

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

**STRATEGIC INVESTMENT IN RAPID TECHNOLOGY DISSEMINATION (SIRTD)
ASSOCIATE AWARD**

**ENHANCING THE PROFITABILITY OF SMALL AQUACULTURE
OPERATIONS IN GHANA, KENYA, AND TANZANIA**

**THIRD ANNUAL REPORT
1 October 2012 – 30 September 2013**



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SIRTD: ENHANCING THE PROFITABILITY OF SMALL AQUACULTURE OPERATIONS IN GHANA, KENYA, AND TANZANIA THIRD ANNUAL REPORT

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This report covers the period from 1 October 2012 to 30 September 2013, which we refer to interchangeably as FY13 and reporting year; however, this work does not use FY13 federal funding.

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EXECUTIVE SUMMARY

The Third Annual Report for the AquaFish Strategic Investment in Rapid Technology Dissemination (SIRTD) Program Associate Award covers activities and accomplishments from 1 October 2012 through 30 September 2013. This three-year Associate Award, titled *Enhancing the profitability of small aquaculture operations in Ghana, Kenya, and Tanzania*, is framed around the FTF objectives and focuses on technology adoption involving best management practices for inputs in fish production to provide economic, environmental, and agronomic efficiency of aquaculture in sub-Saharan Africa. The project uses evidence-based efforts towards accelerating progress for meeting the poverty and hunger goals of FTF: Sustainable intensification of aquaculture; Expanding markets and trade; and Increasing economic resilience in vulnerable rural communities of Kenya, Ghana, and Tanzania. During this reporting period, US and Host Country investigators conducted collaborative efforts focused on SIRTD development goals, including scaling up innovations from previous Collaborative Research Support Program (CRSP) and AquaFish project successes and accelerating best management practice (BMP) adoption rates.

Setbacks in the first two years (addressed in previous annual reports) caused downstream delays in FY13, which are being addressed in the no-cost extension (NCE) approved on 23 September 2013, extending the project end date from 30 September 2013 to 30 September 2014. This project has made excellent progress towards completion of activities in Ghana. The NCE approved will allow for the completion of important work in Tanzania and Kenya, and enables the completion of reports, enhanced communications materials, student degree work, and translations associated with project activities.



COLLABORATING INSTITUTIONS AND PERSONNEL

AquaFish, Oregon State University, USA
Hillary Egna, Lead Principal Investigator

Purdue University, USA
Kwamena Quagrainie, US Co-PI

Virginia Polytechnic Institute and State University, USA
Emmanuel Frimpong, US Co-PI

Kwame Nkrumah University of Science and Technology, Ghana
Steve Amisah, HC Co-PI
Gifty Anane-Taabeah, HC Investigator

Ministry of Fisheries Development, Kenya
Sammy Macharia, HC Co-PI (from July 2011)
Charles Ngugi, HC Investigator (was HC Co-PI thru July 2011)
Judith Amadiva, HC Investigator

Ministry of Natural Resources and Tourism, Tanzania
Kajitanus Osewe, HC Co-PI

Sokoine University of Agriculture, Tanzania
Sebastian Chenyambuga, HC Co-PI
Nazael Madalla, HC Investigator



AquaFish Director and Lead US PI, Dr. Hillary Egna (kneeling on the left) gathers with AquaFish students and SIRTD project participants in Kenya for a photo in July 2012. (Photo Courtesy of Hillary Egna)



INTRODUCTION

Feed the Future (FTF) is a United States Government initiative designed to reduce poverty and hunger. Recognizing that agriculture and rural development have long been neglected in international aid programs and the severe impact that poverty has on livelihoods, health, and ecosystems, FTF renews a USAID commitment to reinvest in activities that lead to sustainable food security globally. To align its strategies and goals with those of the FTF initiative, USAID issued a Request for Assistance (RFA) under the Strategic Investment in Rapid Technology Dissemination program within EGAT for work in this crucial area in 2010.

