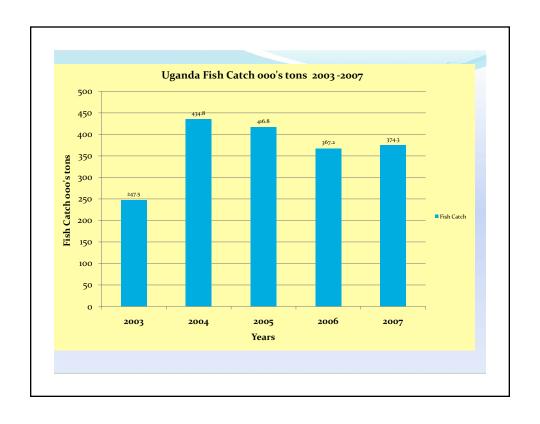
Aquaculture sub sector: an overview

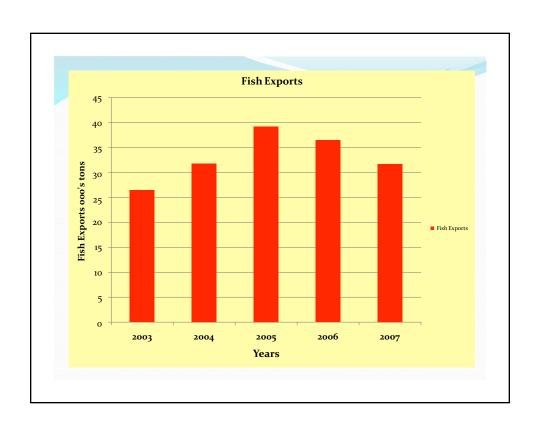
- Fish farming was quite successful at the beginning with over 5,000 ponds constructed through out the country (Jagger and Pender, 2001) and peaked in at approximately 11,000 ponds.
- Like all other sectors, aquaculture went into steep decline in the turbulent years of political turmoil in the country experienced in 1980,s.
- Number of functional ponds and quantity of seed supplied dropped. Regional fish fry centers closed down.

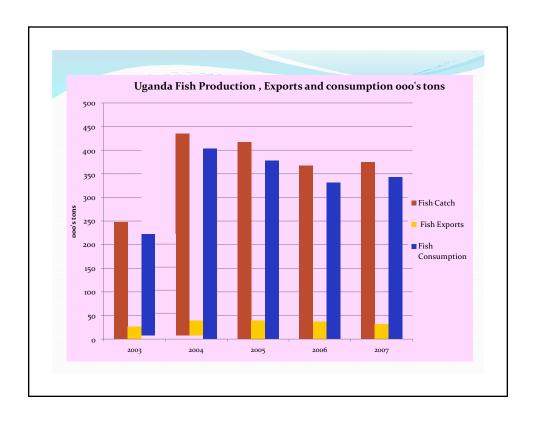
- The 1990's saw renewed activities in research at Kajjansi Research station-an institution mandated to carry out research on fish (Pamela and Jagger ,2001).
- However, these activities have had limited impact due to many constraints as will be shown below

Trends in fisheries produc1on

- Figures 1-3 show fisheries production, exports and consumption trends in Uganda.
- Uganda fish catch has fluctuated downwards.
- Uganda exports close to a third of its fish catchand the rest is consumed at home.







Trends cont'

- The production and exports show that aquaculture has a big potential to contribute to Government revenue, foreign exchange and improving nutritional status of the population.
- This can happen if the policy environment and regulations are favorable. The next section outlines some of the policies that have direct effect on aquaculture sector. Some of them include: Fish policy, PMA, PEAP, Fish Act.

Policy ENVIRONMENT

- Aquaculture has clearly been recognized as an alternative to addressing the diminishing capture fish.
- The fish policy is in place. Overall goal is to ensure increased and sustainable fish production and utilization by properly managing capture fisheries, promoting aquaculture and reducing post harvest losses(MAIIF, 2004).
- It has 13 key objectives and objective 9 states:
 Aquaculture fish will be promoted to reduce the gap between fish supply and increasing demand for food fish

Other supporting Policies and regulations

- PMA and PEAP- spell out how poverty eradication can be tackled through commercialization of agriculture by exploiting key resources sustainably ,water inclusive.
- Thus, integrating aquaculture into "traditional" agriculture and achieving the set targets.
- The Decentralization policy was to empower the rural people to manage resources for their own benefits as suggested by (Bahigwa et al., 2003).

Current regula 1 ons

- The fish Act (1964)-especially rule 2003 regulates aquaculture practices.
- The National Agriculture Research Systems Act (2005) regulates conduct of the key players in aquaculture subsector. Aimed at allowing other players to participate in research activities, other than Kajjansi.
- The Land Act(1995) spells out different forms of ownership and legal rights as regards access to land and use.

Possibili1es of for fish farming to reduce poverty

- Results from farm trials carried out in the districts of Ntungamo, Lira, Mbarara, and Rakai on Nile Tilapia showed that with quality seed and proper management of fish ponds, yields can increase by 40%(from 12kg/100m²- 20kg/100m²/year) (Mbahinzireki and Masaba, 2003).
- Also important in yield increase, the study noted, were temperatures. In Lira where temperatures go as high as 30° C, yields were 2.1t/ha/yr compared to 1.5t/ha/yr in the West where temperatures rarely go above 25°C.

- A study by KARD (1999-2000) show that aquaculture helped the poorest most, those earning less than 500,000(equivalent US \$ 250) per annum.
- 33% of aqua fish harvested from ponds is eaten at home and 53% is sold.
- There is also high demand for aquaculture products driven by population increase, nutritional concerns both domestically and external markets and change in tastes.
- The high demand presents excellent opportunities for those involved in production to expand their operations including poor people.

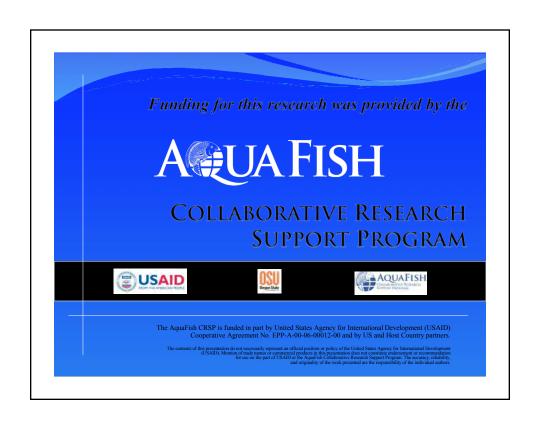
- Unlike crop production, aquaculture products can be tailored to markets by harvesting when required only. Thus helping to regulate the income receipts of the poor.
- There is high possibility of integrating aquaculture production with other crops such as rice, especially for resource poor households.
- The cage culture which has not taken hold in Uganda can also help those with land scarcity.

Constraints in the Subsector

- The subsector faces a number of constraints: These are:
- lack of quality feeds,
- Inadequate extension services,
- Inappropriate management skills possessed by farmers,
- Poor record keeping.

CONCLUDING THOUGHTS

- Analysis of aquaculture subsector has shown that it has prospects to contributing eradication of poverty, but this will happen if a number of issues are addressed.
- The key issue of quality feeds need urgent attention by the concerned. These have direct effect, not only quantity, but cost of production and profitability of the enterprise.
- More work is required by fish scientists to gage how fish farming can be integrated in existing farming systems.



SOURCES AND USES OF MICRO-CREDIT IN POVERTY ALLEVIATION AMONG FISHFARMERS IN OSUN STATE, NIGERIA

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Aquaculture is one of the fastest growing food production systems in the world, Nigeria inclusive with the bulk of its output currently being produced within developing countries and with expectations for aquaculture sustainable food security and poverty alleviation. However, poverty which is a social condition characterized by the inadequacy of basic human needs for the maintenance and socially acceptable minimum standard of living is still prevalent. One of the major obstacles to achieving the objectives of poverty reduction through aquaculture is the inadequate credit facilities to boost production. The study investigates the sources and uses of micro-credit in poverty alleviation among fish farmers in Osun state, Nigeria.

A two stage random technique was used to select 137 respondents from the three Osun state Agricultural Development programmed zones. Structured questionnaire was used to collect data on demographic characteristics, micro-credit sources and use, occupational, income and fish production data. Data was analyzed using descriptive statistics and logit model. The result shows that both formal and informal micro-credit sources were used in the area studied with high interest rate militating against the adequate use of some of the micro-credit sources. Age had a positive significance on poverty at 5% while level of education had a negative significance on poverty at 5 %. Micro-credit was found to reduce inefficiency of the fish farmers. Micro-credit use increased efficiency through improved technology and greater production therefore policies aimed at reducing interest rate, improved education (adult literacy), greater involvement of financial institutions and non-governmental organizations should be focused on to improve or alleviate poverty among fish farmers.

SOURCES AND USES OF MICRO-CREDIT IN POVERTY ALLEVIATION AMONG FISH FARMERS IN OSUN STATE, NIGERIA





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INTRODUCTION

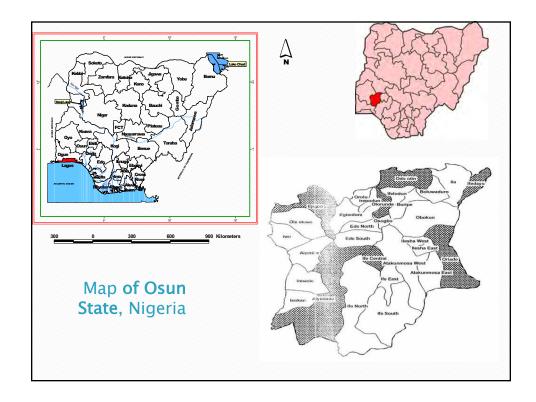
- ▶ Aquaculture is one of the fastest growing food production systems in Nigeria
- Production from this sector increased from 16619tonnes in 1995 to 85087 tonnes in 2007
- ▶ There is therefore ,an expectations for aquaculture sustainable food security and poverty alleviation
- ► This expectation is however faced with a major problem Inadequate micro-credit

Introduction Cont'd

- What is micro- credit?
 - It is the extension of small amount of collateral free loans for either individuals or an organized group, for their self employment and income generation.
- ▶ Why micro- credit?
- ▶ Sources of micro-credit are:
 - -Informal sources (Cooperative society, Personal savings, Friends & relatives, Rotational savings, money lender
 - -Formal sources: Commercial banks, Microfinance Institutions

MATERIALS AND METHODS

- ▶ The study area is Osun State in the South Western Nigeria
- It covers an area of approximately 10456 square kilometers
- It lies within the tropical rain forest region with thick deciduous vegetation in the southern region and grass land towards the North
- It is bounded in the North by Kwara state, in the east by Ekiti & Ondo states, south by Ogun state and west by Oyo State



Materials and Methods Cont'd

- The state is located between latitude 7* 0.5"E to 8* 0.5"W and longitude 4* 70"N to 4*80"S and has 30 local government areas with 3 zones (Iwo, Osogbo & Ife/Ilesa) based on the Osun state Agricultural Development Programme
- A two stage random technique was used to select 137 respondents from the three Osun state Agricultural Development Programme (ADPs) zones. The first stage was the selection of the zone and the second stage was the selection of fish farmers from each zone
- Structured questionnaire was used to collect data on demographic characteristics, micro-credit sources and use, occupational, income, poverty and fish production data
 Data analysis

RESULTS

▶ The result of the findings is presented in the tables 1 - 4

Parameters	Frequency (%)	
Gender		
Male	107(79.3)	
Female	28(20.7)	
Marital Status		
Married	116(85.9)	
Single	10(7.4)	
Divorced	5(3.7)	
Widowed	4(3.0)	
Age Group		
<30	4(3.0)	
31-40	26(19.3)	
41-50	35(25.9)	
51 – above	70(51.9)	
Educational Level		
No formal education	5(3.7)	
Primary	42 (31.1)	
Secondary	26 (19.3)	
Tertiary	59 (43.7)	
Quranic	3(2.2)	

Table 1: Socio-economic characteristics of fish farmers in Osun State , Nigeria Cont'd **Household Size** 1-5 (small) 68(50.4) 6-10 (medium) 51(37.8) 10 – above (large) 16 (11.9) Religion Christians 99(73.3) Muslims 36(26.7) Occupation Fishing 86(63.7) Hunting 2(1.5) Artisan 20(15.0) Timeliness of Micro-credit 56(41.5) 79(58.5)

Sources of Micro-Credit	Rate of patronage	Mean Interest rate	Time lag (months)	Loan duration (months)
Relatives & friends	16(11.9)	3.5	2	4
Cooperative society	50(37)	7.7	4	12
Commercial banks	27(20)	21	12	18
Rotational savings	7(5.2)	3.4	3	4
Money lenders		60	>1	<1
Personal saving	12(8.9)	3	>1	<1
MFI	23(17)	15	1	<1
Total	135			

Uses of Micro - Credit	Frequency	
Fish production	55(40.7)	
Payment of Debts	8(5.9)	
Family matter	30(22.2)	
Socials	16(11.9)	
School fees	26(19.2)	
Total	135	
Problems of Micro-credit		
Location	9(6.7)	
Educational status	18(13.3)	
Asset or collateral	36(26.7)	
Interest rate	60(44.4)	
Administrative bottle necks	12(8.9)	
Total	135	
Poverty Analysis		
Non poor	54(40)	
Poor	81(60)	

- The Foster Greer and Thorbercke (FGT) analysis reveals that 60% of the fish farmers fall under the poverty line which was set at N3010
- ➤ 35.29% of farmers below poverty required about №1063 to reach the poverty line (poverty gap)
- ➤ while 23.26% of them require №1452 to reach the poverty line (poverty severity)
- >23% of the fish farmers that does not use microcredit belong to the core poverty group
- This shows that greater percentage of fish farmers that do not use micro-credit belong to the core poverty class as compared with those that use credit

Table: 3 The maximum likelihood estimate of the logit model Variables Coefficient **Z**-statistics Marginal effect 0.012 0.55 0.002 Age Sex -0.84 -0.104 -0.503 Marital status 1.012*** 1.79 0.233 Number of wives 0.893** 1.91 0.185 Years of education -0.044 -0.212 -0.86 Years of experience -0.003 -0.15 -0.001 Occupation 1.268* 2.99 0.273 Farm size 0.074 0.86 0.015 Fish pond size 0.113 1.09 0.023 -0.000 -0.000 Output -0.46 -0.97 Constant -1.837 Log likelihood -54.66 LR chi2(11) 72.40* 0.40 Pseudo R²

- The maximum likelihood result of the logistic regression shows that marital status, number of wives and occupation were significant at 1%, 5% and 10% and were all positively related to the poverty status of fish farmers
- ➤ This means that an increase number of wives also increase the likelihood of being poor while for married fish farmers and those who have farming as their major occupation are more likely to be poor than their counterpart

Table 4: The maximum likelihood estimate of the stochastic frontier model Coefficient Variables T-statistics Cash function Fuel 0.237 4.111* Feed -0.375 -2.256** Pond size -0.668 -0.381 Labour 0.378 5.873* Constant 6.833 11.648* Efficiency model 1.651*** Age 1.155 Sex -0.155-1.469 0.563 1.983** Marital status Number of wives -1.539 -1.597 Years of education -4.652 -2.802** Micro-Credit 4.509 2.294** Years of experience -0.951 -1.253 -1.408 -0.916 Constant Sigma-squared 9.333 2.534** Gamma 0.994 324.786* Log likelihood -16.074 LR test on the one sided error 128.639 Mean technical efficiency 0.524

