AQUACULTURE & FISHERIES
COLLABORATIVE RESEARCH SUPPORT PROGRAM

DRAFT FINAL REPORT

30 September 2006 to 29 September 2012

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Oregon State University OSU

AQUAFISH COLLABORATIVE RESEARCH SUPPORT PROGRAM

AQUACULTURE & FISHERIES COLLABORATIVE RESEARCH SUPPORT PROGRAM DRAFT FINAL REPORT

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This report covers the period from 30 September 2006 to 29 September 2012. This document serves as the Annual Report for FY 2012 activities.

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Demonstration fish pond in Annai, Guyana. Photo by Ford Evans.

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EXECUTIVE SUMMARY

In 2006 the United States Agency for International Development (USAID) awarded the Aquaculture & Fisheries Collaborative Research Support Program (AquaFish CRSP) Leader with Associates Cooperative Agreement to Oregon State University to "develop more comprehensive, sustainable, ecological and socially compatible, and economically viable aquaculture systems and innovative fisheries management systems in developing countries that contribute to poverty alleviation and food security." This Final Report for AquaFish CRSP covers activities and accomplishments in 20 countries throughout Africa, Asia, and Latin America from 30 September 2006 through 29 September 2012. During this period, Host Country investigators representing 31 institutions and their US partners at 17 universities conducted collaborative efforts on fisheries, aquaculture, and aquatic resource management to improve the livelihoods of the rural poor. Bringing together US and Host Country institutions, AquaFish CRSP has worked to strengthen the capacities of its participating institutions, to increase the efficiency of aquaculture and improve fisheries management in environmentally and socially acceptable ways, and to disseminate research results to a broad audience.

Two no-cost extensions were granted for this award. The first, dated 8 September 2011, moved the end date of the Award to 29 September 2012. The second no-cost extension, dated 21 September 2012, provided for an additional 6 months, moving the end date to 31 March 2013. The Award was originally funded at $8.9 million over five years. Additional funds were awarded in September 2009, which raised the total obligated amount to $12.82 million, and again in May 2012, which raised the total obligated amount to $14.72 million. Project activities were also supported through US non-Federal cost share exceeding $3 million and Host Country matching support of over $1.9 million. The project also generated nearly $70 million through leveraged activities.

ACHIEVEMENTS

Research

The eight Core Research Projects conducted 106 investigations under Implementation Plans 2007-2009 and 2009–2011. With Core Research Projects in Africa, Asia, and Latin America, AquaFish CRSP researchers made significant advances in developing and transferring new technologies and practices to improve the lives of the rural poor globally. Core Research Project investigations focused on poverty alleviation and food security improvement through sustainable aquaculture development and aquatic resources management. Research centered on two broad system approaches (*Integrated Production Systems* and *People, Livelihoods, & Ecosystem Interrelationships*) that encompassed ten more narrowly-defined topic areas. Overall, the 106 investigations were distributed as follows:

System Approach - Integrated Production Systems

1. Indigenous Species Development (14 investigations)
2. Quality Seedstock Development (7 investigations)
3. Sustainable Feed Technology (13 investigations)

4. Production System Design & Best Management Alternatives (17 investigations)

System Approach - People, Livelihoods, & Ecosystem Interrelationships

5. Human Health Impact of Aquaculture (7 investigations)
6. Technology Adoption & Policy Development (11 investigations)
7. Marketing, Economic Risk Assessment, & Trade (14 investigations)
8. Mitigating Negative Environmental Impacts (14 investigations)
9. Watershed & Integrated Coastal Zone Management (5 investigations)
10. Food Safety & Value-Added Product Development (4 investigations)

AquaFish CRSP research projects engaged 17 US universities in research and development activities in 19 Host Countries with 13 partners in Africa, 5 in Latin America, and 13 in Asia, and formed collaborations with over 200 international institutions and organizations located in 27 countries. CRSP projects researched over 300 new technologies and management practices — 89 of which were made available for transfer to farmers and agribusinesses – that led to improved aquaculture production on over 9,000 hectares. AquaFish-supported research also resulted in the publication over 150 peer-reviewed scientific articles.

Examples of specific research accomplishments are presented below; additional research highlights are included in Section 3 (*Research & Technology Transfer Highlights*) and Section 6 (*Core Research Projects*). Full technical reports for all AquaFish Core Research Project investigations can be found online at aquafishcrsp.oregonstate.edu/publications.php.

- Researchers at Can Tho University, Vietnam, developed a pelleted feed with a lower fishmeal content for high-valued farmed snakehead. This new feed was a significant step toward resolving the conflict between poor people who depend on small fish from the Mekong River Basin for their food and farmers who use these small fish as feed for cultured snakehead.
- In the Philippines, CRSP research demonstrated that reduced feeding strategies can decrease feed costs by as much as 50% without lowering yield. These techniques were widely adopted thanks to innovative outreach tools such as podcasts and videos posted online.
- In Banda Aceh, Indonesia, polyculture of seaweed with shrimp, tilapia, and milkfish was introduced by CRSP researchers along with hands-on training for end-users. Prior to CRSP involvement there was no seaweed polyculture in Banda Aceh. Now it is estimated that approximately 200 farmers have incorporated seaweed in their culture systems.
- In Nicaragua CRSP researchers studied the feasibility of communities and local governments co-managing stocks of black cockles, a source of animal protein for coastal communities and employment in a fishery where women make up a large fraction of the workforce. CRSP found that a management system based on no-take areas was much more effective than the traditional management technique that relied on a 4-month closure of the fishing season. Due to the success of no-take areas, the Nicaraguan government is adopting this management system in two additional coastal communities affecting in over 200 direct beneficiaries.
- Fish hatcheries that rely on methyltestosterone (MT) to produce all-male tilapia fingerlings lacked a simple, cost-effective method for removing residual hormone from treatment water. CRSP researchers at the Autonomous Juarez University of Tabasco in Mexico successfully identified bacteria species that consume MT residue and are scaling-up this technology for commercial adoption with assistance from private sector partners.
- CRSP researchers in Kenya found cage-within-pond culture systems utilized pond nutrients more efficiently than pond-only or cage-only systems, which led to better fish growth, higher feed conversion efficiency, and higher fish survival.
- At the Autonomous Juarez University of Tabasco (UJAT) in Mexico, researchers succeeded in spawning snook in captivity and developed a customized diet that increased the survival rate of

fingerlings. Overcoming these initial hurdles is a promising step toward domestication of a popular native fish species that could open new income opportunities for smallholders along Mexico's gulf coast.

- AquaFish CRSP supported efforts to domesticate indigenous species, allowing farmers to tap into local biodiversity and adaptation rather than relying on the introduction of exotic species. Indigenous species under investigation included: Chame (*Dormitator latifrons*), cichlids *(Petenia Splendida* and *Cichlasoma urophthalmus*), Gar (*Atractosteus* spp.), and the mangrove oyster (*Crassostrea corteziensis)* in Mexico; Claroteid catfish (*Chrysichthys nigrodigitatus*), African bony-tongue (*Heterotis niloticus*), and African snakehead (*Parachanna obscura*) in Ghana; the African lungfish (*Protopterus* spp) in Uganda and Kenya; and sahar (*Tor putitora*) in Nepal.

Associate Awards

AquaFish CRSP engaged in two Associate Awards during this reporting period. USAID/Mali awarded AquaFish an Associate Award for aquaculture and fisheries work in Mali that was originally funded for three years beginning 1 October 2007 and continued via a no-cost extension through 31 December 2010. The Mali Associate Award was highly successful and included 20 short-term courses training 358 participants, three sets of on-farm trials demonstrating both improved pond culture practices and rice-fish culture techniques, and the first-ever frame survey of Lake Sélingué. After trials using CRSP rice-fish technology in model farms showed promising results, local adoption rates increased dramatically. Multiplier effects of this project are still impacting the region as CRSP-trained farmers continue to laterally disseminate technologies to other practicing and prospective fish farmers.

In FY2011 AquaFish initiated work on the $1.1 million USAID/Washington Associate Award (through the Bureau for Food Security, BFS), "Enhancing the profitability of small aquaculture operations in Ghana, Kenya, and Tanzania," focusing on scaling-up innovations from previous CRSP project successes and accelerating best management practice (BMP) adoption rates. In the first two years of this project (FY2011 and FY2012), 6 short-term training events have been held, including 3 each in Ghana and Kenya, training a total of 425 participants. In addition to providing support for 12 degree-seeking students, this project has also conducted on-farm demonstrations of BMPs in Ghana (5 demonstration farms) and Kenya (7 demonstration farms).

Capacity Building

AquaFish CRSP achieved great success in building and strengthening the capacities of institutions and individuals through it's numerous training and outreach activities imbedded in Core Research Project investigations. AquaFish engaged the services of many professionals and institutions to build additional expert capacity throughout the CRSP network. A target of 50% participation by women was established for all AquaFish training activities in order to ensure equal opportunities for men and women to benefit from the Program. AquaFish CRSP training and capacity building initiatives were also designed in a manner that benefited targeted stakeholders in both the US and Host Countries. Effective short- and long-term training and capacity building focused on four specific levels of engagement: Institutional, Researcher, Extension Services, and End-Users (e.g., farmers and fishers).

Since program inception in October 2006, AquaFish CRSP has supported 320 students in long-term academic training at Host Country and US institutions. Women represented 48% of this student population. During this same period, 181 short-term trainings were held in 19 countries and reached 6,103 people. For rural smallholders, these trainings covered a range of topics including production and processing best practices for fish and shellfish, value-added processing, marketing and value chain assessment, and sustainable feed technologies.

Gender Inclusivity

From the beginning, AquaFish CRSP has been dedicated to improving gender equality in aquaculture and fisheries sectors and in the CRSP arena. Gender integration is implicit and interwoven into targets, benchmarks, and indicators throughout the AquaFish CRSP Monitoring & Evaluation Plan, as requested by USAID in its RFA. AquaFish required that all Core Research Projects address gender integration within their planned scope of work and have a *Gender Inclusivity Strategy* in their proposals, outlining procedures for monitoring and evaluating gender integration. Researchers also evaluated the effects of specific projects on gender and worked to mitigate any possible negative effects on gender equity. In addition, each project was required to include at least one outreach activity that focused on increasing participation by women. The Director also actively engaged in advancing the role of women in aquaculture through oral and poster presentations at professional meetings, organizing and chairing sessions at professional meetings, and through publications in peer-reviewed journals.

Outreach and Engagement

AquaFish CRSP actively engaged technical and lay audiences through multiple media channels to broadly extend and publicize project achievements. In addition to program-required reports, the ME routinely produced *Aquanews* (the quarterly newsletter of AquaFish CRSP that informs CRSP participants and others of program activities), *EdOp Net* (a monthly newsletter compiled and disseminated electronically by AquaFish CRSP containing listings related to education, training, and employment opportunities), success stories, and activity briefs. The ME also produced press releases, articles, and videos highlighting AquaFish CRSP accomplishments. Efforts to communicate successes of AquaFish CRSP, and CRSPs in general, were bolstered by the initiation of the CRSP Council Knowledge and Data Management Project in Spring 2011. This CRSP-wide effort combined the wealth of information accumulated by all CRSPs into a single information clearinghouse and database. The AquaFish website, hosted by the ME, proved particularly effective in communicating with project participants as well the general public - receiving over 18,000 visits from 151 countries between May 2010 and September 2012. In addition, twenty AquaFish-related videos have been posted online (YouTube and Vimeo) and have been viewed over 8,000 times.

Outreach and dissemination plans were required for all AquaFish projects to ensure CRSP-developed technologies and management practices are effectively adopted by targeted stakeholders. CRSP Core Research Projects successfully engaged 16 women's producers and community organizations to: improve pond production and fisheries management; open new income opportunities in production, marketing, and processing; and ensure food safety and food security. Researchers worked with local stakeholders along the value-chain in a variety of activities including on-farm and demonstration aquaculture trials, community management of fisheries, value-added processing, and group marketing. These activities offered hands-on experiences that promoted successful adoption of CRSP technologies and management practices.

Advisory Bodies

Advisory bodies provided the Director with input and recommendations towards fulfilling the AquaFish CRSP mission and meeting global thematic goals. Throughout the program, AquaFish CRSP looked outward to build linkages among Host Countries through the activities of the Regional Centers of Excellence (RCE), which included centers in Latin America/Caribbean, West Africa, East and Southern Africa, and two in Asia. The Development Theme Advisory Panel also to assisted the ME with thematic reports and reviews of ad hoc proposals and work plan changes. Finally, the External Program Advisory Committee attended annual meetings, met with project participants, and advised the Director on management concerns.

MOVING FORWARD

Two major reviews occurred during the sixth-year of AquaFish CRSP. The first was a USAID sponsored, contractually-mandated evaluation of AquaFish CRSP based on the quality and progress of the research, the achievement of outreach and development impact benchmarks, the degree to which the research activities achieve integration and relevance to development policy and programming, and the administrative and management effectiveness of the ME. This external review was anticipated to occur at the beginning of the fourth year, however it was not initiated until April 2012, well into the sixth year of programming.

The second review also occurred in FY2012 and was a broader evaluation of the CRSP model, commissioned by USAID, and executed through the Board for International Food and Agriculture Development (BIFAD). This review team was charged to evaluate relevant USAID activities and provide recommendation on how to engage the US university community to meet USAID goals and objectives. Although this review did not focus on any particular CRSP, USAID announced that individual CRSPs would not be invited to apply for multi-year extensions until the BIFAD review was completed.

Both the USAID review of AquaFish CRSP (report dated 28 June 2012) and the BIFAD review of the CRSP model (report dated 7 August 2012) were positive. An invitation for AquaFish to apply for a multi-year extension is pending final approval from USAID. Delays in USAID's contractually mandated evaluation of AquaFish CRSP, the BIFAD review of the CRSP model, and internal restructuring within USAID, have led to considerable downstream delays and uncertainty regarding a possible 5-year extension of this CRSP.

Future AquaFish activities will need to align with Feed the Future (FtF), the US Government's new global hunger and food security initiative. The FtF initiative came into being at the end of AquaFish CRSP's life and as a result alignment was not built in the original programming. Indeed, in 2010 when FtF was publicly announced, AquaFish had already programmed its final USAID allocation (FY10 funds). Nonetheless, there are natural synergies between the core work that AquaFish has done and the FtF initiative. AquaFish activities fell primarily under the following FtF objectives: *3.3.1 Inclusive Agriculture Sector Growth* by improving access to agricultural inputs and knowledge, more efficiently using land and labor, enabling more conducive policy environments, and improving management of natural resources; and *3.3.2 Improved Nutritional Status* by improving diet quality and diversity through the addition of animal source protein and micronutrients commonly found in fish. AquaFish additionally supported FtF objectives in *Expanding Markets and Trade* through the development and dissemination of market information for producers and enterprise owners, including activities that focused on equitable access for women, providing greater access to market information, improving post-harvest market infrastructure, and understanding value chains.

AquaFish CRSP has been highly successful in meeting or exceeding performance benchmarks and in achieving its Key Development Targets set for the initial five years of this award for research, capacity building, information dissemination, targeted country involvement, and gender integration. Despite the programmatic complexities associated with uncertain future funding, AquaFish CRSP remains prepared to move forward into another five-year award to further it's mission to enrich livelihoods and promote health by cultivating international multidisciplinary partnerships that advance science, research, education, and outreach in aquatic resources.

1. INTRODUCTION

This Final Report describes the activities and accomplishments of the Aquaculture & Fisheries Collaborative Research Support Program (AquaFish CRSP) from 30 September 2006 to 29 September 2012. AquaFish CRSP was funded by the United States Agency for International Development (USAID) under the authority of the Foreign Assistance Act of 1961 (PL 87-195), as amended. Significant funding was also provided by the participating US and Host Country institutions. Originally housed within USAID's Economic Growth, Agriculture, and Trade (EGAT) Bureau's Office of Agriculture, AquaFish completed this reporting period under the recently formed Bureau of Food Security, which is the lead USAID Bureau for the whole-of-government Feed the Future initiative. During this reporting period, AquaFish CRSP was one of 11 CRSPs, each with a different agricultural sector focus, including: the BASIS/Assets and Market Access CRSP; the Dry Grain Pulses CRSP; the Global Livestock CRSP (ended 2009); the Global Nutrition CRSP; the Horticulture CRSP; the Integrated Pest Management CRSP; the Livestock-Climate Change CRSP; the Peanut CRSP; the Sorghum, Millet and Other Grains CRSP; and the Sustainable Agriculture & Natural Resource Management CRSP. Each CRSP is programmed to address issues of poverty through science and outreach. USAID looked to AquaFish CRSP to "develop more comprehensive, sustainable, ecological and socially compatible, and economically viable aquaculture systems and innovative fisheries management systems in developing countries that contribute to poverty alleviation and food security."

In 1975, the United States Congress passed an amendment to the Foreign Assistance Act of 1961 known as "Title XII -- Famine Prevention and Freedom from Hunger" to ". . . improve the participation of the agriculturally related universities in the United States' governmental efforts internationally to increase world food production and provide support to the application of science to solving food and nutrition problems." This legislation aimed to provide mutual research benefits to both the United States and Host Countries. Under Title XII, the CRSP concept was created by USAID and the Board for International Food and Agriculture Development (BIFAD). The CRSPs are intended as a long-term mechanism to focus capabilities of US Land Grant Universities to carry out the Title XII mandate.

The CRSPs are communities of US Land Grant Universities working with Host Country National Agricultural Research Systems (NARS), International Agricultural Research Centers (IARCs), US agribusiness, private voluntary organizations (PVOs), Host Country colleges and universities, private agencies, USAID/Washington and USAID Missions, and other US federal agencies such as USDA. The CRSPs help build sustainable capacities of Host Countries so that they can solve problems of agricultural production and utilization and address issues of hunger and poverty through science and technology. The collaborative efforts of scientists in these programs benefit the agriculture sector in the US and in participating Host Countries. Research conducted by these programs help targeted communities improve their incomes and alleviate hunger without depleting the natural resource base on which they depend for food, fuel, fiber, and shelter.

In 2004, a USAID Strategic Partnership for Agricultural Research & Education (SPARE) Panel reiterated the relevance of the global fisheries and aquaculture sectors:

> "Fisheries and aquaculture products are globally important sources of much needed, high quality, aquatic animal proteins, and invaluable providers of employment, cash income, and foreign exchange. Fisheries products are the world's most widely traded foods, with commerce dominated by the developing countries. Fisheries products are the primary protein sources for some 950 million people worldwide, and are an important part of the

> diet of many more. In comparison to other sectors of the world food economy, however, the fisheries and aquaculture sectors are poorly planned, inadequately funded, and neglected by all levels of government. This neglect occurs in a paradoxical situation: fishing is the largest extractive use of wildlife in the world; and aquaculture is the most rapidly growing sector of the global agricultural economy... The lack of US engagement in international fisheries and aquaculture not only compromises America's financial position: an important part of our Nation's food security is at risk; and our domestic fisheries and aquaculture industries are rapidly losing their competitive position."

Aquaculture, the cultivation of aquatic plants and animals, is an ancient art, emerging science, and one of the fastest-growing animal food-producing sectors. Global demand for fish has soared in the past decade, while stocks of wild fish have dwindled. In the 21st century, aquaculture promises to be the primary means of increasing fish production. According to the FAO, from1980 to 2010 global production of food fish from aquaculture has expanded at an average annual rate of 8.8 percent with 2010 global production of food fish (excluding plants) at 60 million tonnes. As the contribution of food fish from the global capture fisheries has leveled off, the proportion of total world fish production for human consumption derived from aquaculture has risen from 9% in 1980 to 47% in 2010.

The mission of AquaFish CRSP is to enrich livelihoods and promote health by cultivating international multidisciplinary partnerships that advance science, research, education, and outreach. Bringing together resources from US and Host Country institutions, AquaFish CRSP strengthened the capacities of its participating institutions, to increase the efficiency of aquaculture and improved fisheries management in environmentally and socially acceptable ways, and disseminated research results to a broad audience.

Reaping the benefits of polyculture in Banda Aceh, Indonesia.

AquaFish CRSP's cohesive program of research was carried out in selected developing countries and the United States by teams of US and Host Country researchers, faculty, students, and stakeholders. Work conducted by this CRSP was guided by the concepts and direction set down in the Award, which was funded under USAID CA/LWA No. EPP-A-00-06-00012-00. AquaFish CRSP echoed many of the farsighted and mindful approaches incorporated by the Aquaculture CRSP (1982-2008), however the two CRSPs differed in both organization and theme. Organizationally, AquaFish CRSP was a Cooperative Agreement, with a Leader with Associates (LWA) term of reference, whereas Aquaculture CRSP was a grant. The LWA mechanism allowed for additional USAID funding to complement core activities. Core activities of AquaFish were originally funded by EGAT's Office of Agriculture at $8.9 million to be conducted from 30 September 2006 to 29 September 2011, and amended in September 2009 to $12.82 million for additional work in technology transfer, outreach, impact assessment, and communications. Two no-cost extensions were granted, extending the period of performance beyond the original end date. The first one, dated 8 September 2011, extended the end date of the Award from 29 September 2011 to 29 September 2012. The second one, dated 21 September 2012, extended the end date an additional 6 months to 31 March 2013. Additional funding was awarded in May 2012, which raised the total obligated amount to $14.72 million.

Thematically, AquaFish CRSP focused on aquaculture with its core funds, and on both aquaculture and fisheries with its Associate Awards. Two Associate Awards were received under the Leader Award since 2007, totaling $1,850,000. AquaFish CRSP ME completed an Associate Award focusing on aquaculture and fisheries in Mali, which ended on 31 December 2010, after receiving a three-month no-cost extension. On 28 September 2010, the ME received a second Associate Award for work in Kenya, Ghana, and Tanzania. This Associate Award, originally funded at $1.1million under EGAT, supports adoption of CRSP technologies as part of USAID's Strategic Investment in Rapid Technology Dissemination.

The activities of this multinational, multi-institutional, and multidisciplinary program were administered by Oregon State University (OSU), which functioned as the Management Entity (ME) and had technical, programmatic, and fiscal responsibility for the performance of grant provisions. ME technical and programmatic activities at OSU were carried out by a Management Office (Director and staff), and was supported in the task of program administration by advisory bodies. Management Office personnel and advisory group membership during this five-year period appear in Appendix 1.

Hands-on training in Mali.

AquaFish CRSP researchers made significant advances in developing and transferring new technologies and practices to improve the lives of the rural poor. CRSP work has also led to significant achievements in marketing and trade, aquatic product development, and policy assessments relating to natural resources management and expansion of domestic and export markets. Illustrative highlights are summarized in this report. The full compilation of Final Investigation Reports can be found at aquafishcrsp.oregonstate.edu/publications.php.

One of the many strength of the CRSP model is the integration of developmentally-focused research with human and institutional capacity building. AquaFish CRSP has achieved great success in building and strengthening the capacities of institutions and individuals through it's numerous training and outreach activities that were imbedded in Core Research Project investigations. The participatory process involving public-private partnerships engaged Host Country stakeholders at all levels in an international network and provided them with critical information for sustainable aquaculture development. With over 6,300 short-term training participants and over 300 long-term training participants, AquaFish CRSP capacity building efforts benefited stakeholders in the US and participating Host Countries through the transfer of knowledge and technology. Additionally, the CRSP capacity building strategy included the dissemination of information about best management practices and increased economic opportunities to ultimately increase the sustainability of aquaculture and fisheries in all regions.

Gender inequality occurs in many areas including economic growth, education, information technology, and legal rights. Even though the advancement of women is essential to successful development and lasting progress at the individual, household, community, and global levels, the marginalization of women

Selling fish in Kisumu, Kenya.

is still widely prevalent. In small-scale capture fisheries, typical gender roles play out with men owning boats and doing the fishing while women remain in charge of the processing and sales. In aquaculture, women are often found in the most vulnerable positions as fry catchers, laborers, and in low paying processing plants. AquaFish CRSP worked to improve gender equality in the aquaculture and fisheries sectors and in the CRSP arena. Within the Program's research, training, education, and other activities, AquaFish CRSP endeavored to create equal opportunities for women and men to participate through actions such as: collecting and analyzing disaggregated data from individual projects to gauge gender inclusiveness success; promoting the participation of women in formal and informal education and training opportunities provided through the CRSP by setting a 50% benchmark for training women; requiring each Core Research Projects to have a gender integration strategy; requiring each Core Research Project to have a gender focused investigation; and tailoring specific extension and technical services related to sustainable aquaculture and aquatic resource management to women producers.

Two US government initiatives were enacted during this reporting period (FY2006-FY2012). The first was the Presidential Initiative to End Hunger in Africa (IEHA) that focused US Government efforts on targeted countries in Africa: Ghana, Kenya, Malawi, Mali, Mozambique, Nigeria, Uganda, and Zambia. An RFP released by the ME in 2008 was specifically designed to program more activities in these countries, and resulted in an additional Core Research Project focusing on aquaculture development in Uganda. The Feed the Future (FtF) Initiative was the second US government initiative, supporting a country-driven approach to promote agricultural sector growth to sustainably feed their people. Twenty FtF focus countries were identified based on level of need, opportunity for partnership, potential for agricultural growth, opportunity for regional synergy, and resource availability. Focus countries included 12 in Africa, 4 in Asia, and 4 in Latin America/Caribbean. The Feed the Future Initiative officially came online in 2010 and therefore was not built into the CRSPs original programming. Nevertheless, there were clear synergies between the core AquaFish work and the FtF Initiative in terms of country focus and core investment areas targeting global hunger and food security.

Two major reviews occurred during the sixth-year of AquaFish CRSP. The first was a USAID sponsored, contractually-mandated review to evaluate AquaFish CRSP based on the quality and progress of the research, the achievement of outreach and development impact benchmarks, and the degree to which the research activities achieved integration and relevance to development policy and programming. This review also evaluated the administrative and management effectiveness of AquaFish CRSP including the relationship between ME and subaward institutions, the relationship with USAID/Washington and Missions, fulfillment of cost share requirements, and outreach and intellectual leadership activities undertaken by the ME. This external review was anticipated to occur at the beginning of the fourth year, however it was not initiated until April 2012, well into the sixth-year of programming.

The second review also occurred in FY2012 and was a broader evaluation of the CRSP model, commissioned by USAID, and conducted through BIFAD. The review team was charged to evaluate relevant USAID activities and provide recommendation on how to engage the US university community in agriculture/food security research and capacity building to meet USAID and FtF goals and objectives.

Although this review did not focus on any particular CRSP, USAID announced that individual CRSPs would not be invited to apply for multi-year extensions until the BIFAD review was completed. Both the USAID review of AquaFish CRSP (report dated 28 June 2012) and the BIFAD review of the CRSP model (report dated 7 August 2012) were positive.

This Final Report is not intended to supplant information in the Annual Reports. Rather, this report highlights key achievements and data from those reports that emphasize how AquaFish CRSP has fulfilled, and indeed exceeded, the original plans for this CRSP.

2. PROGRAM HIGHLIGHTS

Since inception in 2006, Oregon State University has served as the Management Entity (ME) of AquaFish CRSP, with technical, programmatic, and fiscal responsibility for the performance of the Leader Award. Technical and programmatic activities at OSU were carried out by the Management Office that consisted of the Director/PI, Dr. Hillary Egna, and support staff. Advisory bodies also served to assist the Management Office in program administration. From FY2006 to FY2012, AquaFish managed a total of eight Core Research Projects, four program-wide projects, and two Associate Awards operating at 17 US universities and 31 HC institutions in 20 countries. Selected programmatic highlights are provided below.

LEADER AWARD

USAID released an RFA for the ME of the Aquaculture & Fisheries CRSP in May of 2006. After a competitive search, the AquaFish CRSP ME was awarded to OSU. Funding for the Award was initially set by USAID at $8,900,000 authorizing program activities from 29 September 2006 to 29 September 2011. Modifications to the original funding level and period of performance are summarized below.

- In September 2009, the ME was awarded additional funding to its core award raising the ceiling from $8.9 million to $12.82 million. The additional funding came in response to an RFA in August 2009, which CRSP Director, Dr. Hillary Egna, applied for with a full proposal, including a technical application and cost proposal for $3.92 million. Increased funding from USAID was for: 1) promoting the extension of CRSP technologies through extension, commercialization, and partnership and 2) assessing the impact and communicate the importance of CRSP research. Work conducted under this additional funding included:
  - A project designed to assess AquaFish CRSP discoveries, technology adoption, and impacts.
  - A project employing a journalistic approach for preparing stories to illustrate successes and sustainable practices of AquaFish CRSP.
  - Support for "add-on" investigations proposed by the active US Lead Institutions to advance USAID's stated objectives for this additional funding.
- In June 2011, the ME requested a one-year, no-cost extension to the OSU Leader Award from USAID in order to allow students to complete degree programs, allow completion of work for which funds were already committed, and to facilitate a smooth transition from the current 5-year award and any future 5-year award. The amendment, signed by USAID on September 8, 2011, extended the Leader Award completion date from 29 September 2011 to 29 September 2012.
- Recognizing the need for additional funding to support existing programs through 29 September 2012, AquaFish CRSP submitted a proposal requesting an additional $1.9 million. This request was approved by USAID, and award modification was fully executed 3 May, 2012.
- In September 2012, the period of performance for AquaFish CRSP was extended from 29 September 2012 to 31 March 2013.

ASSOCIATE AWARDS

Two Associate Awards were obtained during the first six years of AquaFish CRSP, one through USAID/Mali and the other through USAID/Washington.

• In September 2007, the ME responded to a request from the USAID mission in Mali for assistance "to improve the productivity and income of the producers in targeted areas of Mali through facilitation of access to technologies and building the capacity of all actors involved in freshwater fish farming and capture fisheries management in target areas." OSU's proposal, submitted on 10 September 2007 entitled "Aquatic Resource Use and Conservation for Sustainable Freshwater Aquaculture and Fisheries in Mali," laid out a three-year project, from 1 October 2007 to 30 September 2010, that focused on three themes: Pond Culture, Rice-Fish Culture, and Fisheries Planning. In late October 2007, OSU was notified by USAID-Mali that the award had been made, thus establishing the first Associate Award granted under the AquaFish CRSP Leader Award.

- A no-cost-extension, through 31 December 2010 was granted to allow the project to complete proposed work, including the final fisheries planning training activity.
- The Mali Associate Award was highly successful and included 20 short-term training courses for 358 participants, three sets of on-farm trials demonstrating both improved pond culture practices and rice-fish culture techniques, and the first-ever frame survey of Lake Sélingué. After trials using CRSP rice-fish technology in model farms showed promising results, 20-fold increases in local adoption rates followed.

• In August 2010, the AquaFish CRSP Director, Dr. Hillary Egna, responded to a request for an Associate Award Application from USAID/EGAT to "scale-up the dissemination and commercialization of improved agricultural technologies and/or management practices". On 28 September 2010, the AquaFish CRSP ME at OSU was awarded a 3-year, $1.1 million Associate Award to "Enhance the profitability of small aquaculture farm operations in Ghana, Kenya, and Tanzania." This was the culmination of over six months of work with numerous revisions and additional analyses, starting from a call for "concept papers" in March 2010.

- Proposals to partner with AquaFish on this Associate Award were submitted in response to an Invitation to Participate. After technical and programmatic reviews, subcontracts were awarded to two US universities: Purdue University and Virginia Tech.
- This is a three-year award to be completed 28 September 2013. Outreach and extension activities are under way in Ghana and Kenya. Activities in Tanzania are scheduled to begin in FY 2013.

SUBAWARDS

AquaFish partners with US Institutions through formal subcontracts to achieve stated development goals. Activities involved in announcing, reviewing, and awarding subcontracts through the ME are summarized below.

