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COLLABORATIVE RESEARCH SUPPORT PROGRAM**

**STRATEGIC INVESTMENT IN RAPID TECHNOLOGY DISSEMINATION (SIRTD)
PROGRAM**

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

FINAL DRAFT

**SECOND ANNUAL REPORT
1 October 2011 to 30 September 2012**



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SIRTD PROGRAM: ENHANCING THE PROFITABILITY OF SMALL AQUACULTURE OPERATIONS IN GHANA, KENYA, AND TANZANIA— SECOND ANNUAL REPORT (FINAL DRAFT)

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Executive Summary

The Second Annual Report for the AquaFish CRSP Strategic Investment in Rapid Technology Dissemination (SIRTD) Program Associate Award “Enhancing the profitability of small aquaculture operations in Ghana, Kenya, and Tanzania” covers activities and accomplishments from October 1, 2011, through September 30, 2012. During this reporting period, US and Host Country investigators conducted collaborative efforts focused on SIRTD development goals, including scaling up innovations from previous CRSP project successes and accelerating best management practice (BMP) adoption rates.

To align its strategies and goals with those of the Feed the Future (FtF) initiative, USAID issued a Request for Assistance (RFA) for work in this crucial area in 2010. Oregon State University’s AquaFish CRSP 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. In September 2010, the AquaFish CRSP ME at OSU was awarded a 3-year, \$1.1 million Associate Award through USAID’s EGAT/AG Strategic Investment in Rapid Technology Dissemination (SIRTD) Program. This Associate Award, *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. Subcontracts were awarded to partnering researchers at Purdue University (US Co-PI Dr. Kwamena Quagraine) and Virginia Polytechnic Institute and State University (US Co-PI Dr. Emmanuel Frimpong) after their work plans underwent technical and programmatic review.

The focus of this Associate Award is technology adoption involving best management of inputs for fish production to provide economic, environmental, and agronomic efficiency in aquaculture in sub-Saharan Africa. Target technologies of focus include *effluent management practices*, *nutrient management practices*, and *profitability analysis*. This project focuses on Ghana, Kenya, and Tanzania for scale-up of best management practices, but also keeps a regional perspective in mind. As a further step in scaling up innovations from previous CRSP successes and accelerating BMP adoption rates in Ghana, Kenya, and Tanzania, three innovation diffusion techniques are being used: 1) Central Media (series of workshops at the regional level and extension follow-ups), 2) Demonstrations (BMPs at work on farms of selected farmers), and 3) Lateral Diffusion (farmer-to-farmer extension of BMPs).

During this second annual reporting period, CRSP BMPs have been extended through both on-farm demonstrations and short-term training workshops. In Ghana, eight farms have participated in the demonstrations and five farms are currently demonstrating the use of CRSP BMPs. One major short-term training event was held at the Sunyani campus of Kwame Nkrumah University of Science and Technology, Ghana, targeting farmers (importance and application of BMPs) and extension personnel (training-of-trainers). In Kenya, seven farms have participated in demonstrations extending CRSP BMPs, and two short-term training events have been held, one targeting farmers and the other targeting trainers. A total of 234 FtF focus country nationals have received training, including 109 in Kenya and 125 in Ghana.



Introduction

Feed the Future (FtF) is a United States Government initiative designed to reduce poverty and hunger among families, communities, and countries across the globe. 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) for work in this crucial area in 2010.

Oregon State University's AquaFish CRSP 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, *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. Our 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 of the 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." We are focusing on small-scale aquacultural producers, the production of high quality seed, and the adoption of best management practices (BMPs). We are working with private sector partners to expand commercially sustainable agro-input industries and dealer networks, including small enterprises, as well as on seed production training to increase the availability and quality of fingerlings for stocking by fish farmers. Increased access to inputs is being coupled with strategies to help ensure their safe and sustainable use. Our 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 as they become apparent. Our aim is to provide women with equal access to affordable inputs and improved techniques and 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, our project aims to make markets work better for women and men agricultural producers and to extend the availability of nutritious foods. Through the reach of the project, our 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 protein and micronutrients commonly found in fish.

This project has primary focus locations in Ghana and Kenya to leverage work done by the AquaFish CRSP, to consolidate adoption of the technology, and to ensure measurable impact. In addition to the intensive efforts in Ghana and Kenya, a pilot workshop will be held in Tanzania in 2013. The project began on 1 October, 2010, and will continue through 30 September, 2013.