- The result of the final maximum likelihood of the stochastic frontier shows a log likelihood of -160.73 and the log likelihood ratio of 128.38 significant at 1% which shows that the model is fitted
- The mean technical efficiency was found to be 52.35% which means the fish farmers were 47.65% inefficient
- ➤ Increase in age and micro credit increase the level of efficiency of fish farmers. Also married people tend to be more efficient than single

CONCULSION AND RECOMMENDATION

- aquaculture has a great potential to contribute to poverty alleviation and food security through employment and income generation
- the use of micro- credit to increase efficiency, improved technology and greater production is inevitable
- therefore policies aimed at reducing interest rate, improved education (adult literacy), greater involvement of financial institutions and non-governmental organisations should be focused on to improve or alleviate poverty among fish farmers

THANK YOU FOR YOUR ATTENTION

USE OF Moringa oleifera and Leucaena leucocephala TO IMPROVE COST EFFICIENCIES IN TILAPIA OREOCHROMIS NILOTICUS FEED

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Soybean meal has been recommended as the substitute for fishmeal in fish diets because of its high protein content and relatively low price. However, small-scale fish farmers in sub-Saharan Africa have not adopted it because of its high price and limited supply. Thus, there is a need to look for cheap alternative protein sources from locally available feed resources. This study was carried out to evaluate the effects of substituting soybean meal with either *Moringa* oleifera or Leucaena leucocephala leaf meals on pond water quality and growth performance of tilapia. Nine diets were formulated and all of them contained 40% protein (soybean or Moringa leaf meal or Leucaena leaf meal or mixtures of soybean and the leaf meals), 58% energy source (maize bran) and 2% mineral mix. Diet 1, diet 2 and diet 3 contained, respectively, Leucaena leaf meal (LLM), Moringa leaf meal (MLM) and soybean as sole protein sources. In diet 4, diet 5 and diet 6 LLM replaced soybean as a protein source at the levels of 25, 50% and 75%, respectively. In diet 7, diet 8 and diet 9 soybean meal was replaced with MLM at the levels of 25, 50% and 75%, respectively. Two concrete tanks were allocated for each diet and 40 fingerlings were stocked in each tank at a rate of 2 fingerlings/m2. The fingerlings were of mixed sex and had mean (se) weight of 3.1 0.24 g. The fish in the tanks were fed daily on the respective diets at a rate of 10% of body weight for 90 days. Body weights and length of the fish were measured at the start of the experiment and then at day 30, 60 and 90. Pond water temperature, dissolved oxygen (DO) and pH were measured at weekly intervals for the whole experimental period. Water temperature (27.7 - 28.5 0C) did not differ significantly (P > 0.05) among the diets, but the DO (8.7-11.3 mg/l) and pH (7.68 - 8.18) differed significantly (P 0.05) between the diets. (How so?) The growth of fish was significantly (P 0.001) influenced by diets. Fish on diet 3 showed the highest average growth rate (GR) (0.76 0.02 g/d), lowest average feed convention ratio (FCR) (2.7) and highest mean body weight (72.06 1.25 g) and length (11.83 0.20 cm) at 90 days. These were followed by the fish on diet 7 (GR = $0.49 \ 0.01 \ g/d$, FCR = 2.8, mean body weight at 90 days = 47.43 1.17 g and length = 11.3 0.17 cm). Fish on diet 1 had the lowest GR (0.38 0.01 g/d), mean body weight (37.79 1.13 g) and length (9.6 0.22 cm). Fish on diet 2 had the next lowest values (GR = $0.43\ 0.01\ g/d$, body weight = $41.92\ 1.21\ g$ and length = $10.3\ 0.25\ cm$). It is concluded that MLM is relatively better than LLM as a protein source for tilapia diets and that MLM and LLM can be included in tilapia diets to substitute soybean meal at a level of 25%.

Use of Moringa oleifera and Leucaena leucocephala to improve cost efficiencies in Tilapia (Oreochromis niloticus) feed

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Introduction

- Fisheries sector provides food, income and employment for many people in Tanzania.
- The country's fish and fisheries products provide about 40 % of animal protein supply.
- The supply of fish comes from two main sources; fisheries based on the natural water bodies and from fish farming.

- Aquaculture production provides vital animal protein to the population residing in areas which are located far away from the major fishery resources or where transport of fish is either difficult or too expensive.
- The socio-economic benefit from aquaculture is high in regions where protein intake per capita is low and where protein malnutrition prevails.
- Fish farming in Tanzania is done in dams and ponds by commercial farmers and smallholder farmers, mostly using Tilapia species.

- The fish farmers use naturally available feeds (rice and maize bran, kitchen leftovers, and garden remains) to feed the cultured fish.
- These are of low quality and fish reared on these feeds are unable to meet their maintenance and production requirements, especially for protein.
- This prolongs the time to reach the market weight and consequently leads to production of poor quality fish and low profitability of fish farming.

- For several decades, fishmeal and soybean have been used as the main sources of protein in fish feeds.
- However, the limited supplies due to competition with humans and livestock and the high prices of fish meal and soybean make them to be unaffordable by small-scale fish farmers in developing countries.
- In order to enhance aquaculture production, improve food security and reduce the level of poverty in rural areas, a search for cheap and locally available feedstuffs is required.

- Leguminous tree leaves and their pods seem to be appropriate alternative protein sources to fishmeal and soybean.
- Moringa oleifera and Leucaena leucocephala are the most useful trees as feed supplements to animals as their leaves are highly nutritious with excellent palatability, digestibility and balanced chemical composition of protein and minerals.
- However, there is limited information on the feeding value of *Moringa oleifera* and *Leucaena leucocephala* leaf meals for use as protein supplements in tilapia feeding.

Objectives

- To evaluate the effect replacing soybean with Moringa oleifera and Leucaena leucocephala on growth performance, feed conversional ratio and survival rate of cultured tilapia.
- To asses the economic profitability of using Moringa oleifera and Leucaena leucocephala as feed supplements for tilapia.

Materials and methods

- The study was carried out at Kingolwira Fishery Centre, Morogoro, Tanzania (latitude 60° 20' south and longitude 37° 39' East).
- Moringa oleifera and Leucaena leucocephala leaves were harvested and dried in shaded area.
- The dried leaves were chemically analyzed (Proximate analysis) and used as plant protein sources in feed compounding.

Nine Experimental diets formulated

Feed ingredient	Diet	% protein from leaf	% protein from soybean	% energy source in the diet	% minerals in the diet
SB + MB	3	0	100	58	2
LLM+SB+MB	4	25	75	58	2
LLM+SB+MB	5	50	50	58	2
LLM+SB+MB	6	75	25	58	2
LLM + MB	1	100	0	58	2
MLM+SB+MB	7	25	75	58	2
MLM+SB+MB	8	50	50	58	2
MLM+SB+MB	9	75	25	58	2
MLM + MB	2	100	0	58	2

Note: LLM = Leucaena leucocephala leaf meal, MLM = Moringa oleifera leaf meal, SB = Soybeam, MB = Maize bran

Experimental procedure

- Two concrete tanks with surface area of 7.06 m² and depth of 1 m were allocated for each diet.
- Fingerlings were stocked in each tank at a rate of 2 fingerlings/m².
- The fingerlings were of mixed sex and had mean (± se) weight of 3.1 ± 0.24 g.
- The fish were fed twice a day at 0900 h and 1600 h for a period of 90 days.
- The amount of feed provided was 10% of the body weights.

Parameters measured

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

Data analysis

- The data were analyzed using General Linear Model procedure of SAS.
- The diets were used as fixed effect and the initial body weights were used as the covariate. The dependent variables were body weight and growth rate.
- The chi-square test was used to analyze the data on mortality rate.
- Gross margin analysis was used to estimate the profit margin. Gross margin =Total revenue – Total variable costs.
- Input costs were prices of fingerlings, prices of feeds, and labour costs.
- · The revenue was obtained from the sales of fish.

Results

Table 1: Chemical composition of feeds and rations (mean ± sd) used in the experiment

Feed sample	%DM	%ASH	%CP	%CF	%EE
LLM	96.5 ± 0.09	10.6 ± 0.05	23.8 ± 0.14	17.2 ± 0.16	4.5 ± 0.25
MLM	97.0 ± 0.04	10.5 ± 0.04	27.9 ± 0.06	12.2 ± 0.09	5.8 ± 0.09
SB	97.1 ± 0.06	4.3 ± 0.03	52.7 ± 0.11	5.9 ± 0.11	16.2 ± 0.02
MB	96.9 ± 0.04	4.8 ± 0.08	11.2 ± 0.19	6.2 ± 0.12	8.7 ± 0.25
Diet 1	91.2 ± 0.02	8.2 ± 0.02	20.2 ± 0.09	13.3 ± 0.08	5.5 ± 0.08
Diet 2	91.1 ± 0.07	7.5 ± 0.03	22.9 ± 0.10	10.7 ± 0.09	5.9 ± 0.06
Diet 3	91.3 ± 0.01	4.5 ± 0.01	34.4 ± 0.12	6.2 ± 0.06	10.6 ± 0.04
Diet 4	91.3 ± 0.15	6.0 ± 0.11	34.2 ± 0.07	10.5 ± 0.12	8.3 ± 0.08
Diet 5	91.5 ± 0.11	6.6 ± 0.09	33.8 ± 0.11	8.7 ± 0.05	7.1 ± 0.02
Diet 6	91.2 ± 0.21	5.2 ± 0.11	26.3 ± 0.09	12.3 ± 0.04	6.7 ± 0.04
Diet 7	91.6 ± 0.01	5.3 ± 0.08	34.4 ± 0.11	9.5 ± 0.04	9.3 ± 0.04
Diet 8	91.0 ± 0.07	6.3 ± 0.04	34.5 ± 0.16	6.9 ± 0.04	8.4 ± 0.02
Diet 9	91.3 ± 0.07	6.6 ± 0.05	31.0 ± 0.08	7.8 ± 0.06	7.2 ± 0.04

Table 2: Mineral contents of feeds and rations (g/kg) used in the experiment

Feed sample	Ca	Mg	K	P
LLM	2.3	1.0	0.7	2.1
MLM	2.6	1.8	0.5	2.4
SB	2.8	3.2	1.0	5.5
MB	6.1	2.5	1.3	5.2
Diet 1	4.1	1.5	2.2	1.0
Diet 2	5.3	1.8	2.5	1.2
Diet 3	4.4	2.1	3.2	1.0
Diet 4	3.5	1.2	2.8	1.4
Diet 5	3.2	1.7	3.0	1.0
Diet 6	2.7	1.0	2.1	1.3
Diet 7	4.6	2.4	3.3	1.5
Diet 8	4.7	1.6	2.4	1.2
Diet 9	3.6	1.2	2.1	1.4

Table 3: Water quality parameters (mean ± se) of ponds used in the experiment

Treatment		Parameter		
	Temperature (°C)	pН	Dissolved O ₂ (mg/l)	
Diet 1	27.7 ± 0.16	7.72 ± 0.06	8.72 ± 0.06	
Diet 2	27.9 ± 0.17	7.82 ± 0.07	8.72 ± 0.06	
Diet 3	28.3 ± 0.21	7.78 ± 0.06	11.3 ± 0.03	
Diet 4	28.0 ± 0.12	7.69 ± 0.04	10.6 ± 0.04	
Diet 5	27.9 ± 0.13	7.80 ± 0.05	9.6 ± 0.04	
Diet 6	28.1 ± 0.14	7.77 ± 0.04	9.8 ± 0.02	
Diet 7	28.5 ± 0.11	7.77 ± 0.03	10.7 ± 0.03	
Diet 8	28.1 ± 0.12	8.18 ± 0.02	9.6 ± 0.03	
Diet 9	28.1 ± 0.10	8.17 ± 0.02	10.1 ± 0.04	

Table 4: Least squares means and standard error for growth rate (g/d) of fish under different Experimental diets

DIET	DAY 30	DAY 60	DAY 90	DAY 0-90
	0.22 + 0.02	0.24 + 0.024	0.21 + 0.02	0.27 . 0.024
1	$0.33 \pm 0.02^{\circ}$	0.34 ± 0.02^{d}	$0.31 \pm 0.03^{\circ}$	0.37 ± 0.03 ^d
2	$0.33 \pm 0.03^{\circ}$	0.36 ± 0.03^{cd}	0.37 ± 0.03^{c}	0.38 ± 0.03^{d}
3	0.53 ± 0.06^{a}	0.64 ± 0.08^{a}	1.07 ± 0.05^{a}	0.76 ± 0.07^{a}
4	0.37 ± 0.04 bc	0.45 ± 0.04 bc	0.57 ± 0.04^{b}	0.46 ± 0.05 °
5	0.37 ± 0.04 bc	0.42 ± 0.03^{bcd}	$0.43 \pm 0.03^{\circ}$	0.44 ± 0.04 ^{cd}
6	$0.35 \pm 0.03^{\circ}$	0.40 ± 0.03^{bcd}	$0.42 \pm 0.03^{\circ}$	0.44 ± 0.04^{cd}
8	0.42 ± 0.04 bc	0.50 ± 0.06^{b}	0.58 ± 0.04 ^b	0.52 ± 0.05 bc
9	0.40 ± 0.04 bc	0.46 ± 0.05 bc	0.57 ± 0.04 ^b	$0.47 \pm 0.05^{\circ}$

Table 5: Weight gain LSM ± se (g) of fish on different Experimental diets

	DIET	DAY 0-30	DAY30-60	DAY 60-90	DAY 0-90
	1	9.23 ± 1.1^{d}	10.12 ± 0.8^{d}	9.66 ± 1.9 ^g	$26.88 \pm 2.24^{\rm f}$
	2	9.74 ± 1.0^{cd}	10.71 ± 1.0^{cd}	$11.08\pm\!0.88^{fg}$	32.70 ± 2.39 bc
	4	10.96 ± 1.1 bcd	13.17 ± 0.94^{bc}	16.22 ± 0.75^{cd}	39.77 ± 2.23^{cd}
	5	$10.86\pm1.3~^{bcd}$	12.45 ± 0.78 bcde	14.93 ± 0.86^{de}	39.62 ± 2.81^{de}
	6	$10.47\pm1.0~^{bcd}$	11.98 ± 0.92 bcd	12.78 ± 0.82^{ef}	33.76 ± 2.04^{de}
	8	12.53 ± 1.1 bc	14.91 ± 1.8 ^b	18.50 ± 1.0 bc	47.04 ± 2.33 bc
	9	11.93 ± 1.4 bcd	$13.50 \pm .82^{\circ}$	18.38 ± 0.87 bc	41.55 ± 5.34 bc
ı					
п					

Table 6: FCR LSM ± se for the fish fed different Experimental diets

DIET	DAY 30	DAY 60	DAY 90	DAY 0-90
1	2.89±0.04a	2.83±0.03a	2.89±0.02a	2.91±0.02a
2	2.83±0.03b	2.75±0.04b	2.83±0.03ab	2.86±0.03ab
4	2.82 ± 0.04 bc	2.82±0.03a	2.82±0.04ab	2.84 ± 0.04^{b}
5	2.77 ± 0.02^d	2.76±0.04b	2.81±0.05b	2.84 ± 0.04^{b}
6	2.83±0.04b	2.83±0.03a	2.87±0.04ab	2.87 ± 0.02^{d}
7	2.78 ± 0.03 ^{cd}	2.82±0.03a	2.84±0.04ab	2.84±0.03b
8	2.86±0.04ab	2.86±0.04a	2.87±0.04ab	2.87±0.03ab
9	2.91±0.04a	2.85±0.04a	2.85 ± 0.04^{ab}	2.85 ± 0.03 ab

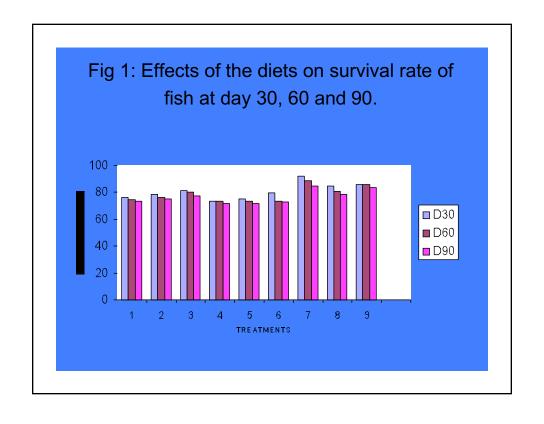


Table 14: Gross margin analysis of experimental diets (1 ha/year)

DIET	YIELD(Kg)	TR (Tsh)	TVC (Tsh)	GM (Tsh)
1	155.4	326 263.4	200 861.0	125 402.4
2	172.2	361 649.2	203 346.1	158 303.1
3	313.1	657 567.0	825 124.4	-167 557.4
4	198.0	415 709.3	405 768.3	9 941.0
5	202.2	424 555.7	357 299.3	67 256.5
6	179.3	376 457.8	273 690.1	102 767.6
7	239.7	503 341.3	426 242.2	77 099.1
8	197.1	413 835.9	348 508.0	65 327.9
9	190.1	399 131.5	282 579.1	116 552.4

Conclusion

- Fish fed MOLM based diets performed relatively better than those fed LLLM based diets, indicating that MOLM is better than LLLM as protein source in tilapia diets.
- 2. The relatively higher weight gain, growth rate and survival rate observed on fish fed MOLM based diets, indicate that MOLM can be used as protein source in tilapia diets to replace soybean meal.
- 3. The results of the present study show that producing fish using diets with higher levels of leaf meals is more economical than using diets with higher levels of Soybean meal.