Oregon State University's AquaFish responded to USAID's RFA with a project that addresses FTF goals and helps reduce gnawing development problems that contribute to keeping the poor poor. This project, titled *Enhancing the Profitability of Small Aquaculture Operations in Ghana, Kenya, and Tanzania*, is framed around USAID and FTF objectives by investing in strong, evidence-based efforts. The project shares the FTF aim of accelerating progress towards meeting the poverty and hunger goals of the UN's Millennium Campaign. The project is working towards these goals by helping to increase agricultural productivity, expand markets and trade, and increase economic resilience in vulnerable rural communities. Improvements in nutritional status are expected to result from increased access to diverse and high quality foods. The ability to access and utilize food must remain stable and sustained over time. Paying attention to cross-cutting themes such as gender, environment (climate change), and natural resource management can result in improved nutrition for all family members.

This AquaFish Associate Award works in three focus countries identified by FTF: Ghana, Kenya, and Tanzania. Feed the Future's overarching goal is "to sustainably reduce global hunger and poverty by tackling their root causes and employing proven strategies for achieving large scale and lasting impact." The project focuses on small-scale aquaculture producers, the production of high quality seed, and the adoption of best management practices (BMPs). Project participants are working with private sector partners to expand commercially sustainable agro-input industries and dealer networks, including small enterprises. Increased access to inputs is being coupled with strategies to help ensure their safe and sustainable use. AquaFish technologies are being refined and tailored to local conditions by supporting national research institutes and building local research capacities, including training local researchers and technicians. Gender inequalities inhibiting women's access to information, inputs, or technology are addressed and anticipated. The aim is to provide women with equal access to affordable inputs and improved technologies.

The project additionally supports FTF objectives in the area of *Expanding Markets and Trade*, through the development and dissemination of market information for producers and enterprise owners, including activities that focus on equitable access for women. Greater access to market information can increase the ability of small-scale agricultural producers to participate in formal and higher-value markets. By improving post-harvest market infrastructure, this project aims to make markets work better for both women and men agricultural producers and to extend the availability of nutritious foods. Through the reach of the project, results are also aiding FTF's objective of *Improving Nutritional Status* (FTF GUIDE, section 3.3.2) by improving diet quality and diversity through the addition of animal source foods and micronutrients commonly found in fish.

This project has primary focus locations in Ghana and Kenya to leverage work done by AquaFish, to consolidate adoption of technologies, and to ensure measurable impact. In addition to the intensive efforts in these two countries, associated activities are planned for Tanzania.

On 23 September 2013, a no-cost extension (NCE) was fully executed for this Associate Award, extending the award end date from 30 September 2013 to 30 September 2014. This extension allows project participants to complete field work in Tanzania and Kenya, and enable the completion of reports, enhanced communication materials, student degree work, and translations associated with project activities in Kenya, Tanzania, and Ghana.

BACKGROUND

The accelerating pace of aquaculture growth in sub-Saharan Africa has received much positive attention because of the potential of the industry to contribute to development and food security by providing jobs and supplementing wild fish protein. Questions are being raised, however, about how long it will be before the industry comes under scrutiny for its environmental practices and the need for regulations. BMPs in aquaculture are now widely recognized as a more viable alternative to conventional aquaculture production methods, and their widespread adoption can help forestall the imposition of prohibitive regulations on smallholder fish farms.

The adoption of BMPs in fish production requires strategies that integrate profitability and efficiency in the fish farming enterprise. Production options that consider both these issues were studied by the PD/A and Aquaculture CRSPs, where decision support tools were developed for assessing farm profitability. The tools utilized financial spreadsheets that incorporated enterprise budgeting. Methods for farm-level record keeping led to improved understanding of the costs and returns associated with fish farming, documentation that is important for securing loans from banks. This is mainstream CRSP "soft" technology that can incorporate farm costs associated with adoption of BMPs and evaluation of profitability.

In November 2009, AquaFish held a two-day workshop in Ghana attended by 60 participants, including fish farmers, fisheries commission officials, extension officers, regulators, and researchers. The workshop was held in the local language and also served as a trial run of one of several methods that could be used together to disseminate BMP guidelines and facilitate adoption. Farmers participating in the workshop showed great enthusiasm for the concepts presented, with many expressing interest in setting aside ponds for AquaFish demonstrations and studies. These workshops thus accomplished: 1) training of extension officers who could follow up with farmers implementing BMPs in a sustained outreach program; 2) reaching a core group of farmers who are expected to continue to spread the BMP ideas to other farmers; and 3) convincing regulators that the aquaculture industry has an active program of examining its environmental practices and continually working on improving these practices, thereby reducing costs of creating a formal regulatory process.