BACKGROUND

The accelerating pace of growth of aquaculture 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 will help forestall 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 profitability and efficiency issues were studied by Purdue University under the previous CRSP 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, CRSP held a two-day national 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 "test drive" 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-funded 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 may 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 year of the project (FY2011), three short-term training events were held, two in Ghana and one in Kenya.¹ Of the 191 trainees in those three events, 31 (16.2%) were women and 160 (83.8%) were men. On a country basis, 23 trainees attended the course in Kenya, including 6 women (26.1%) and 17 men (73.9%), and 168 people were trained in Ghana, including 25 women (14.9%) and 143 men (85.1%). Efforts were made to increase women involvement in BMP trainings and demonstrations, as traditionally far fewer women are involved in aquaculture production compared to men. In Ghana, 6 BMP demonstrations were started in the first year. The first 3, including 1 each in the Ashanti, Brong Ahafo, and Western Regions, were about 75% complete by the end of the first reporting year, and another set of

¹ The Kenya workshop was held in late September 2011 and not included in the first annual report. See notes under "Short-Term Training" later in this report.

three (2 in the Ashanti Region and 1 in the Western Region) were begun in August of 2011. Demonstration sites for Kenya were not scheduled to begin until this second reporting year.



TARGET TECHNOLOGIES

The focus of this project is technology adoption involving best management of inputs for fish production to provide economic, environmental, and agronomic efficiency in aquaculture in sub-Saharan Africa. Target technologies of focus 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 to be addressed 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 avoid wastes and water quality deterioration that threaten fish health. One 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 = weight of feed fed/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 ACRSP measured performance indicators and the profitability of Nile tilapia (*Oreochromis niloticus*) production in Ghana. Research incorporating variable costs, fixed costs, owned inputs, yield, and revenues showed that the integration of economic, social, and environmental objectives into aquaculture production in the Ashanti Region resulted in break-even production of 904 kg/acre and a break-even price of \$0.99/kg. In the Brong-Ahafo region break-even production was 877 kg and the break-even price was \$1.25/kg, indicating better performance for farmers in the Ashanti region. Incorporating BMPs into this analysis could increase profitability by at least 20%. 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 will be 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 in Tanzania, the target is about 100 fish farmers. During FY2012 we have held one regional workshop in Ghana, involving a total of 125 participants, and two national workshops in Kenya, involving a total of 109 participants. A national workshop is planned for Tanzania during the third year of the project.

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 also 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 CRSP 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 CRSP-supported graduate students and fisheries extension officers with the cooperation of 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 cost of BMP implementation.

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

Through regional workshops and demonstrations we 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 who are likely to be interested in their new ideas. These new farmers also become nodes and propagate their own networks, thereby laterally transmitting knowledge without the direct involvement of extension personnel.



GENDER INTEGRATION AND ANALYSIS

The AquaFish CRSP is dedicated to improving gender inclusiveness in the aquaculture and fisheries sectors across the spectrum of CRSP projects and activities. FtF requires that we develop approaches to target both men and women with agricultural interventions. This includes investments in sustainable labor-saving technologies so that shifts in the gender division of labor and products do not systematically disadvantage one sex 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 (i.e., Fisheries Officers who serve as aquaculture extension officers, fish farmers, fish traders and processors, consumers, program personnel, students, etc.), we are 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 woman fish farm proprietors and wife-and-husband joint owners of fish ponds/farms.



MAJOR ACCOMPLISHMENTS TO DATE

In the first two years of this project (Fiscal Years 2011 and 2012), 6 short-term training events have been held, including 3 each in Ghana and Kenya. A total of 425 trainees have attended these events, including 71 women (16.7%) and 354 men (83.3%). In Kenya, 27 women (20.5%) and 105 men (79.5%) were trained, whereas 44 women (15%) and 249 men (85%) were trained in Ghana. The project's focus on promoting the adoption of BMPs on fish farms requires training and working with the owners of fish farms. Considering the fact that only about a tenth of fish farms are owned by women, the gender ratio of potential workshop participants is heavily skewed towards men. In spite of this, efforts to include more women in training activities have met with some success: whereas the percentage of fish farms owned by women is only about 10%, short-term training undertaken by the project has on average included over 16% women farmers (15% in Ghana and 20% in Kenya). In addition, several gender-specific trainings

are planned in the third year in topics such as marketing, aquaculture business planning, nutrition, and post-harvest.

The project has also supported long-term training for 12 students. This included 7 women (58.3%) and 5 men (41.7%), thus exceeding the overall program target of 50% women. Seven of the 12 students are Ghanaians (4 women and 3 men) and five are Kenyans (3 women and 2 men). Among the 7 Ghanaians, 2 are pursuing PhDs and 5 are pursuing Master's degrees. In Kenya, all 5 of the students are working on MS degrees.

