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

IMPLEMENTATION PLAN 2013-2015
ADDENDUM

DECEMBER 2014

AquaFish Management Office
Oregon State University
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AQUAFISH INNOVATION LAB

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IMPLEMENTATION PLAN 2013-2015, ADDENDUM

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

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Tilapia at market, Africa. Photo By Jim Bowman.

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INTRODUCTION

This addendum to the AquaFish *Implementation Plan 2013-2015* includes a revised Work Plan for a University of Connecticut investigation entitled, *Sustainable Snakehead Aquaculture Development in the Lower Mekong Basin of Cambodia* (13IND02UC). The Work Plan was revised in order to provide clarification on objectives and methodologies, and was reviewed by AquaFish Regional Centers of Excellence (RCE) and Development Theme Advisory Panel (DTAP) coordinators, as well as by the AquaFish Management Team. The revised Work Plan included in this addendum was approved by the AquaFish Management Team on 30 April 2014, and replaces the version included in the AquaFish *Implementation Plan 2013-2015*.

RESEARCH PROJECT INVESTIGATION

TOPIC AREA

CLIMATE CHANGE ADAPTATION: INDIGENOUS SPECIES DEVELOPMENT

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ASIA PROJECT: CAMBODIA & VIETNAM - *Improving Food Security, Household Nutrition, and Trade Through Sustainable Aquaculture and Aquatic Resource Management in Cambodia and Vietnam*

Revised Work Plan

SUSTAINABLE SNAKEHEAD AQUACULTURE DEVELOPMENT IN THE LOWER MEKONG RIVER BASIN OF CAMBODIA

Climate Change Adaptation: Indigenous Species Development/Experiment/13IND02UC

Collaborating Institutions and Lead Investigators

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Inland Fisheries Research and Development Institute (Cambodia)	Dr. So Nam Mr. Nen Phanna
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Objectives

To compare performance of domesticated (Vietnamese) vs. non-domesticated (Cambodian) snakehead *Channa striata* with regard to weaning performance and grow-out on pellet feed.

The specific objectives of this investigation are as follows:

- To evaluate the survival rate and growth performance of the two types of snakehead during weaning and grow- out.
- To assess economic efficiency of experimental grow-out of the two types of snakehead on different diets.
- To assess product quality (human sensory analysis) of the two types of snakehead at the end of the experimental grow-out.
- To provide recommendations for policy and best practices for the development of snakehead farming in Cambodia.

Significance

In Cambodia wild snakeheads are generally cultured in smaller cages and ponds. Feed represents more than 70% of the total operational cost and the main type of feed for wild giant snakehead culture is small-sized or low -value fish, representing 60 to 100% of the total feed used depending on feeding strategies adopted by different farmers (So et al., 2005). During the dry season (October to May), the most important source of feed is freshwater small-sized or low-value fish, while more marine small-sized or low-value fish species are used during the rainy season (June to September) (So et al., 2005). Importantly, the snakehead production contributes more than 70% of total aquaculture production in Cambodia due to its popularity as food and high market and trade demand in Cambodia as well as in Viet Nam being found

in most Cambodian and Vietnamese dishes at all wealth class levels (i.e. from poor, medium to rich people).

The government of Cambodia put a ban on snakehead farming in September 2004 by the Announcement No. 4004 kor.sor.ko.sor.chor.norand. The reason for this was the potential negative impacts on wild fish populations from wasteful snakehead seed collection and on other fish species diversity, particularly the small-sized or low-value fish used as feed for snakehead aquaculture, and also potential negative effects on poor consumer groups from decreased availability of small-sized/low-value fish due to dependency of snakehead aquaculture on small-sized/low-value fish (So et al., 2007). In order to remove this ban, the same Announcement mentioned that successful technologies of domesticated breeding, weaning and rearing/growing-out of snakeheads using formulated diets should be developed and applicable in on-station and on-farm levels in Cambodia.