In the first three years of the project (FY11-FY13), nine short-term training events were held, five in Ghana, three in Kenya, and one in Tanzania. Of the 718 trainees in those nine events, 178 (5%) were women and 540 (75%) were men, with an increase in women's involvement to 37% in the third year as compared to the 16% in the first year. On a country basis, 132 trainees attended the course in Kenya, including 27 women (26%), and 545 people were trained in Ghana, including 140 women (25%). Tanzania had 41 attendees, with 11 women (26%) and 30 men (73%). Efforts were made to increase women's involvement in BMP trainings and demonstrations, as traditionally far fewer women are involved in aquaculture production compared to men (e.g., the percentage of women attending short-term training far exceeds the percentage of women fish farmers (<10%). Part of this effort included a training program specifically for women in commercial aquaculture.

Six sites were used for BMP demonstrations in Ghana in the first year. The first three were started in FY11, with one each in the Ashanti, Brong Ahafo, and Western regions. The second set of six included two in the Ashanti Region and one in the Western region. After all six of these demonstrations were completed in FY12, five more were started in May 2012, using 20 ponds on five farms in the Ashanti and Brong Ahafo regions. None of the six demonstration farms in Ghana are owned exclusively by women, but some of the businesses are considered family owned and operated. Demonstration sites for Kenya were not scheduled to begin until FY12. Seven farms in three regions (Rift Valley, Western, and Central) are participating in the demonstrations. The first cycle has been completed and the second cycle is underway. In contrast to Ghana, two of the seven participating farms are owned by women and one of the seven is dually owned by a man and a woman.

TARGET TECHNOLOGIES

The focus of this project is technology adoption involving best management of practices for fish production to provide economic, environmental, and agronomic efficiency in aquaculture in sub-Saharan Africa. Target technologies include effluent management practices, nutrient management practices, and profitability analysis.

Effluent Management Practices

Improved effluent management practices include guidelines on pond operation, management of settling ponds and vegetation ditches, draining to wetlands, top-releases for partial drainage, and water re-use (by holding or re-circulating to other ponds). Specifically, issues include frequency of drainage, installation of drain outlets, and water level maintenance. Of these practices, emphasis is being placed on water re-use to provide the most environmental benefit because intentional drainage, which accounts for most effluent output, can be avoided altogether for longer periods of time than has been traditionally practiced. In areas facing water scarcity, such as baitfish farming in Arkansas, USA, farmers have successfully adapted harvesting methods that involve little or no draining. This technology is clearly viable for most tilapia and catfish farms in Africa. Even where water is not in short supply, the technology produces environmental benefits because of reduced and more easily treated effluents. Some benefits to farmers of reusing water include retaining nutrients from previous production that can be incorporated into the biomass of the new crop.

Nutrient Management Practices

Better nutrient management practices include fertilizing and feeding regimes that reduce waste and prevent water quality deterioration that threatens fish health. A better practice is to regulate pond water fertility by applying fertilizers to ponds in slow-release sacs that can be removed from the pond when the desired plankton concentration is reached. Avoiding excessive feeding saves on input costs and translates directly into farm profitability. Feed that is not eaten often functions like an expensive fertilizer and can lead to highly eutrophic water conditions that both reduce yields and escalate the cost of operations. Feeding is best regulated by observing how much feed the fish are consuming and adjusting the amount offered accordingly. This is more easily done when extruded (floating) feeds are used as opposed to pelleted (sinking) feeds. The use of pelleted feeds often results in high waste loads and lower feed conversion ratios ($FCR = \text{weight of feed fed} / \text{fish weight gain}$).