In addition to short- and long-term training, sites for demonstrating BMPs were established in Ghana and Kenya (no demonstrations were planned for Tanzania). At each demonstration farm in each region, in both countries, ponds were stocked and managed to compare the growth performance of tilapia (*O. niloticus*) under four treatments: 1) One pond filled with new water and fish fed with local feed, 2) one pond reusing old water and fish fed with local feed, 3) one pond filled with new water and fish fed with a commercial (formulated) feed, and 4) one pond reusing old water and fish fed with commercial feed.

In Ghana, the first round of BMP demonstrations included 6 sites. The first 3, including 1 each in the Ashanti, Brong Ahafo, and Western Regions, were begun early in FY2011 and a second set of 3 (2 in the Ashanti Region and 1 in the Western Region) was begun in August of FY2011. All 6 of these demonstrations were completed in FY2012, and a second round of 5 demonstrations was initiated in May 2012, using 20 ponds on 5 farms in the Ashanti and Brong Ahafo Regions. None of the Ghanaian demonstration farms are owned exclusively by women, but some may be characterized more appropriately as family owned.

Demonstrations in Kenya were not scheduled to begin until this year (FY2012). Accordingly, the first cycle of demonstrations was undertaken on seven farms in three regions—Rift Valley, Western, and Central. Stocking of the first ponds began after the first BMP workshop, which was held in September 2011, and the remaining ponds were stocked up through January 2012, depending on the availability of fingerlings. All of Kenya's Cycle 1 demonstrations have been completed, and a second cycle is now being initiated. Two of the seven participating farms are owned by women, and a third (Mwea Aquafish Farm), is jointly owned by a woman and a man. Detail on progress within each of these regions is provided in the full project reports below.

Surveys of farmer adoption of BMPs are being conducted concurrently with all demonstrations; data has been collected from demonstrations already completed and are currently being analyzed. In Ghana, about 200 farmers have already been surveyed, with additional surveys scheduled over the next year (December 2012 and June 2013) to provide the resolution necessary to characterize adoption rates. The goal is to identify the factors determining BMP adoption rates and the economic benefits of BMP adoption. An additional workshop in Tanzania is being planned, as is greater emphasis and outreach to women.



Collaborating Institutions and Personnel

AquaFish CRSP, Oregon State University, USA

Hillary Egna, 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



Trainees obtain hands-on hatchery experience during a workshop in Ghana.



Progress Made and Results Achieved

This Associate Award has the broad objectives of scaling up innovations from the Aquaculture CRSP 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

Two workshops targeting both farmers and extension officers were held in Kenya during this reporting period.² The Farmers Progress Report and Baseline Survey Workshop was held in Nakuru from 9 to 11 May 2012. A total of 38 participants attended (7 women, 31 men). This workshop was attended by farmers, extension officers, technical staff, and CRSP facilitators. A second workshop, the Farmers End-of-Cycle-One Workshop, was held in Nakuru from 12 to 13 June 2012. In attendance at the second workshop were 71 participants (14 women, 57 men). During this workshop, reports about project progress and performance in the three regions were presented.

In addition to these workshops, the application of BMPs was demonstrated on farms in three regions: The Rift Valley Region, the Western Region, and the Central Region. The first cycle of these demonstrations (7 sites) began after the first BMP workshop, which was held in September 2011, with the stocking of the first ponds in October of 2011. Due to difficulties in obtaining sufficient numbers of fingerlings, other ponds were stocked as late as January 2012.

² Another workshop, the “Aquaculture BMP Workshop for Resource Personnel,” a train-the-trainer workshop, was held from 21 to 23 September 2011, with 23 trainees (6 females, 17 males). Participants were given an overview of the BMP project’s objectives and responsibilities. This workshop was not included in the FY11 Annual Report.

Because the Kenya government's aquaculture stimulus program has been going on simultaneously with this project, the demand for fingerlings has been high and the supply of fingerlings has not always been able to keep pace. At each demonstration farm in each region, ponds were managed to compare the growth performance of tilapia (*O. niloticus*) under four treatments: 1) new water and fish fed with local feed, 2) reused water and fish fed with local feed, 3) new water and fish fed with a commercial (formulated) feed, and 4) reused water and fish fed with commercial feed. Detail on progress within each of these three regions is provided below.