In addition, Cambodia is highly vulnerable to the effects of climate change on aquaculture and fisheries, which supply livelihoods for millions and up to more than 75% of all animal protein in the diet (Allison et al., 2009; Halls et al., 2012). However, aquaculture and fisheries can help solve other adaptation problems. As rising sea levels and increased flooding may render some existing farmland unsuitable for cropping, fish cultivation can provide alternative livelihoods and offset these losses. Further, water and nutrients from fish ponds can improve farm productivity and sustain it under drought (WorldFish Center, 2007). Conserving wild fisheries and enhancing aquaculture should be considered twin strategies of adaptation to climate change.

During the first phase of AquaFish CRSP (2007-2009), the Investigation # 2 revealed that nearly 200 freshwater small-sized fish species were detected in the Mekong River Basin of Cambodia and Vietnam, and these freshwater small-sized fish species, including juveniles of commercially important fish species, contribute more than 70% to total freshwater capture fisheries production. After the ban on snakehead culture in Cambodia, snakeheads have illegally been imported from the neighboring countries, particularly from Vietnam, to supply high local market demands in Cambodia. Furthermore, the study showed that freshwater small-sized fish have illegally been exported to Vietnam for feeding the significantly and commercially developed snakehead aquaculture in Vietnam. The first phase study also indicated that the incentives for choosing snakehead before other fish species by tens of thousands of fish farmers are strong as it generates more than 10 times higher profits than other fish species. Therefore, the ban does not only result in positive impacts on poor consumer groups from increased availability of freshwater small-sized fish in Cambodia, but also providing negative effects on food and nutrition security and livelihood of tens of thousands of snakehead farmers who depend on this livelihood for improving household food and nutrition security and generating household income. In other words, these snakehead fish farmers have lost their important livelihoods and household income. Moreover, the ban also does not provide positive impacts on snakehead wild stocks as fishing pressure on wild snakehead using illegal and destructive fishing gears particularly electro-shockers has increased in recent years in order to supply local and external markets.

During the second phase of AquaFish CRSP (2009-2011), the wild striped snakehead *Channa striata* broodstocks were successfully developed, matured and semi-artificially induced spawning using the hormone HCG on-station in Cambodia was accomplished (So et al., 2011). The striped snakehead *Channa striata* aged 30 days old after hatch could gradually and successful accept AquaFish CRSP Snakehead Formulated Feed developed by AquaFish CRSP project (Hien & Bengtson, 2009; 2011) in replacement of small-sized fish in the rate of 10% every three days for a period of 30 days of feeding (So et al., 2011).

This study will focus on weaning performance and grow-out of the wild *C. striata* (non-domesticated) from Cambodia compared to those of domesticated snakehead from Vietnam with assessment of survival

rate and growth performance of the two types of *Channa striata* larvae/fingerling on pellet feed. Furthermore, the assessment of economic efficiency and product quality during grow-out of the both snakehead on different diets will also be conducted in a purpose to provide policy recommendations for snakehead farming in Cambodia.

Quantified Anticipated Benefits

This research will provide information on domesticated breeding, weaning and growing out of snakehead fish, especially development of Cambodia's snakehead aquaculture technologies, in order to lift the ban on snakehead culture in Cambodia. The following are quantifiable anticipated benefits:

- At least 20,000 farmers in Cambodia will benefit from this Investigation by restarting their snakehead culture leading to increased household income and improved snakehead fish market and trade
- 250 scientists, researchers, government fisheries officers/managers and policy makers, extension workers, NGO staff, and private sector working on the issues of snakehead aquaculture in Cambodia as well as in other Mekong riparian countries will be better informed about research methods and findings, and have better recommended policies and strategies for sustainable snakehead aquaculture.
- Two (under)graduate students will be supported and trained by this investigation through their B.Sc./M.Sc. thesis research.
- At least 1,000,000 indirect beneficiaries in Cambodian and other Mekong riparian countries who consume snakehead fish in their protein diets leading to improved household food and nutrition security
- Benefits to the US include improved knowledge and technologies on domestication of freshwater fish species for aquaculture and this aquaculture is considered as a climate change adaptation measure.