Funding for this research was provided by the



COLLABORATIVE RESEARCH SUPPORT PROGRAM







The AquaFish CRSP is funded in part by United States Agency for International Development (USAID)

Cooperative Agreement No. EPP-A-00-06-00012-00 and by US and Host Country partners.

The contents of this presentation do not necessarily represent an official position or policy of the United States Agency for International Developm (USAID) Mention of trade names or commercial products in this presentation does not constitute endodement or recommendation for use on the part of USAID or the Aqual'ish Collaborative Research Support Program. The accuracy, reliability

TRANSFERRING CICHLID CULTURE TECHNOLOGIES TO BRAZIL: YANG YI'S LEGACY

Maria Célia Portella*, Hillary S. Egna, James R. Bowman, Remedios Bolivar, Wilfrido Contreras, Lourens De Wet, Khalid Salie, Charles Ngugi, Nguyen Thanh Phuong Sao Paulo State University, Aquaculture Center, Via Prof. Paulo Donato Castellane, 14884-900 Jaboticabal- SP; portella@caunesp.unesp.br

The second phase of the Host Country Principal Investigator Exchange Project on Tilapia and Other Cichlid Culture of the Aquaculture & Fisheries Collaborative Research Support Program/USAID was proposed to facilitate the sharing and dissemination of effective technologies among South Africa, Ghana, Brazil and Vietnam, countries in which tilapia culture is an ascending activity. The project counted on the mentoring of PIs who have participated in the former Phase I of the HCPI Exchange Project and contributed with their expertise and past experience to assist the new participants and broaden the benefits of the exchange. The Brazilian phase was marked by a 2-day workshop in Jaboticabal, SP. Considering the continental dimensions of Brazil, the activities were concentrated in Sao Paulo State, but in order to give a broader view of the activity, researchers, producers, and representatives of the governmental, educational and private sectors were invited to talk about different aspects of tilapia production in the different regions of the country. The Brazilian government, through the National Council of Science and Technology (MCT/CNPq 454761/2007-4) co-funded the workshop and 220 representatives of almost all the segments of tilapia production chain were present: researchers, producers, farmers, students, extensionists, representatives of feed industries, representative of aquaculture equipment industries, and professional that acts in the post harvesting and commercialization sector. The workshop was followed by trips to private and public fish farms to have an in situ experience of the activity. The high point of the trip was the visit to the Cooperative of Fish Farmers from Santa Fe do Sul and Region. This project was initially supported by the Special Secretariat of Fisheries and Aquaculture, Brazil (currently Ministry of Fisheries and Aquaculture) that installed two Demonstrative Units and about 220 small-scale producers and families were trained to rear tilapia in floating-cages installed in a reservoir. Sixty 6 m³ cages were installed in each Unit and after two years, 120 families organized themselves to create the Cooperative. The PIs visitors identified several aspects that could be improved to increase productivity and reduce production costs and it was suggested that the Aquaculture Center could give technological support to the Cooperative. Dr. Yang Yi's main concern was related to the reservoir support capacity. The Brazilian Aquaculture Legislation allows the use of 1% of the public waters for aquaculture purpose and Dr. Yang Yi claimed for accurate information about the environment and support capacity to avoid pollution and eutrophication. As consequence of this AquaFish CRSP activity, researchers of the Aquaculture Center, with the international collaboration of Dr. W. Contreras, submitted a proposal to MCT/CNPq (560255/2008-8) entitled "Technology and Sustainability for Tilapia Production in Familiar System". In the next two years, we will be working and carrying experiments in order to promote advances to increase tilapia productivity and economic, social and environmental sustainability in the region. Another fruitful proposal related to the AquaFish CRSP HC-PI Exchange Project was the approval of the MCT/CNPq/ProAfrica (490549/2008-0) proposal "Increasing Productivity and Sustainability of Fish Culture through Training, Education and Collaborative Research with Brazil", with Kenyan (Dr. C. Ngugi) and South African (Dr. L. De Wet and Dr. K.

Salie) collaborators. The goal of the project is to provide a basis for enhancing the development and sustainability of aquaculture production systems to improve food supplies and human nutrition on a long-term basis.



São Paulo State University, SP, Brazil Aquaculture Center



TRANSFERRING CICHLID CULTURE TECHNOLOGIES TO BRAZIL: YANG YI'S LEGACY

Maria Célia Portella, Hillary S. Egna, James R. Bowman, Remedios Bolivar, Wilfrido Contreras, Lourens De Wet, Khalid Salie, Charles Ngugi, Nguyen Thanh Phuong

March 2nd, 2010

PHASE II: 2007 - 2008 South Africa Ghana Vietnam Brazil Photos J. Bowman



CRSP HCPI WORKSHOP IN JABOTICABAL

- Lecturers from 13 Brazilian institutions (from several states) and 06 HCPI's
- Co-funded by CNPq/Brazil
- 220 participants (researches, producers, farmers, students, extensionists, representatives of the feed and aquaculture equipment industries, personnel from postharvesting, processing and commercialization sectors)



Marked by dynamic discussion and information exchange/transferring







VISITS IN SITU

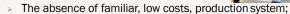


Training Unite on Tilapia Production in Santa Fe do Sul

- It was a project supported by the Special Secretariat of Aquaculture and Fisheries (SEAP, currently Ministry of Fisheries and Aquaculture) and 5 town councils that installed two training unities for tilapia culturing in cages in the Ilha Solteira reservoir aiming at the training of small holders in a new and profitable activity. The project was carried from 2005-2007
- Production was donated for FUNDASUL, an entity supporting beneficent entities.
 The extra production is marketing by those entities or distributed for poor families.
- After the project conclusion 120 trained workers/families joined and created the cooperative association for commercial tilapia production. Recently they received financial support from the governmental bank in order to acquire new equipment and improve the production.
- It was evident the need of technological support and information to increase production and preserve the environment (any special care about water quality)

HCPI's HIGHLIGHTS





- > Few hatcheries (fingerlings production concentrated in 2-3 farms)
- High production costs feeds (the use of the water -public waters or reservoirs was free at that time!);
- > Tilapia market size too big (700-1000 g) expensive. Need to develop market for smaller fish;
- Need to develop cheaper alternatives to produce tilapia in cages, and to force the diminution of feeds' prices;
- Loans and credits for aquaculture;
- Care about the environment and support capacity of the reservoirs (Brazilian law allows the use of 1% of the reservoir area for fish culture in cages ... and currently several aquaculture parks have being demarcated process of regularization of practically all installed farms).
- Yang Yi advised about the need to study the environment the strong presence of macrophytes in the reservoirs ...
- Enhance technology transfer specially for the small farmers (cooperative)

AND WHAT CAME NEXT ...



CNPq Project : Technology and Sustainability of Tilapia Culture in Familiar System

- We are going to carry technical and economic studies on tilapia culture in the cages of the Cooperative of Fish Farmers of Santa Fe do Sul comparing with the systems adopted locally by the farmers, aiming at sustainable production and environmental management.
- To study grow performance and muscle development of different tilapia strains;
- Development of alternative feeds (farm made diets with regional products and by-products), processing (extruded X pelleted), use of the by-products, co-products and wastes from tilapia culture;
- Study of stock density, periodical size selection and the relation with parasite infection and other diseases

AND WHAT CAME NEXT ...



CNPq Project : Technology and Sustainability of Tilapia Culture in Familiar System

- To study the use of mixed sex population (CURRENTLY THE USE OF MT IS BANED IN BRAZIL);
- To study the environmental management;
- Improve cost effectiveness of tilapia production and indicate actions to stimulate the market and increase fish consumption;
- Evaluate the economical, environmental and social sustainability of tilapia production in the Cooperative;
- Transfer of technology to local holders (not only for the Cooperative members).

15 farms in Santa Fe do Sul!

TEAMWORK

- * Aquaculture Center/CAUNESP: 7 (Dalton Carneiro, M.Inez E. Geraldo Martins, Lucia Sipauba Tavares, Wagner Valenti, Teresa C. Konberstein, Maeli Dal-Pai Silva, Eliane Goncalves);
- * Fisheries Institute: 5 (Rose Meire Vidotti, Giovanni Goncalves, Eduardo Onaka, Sergio Schalch, Fabio Stopato);
- * APTA Regional: 3 (Eduardo Abimorad, Daniela Castellane, Fabiana Garcia);
- * Cooperative: 3 (Fernando Carmo, Moises, Glaucio Cicigliano)
- Students: 5 (Thiago Freitas, Gustavo Squassoni, Hellen Buzzolo, Gisele Favero, Munir Zanardi)';
- International Consultant: 1 (Wilfrido Contreras Mexico)

24 Researchers, 5 Institutions

ADVANTAGES

Multidisciplinar and Interinstitutional project;

Each subproject has 1 researcher coordinating the studies (group, sampling, field trips etc);

The commitment of the holders with the project allowing the use of 1/3 of the area for the experiments;

Help in terms of labor (the project would pay only one extensionist and the everyday handling would be done with the help of holders from the cooperative).

BUDGET

- Funds is provided by the Ministry of Fisheries and Aquaculture MPA/ Brazll vla CNPq (National Council for Scientific and Technological Development);
- ✓ The project was approved in Dec 2008 but the funds stated to be directed to the projects only in Sep 2009;

	R\$	USD
Services and Supplies	112.850,00	~ 62,690.00
Equipments	12.030,00	~ 6,683.00
Salary	25.101,36	~ 13,945.00
Total	149.981,36	83,322.98

✓ For internal problems at CNPq OUR PROJECT STILL DID NOT RECEIVE ANY CENT

CURRENT SITUATION



Cooperative of Fish Farmers:

- ➤ In April 2009 they received credit from a governmental bank and in September started production. They have 70 cages (6m³) in water and more 50 to be installed. Their license/permit is for 200 cages;
- Current production is 20 tons/month;
- All profit is being reinvested in the cooperative;
- One employee and a rotating schedule for the other 70 cooperates (small producers of other agricultural products);
- Support and information from Caunesp, Fisheries Institute and APTA Regional (phone, email and eventually visit ~ 400 km). Energy was connected in the small building in the margin.

The opportunity to study the environmental changes after the installation of the cages in those part of the reservoir is lost

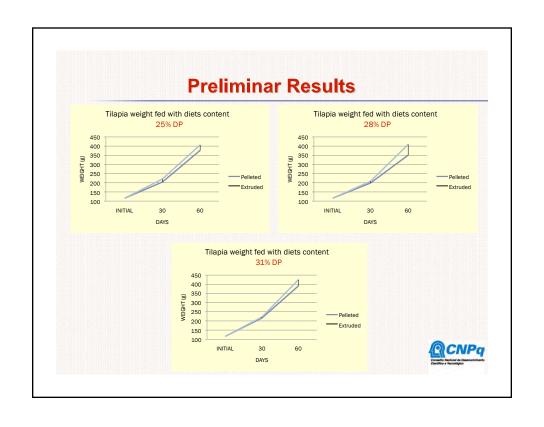
HOWEVER WORK IN PROGRESS

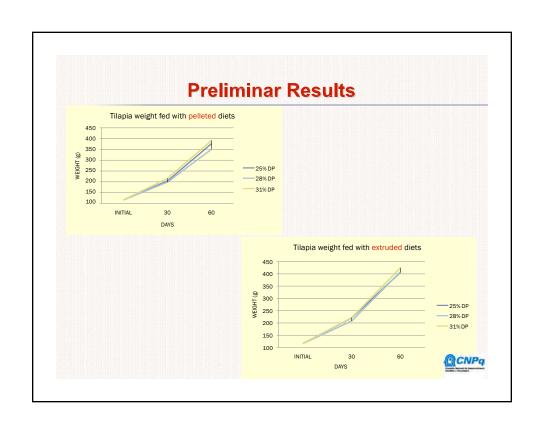
At the Aquaculture Center of the Sao Paulo State University

Performance and economic evaluation of Nile tilapia {Oreochromis niloticus} in floating cages fed with pelleted and extruded diets containg different levels of digestible protein

Dr Dalton Carneiro and Hellen Buzzolo (Master student)



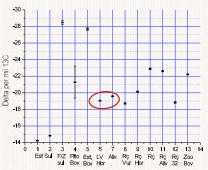


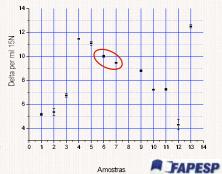


CAUNESP

Production of Nile tilapia (*Oreochromis niloticus*, GIFT strain) in integrated cage and pond system and the use of the stable isotopes technique of carbon (δ^{13} C) and nitrogen (δ^{13} N) to trace the food sources

Dr Maria Celia Portella, Dr Carlos Ducatti and Marcia R.F. Machado (PhD student)





CAUNESP

Average values (± sd) for $\delta^{13}C$ and $\delta^{15}N$ of different organic fertilizers

Carbon (δ ‰ ¹³ C)	Nitrogen (δ ‰ ¹⁵ N)
-31.40 ± 0.03	7.03 ± 0.19
-17.29 ± 0.16	10.32 ± 0.01
-20.49 ± 0.19	7.10 ± 0.06
-19.05 ± 0.03	10.01 ± 0.09
-19.59 ± 0.02	9.47 ± 0.03
	($\delta \%$ ¹³ C) - 31.40 ± 0.03 -17.29 ± 0.16 - 20.49 ± 0.19 - 19.05 ± 0.03