Rift Valley Region

The Rift Valley Region is represented by two farms: Nakuru Fish Farm & Hatchery, located at Kabatini, Nakuru, and Willfay Farm in Subukia. BMP demonstrations are currently underway and fish have been gaining weight at both farms; however, fish at Nakuru Fish Farm & Hatchery have a lower weight than those at Willfay Farm. Differences in weight gain are likely due to temperature differences between the farms. At Nakuru Fish Farm & Hatchery, temperatures range between 16 - 21°C, whereas at Willfay Farm they range between 21 - 26°C.

Challenges faced at the demonstration sites included occasional low water levels; the high frequency of predators, including frogs and birds; uncontrolled reproduction that resulted in high densities of fish and stunted growth; low ambient water temperatures contributing to slow growth; fin rot (fungus) early in the trials. Flow of information from farm management to the field technicians also presented challenges.



Virginia Tech PI Dr. Emmanuel Frimpong outlines water detention practices during a BMP train-the-trainer workshop held in Kenya.

Western Region

The Western Region is represented by two farms: Makhoha's SAFE (Sustainable Aquaculture & Farming Enterprises) Farm and Peter's Fish Farms, which are both located in Kakamega County. Although fish in the demonstration ponds have been gaining weight, their growth during the first two months was slow. At both farms, the treatments with reused water were

performing better than those with new water. The use of the commercial feed resulted in better performance compared to the use of local feeds at Peter's farm. At Makhoha's Farm, feed did not contribute to a difference in growth performance as the farmer was using a local feed which was similar to the commercial feed.

The demonstration farms in the Western Region also faced challenges, including: delayed fertilization of ponds leading to limited natural food for the fish; uncontrolled reproduction that resulted in high fish densities and stunted growth; and the presence of predators such as frogs.



Trainees listen to BMP demonstration progress reports at the June 2012 workshop held in Central Province, Kenya.

Central Region

The Central Region is represented by three farms: Mwea Aquafish Farm in Mwea, Kirinyaga County; Kibathi Farm in Ruiru; and Kamiti Fish & Integrated Farm in Kiambu. Fish growth in this region was generally slow, likely due to stocking the fish at small sizes (approx. 3 g each).

Flooding of ponds at Kibathi Farm and Kamiti Fish & Integrated Farm contributed to the challenges faced by the demonstration ponds in this region. Additional challenges included the presence of predators (frogs) at all farms; uncontrolled reproduction resulting in high population densities and stunted growth; and high mortalities of fish stocked at Kibathi Farm and Kamiti Fish & Integrated Farm due to handling stress and high temperatures during transportation.

All Cycle 1 demonstration ponds have now been harvested, and a second cycle is being initiated. Farmers are using the proceeds from Cycle 1 to buy feed and fingerlings for the second cycle. Participating farmers have all agreed to open their doors to visits by other farmers in their region so that they can learn about the BMPs and the benefits of their use. A Kenyan graduate student has just completed collecting data from the participating Cycle 1 farmers for assessing the factors determining the adoption of BMPs, the rate of BMP adoption, and the economic benefits of BMP adoption. Preliminary analysis is underway.



***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 Ghana during this reporting period. It was held in Sunyani, Brong Ahafo region, from 12 to 14 June, 2012, and attended by farmers from all three study regions. This workshop was attended by 124 trainees, including 19 women (15.3%) and 105 men (84.7%). In accordance with the work plan, Dr. Emmanuel Frimpong joined Dr. Kwamena Quagrainie to co-lead the train-the-trainer workshop in Kenya.

The first round of BMP demonstrations, involving 24 ponds on 6 farms, was completed between November 2011 and February 2012. The second round started in May 2012, using 20 ponds on 5 farms in the Ashanti and Brong Ahafo Regions (3 and 2 demonstrations, respectively). The current demonstrations include two new farms selected using the same criteria as the previous group of farms. One of the new demonstration sites is the Pilot Aquaculture Center (PAC) of the Ghana Fisheries Commission. The decision was made not to continue demonstrations in Western Region (the furthest sites from KNUST) because of logistical constraints and the cost of transporting personnel and inputs to the farms.