Research Designs or Activity Plan

Location of work

All weaning and grow-out trials will be conducted at Freshwater Aquaculture Research and Development Center (FARDeC), Prey Veng province, Cambodia under the direct supervision of the Inland Fisheries Research and Development Institute (IFReDI), which has many broodstock, breeding and weaning earthen ponds, hapa-nets and cement tanks, a small fish feed mill for fish pellet production and laboratories. Training of IFReDI and FARDeC researchers and staff on snakehead domestication breeding, feeding, weaning, growing out and wet and dry diet formulation will be done at Can Tho University (CTU), Vietnam based on information obtained from the first and second phases of AquaFish CRSP Investigations by Dr. David Bengtson, University of Rhode Island and Dr. Tran Thi Thanh Hien, Can Tho University.

Methods

This study will comprise the following interrelated parts:

Collection of brood snakehead fish

In addition to available breeders, adult/mature wild snakehead (*Channa striata*) from different natural water bodies of Cambodia will be collected and conditioned at FARDeC hatchery, Cambodia. Domesticated snakehead (having already adopted to pellet feed) will also be purchased from a hatchery in Can Tho, Vietnam, and also conditioned at FARDeC for induced spawning to produce larvae for the experiment.

Conduct of training and technology transfer

On-the-job/site training of IFReDI/FARDeC researchers and staff on snakehead breeding, weaning, feeding strategies, growing out, and feed formulation techniques (feed formulation based on the optimal diet composition: protein, lipid, mineral, fiber and energy obtained from the first and second phases of

AquaFish CRSP, and on supplemented information from Samantary and Mohanty, 1997; Arockiaraj et al, 1999) will be conducted at Can Tho University, Vietnam.

Induced spawning using HCG hormone
Both types of snakehead broodfish will be checked monthly for egg maturation based on the method of Nikolsky (1963). Both types of broodfish with egg maturation at the same stage will be selected for induced spawning in order to simultaneously produce batches of larvae for the weaning experiment. HCG hormone will be used for induced spawning using the best dose obtained from So et al. (2011) in final technical report during AquaFish-phase 2 or using the recommended dose from the above training.

Weaning experiment (domesticated vs. non-domesticated)
Batches of *C. striata* larvae simultaneously produced from domesticated and non-domesticated snakehead broodstock above will be used for weaning treatments to compare their growth performance and survival rate on pellet feed (null hypothesis: no significant difference between treatments). The two types of larvae/fingerlings will be weaned at the same time using the same weaning protocol for *Channa striata* adopted from Hien and Bengtson (2009; 2011) from live Moina sp. to formulated feed.

The protocol - After yolk absorption at 3 days after hatching (dah), larvae will be fed with live Moina for 7 consecutive days till10 day-old larvae (dah), and then larvae will be fed with a mixture of dead Moina and ground trash fish (replacing Moina by 20% per day) for 7 days more till 17 day-old larvae (dah). We will start weaning both types of *Channa striata* larvae on formulated feed at 17dah with replacement of trash fish by 10% per day until trash fish will be completely replaced by formulated feed. Formulated feed contains 40-50% crude protein.

Experimental set-up (E1) - There are two treatments each with five replicated tanks. Larvae will be stocked in 50-L tanks with stocking density of 5 fish/L. The fish will be fed to satiation by hand twice daily. The remaining feed and faeces will be siphoned out before feeding. Fish mortality, food consumption and water quality, such as temperature, pH and dissolved oxygen will be recorded daily. Larvae will be sampled, weighed and measured at biweekly intervals. At the end of the experiment, final body weight (FBW, mg) and wet weight gain (WWG, mg) including survival rate will be determined.

Statistical analysis - Difference between the treatments on growth and survival rate of the two types of snakehead larvae will be determined by two sample t-test at $p= 0.05$ using SPSS 16.0.

