FEED THE FUTURE INNOVATION LAB FOR COLLABORATIVE RESEARCH ON AQUACULTURE & FISHERIES (AQUAFISH INNOVATION LAB)

IMPLEMENTATION PLAN 2013-2015
ADDENDUM II

AUGUST 2015

AquaFish Management Office
Oregon State University
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USAID FROM THE AMERICAN PEOPLE

Oregon State University OSU

AQUAFISH INNOVATION LAB

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IMPLEMENTATION PLAN 2013-2015, ADDENDUM II

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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.

Disclaimers

Cover Photo

Carrying a basket of *Pangasius* in Bangladesh. Photo courtesy of Lokman Ali.

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INTRODUCTION

This second addendum to the AquaFish *Implementation Plan 2013-2015* includes a revised Work Plan for a North Carolina State University (NCSU) investigation entitled, *The Culture Potential of Pangasius Catfish in Brackish (Hyposaline) Waters of the Greater Barisal Regions in Southern Bangladesh* (13BMA02NC).

The researchers successfully completed the first study of this investigation and demonstrated that *Pangasius* can be grown in brackish waters (with salinities as high as 12 ppt) with no negative impact on production or economics relative to standard freshwater culture. In the second study of this investigation, NCSU had originally proposed culturing *Pangasius* in brackish water with mullet species, however, they were unable to collect enough mullet seed for the second study as they had intended. The revised Work Plan eliminates testing mullet in polyculture with *Pangasius* and instead extends the findings from the first study to evaluate the effect of higher stocking density of *Pangasius* in brackishwater and compares feed types (formulated versus commercial diet). The results of this revised study will provide for the potential to enhance intensification of *Pangasius* culture in brackish water (increased density), and would allow farmers the capacity to use their own formulated feed rather than more expensive commercial feeds for *Pangasius* growout in coastal regions impacted by increased water salinization.

This Work Plan change was reviewed by AquaFish Regional Centers of Excellence (RCE), External Panel Advisory Council (EPAC), and Development Theme Advisory Panel (DTAP) coordinators, as well as by the AquaFish Management Team. The revised Work Plan included in this second addendum was approved by the AquaFish Management Team on 15 July 2015, and replaces the version included in the AquaFish *Implementation Plan 2013-2015*.

RESEARCH PROJECT INVESTIGATION

TOPIC AREA

PRODUCTION SYSTEM DESIGN & BEST MANAGEMENT ALTERNATIVES

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ASIA PROJECT: BANGLADESH - *Enhancing Aquaculture Production Efficiency, Sustainability, and Adaptive Measures to Climate Change Impacts in Bangladesh*

Revised Work Plan

THE CULTURE POTENTIAL OF PANGASIUS CATFISH IN BRACKISH (HYPOSALINE) WATERS OF THE GREATER BARISAL REGIONS IN SOUTHERN BANGLADESH

Production System Design and Best Management Alternatives/Experiment/13BMA02NC

Collaborating Institutions and Lead Investigators

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Objectives

1. Evaluate whether the culture of freshwater *Pangasius* catfish can be successfully cultured in seawater- encroached hyposaline waters of coastal Southern region of Bangladesh.
2. Assess effect of increased stocking density and formulated diet on *Pangasius* culture in hyposaline waters.
3. Evaluate potential economic impacts for *Pangasius* culture in hyposaline environments.

Significance

In Bangladesh, *Pangasius* catfish is considered as one of the most successful aquaculture species due to its relative ease in culture, high-market demand, and suitability to local climate conditions (Rahman *et al.,* 2005; Rahman, *et al*. 2012; Sarker, 2000). The focus of this investigation is to assess the potential for expanding the culture of *Pangasius* to Southern regions containing significant amounts of brackish (hyposaline) waters, the areas that are severely impacted by overfishing and global climate change (*e.g*., seawater encroachment, storms) and are currently underutilized for fish production. Production of *Pangasius* could theoretically ease poverty reductions for millions of low-income people in Southern Bangladesh by creating better employment opportunities through development of activities with backward and forward linkages to the market chain. Additionally, we will assess if indigenous mullet species (striped and goldspot mullet) can be incorporated into *Pangasius* culture to achieve better production yields (therefore better income earnings), potential improvements in environmental water quality through more efficient nutrient utilization, and improving nutrition through greater diversification of food resources in the coastal regions (greater Barisal District).

The river catfish (*Pangasius hypopthalamus*) was introduced to Bangladesh in 1990's, and since then it has become a thriving aquaculture industry with over 300,000 tonnes produced annually (Ali, *et al*. 2011; Edward and Hossain, 2010; Munir, 2009). Currently, much of the *Pangasius* production comes from the North and Central regions of Bangladesh (*e.g*., greater Mymensingh). In these regions, *Pangasius* are cultured both intensively with commercial feeds, semi-intensively (with limited feed), and in extensive (no feed) polyculture with both tilapia and carp (Ahmed, *et al*. 2010). High disease resistance, along with high stocking density with greater production rates (up to 120 fish /m^2, average 40 tonnes / ha; UNFAO, 2010), make *Pangasius* an ideal cultivar for increasing aquaculture production in Bangladesh, particularly in regions unfamiliar with farming this species, as well as reducing the burden of population growth. The greater Barisal district is one such region, which has traditionally relied on fishing or aquaculture of marine species (*e.g*., shrimp) for their economic livelihoods. Through over-fishing and the increasing frequency of natural calamities like cyclones (*e.g.* Sidr, Aila), this region is nearing depletion of wild fish stocks and currently over half a million fishermen have been suffering from severe poverty. Introducing *Pangasius* aquaculture to these coastal communities, whose water resources are largely underutilized, may significantly enhance the dietary consumption of protein for low-income families, as well as provide new sources of income and employment in an area.