In the first round of demonstrations we used a blocked, crossed, 2-factor experimental design with 6 farms as blocks and 4 ponds as experimental units on each farm. The two factors (feed type and water management) each had two levels: Formulated floating feed (BMP1) was contrasted with local, pelleted sinking feed whereas water reuse (BMP2) was contrasted with supplying the ponds with new water. Tilapia (*O. niloticus*) fingerlings were stocked at 3/m² and growth was monitored for 4 to 7 months. Preliminary results indicate that fish reached 180-200 g in six months under the formulated feed treatment while those in the sinking feed treatment reached about 80-110 g in the same period of time. There were significant outliers in the data, especially on the low side. The growth differences between water reuse and new water treatments were minimal when considered alone but there appeared to be enhanced growth in ponds where new water was provided in combination with floating feed. The overall growth rates under all treatments were considered poor and below the 300-400 g estimates often used in economic analysis of pond tilapia culture over 6-month production cycles. In a preliminary linear programming analysis, researchers determined that under the observed growth rates, the best growths would not result in a competitive break-even price for tilapia. Therefore farmers would probably not adopt the formulated feed without a demonstration of better growth.

Better growth rates are anticipated in the second round of demonstrations, as several questions and problems encountered in the first round have been addressed. With the current data, we are testing several tilapia growth models that would ultimately determine the model we use in our final economic analysis. The careful and rigorously tested choice of a growth model is important because the model affects the forecasted growth rates and reliability of predictions that can be made for a farmer deciding between different management practices and profitability. So far, we have considered von Bertalanffy, Gompertz, Logistic, and Chapman-Richards growth models. Thus far the Gompertz model appears to provide the best description of fish growth in the demonstration trials.



*Trainees learn how to distinguish between male and female tilapia (*Oreochromis niloticus*) during a workshop in Ghana.*

Approximately 260 baseline and follow-up BMP knowledge and adoption surveys have been completed to date. Surveys were conducted in December 2011 and June 2012. The number of farmers surveyed to date is 200 and represent Ashanti, Brong Ahafo, and Western regions.

Two more surveys over the next year (December 2012 and June 2013) are needed in order to provide the temporal resolution necessary to characterize adoption rates and separate percentages of farmers who were using BMPs prior to this demonstration and outreach from those adopting BMPs as a result of our demonstrations and outreach activities. The application of economic models for predicting adoption rates will also require data from the ongoing second round of experiments (to be completed in FY 2013). Therefore, preliminary analysis of the survey data has focused on understanding the demographic and socioeconomic characteristics of BMP adopters, which is also an important objective. This analysis is still ongoing.



SHORT-TERM TRAINING

In this second year of the Associate Award, three short-term training events were held (2 in Kenya and 1 in Ghana), with a total of 234 host country nationals receiving training (109 in Kenya and 125 in Ghana). In Ghana (1 training event), 19 women (15.2%) and 106 men (84.8%) were trained. In Kenya (2 training events), 21 women and 88 men were trained (19.3 and 80.7%, respectively). Future trainings are planned to increase women's access to information.

Topics covered in these trainings included the application of aquaculture BMPs, reports on the progress of ongoing BMP field demonstrations, administration of survey questionnaires regarding BMP adoption, and discussions of related extension activities. In the Ghana workshop, the *Farmerline* group made a presentation on their mobile technology and how it might be used in aquaculture extension efforts. Participants were given tours of nearby demonstration sites.



LONG-TERM TRAINING

Twelve students were supported under the FtF project during this reporting year, including 7 women (58.3%) and 5 men (41.7%). Seven of these students are Ghanaians (4 women and 3 men) and five are Kenyans (3 women and 2 men). Among the 7 Ghanaians, 2 are pursuing PhDs and 5 are pursuing Master's degrees. In Kenya, all 5 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 2012, Dr. Hillary Egna (Director, AquaFish CRSP and PI for the Associate Award) travelled to Kenya and Tanzania to meet with key Associate Award partners. In Kenya, Dr. Egna met with the Kenya project team at Mwea Aquafish Farm, one of the demonstration farms in Central Kenya. Dr. Egna, HC Co-PI Mr. Sammy Macharia (Kenya), Judith Amadiva (HC Investigator, Kenya), Charles Ngugi (Fisheries Secretary, Ministry of Fisheries Development, Kenya), and students working on the project met to discuss progress and challenges. Dr. Egna discussed research methods with the students, reviewed survey instruments, and requested that baseline data be collected in order to quantify BMP adoption rates.

In Tanzania a larger project team met and discussed, coordinating workshops, logistics, research direction, and key BMPs developed by the CRSP for non-fed pond systems. This meeting also gave participants an opportunity to interact and debrief each other on specific accomplishments related to the project. In attendance were Dr. Hillary Egna, US Co-PI Dr. Kwamena Quagraine (USA), Mr. Sammy Macharia (Kenya), Ms. Judith Amadiva (Kenya), HC Co-PI Dr. Sebastian Chenyambuga (Tanzania), Ms. Gifty Anane-Taabeah (Ghana), and Dr. Nazael Madalla (Tanzania).