- Upon receiving the Leader Award, the ME rapidly proceeded with a competitive sub-award process for Core Research Projects which included (1) review and comment by the EIP (Emerging Issues Panel) of the RFP approved in the Lead Institution proposal (October 2006); (2) release of a pre-notification of Award publication (October 2006); (3) release of the RFP (November 2006); (4) launch of the RFP website on the same day as the RFP release (pdacrsp.oregonstate.edu/afcrsp/rfpnew); (5) organizing a matchmaking service for Host Country and US interested parties (November 2006 – January 2007); (6) regularly updating the FAQs web posting and answering questions from prospective applicants (November 2006 – January 2007); (7) holding two external, NSF-based technical review panels; (8) conducting a transparent selection process; (9) selecting six proposal finalists; and (10) shepherding the finalists through proposal revisions and first-stage project implementation. This effort by the ME represented a phenomenal amount of work in a relatively short amount of time. Subcontracts with the ME at OSU were awarded to six finalists from: University of Arizona, University of Michigan, North Carolina State University, Purdue University, University of Connecticut, University of Hawaii, Hilo.
- The AquaFish CRSP MT released and widely disseminated a second RFP in November 2008 (aquafishcrsp.oregonstate.edu/rfp2008.php) for one project focusing on IEHA (President's Initiative to End Hunger in Africa) countries. An external NSF-style peer-review panel was conducted to evaluate submitted proposals. The review process included technical, programmatic, and USAID review. The IEHA project was awarded to Auburn University for work in Uganda and South Africa. In total, AquaFish CRSP has managed projects in four IEHA countries: Ghana, Kenya, Mali (Associate Award), and Uganda.
- Another external NSF-style peer-review panel was held in September 2009 to evaluate proposed work for Implementation Plan 2009-2011 submitted from the six existing US lead institutions. The review process included technical, programmatic, and USAID review. After final approval of proposed work by the MT, the six existing US Lead Institutions were granted funded extensions by the ME through 29 September 2011.
- The six original US Lead Institutions negotiated no-cost extensions (NCE) with the ME that extended their work under the Implementation Plan 2007-2009 from 29 September 2009 through 31 December 2009 for five projects and through 31 March 2010 for one other. Contributing to the need for NCEs were a variety of natural and political

> *"Rigor and Integrity are stressed by the ME and external peer-reviews help validate the quality of the proposed research work plans."*
>
> *- External Evaluation Report of the Aquaculture & Fisheries CRSP,* June 2012

events that included the following:
- Severe flooding in Tabasco, Mexico during October–November 2007
- Political turmoil in Kenya resulting from the 2008 presidential election
- Sichuan earthquake in China in May 2008
- El Niño warm water conditions on the Pacific Coast in 2009 that caused slower shellfish growth
- Swine flu pandemic that began in the Spring of 2009 in Mexico

• During FY2009, the AquaFish MT solicited a project submitted by a team of researchers from Oregon State University and Montana State University to assess impacts of the AquaFish CRSP core research. The project began in FY2010 after undergoing an external NFS-style review for both technical content and programmatic alignment.

• Four subcontracts to current US Lead Institutions were amended in 2010 to include "add-on" investigations to advance USAID's stated goals of: 1) promoting the extension of CRSP technologies through extension, commercialization, and partnership; and 2) assessing the impact and communicating the importance of CRSP research.

• Cultural Practice, LLC was awarded a subcontract through Oregon State University in July 2011 to fund the initial work on the "CRSP Council Knowledge and Data Management Project" which was a CRSP-wide effort intended to combine the wealth of information accumulated by all CRSPs into a single information clearinghouse. Deliverables for this award included a database-driven, CRSP-wide website (CRSPs.net), success stories, and thematic fact sheets. A no-cost extension moved the end date of this subaward from 29 September 2011 to 30 June 2012.

• In FY2011 Oregon State University granted two one-year no-cost extensions (NCE) to seven Core Research Projects to complete work delayed by weather (such as typhoon and flooding), on-the-ground logistical constraints (such as delays in acquiring materials and supplies), and other unforeseen circumstances. This action extended the sub-contract end dates to 29 September 2012.

• In Spring of 2012, six US Lead Institutions received additional funding to: (1) conduct Experimental Pond Unit Assessments (EPUA) at one HC site per project and (2) perform Value Chain Analyses (VCA) on one species per project.

• Seven US Lead Institutions received NCE, extending the end date of their subwards from 29 September 2012 to 31 January 2013 for student support and project completion.

CAPACITY BUILDING

Training was supported by AquaFish CRSP in a number of forms, with perhaps the most important being short-term (non-degree) courses and long-term (degree) programs. Short-term training most frequently occurred as seminars, workshops, and short-courses scheduled for periods of half a day to two or three weeks. Trainings focused on specific topics for stakeholders, which were integral to the project objectives. Long-term training encompassed academic programs for a BS, MS, or PhD degree at an accredited university located either in a Host Country or the US as well as high school and certificate programs.

• During the program's initial five years (2006-2011), AquaFish CRSP Core Research Projects conducted 181 short-term training sessions in which 6348 participants were trained. Among these trainees, 2103 were women, constituting 33.1% of all individuals trained and 4245 were men (66.9%).

- Since AquaFish CRSP's inception in 2006, a total of 320 degree students of 25 different nationalities have received program support, including 166 men and 154 women (51.9 and 48.1 % respectively). Attention to gender integration yielded an equal percentage of women and men in long-term training.
- The earliest AquaFish CRSP workshops were associated with Phase II of the *"HCPI Exchange Project on Tilapia and Native Cichlid Technologies."* Four exchange visits were conducted in 2007 and 2008 under this project (South Africa, Ghana, Vietnam, and Brazil), each included a seminar in which participants shared information about the development and status of tilapia or cichlid culture in their home countries. The host PI for each visit also conducted a tour of relevant aquaculture facilities in their countries, with an eye towards showing systems and technologies that had proven successful in their country. Following completion of the exchange visit series, the participants also conducted "Echo-Seminars" back at their home institutions to share their experiences and new knowledge with institutional personnel, farmers, extension personnel, and other interested parties. (CRSP HCPI Exchange Project) (FY08)
- The Borlaug Leadership Enhancement in Agriculture Program (LEAP) provided support for thesis research done by graduate students from developing countries. Funded by USAID, LEAP is part of the overall Borlaug International Agricultural Science and Technology Fellows Program sponsored by the USDA, recognizing the distinguished career of Nobel Laureate Dr. Norman Bourlaug. LEAP fellowships are awarded to students who demonstrate strong scientific and leadership promise. Since 2006, five AquaFish CRSP funded graduate students have received Borlaug LEAP Fellows:
  - Jeanne Coulibaly (Spring 2006)
  - Ravelina Velasco (Spring 2008)
  - Rafael Martinez-Garcia (Spring 2008)
  - Nhuong Tran (Spring 2009)
  - Boamah Yaw Ansah (Spring 2011)
- The CRSP Director coordinated with other faculty to develop an online graduate-level fishery management certificate program at Oregon State University specifically designed for African stakeholders.

> *"Frequently referred to as a "gem" embedded within the CRSP model, the capacity building element (HICD), particularly degree training, is one of the keys to the enduring legacy of the CRSPs and one thing that is not replicated by any other development model..."*
>
> *-BIFAD Review of the Collaborative Research Support Program (CRSP) Model,* August 2012

PUBLICATIONS

AquaFish CRSP actively engaged technical and lay audiences through multiple media channels in an effort to broadly extend and publicize project achievements. Publications can be found on the CRSP website (aquafishcrsp.oregonstate.edu/publications.php). The following summary includes publications generated by the AquaFish CRSP Management Office and does not include publications from subcontracting partners. A complete list of AquaFish publications can be found in Appendix 5.

- *Implementation Plans.* Implementation Plans outline investigations funded by AquaFish CRSP. They include regional and cross-cutting research and research support

activities. Since inception, AquaFish CRSP has published the following Implementation Plans:

- Implementation Plan 2007-2009
- Implementation Plan 2007-2009 Addendum with work plan changes/additions (September 2009)
- Implementation Plan 2009-2011 (April 2010)
- Implementation Plan 2009-2011 (March 2011) and addenda.

• *Annual Work Plans* (annually since FY2010). Annual Work Plans describe the objectives and activities that were planned during each fiscal year.

- Annual Work Plan for FY2010
- Annual Work Plan for FY2011
- Annual Work Plan for FY2012

• *Site Descriptions.* The Site Descriptions provide an overview of research and activity locations for each AquaFish CRSP core project. Site Descriptions were published in a single volume encompassing Implementation Plans 2007-2009 and 2009-2011.

• *Annual Reports* (annually). AquaFish CRSP Annual Reports contain a program overview, research background, staff and fiscal summaries, networking activities, report abstracts, and a publications list.

- First Annual Report (FY 2007)
- Second Annual Report (FY 2008)
- Third Annual Report (FY 2009)
- Fourth Annual Report (FY 2010)
- Fifth Annual Report (FY 2011)

• *Technical Reports* (aka *Final Investigation Reports*). Final Investigation Reports (FIRs) contain the full text of reports that correspond to each investigation completed during this 6-year reporting period. These reports detail the methodology, results, and analyses of all work conducted through the Core Research Projects. FIR compilations can be found on our website as:

- *Technical Reports: Investigations 2007-2009: Volume 1*
- *Technical Reports: Investigations 2007-2009: Volume 2*
- *Technical Reports: Investigations 2009-2011: Volume 1*
- *Technical Reports: Investigations 2009-2011: Volume 2*

• *Research Reports and Peer-Reviewed Publications*. CRSP Research Reports include the abstracts of AquaFish CRSP-supported articles published both in peer-reviewed journals and by the CRSP Program Management Office itself. Abstracts can be found online at http://aquafishcrsp.oregonstate.edu/nops.php. Copies of the complete reports may be obtained by contacting the authors directly.

• *The Collected Abstracts from 1996-2008*. In addition to the online database, AquaFish CRSP also published a PDF of compiled abstracts generated under the Aquaculture Collaborative Research Support Program (ACRSP) and the Aquaculture & Fisheries Collaborative Research Support Program (AquaFish CRSP) from 1996 to 2008. Copies of the complete reports may be obtained by contacting the authors directly.

• *Aquanews* (quarterly). Aquanews is the quarterly newsletter of AquaFish CRSP and informs CRSP participants and others of program activities that are not technical in nature. It contains news stories and information on project activities, meetings, travel, and site visits by CRSP participants.

• *EdOp Net* (monthly). The Educational & Employment Opportunities Network (EdOp Net) is a free monthly newsletter compiled and disseminated electronically by AquaFish CRSP. Newsletters contained listings related to education, training, and employment opportunities that may be of interest to Aquaculture & Fisheries CRSP participants and to researchers, students, and practitioners in fisheries, aquaculture, aquatic sciences, natural resources management, and international development.

• *Brochures and Fact Sheets*. The Management Office produced a series of brochures that included a general AquaFish program brochure as well as three regional brochures focusing on AquaFish work in Africa, Latin America/Caribbean, and Asia (updated March 2011). In addition, the Management Office created three concise one-page fact sheets. Two of the fact sheets provided an overview view of the program

structure and key accomplishments, while the third highlighted the quality of AquaFish CRSP researchers. A brochure was also published summarizing the goal and accomplishments of the Mali Associate Award.

• *Success Stories and Press Releases*. The Management Office generated success stories, press release, activity briefs, and "Diving Deep" profiles to broadly communicate AquaFish achievements in bringing new technologies and practices to stakeholders in Africa, Asia, and Latin America. Titles include:

- *Fish Farmers Association Models Success*
- *Putting Bacteria to Work for Tilapia Farmers*
- *Mali Strengthens Its Aquaculture and Fisheries Sectors*
- *A Native Fish Moves Towards Aquaculture*
- *Reduced Feeding Strategies Lower Production Costs*
- *Fish Farmers Symposium & Trade Fair In Uganda*
- *AquaFish CRSP Leads the Way Toward a Sustainable Aquaculture and Fisheries Economy in Kenya*
- *Polyculture of Freshwater Prawns and Mola in Bangladesh*
- *Fish Farmer Models CRSP Best Management Practices*
- *CRSP Introduces Rice-Fish Culture to Malian Farmers*
- *CRSP Helps Fish Farmers Lower Feed Costs In Tanzania*

• *Poster Presentations*. The AquaFish CRSP Management Office frequently presented posters at professional meetings to extend program achievements and improve visibility of CRSP-funded work. Appendix 5 lists the 30+ poster that have been published by the MT from 2006 to 2012.

THE AQUAFISH CRSP WEBSITE

From the onset of AquaFish CRSP, the Management Office actively developed web-based tools and platforms to aid in information dissemination and to streamline data collection, project reporting and program management. From May 2010 through September 2012, the AquaFish CRSP site had over 18,000 visits from 151 countries.

• Initially, the AquaFish CRSP website was accessed through the pre-existing Aquaculture CRSP website. The official launch of the AquaFish website occurred in November 2008 (aquafishcrsp.oregonstate.edu).

• In FY2009 additional features were added including password-protected network features, an on-line reporting system for US and HC participants, a platform for distributing program-related information, and an interactive database system for managing research, outreach, and other data.

• The AquaFish CRSP website link was posted on SARNISSA's (Sustainable

"The external face of the AquaFish CRSP, as presented by their website, is polished and professional...The website provides a range of information including technical and scientific reports, forward linkages to additional information, current news and announcements and programmatic documents. The design is crisp and up-to-date and should be used ...as a model for other CRSP websites."

- External Evaluation Report of the Aquaculture & Fisheries CRSP, June 2012

Aquaculture Research Network in Sub-Saharan Africa) webpage for Aquaculture Research Institutes. Online archiving of program material by the MT, made many of the AquaFish CRSP publications available to other websites, including the CABI Aquaculture Compendium, that reached out to over 1,000 SARNISSA registered stakeholders.

• The AquaFish CRSP secure website for the MT and project partners evolved over the life of the award. Existing databases, such as short-term and long-term training were updated with features including multiple viewing and querying options, ability to upload documents and photos, and connectivity to user-friendly online reporting forms. Additional features included:

- An online travel database, allowed for more efficient tracking and reporting of authorized trips
- An interactive photo gallery allowed CRSP participants to upload and edit photos
- A multi-media page, provided a platform to help distribute photo, print, and video media
- Single User Accounts (SUA) allowed for various levels of secure access to the AquaFish CRSP website
- Online outreach via Facebook, Twitter, Vimeo, and YouTube
- The ability to view AquaFish field sites and associated research highlights via Google Earth
- A page dedicated to gender issues in aquaculture highlighted AquaFish CRSP efforts in gender equity
- Development of a page dedicated to AquaFish CRSP efforts to promote outreach and capacity building
- A document upload feature on each project reporting page designed to facilitate online reporting and submission of deliverables
- A web-based project performance tracking system linking multiple data bases to allow the Management Office and investigators to monitor project progress.

CRSP COUNCIL/USAID/BIFAD

USAID funded a diverse portfolio of CRSPs, ten in all, covering researchable priorities for crops and animals and the systems they are grown in around the world. All CRSPs were organized to reduce poverty, hunger and environmental degradation in various regions, commodities, and systems. In order to get work done on the ground, however, CRSPs differentiated into focus areas around fish, fisheries products, aquatic ecosystems, livestock, dry grains, pulses, peanuts, sorghum, millet, vegetables, fruits, natural resources management, markets, nutrition, integrated pest management, and so on. AquaFish CRSP focused on aquaculture and fisheries in following the CRSP mission of achieving outcomes by improving incomes, feeding vulnerable populations, enhancing food security, and conserving precious natural resources. Two important steps taken to bring these ten CRSPs together between FY 2006 and FY 2012 are summarized below.

• The first was to combine the wealth of information CRSPs have accumulated over the years in an information clearinghouse. AquaFish CRSP led the way in contracting with a private sector company— Cultural Practice, LLC— in a new CRSP Council Knowledge Management (KM) Project. The AquaFish CRSP Director pressed her fellow directors to buy into the project, which was designed to showcase work from all CRSPs. The AquaFish CRSP Director created a staged contribution plan to allow CRSPs to buy in when funds became available according to each CRSPs own timeline. Additionally, each ME University had a different mode of

contracting with different rules and rates, so AquaFish determined it was best to allow CP, LLC to contract individually. CRSPs could buy in to certain elements of the KM Project (usually for contractual reasons) or into pooled contributions for work across all elements. With help from the KM project leader, Dr. Deborah Rubin of Cultural Practice LLP, as of early September 2011 nine CRSPs had contracted or were in negotiation with CP, LLC. By the end of this reporting period, the KM Project had designed a website that it began populating with CRSP data, and developed various synthesis materials for engaging a broad community of interest.

- The second step in aggregating efforts across CRSPs occurred in July 2011 when the CRSP Council held its first-ever "Council-USAID Partners Meeting" overseas. Because Uganda hosts nine CRSPs, it proved a practical place to convene the CRSPs along with their USAID Washington partners in a face-to-face meeting with USAID and CRSP counterparts in Africa. The Steering Committee of the Council met in the morning, after which our USAID/Washington partners joined in to discuss alignment with FtF and other USAID priorities. The second day's meeting highlighted themes from each CRSP through posters and summaries of CRSP work in Uganda. The USAID/Uganda Mission Director, staff, and representatives from other USAID offices in the region showed interest in the cumulative capacity building successes. An unexpected but rewarding visit by the US Ambassador to Uganda, Jerry P. Lanier, topped off the second day's meeting, which was followed on the final day by visits to CRSP sites in Uganda. Although planning this meeting was difficult, with a brave staff member (Ben Hassankhani) from Pulses CRSP stepping in last minute, the meeting was a huge success. The Council might consider having another overseas Council-USAID meeting perhaps in West Africa within the next two years

Additionally, during this period the AquaFish CRSP Director and PI, Dr. Hillary Egna, actively engaged with the CRSP Council as a member of it's steering committee. Along with AquaFish CRSP partners, the Director also interacted with USAID and BIFAD from 2006 to 2012 as outlined below, providing valuable input to help guide the direction of US foreign assistance:

- The Director organized a CRSP Council Meeting in Portland, Oregon, August 2007 and attended annual CRSP Council meetings, including:
- the CRSP Council Meeting in Washington DC July 2008; the 2009 CRSP Council meeting held in Washington DC in conjunction with the 157th meeting of BIFAD, and a joint USAID-CRSP Council Meeting; the joint USAID/CRSP Directors Meeting (September 2010) in Washington DC via conference call with both CRSP Council and USAID colleagues. An additional CRSP Council meeting was held in De Moines, Iowa, in October 2011 in conjunction with the World Food Prize conference.
- In October 2008, members of the Board for International Food and Agriculture Development (BIFAD) management team conducted a two-week field visit to Kenya. One of AquaFish CRSP's major partners in Kenya, Moi University, had been selected by USAID and BIFAD to be included in the tour. Although the BIFAD team was unable to visit the university, Dr. Charles Ngugi, Head of the Department of Fisheries & Aquatic Sciences and a former ACRSP and current AquaFish CRSP Host Country PI, made a well-received presentation to the team at the UN Offices in Nairobi. In his talk, Dr. Ngugi demonstrated how new technologies have impacted the development and management of the aquaculture industry in Kenya dating back to the initial ACRSP partnership, which began in 1997.
- The AquaFish CRSP Director and Capacity Building Coordinator participated in a conference call with the Long-Term Agricultural Training Assessment Team (under USAID contract) to provide CRSP insight to identify the most effective features of long-term U.S. training programs to build African institutional capacity in agriculture.

- The AquaFish Director was invited by the Association of Public and Land-grant Universities (APLU), in coordination with USAID and USDA, to participate in planning meetings to discuss the whole-of-government Feed the Future initiative research strategy in January 2011 at Purdue University. Dr. Egna provided additional input via a follow-up meeting in June 2011 in Washington DC numerous conference calls, and online reporting.
- In April of 2012, the Director was invited to provide input to BIFAD in Washington DC for their USAID-commissioned review of the CRSP model.

TECHNICAL SESSIONS AND MEETINGS SPONSORED AND ORGANIZED BY THE ME

The Director was successful in facilitating dialog on critical aspects of aquaculture and fisheries in developing countries through sponsoring, chairing, or organizing technical sessions at professional conference around the world. These sessions provided a platform for CRSP and other researchers to present results and forge professional relationships.

- AquaFish CRSP co-sponsored the International Institute of Fisheries, Economics & Trade (IIFET) conference, Portsmouth, UK, 2006.
- Dr. Egna organized the session *Aquaculture CRSP*, World Aquaculture Society Annual Meeting, San Antonio, Texas, February 2007.
- Dr. Egna chaired the session *Aquaculture and AquaFish CRSP*, World Aquaculture Society Annual Meeting, Busan, Korea, May 2008.
- Tilapia and Cichlid Session at the Ecological and Evolutionary Ethology of Fishes conference in Boston June 2008.
- AquaFish CRSP co-sponsored the International Institute of Fisheries, Economics & Trade conference, Vietnam, July 2008.
- AquaFish CRSP co-sponsored ISTA8 Egypt October 2008.
- AquaFish CRSP co-sponsored PondSchool, Oregon, September 2008.
- Dr. Egna chaired the session *International Aquaculture Development for the Poor*, Aquaculture America, Seattle, Washington, February 2009.
- AquaFish CRSP promoted the International Symposium on Aquaculture & Fisheries Education, Bangkok, Thailand, November 2009.
- AquaFish CRSP supported the International Institute of Fisheries, Economics & Trade conference, Montpellier, France, through the Developing Country Aquaculture Economics Best Student Paper Prize and the Aquaculture Economics Professional Travel Award presented.
- Dr. Egna chaired the session *Optimizing Small-Scale Aquaculture for the Poor*: *A Session in Honor of Yang Yi*, Aquaculture 2010, San Diego, California, March 2010.
- Dr. Egna organized and chaired the 9ISTA all-day technical session *Accelerating Aquaculture Development in Poorer Countries*, 9th International Symposium on Tilapia Aquaculture (ISTA9), Shanghai, China, April 2011.
- Dr. Egna presented the talk "Challenges of including gender dimensions in biotechnological research projects" at the 3rd Global Symposium on Gender in Aquaculture and Fisheries Symposium (GAF3), Shanghai, China, April 2011. Dr. Egna was subsequently invited to the FAO Special Workshop on the Future Direction for Gender in Aquaculture and Fisheries Action, Research and Development.
- AquaFish Director Egna organized and chaired the session "Marketing and Globalization," 9th Asian Fisheries and

Aquaculture Forum (9AFAF) Annual Meeting, Shanghai, China, April 2011. The session was co-chaired by AquaFish researcher, Dr. Kwamena Quagrainie.

- AquaFish CRSP sponsored a booth to display CRSP posters, photos, publications and other outreach materials at the 9th Asian Fisheries and Aquaculture Forum (9AFAF) Annual Meeting, Shanghai, China, April 2011.

AQUAFISH CRSP ANNUAL MEETINGS

AquaFish Annual Meetings provided opportunities for US and Host Country Partners to interact face-to-face with project partners and others from the CRSP community. The CRSP Annual Business Meeting included programmatic and project updates and mid-day working sessions with a thematic focus. Annual Meetings were often scheduled to precede major international conference to maximize attendance, leverage travel costs, and provide opportunities for CRSP participants to showcase their research on a global stage.

- In May 2007, a Pre-Synthesis & Orientation Meeting was held in Washington, DC, for US Lead Co-PIs and HC Lead PI from each of the sub-award finalists. Presentations were given by the MT and representatives of USAID on: programmatic overview and management structure, operational detail, and timelines. RCE and DTAP advisory bodies were also introduced at this meeting.
- The FY2008 AquaFish CRSP Annual Meeting took place in Busan, Korea, in May 2008 immediately prior to the World Aquaculture 2008. The Director and the MT provided an overview of administrative procedures, setting up standards of accountability, and building working relationships. Emphasis was placed on the very different procedural landscape that sets AquaFish CRSP operationally apart from its predecessor, the Aquaculture CRSP.
- The FY2009 AquaFish CRSP Annual Meeting was held in Seattle, prior to the Aquaculture America 2009 conference (February 2009). External evaluators were in attendance from World Wildlife Fund and University of Tasmania to assess project output, especially in relation to student training.
- In FY2010, the AquaFish CRSP MT organized and facilitated the AquaFish CRSP Annual Meeting, in San Diego, California, prior to the World Aquaculture Society's "Aquaculture 2010" conference. US and HC personnel were in attendance as well as external evaluators from World Wildlife Fund and University of Tasmania to assess program output. Meeting highlights included:
  - AquaFish CRSP Director Hillary Egna presented the Outstanding Achievement Award to Jim Diana (University of Michigan) during the plenary session of Aquaculture 2010, honoring his accomplishments and contributions to aquaculture.
  - The *SOU-CRSP Yang Yi Travel Award* was established during FY 2010 to support excellent young scientists from one of the Asian partner institutions to present research at professional aquaculture conferences. FY 2010 recipient was Zexia Gao, who used the award to attend the AquaFish CRSP Annual Meeting and Aquaculture 2010.
  - AquaFish CRSP US Lead PIs, Drs. Kevin Fitzsimmons and Jim Diana, presented the AquaFish CRSP award for best student poster at the Aquaculture 2010 student reception.
- The AquaFish CRSP management Office organized and facilitated the AquaFish CRSP Annual Meeting, in Shanghai, China, in April 2011, in conjunction with the 9th Asian

Fisheries and Aquaculture Forum (9AFAF) Annual Meeting, the 9th International Symposium on Tilapia Aquaculture (ISTA9), and the 3rd Global Symposium on Gender in Aquaculture & Fisheries (GAF3). Meeting highlights included:

- AquaFish Director Dr. Hillary Egna, organized and chaired a special session to discuss the prospects for new research on air breathing fishes. The meeting included over 20 participants and ten presentations that outlined research needs for six groups of air breathing fishes.
- AquaFish Director, Dr. Egna organized and chaired a special project-level coordination meeting for training activities planned by CRSP in Africa during 2011.
- With the past SOU President, Dr. Egna presented the Shanghai Ocean University (SOU)-CRSP Yang Yi Young Scientist Travel Fund Award to Pandit Narayan Prasad, from the Institute of Agriculture and Animal Science in Rampur, Chitwan, Nepal. The SOU-CRSP Yang Yi Travel Award was established in 2009 to support excellent young scientists from one of the Asian partner institutions to present research at professional aquaculture conferences.
- Sk. Ahmad- Al- Nahid (Swan) from Bangladesh Agricultural University received the CRSP-ISTA travel award to participate in and present at the 9th International Symposium on Tilapia Aquaculture and the 2011 AquaFish CRSP Annual Meeting.

THE LIBRARY DONATION PROJECT

The Library Donation Project, which began in 1999 under the Aquaculture CRSP, was continued by the AquaFish CRSP Management Office to help strengthen HC libraries in Africa, Asia, and Latin America. Akin to Libraries without Frontiers, this project collected and shipped boxes of scientific references, textbooks, and journals to Host Country libraries around the world. Recipient countries have included China, Mexico, and Kenya.

- Over 500 books and/or journals were sent to Host Country libraries since the inception of AquaFish CRSP.
- In 2011, prior to the AquaFish CRSP Annual Meeting, Dr. Egna was invited to dedicate a library at Shanghai Ocean University in honor of long-time CRSP participant Yang Yi.

COMMUNICATIONS AND MEDIA

In addition to the success stories, brochures, posters, and other outreach documents generated by the Management Office, communication specialists from the ME at Oregon State University reported on project successes globally. Theme-based press releases, videos, and features were published on a range of

topics, including native cichlid aquaculture in Mexico, baitfish farming in Kenya, the effects of Kenya's Economic Stimulus Program on that country's growing aquaculture sector, and the continued impacts that CRSP work has had in Honduras. Press releases, stories, and videos are available at http://aquafishcrsp.oregonstate.edu/news_events.php.

- Videos produced include:
  - "Researchers use bacteria to break down sex-changing steroid."
  - "Researchers aim to bolster stocks of snooks."
  - "Tilapia research and public outreach improve Hondurans' diets and incomes."
  - "Researchers aim to boost production of two native fish species in Mexico."
  - "The AquaFish CRSP Kenya Baitfish Project: Making the Connections."
- Press releases include:
  - "Bacteria on steroids: A new way to make water at tilapia farms safer?"
  - "Hooking up snooks: Researchers are trying to bolster stocks of the lucrative snook, but getting the fish to 'do it' and then getting their kids to eat is no easy catch."
  - "Researchers aim to boost production of two native fish species in Mexico."
  - "With U.S. help, Kenya aims to boost economy via fish farming."
  - "Small-scale changes could make long-term improvements in Asian aquaculture."
  - "USAID research increases profits for small-scale fish farmers in southeast Asia."

> *"The MT has developed several communication pieces to explain AquaFish…research and outreach activities to lay audiences using print and multimedia. The communication pieces were prepared to the highest level of quality and convey the program in a straightforward manner."*
>
> *- External Evaluation Report of the Aquaculture & Fisheries CRSP,* June 2012

REGIONAL CENTERS OF EXCELLENCE (RCE)

Regional Centers of Excellence (RCEs) provided technical advice on emerging issues and gaps in the portfolio from a regional perspective. Centers developed useful materials for Missions, other regional stakeholders and end-users, and gauged opportunities for collaboration based on regional or national needs. Five centers were formed since FY2006. Coordinators for the three original RCEs were selected at the May 2007 *Orientation Meeting & Pre-Synthesis Workshop* held in Washington, DC. In FY2011, two new RCEs were created: (1) the original RCE-Africa was reassigned to East and Southern Africa and a new RCE-West Africa was formed; and (2) an additional RCE-Asia was formed. The AOTR concurred with the Lead Coordinator selections:

- RCE-East & Southern Africa (formerly RCE-Africa): Charles Ngugi (Kenya, PU Project)
- RCE-West Africa (as of FY2011): Héry Coulibaly (Mali, Permanent Assembly of the Chambers of Agriculture)
- RCE-Asia: Remedios Bolivar (Philippines, NCSU Project)
- RCE-Asia (as of FY2011): Yuan Derun (Thailand, UM Project)
- RCE-LAC: Wilfrido Contreras-Sanchez (Mexico, UA Project).

3. RESEARCH & TECHNOLOGY TRANSFER HIGHLIGHTS

The CRSP model is based on international partnership and collaboration with a goal to provide long-term support to solve food problems and to improve agricultural systems in developing countries. Teams of U.S. and Host Country researchers, administrators, service personnel, and students implement a cohesive program of research, outreach, and training in participating Host Countries and the United States.

AquaFish CRSP focused on aquaculture and the nexus between aquaculture and fisheries, targeting high priority constraints facing poorer countries. Over the past twenty years, great progress has been made in increasing fish production through aquaculture, yet challenges still face the sector in terms of pressures from global trade, environmental impacts, water use conflicts, and distribution of and access to benefits. The capture fisheries sector, which supplies about half of the world's food fish, is also experiencing great challenges that must be overcome for the sustainable management of fish stocks and livelihood security of fishing communities.

The mission of AquaFish CRSP was to enrich livelihoods and promote health by cultivating international multidisciplinary partnerships that advance science, research, education, and outreach in aquatic resources. Bringing together resources from U.S. and Host Country institutions, AquaFish CRSP strived to strengthen the capacities of its participating institutions, to increase the efficiency of aquaculture and improve fisheries management in environmentally and socially acceptable ways, and to disseminate research results to a broad audience.

Core Research Projects consisted of 106 investigations that fell under one of two System Approaches: (1) Integrated Production Systems (IPS) and (2) People, Livelihoods, & Ecosystem Interrelationships (PLEI). The two System Approaches were interconnected when viewed from a holistic, sector-wide perspective, in that advances in production systems influence people, livelihoods, and ecosystems. Likewise, social, political, and environmental concerns can influence production systems, cultured species, etc (Figure 4.1).