CAUNESP - LARVICULTURE LABORATORY

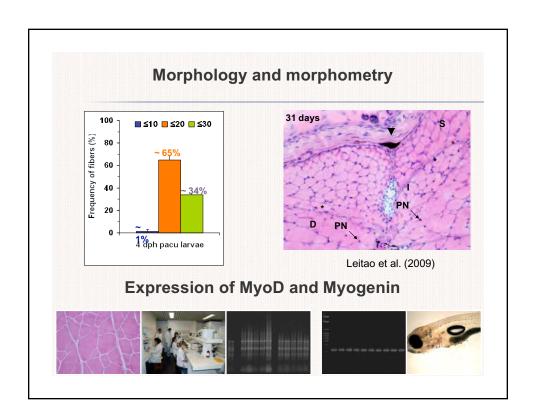
Growth performance and muscle development of three tilapia strains in the initial phase and in grow out culture in cages placed in reservoir

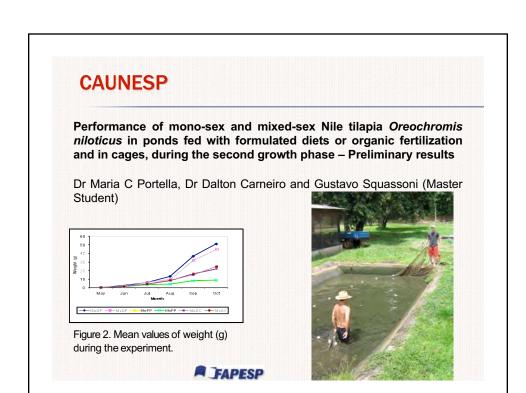
Dr Maria Celia Portella and Thiago M. Freitas - Master Student

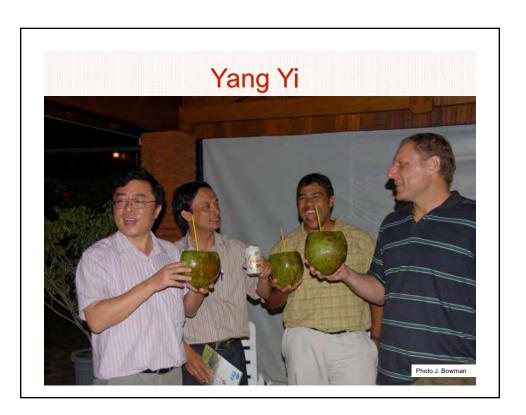
Supreme, GIFT and Thai; 400 larvae/100 L; Feed: 55% CP diet; Experiment started in Feb 20, 2010

Analysis: diameter of the white muscle fibers (hypertrophy and hyperplasia), expression of the MRF's, zootechnical parameters









PERSPECTIVES

- MESMO QUANDO TUDO PARECE PEROTDO.

 NUNCA DESISTA!!!
- Receive the total amount of funds in the next weeks;
- Contract an extensionist to follow up the activities in situ (Santa Fe do Sul);

Never ever give up!

- Install the first experiment in March 2010 (three tilapia strains in cages placed in the reservoir – 2nd part of the Master Dissertation of Thiago Freitas);
- Ask for an one-year extension for completation of the project;
- Re-evaluate the project using stable isotopes and install it;
- Re-evaluate the study of the water quality in the reservoir area;
- Defend 2 Master Dissertations in 2010.



UTILIZATION OF LOCAL FEED INGREDIENTS FOR FRESHWATER AQUACULTURE

Kevin Fitzsimmons*, Pamila Ramotar, Jason Licamele, Michelle Ferman Environmental Research Laboratory. University of Arizona. Tucson, Arizona. kevfitz@email.arizona.edu

The Guyanese government has supported recent initiatives to develop aquaculture through its Department of Fisheries and Office of Aquaculture. The Office of Aquaculture manages the Mon Repos Aquaculture Station, which conducts basic research and extension activities. Collaborative efforts between Guyana, the United Kingdom, Norway and the World Bank are developing economic models to meet the demands of the Guyanese economy and the environment. Experts from the US, UK, and Israel are coordinating efforts to work with the public and private sectors of aquaculture in Guyana. Three programs with US Agency for International Development (USAID) support; Aquaculture/Fisheries Collaborative Research Support Program (A/F CRSP), Farmer to Farmer, and the Guyana Trade and Investment Support (GTIS) have collaborated along with Aquaculture without Frontiers (AwF) volunteers, the UK's Department for International Development (DFID), Israel's Department of Fisheries, and UN-FAO experts to increase productivity of aquaculture and to implement best management practices. This collaboration has avoided duplication of efforts and provided synergies in several areas. Development of the aquaculture industry is dependent on a local source of aquaculture feeds that is cost effective. Fishmeal and soy bean meal are both relatively expensive imported ingredients. A variety of locally available ingredients were collected, sent for proximate analyses, and then selected for inclusion in several test diets for tilapia feeding trials. The ingredients included; copra meal, palm kernel oil meal, brewery wastes, shrimp meal, and a locally available meal from fish carcasses. The results of the analyses and feed trial will be presented.

Utilization of local feed ingredients for freshwater aquaculture

Pamila Ramotar
Department of Fisheries
Ministry of Agriculture

Kevin Fitzsimmons, Jason Licamele, Michelle Ferman University of Arizona

3 March 2010

Introduction

- ◆Capacity building in aquaculture sector
- → Government, private sector, NGO's
- → Introduction of YY supermales.
- → Develop alternative feed ingredients.
- ◆ Analyze results of ingredient analyses.
- → Manufacture experimental diets.
- → Test diets on fingerlings and adults





Need for lower cost diets

- ◆ Producers of tilapia, pacu and shrimp currently importing feeds or purchasing locally manufactured feeds with mix of local and imported ingredients.
- ◆ Fishmeal and soybean are especially expensive on local markets

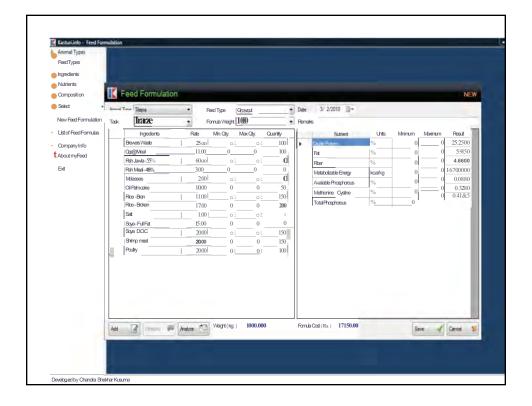
Local ingredients identified, samples collected and analyzed



- → Fish meal from carcass
- → Shrimp head meal
- → Poultry by-product meal
- → Broken rice
- → Rice bran
- → Palm kernel meal
- → Brewers waste
- → Copra meal
- + Cassava

Proximate and mineral analyses

- → Determine protein, fat, carbohydrate, fiber, moisture and ash contents
- → Determine mineral contents
- → Check literature for caloric values
- → Check literature for amino acid profiles
- → Check literature for fatty acid profiles

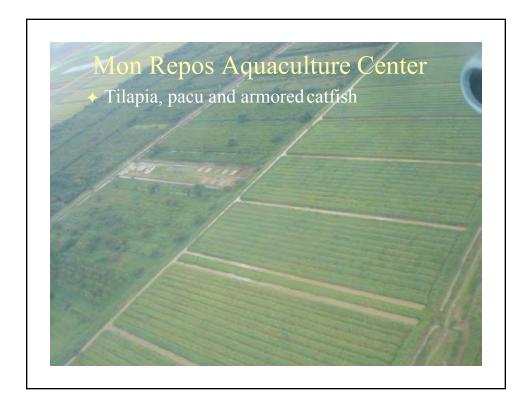


Diet formulation

- → Want to remove imported fish meal from test diets and replace with lower cost local ingredients
- ◆ Used mix of shrimp head meal and poultry by-products (feather meal and processing by-products)







Growout feed trial

- → All male *do Oreochromis niloticus* (Niletilapia)
- → 10 fish (average = 80 g) stocked into 12 one m³ tanks. Each tank with a trickling biofilter of crushed shell and gravel.
- → Randomly assigned control or three treatment diets
- → Fed at 3% of body weight per day in two feedings

Experimental Diets

→ control 25% fishmeal

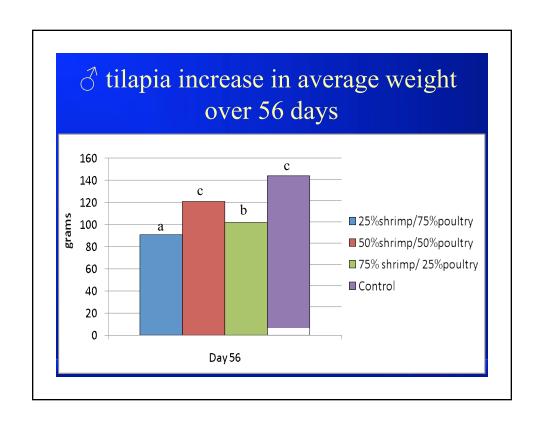
→ Diet 1 7% shrimp meal / 18% poultry

→ Diet 2 12.5% shrimp meal/12.5% poultry

→ Diet3 18% shrimp meal / 7% poultry









- → Local ingredients can be used in formulations to make a balanced diet
- → Growth of fish fed diet with local ingredients is not significantly different from diet with imported soybean and fishmeal.
- → Still need to improve manufacturing as pellets have poor stability and lots of fines







PARTIAL SUBSTITUTION OF FISH MEAL WITH PORK MEAL IN PRACTICAL DIETS FOR THE MAYAN CICHLID CICHLASOMA UROPHTHALMUS JUVENILES

Benigno Garc, Carlos A.*, Gabriel Marquez-Couturier, Wilfrido M. Contreras-Sanchez, Roberto Civera-Cerecedo, Ernesto Goytortua-Bores

Laboratorio de Acuacultura, Universidad JuAutde Tabasco. Carretera Villahermosa Ckm 0.5, 86139, Villahermosa, Tabasco, Mexico. *Corresponding author, Tel/Fax: +52 993 3 54 43 08. E-mail: alvarez alfonso@hotmail.com

The Mayan cichlid (*Cichlasoma urophthalmus*) is one of the most important native freshwater fishes in Southern Mexico. This species has been widely studied to develop the technological package for intensive culturing. However, despite the knowledge of the nutritional requirements for the species, non-practical diets have not been developed for evaluating different protein sources. For this reason, the present study evaluates the substitution of fish meal with pork meal on growth, survival, and chemical composition of the Mayan cichlid juveniles.

In this study, five practical diets were evaluated, fish meal (FM) was partially substituted by pork meal (PM). Diets evaluated were 100%PM-0%FM (T1); 75%PM-25%FM (T2); 50%PM-50%FM (T3); 25%PM-75%FM (T4); 0%PM-100%FM (T5). Ten fish per tank were stocking 10 fish per tank randomly assigned (5.0 0.1 g). Treatments were run in triplicates and lasted 56 days. Each fourteen days, wet-weight and total-length were measured in all fish. Additionally, several food quality indexes (Protein efficiency rate, PER; daily feed intake, DPI; daily protein intake, DPI; food conversion rate, FCR; specific growth rate, SGR), survival and chemical composition of complete fish were analyzed.

Our results indicate that the highest weight was obtained in the fish fed with T3 and T4, being statistically higher (P<0.05) than the other treatments (Fig. 1). No statistical differences (P>0.05) were detected among treatments for total length. Survival was statistically different between treatments where fish fed with T1 and T2 had only 50% survival, while fish fed with T3 and T4 had 65 and 75%, respectively, fish fed with T5 had 100% survival. On the other hand, differences between the DPI (0.065) and DFI (0.131) were only detected for the fish fed with T4 compared with T2 (DPI, 0.055 and DFI, 0.106 respectively). Finally, the chemical composition for whole body did not showed statistical differences between treatments. We conclude that the substitution of fish meal by pork meal is feasible using between 25 to 50% for the grow-out of *C. urophthalmus* juveniles.

Funding for this research was provided by F&A CRSP. Project 07IND02UA under Grant No. EPP-A-00-06-00012-00 from the United States Agency for International Development (USAID).

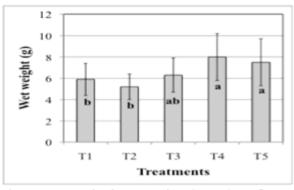


Figure 1. Final growth $(g\pm SD)$ of C. urophthalmus fed pork meal diets.



PARTIAL SUBSTITUTION OF FISH MEALWITH PORK MEAL IN PRACTICAL DIETS FORTHE MAYAN CICHLID Cichlasoma urophthalmus JUVENILES



Benigno García-Hernández, Carlos A. Álvarez-González, Gabriel Marquez-Couturier, Wilfrido M. Contreras-Sánchez, Roberto Civera-Cerecedo, Ernesto Goytortua-Bores and Kevin Fitszimmons.

Tropical Aquaculture Laboratory, DACBiol, UJAT

Environmental Research Lab

Department of Soil, Water and Environmental Science
University of Arizona







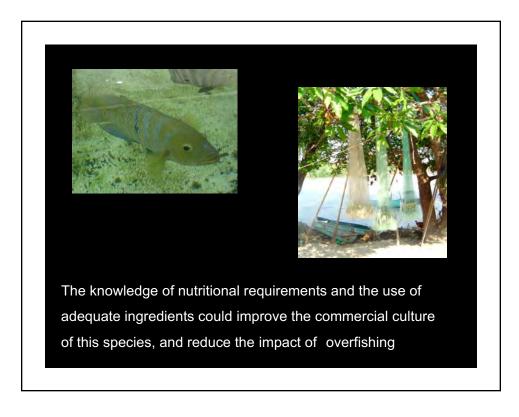


In Tabasco, we have developed the technology for native species with high commercial value in the regional market





Author	Year	Ingredient	Range of substitution (%)	Species	Optimum substitution level (%)
Warith et al.	(2001)	Fish meal for poultry by-product meal	20% to 100%	Clarias gariepinus	40%
Millamena	(2002)	Fish meal for pork meal and blood meal	0% to 100%	Epinephelus coioides	80%
Zhang et al.	(2006)	Fish meal for meat and bone meal	20% to 100%	Carassius auratus gibelio	20%
Shapawi et al.	(2007)	Fish meal for poultry by-product meal	50% to 100%	Cromileptes altivelis	50%
Zhang et al.	(2008)	Fish meal for mix of animal end vegtable meals	0% to 65%	Pseudosciaena crocea	26%



OBJECTIVE

To evaluate the optimum substitution level of fish meal for pork meal on growth and survival of the Mayan cichlid *Cichlasoma urophthalmus*.



MATERIALS AND METHODS

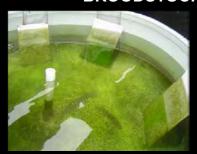
Reproduction was conducted in circular 2000 L tanks

Nine adult fish were placed per tank (250 g mean weight)

Sex proportion of 2:1 females - male.