Profitability Analysis

Appropriate stocking and feeding regimes can reduce the cost of production through reduced aeration, better water quality, higher survival, reduced use of medication and chemicals, and improved feed conversions. Previous work conducted under the Aquaculture Collaborative Research Support Program (ACRSP) measured performance indicators and the profitability of Nile tilapia (*Oreochromis niloticus*) production in Ghana. Initial profitability analyses that included variable costs, fixed costs, owned inputs,

yield, and revenues showed that the integration of economic, social, and environmental objectives into aquaculture production indicated that the inclusion of BMPs could result in increased profits. A financial decision support tool has been developed to assist existing and prospective fish farmers considering the adoption of BMPs to assess and select production scenarios and profitability relationships for their farm enterprises. The tool consists of financial spreadsheet templates that fish farmers will be able to populate with data to develop their own financial profiles and determine benchmarks that serve as bases for investment decisions, comparisons, and/or improvements to the farm enterprise. This tool was presented to farmers in the third year of the project (FY13).

OUTREACH AND DIFFUSION TECHNIQUES

Three innovation diffusion techniques are being simultaneously deployed: 1) Central Media (series of workshops at the regional level), 2) Demonstrations (BMPs demonstrated at selected farms), and 3) Lateral Diffusion (farmer-to-farmer extension of BMPs).

Central Media (workshops)

This is a series of workshops at national or regional levels in which we are targeting as many farmers as possible to expand first exposure to BMPs. These workshops include regional extension officers (i.e., a train-the-trainer model) who are expected to follow up with adopters and liaise between these adopters and researchers to provide reliable advice and sustain adoptions. Communications media are being developed in local languages. In Ghana, the Western, Ashanti, and Brong-Ahafo regions are being targeted, where there are an estimated 2,869 fish farmers with about 4,500 farm ponds. In Kenya, we are targeting about 600 fish farmers, and the target for Tanzania is about 100 fish farmers. During FY13, the project organized and held three workshops—two in Ghana involving 252 participants and one in Tanzania that involved 41 participants.



AquaFish trainers lead a workshop in Ghana, January 2013 (Photo courtesy of Emmanuel Frimpong)

BMP Demonstrations (BMPs demonstrated at selected farms)

The demonstration effect has been identified as one of the principal variables that explain diffusion of innovations. Demonstrations are used both to take advantage of their positive effects in the diffusion process and to provide the data needed to estimate the economic benefits of selected components of BMPs for monitoring and evaluation of the intervention. On-farm BMP demonstrations are crucial for

showing skeptical farmers the benefits that can be achieved with BMPs. In the Ashanti and Brong-Ahafo regions of Ghana, AquaFish projects had already established working relationships with many farmers prior to the beginning of this project. Farmers whose farms were accessible to researchers and had the highest potential for the diffusion of new ideas to other farmers were selected as demonstration sites. In Kenya, the two focal BMP management schemes (i.e., water re-use and nutrient management) are being demonstrated in three regions: Rift Valley Region, Western Region, and Central Region. Accurate data are being collected from these demonstrations, including stocking densities, fertilization rates, feeding rates, monthly water quality, yields, and FCRs. These ponds are being managed by AquaFish-supported graduate students and fisheries extension officers with the cooperation from the farmers. Ponds are visited during workshops to show farmers the benefits of BMPs. In addition, data collected from these ponds are being compared with data from ponds under “regular” management within the same farms. These data will be used for with-versus-without analysis of the benefits and costs of BMP implementation.

Lateral Diffusion (farmer-to-farmer extension of BMPs)

Through regional workshops and demonstrations, participants are establishing a business enterprise network in each country. One vital function of these networks is farmer-to-farmer extension of BMPs. Under the innovation diffusion model, farmers exposed and trained in workshops constitute nodes in a social network. These farmers spread information to other farmers and become nodes, propagating their own networks, thereby laterally transmitting knowledge without the direct involvement of extension personnel.

GENDER INTEGRATION AND ANALYSIS

AquaFish is dedicated to improving gender inclusiveness in the aquaculture and fisheries sectors across the spectrum of AquaFish projects and activities. FTF requires that agricultural interventions involve both men and women. These include investments in sustainable labor-saving technologies so that shifts in the gender division of labor and products do not systematically disadvantage one gender over the other. Where water, fuel, and labor constraints increase the domestic chore burden on women and girls and prevent women from expanding agricultural production, labor-saving technologies might be introduced to mitigate this effect. Involving and recognizing both the men and women producers within the household in agricultural programs can be more sustainable than focusing only on the head-of-household (FTF Guide, May 2010).