Each investigation was also aligned with a specific area of inquiry called a Topic Area, with four Topic Areas within IPS and 6 within PLEI. Each Core Research Project contained between five and eight investigations covering a variety of Topic Areas in describing aquaculture research to improve diets, generate income for smallholders, manage environments for future generations, and enhance trade opportunities. The ten AquaFish CRSP Topic Areas were:

- **Integrated Production Systems**
    1. Indigenous Species Development (IND)
    2. Quality Seedstock Development (QSD)
    3. Sustainable Feed Technology (SFT)
    4. Production System Design & Best Management Alternatives (BMA)
- **People, Livelihoods, & Ecosystem Interrelationships**
    5. Human Health Impact of Aquaculture (HHI)
    6. Technology Adoption & Policy Development (TAP)

7. Marketing, Economic Risk Assessment, & Trade (MER)
8. Mitigating Negative Environmental Impacts (MNE)
9. Watershed & Integrated Coastal Zone Management (WIZ)
10. Food Safety & Value-Added Product Development (FSV)

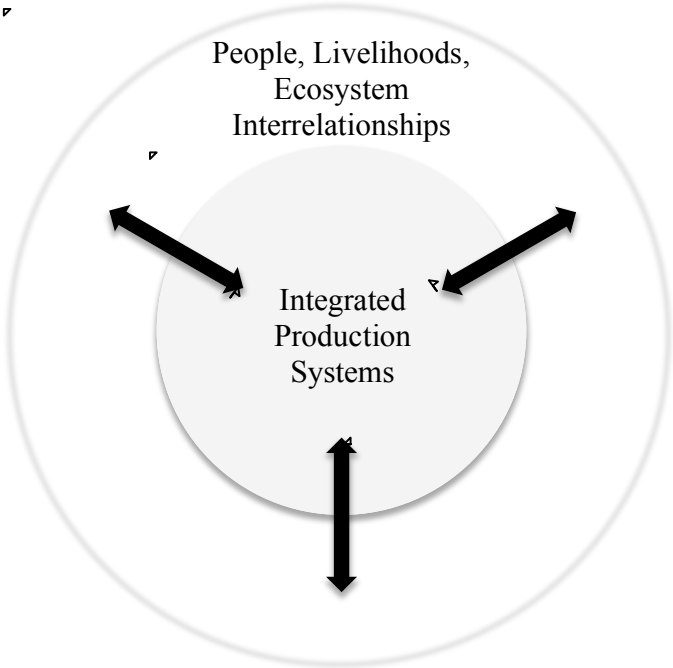

Figure 2. The relationship between the two System Approaches, People, Livelihoods, Ecosystem Interrelationships (PLEI) and Integrated Production Systems (IPS).

AquaFish CRSP researchers made significant advances in developing and transferring new technologies and practices to improve the lives of the rural poor. CRSP work has also led to significant achievements in marketing and trade, aquatic product development, and policy assessments relating to natural resources management and expansion of domestic and export markets. The following highlights summarize illustrative accomplishments in investigations within each of the ten AquaFish CRSP Topic Areas from Implementation Plans 2007-2009 and 2009–2011. For the full compilation of Final Investigation Reports, please visit http://aquafishcrsp.oregonstate.edu/publications.php.

AQUAFISH COLLABORATIVE RESEARCH SUPPORT PROGRAM

AquaFish CRSP researchers shine as scientists

In 2012, primary investigators across the Collaborative Research Support Programs were surveyed to take a snapshot of their overall research programs*. Fifteen of the 19 AquaFish CRSP US Project PIs and Co-PIs responded for a 79% return rate, providing details highlighting their success in securing extra-CRSP funding, awards, and honors. Responses from AquaFish CRSP investigators indicated that:

- In addition to CRSP funding, PIs were awarded an average of over $590,000 in a representative year
- 47 percent of CRSP researchers reported annual awards of $500,000 or greater, and 27 percent reported annual awards of $1 million or greater.
- Annual extra-CRSP awards ranged from $35,000 to $1.55 million.

Some awards and honors received by AquaFish researchers.

AquaFish CRSP PIs have received awards and honors through numerous outlets, and include:

- Fellows in academic societies (including the American Association for Advancement of the Sciences) (4).
- Fulbright scholars (**2**)
- Professional society presidents (**2**)
- Endowed chairs (**1**)
- USDA CSREES Service Award (1)
- Early Career/Lifetime Achievement Awards (2)
- Sea Grant Extension Agent of the Year (1)

Non-CRSP funding secured by AquaFish CRSP US Project PIs and Co-PIs.

USDA: 12 of the 15 researchers (80%) reported receiving funding from USDA, including **8** from NIFA.
USAID: 2 of the 15 researchers (13%) reported receiving additional funds from USAID.
NOAA: 5 of the 15 researchers (33%) reported receiving funds from NOAA.
NSF: 4 of the 15 researchers (27%) reported receiving funds from NSF.

Other U.S. government funding sources:
Department of Energy
National Institutes of Health
U.S. Environmental Protection
U.S. Geological Survey
Bureau of Reclamation
U.S. Fish and Wildlife Service

Researchers were also funded by the World Bank, DANIDA, MacArthur Foundation, David & Lucile Packard Foundation, various grower associations, and many others.

**This info sheet is based on data collected and presented by the Horticulture CRSP and kindly made available for use by the AquaFish CRSP.*

USAID FROM THE AMERICAN PEOPLE

OSU Oregon State University

TOPIC AREAS: INTEGRATED PRODUCTION SYSTEMS

Production System Design & Best Management Alternatives (BMA)

• On-farm polyculture trials in Nepal with the indigenous fish sahar (*Tor putitora*) and Nile tilapia (*Oreochromis niloticus*) have produced promising results. As a predator, sahar offers the advantage in polyculture of controlling tilapia recruitment in aquaculture ponds. For small-scale, resource-poor farmers who use low production, mixed-sex tilapia monoculture systems, sahar-tilapia polyculture can both help improve productivity and provide a new, desirable fish product. Trials showed that a stocking ratio of 1:16 sahar to tilapia had the best overall production. On the basis of these trials, cultured sahar has been available for human consumption by farmers, and tilapia production has improved a full 15%. Further, as Sahar is a popular food and game fish in Bangladesh, India, Nepal, and Pakistan, and is under threat from overfishing and habitat loss, culturing sahar can help decrease fishing pressures on wild stocks. — 07BMA02UM

• A tilapia cage-culture trial designed as a working enterprise model promoted small-scale fish farming on Lake Victoria. Members of Uganda's Jinja United Group Initiative for Poverty Alleviation & Economic Development (JUGIPAED) participated in the project. The livelihood of fishers is threatened due to reduced fish catches caused by overfishing and depleted fish stocks in the lake. Small-scale cage culture technology can provide an alternative income opportunity for local fishers and farmers. CRSP work demonstrated that cage culture ventures can be profitable. CRSP investigators provided technical assistance and "partnered" with JUGIPAED on a combined cost-share/research basis. This dual purpose approach offered a hands-on experience to the participating farmers with CRSP mentoring in a successful business model. — 09BMA01AU

• In Uganda, just under 300 participants attended the 3rd and 4th Annual Fish Farmers Symposium & Trade Fair held in January 2010 and 2011. The events were organized in partnership with the Walimi Fish Farmers Cooperative Society. Topics reflected the requests and interests of event attendees: (1) accessing inputs, return on investment, and quality of service delivery; (2) markets, marketing, and market information; (3) current support services and their accessibility for the aquaculture private sector; (4) feeds and feeding guidelines; (5) enterprise budgets; (6) farmer-based value-addition; and (7) financing. Study tour visits to farms and other associated businesses were introduced by CRSP and have proven a successful outreach tool for information exchange. The popularity of these tours is evidenced in their growth from one tour in 2010 to four tours in 2011, including one offered to Kenyan farmers. Participants have enthusiastically acknowledged the success of this multifaceted annual event as a forum for information exchange, networking, and working out practical solutions to current production challenges. — 09BMA02AU

• Under eutrophic conditions in aquaculture ponds, blooms of the toxin-producing cyanobacteria *Microcystis aeruginosa* can develop. Buildup of this blue-green algae degrades water quality and causes harmful levels of microcystin (MC) toxin to develop. The toxin is a secondary metabolite that can be lethal to aquatic animals. When accumulated in fish and shellfish tissue, the toxin also affects the food product's quality and safety for human

consumption. CRSP work focused on controlling MC in indoor recirculating culture systems for shrimp. The red swamp crayfish (*Procambarus clarkii*) and the freshwater prawn *Macrobrachium rosenbergii* were used as test species in experiments to identify the lethal mechanisms of the MC toxin. For the crayfish, the toxin from MC exposure lowered the survival rate of juvenile crayfish and adversely affected the disease immunity of adult crayfish, leading to poor grow-out in culture systems. In the case of prawns, no accumulation of MC toxin in tissues was found. These results highlight MC's complexities and the need for continued studies to characterize its mode of action in different aquatic organisms.—09BMA05UM

• In 2006, a CRSP evaluation of prawn farm practices in Thailand identified the negative environmental impacts of pond effluents and overfeeding. To follow-up, CRSP researchers at The University of Michigan partnered with the Network of Aquaculture Centres in Asia-Pacific to present a workshop for farmers and managers that reviewed the current status of prawn farming and educated them on how to minimize environmental impacts from farming practices. Surprisingly, the researchers found that farmers had already voluntarily changed their practices in response to the 2006 evaluation. The intensive monoculture system used by 96% of prawn farmers in 2005 had been reversed with polyculture now practiced by an estimated 80% of farmers. Best practices based on an integrated prawn-shrimp culture and lower stocking density of prawns allowed farmers to retain and reuse their pond water rather than discharge it.—09BMA06UM

Sustainable Feed Technology (SFT)

• In the lower Mekong River Basin in Vietnam and Cambodia, aquaculture of snakehead, a carnivorous fish, depends largely on wild-caught, small-size freshwater fish species. Cost, availability, resource depletion, feed efficiency, and competition with human food uses of the low-value fish have led to recommendations for alternative, locally sourced snakehead feeds. Experimental diets testing the replacement of fishmeal (FM) at varying percentages found the following dietary levels to have no negative effect on growth performance: 30% replacement with soybean meal (SM) or 40% replacement with SM and phytase or taurine supplements; 30% replacement of the SM-FM mix with rice bran; and 60% replacement with SM and a combined phytase and alpha-galactosidase supplement. Additionally, CRSP researchers found that 50% of the fish fed to snakehead can be replaced with formulated feeds. Successful on-farm trials verified the benefits of formulated feed both for its reduced impact on capture of fish resources and the cost savings it will bring farmers. This work has led the way towards a more sustainable feed technology for snakehead aquaculture that will reduce pressures on a fishery that supplies an important food source for rural communities in the region. —07SFT01UC, 09SFT01UC

• In Guyana, locally derived copra and shrimp meals proved successful as lower-cost protein alternatives to fishmeal for tilapia and pacu farmers. Poultry by-products and brewers waste also showed promise. This work was a collaborative effort between farmers' cooperatives (National Aquaculture Association of Guyana, Trafalgar Union Women's Cooperative for Tilapia) and a local feed mill (Maharaja Oil & Feed Mill) that focused on improved feed formulations and manufacture techniques. This work was expanded during the 2009-2011 Implementation Plan, during which CRSP trainings for small-holder farmers in rural northern and southern Guyana successfully transferred sustainable feed and production technologies. These trainings targeted individual farmers, small communities, women farmers, a feed mill, and tilapia hatchery. Three workshops were held in an isolated area in southern Guyana to help communities develop small-scale aquaculture, including their own feed production and marketing structure. A demonstration farm that integrates aquaculture with vegetable

production was set up as a working model for the surrounding communities. The 16 women members of the Trafalgar Women's Cooperative benefitted from women-focused trainings in aquaculture production basics, tilapia biology, and sustainable feed formulation and feeding regimes. Working together, CRSP investigators guided these stakeholders towards successful adoption of technologies and practices that will ensure improved livelihoods from aquaculture. Now the potential for a US export market for tilapia and brackish water shrimp exists. – 07SFT04UA, 07SFT05AU, 09SFT03UA

• Tanzanian researchers found that leaf meal made from two local, native leguminous tree species — *Leucaena leucocephala* (LLLM) and *Moringa oleifera* (MOLM) — can replace costly soybean meal in tilapia diets. While growth performance is higher when fish are fed with soybean meal, lower cost and local availability of these leafmeals make them a suitable alternative for small-scale farmers. Due to rising prices, soybean meal and fishmeal have become prohibitively expensive. Of the two, MOLM-diets showed higher fish productivity. As a result of this work, rural Tanzanian fish farmers can increase their profitability by using these locally available, low-cost protein sources for fish feed. — 07SFT06PU

• In Kenya, training of three groups of small-scale commercial farmers in a cage-cum-pond system for tilapia has provided them with a cost-effective approach for managing feed costs and lowering the levels of pond waste that reaches public water systems. In this two-crop system—originally developed by CRSP researchers in Asia—the caged fish are fed with commercial feeds while the pond fish feed on the natural foods generated by the fertilizing effects of the cage wastes. In the research stage, CRSP investigators established cage stocking density parameters that will guide farmers in their stocking decisions. While the lowest density (50 fish/m^3) led to better growth, low FCR, and higher survival rates, these factors would need to be balanced against potential lower yield. In preparation for commercial adoption, farmers were comprehensively trained in cage management and production practices. A smaller, select group of farmers was trained in cage construction. These trainees transferred their newly acquired knowledge to their respective groups to construct six cages for an on-farm trial at their farm sites. A post-trial workshop afforded the farmers an opportunity to evaluate their experiences and challenges with the integrated cage culture technology. In addition to introducing an environmentally friendly culture system to a new group of farmers, this CRSP work lead the way for community-wide diffusion as other farmers adopted this technology on the basis of the success of the first adopters. — 09SFT02PU

• For small-scale, rural tilapia farmers in the Philippines, feed is the most costly component, representing 60-80% of the total production cost. Reducing this cost requires either application of less feed or use of lower cost feeds. A series of studies on feed reduction strategies and alternative protein sources found: (1) feed reduction strategies can significantly reduce the quantity of feeds consumed by about 55% without affecting the final weight, specific growth rate, and FCR (food conversion ratio); (2) fish fed at 50% satiation show comparable or even better results in terms of the production efficiency than control fish; 3) alternate protein sources (poultry meal, fermented, deboned meat-poultry byproduct, Nupro yeast extract) may serve as suitable substitutes for fishmeal in tilapia diets. Building on the findings of earlier alternate day feeding experiments, CRSP researchers established that farmers can reduce production costs if they switch from a 100% daily feeding schedule to one of the following regimes for supplemental feeds: (1) a delayed supplemental feeding of 45–75 days, (2) 50% or 67% subsatiation feeding, or (3) alternate-day feeding at the 100% satiation level. Research has also shown that tilapia grown on a low crude protein-amino acid supplemented diet with 0% fishmeal brings a 10% cost savings on feed. A training on these feeding strategies, which was

attended by over 60 tilapia farmers, feed manufacturers, representatives of local and regional Filipino government agencies, and university students, was featured on a local news channel: http://www.youtube.com/watch?v=5cM-T5N3Iwk&feature=related. Farmers have adopted these new technologies and have increased their profits. Diffusion by example, through podcasts, and through the media has exposed a broad population of Filipino as well as international stakeholders to these beneficial CRSP technologies. — 07SFT02NC/09SFT04NC/09SFT06NC

Indigenous Species Development (IND)

• Chame (*Dormitator latifrons*), a fish low on the trophic chain, is a popular aquatic food for poor communities throughout the Latin American region. Its use as a source for fishmeal and the dependence on wild-caught juveniles for aquaculture are depleting native supplies. CRSP researchers developed the first successful techniques for controlled reproduction of chame in captivity, to open sources for domesticated broodstock. These research accomplishments represent significant steps towards the development of broodstock to supply fingerlings for chame aquaculture. — 09IND03UH

• As part of an integrated effort to better manage the Lower Mekong Basin fishery for both snakehead and small-sized fish, CRSP researchers successfully developed feed formulations that reduce fishmeal content (07SFT01UC/09SFT01UC). This effort addressed the competing interests in small-sized fish from the inland fisheries for livestock and fish feed versus their use as a significant food source for the rural poor. Farmed snakehead has been under a ban in Cambodia since 2005 due to fish population declines in the Mekong River from over collection of snakehead seed and loss of species diversity with overfishing of small-sized fish used as snakehead feed. Taking a sustainable approach, CRSP researchers built a framework for snakehead aquaculture with new technologies that ease the resource conflicts and, in conjunction with management plans, ensure a viable fishery in the lower Mekong River Basin. A snakehead hatchery at the Freshwater Aquaculture Research & Development Center in Cambodia is operational and making progress in establishing the protocols for raising snakehead from seed. This represents a significant accomplishment for developing Cambodian snakehead broodstocks as well as development of programs to reduce diseases associated with import of Vietnamese broodstocks and to address illegal snakehead imports. In a companion study at Can Tho University in Vietnam, CRSP researchers worked on snakehead diseases and have prepared and disseminated an "Atlas of Pathogenic Agents in Snakehead" to farmers in three Vietnamese provinces. — 09IND02UC

• CRSP researchers at the Universidad Juárez Autónoma de Tabasco (Mexico) focused efforts to domesticate native fish species for aquaculture through the development of broodstock lines and feeding protocols for larval and adult fish. For example, while snook could spawn in captivity, survival of the larvae was problematic. Efforts emphasized finding the right live feed for the larvae to survival. For the native cichlid species, tenguayaca and castarrica, broodstock selection was advanced to the F_2 generation. This work is representative of the scientific success that CRSP has engendered at the institutional level in HC partner countries. Bringing native species into "local" aquaculture is an important step in self-sufficiency, implementing workable approaches to reduce pressures on the often-overfished wild-caught fisheries, and addressing cultural food preferences by bringing traditionally favored food fish into aquaculture. — 07IND01UA, 07IND02UA, 09IND05UA

• Domestication of several native species for Ghanaian aquaculture was initiated for three species: Claroteid catfish (*Chrysichthys nigrodigitatus*), African Bony-Tongue (*Heterotis*

niloticus), and African snakehead (*Parachanna obscura*). Work focused on the nutritional requirements of *Chrysichthys* and *Heterotis*. A market survey of the African snakehead established that aquaculture would be a useful step in ensuring a consistent supply of this popular fish while protecting its wild populations. An information brochure on the three species was distributed as an educational resource. This work was also part of a larger analysis of aquaculture in Ghana to identify constraints on and opportunities for its development. Efforts toward diversification of Ghanaian aquaculture contributed to new market and income opportunities along the value chain. — 09IND06PU

Quality Seedstock Development (QSD)

• Tilapia seed production is estimated to be over 1.2 billion annually in the Philippines and demand is expected to triple in the coming years. To meet the growing demand for quality tilapia seed, production improvements are essential. CRSP work focused on the relationship between broodstock age and seed production in the GIFT strain of Nile tilapia, which is the major strain farmed in the Philippines. Results showed that broodstock ranging in age from eight months to two years could be used for tilapia seed production with no significant loss in final growout yield. CRSP researchers also established protocols for broodstock selection using IGF-I gene expression as a proxy for fecundity and grow out performance. For tilapia farmers these technology improvements will help ensure seedstock quality at affordable prices. — 07QSD01NC, 09QSD01NC

• Among the environmental issues faced by the artisanal fishery of Lake Victoria is the threatened status of the native sharktooth catfish, which is being depleted by Nile perch fishers who use it for baitfish. Farmed juvenile catfish sold as an alternative to wild-caught baitfish offered a sustainable solution. Farmers participated in an AquaFish CRSP project that trained them in both production and business techniques that led to the establishment of six baitfish markets along the shores of Lake Victoria. The Bidii Fish Farmers Association was a model farming cluster enterprise. Through CRSP trainings, this cluster developed a profitable catfish-baitfish business with sales to baitfish dealers and other farmers in need of seed stocks. Bidii farmers also partnered with a Kenyan women's project (Women in Fishing Industry Project) to train women in pond construction and catfish breeding. The interest of other farmers in adopting the cluster model and enlisting the aid of successful farmers in setting up their clusters verified the significant achievement of this work. — 07QSD02PU

• CRSP researchers set up three integrated aquaculture–agriculture demonstration units for tilapia culture in southeastern Mexico (Tabasco). Two units were located in indigenous communities that had earlier partnered with the former Aquaculture CRSP as part of a community-based aquaculture project. The third educational unit was set up at the Universidad Juárez Autónomo de Tabasco. The training component was multifaceted, beginning with a training of trainers. These trainees then worked with farmers in the Chol community of Cartidad Guerrero (Lacadon Village Farmer's Cooperative) to set up the on-farm demonstration site. An additional demonstration was set up in the Chontal community in Oxiacaque, Nacajuca County. Farmers were trained in water and nutrient delivery, drainage, sun angles, shade problems, and harvest plans. — 09QSD02UA

• Training farmers and potential farmers in the basic techniques of aquaculture, thereby providing them with essential knowledge and skills, often led to ripple effects in information diffusion and technology transfer. In Ghana, two CRSP trainings that dealt with basic production practices to raise Nile tilapia and African catfish, from propagation through grow-out, offer such an example. Over 60 small- to medium-scale farmers attended the trainings.

Their enthusiasm and interest was strongly evidenced by their requests for a regular schedule of trainings to reach new farmers and to cover areas not included in the original Ashanti and Eastern regional focus. — 09QSD05PU

TOPIC AREAS: PEOPLE, LIVELIHOODS, & ECOSYSTEM INTERRELATIONSHIPS

Human Health Impacts of Aquaculture (HHI)

• Experimental work identified chitosan-modified clay as an environmentally benign coagulant treatment to remove the toxin-producing cyanobacteria *Microcystis aeruginosa* from pond water. Under eutrophic conditions, blooms of this blue-green algae degrade water quality and harmful levels of the microcystin toxin can accumulate in tilapia affecting food quality and food safety. This experimental work also documented the lethal effects on other aquatic organisms such as the water flea (*Daphnia magna*) and red swamp crayfish (*Procambarus clarkii*) that are important contributors to aquaculture productivity. The coagulant treatment was shown to be effective for use in aquaculture and offers a relatively simple, and environmentally benign, control option to maintain the health of tilapia ponds and ensure the food safety of pond-raised fish. — 07HHI01UM

• A two-part workshop on aquaculture sanitation for researchers, practitioners, and community stakeholders was conducted at Universidad Autónoma de Sinaloa–Culiacán in September 2008. Part I included a conference (19 presentations) and a one-day field trip for 36 stakeholders to a pilot site in Santa Maria Bay (Altata) for shellfish polyculture with oyster, pen shell, and shrimp. The Altata site is now targeted for “shellfish growing water classification” by the State of Sinaloa and the Mexican Federal Government. Part II was conducted in Santiago Ixcuintla (Nayarit). Thirty-nine attendees participated in the conference (12 presentations) and two field visits to Pozo Chino and Boca de Camichin, both major oyster growing areas. Pozo Chino is now targeted for “shellfish growing water classification” by the State of Nayarit and the Mexican Federal Government. — 07HHI03UH

• Forty-three attendees, from educational, private sector, and governmental institutions, participated in the Regional Workshop on Shellfish Culture & Sanitation held 28–30 September 2009 at Universidad Autónoma de Sinaloa – Culiacán. Attendance by representatives of the Aquatic Sanitation Committees (ACS) for five of the Mexican States on the Pacific Coast was significant due to the ACS role in providing extension services to shrimp and bivalve producers. The workshop offered a networking opportunity for the various stakeholders. In this respect, the group’s issuance of the "Declaration of Culiacán" — a public manifesto expressing the needs of the sector and requesting specific actions from industry and responsible government agencies — can be seen as a successful example of a newly established linkage. — 07HHI04UH

• In the Aserradores Estuary of Nicaragua, 66 families have participated in the CRSP community-based co-management program for the native black cockle (*Anadara* spp.) fishery. This program offered a more effective management system to the traditional seasonal ban from April to July. CRSP worked closely with these families, involving them in monitoring activities and management of the boundary markers for the no-take areas. CRSP’s accomplishments at the community level can be measured by the success of the community partners and cockle collector cooperatives in managing healthy cockle populations under the no-take area model.

The Nicaraguan government has shown interest in community-based co-management, and has tested this approach in two other estuarine communities dependent on cockles. — 09HHI01UH

Food Safety & Value-Added Product Development (FSV)

- The rural poor of Cambodia and Vietnam process small-value fish into *prahoc*, a fermented fish paste that forms a major portion of their diets and provides a key source of protein. Following traditional fermentation practices, women take fresh-caught fish and process it into fish paste. *Prahoc* is used in the home and provides a source of income when sold in local and regional markets. Quality varies and the short shelf life poses health and safety concerns. To address these issues and also provide women processors with better income opportunities, CRSP researchers developed processing standards for food quality and safety. CRSP researchers also addressed issues with opening export markets. In addition to disseminating information in workshops, they met with government policymakers and made use of mass media to raise public awareness. — 09FSV01UC

- Coastal shrimp farmers in the Philippines and Banda Aceh, Indonesia adopted a new polyculture technique with shrimp and seaweed that they learned in CRSP trainings. CRSP researchers addressed the difficulties that farmers were having in properly drying seaweed with a special training to instruct them in drying techniques to keep the seaweed uncontaminated with sand and snail shells. In other CRSP trainings, local women were taught how to process the seaweed and prepare value-added food such as seaweed-flavored chips, seaweed pickles, and agar candies. As seaweed culture develops within these poor coastal communities and markets expand for the raw and processed seaweed, men and women have improved income opportunities. — 09FSV02NC

Technology Adoption & Policy Development (TAP)

- AquaFish CRSP researchers developed a series of seven podcasts on tilapia aquaculture that are available for download from the CLSU computer center and North Carolina State University server and also through the AquaFish CRSP website. A diverse group of farmers, feed company personnel, local and regional government officials, journalists, and CLSU faculty, staff, and students attended the January 2009 workshop that launched the podcast. While most of the attendees were unfamiliar with online tools, they left the workshop with training on accessing the podcast as well as other online information sources on tilapia aquaculture. Media coverage also informed a larger population of this new outreach technology. For Filipino farmers, many of whom already have internet access, the podcast offered an easily obtained outreach tool with readily available information on tilapia production techniques. Interest in the podcasts was excellent with 285 downloads and 444 hits on the NCSU iTunes server over a 2-month period, indicating their effectiveness as a tool for disseminating tilapia culture technologies worldwide. — 07TAP02NC, 09TAP02NC

- Among the first steps in building Ghana's aquaculture industry was an assessment of the constraints on its growth. Cage culture is considered a technology that can help boost production provided the barriers to expanded growth are addressed. Based on a comprehensive evaluation that identified lack of capital and technical knowledge as major constraints, CRSP researchers have recommended several immediate remedial steps to stimulate the needed growth: a guaranteed loan program for farmers, subsidized feed costs for smallholders similar to those available in terrestrial agricultural production, and a more specialized aquaculture extension program patterned after the successful agricultural model. These efforts were at the heart of the CRSP approach to capacity building, which took a fundamental approach to build

the infrastructure that will bring farmers into aquaculture and ensure their success through access to technical knowhow and equitable loan financing. — 09TAP04PU

Marketing, Economic Risk Assessment & Trade (MER)

• AquaFish CRSP researchers trained small- and medium-scale fish farmers in Ghana and Kenya how to successfully enter urban markets. Trainings covered the importance of value chains, principles of supply chain management, principles of marketing, group marketing, developing new markets, and developing distribution and marketing networks. Researchers engaged farmers in collective efforts to plan production, and manage supply and sales. Kenyan baitfish farmers (see Quality Seedstock Development: 07QSD02PU) using the cluster farming system achieved significant improvements in their marketing capabilities and have assisted other farmers in adopting the collective model. — 07MER02PU

• With the evaluation of the tilapia supply chain in the Philippines completed, CRSP researchers developed the following recommendations for an improved and sustainable supply chain of farmed tilapia: (1) better quality broodstock and improved technology transfer; (2) promotion of niche market opportunities for farmers and consumers; (3) incentives for small farms to participate in supply chains; (4) establishing an accreditation program to improve quality assurance in the feed, hatchery, and processing sectors; (5) providing capital to improve facilities and cost efficiencies in the entire supply chain. Implementation of these recommendations can open new opportunities for small-holder tilapia farmers to enter into the supermarket and fast food markets. — 09MER03NC

• As part of the multifaceted approach for developing recommendations for managing the lower Mekong River Basin fisheries for small-sized fish and establishing sustainable snakehead aquaculture, CRSP researchers conducted a value-chain analysis of wild-caught versus farmed snakehead in Vietnam and Cambodia. In Vietnam, data showed that wholesalers reap about 90% of the total profits in the system whereas farmers take in only about 6% profit. While retailers make the greatest profit per kilogram of fish, they account for a small percentage of total profits due to the small number of fish that each retailer sells. Coupled with other aspects of CRSP work on snakehead feed technology and hatchery production, these results will inform policymakers in decision making to develop an interregional snakehead aquaculture industry that takes the roles and economic viability of major stakeholders into account. — 09MER04UC

Watershed & Integrated Coastal Zone Management (WIZ)

• CRSP researchers established that the current standing stock of oysters (~736 MT) cultured in the Boca de Camichin Estuary on the Pacific Coast of Mexico is below the maximum sustainable limit projected by the study (~1100 MT). The finding was presented to the Boca de Camichin management committee, a multi-institutional-governmental organization that is developing and implementing a management plan for the area. Based on recommendations, the Mexican government imposed a ban on establishing new oyster farms, which will ensure a sustainable oyster industry within the carrying capacity of the estuary. — 07WIZ02UH

• In Uganda, CRSP researchers developed a set of site suitability maps for selecting the location of earthen aquaculture ponds to better capture and manage water. These maps incorporated the following site selection criteria: water requirement, water temperature, soil texture, slope gradient, potential for farm-gate sales, access to local and regional markets, and availability of farm inputs. Major wetland areas were designated as protected sites on the maps. In another component of this work, researchers and extensionists were trained at a CRSP workshop at Makerere University in techniques for advising local farmers in their site selections. This new technology offers a more sustainable approach for community water

supply management and natural resource conservation for rural Uganda fish farmers. — 09WIZ02AU

Mitigating Negative Environmental Impacts (MNE)

- Small shrimp farmers in coastal areas of Indonesia (Banda Aceh) and the Philippines are now dealing with shrimp diseases and environmental degradation. These problems largely stem from their monoculture systems and are indicative of adverse environmental effects contributing to loss of mangroves and degraded water quality. To deal with these issues, workshop trainings were held to introduce farmers to more sustainable techniques incorporating seaweed culture into tilapia-shrimp polyculture and educate them in production and management practices to improve productivity and control diseases. In Banda Aceh, workshops on soft shell mud crab farming as another polyculture option were also held as part of the tsunami recovery program. With an attendance of almost 300, trainees were enthusiastic and requested follow-up training. — 07MNE02NC

- Assessments of environmental and economic impacts of alien species in freshwater reservoirs in China (Taihu icefish: *Neosalanx taihuensis*) and Vietnam (Nile tilapia: *Oreochromis niloticus*) led to recommendations to eliminate further stocking of these species. While alien species have contributed to economic development, their populations threaten native species biodiversity and development of sustainable local fisheries. — 07MNE03UM

- AquaFish CRSP researchers developed a novel use for life cycle assessment (LCA) — to evaluate the ecological footprint of three shrimp farming systems: (1) intensive farming for overseas export markets, (2) semi-intensive farming for export to the mainland, and (3) semi-intensive farming for local consumption. Their findings showed that the main differences among the three scenarios were related to energy use, global warming, and eutrophication potential. — 07MNE05UM

- In evaluating the resource conflicts in the lower Mekong River Basin over the use of the small-sized/low-value fish as food for human consumption versus its use as food for livestock and farmed fish, CRSP researchers held high-level stakeholder consultations in Cambodia and Vietnam. These meetings were structured as forums for dialogue among the concerned parties in the government, NGOs, research and academic institutions, and private sector. The fundamental problem in management of this major fishery is that demand is outstripping supply. This situation is further complicated by the needs of the poor pitted against two growing industrial sectors. In preparing recommendations based on a comprehensive analysis of these competing interests, CRSP researchers sought input on the diverse perspectives of these stakeholders. For the poor domestic consumer, their food security depends on a stable fishery on which they can rely for a steady source of small-sized fish. For industry, food security can be viewed through expanded income-generating opportunities as the fishing and aquaculture industries grow. Input from these high-level meetings combined with the data collected from four years of multidisciplinary studies were developed into recommendations to sustainably conserve the biodiversity of this major Mekong River Basin fishery. — 09MNE04UC

- Addressing the competing interests of aquaculture expansion versus natural resource conservation, AquaFish CRSP organized and led a symposium at the September 2011 American Fisheries Society meeting in Seattle, Washington entitled *"The Effects of Semi-Intensive Aquaculture on Biodiversity In Nearshore and Inland Waters*." The 12 invited international experts spoke on a wide range of topics that drive the debate between the benefits

and drawbacks of aquaculture relative to natural biodiversity. Symposium topics covered invasive species effects, effluents and eutrophication, antibiotic effects, environmental performance, use of aquaculture feeds, and social and economic impacts. The full proceedings from the symposium can be found on the AquaFish website (http://aquafishcrsp.oregonstate.edu/publications.php). As an outcome of the symposium, a paper co-authored by several participants was developed collaboratively, titled "Responsible aquaculture by 2050: valuing local conditions and human innovations will be key" and submitted to the journal *Bioscience*. Several participants also submitted their contributed papers for publication in various peer-reviewed journals. - 09MNE06UM/Capacity Building Initiatives in Host Countries (ME)

4. SUCCESS STORIES, OUTREACH DOCUMENTS, & MEDIA

AquaFish CRSP communicated programmatic success to lay audiences through a variety of media outlets. Success Stories and Activity Briefs were formatted using USAID templates. Press releases were written by Oregon State University journalists in cooperation with the Management Office. Brochures and fact sheets were produced by the Management Office as well as by Cultural Practices LLC through subcontract with the ME.