FtF team members meet to discuss project progress and plan future work during a CRSP conference in Zanzibar.



MONITORING AND EVALUATION

AquaFish CRSP reports under USAID impact reporting framework to achieve outcomes that have meaning for stakeholders, including Missions, HC decision makers, and end-users. USAID indicator targets and results for FY12, along with revised targets for FY13, that are reported against for this Associate Award are presented in Table 1.

Table 1. AquaFish CRSP SIRTD Associate Award FY2012 USAID Indicator Report.

	FY 2012 Targets	FY 2012 Actuals	Revised FY 2013 Targets
4.5.2 Agriculture Sector Productivity			
Number of new technologies or management practices under research as a result of USG assistance.	0	0	0
Number of new technologies or management practices made available for transfer as a result of USG assistance.	3	4	4
Number of new technologies or management practices being field tested as a result of USG assistance.	3	4	4
Number of additional hectares under improved technologies or management practices as a result of USG assistance.	150	180	245
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Female	34	20	24
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Male	302	200	240
Number of rural households benefiting directly from USG interventions - Female Headed Household	17	18	20
Number of rural households benefiting directly from USG interventions - Male Headed Household	132	110	132
Number of producers organizations receiving USG assistance.	1	4 ⁽¹⁾	4 ⁽¹⁾
Number of water users associations receiving USG assistance.	1	1	1
Number of trade and business associations receiving USG assistance.	0	0	0
Number of community-based organizations (CBOs) receiving USG assistance.	1	1	1
Number of producers organizations who have adopted new technologies or management practices as a result of USG assistance.	1	4 ⁽¹⁾	4 ⁽¹⁾

Table 1. CONTINUED:

4.5.2 Agriculture Sector Productivity	FY 2012 Targets	FY 2012 Actuals	Revised FY 2013 Targets
Number of water user associations who have adopted new technologies or management practices as a result of USG assistance.	1	1	1
Number of trade and business associations who have adopted new technologies or management practices as a result of USG assistance.	0	0	0
Number of community-based organizations (CBO) who have adopted new technologies or management practices as a result of USG assistance.	1	1	1
Number of agriculture-related firms benefiting directly from USG supported interventions.	2	2	2
Number of women's organizations/associations assisted as a result of USG interventions.	0	0	0
Number of public-private partnerships formed as a result of USG assistance.	0	1	1
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	55	40 ⁽²⁾	52 ⁽³⁾
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	135	194 ⁽²⁾	113 ⁽³⁾
Number of individuals who have received USG supported long-term agricultural sector productivity food security training - Female	2	7	7
Number of individuals who have received USG supported long-term agricultural sector productivity or food security training - Male	1	5	5
Value of new private sector investment in the agriculture sector or food chain leveraged by FTF implementation.	NA	NA	NA
Number of jobs attributed to FTF implementation (disaggregated by gender, ag. vs. non-ag.)	NA	NA	NA

Table 1 footnotes:

¹ In Kenya, the project is working with three fish farmer cluster groups, bringing the total number of producers' organizations to four. It is expected that this will continue through FY2013.

² High interest in these workshops resulted in greater attendance than planned. With the high percentage of male farm owners, the short-term training numbers are skewed towards men.

³ Based on an average of 45 trainees for each of the three remaining workshops for FY2013 at a 5:1 male:female ratio; plus an additional workshop for women participants.

NA = Not Applicable – not part of approved Work Plan.

Appendix 1 shows the Associate Award's USAID indicator targets and results for FY12, along with revised targets for FY13.



Challenges

The global increase in fuel prices have led to corresponding increases the cost of inputs, especially commercially formulated fish feeds. The project faced challenges obtaining supplies, including feed and seed, in both Kenya and Ghana. This project is being implemented at the same time that the Government of Kenya is implementing its nationwide aquaculture stimulus program, and as a result the supply of basic inputs such as fingerlings and feed has been limited.