This project recognizes that providing equal opportunities for women’s involvement is necessary because such a directed involvement of women is one of the keys to advancing economic and social development, not only in aquaculture but for a holistic household and family economy. Women play a major role in the production, processing, and marketing of agricultural products in Ghana, Kenya, and Tanzania, but agricultural information and production resources are not reaching and benefiting them equally. The project’s intent is therefore to ensure that no one is excluded from participating in the training or educational activities and opportunities conducted on the basis of gender. Further, where women are members of the larger populations under consideration (e.g., Fisheries Officers who serve as aquaculture extension officers, fish farmers, fish traders and processors, consumers, program personnel, students, etc.), the project actively recruiting women to participate in these activities. Qualified women graduate students from host countries have been selected for long-term training, and efforts are being made, when selecting participants for short-term training, to invite all known women fish farm proprietors and wife-and-husband joint owners of fish ponds/farms.



PROGRESS MADE AND RESULTS ACHIEVED

This Associate Award has the broad objectives of scaling up innovations from previous CRSP and AquaFish successes, and accelerating BMP adoption rates in Ghana, Kenya, and Tanzania. Progress made and results achieved for the two subcontracting US Lead Institutions (Purdue University and Virginia Polytechnic Institute and State University) are presented separately below.

ENHANCING THE PROFITABILITY OF SMALL AQUACULTURE OPERATIONS IN KENYA AND TANZANIA (10BMA01PU)

Purdue University (USA), Ministry of Fisheries Development (Kenya), Kenyatta University (Kenya), Moi University (Kenya), Sokoine University of Agriculture (Tanzania), and Ministry of Natural Resources and Tourism (Tanzania), with Oregon State University.

Investigation Objectives

The specific objectives of this investigation are to:

- A. Provide information on BMP adoption in Kenya and Tanzania
- B. Quantify adoption of BMPs in Kenya
- C. Quantify production and financial efficiencies for BMPs adopters versus non-adopters in Kenya
- D. Assess economic benefits of adopting BMPs in Kenya

Investigation Progress

Because of the collaborative activities that AquaFish has with the Kenya Ministry of Fisheries Development and the efforts of this Associate Award, BMPs have become part of the Kenya government's fisheries extension curriculum. Fish farmers are adopting the use of commercial floating feed and reusing pond water instead of draining ponds every year.

The graduate student working on this project, Akuffo Amankwah at Purdue University, secured a Norman E. Borlaug Leadership Enhancement in Agriculture Program (LEAP) fellowship to collect more data. He will be traveling to Kenya and Ghana in Spring 2014 for data collection.

ENHANCING THE PROFITABILITY OF SMALL AQUACULTURE OPERATIONS IN GHANA (10BMA02VT)

Virginia Polytechnic Institute and State University (USA) and Kwame Nkrumah University of Science and Technology (Ghana) with Oregon State University

Investigation Objectives

The specific objectives of this project are to:

- A. Widely disseminate information on readily adaptable BMPs in Ghana, Kenya, and Tanzania
- B. Quantify adoption of selected BMPs in Ghana
- C. Quantify production and financial efficiencies for adoption of selected BMPs in Ghana
- D. Assess economic benefits of adopting the Selected BMPs in Ghana

Investigation Progress

One new workshop was conducted in the reporting period. This year's workshop and training was conducted in Tarkwa in the Western region and was attended by farmers from all three study regions. This was the third regional BMP workshop that was attended by 171 participants, including trainers. Dr. Emmanuel Frimpong led the program and Dr. Hillary Egna chaired. The second round of demonstration experiments involving 5 farms and 20 ponds was completed in November-December 2012.

Approximately 550 surveys have been administered, including three baseline and three follow-up surveys. These surveys included approximately 350 farmers from all the study regions (Ashanti, Western, and Brong Ahafo regions). The final follow-up survey was completed in August 2013 and marks the end of active data collection for this project in Ghana. Analysis of the data is currently ongoing at Virginia Tech.