BROODSTOCK





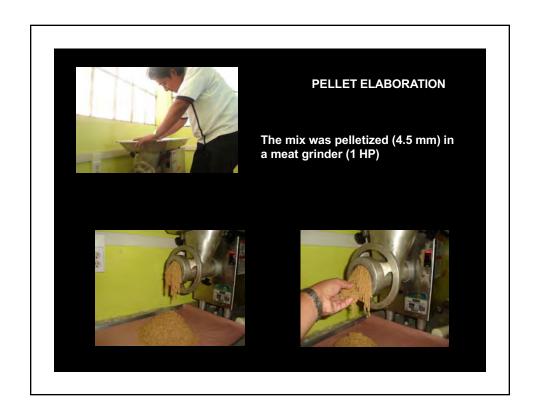


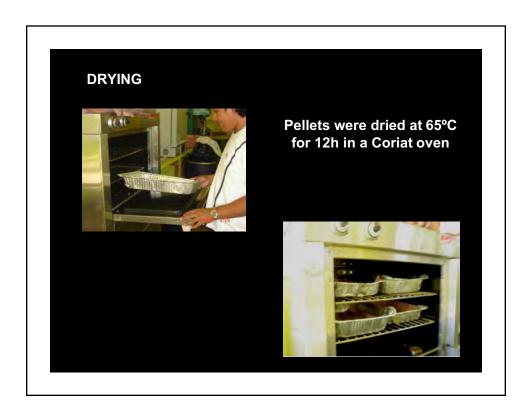


Ingredient (g/kg DB)	100%FM- 0% PM	75%FM-2 5%PM	50%FM- 50%PM	25%FM- 75%PM	0%FM-10 0%PM
Fish meal	49.93	37.50	25.00	12.56	0.00
Pork meal	0.00	15.51	31.55	47.05	62.60
Soybean meal	22.95	23.20	22.95	23.20	23.60
Integral sorghum meal	13.45	10.46	7.54	4.64	1.49
Fish oil	5.87	5.62	5.38	5.10	4.94
Soybean lecithin	2.90	2.81	24.8	2.55	2.47
Grenetin	3.00	3.00	3.00	3.00	3.00
Chromium oxide	1.00	1.00	1.00	1.00	1.00
Vitamin C	0.50	0.50	0.50	0.50	0.50
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Mineral premix	0.15	0.15	0.15	0.15	0.15
Nutrient (g/100g DB)					_
Protein	45.2	44.9	44.7	45.1	45.0
Lipid	15.1	14.9	15.0	14.9	15.0
Fiber	0.5	1.0	1.5	2.0	2.5
Ashes	10.8	12.9	15.2	17.3	19.4





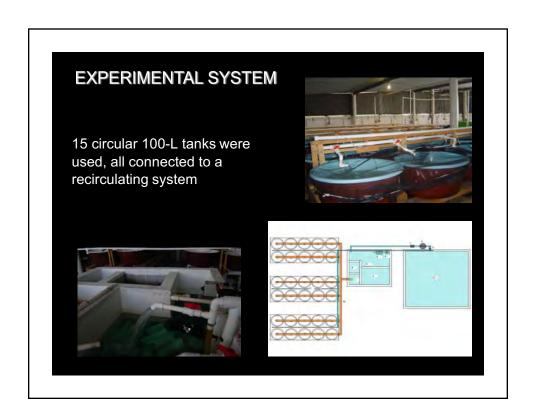


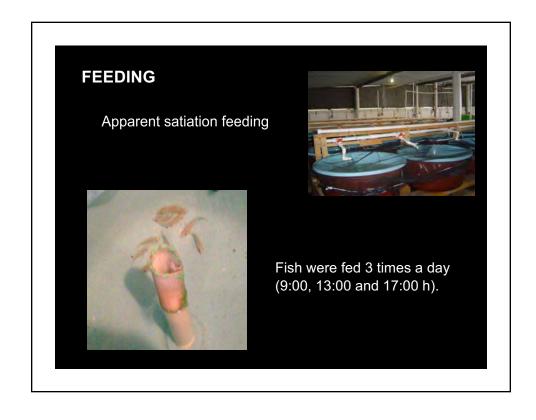


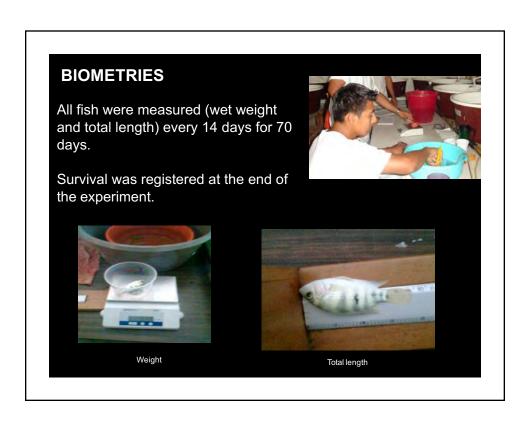
EXPERIMENTAL DESIGN

540 juveniles were selected for the experiment (5.0 \pm 0.1 g).

Treatments	Feeding time (days)	Replicates	Fish / tank
100% FM - 0% PM	70	3	10
75% FM - 25% PM	70	3	10
50% FM - 50% PM	70	3	10
25% FM - 75% PM	70	3	10
0% FM - 100% PM	70	3	10









Survival, growth and food quality indexes

Fed conversion rate (FCR):

Specific growth rate (SGR):

Condition factor (CF):

Protein efficiency rate (PER):

Weight gain (WG%):

Daily protein intake (DPI):

Daily fed intake (DFI):

Survival (Sur%):

Statistical analysis

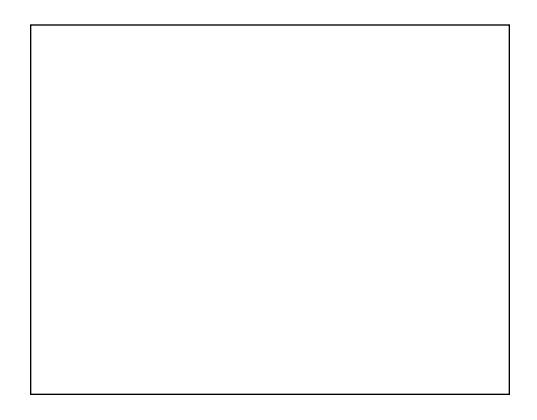
Normality and homoscedasticity were tested.

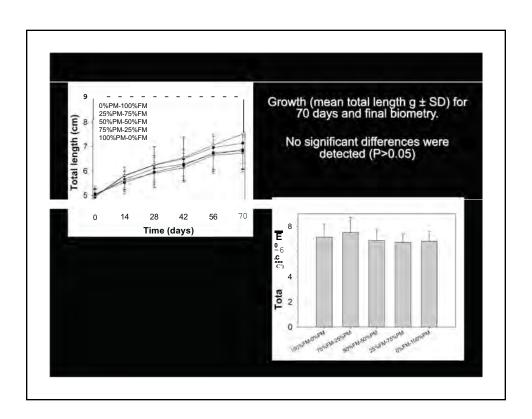
Wet weight and total length ANOVA and Tukey tests

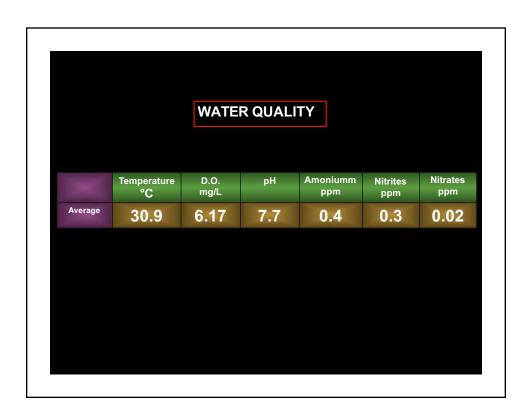
Survival and indexes: Kruskal-Walis and and Nemenyi tests.

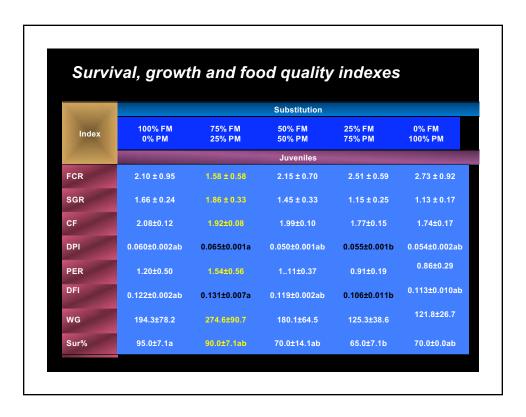
All statistics were conducted using STATISTICA 7.0

Significant difference declared at < 0.05









Nutrients	100% FM 0% PM	75% FM 25% PM	Substitution 50% FM 50% PM	25% FM 75% PM	0% FM 100% PM	
A CONTRACTOR OF THE PARTY OF TH	Juveniles					
Protein	60.8 ± 2.0	59.2 ± 1.3	61.0 ± 2.6	59.2 ± 1.0	59.8 ± 1.7	
Lípids	16.1 ± 16.1	15.0 ± 0.4	15.4 ± 3.7	16.6 ± 2.9	16.9 ± 4.0	
Ashes	13.8 ± 0.6	12.9 ± 0.5	14.2 ± 2.1	12.7 ± 1.9	14.6 ± 1.7	
Fiber	0.03 ± 0.04	0.04 ± 0.02	0.01 ± 0.02	0.01 ± 0.01	0.04 ± 0.03	
Energy (cal/g)	5309.1 ± 136.9	5188.4 ± 106.0	5063.5 ± 315.5	5401.9 ± 461.1	5140.5 ± 195.5	

CONCLUSION

We conclude that partial substitution between 25% to 50% of pork meal is adequate in practical diets for Mayan cichlid juveniles (*Cichlasoma urophthalmus*)

Funding for this research was provided by the



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.

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OPTIMIZING UTILIZATION OF BIVALVE RESOURCES THROUGH COMMUNITYBASED AQUACULTURE, SANITATION AND FISHERIES MANAGEMENT ON THE PACIFIC COASTS OF MEXICO AND NICARAGUA

Haws, M.C.*, Gaxiola-Camacho, E., Rodriguez-Dominguez, G., Hernandez, N., Sandoval, E., Rivas, C., Bravo, J.R., Crawford, B., Supan, J. and Saborio-Coze, A. Maria C. Haws Pacific Aquaculture and Coastal Resources Center, University of Hawaii Hilo 1079 Kalanianaole Hwy.

Hilo, HI 96720 haws@aol.com

Molluscan resources are an often overlooked in aquaculture, fisheries and biodiversity conservation. Molluscan resources are threatened by habitat degradation, IUFF fishing (illegal, unreported and unregulated) and gaps in policy and regulation. At the same time, their potential for aquaculture development is high, given that they require fewer inputs than many other species and have lower technology requirements. Molluscan aquaculture in Latin America is disproportionately low in comparison to its potential. In part this is due to a wide-spread preference for investment and research related to shrimp culture due to its profitability. As shrimp culture continues to encounter disease, economic and environmental issues, the drive to diversify aquaculture has brought increased attention to the potential of molluscan aquaculture. Bivalves in particular are increasingly of interest in recognition of the ecological services they provide, and threats to their existence due to impacts related to global climate change such as ocean acidification.

Integrated and long-term approaches are necessary to improve molluscan fisheries management and at the same time increase benefits accruing to poor coastal communities by developing molluscan aquaculture. Community awareness raising and involvement are a key part of implementing successful solutions to these problems. Environmental issues may also pose an obstacle, particularly with respect to shellfish sanitation- an issue linked to community sanitation and public health. Improving bivalve sanitation must accompany such efforts.

The Aquaculture and Fisheries Collaborative Research Support Program (AquaFish CRSP) and the Sustainable Coastal Communities and Ecosystems Program (SUCCESS), both funded by the United States Agency for International Development (USAID), have made improving molluscan fisheries, development of aquaculture appropriate for coastal communities, and shellfish sanitation priorities for their global work programs. On the Pacific Coasts of Mexico and Nicaragua, considerable success has been encountered with developing molluscan aquaculture in a manner suitable for resource-poor coastal community groups, establishing shellfish sanitation programs and establishing no-take zones for bivalves that are supported and controlled by the community. These efforts utilize simple methodologies that can be adopted in other areas, but require a long-term commitment on the part of the donors and technical assistant providers (3-5 years minimum). Additionally, all stakeholders including the community, private sector, government agencies and non-profit organizations must be fully involved in order for these efforts to be sustainable. Coupling on-the-ground activities with development of appropriate policies, regulation and enforcement is also required.

OPTIMIZING UTILIZATION OF BIVALVE RESOURCES THROUGH COMMUNITY-BASED AQUACULTURE, SANITATION AND FISHERIES MANAGEMENT ON THE PACIFIC COASTS OF MEXICO AND NICARAGUA



Maria Haws, Eladio Gaxiola-Camacho, Guillermo Rodriguez-Dominguez, Nelvia del Soccoro Hernandez, Erick Sandoval, Carlos Rivas LeClair, Juan Ramon Bravo, Brian Crawford, John Supan, Agnes Saborio-Coze

University of Hawaii Hilo ; Autonomous University of Sinaloa (UAS), Mexico; Louisiana State
University; Central American University (UCA), Nicaragua













Partners and Sponsors

Mexico

- Autonomous University of Sinaloa (UAS)
- □ Center for Food and Development Research (CIAD)
- Sinaloa State Committee for Aquaculture Sanitation (CESASIN)
- □ Technological University of the Coast
- □ University of Hawaii Hilo
- □ University of Rhode Island

Nicaragua

- Central American University (UCA)
- Ministry of the Environment (MARENA)
- □ National University of Nicaragua (UNAN)
- ☐ Ministry of Health (MINSA)
- □ Nicaraguan Institute of Fisheries and Aquaculture (INPESCA)
- □ University of Hawaii Hilo
- □ University of Rhode Island

United States Agency for International Development (Aquaculture and Fisheries Collaborative Research Support Program and SUCCESS Program); United States Department of Agriculture; Conservation International; David and Lucille Packard Foundation; European Union; Government of Japan; Government of Spain.

Related publications

- Haws, M.C., B. Crawford, S.C. Ellis, N. Jiddawi, A. Mmochi, E. Gaxiola-Camacho, G. Rodriguez-Dominguez, G. Rodriguez, J. Francis, C. Rivas-LeClair, A. Saborio-Coze, N. Hernandez, E. Sandoval, K. Dabrowski, M.C. Portella and M. Jaroszewska. 2009 (in press). Aquaculture research and development as an entry-point and contributor to natural resources and coastal management. Coastal Management Journal.
- Crawford, B.C., M.D. Herrera, N. Hernandez, C. Rivas-LeClair, N. Jiddawi, M. Semba, M.C. Haws. 2009 (in press). Small Scale Fisheries Management: Lessons from Cockle Harvesters in Nicaragua and Tanzania. Coastal Management Journal.
- Fong, S. W., F.C. Cordero-Martinez and M.C. Haws. 2009. Marketing Extension and Outreach in Sinaloa, Mexico: A Preliminary Analysis of Preferences for Oysters. Marine Resource Economics. 24:89-95.
- Haws, M.C., E. Ochoa-Moreno and A.A. Rojas Umana. 2008. (eds.). Human Health and Aquaculture: three case studies of the relationships between human health, the environment and aquaculture in coastal communities of Sinaloa, Mexico. Pond Dynamics/Aquaculture Collaborative Research Support Program, Oregon State University. 157 pp.