Some studies suggest *Pangasius sp.* may be tolerant of salinity (David, 1962). Recently, juveniles of *Pangasius* catfish are reported to tolerate salinities up to 13 ppt without significant mortality (Castaneda *et al.,* 2010). Before significant resources can be allocated for promoting this industry in coastal regions, the growth performance of *Pangasius* in hyposaline waters must first be evaluated. Through increasing tidal (seawater) encroachment and storms, nearly 40 percent of the farmable water bodies in the greater Barisal district are now hyposaline (0.5 to 7.5 ppt), and this percentage is expected to increase in future years. This has significantly impacted culture of traditional freshwater species in the area. If *Pangasius* culture can be achieved in greater Barisal and other coastal regions, the production levels of this fish could effectively double (600,000 metric tones), thus may significantly impact the diet and economic viability of coastal communities. As similar problems exist for the lower Mekong Delta in Vietnam (Halls and Johns, 2013), a better understanding of growth performance and salinity tolerance can benefit aquaculture production throughout South-East and Central Asia. This investigation will focus on the salinity ranges endemic to coastal in-land regions of Southern Bangladesh (0-8 ppt) to assess the economic feasibility of pangasius culture in these locales. The results from these studies will be presented at the AquaFish Innovative Lab Project Workshop and Farmers' Day.

Quantified Anticipated Benefits

1. We anticipate that culture of *Pangasius* catfish in hyposaline, brackish waters will yield similar production and economic returns as fish farmed in freshwater.
2. Culture of *Pangasius* catfish in brackish-waters of Southern Bangladesh has the potential to enhance annual aquaculture production to 600,000 metric tonnes.
3. We anticipate that successful development of this project will increase livelihood options and better food-security for low-income families impacted by overfishing and rises in sea level (global climate change).
4. Greater production of *Pangasius* will lead to increases in employment opportunities in coastal communities, economies which are traditionally disaffected by global climate change events (*e.g.*, cyclone damage to fishing boats).

Plan of Work

Location

These studies will be performed in two districts of coastal Bangladesh, the Barisal district (Bakerganj Upajila village) and the Pauakhali district (Kotwali Upazila village).

Methods

1. Evaluate the growth performance of pangasius catfish cultured in brackish (hyposaline) water.
This study will assess whether pangasius catfish can be successfully cultured in the brackish water ponds of Southern Bangladesh (Barisal District), therefore the experimental design must reflect the surface water salinities in this farming region (2-8 ppt). Using ponds from participating farmers as well as those utilized for research by the Upazila Fisheries Office (Mr. Abdul Aziz), we will contrast *Pangasius* production under two salinity treatment ranges, each replicated with an on-site freshwater control group (T1). The proposed design is as follows:

Parameter	Treatment 1	Treatment 2	Treatment 3
Pangasius fingerlings	800 (2.0/m^2)	800 (2.0/m^2)	800 (2.0/m^2)
Salinity range (ppt)	0-0.5	2-5	>5-8
Feeding	std. regimen	std. regimen	std. regimen
Replicates (*n*)	6	3	3

Surface water salinities fluctuate extrinsically, and likely will not vary enough within a given locale to fully represent all treatment groups. Therefore, this design contrasts two salinity *ranges* at different test sites (T2 area 2-5 ppt, T3 area >5-8 ppt), with each also containing a freshwater control (T1) regulated from available ground water resources (additional site selection criteria). This will enable each of two treatments (n=3) to be contrasted against the current *Pangasius* culture practice (n=6). The availability of fresh well water also allows for the surface water salinity of the treatment ponds to be adjusted downwards, if needed due to high temperatures or drought. The historically stable hyposaline areas will be used for treatments T2 and T3.