The first and second round of demonstrations are complete and extensive surveys have been conducted to document the adoption of water reuse and the use of formulated feeds. Demonstrations showed marked improvement in the second round over the first round after some basic management problems were identified and corrected. Changes in protocol that were approved for the second round included the use of a different hatchery with better sex-reversal rates for tilapia *Oreochromis niloticus*, reduced tilapia stocking density to 2/m², and stocking of 20% catfish *Clarias gariepinus* before the possible onset of unwanted reproduction in ponds. Average tilapia growth approached 350g in 5 months, which is about double what was observed in the first round of demonstrations. In addition, some farms performed exceptionally well, averaging almost 400g in 5 months (stocking at 10g fish), implying that better management practices could further improve productivity on the average farm. Reused water did not result in significantly smaller fish, which translates to significant environmental benefits as long as the cost of recycling water is kept lower than the cost of filling ponds with new water. The commercially available formulated floating feed resulted in much larger sizes of tilapia, compared to the farm-made sinking feed. Ongoing economic analysis will answer the question of whether the floating feed is more profitable. The preliminary analysis already indicates better water quality in floating feed ponds.

Preliminary analysis of the survey data indicate that certain characteristics of farmers predict adoption of BMPs, including their geographic location, labor availability, and participation in the AquaFish training programs or frequency of interaction with extension personnel.



AquaFish workshop participants (left) and workshop coordinators (right) in Ghana, July 2013. (Photos by Hillary Egna).





CAPACITY BUILDING

SHORT-TERM TRAINING

In this third year of the Associate Award, three short-term training events were held (2 in Ghana and 1 in Tanzania), with a total of 293 host country nationals receiving training (252 in Ghana and 41 in Tanzania). For the two training events in Ghana, 96 women (38%) and 156 men (62%) were trained. In Tanzania, 11 women and 30 men were trained (27 and 73%, respectively). Although SIRTD project work continued in Kenya during FY13, all short-term training in Kenya was completed by FY12. In Ghana, two training events took place: one was the third in a series of pond aquaculture BMP workshops, while the other focused on training women on commercial-scale aquaculture practices (79 of the 87 attendees were women).

Over the life of the SIRTD Associate Award project (2011-2013) a dedicated effort has led to an increase in the number of women participating in AquaFish trainings from 16% in 2011 to 37% in 2013. The underrepresentation of women in aquaculture poses a potential challenge to involvement in trainings; however, AquaFish continues to work towards the goal of involving equal numbers of men and women. The increase in women's participation in this Associate Award over time is an indication of these efforts.

LONG-TERM TRAINING

Twelve students were supported under the SIRTD project during this reporting year, including seven women (58%) and five men (42%). Seven of these students are Ghanaians (four women and three men), and three are Kenyans (two women and one man). Among the seven Ghanaians, two are pursuing PhDs, and five are pursuing Master's degrees. In Kenya, all five of the students are working on MS degrees.

Supported Host Country students are enrolled in universities in Kenya (Kenyatta University, Moi University, and University of Nairobi), Ghana (Kwame Nkrumah University of Science and Technology), and the United States (Purdue University and Virginia Polytechnic Institute and State University).

PROJECT-LEVEL COORDINATION

In July 2013, Dr. Hillary Egna (AquaFish Director and PI for the Associate Award) traveled to Ghana to meet with key Associate Award partners and to attend the third Ghana BMP Training Workshop. From 2-5 July, Dr. Egna chaired a workshop on Pond Aquaculture BMPs at the Faculty of Engineering at Kwame Nkrumah University of Science and Technology (KNUST) in Tarkwa, Ghana. The first day of the workshop was moderated by Dr. Regina Edziyie and Dr. Nelson Agbo from KNUST and involved presentations on BMP, break-out sessions discussing the pros and cons of BMPs, pond construction and maintenance, and aquaculture basics. The second day focused largely on developing business skills and a fish marketing seminar, and concluded with a tour of a fish farm led by Dr. Steven Amisah from KNUST.

Immediately following the BMP workshop, AquaFish hosted an inaugural Africa Regional Meeting at the KNUST Engineering guest House in Kumasi, Ghana, from 5-9 July 2013. The meeting was chaired and organized by Hillary Egna. Local organizers were Steve Amisah, Kwamena Quagrainie, Nelson Agbo (HC Co-PI), and other KNUST faculty. This provided the Associate Award participants a chance to coordinate with leader award activities and to provide an update to the other AquaFish teams in Africa.