Grow-out diet experiments (domesticated vs. non-domesticated)
Batches of the two types of snakehead larvae/fingerling which are accepting formulated feed from the weaning experiment above will be used in experimental grow-out on three diet treatments to compare their growth performance and survival rate, and to see if the fingerlings of domesticated snakehead origin are more adapted to pellet feed compared to those of non-domesticated.

Diet treatments (null hypothesis: no significant difference among treatments) - The two types of snakehead fingerlings will be fed with three diets (diet 1: formulated feed only; diet 2: trash fish only; diet 3: 50:50 mixture of formulated feed and trash fish). There will be 6 treatments each with 3 replicates as following:

1. Domesticated fed formulated feed (d-FF) x 3 replicates
2. Non-domesticated fed formulated feed (n-FF) x 3 replicates
3. Domesticated fed trash fish (d-TF) x 3 replicates
4. Non-domesticated fed trash fish (n-TF) x 3 replicates
5. Domesticated fed 50% formulated feed + 50% trash fish (d-FF+TF) x 3 replicates
6. Non-domesticated fed 50% formulated feed + 50% trash fish (n-FF+TF) x 3 replicates

Experimental set-up -The experiment will be conducted in 18 hapas (5x3x1.5m) with a stocking density of 750 fingerlings/hapa. Hapas will be placed in 3 earthen ponds (300m2), each with six hapas (assigned 3 hapas for domesticated and 3 for non-domesticated).In pond 1, snakehead fingerlings in the six hapas will be fed trash fish (control treatment). In pond 2, snakehead fingerlings in the six hapas will be fed formulated feed. In pond 3, snakehead fingerlings in the six hapas will be fed 50:50 mixtures of formulated feed and trash fish. The fish will be fed to satiation by hand twice daily at 09:00h and 16:00h.The amount of feed used and fish mortality will be recorded daily. Water quality parameters such as: Transparency (Secchi disk), temperature, pH, dissolved oxygen, NH3, NO-2 will monitored weekly. Growth will be measured monthly by weighing 30 fishes/hapa. The survival rate will also be determined. The experiment will last for 6 months. At the end of the experiment, a sensory evaluation will be conducted to compare the fillet quality of both experimental snakehead fed by different diets for experimental treatments based on method adopted from Hien and Bengtson (2009; 2011)

Cost/Benefit Analysis - Cost and benefit analysis will also be conducted to determine economic returns and efficiencies of both *Channa striata* cultured on three different diets as the following formulas:

- Total Revenue = Quantity * Price/unit
- Total Cost =Variable Cost + Fixed Cost
- Net return = Total Revenue – Total Cost
- Economic Efficiency = Total Revenue/Total Cost

The analysis will be based on farm-gate prices in Cambodia for harvested *Channa striata* and current local market prices for all other items (e.g. cost of the traditional freshwater small-sized fish and cost of the formulated feed) will be expressed in US dollars (US$).

Statistical analysis - The grow-out experiment is a two-factor design (fish origin x diet), so interaction terms will be tested by two-way ANOVA at p=0.05 using SPSS 16.0.

Schedule

The duration of implementation of this proposed investigation will be 24 months, starting from 1 October 2013 till 30 September 2015.

This investigation is planned to be implemented as below:

Activity	**Beginning**	**Ending**
Collection of wild or non-domesticated broodfish	December-2013	February-2014
Collection of domesticated broodfish	March-2014	April-2014
Hand-on training at Can Tho University	April-2014	April-2014
Experimental designs	April-2014	May-2014
Implementation of the experiments	June-2014	March-2015
Analysis of results and report preparation	April-2015	July-2015
National workshop on “Consultation and dissemination of research findings	August-2015	August-2015
Finalization of final technical report	Sept-2015	Sept-2015

Deliverables

The deliverables of this investigation will include (1) final technical report, including policy recommendations, and (2) factsheet.

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