Issues for bivalve management in LAC region

- Significance of bivalve fisheries, aquaculture and conservation often overlooked
- Women, poor and children are often primary users of shellfish resources
- ☐ Gaps in policy and regulations
- Fisheries management often inadequate or absent
- Linkages between fisheries, aquaculture and sanitation issues
- Sanitation complicated by influences by local communities, other sectors and upper watershed
- Ecosystem status

Strategies for addressing issues

- Ideally approaches should be integrated and multi-disciplinary
- Approach spatial coverage should be considered (e.g. local fishing grounds vs. watershed)
- □ Local stakeholders benefit most from approaches which maximize their benefits while assuring long term sustainability for species and habitats
- □ Stakeholder engagement is critical for success
- Long-term efforts and funding

Information needs

- Rapid assessment of socioeconomic and governance issues
- Utilization and status of bivalve resource
- □ Policy and regulation review
- Water quality monitoring and sanitary assessments
- Population assessment
- Market studies
- ☐ Feasibility studies for aquaculture possibilities

Species

Mexico

- □ Crassostrea gigas (Pacific Oyster)
- □ Crassostrea corteziensis (Pleasure Oyster)

Nicaragua

□ Anadara similis, A. tuberculosa (Black cockles)

C. corteziensis





A. similis

3 large estuaries



- Bahia Santa Maria, Sinaloa, Mexico
- Boca de Camichin, Nayarit, Mexico
- Aserradores, Nicaragua
- Combined issues of bivalve fisheries, aquaculture and sanitation
- Integrated with coastal management initiatives



Santa Maria Bay

Previous work:

- □ Bay management plan and committee
- Previous success with community-based management for blue crab fishery/legal adoption
- □ Water quality studies-2007
- □ Training in oyster farming for women and cooperatives
- Marketing study with emphasis on sanitation
- Fisheries and shrimp culture are major economic contributors-need for alternative livelihoods
- Bivalve culture identified as prime opportunity in bay management plan

Obstacles

- Lack of oyster larvae and spat
- Development of native species
- Little experience with bivalve culture
- Seasonality of production

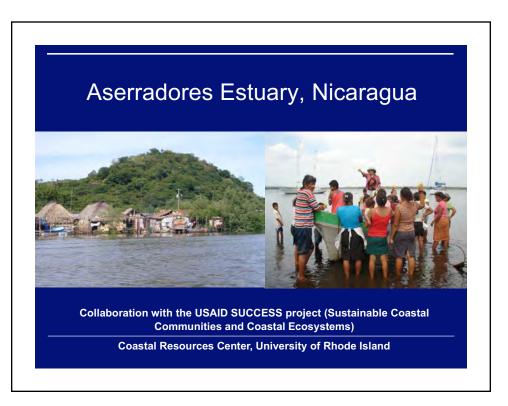


Boca de Camichin

- □ 30 year old oyster culture industry
- □ Native species, Crassostrea corteziensis
- Conservation and Development Committee
- □ Water quality monitoring-2007

Obstacles

- E. coli levels high at main growing area
- Infrastructure development and urban growth in watershed and adjacent coastal areas may stress ecosystem, thereby affecting oyster industry
- Is oyster industry reaching carrying capacity of system?





Previous work

- Water quality studies in Padre Ramos,
 Aserradores and Ballona Estuaries
- Aserradores had the best water quality
- Household surveys in multiple communities
- ☐ Rapid assessment of bivalve utilization
- □ Previous trials for aquaculture (funded by Japan)
- Experimental co-management of the cockle fishery

Aserradores Estuary, Nicaragua

- One of the poorest areas in the country
- □ Coastal fisheries in decline
- Cockle gathering important source of income and food, particularly for women and children
- Cockle management is inadequate
- □ Water quality studies indicate presence of pathogens related to shellfish borne diseases



Activities in 2009 Mexico

- □ Oyster spat collection –Bahia Santa Maria
- □ Completion of estuary carrying capacity study- Boca de Camichin
- □ Oyster relay and depuration trials-Boca de Camichin
- □ Training
 - International workshop on bivalve culture and sanitation
 - Regional workshop on bivalve culture and sanitation
 - Training in Best Management Practices



Activities in 2009-Nicaragua

- ☐ Depuration of black cockles (*Anadara* spp)-laboratory and field trials
- ☐ Market study of consumer preferences related to black cockles







Spat collection for native oysters Crassostrea corteziensis

- ☐ Spat abundant-could support a large industry
- ☐ Spat growth slow in nursery system, possibly related to El Niño







Carrying Capacity of Boca de Camichin

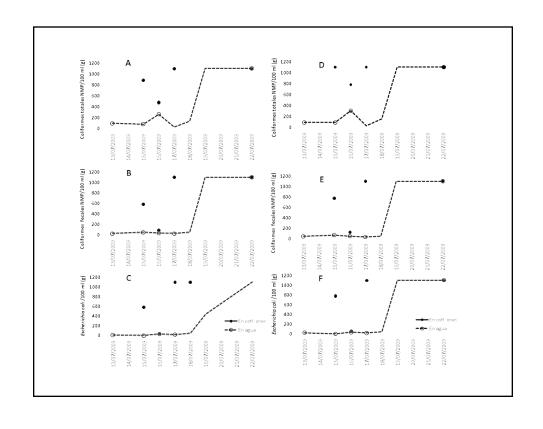
- □ System is predominantly heterotrophic during all seasons
- □ While carrying capacity has not been exceeded, caution is indicated
- □ Reduction in freshwater flows, decrease in tidal flows or increases in organic matter could negatively affect water quality
- Oyster industry should not be expanded at the moment
- □ Caution indicated with infrastructure creation and development

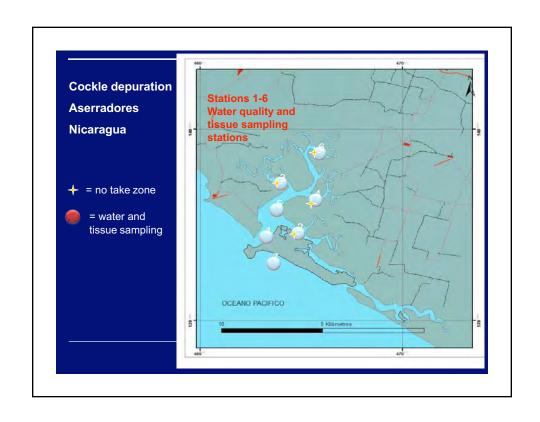


Oyster and cockle depuration

□ Relay and depuration tested in Mexico and Nicaragua







Cockle depuration, Nicaragua in laboratory

Time in tank	Fecal coliform (MPN/g)	E. coli (MPN/g)	Salmonella sp. UFC/ 25 g	Vibrio parahaemolyticus
0 hrs	330	330	Not detected	< 1.0x10 ³ UFC/g
4 hrs	78	78	Not detected	< 1.0x10 ³ UFC/g
8 hrs	78	78	Not detected	< 1.0x10 ³ UFC/g
12 hrs	20	20	Not detected	< 1.0x10 ³ UFC/g
24 hrs	< 20	< 20	Not detected	< 1.0x10 ³ UFC/g
48 hrs	< 20	< 20	Not detected	< 1.0x10 ³ UFC/g
72 hrs	< 20	< 20	Not detected	< 1.0x10 ³ UFC/g

Cockle depuration Field site

Depuration time	Fecal coliform (MPN/g)	E.coli (MPN/g)	Salmonella sp UFC/ 25 g	Vibrio parahaemolyticus
0 hrs	170	130	Re-testing	< 1.0x10 ² UFC/g
4 hrs	350	130	Re-testing	< 1.0x10 ² UFC/g
8 hrs	50	20	Re-testing	< 1.0x10 ² UFC/g
12 hrs	20	20	Re-testing	< 1.0x10 ² UFC/g
24 hrs	<20	<20	Re-testing	< 1.0x10 ² UFC/g
48 hrs	65	50	Re-testing	< 1.0x10 ² UFC/g
72 hrs	170	<20	Re-testing	< 1.0x10 ² UFC/g

Oyster and cockle depuration

- □ Relay and depuration tested in Mexico and Nicaragua
- Mexico
 - C. corteziensis depuration only partially successful
- Nicaragua
 - Cockle depuration rates documented in laboratory and field in Nicaragua
 - Depuration in selected sites could be a practical approach in Nicaraguan estuaries

Cockle market study

- □ Consumers and vendors concerned about cockle safety but believe that live product is safe
- □ Low awareness of shellfish sanitation
- □ As much as half of production is legally or illegally exported, making this a regional health issue
- □ Price is stable; stakeholders satisfied with price and quality except for cockle collectors
- □ Results suggest that depurated or certified product could increase acceptability and price





Next steps

- □ Development of small, multi-purpose bivalve hatchery at the University of Sinaloa
 - C. gigas, C. sikamea, C. corteziensis
- ☐ Continued technical support to shellfish farmers
- ☐ Increasing participation of coastal women and girls in alternative livelihoods
- □ Continue and expand co-management of cockle fisheries







Funding for this research was provided by the



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DEVELOPMENT OF AN ELEOTRIDAE FISH, DORMITATOR LATIFRONS (PACIFIC FAT SLEEPER) FOR AQUACULTURE ON THE PACIFIC COASTS ECUADOR, NICARAGUA AND MEXICO

Haws, M.C*., Elao, R., Ochoa-Moreno, E., Guevara, G., Arriaga, L., Rodriquez-Montes de Oca, G., Gaxioloa-Camacho, E., Rodriguez-Dominguez, G., Crawford, B., and Hernandez, N., and Rivas-LeClair, C.

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Dormitator latifrons, an eleotridae fish, is widely distributed along the Pacific Coast of the Americas from Southern California to Northern Peru. Variously known as chame, popoyote or puyeque in Ecuador, Central America and Mexico, its pattern of consumption varies considerably over its range. In some areas such as the province of Manabi, Ecuador, it is a prized fish species. It is a valuable fisheries resource in southern Mexico, with 350 MT fished in 2005. Most commonly, it is considered a fish of last resort, consumed during hard times when other foods are scarce. Its flesh is firm, white and has a mild flavor. D. latifrons reproduces naturally in earthen ponds, and fingerlings are captured coastal wetland areas; hence fingerlings have been traditionally obtained in this way in Ecuador for extensive culture. This fish is extremely hardy, being euryhaline (0-42 ppt tolerance range), is omnivorous with detrivore habits, and can survive several days out of the water. D. latifrons is closely associated with freshwater and brackish water wetlands.

Given these characteristics, this species appeared to be a natural candidate for aquaculture development in Ecuador, as part of an integrated coastal management program sponsored by the Sustainable Coastal Communities and Ecosystems (SUCCESS) and related efforts supported by the Aquaculture and Fisheries Collaborative Research Support Program (AquaFish CRSP), both funded by USAID. In 2005, work began in Cojimies, Ecuador with culture trials conducted with small-scale farmers. Culture of *D. latifrons* was chosen as an alternative livelihood for the coastal management effort due to its linkage with threatened wetlands, the possibility of polyculture with shrimp, and to provide a monoculture species for poorer stakeholders without resources for shrimp culture. Considerable success was encountered in both monoculture and polyculture of this fish. Fish up to 220 g have been obtained in six months using extensive methods; up to 450 g can be obtained using formulated feeds. In the case of extensive culture, fish were stocked at a rate of 1-2/m2. Feeding was variable, ranging from locally available sources such as ground corn and green plantains, supplemented in the case of polyculture with commercial shrimp feed. Fertilization was also practiced.

In 2008, the AquaFish CRSP supported a study of the potential for further regional development of D. latifrons for aquaculture. Potential was found to be high, if the problem of hatchery production of juveniles can be overcome. Protection of coastal wetlands is also key to maintaining this species as a viable fisheries resource.



Dormitator latifrons

- □ Common names:
 - Pacific fat sleeper
 - Puyeque
 - Popoyote
 - Chame



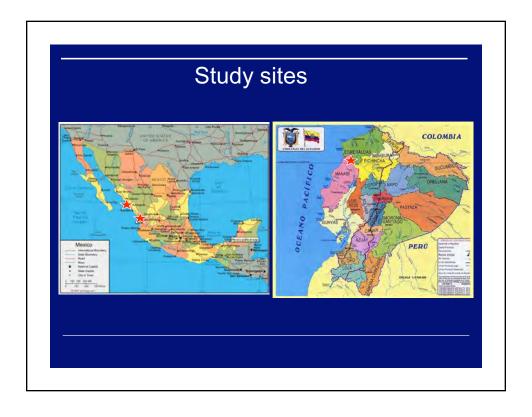
Potential for Aquaculture

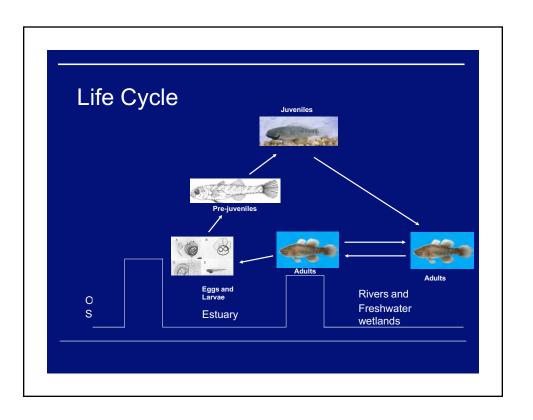
- □ Previous trials demonstrate:
 - High growth rates
 - Natural reproduction in ponds
 - Omnivorous diet
 - Locally-sourced foods
 - Hardy, can survive in moist conditions for several days
 - Easily cultured by novice farmers

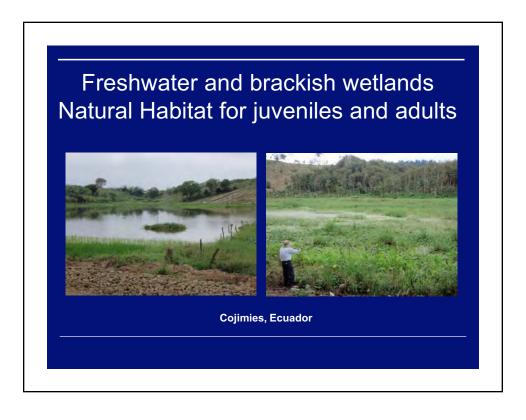
Relevance to AquaFish CRSP priorities

- □ Development of local species
- □ Low-trophic level species
- □ Food security for poor communities
- Integrated approaches to fisheries and aquaculture
- □ Potential benefits to socially marginalized stakeholders, including women









Abundance in Sinaloa? Yes!!!





www.noroeste.com.mx

Ecuador

- ☐ Considered a delicacy in the province of Manabi, Ecuador
- ☐ Grow-out trials under USAID-SUCCESS program
- □ Threatened, rare or extinct in some regions
- Further development limited by fingerling scarcity
- □ Due to wetlands destruction/degradation
- Only source in some areas is from shrimp ponds

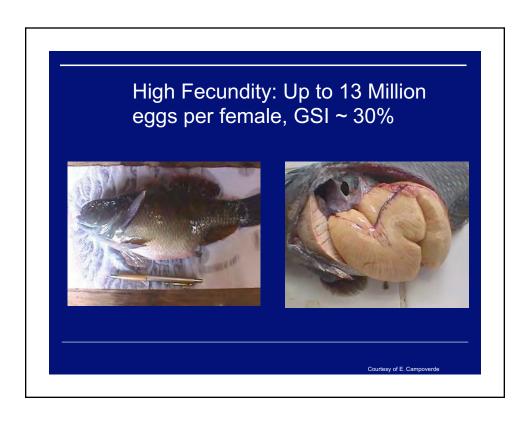
Research priorities for further development