MONITORING & EVALUATION

AquaFish operates under USAID's Feed the Future Monitoring System (FTFMS) to achieve outcomes that have meaning for multiple stakeholders. The FTFMS indicator targets and results for FY13-FY14 as requested by USAID in accordance with FTFMS for this Associate Award are presented in Table 1.

Table 1. USAID indicator targets and results for FY13.

Indicator Number	Indicator	2013 Target	2013 Actual	2014 Target
4.5.2(2)	Number of hectares under improved technologies or management practices as a result of USG assistance			
	Total	434	392	392
	Continuing	189	189	392
	New	245	203	0
4.5.2(6)	Number of individuals who have received USG supported long-term agricultural sector productivity or food security training			
	Total	12	12	2
	Female	7	7	1
	Male	5	5	1
4.5.2(7)	Number of individuals who have received USG supported short-term agricultural sector productivity or food security training			
	Total	165	206	40
	Female	52	63	20
	Male	143	143	20
4.5.2(11)	Number of food security private enterprises (for profit), producers organizations, water users associations, women's groups, trade and business associations, and community-based organizations (CBOs) receiving USG assistance			
	Total	8	8	2
	New	0	0	0
	Continuing	8	8	2
4.5.2(39)	Number of new technologies or management practices in one of the following phases of development: (Phase I/II/III)			
	Total	6	6	3
	Phase 1 Number of new technologies or management practices under research as a result of USG assistance	0	0	0
	Phase 2 Number of new technologies or management practices under field testing as a result of USG assistance	3	3	1
	Phase 3 Number of new technologies or management practices made available for transfer as a result of USG assistance	3	3	2



PUBLICATIONS

- Agbo, N.B., Amisah, S., Tettey, E., Frimpong, E. 2103. Effects of Dietary Protein Levels on Growth Performance of Claroteid Catfish, *Chrysichthys Nigrodigitatus*, Fingerlings (Aquaculture Nutrition)
- Anane-Taabeah, G., Frimpong E., Amisah, S. 2013. The Cage Aquaculture Innovation-Decision Process and Factors Affecting Cage Aquaculture Adoption in Ghana (Aquaculture) [In Review].
- Ansah, Y. B., Frimpong, E. A., Amisah, S., and Adjei-Boateng, D. Effects of Two Aquaculture Best Management Practices on Tilapia Growth. Aquaculture America Conference, Las Vegas, Nevada. March 2, 2012.
- Ansah, Y. B., Frimpong, E. A., Amisah, S., Adjei-Boateng, D. 2012. Effects of Two Aquaculture Best Management Practices on Tilapia Growth. Virginia Tech Graduate Research Symposium, Blacksburg, Virginia. March 28, 2012.
- Ansah, Y. B. 2012. Adoption of Environmental BMPs in Small-Scale Fish Farming. Seminar Given at the International Water Management Institute (Ghana). June 27, 2012.
- Ansah, Y. B., Frimpong, E. A. 2012. Comparison of the Performance of Growth Models for Farmed Tilapia. Abstract Accepted for Presentation at the 142nd Annual meeting of the American Fisheries Society, St. Paul, Minnesota. August, 2012.
- Ansaha, Y.B., Frimpong, E., Namarab, R. 2013. Characteristics of Adopters of Environmental Best Management Practices in Pond Aquaculture. Proceedings from World Aquaculture Society: Aquaculture 2013. Session presentation: *Water Resources & Rural Development*.
- Aquaculture: A Better Alternative. 2013. [Outreach document] AquaFish Ghana BMP Training Workshop #3: Tarkwa, Ghana.
- Chenyambuga, S., Madalla, N. A., Mnembuka, B. V. 2012. Management and Value Chain of Nile Tilapia Cultured in Ponds of Small-Scale Farmers in Morogoro Region, Tanzania. International Institute of Fisheries Economics & Trade Conference, Tanzania. July 17, 2012.
- Evans, F., Ichien, S., Egna, H. 2012. Enhancing Economic and Trade Opportunities in Aquaculture Markets to Alleviate Poverty and Increase Food Security in Africa, Asia and Latin America. Aquaculture America 2012, Las Vegas, Nevada. February 2012. ([Link](#))
- Ichien, S., Egna, H. 2012. Evaluating Technology Adoption by the Small-Scale Aquaculture Operations in Developing Countries for Improved Productivity and Profitability. International Institute of Fisheries Economics & Trade Conference, Dar es Salaam, Tanzania. July 2012. ([Link](#))
- Ichien, S., Egna, H. 2012. Evaluating Value Chains and Consumer Preferences in Asian and African Aquaculture to Help Overcome Unemployment and Poverty. International Institute of Fisheries Economics & Trade Conference, Dar es Salaam, Tanzania. July 2012. ([Link](#))
- Ichien, S, Egna, H. 2013. Best Management Practices- Non-fed Pond Systems. [Outreach document] AquaFish Ghana BMP Training Workshop #3: Tarkwa, Ghana. ([Link](#))