This section presents success stories, outreach documents, and other media disseminated through the ME or, in the case of news articles, written about the program. Outreach documents were also produced by subcontract Core Research Project partners, but due to space limitations are not included here.

SUCCESS STORIES, ACTIVITY BRIEFS & DIVING DEEP STORIES

Success Stories, Activity Briefs, and Diving Deep stories produced by the ME include:

- SS-1: Success Story: Fish Farmers Association Model Success
- SS-2: Success Story: Putting Bacteria to work for Tilapia Farmers
- SS-3: Success Story: Mali Strengthens Its Aquaculture and Fisheries Sectors
- SS-4: Success Story: A Native Fish Moves Towards Aquaculture
- SS-5: Success Story: Reduced Feeding Strategies Lower Production Costs
- SS-6: Success Story: Fish Farmers Symposium & Trade Fair Uganda

- AB-1 Activity Brief: AquaFish CRSP Leads the Way Toward a Sustainable Aquaculture and Fisheries Economy in Kenya

- DD-1 Diving Deep: Polyculture of Freshwater Prawns and Mola in Bangladesh
- DD-2 Diving Deep: Fish Farmer Models CRSP Best Management Practices
- DD-3 Diving Deep: CRSP Introduces Rice-Fish Culture to Malian Farmers
- DD-4 Diving Deep: CRSP Helps Fish Farmers Lower Feed Costs In Tanzania

Success Story

AquaFish CRSP: Sustainable Aquaculture and Fisheries for a Secure Future

No. SS-1 November 2009

Fish Farmers Association Models Success

Cluster enterprises offer fish farmers new marketing options

"We own our fish ponds." said Ambuli. "The group coordinates production and sells collectively."

In Kenya, aquaculture is mainly practiced by small-scale farmers who often face challenges in bringing their fish to market. To help farmers raising catfish fingerlings as baitfish for Lake Victoria fisheries, the AquaFish CRSP partnered in 2007 with the USAID Kenya Business Development Services program in a marketing assistance project. The goal was to teach farmers how to form cluster enterprises and successfully raise and market baitfish to the commercial fishermen who use juvenile catfish as bait for Nile perch. Of the first four clusters to form, the Bidii Fish Farmers Association (FFA) stands out as a model. Its membership has grown from 10 members to 25, including nine women. "We own our fish ponds," says Bidii Chairman George Ambuli. "The group coordinates production and sells collectively." Since May 2008, Bidii has been regularly selling catfish fingerlings to baitfish dealers.

Receiving their first batch of catfish fry to stock their aquaculture ponds is a joyous occasion for these new baitfish farmers from Western Kenya.

Bidii's task of setting up a cluster enterprise was relatively simple. With guidance from Moi University and the Ministry of Fisheries and CRSP funding, the group decided on a name, developed a constitution, and established a leadership structure. Under its governance structure, there are three executive officers: chairman, secretary, and treasurer. The FFA's revenue-sharing arrangement requires that 80 percent of revenue be returned to members while 20 percent is kept for administrative and other promotional expenses. Bidii currently holds two bank accounts. Future plans focus on developing a well-equipped hatchery and owning a feed mill to ensure a reliable supply of fish feed.

Ambuli is proud of his group. Their initial steps into the baitfish business in 2007 were rocky. "Our first three attempts to culture catfish failed with 100 percent losses due to poor management skills and improper

feed. Three members withdrew. Knowing the fishermen on Lake Victoria needed baitfish, the remaining seven of us pledged to continue." With hands-on training led by CRSP's Moi University partners, Bidii farmers mastered fish propagation techniques and learned how to set up marketing links with baitfish dealers.

Bidii's success has recently led to a partnership with the Women in Fishing Industry Project (WIFIP). "WIFIP helps women fish traders identify income generating activities," says Jennipher Kere, Executive Director. "WIFIP seeks to engage women in aquaculture to provide additional household income and to support them during the annual fishing ban on Lake Victoria, when income is at its lowest." Bidii cluster farmers are training women and others in fishpond construction and catfish breeding. Since 2008, their training has helped six new groups enter the baitfish business.

Women baitfish traders buying a fingerling catch from Lake Victoria fishers. These women, some of whom have taken up fish farming as a new income source, are now relying on farm-raised catfish fingerlings to sell to Nile perch fishers.

To view an AquaFish CRSP video on the baitfish project, see http://www.youtube.com/watch?v=xDi454ieqoY

George Ambuli, Chairman of the Bidii Fish Farmers Association, receives an award from US CRSP researcher Jennifer Dennis of Purdue University.

Fish farmers belonging to the Visiki cluster, who were trained by members of the successful Bidii Fish Farmers Association, join together to construct a fish pond for raising baitfish.

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Success Story
AquaFish CRSP: Sustainable Aquaculture and Fisheries for a Secure Future
No. SS-2 November 2010

Putting Bacteria to Work for Tilapia Farmers

Masculinization Systems for Tilapia Are Made Safe with Steroid-Eating Bacteria

"With MT being removed by the bacteria and also the growing importance of bioflocs in aquaculture, this is going to be a great success for sure."

— Wilfrido Contreras-Sánchez, AquaFish CRSP researcher

AquaFish CRSP graduate student Lucero Vazquez Cruz examines a Petri dish with bacteria that can degrade the tilapia masculinization hormone methyltestosterone.

Tilapia is one of the most popular fish used in developing country aquaculture. It's an easy, economical fish for poor farmers to raise as food for their families and to sell. But, tilapia are prolific breeders, quickly overpopulating ponds with too many fish stunted in growth and too small to profitably market. One solution is for farmers to stock their ponds with only male fingerlings purchased from local fish hatcheries. An all-male population will grow more quickly than a mixed-sex population, producing larger, more uniformly-sized fish and tidy profits for farmers.

To turn young tilapia into males — starting at the fry stage, when they're no larger than an inch — hatcheries feed them food containing the synthetic steroid methyltestosterone (MT). After three to four weeks of MT treatment, the young fish are masculinized. But MT treatment carries an environmental cost. As the young fry feed on MT-laced feed, they excrete unused hormone back into the hatchery water in their urine and feces. This MT residue does not naturally degrade. With hatcheries producing thousands of MT-treated fish each year, disposal is a growing problem.

MT is a member of a class of hormones that can cause cancers and other health problems under prolonged exposure. Hatchery workers are exposed to MT when they wade into treatment ponds to collect fingerlings ready for sale. Many hatcheries routinely discharge MT-laced water into local streams and rivers where it can harm wildlife. "The health of local residents who swim in or wash clothes in these bodies of water also might be at risk," according to CRSP researcher Dr. Wilfrido Contreras-Sánchez at the Autonomous Juarez University of Tabasco in Mexico.

Contreras-Sánchez has developed a simple, cost-effective system for removing MT from the hatchery water. By using bio-filters covered with bacteria that eat MT, the residue is eliminated from the water. These are

Mexican workers net tilapia broodstock at a government hatchery. Broodstock such as these produce fry that are treated with MT to generate all-male fingerling populations for sale to fish farmers.

Dr Wilfrido Contreras-Sánchez scoops young tilapia from an experimental MT-treatment tank fitted with the bio-filtration system.

common bacteria typically known as the agents of disease and spoilage — *Pseudomonas aeruginosa* (pneumonia and other ailments), *P. fluorescens* (milk spoilage), and *Bacillus ceresus* (food poisoning). Contreras and his colleagues initially discovered these species among healthy bacterial colonies populating a hatchery's water filtration system. Their bet that some of these bacteria fed on MT proved right. In a series of experiments, the UJAT team identified these three species and also discovered that *P. aeruginosa* acts as a probiotic by enhancing fish growth and survival.

This MT elimination technology is now ready for commercial scale-up. For the initial transfer step, UJAT has partnered with the Mexican fish farm Pucte del Usumacinta, which masculinizes up to 750,000 fry each month. The company is excited about the probiotic effect, and its industrial applications in bioflocs. As Contreras-Sánchez enthusiastically phrased it, "With MT being removed by the bacteria and also the growing importance of bioflocs in aquaculture, this is going to be a great success for sure."

The CRSP MT-removal technology will scale-up from this simple filtration tank to commercial-sized systems capable of filtering MT-treatment water in large hatcheries.

To view an AquaFish CRSP video on the MT-Elimination project at UJAT, see www.aquafishcrsp.oregonstate.edu/video/index.php?video=1

Photo of Mexican workers by Jim Bowman; all others by Tiffany Woods, Oregon State University

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Success Story

AquaFish CRSP: Sustainable Aquaculture and Fisheries for a Secure Future

No. SS-3 January 2011

Mali Strengthens Its Aquaculture and Fisheries Sectors

Building Capacity through South-South Collaborations

"Dissemination of the technology of rice-fish culture has a bright future in Mali…rice plus fish equals increased food security, food safety, environmental protection, increased incomes, and employment."

— Alhassane Touré

Charles Ngugi, an AquaFish CRSP expert in African aquaculture production, shows a group of Malian farmers and DNP personnel how to establish elevations in preparation for pond excavation.

AquaFish CRSP recently completed a three-year project (1 October 2007– 31 December 2010) that successfully trained Malian stakeholders in improved production technologies and management practices for aquaculture and freshwater fisheries. Using a South-South approach, CRSP researchers from Kenya, China, and Thailand worked closely with Malian farmers, fishers, and extensionists to transfer their expertise in three primary areas of the country's development needs: sustainable aquaculture production practices, integrated rice-fish farming, and community-based fisheries management.

Funded under an Associate Award from USAID/Mali, AquaFish CRSP partnered with Mali's Direction National de la Pêche (DNP) to implement a program of on-the-ground trainings and research activities that addressed local conditions and constraints. With a goal to increase productivity and income, the CRSP team led 20 workshops attended by 358 participants and set up field demonstrations and on-farm trials to test practical examples of sustainable aquaculture production systems suitable for Mali. On Lake Sélingué, Mali's largest capture fisheries system, a Malian team conducted the first-ever management evaluation of the lake's fisheries.

Dr. Charles Ngugi of Kenyatta University (Kenya) led the pond production component that focused on training Malian farmers and extensionists in basic techniques ranging from pond construction and management to record keeping and marketing. This production component was designed to both introduce stakeholders to new technologies and management practices in workshops and promote adoption through local on-farm trials. In addition to eight in-country trainings, Dr. Ngugi led a comprehensive 10-day course in Kenya for four Malian farmers and DNP technicians. Once back in Mali, this group of trainees became key players in providing support services and promoting the CRSP production model. Three sets of on-farm trials were conducted in 2009 and 2010. Several of the participating farmers successfully adopted the new production techniques, thereby realizing crop increases which in some cases rose substantially from the baseline of 1500 kg/ha/yr to an 18,000 kg/ha/yr equivalent.

The rice-fish culture component began with a 2008 intensive training in China for two DNP officers. Dr. Liu Liping of Shanghai Ocean University (China) and

USAID FROM THE AMERICAN PEOPLE OSU Oregon State AQUAFISH COLLABORATIVE RESEARCH SUPPORT PROGRAM

Dr. Yuan Derun of the Network of Aquaculture Centres in Asia-Pacific (Thailand) also led four in-country workshops. The Chinese-trained DNP officers assisted in setting up demonstrations of the rice-fish culture system. Four farmers cooperated in the 2009 trials. The most successful field trial yielded 305 kg of food fish, a 3650 kg/ha equivalent, which earned an extra $121 in additional income for the farmer, who also harvested a profitable rice crop. By project end in 2010, over 20 farmers had adopted this new technology. With their extensive training and project involvement, the two DNP officers now provide extension and outreach to farmers using the Chinese rice-fish culture model. According to one of these DNP officers, Alhassane Touré, "Dissemination of the technology of rice-fish culture has a bright future in Mali… rice plus fish equals increased food security, food safety, environmental protection, increased incomes, and employment."

A rice field modified for rice-fish culture by a farmer who is testing the new culture method. Water channels connected to a centrally located sump will provide a refuge for fish once the field is planted in rice and flooded.

In 2009, a CRSP-trained survey team conducted a frame survey of Lake Sélingué to assess its fishing capacity. Peter Nzungi, a CRSP collaborator with the Kenyan Fisheries Department, guided the Malian team, which interviewed fishers and recorded data on gear types, fish catches, etc. The data formed the basis for a report submitted to DNP with recommendations for a sustainable management plan for the lake's fisheries. To bring the lake's community into the discussions and ultimate management, four stakeholder workshops were held. One of these workshops was an intensive study tour for four Malian participants to showcase Kenya's successful co-management of its Lake Victoria fisheries. In following Kenya's example, the public-private partnership being developed at the community level promises a successful outcome for Lake Sélingué's co-management, which itself can further serve as a model for Mali's other freshwater fisheries.

Traders, who are traditionally women, buy fish on the shore of Lake Sélingué from fishermen who are bringing in their day's catch.

AquaFish CRSP's successful work in Mali illustrates how effective South-South collaborations can be in building capacity in developing countries. The significant accomplishments of this project stem from several basic elements: (1) the first-hand, developing world perspective of the project's Kenyan and Chinese partners; (2) the emphasis on training stakeholders at all levels; (3) the CRSP hands-on approach to training; and (4) the strong enthusiasm of the Malian trainees. This working partnership overcame the language barriers that might have stood between the French-speaking Malians and their English- and Chinese-speaking CRSP trainers. By the end of the project in 2010, Malian stakeholders had taken significant steps towards building a framework for self-sufficiency in aquaculture production and sustainable fisheries management. One measure of their current success under the CRSP model is evidence of the multiplier effect already at play. A number of CRSP trainees are now conducting their own workshops and demonstrations and training fellow stakeholders in the adoption of modern, sustainable techniques for improving productivity and income.

Wu Zongwen, a CRSP Chinese collaborator, shows DNP personnel, Békaye Tangara (center, back), Dr. Héry Coulibaly (center, front), and Alhassane Touré (right front), a sample of zooplankton on which catfish feed.

For more information, contact Dr. Héry Coulibaly, Lead Coordinator for the AquaFish CRSP Regional Center for Excellence in West Africa, at <herycoulibaly55@yahoo.fr>.

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Success Story

AquaFish CRSP: Sustainable Aquaculture and Fisheries for a Secure Future

No. SS-4 May 2011

A Native Fish Moves Towards Aquaculture

Farmed Snook Promises a New Livelihood for Mexican Fishers

"We need to increase the population in the wild. They're overfished. There has also been a lot of habitat degradation from cutting down mangroves and from oil refineries and wells."

— Kevin Fitzsimmons, AquaFish CRSP researcher

Along the shores of the Gulf of Mexico, declining fish stocks are causing the incomes of Mexican fishermen to plummet. One of these native fish is snook, a popular sport fish and lucrative catch for commercial fishermen. These days local fishermen are lucky if they net any. Ramón Dominguez Sánchez, president of a local fishing cooperative in Jalapita, Mexico would like to see this change. He and the coooperative are ready to become fish farmers just as soon as AquaFish CRSP researchers at the Autonomous Juarez University of Tabasco bring snooks into aquaculture.

Known as *robalo* in Spanish, snooks include several species found in coastal waters from Florida to Brazil. As the most expensive food fish sold in Mexico, snook rank as the country's eighth most important aquatic product in dollar value. Thus, the economic incentive for keeping a healthy fishery is strong. "We need to increase the population in the wild. They're overfished. There has also been a lot of habitat degradation from cutting down mangroves and from oil refineries and wells," says Kevin Fitzsimmons, a lead AquaFish CRSP researcher at the University of Arizona.

Ramón Dominguez Sánchez has fished for 40 years. With declining fish stocks, he is ready to start an aquaculture business to raise and sell snook.

CRSP researchers plan to boost wild populations by breeding snook in captivity. To replenish wild stocks, the university in Tabasco plans to sell fingerlings to the government for release into coastal lagoons and rivers. To help impoverished fishermen, it also aims to supply fingerlings to fishermen-turned-fish farmers whose entry into aquaculture will reduce pressures on the threatened fishery while promising them a more stable income source.

Getting snook to breed and survive in captivity has involved several major hurdles. With the cooperation of local fishermen, the CRSP team first obtained healthy wild adult fish for hormone testing to find the right dosage to induce them to spawn. Despite the stresses of being in captive surroundings and handled for hormone treatment,

Reduced catches of wild snook are threatening the livelihood of this fisherman. In the poor, isolated fishing communities along the Southeastern coast of Mexico, the artisanal snook fishery is a primary income source.

CRSP researchers keep breeding stocks of snook in open-air pools at a coastal facility in Jalapita, Mexico. Members of the local fishermen's cooperative helped initiate UJAT's project to bring snook into aquaculture.

some of the fish settled into their natural breeding behavior and spawned. But, getting the tiny larvae to survive presented additional challenges. Each experimental hatch died within eight days. Autopsies revealed empty stomachs. The explanation proved simple: researchers had been feeding the larvae food that was too big for their mouths.

The annual catch of snook reached 8,000 metric tons in 2008, earning more than $25 million for Mexican fishermen. At market, snooks bring in one of the highest prices for fish vendors.

Again, local fishermen played a key role in finding a solution. They collected water samples and snook larvae from nearby spawning grounds. Using these samples, researchers were able to identify the natural, small-enough sized plankton that tiny snook would normally eat in the wild. With this information, the CRSP team is now on its way to developing a customized diet to nourish young fish produced in captivity until they are large enough to feed on more conventional fish feeds.

"It's a challenge," says Wilfrido Contreras-Sánchez, the lead Mexican investigator conducting the research. "Not much is known about snooks. There are still many questions." But the time is getting closer for Dominguez Sánchez and other fishermen who are depending on CRSP scientists to open new income opportunities with snook aquaculture and a way to rebuild the wild fishery.

To view an AquaFish CRSP video on the snook breeding project at UJAT, see www.aquafishcrsp.oregonstate.edu/video/index.php?video=2

Photos by Tiffany Woods, Oregon State University

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Success Story

AquaFish CRSP: Sustainable Aquaculture and Fisheries for a Secure Future

No. SS-5 June 2011

Reduced Feeding Strategies Lower Production Costs

CRSP Research Helps Tilapia Farmers in the Philippines Increase Profits

"We are developing technologies and building capacity to enhance the cost effectiveness of producing tilapia in the Philippines. The purpose is to improve the incomes and livelihoods of small-scale tilapia farmers in the Philippines who largely depend on fish as a primary source of dietary protein."

—Russell Borski, AquaFish CRSP researcher

Rapid growth of aquaculture in the Philippines is partly due to the availability of high-quality manufactured feeds. Photo by Jim Bowman

In the Central Luzon region of the Philippines, many smallholder family farms raise tilapia on a commercial scale in semi-intensive aquaculture systems. For this form of culture, the natural food in the ponds is not sufficient to support a large population of fish being grown for commercial markets. Farmers initially stock their ponds with fingerlings and add fertilizer on a regular schedule to promote growth of the plankton, algae, and bottom-dwelling invertebrates that nourish the tilapia. Farmers supplement this natural diet with manufactured feed designed to promote maximum growth. Depending on the farmer, supplemental feeding starts sometime in the period between 30–45 days after stocking. Since commercial fish feed represents 60–70% of production costs, it has a significant influence on the profitability of these small farm enterprises. To stay competitive, Filipino farmers are relying more heavily on commercial fish feed. With rising feed costs, declining profit margins threaten their livelihoods from aquaculture.

For a number of years, AquaFish CRSP researchers at Central Luzon State University (CLSU) have been working on reduced feeding technologies to control management costs without compromising marketable fish production. Their goal has been to develop a variety of options that allow farmers to select the cost-cutting strategy that best suits their individual farm situation and production approach.

According to Russell Borski of North Carolina State University, the Lead US PI for this AquaFish CRSP project, "We are developing technologies and building capacity to enhance the cost effectiveness of producing tilapia in the Philippines. The purpose is to improve the incomes and livelihoods of small-scale tilapia farmers in the Philippines who largely depend on fish as a primary source of dietary protein."

AquaFish CRSP investigators at CLSU have developed three categories of reduced feeding strategies for supplemental feed inputs: (1) delayed onset—lengthening the period before supplemental feeding is started, (2) subsatiation—feeding below the traditional recommended daily feeding level, and (3) alternate day—feeding fish on alternate days at 100% satiation levels. Using any one of these, farmers can reduce their overall supplemental feed costs without a net reduction in marketable fish yields. Local farmers have collaborated with the CRSP team to test reduced feed strategies in on-farm conditions. These trials have successfully shown that each strategy offers a viable cost-cutting approach by which to improve profit margins. The following cost and profit data are based on simple cost-return analyses of the on-farm trial results:

- Delaying the onset of supplemental feeding to a period greater than 45 days, but no more than 75 days, reduces the overall amount of commercial feed over the shortened supplemental feeding period. A 75-day delay can lower total fish feed inputs by 37% for a $500/ha profit increase over that obtained when supplemental feeding is started at 45 days after stocking.

- Feeding at the 67% subsatiation level, farmers can lower production costs by $500/ha, increasing profits by $900.

- Reducing feed inputs to the 50% subsatiation level can raise profits to $1300/ha versus $14/ha at the 100% daily ration. Total supplemental feed inputs across the growout period can be cut by 56%.

- Feeding tilapia on alternate days at the recommended daily supplemental feed ration (100% satiation) can lower feed inputs by over 50%. A $556/ha profit is realized versus a $448/loss with daily feeding at a full ration.

Jason Isais, a CRSP graduate student at CLSU, measures out pelleted tilapia feed for a reduced feeding trial. Photo by Remedios Bolivar.

Large, market-sized tilapia can still be produced when farmers follow reduced-feeding strategies.

Interestingly, the CRSP team has found that using a combination of delayed onset supplemental feeding and reduced feed rationing (i.e., subsatiation or alternate day feeding) proves less cost-effective than following any one of these strategies individually.

Reduced feeding strategies also carry additional benefits. Under reduced feeding regimes, tilapia will convert a greater portion of feed to body weight without any adverse effect on their survival rates than they do under a 100% daily ration regime. The bottom line for farmers is a considerably lower production cost for fish yields comparable to those under standard feeding practices. The reduced feed inputs also lead to lower waste production and thus improved water quality, which brings with it an indirect cost benefit.

More recently, the CRSP researchers have shown that elimination of fishmeal, whose cost has risen considerably over the years, from manufactured diets can produce further costs savings for farmers, reducing feed costs by 8% over and above the > 50% savings obtained with the alternate-day feeding strategy.

To assist farmers in their decision making to select the best option for their farms, AquaFish CRSP has produced English-language podcasts with technical guidance on each of the reduced feeding strategies. There are also Tagalog versions available for the alternate-day feeding and 50% subsatiation feeding strategies. Download the podcasts from the website at: www.aquafishcrsp.oregonstate.edu/publications.php.

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Success Story

AquaFish CRSP: Sustainable Aquaculture and Fisheries for a Secure Future

No. SS-6 June 2011

Fish Farmers Symposium & Trade Fair In Uganda

An Annual Forum Where Fish Farmers Learn and Share

"One can make money from fish farming if it is done right."

— Fish Farmer Participant, 2011 Study Tour

WAFICOS member Rhona Buwule of the Edhron Fish Farm pauses for a photo during a pre-harvest pond sampling of tilapia ready for market. She and her husband run a successful family aquaculture business that includes value-added processing of catfish. Photo courtesy of Nelly Isyagi.

With the annual Fish Farmers Symposium & Trade Fair, fish farmers in Uganda have a unique opportunity to network, learn new skills, and check out the latest in aquaculture equipment and products. Stakeholders all along the aquaculture value chain are invited to attend. In its 4th year, the event is sponsored by the Walimi Fish Farmers Cooperative Society (WAFICOS) with USAID support. AquaFish CRSP helped organize the 2010 and 2011 symposia and related study tours.

The symposium serves as a forum for exchanging information, sharing experiences, and working out practical solutions to current production challenges. An array of technology demonstrations and product displays greet visitors at the concurrently running trade fair where inputs and farmed fish products are also for sale.

One of several fish farmer associations in Uganda, WAFICOS is a successful service model for the Uganda aquaculture sector. Since its creation in 2004, the association has grown to over 300 members mostly from central Uganda. Its membership covers the spectrum of the aquaculture sector — grow-out farmers, fish seed producers and breeders, feed manufacturers, suppliers, processors, extensionists, and researchers. Members have access to technical advisory services, affordable input supplies, and equipment rentals. A major thrust of the Society's outreach services is the annual symposium/trade fair.

Aquaculture in Uganda has been practiced largely at a subsistence level, with a poorly functioning marketing system. WAFICOS started during a critical transition period when Uganda was turning to aquaculture to fill the gap created by a declining wild fishery unable to keep up with growing supply demands. The need for a rapid scale-up of farmed fish production along with an improved marketing infrastructure presented daunting challenges at all levels of the aquaculture sector. As WAFICOS has grown in size and services to meet these challenges, it has become a valuable partner in the government's efforts to build a competitive and profitable aquaculture economy.

USAID initially offered development assistance to WAFICOS through its Fisheries Investment for Sustainable Harvest (FISH) Uganda program, which operated from May 2005 to November 2008. As the lead US partner institution under that program, Auburn University helped WAFICOS start the annual symposium/trade fair event, using it to showcase the FISH program's model fish farms and production technologies. Since 2009, Auburn University has continued in its organizational

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role under the AquaFish CRSP umbrella. Additional USAID funding in 2010 and 2011 was provided through the LEAD-Uganda project (Livelihoods and Enterprises for Agricultural Development). With AquaFish CRSP and FISH guidance, the symposium/trade fair has developed into a self-sustaining event. WAFICOS is expanding the symposium's focus beyond central Uganda, attracting participants nationwide as well as from the neighboring countries of Kenya and South Africa.

WAFICOS Chairman Paul Ssebinayansi (left) and Executive Committee Member Mary Zaramba (right) preside at the lively 2011 symposium session on "How I Sold my Fish at a Loss." Mrs. Zaramba started with her story on "thousands of dollars" lost in sales, all for a lack of marketing experience when she and other WAFICOS farmers attempted to sell their fish in DR Congo. Photo by Suzanne Njeri, Kenyan Fish Farmer.

By polling symposium attendees about their criticial issues, WAFICOS customizes the next year's agenda to address current needs. Among the popular topics that were requested for the 2011 symposium were feeds and feeding guidelines, enterprise budgets, farmer-based value addition and marketing, input requirements, and financing. Along with these topics, the 2011 attendees found the farmer-led discussion, "I sold my fish at a loss," a valuable practical exercise. This session, which moved between laughter and serious discussion, epitomizes the symposium model for networking and experience-based information exchange. Participants shared stories of their mistakes, what they learned, and ideas for steps to take to avoid business failures from fish production to marketing. Farmers and service providers collectively acknowledge this type of dynamic, interactive focus as one of the symposium's most beneficial features.

In 2010, CRSP helped expand the demonstration component to include an optional one-day study tour. To meet a broader range of interests, WAFICOS added two additional tours in 2011. On the tours, participants visit farms, hatcheries, processors, suppliers, and research institutions for demonstrations of production technologies and farmer-based, post-harvest handling and product value addition. Also new in 2011 was a three-day tour for 11 Kenyan farmers, two of whom had attended the symposium. The comments of one farmer illustrate how well the study tours fulfill the WAFICOS capacity building objectives: "I have learnt pond construction, designing and maintenance. I realize now how pond water depth, productivity and water quality are critical and these remain critical challenges for most upcoming farmers."

The annual symposium events are a key element in the success of the USAID-WAFICOS partnership. Adoption rates of innovative technologies and best management practices presented at the symposia are on the rise as is the improved business status of farmers. Leveraging on the goodwill created by the symposium's accomplishments, WAFICOS has been able to establish strong collaborative relationships with other institutions working to build a sustainable aquaculture sector in Uganda.

For WAFICOS, the "Walimi" in its title (the Swahili word for "farmers") stresses the Society's overall focus on strengthening the structure of the aquaculture sector through fish farmer members and other stakeholders along the value chain. This goal matches with those of AquaFish CRSP to enrich livelihoods by helping small-holder farmers, processors, and other market players to raise fish for food and income. As captured in the words of one enthusiastic farmer participant, "One can make money from fish farming if it is done right."

Student interns learning how to seine a pond at the Blessed Investments Ltd fish farm. The young woman pictured here illustrates the success of women in Ugandan aquaculture where their numbers are increasing in farm ownership and skilled positions. Photo courtesy of Nelly Isyagi.

Symposium Proceedings and reports are at: http://symposium.x10hosting.com/

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Activity Brief

AquaFish CRSP: Sustainable Aquaculture and Fisheries for a Secure Future

No. AB-1 Feburary 2010

CRSP Leads Kenya Toward a Sustainable Aquaculture and Fisheries Economy

Since 1997, the Aquaculture CRSP (ACRSP: 1997-2007) and Aquaculture & Fisheries CRSP (AquaFish: 2007 to present) have partnered with Kenyan institutions such as Moi University and the Kenya Department of Fisheries (DOF) to develop aquacultural systems that better serve the country's rural poor. This CRSP-government partnership is expected to further expand under Kenya's first *Oceans & Fisheries Policy*, announced in April 2009 by the Kenya Ministry of Fisheries Development. A newly established Aquaculture Directorate—one of four created in the Fisheries Department—has a promising 2009 budget of $16 m, a first-time allocation for aquaculture. These monies are currently dedicated for a country-wide building enterprise of small-scale ponds as well as developing hatcheries, expanding technical training, and improving seed and feed production. With the ability to draw upon a well-established record of collaborative successes, CRSP and CRSP-trained Kenyans will be in a pivotal position to help implement these goals for growing the freshwater aquacultural subsector.