Seed quality also presented challenges. Partly due to demands from the Kenyan aquaculture stimulus expansion and in spite of the assurance of all-male fingerlings from hatcheries, Kenyan researchers experienced cases where mixed-sex fish were stocked, resulting in unwanted reproduction and high densities of fish in demonstration ponds, which adversely affected growth performance. In Ghana, sex reversal of tilapia stocked into demonstration ponds was largely unsuccessful, as unwanted reproduction began naturally in many ponds early in the production cycle. Although the original supplier was a nationally recognized fingerling producer, it became clear that this hatchery had mixed stocks of fish with unknown origins and poor growth. To achieve improved growth in the second round of experiments, fingerlings were acquired from an alternate source, Crystal Lake Ltd. The stocking density for all ponds has been reduced from 3/m² to 2/m², and, to provide added guarantee against unwanted reproduction and stunting, the protocol for the second round of demonstrations includes the introduction of *Clarias* fingerlings. All ponds were stocked with tilapia at the same time (early June 2012), and *Clarias* stocking took place in mid-August 2012.

Other challenges encountered were of a more climatic nature. The weather pattern has varied considerably across the demonstration farms, and this has occasionally led to low water levels and temperatures, resulting in poor fish growth. Conversely, flooding caused problems in other regions. In Ghana, several problems encountered in the first round of demonstrations were addressed in the second round, in particular errors in data reporting from some of the demonstration ponds.



Lessons Learned

Through this project, AquaFish CRSP is playing a crucial role in filling extension education and service gaps in Ghana. Many farmers have come into contact with extension officers and scientists for the first time through the demonstrations and workshops supported under this Associate Award. CRSP training programs are well attended and play a crucial role in extension and farmer-to-farmer networking. In Kenya, collaboration with the Ministry of Fisheries Development and the fisheries extension services has been beneficial. Fisheries extension officers have incorporated outreach activities from this project as part of their work under the government stimulus program. One criterion for selecting demonstration farms was that the farmers had to agree to have an open door policy to allow other farmers to visit their site and learn about BMPs. Most farmers who participated in workshops acknowledged having visited demonstration sites, which provides evidence that lateral diffusion (farmer-to-farmer extension) of BMPs is taking place. It is clear that demand is high for extension support in Kenya and Ghana, and quite probably throughout sub-Saharan Africa.

This project also provides an example of how research and extension work designed to directly benefit local fish farmers has also contributed to institutional and technical capacity building. The benefits to KNUST, for example, include increased student enrollment in aquatic science programs and student involvement in research and development activities, as well as development of the research skills and output of faculty members. The contribution of matriculated undergraduate and graduate students to regional aquaculture development continues to be important, whether through university-based research institutions, the government, or the private sector.



Program Director, Dr. Hillary Egna, and project participants visit the BMP demonstration site at Mwea Aquafish Farm in Kenya.



Success Stories

Benefits of Floating Feeds - Kenya

Wilfred Makokha, a farmer from Kakamega in Western Province, Kenya, observed that the use of the pelleted floating feed helps his fish see the feed and eat well. He said “formerly the feed we use sinks immediately. We throw them into the water and the fish finds it difficult to locate the feed. Now the feed stays on the surface of the water for a long time and the fish easily locate the feed and eat well.” Another farmer said that it used to take a long time for the fish to mature when they were using the sinking feeds, but now the fish grow faster. “Now they feed better and mature early.”



Dr. Charles Ngugi demonstrates the application of floating feeds at the Mwea Aquafish Farm in Mwea, Kirinyaga County, Kenya.

Bidii Feed Innovation - Kenya



Bidii FishFarmer members confer with extension agent in Luanda, Kenya.

In addition, many of the farmers are showing a lot of enthusiasm in applying the lessons learned from the BMP workshops on their farms.

In Kenya, the Bidii Fish Farmers Association in Luanda, Western Province, realized the benefit of and the increasing demand for floating pelleted feeds. They are experimenting with an innovative way of making their feeds float. This is an association that has its own feed manufacturing machine and manufactures fish feed to sell to its members. With attention shifting to floating pelleted feeds, they are trying to include ‘pop-corn’ in their feed formulation. The notion is that pop-corn is light and has the potential of making the feed float on the surface of the water. With pop-corn added to their standard sinking feed, the modified feed floated for 50-70 seconds in their initial trial of this innovation. For these fish farmers this is a success that stems from the introduction of the BMPs. In

Adopting BMPs - Ghana

Paul Osei Kwame has operated a successful 25-acre farm—Oseibros Farms Company Limited—in the Ashanti Region of Ghana for over 24 years. Originally running an integrated operation including poultry, crops, and maize grit extraction, Mr. Osei added aquaculture in 2008. He now has 20 ponds where he raises Nile tilapia fingerlings for sale to other fish farmers. As a farmer who believes in the application of science to agricultural production, he readily agreed to participate in the CRSP's project, allowing Oseibros Farms to serve as one of six demonstration sites for BMP testing and demonstration. Mr. Osei has adopted the CRSP recommendation to lower the frequency of pond draining to both save water and lessen the environmental impact of his farm's pond effluent. According to Mr. Osei, "While the BMP's help in improving on-farm activities, they also contribute immensely to the effective regulation of waste disposal." With higher profits from cost savings and a commitment to a lighter environmental footprint, Mr. Osei has further expanded his aquaculture operations. His farm is now producing



Demonstration provided practical training for KNUST students, shown here sampling fish at Oseibros farms, Kubases, Ghana

tilapia broodstock and table-size food fish for sale to the local food markets. For the

future, Mr. Osei plans to start new fish farms at two other locations and process fresh fish on site, with an eye toward entry into the export market.