- Macharia, S., Amadiva, J. 2012. Developing Aquashops in Kenya. International Institute of Fisheries Economics & Trade Conference, Tanzania. July 17, 2012.
- Manyala, J., Amadiva, J., Ngugi, C., Quagrainie, K. Review of Status and Opportunities in Farmed Fish Marketing in Kenya. International Institute of Fisheries Economics & Trade Conference, Tanzania. July 17, 2012.
- Ngugi, C., Kwamena, Q. 2013. Pond Management Fact Sheet: Feeding. [Outreach document] AquaFish Ghana BMP Training Workshop #3: Tarkwa, Ghana. ([Link](#))
- Ngugi, C., Kwamena, Q. 2013. Pond Management Fact Sheet: Pond Liming. [Outreach document] AquaFish Ghana BMP Training Workshop #3: Tarkwa, Ghana. ([Link](#))
- Ngugi, C., Kwamena, Q. 2013. Pond Management Fact Sheet: Stocking & Harvesting. [Outreach document] AquaFish Ghana BMP Training Workshop #3: Tarkwa, Ghana. ([Link](#))
- Ngugi, C., Kwamena, Q. 2013. Pond Management Fact Sheet: Pond Fertilization. [Outreach document] AquaFish Ghana BMP Training Workshop #3: Tarkwa, Ghana. ([Link](#))
- Quagrainie, K., Dennis, J. 2013. Forming an Effective Fish Farmers' Marketing Cooperative in Sub-Saharan Africa. [Outreach document] AquaFish Ghana BMP Training Workshop #3: Tarkwa, Ghana. ([Link](#))
- Virginia Tech and AquaFish. 2013. Effluent Best Management Practices. [Outreach document] AquaFish Ghana BMP Training Workshop #3: Tarkwa, Ghana. ([Link](#))



APPENDIX 1: ACRONYMS

AA	Associate Award
ACRSP	Aquaculture Collaborative Research Support Program
AquaFish	Aquaculture & Fisheries
BMP/BMPs	Best Management Practice(s)
CGIAR	Consultative Group on International Agricultural Research
EGAT	Economic Growth and Trade
FCR	Feed Conversion Ratio
FTF	Feed the Future
FTFMS	Feed the Future Monitoring System
FY	Fiscal Year
HC	Host Country
HC PI	Host Country Principal Investigator
IWMI	International Water Management Institute
KNUST	Kwame Nkrumah University of Science and Technology (Ghana)
KU	Kenyatta University (Kenya)
LEAP	Leadership Enhancement in Agriculture Program (Borlaug LEAP)
LWA	Leader with Associates Award
ME	Management Entity
MU	Moi University (Kenya)
MOU	Memorandum of Understanding
MT	Management Team
NCE	No-cost extension
NSF	National Science Foundation
OSU	Oregon State University (USA)
PD/A CRSP	Pond Dynamics/Aquaculture Collaborative Research Support Program
SIRTD	Strategic Investment in Rapid Technology Dissemination
SUA	Sokoine University of Agriculture (Tanzania)
USAID	United States Agency for International Development
USG	United States Government
VT	Virginia Polytechnic Institute and State University (USA)