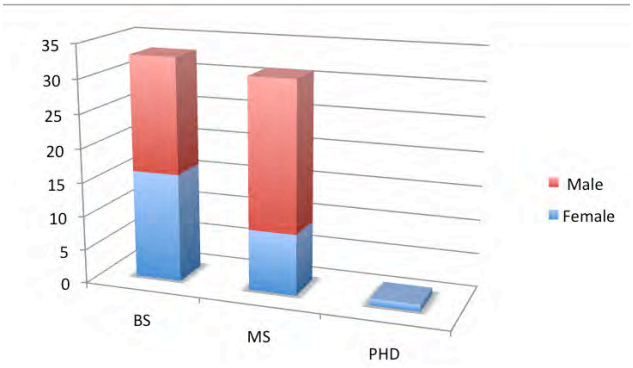
Capacity Building

CRSP activities in Kenya have engaged stakeholders at all levels—from farmers, fishers, and small entrepreneurs to extensionists, researchers, and government policymakers. Through targeted outreach and training programs for fishers, farmers and fisheries officers, CRSP has brought new technologies to rural communities and helped build the support structure for extension services. A doubling in the number of Kenyan fish farmers to over 4500 and substantial increases in farmed fish production—from less than 1 t in 1996 to 4 t by 2006 (DOF data)—verifies the robustness of the CRSP development model. Farmers adopting CRSP technologies and management practices designed for their local farm conditions have already begun to experience dramatic yield increases. In two different sets of on-farm trials in central and western Kenya, participating farmers saw yield increases of 330% (from 1 to 3.5 t ha- 1) in 2000 and of 420% in 2001.

A local Kenyan vendor, who has benefited from AquaFish CRSP market trainings, offers farmed tilapia at an open-air market in the western Kenyan town of Luanda. She can sell her tilapia for a higher price since it is dried, a value-added feature that helps generate additional income. (photo by Charles Ngugi)

CRSP-trained Kenyans Enos Mac'Were and Bethuel Omolo assist a Dominion Farms worker in inspecting tilapia cages at the company's site on Lake Kanyaboli. Mr. Mac'Were is currently in charge of aquaculture operations for Dominion Farms and also works as an aquaculture consultant in Kenya and Uganda. Mr. Omolo currently serves as the Head of Station at the Bungoma District Fisheries Office, Kenya. (photo by Jim Bowman)

Graduate and undergraduate education has been another focus of CRSP training efforts in Kenya. Since 1999, 65 Kenyan students have graduated with degrees in aquaculture studies from six Kenyan institutions and two US Universities. The majority of these students—22 women and 31 men—attended Moi University, the principal Kenyan educational institution collaborating with the CRSP program. CRSP-trained graduates have



CRSP-trained Kenyan students have graduated from aquaculture programs with BS (33), MS (31), and PhD (1) degrees. Women graduates represent 40% of the overall student population. In addition to Moi University, students have attended Kenyatta University (1), Mombasa Polytechnic (1), Murang'a College of Technology (1), Nyanchwa University College of Science and Technology (1), University of Nairobi (5), Auburn University (1), and University of Georgia (2).

entered the aquacultural subsector at various levels. As government employees, some are forming a well-trained workforce of policy makers, fisheries officers, and extensionists whose expertise is essential for developing rural aquaculture. Others are proving instrumental in laying the groundwork for a robust business economy in their career roles as entrepreneurs, consultants, and employees of aquaculture companies.

Aquaculture Research

AquaFish CRSP is building on the earlier sucesses of the ACRSP as it broadens its development focus. Under ACRSP, the basics of small-farm production were at the forefront with emphasis on pond construction, pond fertilization, feed formulations and feeding regimes, improved "seed" production, and polyculture of Nile tilapia and African catfish. Much of this work is captured in the 2007 CRSP publication *A New Guide to Fish Farming in Kenya*, a primer on the basics of tilapia and catfish farming. Co-authored by Kenyans Charles Ngugi and Bethuel Omolo and US CRSP researcher James Bowman, it is recognized as a useful how-to training guide for tilapia farming in Africa.

Research activities in production technologies and watershed management have also formed an integral component of CRSP's locally directed development work. Kenyan researchers, graduate students, and their US

Spotlight on CRSP Graduates

GOVERNMENT

Wilson Maina, Acting Director of Aquaculture in the Ministry of Fisheries Development, hands a copy of the Ocean & Fisheries Policy to CRSP researcher Jim Bowman. A CRSP-supported student at the University of Nairobi, Mr. Maina received his MS in 1999. He has since successfully advanced in his career, moving from his initial position of Fisheries Officer to Principal Fisheries Officer and recently to his current position at DOF.

ACADEMIA

Leah Cherop completed her CRSP-supported MS degree at Moi University in 2005. She decided on an academic position in aquaculture. After serving two years as a part-time lecturer at Moi, Ms. Cherop joined the faculty in the Department of Fisheries & Aquatic Sciences where she is now planning to pursue a PhD.

PRIVATE ENTERPRISE

James Mugo currently works as the Manager of the Mwea Fish Farm, a private business that focuses on production quality tilapia and catfish seed. Mr. Mugo started in aquaculture as a fish farm manager after completing his BS degree. When he started his MS in 2005 at Moi University, he took over management of the University's fish farm. CRSP recently funded Mr. Mugo to train fish farmers in Mali and Tanzania on pond construction and catfish propagation techniques.

CRSP trainees attending a 2005 hatchery management course held at the Moi University Fish Farm prepare a "hapa" (a fine-mesh net-cage) for receiving catfish fry for nursing until they are old enough to be released into the open pond. (photo by Jim Bowman).

collaborators have been working to improve fingerling production techniques for African catfish, identify feeding regimes that will promote reproductive success of Nile tilapia brood fish, and determine stocking ratios for Nile tilapia-African catfish polyculture. With the completion of ecological and hydrological assessments of the Nzoia River Basin, they also have initiated the establishment of baseline data for sustainable management of this major watershed. Located in western Kenya, the Nzoia River flows into Lake Victoria and traverses a region populated by over 1.5 million people.

This record of CRSP work represents a significant scientific accomplishment both in its graduate student research training and its contributions to a growing Kenya-based research record. Through this multifaceted approach, CRSP is developing a strong local research expertise in aquaculture and freshwater fisheries which Kenyans can directly apply to their efforts to improve the lives of the rural poor.

ACRSP also spearheaded a collaborative effort that partnered two US institutions—Oregon State University and Auburn University—with Kenya's Department of Fisheries and Moi University to develop the aquaculture facilities at Moi and Sagana Fish Culture Farm into regional research and training centers. CRSP funding helped Sagana to develop into one of Kenya's top aquacultural research and training centers, a status reflected in its new name—Sagana Aquaculture Centre.

With a fundamental production structure now in place, AquaFish CRSP is turning its attention to strengthening the farm-to-market economic component to better serve the growing producer population. In this regard, CRSP has partnered with the USAID-KBDS (Kenyan Business Development Services program) to develop supply chain and group marketing systems for pond-raised African

US CRSP researcher Karen Veverica provided much-needed basic aquaculture training for officers of the Kenya Fisheries Department, beginning soon after CRSP initiated its Kenya project in 1997. Here participants in a 2000 short-course learn about post-harvest processing of cultured tilapia. CRSP funding helped the former Sagana Fish Culture Farm, where the training took place, to develop into one of Kenya's top aquacultural research and training centers, a status reflected in its new name – Sagana Aquaculture Centre. (photo by Jim Bowman).

Fish farmers from western Kenya receive catfish fry for their ponds. This farmer group is one of several participating in a joint AquaFish CRSP and USAID-KBDS project that is creating a new market structure for farm-raised catfish fingerlings to reduce the threat to native stocks in Lake Victoria. The catfish fingerlings will be sold as bait to fishermen who earn their living on the lake, fishing for Nile perch (photo by Charles Ngugi).

catfish fingerlings to sell as baitfish to perch fishers on Lake Victoria. In developing both a new product and market, this project promises stable economic returns for farmers and vendors and a sustainable source of baitfish. On a larger scale, a viable market of farmed baitfish also represents a significant step towards protecting the lake's catfish populations which are under threat from overfishing of fingerlings.

Success in establishing a new farmed baitfish industry models the AquaFish CRSP program goals of integrating income generation opportunities with market access. In 2008, the baitfish project started off with six clusters in Kenya's Western Province, each with up to 10 members

and all close to the Lake Victoria market channels for catfish fingerlings. As of the end of 2009, 100 cluster farmers have attended CRSP trainings and production levels of fingerlings have reached 2,000 per day, supporting 20 traders along the lake shores. One cluster has grown to 25 members with nine women farmers among them, a significant accomplishment given the low number of female fish farmers in Kenya. Impressed with the CRSP baitfish clusters, the Women in Fishing Industry Project (WIFIP) has partnered with cluster farmers to train local women in fish pond construction and catfish breeding. Based at Lake Victoria, WIFIP is promoting aquaculture as a means of providing additional household income for women fish traders.

Kenyan researcher Charles Ngugi is one of the international CRSP experts collaborating on AquaFish CRSP's sustainable aquaculture and fisheries project in Mali. Here, during a February 2009 workshop, Dr. Ngugi (center) instructs Malian fish farmers, government fisheries officers, and extensionists in the basics of surveying techniques that they will use to lay out and construct fish ponds. (photo by Jim Bowman)

Regional and Local Focus

AquaFish CRSP is also helping to position Kenya as a major regional player in the development of Africa's aquaculture economy. Kenyan CRSP researcher Dr. Charles Ngugi of Moi University currently leads the CRSP's Regional Center of Excellence (RCE-Africa), whose charge is to offer technical expertise and foster collaborative partnerships across Africa and in particular with IEHA (Presidential Initiative to End Hunger in Africa) countries. Dr. Ngugi is actively developing ties with fellow African researchers and organizations such as SARNISSA (Sustainable Aquaculture Research Network in Sub-Saharan Africa), ANAF (Aquaculture Network for Africa), and NEPAD (New Partnership for Africa's Development). He is recognized as a regional expert, having recently contributed to SARNISSA's 2009 aquaculture status and policy reviews for Cameroon, Côte D'Ivoire, Ghana, Kenya, Malawi, and Uganda. Working beyond Kenya's borders, Dr, Ngugi is also a collaborator on the AquaFish CRSP Associate Award in Mali (2007-2010). Along with other AquaFish CRSP international partners from China and Kenya, he is training Malians in technologies and practices that will lead to a more sustainable freshwater aquaculture subsector in that country.

Within Kenya, the CRSP's RCE-Africa has collaborated with the Department of Fisheries to provide startup funding to the Aquaculture Association of Kenya (AAK), a new organization that actively promotes private-sector aquaculture. AAK Vice-Chairman William Kiama is a CRSP farmer-trainee who is a success story in his own right. A model fish farmer, he serves as an enthusiastic "aquaculture ambassador" both in Kenya and regionally. In March 2009, Mr. Kiama, Dr. Ngugi, and seven other CRSP-trained Kenyans—among them researchers, extensionists, and Department of Fisheries officials—participated in the FAO National Aquaculture Stakeholders Workshop which was held to develop a National Aquaculture Development Strategy for implementing *Kenya's Ocean & Fisheries Policy*. As a member of the Board of Directors for the government's Kenya Marine & Fisheries Research Institute (KMFRI), Dr. Ngugi is also positioned to contribute his broad experience in guiding KMFRI's activities to foster growth of the aquaculture subsector under the new policy. The important national roles taken by these CRSP collaborators and trainees illustrates the successful ripple effect of CRSP's former and on-going contributions to aquaculture development in Kenya and Sub-Saharan Africa.

At a Nairobi fish market, vendors sell tilapia as whole fish or as higher-priced value-added fillets. Native to Kenya, tilapia is as popular here as it is elsewhere throughout the world where it has become a major farmed fish species.

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Polyculture of Freshwater Prawn and *Mola* in Bangladesh

A Solution for Income Generation and Household Nutrition in Rural Communities

"BAU researchers have demonstrated 'Prawn-Mola' culture technology in my farm. I can now regularly feed my family with mola-curry and sell prawn in the market."

— Prawn farmer Israfil

Seining a Mola-Prawn pond in Fulpur, Bangladesh.

Bangladesh is a land rich in inland water resources that are suitable for the culture of many aquatic species, including the giant freshwater prawn, Macrobrachium rosenbergii. In response to the high export potential of this species, the government of Bangladesh has launched an initiative to increase prawn production to 60,000 mt in 80,000 ha of low-lying floodplains and homestead ponds over the next 10 years. A recent survey showed that annual prawn yields are in the range of 300-600 kg/ha, which is relatively low; however this production can be increased through improved management and diversification of technologies. All-male prawn culture may be one of the options for increasing production, however this needs clarification through on-station and on-farm trials comparing it with mixed- sex and all-female production.

The country also faces the dual challenges of feeding its own people and increasing export earnings through the development of new products. Culturing freshwater prawns for the export market together with the nutrient-dense small fish mola (Amblypharyngodon mola) for household consumption may be an innovative option. If mola and prawns can be cultured together, farmers will have the option of harvesting mola throughout the year for family consumption without affecting the production of the giant prawn cash crop. Mola, which grow to 15 cm in length and reproduce on their own, have been found to contain vitamin a and other essential micro-nutrients in concentrations up to 50 times higher than most fishes consumed by Bangladeshis. Mola are omnivorous surface feeders, a characteristic that can improve the culture environment for prawns through grazing on phytoplankton blooms and thus reducing oxygen deficiency problems. Moreover, mola feces are rich in bacteria and may serve as a good food source for prawns scavenging for detritus.

A collaborative project between Bangladesh Agriculture University (BAU) and the AquaFish CRSP was planned to develop a new sustainable polyculture technology for all-male freshwater prawns and mola to increase the average productivity of high-value prawns for export as well as to provide mola for household consumption. The project idea was conceived by the late Dr. Yang Yi during his last visit to Bangladesh, when he observed that prawns were being cultured as a monoculture in small-scale household systems, yet families were being deprived of fish for household consumption throughout the prawn culture period. Technical support for the new project was provided by Professor Jim Diana of the University of Michigan. The project was set out to address the following objectives:

- To compare growth and production performance of all-male and all-female freshwater prawn in pond culture systems; laden
- To evaluate the potential of addition of mola at different densities including the effects on pond ecology, production of freshwater prawns, and total production of both species in polyculture; and
- To understand the benefit of selective harvesting of prawn and partial harvesting of mola on production of cash crop and impact on family nutrition.

These objectives were addressed through a series of studies carried out at the Fisheries Field Laboratory of BAU. In addition, another polyculture technology including prawns, mola, and two carp species was tested at BAU and validated in rural farms in Fulpur Sub District, Mymensingh.

Nutrient-rich Mola harvested from a pond.

In these experiments, the production performances of all-male and all-female freshwater prawn in monoculture were evaluated simultaneously with the addition of mola stocked at different densities into polyculture with freshwater prawn. The addition of mola at different densities had no effect on survival, gain in weight, or production performance of freshwater prawn while providing a valuable additional product for home consumption. Therefore, mola may be stocked as an additional species with freshwater prawn that would give higher total production, provide family nutrition, and generate additional income.

In order to more fully utilize the production potential of the polyculture ponds, the effects of adding silver carp (Hypophthalmichthys molitrix) and catla (Catla catla) to the mola-prawn polyculture system were also evaluated. Net production of prawns was significantly higher with silver carp and with silver carp-catla, but not with only mola or mola-catla.

Giant freshwater prawns harvested from a polyculture pond.

In a third set of experiments, the effects of selective harvesting (at the appearance of blue claw) and claw ablation of blue-clawed prawns in the all-male prawn-finfish polyculture system were evaluated. In ponds stocked with all-male prawn, silver carp, catla, and mola, selective harvesting of prawns resulted in higher net production of freshwater prawns than either claw ablation or simple polyculture of these species. The combined net production of prawns plus fish was also higher when selective harvesting was done.

Polyculture of prawn with mola and small numbers of filter feeding carps like silver carp and catla may result in an ecologically balanced pond culture system, where synergisms take place that result in higher production of both prawn and fishes. Selectively harvesting from

all-male prawn populations results in higher production than culturing all-female populations or practicing other management options. Mola should be regularly partially harvested using a lift net or small seine net to keep their population under control and provide family nutrition year round. Prawn can sold at a higher price as export item to provide family income and thus serves as a cash crop.

Through this series of experiments, Bangladesh has developed an all-male prawn production technology and established that selective harvesting is a better management technique for increased prawn production. Through partial harvesting of mola, production and household consumption increase to improve family nutrition.

Freshwater prawn and mola culture technology has been widely accepted by extension agencies like DoF, WorldFish Center, and Winrock International for large scale dissemination using their countrywide networks. The technology has spilled over to West Bengal and Nepal and is in the process of expansion there. Through the efforts of BAU, the University of Michigan, and the AquaFish CRSP research team, the management of prawn culture in Bangladesh has progressed from one focused only on export sales to one including production for home consumption that is ready for large-scale dissemination to small-scale farmers. The new approach still provides a comparable income for farmers, yet provides household food as well. A training and extension manual in Bangla language has been prepared by the WorldFish Center with the technical assistance of the BAU research team for country-wide dissemination of the prawn-mola culture technology.

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Fish Farmer Models CRSP Best Management Practices

Improved Practices Save Money and the Environment

"While the BMP's help in improving on farm activities, they also contribute immensely to the effective regulation of waste disposal"

— Paul Osei Kwame, Oseibros Farms Company

For over 24 years Mr. Paul Osei Kwame has operated a successful 25-acre farm—Oseibros Farms Company Limited—in the Ashanti Region of Ghana. Originally running an integrated operation with poultry, crops, and maize grit extraction, Mr. Osei added aquaculture in 2008. Three years later, he now has 20 ponds where he raises Nile tilapia fingerlings for sale to other local fish farmers.

Mr. Osei is a farmer who believes in the application of science to agricultural production. He wants to "get it right" by learning and applying the best management practices in his fishponds. In 2009, Oseibros Farms was one of 12 farms that participated in an AquaFish CRSP water quality study that led to development of Best Management Practices (BMPs) for reducing the negative effects of pond effluent discharges into local streams. Participating CRSP institutions included Kwame Nkrumah University of Science and Technology (KNUST)and Virginia Polytechnic Institute and State University. Mr. Osei enthusiastically 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."

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

Under the AquaFish CRSP's new Feed the Future (FtF) project in Ghana, the focus of activities has turned from research to outreach with the initiation of on-farm BMP demonstrations in early 2011. The main objective is to demonstrate how increased profitability and environmental benefits can be simultaneously achieved in the production of all-male Nile tilapia. Mr. Osei readily agreed to participate in this activity, allowing Oseibros Farms to serve as one of six demonstration sites to test two BMPs to improve fishpond management—(1) floating fish feeds and (2) reusing "old" pond water. These new approaches combine profit-motivating practices with environmental benefits. Replacing sinking fish feed with floating feed reduces production costs by lowering feed waste from the loss of uneaten feed that sinks to the bottom of ponds. Reusing old water rather than refilling ponds with new water at the beginning of each new production cycle reduces input and labor costs. Preliminary data show positive results with savings from lower feed costs and improved production potential with better feed conversion. While the effect of old pond water on growth differences is still under investigation, reusing old water clearly reduces costs and thus makes sense from an economic standpoint.

Mr. Osei has fully embraced the CRSP model. His farm is a CRSP demonstration site for the Ghana FtF project. He has taken a leadership role in his local fish farming community with training on his farm as the focal point. Farmers can visit Oseibros Farms to learn about CRSP technologies or to attend workshops and trainings. Mr. Osei also hosts university student interns and sponsors outreach activities for elementary and secondary schools. To date, 15 PhD and MSc students from KNUST have visited or conducted research at the farm.

With higher profits from cost savings and a commitment to a lighter environmental footprint, Mr. Osei is further expanding his aquaculture operations. His farm is now producing tilapia breeding stock and table-size fish for sale to the local food markets. For the future, Mr. Osei plans to start fish farms at two other locations and process fresh fish on site, with an eye toward entry into the export market.

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CRSP Introduces Rice-Fish Culture to Malian Farmers

Hands-On Training Ensures Success

"Rice-fish culture has a bright future"

— Alhassane Touré, DNP Technical Officer

The landlocked West African country of Mali has one of the world's largest freshwater fisheries. Over 100,000 tons are caught annually from lakes and rivers largely situated in the southern regions of the country. Malians fish on a daily basis, consuming an estimated 10.5 kg per person each year. Even with over 700,000 fishers bringing in daily catches, the rising demand of both a growing population and expanding export markets is outstripping supplies. While Mali's economy is centered on agriculture and fisheries, crops and livestock are the major industries for marketable products and employment. Although a relatively small economic player, aquaculture is an emerging subsector. With declining wild fish stocks and the potential to tie into irrigated agriculture systems, fish farming is the next promising frontier for economic growth. For poor rural farmers who adopt the sustainable technologies promoted by AquaFish CRSP, aquaculture offers additional income and food security for their families and local consumer markets.

Mme. Diallo Madeleine BA, Minister of the Ministère de l'Élevage et de la Pêche, and her entourage of Malian farmers and government officials enjoy an enthusiastic explanation by DNP officer Alhassane Touré (to her left) of the rice-fish culture system on display at the farm of Mr. Mamadou Samaké.

From 2007–2010, AquaFish CRSP collaborated with Mali's Direction Nationale de la Pêche (DNP) on an aquaculture training and research program targeted directly at farmers, fishers, and extension support personnel. Funded under an Associate Award from USAID/Mali, the program included a rice-fish component for stakeholders in the inland delta region of the Niger River. Employing a South-South approach, CRSP Chinese experts from Shanghai Ocean University and the Network of Aquaculture Centres in Asia-Pacific collaborated with DNP personnel to hold hands-on workshops and set up field demonstrations to help local farmers successfully integrate aquaculture into their irrigated rice cropping practices. The project started in September 2008, with a training held in China for Malian extension personnel. Two DNP fisheries officers traveled to Shanghai for a short course led by Dr. Liping Liu and Dr. Wu Zongwen of Shanghai Ocean University. While there, Alhassane Touré (regional fisheries director of the Koulikoro Region) and Tiéman Traoré (fisheries service officer of Kati, DNP) visited field sites in Zhejiang Province, where rice-fish culture has been practiced for centuries. FAO has designed this area as a Globally Important Agricultural Heritage System. Timed during harvest, the farm visits gave the Malians a view of both traditional and modern rice-fish systems. Local farmers shared their experience, emphasizing the role that rice-fish culture plays in generating ecological, economic, and social benefits for their communities. Working with their Chinese trainers, Touré and Traoré developed a plan for adapting rice-fish culture to Malian rice production cycles and irrigation systems. Their goal was to

Tiéman Traoré and Liping Liu discuss rice-fish culture practices on display at a traditional farm in China, where the rice harvest is underway.

develop a low-cost technology using local techniques that would fit into the existing rice culture practices. Throughout the life of the project, the Chinese partners made frequent visits to Mali to assist with trainings and supervise the demonstration plots from pond construction through harvest.

Work in Mali began in June 2009. The Malian-Chinese team set up demonstration sites in four farmers' fields in the Baguineda irrigation area of Mali's Koulikoro Region. Following the DNP plan, farmers constructed fish ponds or sumps at the corners of their irrigated rice fields, connecting the pond to a system of water channels surrounding the field. To guard against flooding and fish escape, they raised the surrounding field embankments with the excavated soil. Once the rice seedlings were planted, the cooperating farmers stocked the ponds with Nile tilapia and African catfish fingerlings in August.

Four months later in mid November, the fish were ready for harvest. A celebratory event, Mme. Diallo Madeleine BA, Minister of the Ministère de l'Élevage et de la Pêche attended the first harvest at the farm of Mamadou Samaké, whose enthusiastic adoption of the new rice-fish technology raised him to the status of a model adopter for the rice producer community. Although modest by first world standards, the initial 115 kg fish harvest from Mr. Samaké's 0.084 ha rice field brought in US$121 in extra income. Extrapolated up to a hectare-size field, this first modest harvest was equivalent to 1360 kg of fish. For those farmers who have traditionally enjoyed a small fish harvest of wild fish (up to 25 kg) that have migrated into their irrigation channels, the promise of a formalized rice-fish culture is significant. In an impoverished country that ranks among the poorest in the world, this additional income is a significant profit for the average Malian farmer who typically earns only US$1500 for a year's work. As word of Mr. Samaké's success spread through the Baguineda rice producer community, the profit potential of rice-fish systems led 22 farmers to adopt the new technology for their fields in the 2010 season.

A DNP official inspects the fish sump of a completed rice-fish system near Baguineda.

With two trained extension personnel in place, CRSP sponsored four workshops in November 2009 and February 2010 for stakeholders at all levels. Ninety fish farmers, fishers, middlemen, traders, and government officers attended. Since Malian women are primarily involved in post-harvest activities, their 38% attendance (9 of 24 attendees) at the November 2009 fish processing workshop was significant. The trainings were designed to build capacity along the value chain and within the service sector in all aspects of aquaculture including production and post-harvest technologies, Best Management Practices, aquaculture techniques and systems, and government policy. Working side-by-side with their Chinese colleagues, Touré and Traoré led the workshops, exemplifying the CRSP model that stresses capacity building designed for local circumstances and needs and delivered by local experts.

By using a comprehensive training method that started at the top with extension personnel coupled with an international collaboration with Chinese experts, AquaFish CRSP successfully introduced rice-fish culture to Mali. The training program helped establish a dependable extension support system for farmers and provide stakeholders with a strong foundation on which to successfully build their livelihoods. The local focus, with a rice-fish culture system designed to fit Malian conditions, will ensure the continued growth and spread of this new, income-generating technology. The multiplier effect was in evidence early, with the success of Mr. Samaké's first fish harvest. As Alhassane Touré foresees the diffusion, the "Dissemination of the technology of rice-fish culture has a bright future in Mali…rice + fish = increased food security, food safety, environmental protection, increased incomes, and employment."

Trainees pose with their trainers for a post-workshop portrait outside the offices of the Office du Perimetre Irrigue de Baguineda (OPIB).

This research was made possible by the United States Agency for International Development (USAID) through the Aquaculture & Fisheries Collaborative Research Support Program (AquaFish CRSP) under Cooperative Award No. EPP-A-00-06-00012-00 and by participating US and Host Country institutions.

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CRSP Helps Fish Farmers Lower Feed Costs In Tanzania

Local Solutions Improve Profitability

"Availability of this locally sourced, low-cost feed will be a major step towards improving profitability of smallholder aquaculture enterprises in Tanzania."

— Dr. Kwamena Quagrainie, AquaFish CRSP researcher

The government of Tanzania looks to aquaculture as a viable enterprise for poor smallholder farmers, who can provide their families with much needed protein and also earn income from the fish they sell locally. Since 2003, AquaFish CRSP has collaborated with the Tanzanian Fisheries and Aquaculture Development Division and researchers at Sokoine University of Agriculture to help strengthen the aquaculture sector. An obstacle blocking growth of aquaculture is the high cost of fish feeds, particularly the feeds with high protein. Fortunately, local forage trees offer a promising low-cost solution. CRSP researchers are currently developing an affordable feed formulation using the leaves of Leucaena leucocephala and Moringa oleifera.

Farmers learn to make pelleted fish feed at a 2011 CRSP hands-on training session using simple meat grinder production technology. The feed mix contains maize bran and Moringa oleifera leaf meal as the protein components, both affordable, locally available ingredients that farmers can easily obtain. .

Tanzanian farmers raise Nile tilapia in earthen ponds. They fertilize their ponds with manure and compostable leaves to stimulate growth of the plankton that supply tilapia with much of their food. But to improve production potential of the tilapia crop, farmers supplement this natural food with fish feed. For most small farmers, this feed consists of rice and maize bran, kitchen leftovers, and garden remains. Low in protein and other essential nutrients, these plant-based feeds are insufficient for promoting rapid growth of marketable fish. But, higher quality commercial feed formulated with fishmeal or soybean meal is in short supply in sub-Saharan Africa and is too expensive for the average Tanzanian farmer. Also, producing fishmeal from wild-caught and other fish raises significant environmental and food security issues.

Kajitanus Osewe, Deputy Director of Fisheries & Aquaculture in the Ministry and emeritus Aquaculture CRSP investigator, finds the affordability of nutritious feeds to be a major hindrance to the development of the Tanzanian aquaculture industry. As Osewe sums up the current situation, "There is limited formulated feed available to fish farmers, and they are also expensive, which is a disincentive to aquaculture growth."

Leucaena and Moringa were originally introduced as forage for cattle, sheep, and goats that graze on their edible parts as they roam freely in and around Tanzanian villages and towns. Now they are now well established as inexpensive, local sources for quality livestock forage in Tanzania's subsistence farming system. According to Sokoine University investigator Dr. Sebastian Chenyambuga, these shrubby trees are ideal for the country's dry, tropical climate. "Leucaena leucocephala and Moringa oleifera are deep rooted and can access soil water and nutrients that are out of reach of most crops and forage species, and this enables them to produce and retain high-quality green forage throughout the year," says Chenyambuga.

The CRSP team at Sokoine University has partnered with researchers at the University of Arkansas at Pine Bluff to develop an affordable tilapia feed formulation using the readily available forage leaves. The goal is a nutritious, protein-balanced diet that farmers can prepare themselves. Ongoing CRSP studies are focusing on dietary elements such as digestibility the leaf meal as well as growth performance and survival of fish fed on experimental feed formulations. Preliminary studies show that these leaf meals can lower feed costs when substituted for up to 50% of the soybean feed component. Of the two species, Moringa appears to have the best nutritional potential. In recent experimental feed trials, CRSP researchers at Sokoine University found that tilapia fed with a formulation of Moringa and sunflower leaf meals have a higher growth rate than with standard fish feed formulated with soybean meal.

While a CRSP-supported MSc student at Sokoine University, Margareth Kibodya Mbwana helped with the laboratory analysis of Leucaena and Moringa leaf meals. In this particular test, she is determining their crude fiber content.

Building capacity through training is also an integral part of the AquaFish CRSP program in Tanzania. Since 2003, CRSP workshops in aquaculture basics have helped fish farmers improve their production and business management skills as well as profitability. The training focus is comprehensive covering an array of topics dealing with pond construction and management, fish reproductive control, fish feed and health management, record-keeping, and enterprise management. CRSP stresses a hands-on approach in its workshops and on-farm trials to ensure that farmers get practical experiences that they can directly apply to their operations.

Tilapia farmers Ramadhanim, Abdallah, and Chamirunda stand in a newly constructed earthen pond with a composting crib in the background for holding the dry manure used as pond fertilizer. As CRSP cooperators in a 2009 on-farm trial, they helped CRSP researchers test the tilapia-catfish predation culture technique in their small-scale farm conditions to verify its success in improving yield while controlling tilapia overpopulation.

To ensure that there is a network of aquaculture experts who can advise farmers, CRSP also supports graduate training. One of the CRSP student success stories is Margareth Kibodya Mbwana, who completed her MSc in Management of Natural Resources for Sustainable Agriculture at Sokoine University in 2011. Margareth is well on her way to realizing her professional goal to help build fish farming in Tanzania. In July 2011, she was selected as one of the two Tanzanian candidates to participate in CRSP's CAP (Certification of Aquaculture Professionals) intensive course held at Auburn University. As a trained technical advisor and role model for gender integration, Margareth will be an instrumental player in guiding both men and women producers in farm management and technology adoption.

Two CRSP-trained farmers, Amina Ramadhani and Abdallah Abdallah, embody the promise of a successful aquaculture sector. Fish farming is improving their livelihoods and the nutritional status of their families. They now raise their own fish for food and generate a small income from fish sales. For 2010, Amina reported earnings of approximately 450,000/= Tanzanian Shillings (≈ 280 USD). CRSP plans to enlist the help of farmer cooperators such as Amina and Abdallah to mentor fellow tilapia farmers in adopting the leaf meal feed innovation as well as other CRSP technologies.

The next phase of the sustainable feed project will see production of a formulated leaf meal feed by a pilot commercial operation to produce feed with locally grown leaf meals. As Dr. Kwamena Quagrainie of Purdue University, the US Lead investigator on the CRSP project, notes "Availability of this locally sourced, low-cost feed will be a major step towards improving profitability of smallholder aquaculture enterprises in Tanzania."

Standing on the bank of a CRSP-designed fish pond, Dr. Sebastian Chenyambuga (left) of Sokoine University discusses the benefits of CRSP training with fish farmers Abdallah Abdallah and Mrs Amina Ramadhani. Both farmers have improved their tilapia production by adopting CRSP pond construction techniques and production practices.