Paul Osei Kwame (right) confers with Dr. Daniel Adjei-Boateng of KNUST, one of several Ghanaian CRSP investigators helping him manage the project's on-farm research and demonstration work at the Oseibros Farm.

Farmerline - Ghana



Mobile technology for extension and market information dissemination: Farmerline leader Alloysius Attah (center) poses with a group of farmers proudly displaying their cell phones during a visit to Rev. Sarfo's farm (a project demonstration site) as part of the 2012 workshop activities in Sunyani, Ghana.

In Ghana, project participants are benefiting through interactions with private sector stakeholders such as *Farmerline* – a small Ghanaian company that utilizes mobile and web-based systems to furnish farmers and investors with relevant agro-industry and marketing content to improve productivity and income (<http://farmerline.org/>). As business people, *Farmerline* personnel come with a good sense of how technology can serve farmers, but with less of an understanding of farmers' economic situations and problems. This project has benefitted both the farmers and *Farmerline* by bringing both parties together to facilitate interaction.

Borlaug LEAP Fellowship

Yaw Ansah, a PhD student at Virginia Tech, through his participation in this project, has been awarded a 2010-2011 Borlaug LEAP Fellowship. This fellowship leveraged significant in-kind support through collaboration with the International Water Management Institute (IWMI), represented by Dr. Regarssa Namara in Accra, Ghana. Dr. Namara provided valuable input in the development of the BMP survey instrument and IWMI provided office space and access to the rich CGIAR library in Ghana during Yaw Ansah's two 6-week visits to Ghana in summer 2011 and summer 2012. The LEAP fellowship ended 30th June 2012.



Long-Term Training: Virginia Tech students Yaw Ansah (front left) and Gifty Anane-Taabeah (third left) prepare a group of national service personnel and graduate students for survey administration during the second regional BMP workshop in Sunyani, Ghana.



Presentations and Publications

- 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., and Adjei-Boateng, D. Effects of two aquaculture best management practices on tilapia growth. Virginia Tech Graduate Research Symposium, Blacksburg, Virginia. March 28, 2012.
- Ansah, Y. B. Adoption of environmental BMPs in small-scale fish farming. Seminar given at the International Water Management Institute (Ghana). June 27, 2012.
- Ansah, Y. B. and Frimpong, E. A. 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.
- Chenyambuga, S., Madalla, N. A., and Mnembuka, B. V. 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. and Egna, H. 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.
- Ichien, S. and Egna, H. 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.
- Ichien, S. and Egna, H. 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.
- Macharia, S. and Amadiva, J. Developing Aquashops in Kenya. International Institute of Fisheries Economics & Trade Conference, Tanzania. July 17, 2012.
- Manyala, J., Amadiva, J., Ngugi, C., and Quagrainie, K. Review of Status and Opportunities in Farmed Fish Marketing in Kenya. International Institute of Fisheries Economics & Trade Conference, Tanzania. July 17, 2012.

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Committed to Gender Integration: CRSP Experiences in Working with Men and Women from Lab to Field. CRSP Digest Newsletter, Vol. 1, no. 1.

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(<http://crsps.net/site/wp-content/downloads/CRSP%20Digest/18-2012-3-2.pdf>)



Nursery ponds, Mwea Aquafish Farms, Kenya.

Appendix 1: Acronyms

AA	Associate Award
ACRSP	Aquaculture Collaborative Research Support Program
BMP/BMPs	Best Management Practice(s)
CGIAR	Consultative Group on International Agricultural Research
FCR	Feed Conversion Ratio
FtF	Feed the Future
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
NSF	National Science Foundation
OSU	Oregon State University (USA)
SIRTD	Strategic Investment in Rapid Technology Dissemination
SUA	Sokoine University of Agriculture (Tanzania)
USAID	United States Agency for International Development
VT	Virginia Polytechnic Institute and State University (USA)