All ponds (400 m^2) will be dried and limed (5 g/m^2 CaCO3) according to standard practice, and fertilized one week prior to stocking (28 kg N; 7 kg P/ ha). *Pangasius* fingerlings (7.5-10 cm) will be stocked in all ponds for a 180-day grow-out period. Fish will be fed commercial floating feed (30% CP; Mega Feed, commercially produced in Bangladesh) using a standard *Pangasius* feeding regimes: 10% BW from 0-30 days, 7.5 % BW from 30-60 days, 5 % BW from 60-90 days, and 3% BW thereafter. Feed amounts will be recorded for cost-benefit analysis performed at the end of study. Growth performance (weights/ lengths) will be taken by monthly sub-sampling of all ponds, with feeding rates adjusted at these times. Salinity, temperature, and water quality (turbidity, pH, alkalinity and DO) will be measured every week on site, with additional analysis of ammonia, nitrite, nitrate and phosphate performed at the Water Quality and Pond Dynamics Laboratory (BAU). Salinity treatment groups (T2, T3) will be tested for significant differences in survival, growth (mean length and weight), growth efficiency (specific growth rates, feed conversion ratio), and water quality parameters with respect to the control group (T1) using One Way Analysis of Variance (ANOVA). A marginal cost-benefit analysis will be determined for each salinity trial incorporating total production yields (kg), expected market returns, feed and labor and other input costs.
Null Hypothesis 1: No difference in growth performance, water quality, or economic return is observed with Pangasius cultured at 2-5 ppt salinity compared to those cultured in freshwater.
Null Hypothesis 2: No difference in growth performance, water quality, or economic return is observed with pangasius cultured at >5-8 ppt salinity compared to those cultured in freshwater.

2. Evaluate effects of increased stocking density and formulated diets on growth performance of Pangasius in hyposaline waters. -
This study will evaluate the effect of a higher stocking density (3 fish/m^2 vs 2 fish/m^2) and feed type (formulated vs commercial diet) on Pangasius culture in brackishwater. This study will provide information that could further increase the profitability of growing Pangasius in brackish water as it

provides for the potential to enhance intensification (increased density) and would allow farmers the capacity to use formulated feed rather than more expensive commercial diets in growing Pangasius in coastal regions impacted by increased water salinization. Ponds (N = 12; 400 m^2) from the Patuakhali District will be utilized for this study, with specific site selection dependent on the salinity range (T2, T3; Exp. 1) yielding the best economic parameters for *Pangasius* culture (see Expt 1). The study will be performed with the following experimental design (n = 4):

Parameter	Treatment 1 - control	Treatment 2	Treatment 3	Treatment 4
Pangasius Fingerlings	800 (2.0/m^2)	1200 (3.0/m^2)	800 (2.0/m^2)	
Salinity Range (Ppt)	best of Expt. 1	best of Expt. 1	best of Expt. 1	
Feeding	std. regimen commercial diet	std. regimen commercial diet	std. regimen formulated diet	
Replicates (*N*)	3	3	3	

The proposed design contrasts *Pangasius* grown on a commercial diet (CP, 30% protein) at a standard stocking density (2 fish/m2) under the best brackishwater condition determined from study 1 (T1 - control) with that of fish grown at a higher stocking density (T2; 3 fish/m2) or on a formulated diet (T3). The preparation and fertilization of pondsand feeding regimen for pangasius will be performed as described in Experiment 1. For treatment 2 fish stocking density will be increased by 50% (3 fish/m2) and for treatment 3 fish will be fed a formulated diet rather than a commercial one. The formulated diet will consist of fishmeal, rice bran, wheat bran, mustard oil cake, flower, binder and vitamin-mineral premix. The feed will be pelleted using a low cost pellet machine. Animals will be grown out for 4 months to marketable size.

Growth and water quality measurements will be collected as described previously, with food amounts recorded daily for economic analysis. All treatment groups will be tested for significant differences in survival, growth (mean length and weight), growth efficiency (specific growth rates, feed conversion ratio), and water quality using ANOVA. A marginal cost-benefit analysis will be determined incorporating total production yields (kg), expected market returns, feed and labor costs for these treatments.

Null Hypothesis: No improvement in growth, water quality, or economic returns is observed with pangasius cultured at a higher density or on formulated feed.

Schedule

May to Oct 2014: Study 1; pangasius catfish monoculture in brackish (hyposaline) water.
May to Sept 2015: Study 2; Monoculture trial of Pangasius stocked at higher density and fed formulated diet in brackish water.
Jan to Aug 2015: Analyses, technical report, present results at the AquaFish Project Workshop.

Deliverables

1. Identification of the viable salinity range for pangasius culture – growth metrics (specific growth rate, feed conversion ratio), feed costs, total production yield (kg) and estimated market return will be compared against freshwater culture (Study 1, T1) to identify whether Pangasius culture in hyposaline waters is economically viable. We anticipate equivalent production yields for at least the midrange (2-5 ppt) treatment group. The research trials will be done on-farm, and hence will directly benefit 12

participating farming households (~ 4800 m^2 of farming area) within the Host Country.

2. Improvements in Production Yield – Total production yield (kg) and estimated market return will be contrasted between pangasius grown at different salinities as well as fish grown at a higher density and with formulated diets. We anticipate improvements in returnswith pangasius cultured on formulated diet and at a higher density. The research trials will be done on-farm, and hence will directly benefit 12 participating farming households (~ 4800 m^2 of farming area) within the Host Country.

Documentation and Dissemination – Two students will receive training on Pangasius culture and its economic impacts as part of their thesis work. The findings from these studies will be documented through the Technical Reports of the AquaFish Innovation Lab, presentations through the AquaFish Innovative Lab Project Workshop, and peer-reviewed literature (1 manuscript). Should technologies for hyposaline culture of pangasius prove effective, then results will also be disseminated through production of an extension factsheet in the local language for wider outreach to farmers, extension agencies of the government, and NGOs.