This research was made possible by the United States Agency for International Development (USAID) through the Aquaculture & Fisheries Collaborative Research Support Program (AquaFish CRSP) under Cooperative Award No. EPP-A-00-06-00012-00 and by participating US and Host Country institutions.

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BROCHURES AND FACT SHEETS

The ME has developed brochures and fact sheets that highlight AquaFish CRSP activities throughout the world from a broad, program-wide perspective. These materials can be found online at http://aquafishcrsp.oregonstate.edu/publications.php. Brochures and Fact Sheets include:

Brochures

- AquaFish Collaborative Research Support Program
- Supporting Ongoing Research in Africa: AquaFish Collaborative Research Support Program
- Supporting Ongoing Research in Asia: AquaFish Collaborative Research Support Program
- Supporting Ongoing Research in Latin America and the Caribbean: AquaFish Collaborative Research Support Program

Fact Sheets

- AquaFish CRSP Overview: Sustainable aquaculture and fisheries for a secure future
- AquaFish Collaborative Research Support Program (CRSP) Key Accomplishments

Regional Centers of Excellence

The AquaFish CRSP supports centers led by Host Country Principal Investigators in:

- **East and Southern Africa**: Dr. Charles Ngugi
- **West Africa**: Dr. Héry Coulibaly
- **Asia**: Dr. Remedios Bolivar
- **Latin America**: Dr. Wilfrido Contreras-Sánchez

Contact RCE Lead Coordinators at: aquafish@oregonstate.edu

Outreach

Publications
Peer-reviewed journal articles
Aquanews newsletter
Technical manuals
EdOp Net (employment & educational opportunities in aquaculture)

Workshops and short courses in aquaculture & fisheries topics

Long-term (degree) training and graduate fellowships

Podcasts of region-specific information to local farmers

Online resources

International conference sponsorship and student support

Linkages with other aquaculture and fisheries organizations worldwide

Donations of scientific references, textbooks, and journals to Host Country libraries

Gender integration across all projects

U.S. Partners

Oregon State University-Lead Award Institution
Alabama A&M University
Auburn University
Louisiana State University
Montana State University
North Carolina State University
The Ohio State University
Purdue University
Texas Tech University
The University of Arizona
The University of Michigan
University of Arkansas at Pine Bluff
University of Connecticut - Avery Point
University of Georgia
University of Hawai'i at Hilo
University of Rhode Island
Virginia Polytechnic Institute & State University

International Partners

Bangladesh Agricultural University, Bangladesh
Can Tho University, Vietnam
Central Luzon State University, Philippines
CIAD-Center for Research for Food & Development, México
CIDEA-Central American University, Nicaragua
Department of Fisheries, Guyana
Direction Nationale de la Pêche, Mali
FishAfrica, Kenya
Gulu University, Uganda
Hainan University, China
Huazhong Agricultural University, China
Inland Fisheries Research & Development Institute, Cambodia
Institute of Agriculture & Animal Science, Nepal
Kenyatta University, Kenya
Kwame Nkrumah University of Science & Technology, Ghana
Makerere University, Uganda
Ministry of Fisheries Development, Kenya
Ministry of Natural Resources & Tourism, Tanzania
Moi University, Kenya
National Fisheries Resources Research Institute, Uganda
Network of Aquaculture Centres in Asia-Pacific, Thailand
Nong Lam University, Vietnam
Shanghai Ocean University, China
Sokoine University of Agriculture, Tanzania
Southeast Asian Fisheries Development Center, Philippines
Stellenbosch University, South Africa
Ujung Batee Aquaculture Center, Indonesia
Universidad Autónoma de Sinaloa (Culiacán & Mazatlán), México
Universidad Autónoma de Tamaulipas, México
Universidad Juárez Autónoma de Tabasco (UJAT), México
Wuhan University, China

Photo Credits

Inside Panel: Fishermen returning from a night of fishing on the Tri An Reservoir in Vietnam. Photo by Van Man Tran, a CRSP MSc student at Can Tho University.

Outside Panel: CRSP US Lead PI Dr. Kwamena Quagrainie and CRSP graduate student, Jeanne Coulibaly, interview a Kenyan fish vendor about marketing farmed tilapia. Photo by Host Country Lead PI, Charles Ngugi

AquaFish

COLLABORATIVE RESEARCH SUPPORT PROGRAM

The AquaFish CRSP mission is to enrich livelihoods and promote health by cultivating international multidisciplinary partnerships that advance science, research, education, and outreach in aquatic resources.

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USAID FROM THE AMERICAN PEOPLE

OSU Oregon State University

December 2010

Aquaculture in our World

- Farming aquatic animals and plants has an ancient tradition with its earliest beginnings in China over 4000 years ago.
- Today, aquaculture products are the single most important source of dietary animal protein in many developing countries.
- Capture fisheries can no longer meet global food fish demand, which has tripled since 1990.
- Aquaculture and sustainable fisheries management offer the primary means for offsetting the widening gap between supply and demand.
- The number of people employed in fisheries and aquaculture has been growing steadily in low and middle-income countries, providing an important source of income for the rural poor

Source: Food and Agriculture Organization (FAO). 2009. State of World Fisheries and Aquaculture

Goals of the AquaFish CRSP

- Use innovative research to understand and remove constraints on fisheries and aquaculture development facing poorer countries.
- Build US and Host Country capacity in aquaculture and fisheries management to ensure long-term impacts.
- Improve resource management, income generation, and market access.
- Develop sustainable end-user level aquaculture and fisheries systems for poorer countries.
- Give the poor better access to well managed resources as a poverty eradication measure.
- Foster wide dissemination of research results and technologies to local stakeholders.
- Enhance Host Country self-determination and provide return benefits to the US.

Global Themes

The AquaFish CRSP brings together resources from US universities and Host Country institutions to target constraints facing poorer countries through four global themes:

Improved Health and Nutrition, Food Quality, and Food Safety

Environmental Management for Sustainable Aquatic Resources Use

Income Generation for Small-Scale Fish Farmers and Fishers

Enhanced Trade Opportunities for Global Fishery Markets

AquaFish Projects

Development of Alternatives to the Use of Freshwater Low Value Fish for Aquaculture in the Lower Mekong Basin of Cambodia and Vietnam: Implications for Livelihoods, Production and Markets
University of Connecticut - Avery Point; University of Rhode Island: Cambodia & Vietnam

Improving the Cost Effectiveness, Sustainability, and Income Opportunities of Aquaculture in The Philippines and Indonesia
North Carolina State University; The University of Arizona: Indonesia & Philippines

Improving Sustainability and Reducing Environmental Impacts of Aquaculture Systems in China, and South and Southeast Asia
The University of Michigan: Bangladesh, China, Nepal & Vietnam

Improving Competitiveness of African Aquaculture through Capacity Building, Improved Technology, and Management of Supply Chain and Natural Resources
Purdue University; University of Arkansas - Pine Bluff ; Virginia Polytechnic Institute & State University: Ghana, Kenya & Tanzania

Developing Sustainable Aquaculture for Coastal and Tilapia Systems in the Americas
The University of Arizona; Texas Tech University: Guyana & México

Human Health and Aquaculture: Health Benefits through Improving Aquaculture Sanitation and Best Management Practices
University of Hawai´i at Hilo; Louisiana State University; The Ohio State University: México & Nicaragua

Hydrology, Water Harvesting, and Watershed Management for Food Security, Income, and Health: Small Impoundments for Aquaculture and Other Community Uses
Auburn University; Alabama A&M; University of Georgia: South Africa & Uganda

Assessing the Impacts of CRSP Research: Human Capital, Research Discovery, and Technological Adoption
Oregon State University; Montana State University: all host countries

AquaFish Associate Award Projects

Aquatic Resource Use and Conservation for Sustainable Freshwater Aquaculture and Fisheries in Mali
Oregon State University: Mali

Enhancing the Profitability of Small Aquaculture Operations in Ghana, Kenya, and Tanzania
Oregon State University: Ghana, Kenya, & Tanzania

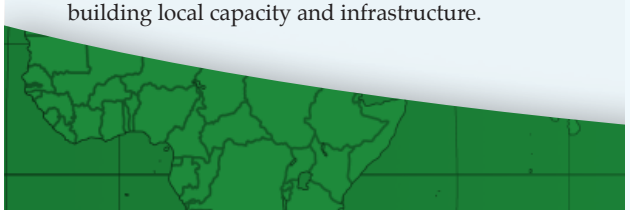
Feed The Future

The number of people suffering from chronic hunger totaled 925 million in 2010. In developing countries, vitamin and mineral deficiencies affect 1 out of 3 people. Such undernourishment severely impairs productivity and the physical and intellectual development of adults and children, thereby restricting their future earning capacity and perpetuating poverty. USAID is responding to this crisis with their global initiative, Feed the Future (FtF). As part of an overall strategic approach, FtF promotes actions that sustainably reduce global hunger and extreme poverty.

Our Commitment

In aligning our goals with FtF, AquaFish CRSP strives to improve the livelihoods of smallholder fishers and farmers by:

- Promoting development of regional government-led programs that honor locally identified needs in sustainable aquaculture and fisheries management.
- Mobilizing aquaculture resources through collaboration with international partners to strengthen the capacity of stakeholders.
- Implementing comprehensive approaches to improve nutrition through sustainable aquaculture development and fisheries management initiatives.
- Leveraging resources and investments to align US and Host Country development priorities and provide essential financial and technical support.
- Establishing benchmarks to gauge Host Country progress towards improving livelihoods and building local capacity and infrastructure.



Global Themes

AquaFish CRSP brings together resources from US partners and Host Country institutions to target constraints facing poorer countries through four global themes:

Improved Health and Nutrition, Food Quality, and Food Safety

Income Generation for Small-Scale Fish Farmers and Fishers

Environmental Management for Sustainable Aquatic Resources Use

Enhanced Trade Opportunities for Global Fishery Markets

U.S. & International Partners

Oregon State University- Lead Award Institution
Alabama A&M University
Auburn University
Direction Nationale de la Pêche, Mali
FishAfrica, Kenya
Gulu University, Uganda
Kenyatta University, Kenya
Kwame Nkrumah University of Science & Technology, Ghana
Makerere University, Uganda
Ministry of Fisheries Development, Kenya
Ministry of Natural Resources & Tourism, Tanzania
Moi University, Kenya
National Fisheries Resources Research Institute, Uganda
Purdue University
Sokoine University of Agriculture, Tanzania
University of Arkansas-Pine Bluff
University of Georgia
Virginia Polytechnic Institute & State University

Regional Centers of Excellence

The RCE is a support center that provides technical advice from a regional perspective.

For more information, contact the Lead Coordinators at aquafish@oregonstate.edu

RCE-East & Southern Africa—Dr. Charles Ngugi

RCE-West Africa—Dr. Héry Coulibaly

Sources:
Feed the Future. March 2011. <http://www.feedthefuture.gov/>
World Health Organization. March 2011. <http://www.afro.who.int/>

Supporting ongoing research in

AFRICA

AQUAFISH
COLLABORATIVE RESEARCH SUPPORT PROGRAM

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May 2011

Research Highlights in Africa

Regional Projects

AquaFish CRSP promotes integrative, crosscutting research to address the root causes of poverty and hunger through aquaculture development and fisheries management. Our projects are actively implementing USAID's FtF objectives to accelerate inclusive agriculture sector growth and improve the nutritional status of rural stakeholders. In Africa, these projects are:

Improving Competitiveness of African Aquaculture through Capacity Building, Improved Technology, and Management of Supply Chain and Natural Resources

US Lead Institution: *Purdue University*

US Partners: *University of Arkansas-Pine Bluff; Virginia Polytechnic Institute & State University*

Host Countries: *Ghana, Kenya, & Tanzania*

Hydrology, Water Harvesting, and Watershed Management for Food Security, Income, and Health: Small Impoundments for Aquaculture and Other Community Uses

US Lead Institution: *Auburn University*

US Partners: *Alabama A&M; University of Georgia*

Host Countries: *South Africa & Uganda*

Nutrition

Approximately 26 percent of Africa's children are currently malnourished. Tanzania is among the sub-Saharan countries that have embraced fish farming as a smallholder enterprise that can provide affordable protein to the poor. Tilapia, an indigenous African fish that is farmed worldwide, is a relatively easy fish for small farmers to cultivate. However, feed costs present significant budget challenges that impede aquacultural development in the rural communities that need it most. **To address this issue, Tanzanian researchers have developed a lower cost feed containing leafmeals derived from local leguminous tree species. These high-protein leafmeals replace the more costly soybean meal used in tilapia diets.**

A CRSP graduate student runs laboratory experiments to demonstrate that fats and proteins in local leafmeal make it a suitable and cost-effective protein alternative in fish feed.

Productivity

Aquaculture production in Africa increased by 56 percent in volume and more than 100 percent in value between 2003 and 2007. Despite this growth, most sub-Saharan nations are net food importers. Building a viable aquaculture economy requires improved access and integration into urban fish markets for small- and medium-scale commercial fish farmers. Through CRSP trainings, farmers are learning collective marketing techniques to plan production and manage supply and sales. **Kenyan baitfish farmers who have put these techniques to practice are serving as a regional model. Up the supply chain, new market opportunities are opening for the fish brokers and women vendors who sell the baitfish to Lake Victoria fishers.**

Farmers in Kenya and Ghana have learned group marketing and value chain management techniques to successfully sell in urban centers such as this Nairobi fish market.

Environment

Environmental degradation and water scarcity in Africa threaten inland fish production. At issue are the competing water needs of agricultural and aquaculture. Agricultural irrigation demands threaten productive freshwater fishery habitats. Effluent from poorly managed agriculture and aquaculture operations contaminate watersheds. Best solutions follow a cooperative model to manage community water supplies and conserve natural resources. **Ugandan researchers are modeling surface catchment using an integrated suite of software approaches to assess water availability and promote wetland protection. These tools will aid local decision makers in their efforts to sustainably utilize community water resources.**

Development of a water resource management center at Makerere University in Uganda is leading the way for regional cooperation in sustainable water usage for aquaculture.

Feed The Future

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Our Commitment

In aligning our goals with FtF, AquaFish CRSP strives to improve the livelihoods of smallholder fishers and farmers by:

- Promoting development of regional government-led programs that honor locally identified needs in sustainable aquaculture and fisheries management.
- Mobilizing aquaculture resources through collaboration with international partners to strengthen the capacity of stakeholders.
- Implementing comprehensive approaches to improve nutrition through sustainable aquaculture development and fisheries management initiatives.
- Leveraging resources and investments to align US and Host Country development priorities and provide essential financial and technical support.
- Establishing benchmarks to gauge Host Country progress towards improving livelihoods and building local capacity and infrastructure.

Global Themes

AquaFish CRSP brings together resources from US partners and Host Country institutions to target constraints facing poorer countries through four global themes:

- **Improved Health and Nutrition, Food Quality, and Food Safety**
- **Income Generation for Small-Scale Fish Farmers and Fishers**
- **Environmental Management for Sustainable Aquatic Resources Use**
- **Enhanced Trade Opportunities for Global Fishery Markets**

U.S. & International Partners

Oregon State University-Lead Award Institution
Bangladesh Agricultural University, Bangladesh
Can Tho University, Vietnam
Central Luzon State University, Philippines
Hainan University, China
Huazhong Agricultural University, China
Inland Fisheries Research & Development Institute, Cambodia
Institute of Agriculture & Animal Science, Nepal
Network of Aquaculture Centres in Asia-Pacific, Thailand
Nong Lam University, Vietnam
North Carolina State University
Shanghai Ocean University, China
Southeast Asian Fisheries Development Center, Philippines
The University of Arizona
The University of Michigan
University of Connecticut - Avery Point
Ujung Batee Aquaculture Center, Indonesia
Wuhan University, China

Regional Center of Excellence

The RCE is a support center that provides technical advice from a regional perspective.

For more information, contact the RCE-Asia Lead Coordinator Dr. Remedios Bolivar at aquafish@oregonstate.edu

Sources:
Feed the Future. March 2011. <http://www.feedthefuture.gov/>
World Health Organization. March 2011. <http://www.afro.who.int/>

Supporting ongoing research in

ASIA

AquaFish Collaborative Research Support Program

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May 2011

Research Highlights in Asia

Regional Projects

AquaFish CRSP promotes integrative, crosscutting research to address the root causes of poverty and hunger through aquaculture development and fisheries management. Our projects are actively implementing USAID's FtF objectives to accelerate inclusive agriculture sector growth and improve the nutritional status of rural stakeholders. In Asia, these projects are:

Improving Sustainability and Reducing Environmental Impacts of Aquaculture Systems in China, and South and Southeast Asia

US Lead Institution: *The University of Michigan*

Host Countries: *Bangladesh, China, Nepal & Vietnam*

Development of Alternatives to the Use of Freshwater Low Value Fish for Aquaculture in the Lower Mekong Basin of Cambodia and Vietnam: Implications for Livelihoods, Production and Markets

US Lead Institution: *University of Connecticut - Avery Point*

US Partner: *University of Rhode Island*

Host Countries: *Cambodia & Vietnam*

Improving the Cost Effectiveness, Sustainability and Income Opportunities of Farming Fish in the Philippines and Indonesia

US Lead Institution: *North Carolina State University*

US Partner: *The University of Arizona*

Host Countries: *Indonesia & Philippines*

Nutrition

Asia accounts for approximately two-thirds of the world's hunger. In rural Cambodia, poor women process small-sized, low-value fish caught in the Mekong River into a fermented fish paste known as prahoc. A key source of protein in regional diets, prahoc varies in quality and has a short shelf life that poses health and safety concerns, particularly for children. **CRSP researchers are training processors in best production practices for improved quality and food safety. Processors are also learning value-added product development and labeling and packaging standards that will help open new income opportunities.**

CRSP researchers organized the Women's Fermented Fish Paste Association in Cambodia's Siem Reap Province. Members of this first-time cooperative who adopt prahoc processing standards will have opportunities to move into regional and international markets.

Productivity

In Asia, aquaculture currently represents about 91 percent of world production. With rising population, aquatic food consumption is steadily increasing. Aquaculture is beginning to play a larger role in meeting demand and will continue to grow as wild fish catch rates decline. Rising production costs due in part to loss from feed wastage and high commercial feed prices already present challenges, particularly for small fish farmers in poor countries. **CRSP researchers in the Philippines are making significant strides in developing feed strategies that lower production costs. Working with tilapia, they have successfully tested lower-cost regimes to reduce feed inputs that farmers can now put into practice.**

CRSP researchers have found that a daily 67% subsatiation feeding strategy effectively reduces tilapia production costs. This low-cost regime maintains standard productivity levels when compared to a traditional 100% daily satiation regime.

Environment

Aquatic disease and environmental degradation raise concerns about the environmental consequences of aquaculture. Monoculture, commonly used for shrimp produced in the Philippines and Indonesia, is one practice known to threaten the region's coastal resources and ecological balance. Shrimp farmers recognize the need for sustainable practices to maintain a viable aquaculture sector that provides their livelihood. **CRSP researchers are training small farmers in Banda Aceh, Indonesia, in polyculture techniques that incorporate best management practices for controlling disease, mitigating damage to the ecosystem, and improving overall productivity.**

CRSP researchers have trained Indonesian farmers to incorporate seaweed into tilapia-shrimp polyculture, thereby reducing the negative environmental impacts on mangroves and water quality from traditional shrimp monoculture.

Feed The Future

The number of people suffering from chronic hunger totaled 925 million in 2010. In developing countries, vitamin and mineral deficiencies affect 1 out of 3 people. Such undernourishment severely impairs productivity and the physical and intellectual development of adults and children, thereby restricting their future earning capacity and perpetuating poverty. USAID is responding to this crisis with their global initiative, Feed the Future (FtF). As part of an overall strategic approach, FtF promotes actions that sustainably reduce global hunger and extreme poverty.

Our Commitment

In aligning our goals with FtF, AquaFish CRSP strives to improve the livelihoods of smallholder fishers and farmers by:

- Promoting development of regional government-led programs that honor locally identified needs in sustainable aquaculture and fisheries management.
- Mobilizing aquaculture resources through collaboration with international partners to strengthen the capacity of stakeholders.
- Implementing comprehensive approaches to improve nutrition through sustainable aquaculture development and fisheries management initiatives.
- Leveraging resources and investments to align US and Host Country development priorities and provide essential financial and technical support.
- Establishing benchmarks to gauge Host Country progress towards improving livelihoods and building local capacity and infrastructure.

Global Themes

AquaFish CRSP brings together resources from US partners and Host Country institutions to target constraints facing poorer countries through four global themes:

- **Improved Health and Nutrition, Food Quality, and Food Safety**
- **Income Generation for Small-Scale Fish Farmers and Fishers**
- **Environmental Management for Sustainable Aquatic Resources Use**
- **Enhanced Trade Opportunities for Global Fishery Markets**

U.S. & International Partners

Oregon State University - Lead Award Institution

CIAD-Center for Research for Food & Development, México

CIDEA-Central American University, Nicaragua

Department of Fisheries, Guyana

Louisiana State University

Universidad Autónoma de Sinaloa Culiacán, México

Universidad Autónoma de Sinaloa Mazatlán, México

Universidad Autónoma de Tamaulipas, México

University of Hawai'i at Hilo

Universidad Juárez Autónoma de Tabasco (UJAT), México

Texas Tech University

The University of Arizona

The Ohio State University

Regional Center of Excellence

The RCE is a support center that provides technical advice from a regional perspective.

For more information, contact the RCE-LAC Lead Coordinator Dr. Wilfrido Contreras-Sánchez at aquafish@oregonstate.edu

Sources:
Feed the Future. March 2011. <http://www.feedthefuture.gov/>
World Health Organization. March 2011. <http://www.afro.who.int/>

Supporting ongoing research in

LATIN AMERICA & THE CARIBBEAN (LAC)

AquaFish Collaborative Research Support Program

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USAID FROM THE AMERICAN PEOPLE

Oregon State University OSU

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Research Highlights in LAC

Regional Projects

AquaFish CRSP promotes integrative, crosscutting research to address the root causes of poverty and hunger through aquaculture development and fisheries management. Our projects are actively implementing USAID's FtF objectives to accelerate inclusive agriculture sector growth and improve the nutritional status of rural stakeholders. In LAC, current projects are:

Developing Sustainable Aquaculture for Coastal and Tilapia Systems in the Americas

US Lead Institution: *The University of Arizona*

US Partner: *Texas Tech University*

Host Countries: *Guyana & México*

Human Health and Aquaculture: Health Benefits through Improving Aquaculture Sanitation and Best Management Practices

US Lead Institution: *University of Hawai'i at Hilo*

US Partners: *Louisiana State University; The Ohio State University*

Host Countries: *México & Nicaragua*

Nutrition

With 53 million undernourished people, LAC ranks third in the world for chronic hunger. For coastal communities, shellfish are healthy foods high in protein and micronutrients that can help meet nutritional needs, particularly when other food sources are scarce. While there is general awareness of the need to carefully select and handle seafood, communities that rely on oysters and cockles—often consumed raw—are vulnerable to water-borne diseases caused by coliform bacteria. **In CRSP trainings, Nicaraguan cockle collectors, who are typically women, have learned when and how to collect cockles that are safe to eat and sell. By following shellfish sanitation standards, their market opportunities will grow.**

Cockle collectors in Nicaragua have learned essential skills to ensure the food safety of this important native shellfish consumed by their families and sold in local markets.

Productivity

LAC has the fastest growing aquaculture industry in the world, averaging a 21 percent annual increase between 1970-2008. This growth is largely due to advances in industrial-scale aquaculture aimed primarily at export markets. Yet aquaculture's role in regional markets remains vastly underdeveloped. As increasing challenges inhibit export market expansion, small-scale aquaculture shows promising potential for local markets. Integrated aquaculture and agriculture systems—aquaponics—is on the forefront of innovative technologies for smallholders. **CRSP researchers are developing sustainable aquaponics systems in México, which incorporate community needs and practices into resource conservation and food production.**

CRSP trainers helped the Lacadon Village Farmer's Cooperative in México set up an integrated aquaponics cropping system to produce crops and fish for local consumption and markets.

Environment

Shrimp and tilapia dominate the aquaculture industry in LAC, often at the expense of natural ecosystem health. Environmental damage to breeding grounds and overfishing of native species are also depleting wild-caught fisheries. CRSP research to introduce native species into aquaculture to replenish wild populations will both open new aquaculture opportunities for smallholder fish farmers and address natural resource conservation issues. **Méxican and US researchers are working on captive breeding techniques to create broodstocks of native snook, chame, and cichlid species. In the near future, aquaculture of these species will provide fish for the market and thereby reduce pressures on threatened fisheries.**

Captive breeding of chame, a food fish for the poor, offers promise for restocking wild populations being depleted by the fishmeal industry and for a new low-cost farmed fish.

AquaFish CRSP Overview

sustainable aquaculture and fisheries for a secure future

AquaFish Collaborative Research Support Program

- Managed by Oregon State University.
- Directed by Hillary S. Egna, PhD.
- Competitive award initiated by USAID in October 2006.
- Builds on previous CRSP program in aquaculture.
- Involves 17 US universities and 31 Host Country institutions in 20 countries.
- Linkages with over 200 collaborating international organizations and institutions.
- Leveraged nearly $7 for every USAID dollar.

CRSP Technologies for End-Users

- Hormone-eating bacteria eliminate hazardous residue of methyltestosterone from hatchery treatment water.
- GIS suitability maps help Ugandan farmers select earthen pond sites with better water capture and multi-use management.
- Seaweed-shrimp polyculture for Tsunami survivors in Indonesia reduces shrimp diseases, offers a new income source, and protects threatened mangroves.
- Successful breeding of snook in captivity heralds a new farming enterprise for Mexican fishermen losing their livelihoods to declining wild stocks.

Bringing Sustainable Fish Farming to Smallholders

- Culturing high-protein mola with export-value freshwater prawns feeds poor Bangladeshi families who profit from prawn sales.
- CRSP-trained Ghanaian farmers exemplify the ripple effect as they transfer basic skills in fish handling to fellow farmers, helping the country build a viable aquaculture sector.
- 2 local women's farmer groups in Guyana promote CRSP technologies in fish farming projects they set up in impoverished coastal and interior regions.

Improving Resource Management, Income Generation, and Market Access

- Filipino tilapia farmers increase profits with 50% lower feed costs from reduced feeding strategies.
- 33% of Vietnamese snakehead farmers use pelleted feed made with soybean meal replacing 30–50% whole wild-caught fish from the Mekong River.
- Kenyan baitfish farmers sell catfish fingerlings in six Lake Victoria markets to Nile perch fishermen, increasing farm income by 65% while helping to protect wild catfish populations.
- Policy recommendations to the governments of Cambodia, Mexico, and Nicaragua for sustainably managing productive fisheries.

Building Capacity: Training, Outreach, and Gender Integration

- 324 degree-seeking students (48% women): Bac (5); BS/BA (152); MS/MA (134); PhD (33).
- 7100 stakeholders trained in 219 short-term workshops and trainings sessions.
- 14 women's organizations and community groups worldwide collaborating to improve women's opportunities in all levels of the value chain.

Program Accomplishments

- Over 100 investigations conducted since inception in 2006.
- 120 peer-reviewed scientific articles published.
- International leader in training smallholders in improved fisheries management and aquaculture production.
- Reducing global hunger and poverty through innovative technologies and practices targeting local needs — food production for families and market access to build livelihoods.

Learn more at aquafish.oregonstate.edu

Enriching livelihoods and promoting health through sustainable aquaculture and fisheries management.

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AquaFish Collaborative Research Support Program (CRSP) Key Accomplishments

Since its inception in October 2006, the AquaFish CRSP at OSU has:

- Engaged 17 US universities in research and development activities in 19 Host Countries with 13 partners in Africa, 5 in Latin America, and 13 in Asia.
- Collaborated with over 200 international institutions and organizations located in 27 countries.
- Conducted 100 research investigations in aquaculture and fisheries; CRSP researchers have had 120 peer-reviewed scientific articles published.
- Developed 92 new technologies, management practices, and aquatic products — 40 of which have been transferred to farmers and agribusinesses.
- Improved aquaculture production on 9,800 hectares.
- Trained 7100 stakeholders from farmers and fishers to extensionists and government policy makers in 200+ workshops and hands-on trainings.
- Leveraged 7$ for every 1$ of USAID support.
- Supported the degree programs for 324 degree-seeking students (5 Bac; 152 for BS/BA, 134 for MS/MA and 33 for PhD) of 25 nationalities in the United States and Host Countries.
- Worked with 14 women's producers and community organizations to improve pond production and fisheries management, open new income opportunities in production, marketing, and processing, and ensure food safety and food security.
- Worked with local stakeholders along the value-chain in a variety of activities including on-farm and demonstration aquaculture trials, community management of fisheries, value-added processing, and group marketing, which offer hands-on experience that promotes successful adoption.

AquaFish CRSP strives to improve the livelihoods of smallholders along the aquatic resources value chain. In aligning our goals with the Feed the Future global initiative, these efforts include focusing on locally identified needs, mobilizing resources through international collaboration, improving nutrition through sustainable development, and leveraging resources and investments to align development priorities as well as provide essential financial and technical support. Our projects actively implement USAID's FtF objectives to accelerate inclusive agriculture sector growth and improve the nutritional status of rural stakeholders.

We believe that the USAID's Collaborative Research Support Program is critical to help build the human and institutional capacity of developing countries and are a cost-effective way to leverage the expertise of faculty at US universities, most of whom donate their time, for the benefit of developing countries and globalizing our future US workforce. CRSPs improve agricultural practices, address the food crisis, and help poor countries become more self-sustaining. In so doing, the CRSPs help achieve our national security goals with the countries in which they are engaged.

PRESS RELEASES FROM THE ME

Press releases from the ME written by Oregon State University journalists in cooperation with the Management Office, include:

- Bacteria on steroids: A new way to make water at tilapia farms safer?
- Hooking up snooks: Researchers are trying to bolster stocks of the lucrative snook, but getting the fish to 'do it' and then getting their kids to eat is no easy catch.
- Researchers aim to boost production of two native fish species in Mexico
- With U.S. help, Kenya aims to boost economy via fish farming
- Small-scale changes could make long-term improvements in Asian aquaculture
- USAID research increases profits for small-scale fish farmers in southeast Asia

Videos produced by the ME are available on the AquaFish CRSP website (http://aquafishcrsp.oregonstate.edu/video/) and include:

- Researchers use bacteria to break down sex-changing steroid.
- Researchers aim to bolster stocks of snooks.
- Tilapia research and public outreach improve Hondurans' diets and incomes.
- Researchers aim to boost production of two native fish species in Mexico.
- The AquaFish CRSP Kenya Baitfish Project: Making the Connections.

Bacteria on steroids: A new way to make water at tilapia farms safer?

By Tiffany Woods

Source: Wilfrido Contreras Sanchez

VILLAHERMOSA, Mexico – It's no secret that baseball stars, bodybuilders and cyclists have used steroids. Now it turns out that even bacteria get juiced.

Researchers in Mexico have found that three common species of bacteria have voracious appetites for methyltestosterone (MT), a potentially harmful steroid that fish farmers use to change the sex of tilapia. The discovery may eventually result in a safer environment for farm workers and nearby residents and wildlife. It has global implications given that tilapia is raised in more than 100 countries, according to the U.N. Food and Agriculture Organization.

Tilapia producers add methyltestosterone to the powdered food they dish out to large tanks of tiny tilapias called fry every day for three to four weeks to turn them into males. They want males because they grow faster than females and because having only one gender prevents reproduction. (Breeding makes the farmers' operation less cost-efficient.) The young tilapias swallow the steroid but then excrete it back into the water through their feces and urine.