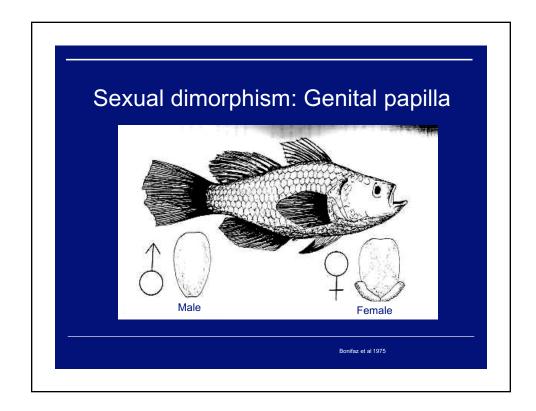
- Resolve fingerling shortage-induced spawning methods
- ☐ Fisheries population assessment
- Development of improved, locally available feeds
- ☐ Marketing tests and promotion

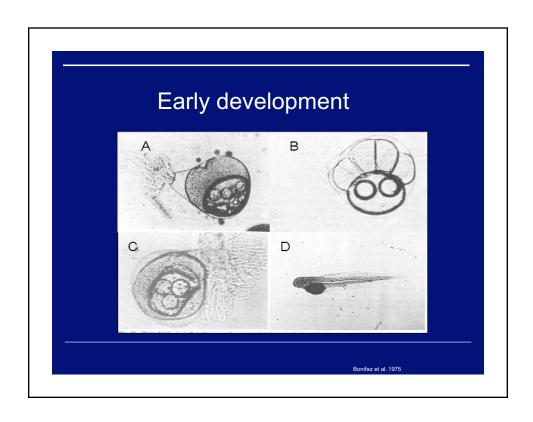
Feeding habits in natural habitats

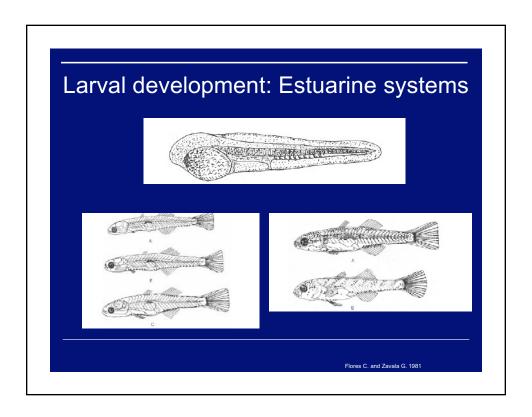
- □ Larvae → phythonand zooplankton
- ☐ Juveniles and adults→
 detritus

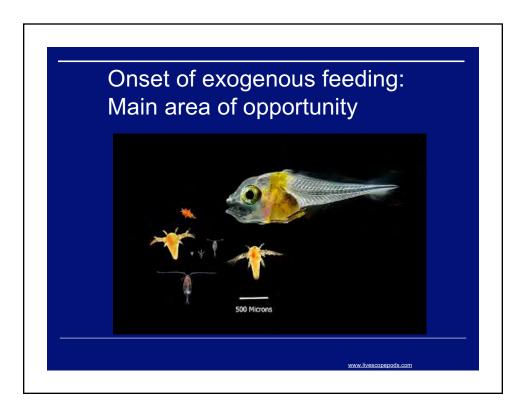












Capture and commercialization in México States: Guerrero, Oaxaca y Chiapas Capture levels Aprox. 400 MT per year Market price. \$60.00 pesos per kilo (fillet)= ~\$4.10 USD

Culture in Ecuador

- □ Only country with reported aquaculture production
- ☐ Mainly in the Manabi province
 - 2,000 MT in 1993, going down to 45 MT per year as 2002
 - Situation?
 - □ Cultured fish are wild capture (100%), mostly 3-5 cm juveniles
 - □ Disappearing wetlands = dwindling source of fingerlings

Main Goal: Juvenile production





Main areas of oportunity:

- Juvenile production in laboratory conditions: has not been achieved
- □ Promote consumption to overcome stigma
- □ Culture conditions in terms of:
 - High density rearing
 - Polyculture
 - Nutritional requirements for optimal growth in commercial culture







INDUCED REPRODUCTION OF THE FAT SNOOK CENTROPOMUS PARALLELUS IN CAPTIVITY USING GNRH-A INJECTIONS AND IMPLANTS

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The common snook (*Centropomus parallelus*), is a species of fish widely distributed in the Atlantic coast of America, from southern United States to southern Brazil. In Mexico, is particularly common in the states of Tamaulipas, Veracruz and Tabasco, having a large market since the species is highly appreciated. In recent years, our laboratory has dedicated efforts to contribute to the development of the technological package for snook culture. In the current study, we conducted two experiments to induce spawnings of *C. parallelus* using GnRH-a injections and implants. Our goal was to evaluate the effectiveness of the hormone and determine egg and larvae quality. In the first experiment we evaluated injections using a control and two different hormone dosages (0, 75 and 150 mg/kg), egg size was evaluated before and after injections using cannulation since females did not spawn. In the second experiment, implants were evaluated using a control and two different hormone dosages (0, 100 and 200 mg/fish), egg and larvae quality were evaluated.

Our results indicate that injections were not effective inducing spawnings; however, egg size increased considerably in females were the dose of 150 mg/kg was used (fig. 1). In experiment 2, spawnings were obtained from both dosages evaluated. Fish in the control group did not spawn. Eggs obtained from fish implanted with 100 and 200 mg/fish had no significant differences in egg size (fig. 2). Fertilization rate was 100% for both dosages. Larval size was similar for both species.

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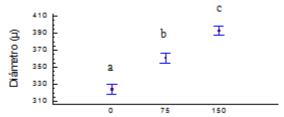


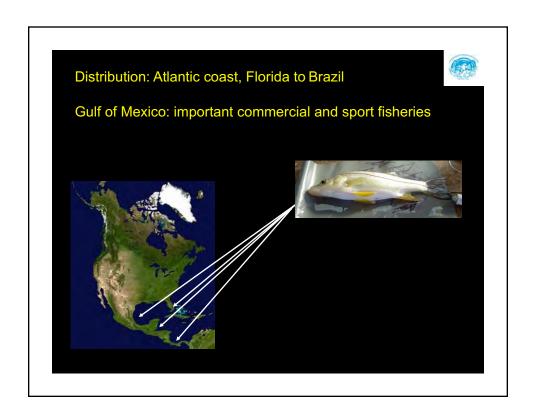
Figure 1. Egg diameter after injections in exp. 1. Different letters indicate significant differences.

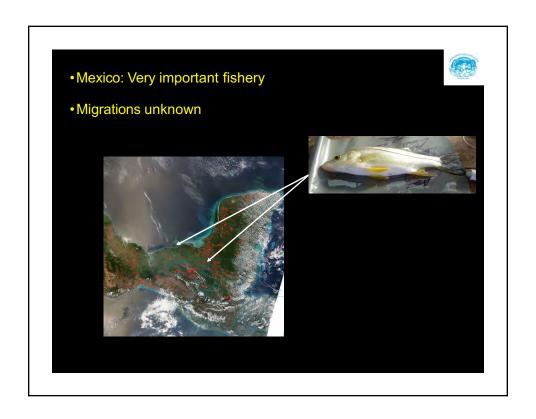


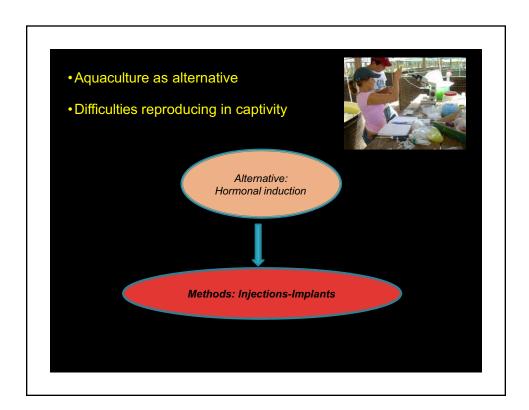
Figure 2. Diameter of eggs obtained after spawnings in experiment 2.











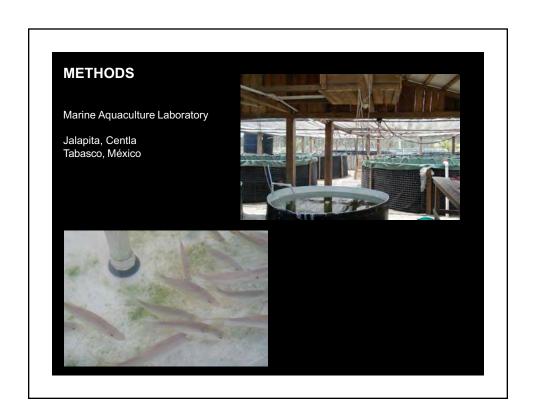
OBJETIVES

GENERAL:

To evaluate induction of reproduction in *Centropomus parallelus* under captivity using GnRH-a injections and implants.

PARTICULAR:

- •To evaluate effectiveness of GnRH-a injections and implants ewhen inducing reproduction of *Centropomus parallelus*.
- To determine egg and larval quality obtained.









Experimental design: Complete Random block Three treatments

Four pseudo-replications (through time)





Average weight and Length

Females 252 - 540 g 26 - 35 cm

Males 155 - 305 g 25 - 33 cm

• RECIRCULATION SYSTEMS

2000 L Tanks connected to a sand filter

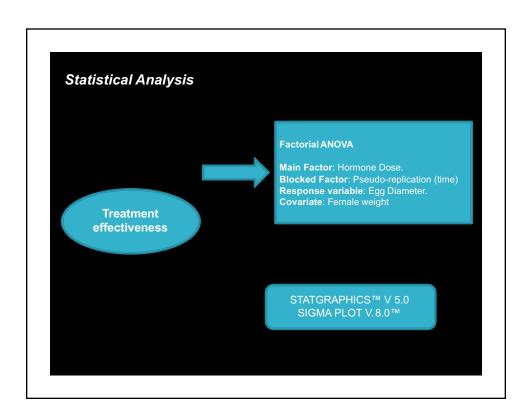
plástico de 30 L para colectar los huevos con una malla de 400 µ

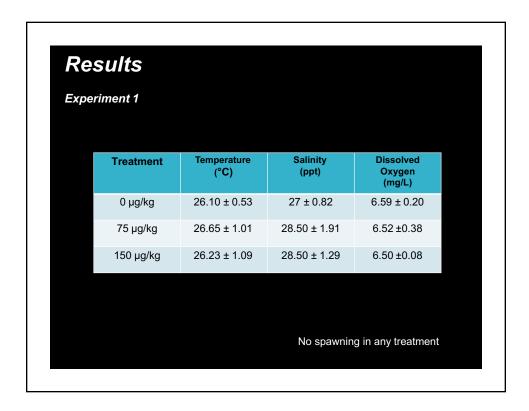


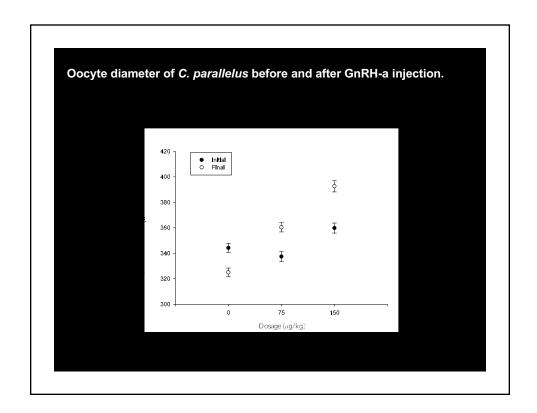


•EGG COLLECTORS

Each tank had an egg collector made of 400 μ mesh placed inside a 30 L plastic tank







Results Experiment 2 GnRH-a Injections

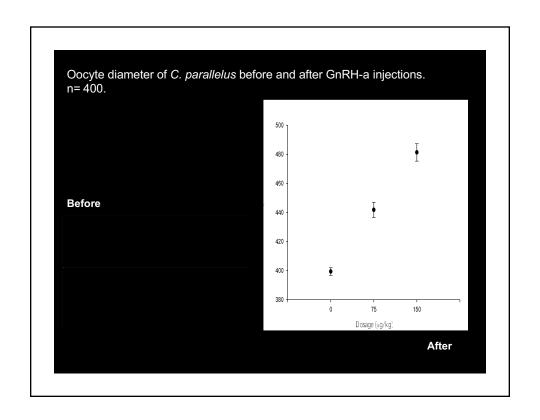
Female weight and length 174 - 452 g 27 - 37 cm

Male weight and length 144 - 394 g 25.6 - 34.5 cm

Temperature: 27.8 °C Salinity: 35

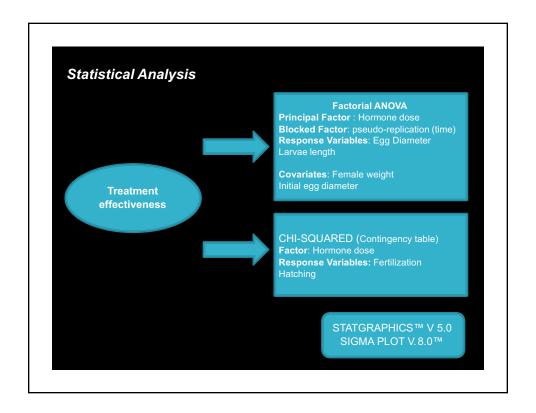
• Dissolved Oxygen: 6.85

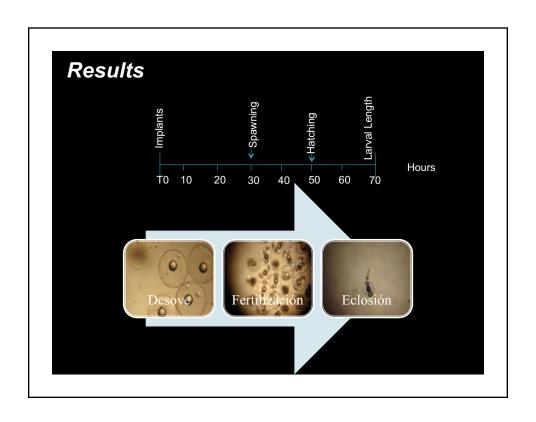
Treatments	Temperature (°C)	Salinity (ppm)	Dissolved Oxygen (mg/L)
0 μg/kg	26.10 ± 0.53	27 ± 0.82	6.59 ± 0.20
75 μg/kg	26.65 ± 1.01	28.50 ± 1.91	6.52 ±0.38
150 µg/kg	26.23 ± 1.09	28.50 ± 1.29	6.50 ±0.08