Fish biologist Wilfrido Contreras Sanchez worries that MT residue might endanger the health of workers who wade into the water to scoop up juvenile fish. Also, many tilapia producers discharge the hormone-laced water from the tanks into streams, rivers and lagoons where it might harm other fish and amphibians, said Contreras, who heads the biological sciences division at the Autonomous Juarez University of Tabasco where the bacterial research was conducted. Additionally, the health of local residents who swim in or wash clothes in these bodies of water might be at risk, he said.

Contreras said little is known about how the use of MT in aquaculture might affect humans or wildlife. MT is an androgen and is prescribed to stimulate puberty in slow-developing adolescent boys and to treat breast cancer. The U.S. Food and Drug Administration has said that prolonged use of high doses of androgens has been associated with the development of liver cancer and that androgens may increase elderly people's chances of developing prostate cancer. High doses in women can lead to deeper voices, facial hair, acne and irregular menstrual cycles, the FDA said.

Contreras hopes that the bacteria he studied will eliminate potential hazards if added in sufficient amounts to the water filters in the tanks where the tiny tilapias dine on MT. They're naturally present in all fish culture systems (particularly in the filters) but not in large enough quantities to degrade the hormone, he said.

In lab tests, he and fellow researchers found that *Pseudomonas fluorescens*, which spoils milk, and *Bacillus ceresus*, the culprit of food poisonings, each removed 99 percent of the hormone after 20 days in flasks. Another species, *P.aeruginosa,* which can cause rashes, pneumonia, bladder infections and swimmer's ear and can even break down crude oil, devoured 97 percent of the hormone after 16 days in flasks.

Because the single-celled *P. aeruginosa* had multiplied rapidly in the lab, researchers selected it for the next leg of the experiment. They added billions of the bacteria to filters that used gravel and special plastic balls to clean the water of three 8,000-liter concrete tanks. The filters were inside plastic drums that stood on the edge of the tanks. Each tank held 5,700 young tilapias that were fed MT daily (The fish ate the MT before it was pumped into the bacteria-smothered water filters on the other end of the tanks).

The trial showed a trend toward lower levels of MT over time in the tanks where bacteria had been added versus the control tanks without bacteria, Contreras said.

He and his team plan to conduct more experiments to fine tune how many bacteria to use, what species or combination of species to use and how long to let them feast, Contreras said. If the kinks are worked out, the university hopes to grow mass quantities of whatever bacteria are finally selected and then sell the microorganisms to tilapia producers in the form of a concentrate, he said.

MT aside, the researchers uncovered something unexpected in their experiment. The fish in the tanks with *P. aeruginosa* weighed more than those in tanks without the bacteria. Some species of bacteria in aquaculture systems enhance growth, and *P. aeruginosa* may be one of them, Contreras said. Also, lab tests found no diseases in the kidneys, livers or spleens of fish raised in tanks with the bacteria. Because the bacteria are already ubiquitous and may be eaten by tilapias, Contreras doubts that they would cause any health problems, like infections, in people or fish.

The research was funded by Oregon State University, the University of Arizona, the Autonomous Juarez University of Tabasco, and the U.S. Agency for International Development through its AquaFish Collaborative Research Support Program.

Hooking up snooks: Researchers are trying to bolster stocks of the lucrative snook, but getting the fish to 'do it' and then getting their kids to eat is no easy catch.

By Tiffany Woods

Source: Kevin Fitzsimmons; Wilfrido Contreras Sanchez; Reynaldo Patino

JALAPITA, Mexico – The facility is part fertility clinic, part singles bar. It's tucked away on the beach in the sleepy village of Jalapita on Mexico's gulf coast amid coconut trees that stretch for miles. Under a blue sky, swimming pools bubble like hot tubs as palm fronds rustle in the warm breeze and tropical birds chatter. In one pool, four glistening, slender bodies eye each other across the water, their libidos artificially primed to put them in the mood.

This is where snooks come to hook up.

The fish are part of an experiment that aims to boost their population. Scientists at the Autonomous Juarez University of Tabasco in Mexico are trying to use these wild fish as a broodstock to crank out juveniles in captivity. The university aims to sell young snooks to fishermen-turned-fish farmers as a way to relieve fishing pressure on wild stocks. It also hopes to sell them to the government to release into coastal lagoons and rivers.

"We need to increase the population in the wild. They're overfished. There has also been a lot of habitat degradation from cutting down mangroves and from oil refineries and wells," says Kevin Fitzsimmons, a professor at the University of Arizona and former president of the World Aquaculture Society.

He's one of the participants in the snook project, which also involves Texas Tech University. The work is partially funded by the U.S. Agency for International Development through its AquaFish Collaborative Research Support Program, which is headquartered at Oregon State University.

This funny-named fish, known as *robalo* in Spanish, is the most expensive fish sold in Mexico City, according to the country's National Commission on Aquaculture and Fishing. Fishermen in Mexico earned more than $25 million for landing about 8,000 metric tons of snooks in 2008, making it the country's eighth most important aquatic product in terms of value, the commission reported.

Various species of snooks inhabit coastal waters, estuaries and lagoons from Florida to Brazil. A widespread one is the aptly named common snook, a silvery, streamlined, snouted carnivore with a dark lateral pinstripe and a bulldoggish underbite. These acrobatic fighters, which can reach 4 feet and 50 pounds, are highly prized by sport anglers. Fishermen in Florida and Texas used to catch snooks until those states banned commercial captures in 1957 and 1987, respectively, to protect the population.

"In Texas there's anecdotal evidence that they're making a comeback. Sport fishermen are finding them more often and in places where they didn't find them before," says Reynaldo Patino, the leader of the Texas Cooperative Fish and Wildlife Research Unit at Texas Tech University and one of the researchers involved in the project.

Efforts to influence what snooks do when no one is looking is complicated by their sexual plasticity. They're protandric hermaphrodites, meaning they can change from males into females. So far, researchers have had some success in getting them to breed in captivity, but getting their kids to eat has been a real head-scratcher.

"It's a challenge," says Wilfrido Contreras Sanchez, the lead investigator and the director of biological sciences at the university in Tabasco that's conducting the research. "Not much is known about snooks. There are still many questions."

To help answer those questions, he began contracting fishermen in Jalapita in 2006 to catch two species of snooks: fat and common. Researchers later injected some and implanted others with different doses of a hormone to induce spawning. They wanted to know which treatment and which dosage produced the most mature eggs and resulted in the highest rates of fertilization, hatching and larval survival. None of the injected fish released its eggs, and only some of the fish with the implanted hormonal pellets did.

Maria de Jesus Contreras Garcia, a graduate student helping conduct the research, suspects that stress, which can adversely affect reproduction, may be to blame. Human contact may have frazzled the fish because researchers injected the hormone into each of them on three different occasions, she says. They handled the fish with implants only once.

On one occasion, Contreras Garcia wanted to know how much time would pass between implantation and spawning so she and a colleague chaperoned three fish for 24 hours. They slept in a hammock and sofa bed in a makeshift house on the beach and set an alarm to sound every hour so they could alternate shifts. With flashlight in hand, she'd groggily lumber to the holding tank and scan the water for eggs. No luck.

Other snooks did spawn though. Almost all of the eggs hatched. But the tiny fish, still in their larval stage, lived for just eight days and were only about as long as the thickness of three stacked dimes. Autopsies revealed empty bellies. The food they were given, although microscopic, was too big for their small mouths, Contreras Sanchez says.

He thinks they might survive if fed the same diet that recently hatched wild snooks around Jalapita feast on. He plans to hire local fishermen to collect microscopic animal and plant plankton as well as snook larvae from nearby spawning grounds. Researchers will dissect their wee stomachs to see if the grub inside is the same as the collected plankton. They then hope to customize a recipe for a locavore diet that they can duplicate in mass quantities in the lab.

They'll also inspect snooks' stomachs, intestines and pancreases to identify enzymes that help digest their food. Certain enzymes break down certain substances, so if they can indentify the enzymes, they'll know what to feed the fish, Contreras Sanchez said. Additionally, they're continuing to refine their work with hormonal injections and implants to see if they get better results. And they've added a third species to their research, the Mexican snook.

About a mile up the road from the research facility, fisherman Ramon Dominguez Sanchez is eager for results. He's eating a mango from a tree in his dirt yard as two women scrub clothes by hand. A few feet away, one of his sons sits under the hood of a truck and replaces the fuel filter. It smells of gas.

The broad-shouldered, thick-necked, flip-flop-wearing Dominguez is the president of a fishing cooperative in Jalapita that would like to buy young snooks from the university, rear them and sell them. The sooner the co-op can do this the better because harvests, at least for him, are declining, says Dominguez, 54, who has been hauling in nets for 40 years. During the previous week he pulled in about $10 worth of fish but there wasn't a snook in the bunch, he says. So Dominguez wants to see the research succeed.

Perhaps it's this pressure to perform that's causing some of the snooks not to cooperate. Back at the beachside research station, the two couples that were checking each other out in the pool have lost interest. Apparently, they're just not that into each other. Researchers vow to keep trying though. Sometimes love just needs time.

With U.S. help, Kenya aims to boost economy via fish farming

By Jeff Hino

Source: Hillary Egna

CORVALLIS, Ore. - Aquaculture is helping jump-start Kenya's struggling economy, thanks in part to an international program led by Oregon State University.

Kenya is in the midst of rebirth: The East African nation signed a new constitution in August, and has launched an economic stimulus program that includes a novel $16 million effort to increase fish farm production from 1,000 tons in 2008 to 15,000 tons in 2012.

The initiative comes as natural fish stocks in Lake Victoria are declining from overfishing and demand for fish is increasing. Government officials are counting on fishponds - which will be home to millions of tilapia, catfish and ornamental fish - to supply a more sustainable source of protein and income.

A key partner in the efforts is the Aquaculture & Fisheries Collaborative Research Support Program, known as AquaFish CRSP. It's funded by the U.S. Agency for International Development (USAID) and is headquartered at OSU. The program works with developing countries to improve the livelihoods of the rural poor while growing their aquatic product industry. Other projects include researching beneficial bacteria for tilapia ponds in Mexico and evaluating the effects of invasive species in China and Vietnam.

"It's less about fish than about poverty reduction," said OSU's Hillary Egna, the director of AquaFish CRSP. "We work with people who work with the poor, and we help them build capacity for small-scale economic development."

AquaFish CRSP has been helping improve Kenyan aquaculture since 1997. One beneficiary is George Ambuli, the CRSP-trained chairman of a fish-farming cooperative in a small village near Lake Victoria.

"I'm proud to say that fish farming has made me what I am today," he said. "I eat fish, I have a cell phone in my pocket, and I am paying the school fees for my 9-year-old daughter, all with my fish money."

The aquaculture component of the stimulus package was created in late 2009. The program aims to increase the country's fishponds from 7,500 to 48,000. "Fish production in Kenya was a very small industry prior to this cooperative research program," said Kwamena Quagrainie, a lead U.S.-based researcher for CRSP's projects in Africa. "CRSP started with research to understand the whole fish production industry, including pond construction, management and the varieties of fish species that can be produced."

The initiative is expected to benefit some of the country's poorest farmers, as well as two traditionally underprivileged groups: women and youth. Though fishponds continue to be owned almost exclusively by men, women are increasingly involved in all phases of fish farming, including feeding, fertilization and predator control. Kenya's vastly underemployed youth, meanwhile, are finding jobs and gaining skills in pond construction.

But the huge growth in fish farming has presented some cultural and economic challenges. The demand for fingerlings to stock the fast-growing number of fishponds has skyrocketed from 1 million to 28 million in less than a year, forcing the government to lean heavily on private industry. Officials plan to upgrade more than 30 of the nation's hatcheries to help meet demand.

Another obstacle is a sudden need for programs to train new fish farmers how to manage their ponds and market their fish. On top of that, farmers who have built their own ponds without stimulus funding are looking to the government for guidance and training. The government is working to meet these demands as it phases out its involvement over the next 18 months.

As Kenya's aquaculture program expands, fisheries officials plan to put additional marketing structures into place. Outreach efforts include encouraging farmers to improve their income by including value-added activities like gutting, scaling and drying fish for market. The government is building 80 small refrigeration centers around the country, which will help farmers sell fish beyond neighborhood markets.

Although perception persists that farmed fish are not as good as captured fish, Fisheries Director Godfrey Monor is confident that in time, half of the fish consumed in Kenya will be farm-grown.

Researchers aim to boost production of two native fish species in Mexico

By Tiffany Woods

Source: Hillary Egna; Kevin Fitzsimmons; Wilfrido Contreras Sanchez

REFORMA, Mexico – Rafael Fernandez Guzman raises tilapia out in the lush, green Mexican countryside. It's a place where cows graze and the roads are lined with stands selling tortillas, papayas, potted plants, bananas and roasted chickens.

The straw hat-wearing, cell phone-carrying former cattle rancher farms the fish in rectangular, excavated earthen ponds roughly the size of basketball courts not far from the city of Villahermosa. His customers drive up and buy them fresh from the water, still breathing and flopping. He sold 120 metric tons of tilapia in 2009, the equivalent of 230,000 fish, he says.

Now he wants to branch into popular native species like Mayan cichlids and bay snooks (they're not actually related to snooks) because customers regularly ask for them, he says. The problem is, though, that he's not sure if these fish would be as lucrative as tilapia. He wouldn't stray from tilapia, he says, unless he could earn a profit margin of at least 25 percent.

Researchers at the Autonomous Juarez University of Tabasco in Villahermosa are trying to make sure that he can. Through systematic breeding, they're working to develop improved broodstocks of Mayan cichlids and bay snooks that would produce fast-growing, meaty fish that are consistent in size and quality and could compete economically with tilapia when raised in farmed conditions. The university aims to sell the juveniles, known as fingerlings, to fish farmers in southeastern Mexico.

Production of these species in captivity is also necessary because environmental degradation and overfishing have reduced their populations, says Kevin Fitzsimmons, a professor at the University of Arizona and a former president of the World Aquaculture Society.

He's one of the participants in the project, which is partially funded by the U.S. Agency for International Development through its AquaFish Collaborative Research Support Program headquartered at Oregon State University. Hillary Egna, the program's director, initiated the project.

For nearly a decade, the university in Villahermosa has been breeding and raising these native cichlids in captivity and selling them to the state of Tabasco and local governments for repopulation efforts, but this is its first attempt to improve the genetics of farmed stocks, says Wilfrido Contreras Sanchez, the lead Mexican researcher on the project.

The omnivorous Mayan cichlid, known locally as *castarrica*, is native to the fresh and brackish waters of Central America and southeastern Mexico. It has black vertical bands on its sides and is just the right size to fit on a dinner plate. The carnivorous bay snook, also known as *tenguayaca* or giant cichlid, has a line of large black spots on its sides, inhabits fresh waters in southeastern Mexico and Central America and grows slightly bigger than the Mayan cichlid.

Researchers chose these two species because they have been overexploited, they fetch higher prices than tilapia in local markets, consumers like them, and fish farmers want to raise native species because of their popularity, Contreras says.

The challenge, however, is to produce fish that grow fast enough to compete with the quick-growing tilapia, a popular, easy-to-raise, non-native farmed cichlid that is ready for market after six months in grow-out ponds. The reason for wanting to speed up their growth is simple: The longer fish take to reach market sizes, the more money producers have to spend on feeding them.

Contreras doubts that these native species could ever grow as fast as tilapia. But, he says, if the time were shortened even just partially, the economics might

work out in the end because of their more lucrative price. At local fish markets, one kilogram (2.2 pounds) of tilapia sells for around 40 pesos (about $3.40) but bay snooks and Mayan cichlids command at least twice that.

Libido Rivera Lopez knows about the economics. The wiry, soft-spoken fish farmer and other members of a cooperative in the community of Cucuyulapa took a stab at raising Mayan cichlids but threw in the towel because the fish took too long to reach a marketable size. They went back to their trusty tilapia.

But if the researchers' work is successful, Rivera might have a second chance. At one of the university's campuses near Villahermosa, the project is in full swing. Dozens of mesh cages holding Mayan cichlids and bay snooks float in two earthen ponds. The fish are the offspring of nearly 200 wild progenitors that underwent a rigorous physical exam, including blood cell counts, before being deemed healthy enough to be parent material. Once the blood work was done, the fish consummated their relationships in nuptial tanks and spawned hundreds of thousands of small fry.

Researchers have been gradually weeding out the slow-growing offspring. It's tedious, repetitive, slimy, sweaty, wet work. The kind you give to students – like Enrique Hernandez Gonzalez. The biology undergraduate is up to his waist in the pond water, dragging the cages to shore and scooping Mayan cichlids into a bucket. Standing in the sweltering humidity under a tree, graduate student Beatriz Adriana Hernandez Vera then weighs and measures their flopping, slippery bodies as Rosa Aurora Perez Perez, also a graduate student, records the data on a clipboard. Thousands of squirming fish have passed through their hands since the selection process started in 2009.

They'll keep an elite group of the largest and heaviest ones. They'll then breed those lucky few, cull their undersized offspring, breed the survivors, discard the lightweights and voilà, several crosses later, they'll have the final crème de la crème parent stock: 880 hearty Mayan cichlids and 960 robust bay snooks, with both groups equally split by gender. They'll be maintained as broodstock to supply a steady stream of fingerlings to fish farmers.

One day, those offspring just might end up at Rafael Fernandez's fish farm.

CRSP KNOWLEDGE AND DATA MANAGEMENT PROJECT
OUTREACH DELIVERABLES

Cultural Practice (CP), LLC was awarded a subcontract through Oregon State University in July, 2011, to fund the initial work on the "CRSP Council Knowledge and Data Management Project," a CRSP-wide effort to combine the wealth of information accumulated by all CRSPs into a single information clearinghouse/ database. Outreach documents produced as deliverables under a subaward through AquaFish CRSP include:

- The Collaborative Research Support Program (CRSP) Approach. Two-page flyer.
- Degrees of Progress: The shape and impact of CRSP training programs for higher education. Two-page flyer.
- Harnessing Science to "Feed the Future": The CRSP contribution to achieving food security and improving nutrition status. Four-page flyer.
- Putting the "Collaborative" in CRSP: Cultivating diverse international partnerships to improve livelihoods. Four-page flyer.
- Building the Technical and Institutional Capacity to Feed the World. One-page "Learning from Success" publication.
- CRSP Research Increases Agricultural Productivity. One-page "Learning from Success" publication.
- Strengthening Value Chains to Benefit Small Producers. One-page "Learning from Success" publication.

Additional outreach material developed by CP LLC can be found at www.crsps.net and include:

- CRSP Brochure. 8-panel gate-fold general brochure.
- The CRSP Digest Project: Learning from Success. Two-page flyer.
- "Famine Prevention and Freedom from Hunger": A look at Title XII legislation and the Collaborative Research Support Programs. Two-page flyer.
- Addressing Food Security through CRSP Commodity, Policy, and Market Research. Two-page "Learning from Success" publication.
- AquaFish CRSP Strengthens Fish Value Chains for Men and Women Fish Farmers. Two-page "Learning from Success" publication.
- Reducing the Gender Gaps in Agriculture: The Experiences of IPM, Peanut and SANREM CRSPs. Two-page "Learning from Success" publication.

CRSP
COLLABORATIVE RESEARCH SUPPORT PROGRAMS

The Collaborative Research Support Program (CRSP) Approach

The CRSPs are a USAID program that funds U.S. universities and partners overseas to jointly pursue scientific investigations to overcome critical agricultural constraints facing today's global food systems.

Managed by U.S. universities, the CRSPs are applied research programs that support students and researchers in the U.S and around the world to work with leading scientists. They seek scientific solutions to overcome hunger and poverty while building the capacity of the institutions in which they work. Short-term, non-degree training courses provide applied agricultural science skills to development workers and rural producers.

DRY GRAIN PULSES CRSP

Its extensive network of developing country partners and their active participation in defining the programs' activities helps the CRSPs to always keep the end users in mind, whether the research occurs in the lab or in the field. Research projects serve as the vehicle for capacity building from the college campus to the communities.

The CRSPs are a unique partnership between U.S. universities, developing country individuals and institutions, and USAID Bureaus and Missions seeking solutions to hunger and poverty through agricultural research, training, and outreach. These partnerships include other Federal agencies, International Agricultural Research Centers including the Consultative Group for International Agricultural Research, non-governmental organizations, and the private sector. Typically, both the U.S. and host country institutions also make cash and in-kind contributions to the programs. These "matching" and leveraged funds range from 20% to over 100% of USAID support, making the CRSPs an extremely cost-effective mechanism.

A Brief CRSP History

Created in 1977, under Title XII of the International Development and Food Assistance Act of 1975, the CRSPs focus the scientific expertise of U.S. universities on improving agricultural productivity and marketing systems and enhancing food security in both the U.S and in developing countries.

The U.S. Congress authorized USAID to provide program support for long-term collaborative university research and coordination with other Federal and State efforts. In October 2000 Title XII was reauthorized, continuing these long-term collaborative university research programs "to achieve the mutual goals among nations of ensuring food security, human health, agricultural growth, trade expansion, and the wise and sustainable use of natural resources."

The CRSPs' approach has achieved critical scientific advances in plant and animal productivity and environmental management. The CRSPs also create and maintain a global scientific network focused on solving the agricultural problems of rural communities and have helped to educate some of the current leaders in major agricultural institutions and government positions worldwide.

Each CRSP works with its partners to develop an overarching plan to guide its interdisciplinary, collaborative research program. Following the guidance of USAID development priorities, including the recent Feed the Future strategy, this plan addresses key constraints, such as nutrition, horticulture, market access, or environmental management.

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Demand-driven, each CRSP seeks to address not only the critical research questions in its area of expertise but also the larger development questions and priorities expressed through relevant USAID strategies.

In short, the CRSP approach:

- Requires a coordinated, multi-disciplinary research strategy, collaboratively developed and cooperatively implemented, with shared responsibilities between U.S. and host country institutions and scientists.
- Develops enduring and sustainable human and institutional capacity in the countries where CRSP activities are located.
- Provides support to students in graduate degree programs, research assistantships, and workshops in conjunction with their research activities.
- Furthers USAID priority goals to support economic growth and to reduce poverty by generating and applying agricultural knowledge and technologies in both developing and transition countries and in the U.S.

Collaborative Research Support Programs

Aquaculture and Fisheries (AquaFish)
Oregon State University, Management Entity
Dr. Hillary S. Egna, Director • aquafishcrsp.oregonstate.edu

BASIS Assets and Market Access (BASIS-AMA)
University of Wisconsin, Management Entity
Dr. Michael Carter, Director • www.basis.wisc.edu

Dry Grain Pulses (Pulse)
Michigan State University, Management Office
Dr. Irvin E. Widders, Director • pulsecrsp.msu.edu

Global Nutrition
Tufts University, Management Entity
Dr. Patrick Webb, Program Director Asia
Dr. Jeffrey Griffiths, Program Director Africa
nutritioncrsp.org

Horticulture
University of California, Davis, Management Entity
Dr. Elizabeth Mitcham, Director • hortcrsp.ucdavis.edu

Integrated Pest Management (IPM)
Virginia Tech, Management Entity
Dr. R. Muni Muniappan, Director
www.oired.vt.edu/ipmcrsp

Livestock-Climate Change
Colorado State University, Management Entity
Dr. Richard Bowen, Director • lcccrsp.org

Peanut
University of Georgia, Management Entity
Dr. Jonathan (Tim) Williams, Director • peanutcrsp.org

Sorghum, Millet and Other Grains (INTSORMIL)
University of Nebraska, Management Entity
Dr. John Yohe, Director • intsormil.org

Sustainable Agriculture and Natural Resource Management (SANREM)
Virginia Tech, Management Entity
Dr. Adrian Ares, Director • www.oired.vt.edu/sanremcrsp

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COLLABORATIVE RESEARCH SUPPORT PROGRAMS

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Photo page 2 by Deborah Rubin. This publication was made possible through support provided to Cultural Practice LLC by the United States Agency for International Development (USAID) through the Collaborative Research Support Programs. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID.

For more information, visit the CRSP website at www.CRSPs.net.

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COLLABORATIVE RESEARCH SUPPORT PROGRAMS

Degrees of Progress

The shape and impact of CRSP training programs for higher education

Educating students and training farmers, herders, fishers, and policy makers are central to the research programs of the Collaborative Research Support Programs (CRSPs). Thousands of students have received degrees since the CRSP programs started in the late 1970s. As graduates, they have made important contributions to U.S. and developing country agriculture, proving the theory of change that a better educated community of agricultural scientists is a necessary step in achieving better development outcomes. Graduates of higher education are more aware of and better able to use new technologies as well as to develop new ideas to solve development problems. By matching USAID funding with university and host country contributions, the CRSP training programs are a cost-effective way to offer structured training programs to both U.S. and developing country students and to achieve results that benefit everyone.

IPM CRSP

AQUAFISH CRSP

CRSPs train students in-country, through south-south exchanges and in the U.S. CRSP students come from all over the world, including the U.S.

Who are the CRSP students?

Over the past three years (2008-2010) more than 1,300 participants have received funding as part of CRSP degree training programs at U.S. and overseas universities. This number does not include participants who joined during FY2011 under the newly launched Global Nutrition or Horticulture CRSPs. They came from 72 different countries, including the U.S. According to a recent study on USAID-supported training programs, from 1978 to 2007, 3,145 CRSP participants earned degrees, about 88 percent in post-graduate programs. Between 40-50 percent come from Sub-Saharan Africa, with significant numbers also coming from Bolivia, Ecuador, Ghana, Indonesia, and China. Their degrees have been granted in dozens of scientific fields, from agronomy, entomology, food science, to agricultural economics and other social sciences.

GLOBAL LIVESTOCK CRSP

Capacity development *refers to a process of change in which people, organizations, and society as a whole improve their potential performance and unleash, strengthen, create, adapt, and maintain capacity over time. Capacity-building programs in agriculture and food security draw on a theory of change that envisions developing better capacity leading to more effective research and, in turn, more effective and more sustainable development outcomes.*

-- Clara Cohen, 2010 "Developing Institutional and Human Capacity for Agricultural Research"

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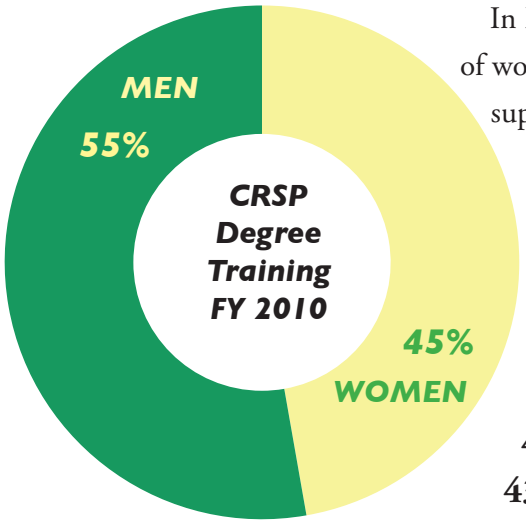
Degree Training Participants, FY 2008 - 2010

	2008				2009				2010			
	PhD	Masters	Bachelors	Other	PhD	Masters	Bachelors	Other	PhD	Masters	Bachelors	Other
AquaFish	18	48	50	3	18	73	75	3	21	98	73	4
BASIS/AMA	13	13	1	0	19	14	3	0	26	21	5	0
Global Livestock	11	22	3	0	5	20	17	0	-	-	-	-
Horticulture	-	-	-	-	-	-	-	-	0	1	0	0
IPM	27	35	0	0	23	34	0	0	17	30	10	1
INTSORMIL	21	20	0	0	20	19	1	0	19	26	1	0
LCC	-	-	-	-	-	-	-	-	9	2	2	0
Peanut	7	1	0	0	10	10	0	0	16	17	2	0
Pulses	2	8	0	0	4	18	0	0	11	33	0	0
SANREM	32	36	30	0	24	24	18	0	22	24	2	0

Note: This data has been drawn from CRSP Annual Reports. It does not include the figures for the Global Nutrition CRSP which got underway in FY 2011. The Horticulture CRSP and Livestock-Climate Change (LCC) CRSP were initiated in 2010. The Global Livestock CRSP ended in 2010. This table does not reflect the number of degrees awarded but rather the number of individuals trained.

From **FY 2008-10,** the active CRSPs gave out **1,338 awards** for funding to students in degree programs.



In FY 2010, the percentage of women in degree programs supported by CRSPs were:

53.4% - IPM
38.4% - LCC
48.6% - Peanut
50% - SANREM
44.4% - AquaFish
34.6% - BASIS/AMA
47.8% - INTSORMIL
43.5% - Dry Grain Pulses

CRSP COLLABORATIVE RESEARCH SUPPORT PROGRAMS

Initiated by Title XII legislation, **Collaborative Research Support Programs** mobilize the capacities of land-grant universities to address issues of food security, human health, agricultural growth, trade expansion and sustainable use of natural resources in the developing world. Ten CRSPs are currently active: AquaFish, BASIS/AMA, Dry Grain Pulses, Global Nutrition, Horticulture, INTSORMIL, IPM, Livestock-Climate Change, Peanut and SANREM. The CRSPs receive core funding from the United States Agency for International Development, Bureau for Food Security.

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CRSP
COLLABORATIVE RESEARCH SUPPORT PROGRAMS

HARNESSING SCIENCE TO "FEED THE FUTURE"

The CRSP contribution to achieving food security and improving nutritional status

Over the past two years, in response to emerging food crises and in an effort to avoid future ones, the U.S. Government created a new agriculture, food security, and nutrition initiative called **"Feed the Future"** (www.feedthefuture.gov). This whole-of-government effort is led by the U.S. Agency for International Development.

The USAID-funded **Collaborative Research Support Programs (CRSPs)** are well positioned to achieve FTF objectives. The CRSPs focus the best of U.S. university scientific expertise and development experience to create new knowledge, to train students, farmers, and entrepreneurs, and to tackle the thorniest of agricultural development questions. The CRSPs carry out USAID's agricultural goals in each of the Feed the Future priority countries.

OVERCOMING GENDER INEQUALITIES

In line with Feed the Future principles, CRSPs have multiplied their efforts to reduce gender inequalities that constrain agricultural development. By integrating closer attention to gender issues, CRSP activities:

- help to identify and reduce institutional barriers to gender equality;
- include women in their degree programs and short-term trainings;
- conduct research on problems faced by women as producers, processors, and traders; and,
- increase women's incomes and access to assets

The CRSPs have significantly increased women's participation in their degree and short-term training programs. From FY 2007 to 2011, the **number of women** in degree programs supported by INTSORMIL increased from 37.7% to 50%; for IPM, women have increased from 35.1% to 53.9%. AquaFish, SANREM and the Peanut CRSP have all maintained an average of about 50% women and Dry Grain Pulses about 46% over the same period.[1]

♦ Women play key roles in managing pests and crops diseases. **IPM CRSP's** Gender Global Theme offers gender trainings to improve their skills in participatory research and gender analysis. Each regional program has an identified gender expert.

♦ The **Horticulture CRSP** includes on their core management staff a Gender Equity Coordinator**; IPM, SANREM, and Peanut CRSP** share the advice of the Women in International Development Program Director at Virginia Tech University.

The overarching goal of the Feed the Future (FTF) initiative 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 key objectives of the program are to:

- accelerate inclusive agricultural sector growth, and
- improve nutritional status (especially of women and children).

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[1] *Horticulture, Livestock-Climate Change and the Global Nutrition CRSPs are too new to have data during this period*

Advancing the Productivity Frontier

♦ In Uganda, the **Peanut CRSP** worked with international and national research organizations to adapt peanut varieties for resistance to the groundnut rosette virus, a serious disease capable of causing total crop failure. To date, resistant varieties are planted on 30-40% of farms in the country, yields are up, and risks of yield losses are down.

♦ In Nicaragua, the **INTSORMIL CRSP,** working with Instituto Nicaraguense de Tecnologia, Texas A&M University, and the Centro Nacional de Tecnologias Agropecuarias in El Salvador, tested a new drought-tolerant variety of sorghum, INTA Segovia. It can yield up to 23% more grain than the best local variety. Farmers are now being trained to grow and sell certified seed.