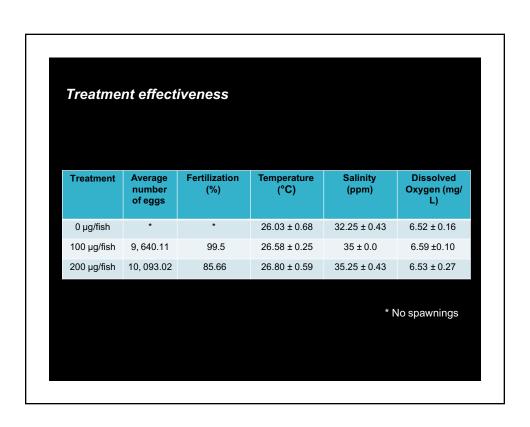


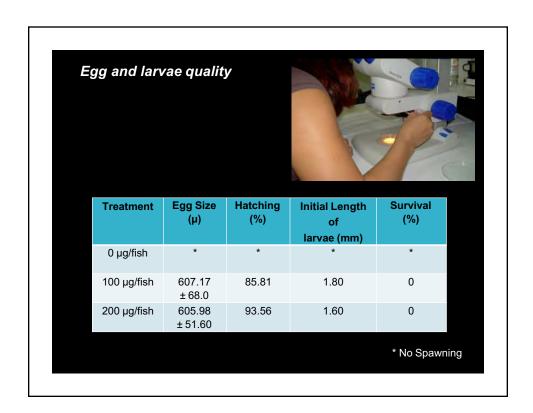


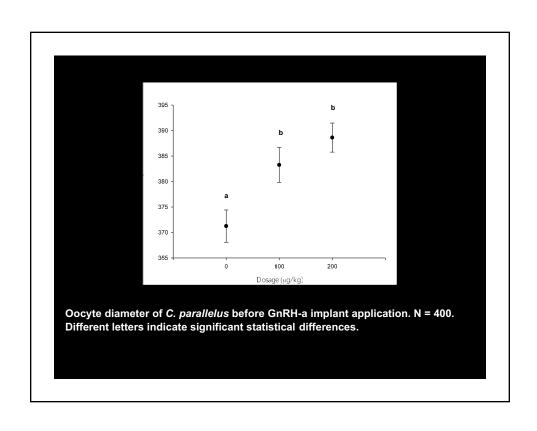


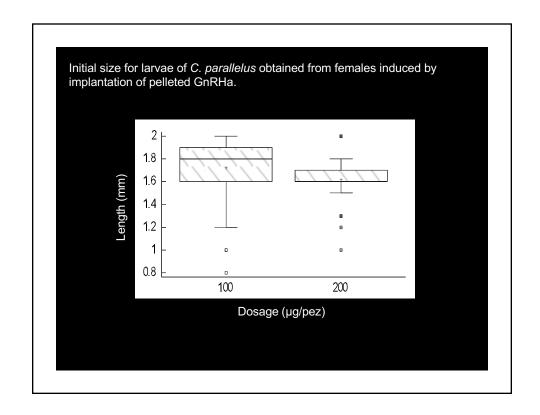


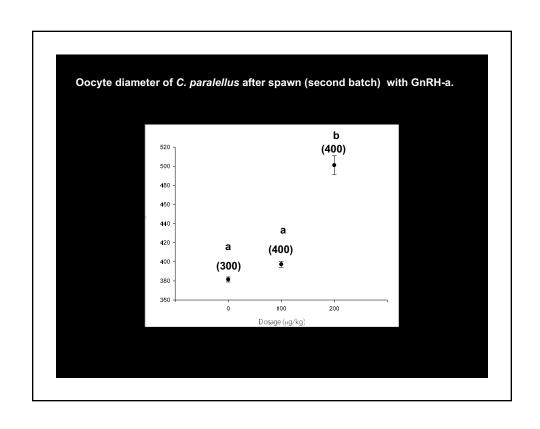












Conclusions

Injections

75 and 150 µg injections were effective inducing egg maturation, but no spawnings were obtained

Implants

100 and 200 µg of GnRH-a implants were effective

- 1. Maturation
- 2. Spawning
- 3. Larvae production

Funding for this research was provided by the



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ISOLATION AND CHARACTERIZATION OF BACTERIA FROM BIOFILMS FORMED IN FILTERS USED TO ELIMINATE METHYLTESTOSTERONE FROM INTESIVE TILAPIA MASCULINIZATION SYSTEMS

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Methyltestosterone (MT) is commonly used in aquaculture to produce all-male populations; particularly in the tilapia industry. To reduce the potential contamination of effluents from farms, we have proposed the use of filters that trap MT in activated charcoal. These filters have also a biofiltration component where microbial populations are easily formed. We hypothesized that some of the MT degradation occurs in the biofilter due to the active use of MT as carbon source. Therefore, we proposed: a) isolate and characterize heterotrophic bacteria obtained from biofilms formed in a filtration system used for tilapia (Oreochromis niloticus) masculinization, and b) determine the capacity of adaptation of isolated bacteria in a culture media enriched with MT as the only source of carbon. Primary isolates were obtained from biofilms collected at 7, 11, 20 and 28 days of the masculinization trial. Isolates were inoculated in nutritious agar and eosinmethylene blue agar. Identification was conducted using API WEB and dichotomic keys (Koneman et al., 1999). Adaptation trials were conducted in flasks containing mineral medium enriched with MT (45 mg/100 ml) as the only carbon source. Each flask was inoculated with 2ml of a bacterial suspension (0.5 in the McFarland scale) and incubated at 30 with agitation at 175 rpm for 26 days. Adaptation was measured by counting bacteria daily using the plate counting method.

We isolated and characterized *Bacillus ceresus*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Pseudomonas fluorescens* and *Serratia marcescens*. All of them were able of using MT as source of carbon and energy. *P. aeruginosa* was the species with the fastest adaptation; initial growth was perceived at 48 hours and reached the highest number of microorganisms. *B. subtilis y P. fluorescens* showed initial growth at 72 hours while *B. ceresus y S. marcescens* initiated growth later (96 and 198 hours, respectively (fig. 1). *P. aeruginosa* seems to be a species capable of utilizing a large amount of organic compounds as substrate to grow. This capability allows it to colonize niches and inhospitable environments where nutrients are scarce. Our results indicate that the bacteria we isolated are potential MT biodegraders.

Funding for this research was provided by F&A CRSP. Project 07MNE06UA under Grant No. EPP-A-00-06-00012-00 from the United States Agency for International Development (USAID).

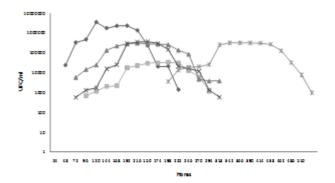
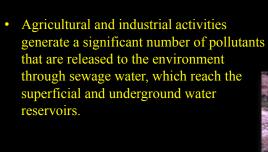


Figure 1. Growth kinetics of bacteria in mineral medium enriched with MT.

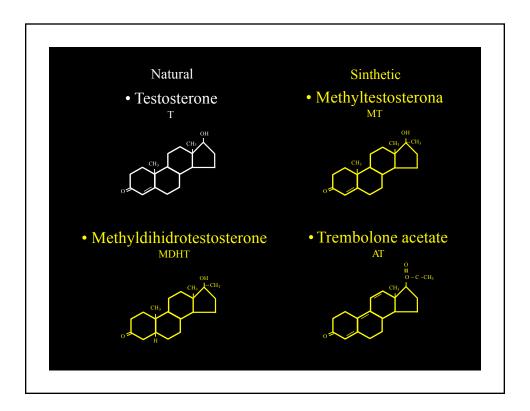
P. aeruginosa;
B. ceresus;
P. fluorescens;
S. marcescens.

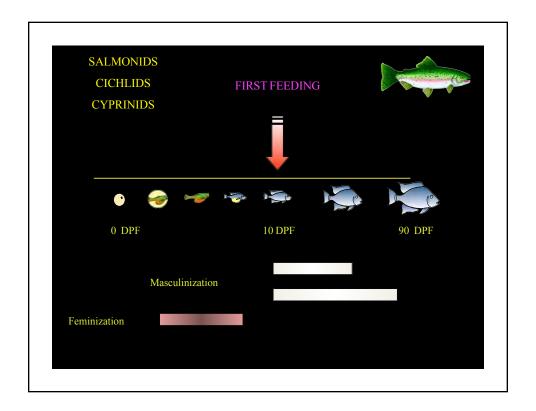










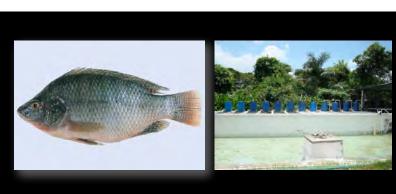


Water treatments aim at

- 1)Eliminating waste, floating fats and oils, sand, and all other coarse elements water may contain;
- 2)Eliminating decantable materials, both organic and inorganic (MT);
- 3)Eliminating biodegradable organic matter dissolved in water; and
- 4)Stabilizing and disposing mud extracted as a result of those processes







Another possible approach to eliminating MT from masculinization systems involves the use of bacterial degradation since it has been reported that some bacteria are capable of degrading steroids (Voishvillo et al, 2004).

OBJECTIVE

The goal of our research was to isolate, characterize and cultivate the species of bacteria responsible for degradation of steroids and determine if bacteria present in biofilters capable of degrading MT.



Isolation of microorganisms

- Heterotrophic bacterial colonies were obtained from biological filter units present in our masculinization tanks
- Samples for inoculation were obtained from a traditional 28-day MT-masculinization process (60 mg/kg of food feeding regime).





Identification of microorganisms

- Samples were collected on days 7, 11, 20 and 28. Culture media used for this phase were nutritive agar, methylene blue and eosin based agar.
- Bacteria identification was performed using the identification system API WEB (Biomérieux™)















Experiment 1. Use of bacterial degradation

To evaluate the MT degradation capacity based on its use as carbon source; based on Perez *et al.*, (2006) containing different 17 α -Methyl testosterone (Argent Labs) concentrations for each 100 mL of culture media (1 μ g; 10 and 40 mg MT).

Reagent	Concentration (g/L) used by genus		
	Pseudomonas	Bacillus	Serratia
$(NH4)_2SO_4$		1	2.38
NH ₄ Cl	0.1	-	-
CaCl ₂	0.001	0.1	14.7
MgSO ₄ .7H ₂ O	0.05	0.1	0.246
K ₂ HPO ₄ .3H ₂ O	0.1	6.3	-
$KH_2PO_4.7H_2O$	0.05	1.83	1.36
FeSO ₄ .7H ₂ O	0.001	0.1	0.003
KCL	0.01	-	-
Na ₂ HPO ₄ .7H ₂ O		-	2.68

Treatment

- Erlenmeyer flasks containing 100 mL of culture media were inoculated with 2 mL of bacterial suspension containing 15 x 10-8 CFU/ 100 mL (0.5 Mc Farland turbidimetric units).
- Flasks were placed in a temperature-controlled shaker bath and maintained to constant temperature and agitation (30° C @ 175 rpm) during a culture period of 20 days.







Treatment

Treatment		
1) Control:	No bacterial colonies	
	added.	
2) BC1	Pseudomonas aeruginosa	
3) BC2	Pseudomonas fluorescens	
4) BC3	Bacillus subtilis	
5) BC4	Bacillus cereus	
6) BC5	Serratia marcescens	











Determination of MT to assess the capacity gradient

General sampling days were for all treatments on day: 0 (before bacteria added), 2, 6, 10, 16 and 20. All samples were frozen (-20°C)

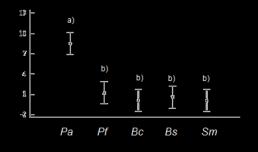
The MT concentration was measured by Metiltestosterone EIA Ridascreen $^{\text{TM}}$ determination kit (R3601, r-Biopharm) and data were processed by RIDA®SOFT Win software to obtain the final concentration.

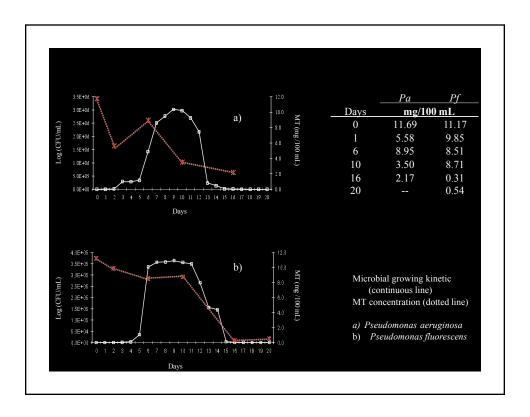


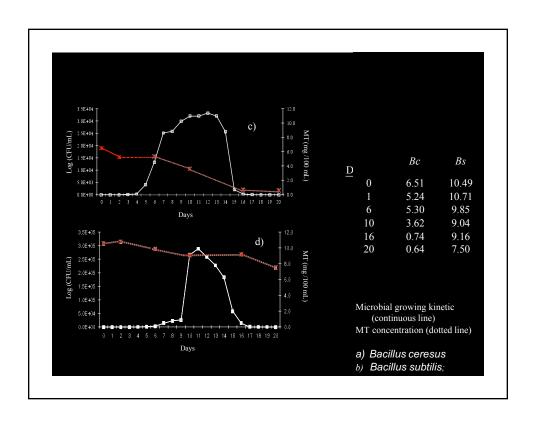
Results

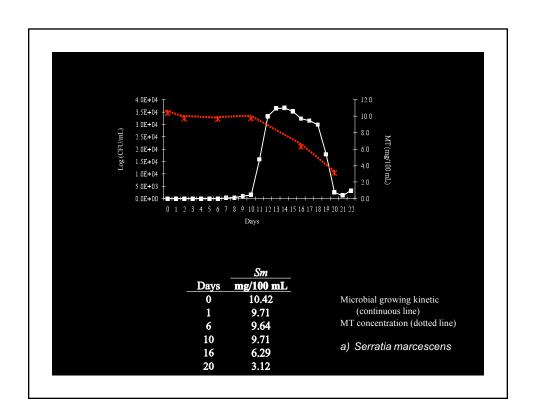
Average (\pm SE) of total microorganism concentration observed at day 22 of culture in mineral media enriched with 40 mg/100 mL of MT.

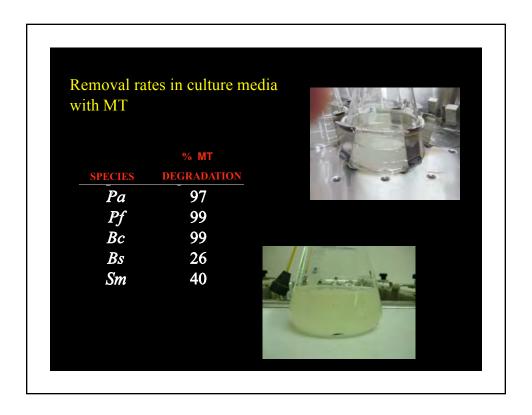
- Pa) Pseudomonas aeruginosa
- Pf) Pseudomonas fluorescens
- Bc) Bacillus ceresus
- Bs) Bacillus subtilis
- Sm) Serratia marcescens

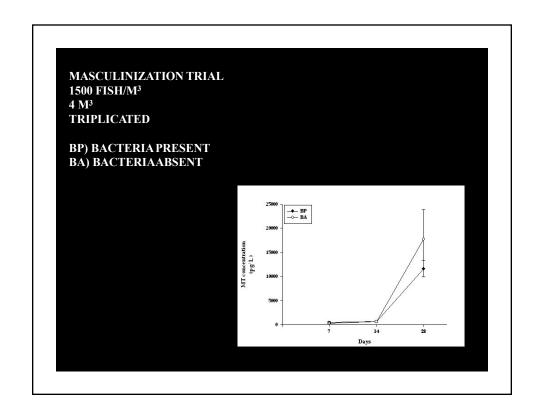












SURVIVAL AND GROWTH Survival (%) Males (%) Treatment Bacteria Present (BP) 20.6 ± 5.06a 100 Bacteria Absent (BA) 16.8 ± 2.71^{b} 100 Treatment Weight Bacteria Present (BP) 0.26 (± 0.38 g)a n=300 Bacteria Absent (BA) 0.18 (± 0.35 g)^b n=300

CONCLUSIONS

- Our results strengthen the idea that biodegradation of 17α -Metyltestosterone can be effectively achieved with bacterial biofiltration using the species isolated in our masculinization systems.
- All species tested (*Pseudomonas fluorescens*, *Pseudomonas aeruginosa*, *Bacillus subtillus*, *Bacillus ceresus y Serratia marcescens*) showed significant biodegradation of MT, in culture media.



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