♦ The **AquaFish CRSP** worked with Malian government ministries, producer associations, and community members to teach fish pond construction and techniques to improve fish productivity. In South-South exchanges, Malians traveled to Kenya and both Kenyan and Chinese specialists traveled to Mali to provide and receive instruction in new techniques.

Growing beans brings multiple benefits for smallholder farmers in Western Kenya: they improve quality, provide nutritious food, and earn money. The **Dry Grain Pulses CRSP** conducts trials with farmers to test new varieties and new cultivation techniques to increase these benefits. New varieties grown with fertilizers have increased yields between 41-71% on farmers' test plots; composting and legume planting is improving these degraded soils.

Expanding Markets and Trade

♦ In Uganda, **AquaFish CRSP** partner Auburn University supported a trade fair for fishers and fish farmers, processors, and marketers with the Walimi Fish Farmers Cooperative Society. Now a self-sustaining event, the fair attracts attendees from across the country and neighboring nations. The fair hosts seminars on entrepreneurship and technical advice, offers site visits, and promotes new equipment and markets.

♦ The **Livestock-Climate Change CRSP** is interviewing Ethiopian and Kenyan women from pastoralist households to better understand the relationship between climate change and livestock marketing. Mitigating the impact of climate change-related risks on market access and value chains is a key factor in improving livelihoods and expanding income opportunities for pastoralists.

IRV WIDDERS /DRY GRAIN PULSES CRSP

Increasing Economic Resilience in Vulnerable Rural Communities

♦ The **BASIS/AMA CRSP** researches and tests policy options to help communities weather economic shocks. In Ghana, researchers investigate ways to expand access to financial services for the poor. In Washington, D.C. the results of this and other work were highlighted in a forum on "Building Resilience and Assets for Food Security: Evidence and Implications for Feed the Future." Leading edge researchers and policy analysts explained tools such as index insurance products and financial programs, and discussed different interventions, such as conditional cash transfers, and policy options.

♦ In Southern Africa, the **SANREM CRSP** used biophysical and social science research to test and optimize a private enterprise economic model known as Community Markets for Conservation (COMACO). This model links improvements in food security and rural livelihoods to sustainable agriculture and natural resource management practices. The economic analyses identified potential opportunities to derive profit from soil sequestration and reforestation associated with conservation farming activities.

FTF Objective II:
IMPROVING NUTRITIONAL STATUS (ESPECIALLY OF WOMEN AND CHILDREN)

CRSP research has contributed greatly to enhancing the nutritional status of people in the developing world. The recently initiated Global Nutrition CRSP, operating in Uganda and Nepal, will focus on identifying the best policy mechanism for achieving large scale improvements in child nutrition. This CRSP research will expand an historical orientation on the biological way to improve human nutrition to emphasize research that will help to identify and explain what works operationally, on the ground, to encourage the behavior changes that result in better nutritional status, and how these changes can be scaled up.

In addition to the **Global Nutrition CRSP,** nearly every CRSP also has nutrition-oriented activities.

Building on observational studies from the **Human Nutrition CRSP** in the 1980s, findings from the former **Global Livestock CRSP** research in Kenya showed that adding small amounts of animal source foods to children's diets improved their nutritional status and cognitive development. A community-based nutrition education and microfinance activity in Ghana built on this research. Women in the micro-credit groups started or expanded businesses and used the funds to purchase animal source foods for their households. The project has continued under the leadership of local rural banks.

SUSAN JOHNSON /GLOBAL LIVESTOCK CRSP

♦ In Uganda and Rwanda, the **Dry Grain Pulses CRSP** is studying alternative methods for post-harvest storage and processing of beans that can enhance their nutritional value. Some options being tested are improving the nutrient quality of bean flour, developing recipes to increase consumption, and improving storage and transport containers to promote cleanliness and freshness of the harvested product. Drawing on the CRSP results, an article published on scidev.net reported that the techniques of "solar powered heaters to kill pests, simple, airtight containers and other storage technologies" were dramatically improving bean storage.

♦ The **Global Nutrition CRSP** will be working in FTF countries: Nepal and Uganda. It will focus on answering the "how" and "why" of successful nutrition interventions, seeking to overcome widespread maternal and child malnutrition, even in countries demonstrating agricultural growth and poverty reduction. To date, limited empirical evidence exists to determine how to bring and sustain the greatest improvements on the largest scale. The CRSP will clarify the impact pathways by which evidence-based interventions can be most effectively moved from community-level pilots to national programs and policies.

CAROLYN FONSECA/PEANUT CRSP

♦ Recognizing the nutritional and health values of peanuts, the **Peanut CRSP** established a school feeding program in Guyana based on peanut butter produced by cooperatives using locally grown peanuts. The initiative has grown from a village to national program and established a new cottage industry employing local women in the production of the peanut-based snack.

For more information on the CRSPs and Feed the Future, visit our website at:

CRSPS.ORG ♦ CRSPS.NET

CRSPs in Feed the Future focus countries 2009 - 2011

	AquaFish	BASIS/AMA	Horticulture	IPM	INTSORMIL	Livestock -Climate Change	Global Nutrition	Peanut	Dry Grain Pulses	SANREM
Africa										
Ethiopia		•		•	•	•				
Ghana	•	•	•	•	•			•		•
Kenya	•	•	•	•	•	•		•	•	•
Liberia		•								
Malawi		•	•							
Mali	•	•		•	•	•			•	•
Mozambique		•			•				•	•
Rwanda			•						•	
Senegal				•	•	•		•	•	
Tanzania	•		•	•	•	•			•	
Uganda	•	•	•	•	•		•	•	•	•
Zambia			•		•				•	
Asia										
Bangladesh	•	•	•	•		•				
Cambodia	•	•	•	•						•
Nepal	•		•	•		•	•			•
Tajikistan				•		•				
Latin America and Caribbean										
Guatemala		•	•	•	•				•	
Haiti			•		•			•	•	•
Honduras			•	•	•				•	
Nicaragua	•	•	•		•				•	
Strategic Partner Countries										
Brazil		•						•		
India		•	•	•						
Nigeria									•	
S. Africa	•	•	•		•				•	

Key: *AQUAFISH: Aquaculture and Fisheries; BASIS/AMA: Broadening Access to Input Market Systems/Assets and Market Access; INTSORMIL: Sorghum, Millet and other Grains; IPM: Integrated Pest Management; SANREM: Sustainable Agriculture and Natural Resource Management*
Source: *CRSP Council 2011; individual CRSP Annual Reports for FY 2010 and work plans for FY 2011.*

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CRSP
COLLABORATIVE RESEARCH SUPPORT PROGRAMS

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CRSP
COLLABORATIVE RESEARCH SUPPORT PROGRAMS

Putting the "Collaborative" in CRSP

Cultivating diverse international partnerships to improve livelihoods

The Collaborative Research Support Programs represent a network of over **500** collaborating institutions ranging from small and local to large and international. Through these networks, the CRSPs can bring their scientific solutions to overcoming hunger and poverty to people around the world.

Often more than one CRSP partners with an entity, thus the total number of *partnerships* is over 700.

CRSP projects are implemented in over 55 host countries, collaborating with institutions located in over seventy countries around the globe. CRSPs actively partner with organizations and institutions in all of the Feed the Future priority countries.

U.S. and host-country universities and research institutes are at the heart of CRSP projects. They both make cash and in-kind contributions to the programs. The active involvement of host country partners guarantees that all CRSP research is well designed, ethically implemented, peer-reviewed, and available to the public.

CRSP collaborations build scientific research capacity. Students from host-country universities are trained as part of CRSP partnerships and apply their skills to solve host-country problems.

CRSP researchers engage the communities where they work by partnering with local NGOs and government offices. These groups help make local connections and provide valuable perspectives that inform the projects and lay the groundwork for trust and sustainability.

Centers belonging to the Consultative Group on International and Agricultural Research (CGIAR) are also important CRSP partners. CGIAR centers are located in several countries throughout the world and house experts in various agricultural fields such as grains, livestock, aquaculture, and tropical agriculture. CRSPs test and apply CGIAR research to extend its reach in the field.

AQUAFISH CRSP

Educating students in university and college programs helps to create both entrepreneurs and advance scientific innovation that contributes to advancing the work of the private sector in both developing countries and in the U.S. The CRSPs have trained thousands of students in its degree programs since 1978. In 2010, they partnered with over 69 private sector firms.

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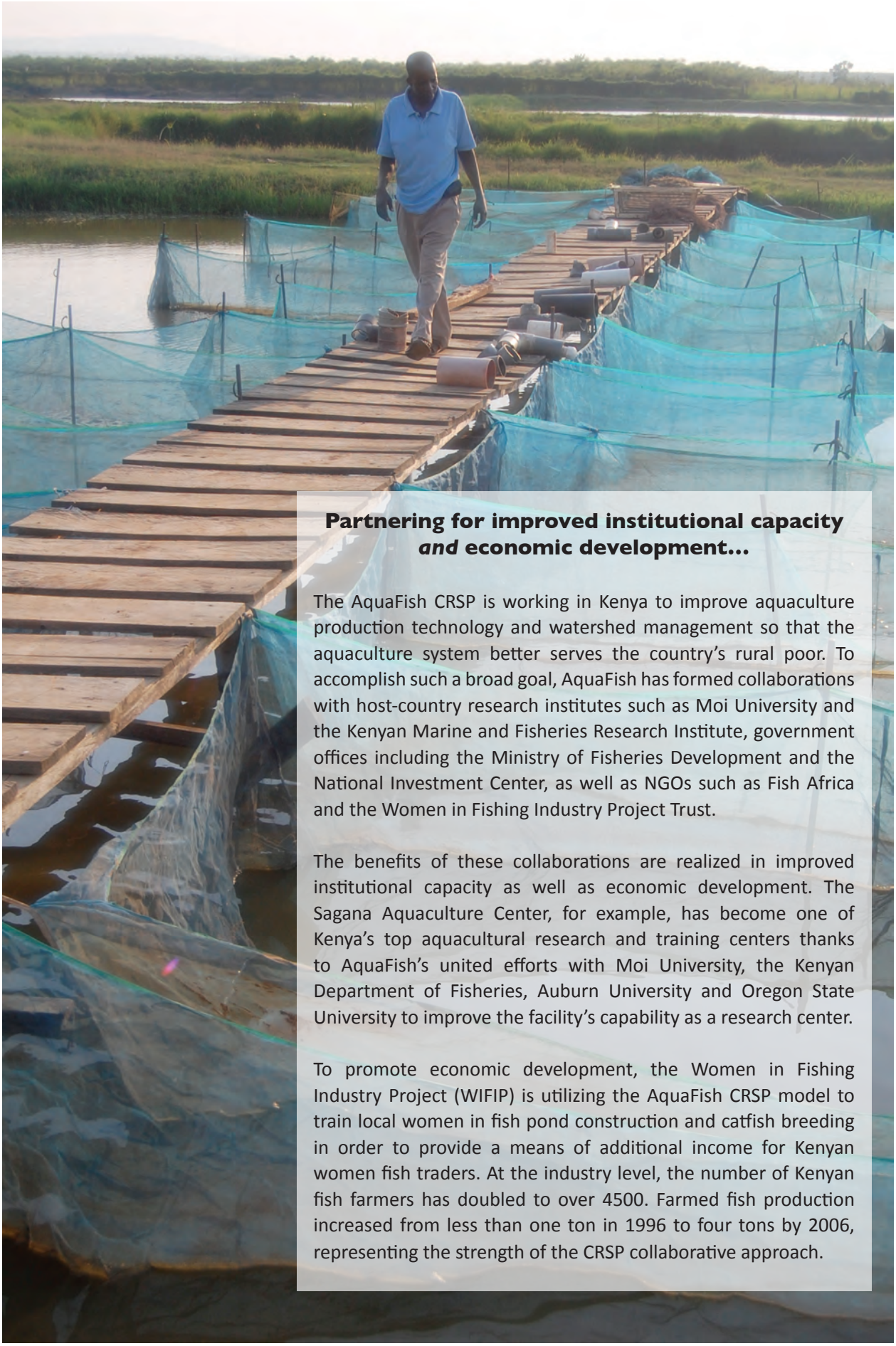


Partnering for improved institutional capacity *and* economic development...

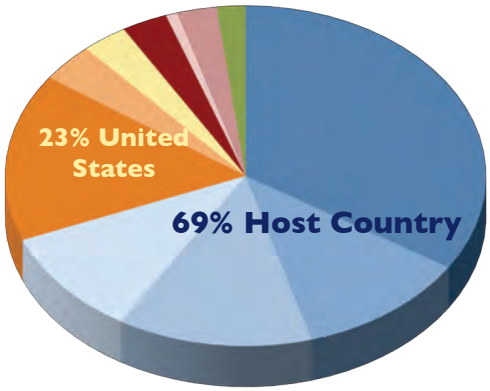
The AquaFish CRSP is working in Kenya to improve aquaculture production technology and watershed management so that the aquaculture system better serves the country's rural poor. To accomplish such a broad goal, AquaFish has formed collaborations with host-country research institutes such as Moi University and the Kenyan Marine and Fisheries Research Institute, government offices including the Ministry of Fisheries Development and the National Investment Center, as well as NGOs such as Fish Africa and the Women in Fishing Industry Project Trust.

The benefits of these collaborations are realized in improved institutional capacity as well as economic development. The Sagana Aquaculture Center, for example, has become one of Kenya's top aquacultural research and training centers thanks to AquaFish's united efforts with Moi University, the Kenyan Department of Fisheries, Auburn University and Oregon State University to improve the facility's capability as a research center.

To promote economic development, the Women in Fishing Industry Project (WIFIP) is utilizing the AquaFish CRSP model to train local women in fish pond construction and catfish breeding in order to provide a means of additional income for Kenyan women fish traders. At the industry level, the number of Kenyan fish farmers has doubled to over 4500. Farmed fish production increased from less than one ton in 1996 to four tons by 2006, representing the strength of the CRSP collaborative approach.

JEFF HINO /AQUAFISH CRSP

The majority of CRSP collaborations are with host-country institutions. Host country collaborators play a critical and significant role in CRSP projects as equal partners in research, knowledge transfer and capacity building.



- Host Country Research Institutes
- Host Country Government
- Host Country NGOs
- Host Country Private Sector
- US Universities
- US Government
- US Private
- International NGOs
- UN/Multilateral Organizations
- CGIARs/IARCs
- Other

U.S. Collaborating Universities

The collaborative character of the research offered through the CRSPs is defining of its approach. They continue to be an innovative mechanism for strengthening collaboration among U.S. universities. The lead U.S. university is responsible for coordinating links to other U.S. universities, through sub-grants and Memoranda of Understanding; those universities, in turn, have their own subawards with an ever wider circle of organizations. The research activities are consequently institution to institution as well as researcher to researcher. In 2010, **eighty-three** U.S. universities in **41 states** collaborated on CRSP projects. Of these, 11 are Minority Serving Institutions (MSIs).

Alabama A&M University
Auburn University
Clemson University
Colorado State University (ME)
Columbia University
Cornell University
Delaware State University
Duke University
Emory University
Florida A&M University
Florida International University
Fort Valley State University
George Mason University
Georgia Institute of Technology
Georgia State University
Harvard University
Indiana University
Iowa State University
Johns Hopkins University
Kansas State University
Louisiana State University
Massachusetts Institute of Technology
Michigan State University (MO)
Montana State University
New Mexico State University
N. Carolina Ag. & Technical State University
North Carolina State University
Ohio State University
Oregon State University (ME)
Pennsylvania State University
Princeton University
Purdue University
Rutgers - State University of New Jersey
South Dakota State University
Syracuse University
Tennessee State University
Texas A&M University
Texas Tech University
Tufts University (ME)
Tuskegee University
University of Alabama at Birmingham
University of Alaska
University of Arizona
University of Arkansas at Pine Bluff
University of California, Berkeley
University of California, Davis (ME)
University of California, Riverside
University of California, San Diego
University of Colorado
University of Connecticut
University of Connecticut–Avery Point
University of Denver
University of Florida
University of Georgia (ME)
University of Hawaii
University of Hawaii at Hilo
University of Hawaii at Manoa
University of Idaho
University of Illinois at Urbana-Champaign
University of Iowa
University of Michigan
University of Minnesota
University of Missouri
University of Montana
University of Nebraska (ME)
University of Puerto Rico
University of Rhode Island
University of San Francisco
University of Tennessee
University of Texas
University of Vermont
University of Virginia
University of Washington
University of Wisconsin, Madison (ME)
University of Wyoming
Virginia State University
Virginia Tech University (ME)
Washington State University
West Texas A&M University
Yale University

Note: Data on this page draws from FY 2010 except for the Global Nutrition CRSP which only started in 2011. Universities with a CRSP Management Entity or Management Office are denoted in red.

Partner Countries and Key Collaborations

	AquaFish	BASIS/AMA	Horticulture	IPM	INTSORMIL	Livestock-Climate Change	Global Nutrition	Peanut	Dry Grain Pulses	SANREM
Total Partnerships	153	65	55	78	63	54	16	43	97	83
Host Country Partnerships	100	33	39	46	43	34	1	22	64	48
Africa and Middle East										
	Egypt Ghana Kenya Lebanon Mali S. Africa Tanzania Uganda	Ethiopia Ghana Kenya Liberia Malawi Uganda	DRC Ghana Kenya Nigeria S. Africa Tanzania Uganda Zambia	Ethiopia Ghana Kenya Mali Niger Nigeria Senegal S. Africa Tanzania Uganda	Botswana Burkina Faso Ethiopia Ghana Kenya Mali Mozambique Niger Nigeria Senegal S. Africa Tanzania Uganda Zambia	Ethiopia Kenya Mali Niger Senegal Tanzania	Uganda	Burkina Faso Ghana Kenya Mali Senegal Uganda	Angola Benin Burkina Faso Ghana Kenya Mali Mozambique Niger Nigeria Rwanda Senegal S. Africa Tanzania Togo Uganda Zambia	Ghana Kenya Lesotho Mali Uganda
Asia										
	Bangladesh Cambodia China Indonesia Malaysia Nepal Philippines Thailand	Cambodia India Indonesia	India Nepal Sri Lanka Taiwan Thailand	Bangladesh Cambodia India Indonesia Philippines Taiwan Uzbekistan	Malaysia S. Korea	Mongolia Tajikistan	Nepal	Laos Thailand		Cambodia India Indonesia Philippines Taiwan Vietnam
Latin America and Caribbean										
	Brazil Costa Rica Ecuador Guatemala Guyana Honduras Mexico Nicaragua	Guatemala Nicaragua Peru	Costa Rica Dom. Rep. El Salvador Haiti Honduras Nicaragua	Dom. Rep. Ecuador Guatemala Honduras Mexico Peru	Argentina Costa Rica El Salvador Guatemala Honduras Nicaragua			Bolivia Brazil Costa Rica Guyana Haiti	Colombia Dom. Rep. Ecuador Haiti Honduras	Bolivia Ecuador Haiti Mexico Peru

Note: Data in the table draws from FY 2010 except for the Global Nutrition CRSP which only started in 2011.

Initiated by Title XII legislation, **Collaborative Research Support Programs** mobilize the capacities of land-grant universities to address issues of food security, human health, agricultural growth, trade expansion and sustainable use of natural resources in the developing world. Ten CRSPs are currently active: AquaFish, BASIS/AMA, Dry Grain Pulses, Global Nutrition, Horticulture, INTSORMIL, IPM, Livestock-Climate Change, Peanut and SANREM. The CRSPs receive core funding from the United States Agency for International Development, Bureau for Food Security.

This publication was made possible through support provided to Cultural Practice LLC by the United States Agency for International Development (USAID) through the Collaborative Research Support Programs. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID.

For more information, visit the CRSP website at www.CRSPs.net.

Building the Technical and Institutional Capacity to Feed the World

Photo credit t: D. Rubin

Students at Egerton University in Kenya monitoring environmental data in the Njoro River watershed

To solve the puzzle of sustainably producing more food and feed for tomorrow under conditions of increasing resource scarcity it is critical to build the knowledge and skills of actors in the global food system today. This task has been undertaken by the **Collaborative Research Support Programs** or **CRSPs** who are world leaders in offering scientific training to students from the U.S. and developing countries. Jointly funded by USAID, U.S. universities, and other partners, the CRSPs have not only supported students in degree programs but also faculty research and the professional development of many agricultural practitioners. They have also trained many thousands of producers in field schools, training programs, and exchange visits. Overall, about one-fourth of CRSP budgets are allocated to training.

From 1978 to 2011, a total of at least 3,791 students received funding under CRSP activities to obtain at least 3,820 degrees (some students were supported for multiple degrees).* By current best estimates, 30 percent of these degrees were PhDs, 40 percent were MSc/MA, and 20 percent were BS degrees, with no reporting on 10 percent. By conservative estimates, if each of these students went on to teach, train, or mentor even 100 other students, farmers, or agricultural development professionals, they will have assisted about 380,000 people.

These students came from 130 countries, with 25 percent coming from sub-Saharan Africa, 23 percent from the U.S., 22 percent from Latin America and the Caribbean, and 21 percent from Asia, 2 percent from Europe and Eurasia, 2 percent from the Middle East and 5 percent not reporting. They studied in 36 of the 50 states, with the top four being Texas, Indiana, Nebraska, and Kansas.

Their degrees have been granted in dozens of scientific fields, from agronomy, entomology, and food science, to agricultural economics and other social sciences.

The CRSPs have also created lasting relationships between U.S. and developing country universities such as with Moi and Egerton Universities in Kenya, Ahmadou Bello University in Nigeria, and the University of Philippines, Los Baños in the Philippines.

Many CRSP graduates have gone on to have the authority to shape agricultural programs and policies in international and national institutions. A graduate of the former Bean/Cowpea CRSP, Augustine Langyintuo, now heads the Policy Program of the Alliance for a Green Revolution in Africa (AGRA), an African-led organization that supports sustainable and profitable smallholder farming in Africa. He is joined by Margaret Kroma, a SANREM CRSP graduate, who is the Gender Advisor for the Policy Program and contributes to gender integration across the institution. Michael Roth, an INTSORMIL CRSP graduate, later became the BASIS CRSP Project Director.

*There is missing data from some years for a few CRSPs.

The CRSP Digest Project is supported by individual CRSPs as a joint knowledge management activity. Implemented by Cultural Practice LLC, the Digest Project compiles, synthesizes, and disseminates data about CRSP activities and achievements to stakeholders such as development practitioners, USAID staff, students, researchers, and others. It organizes outreach events to circulate research findings among the agricultural research and development community. For more information visit www.crsps.net.

Check the website for updates or sign up to receive news via the email (crsps@crsps.net), Twitter, and Facebook.

CRSP Research Increases Agricultural Productivity

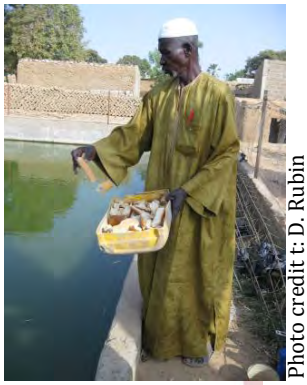


Photo credit t: D. Rubin

Feeding fish in an AquaFish fish pond in a Malian village.

Achieving increases in productivity, defined as deriving greater output per unit of input, is a central feature of USAID-funded agricultural programs, and particularly the work of the **Collaborative Research Support Programs**, or **CRSPs**. Productivity gains can come from improvement in breeding, from changes in cultivation practices, and from reducing losses post-harvest. Productivity per unit of labor can be improved through the use of more efficient tools.

Collectively, the CRSPs contribute significantly towards increasing agricultural productivity while raising producer incomes and improving the natural environment. A few recent examples include the work of the AquaFish CRSP which has developed higher yielding sustainable rice-fish ponds in Mali. Using a different approach in the Philippines, AquaFish researchers have helped to reduce the cost of supplemental feed by developing alternative feeding regimes. The options included delaying until the fish are older to start the feed, feeding less that typically recommended amounts, or feeding 100% of feed but only on alternate days. These techniques have helped fish farmers to save money while maintaining production levels.

The SANREM CRSP is working in western Kenya and eastern Uganda on conservation agriculture techniques to arrest soil degradation and erosion, and ultimately to reverse declining yields of maize and beans.

Plant crop yields are being increased through the work of the PULSE CRSP, which combines conventional and molecular approaches with participatory farmer research to increase resistance to both biotic and abiotic stresses in beans in Ecuador and Rwanda. The Peanut CRSP has used traditional breeding methods to achieve higher yields of groundnuts in Uganda by creating resistance to the *Rosette Virus*, adding an estimated US$50 million in farmer incomes. INTSORMIL has successfully launched new, higher-yielding varieties of sorghum in Central America for use as cattle fodder and has helped breed *Striga* resistant varieties that have been released through national programs in Africa.

New technologies often prove to be the pathway towards higher and more secure harvests. The IPM CRSP is testing ecologically-based IPM techniques to raise the productivity of high-value horticultural crops in East Africa. The Horticulture CRSP has developed the Coolbot™, an inexpensive option for creating cold storage for fruits and vegetables.

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Strengthening Value Chains to Benefit Small Producers

Photo credit t: D. Rubin

Members of the Cooperative Feminins de Transformation et Conservation des Produits de Peche (de Nayaton) in Bamako, Mali (AquaFish CRSP)

The **Collaborative Research Support Programs**, or **CRSPs**, are working to build efficient and effective value chains across the globe. They have recognized that scientific advances to increase yields without regard to the market can have negative consequences for small producers if it creates a glut on the market and reduces farmers' returns. As a result, several CRSPs have adopted a value chain approach in their applied research programs.

The AquaFish CRSP has targeted fish farmers on the Kenyan shores of Lake Victoria, providing them with technical assistance in "best practice" fishpond management. Kenyan women, who previously engaged in fish trading and processing are now entering the fish value chain as fish farmers of catfish and tilapia. By producing and selling fingerlings either as baitfish for the large Nile perch fishing industry or to other fish farmers, women can increase their income and overall food security.

A critical part of strengthening value chains lies in providing producers with accurate and timely market information. Several CRSPs have supported activities utilizing mobile technologies to link farmers to markets. Researchers with the Livestock Climate Change CRSP have been working in Mali to expand a livestock market information system s and to conduct market chain analyses and examine household marketing and migration decision making by pastoralists. Both of these efforts are expected to bring more pastoralists into the livestock markets.

The INTSORMIL CRSP has also adopted a value chain approach. Its researchers mapped the sorghum and millet value chain in Zambia. The lack of improved seed was identified as a major constraint in expanding the market. Other research investigated the value chain of sorghum-based beer manufactured in Zambia. The beer companies source from more than 2,500 small holder sorghum producers.

Access to credit is often a fundamental prerequisite for participation in value chains. In Ethiopia and Ghana, the Global Livestock CRSP formed credit and savings groups that allowed producers to start businesses, e.g., fattening animals for sale and trading in agricultural products.

Also in Zambia, the Pulse CRSP is investigating the supply chains used by the Zambian pulse producers and a description of the characteristics of its actors.

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AQUAFISH CRSP IN THE NEWS

Stories in the press that feature AquaFish CRSP include:

- OSU Gets $8.9 Million Grant for Aquaculture, Fisheries Project. Gazette Times, Corvallis, Oregon. October 18, 2006.
- Hatching Dreams for a Better Life: An international program works to improve lives and livelihoods with aquaculture. Oregon's Agricultural Progress, Corvallis, Oregon. Winter 2011.
- Form Best Practice to Best Outcomes in Ghana. Feed the Future (http://feedthefuture.gov). August 21, 2012.
- Fishing for the Future. Global Waters, Washington DC. August 2012.

CORVALLIS Gazette-Times

OSU gets $8.9 million grant for aquaculture, fisheries project

October 18, 2006 12:00 am • By Mark FloydOSU News Service

Oregon State University has received a five-year, $8.9 million grant from the U.S. Agency for International Development to lead a new research program designed to reduce poverty in developing countries by improving access to fish and water resources.

OSU will lead the Aquaculture and Fisheries Collaborative Research Support Program, partnering with other universities and institutions around the world.

"Poverty remains the single biggest threat to children's health today, and giving the poor better access to well-managed water resources can help toward the eradication of poverty," said Hillary Egna, an international aquaculture specialist in OSU's College of Agricultural Sciences and director of the new program.

"Our goal is to create global partnerships that develop sustainable solutions in aquaculture and fisheries for improving health, building wealth, conserving natural environments for future generations and strengthening poor societies' ability to self-govern."

Most of the grant money will be meted out to research teams from institutions around the world that will apply to the new center for funding, and competitive proposals for multi-disciplinary projects will be accepted beginning this fall. Roughly one-third of the research funds will target each of three regions n Africa, Asia and Latin America/Caribbean.

OSU has directed a Collaborative Research Support Program (or CRSP) in pond dynamics and aquaculture for years, Egna said. The new program will focus more on increasing access to water, and reducing the number of constraints to using aquaculture and fisheries to promote local economies.

"We've made a lot of progress over the last 20 years in increasing fish production through aquaculture," she said, "but challenges still remain in terms of pressures from global trade, environmental impacts, water use conflicts and the distribution of benefits."

Egna said the "capture" fisheries sector supplies a majority of the world's fishery products. Aquaculture is gaining market share and can generate a lot of money for developing countries. However, the profits from those export-oriented aquaculture enterprises don't always benefit local economies as much as they could.

Increasing the ability of developing countries to build their infrastructure and capacity n through training and education n is another primary goal, Egna pointed out.

"In one country, it might be access to fingerlings that is the critical roadblock to building aquaculture," she said. "In another area, it might be limited educational opportunities for women, where a community-based outreach model could be implemented.

"Ultimately, we want to give producers and other stakeholders in developing countries better options to help their people," she added. "Our goal is not to go in there and tell them what to do."

The U.S. Agency for International Development administers the U.S. foreign assistance program, providing economic and humanitarian assistance in more than 120 countries worldwide.

AGRICULTURAL EXPERIMENT STATION
OREGON'S AGRICULTURAL PROGRESS
The Research Magazine for the Oregon State University Agricultural Experiment Station

Hatching Dreams for a Better Life

Winter 2011
An international program works to improve lives and livelihoods with aquaculture.
Peg Herring

The classic fish story is about the one that got away. The modern story for many commercially important fish is that not *enough* got away. The world is running out of fish to catch. It's been estimated that stocks of some marine fish have declined by 90 percent in the last 50 years. To meet the demand for protein from a growing human population, and to take pressure off of dwindling wild stocks of fish, people are turning to fish farming.

For more than 20 years, Hillary Egna, a resource geographer at Oregon State University, has led an international program that connects U.S. scientists with researchers in developing countries around the world. The goal? To help impoverished parts of the world develop small-scale aquaculture and sustainable fisheries.

AquaFish is one of nine Collaborative Research Support Programs within USAID, the federal agency for international development. As director of the program, Egna has overseen more than 70 projects that have connected 25 U.S. land-grant universities with research partners in more than 30 host countries.

"It's less about fish than about poverty reduction," Egna said. "We work with people who work with the poor, and we help them build capacity for small-scale economic development."

There's the old saying that when you give a man a fish, he has food for a day; when you teach a man to fish, he has food for a lifetime. The AquaFish program at OSU is dedicated to that proposal. Developing countries can no longer count on foreign aid to provide their people with food and finances. It is increasingly important for these countries to establish profitable businesses that will sustain local communities. Aquaculture can provide both nourishment and employment to these countries.

Since 1980, AquaFish CRSP (and an earlier program that focused on pond aquaculture) has trained scientists around the globe, from Rwanda to Nicaragua to Vietnam. More than 800 students have been formally trained in aquaculture research and management professions. Those professionals in turn have reached more than 30,000 people through local workshops and community projects.

"This has created a huge international network of researchers and trained practitioners who share knowledge within and among host countries," Egna said. "Our partners are our projects. They are their countries' agents of change." By training scientists and Extension educators in their own countries, the AquaFish program builds capacity in these countries to establish and sustain industries in hatchery production, fish farming, and marketing of aquatic products.

Aquaculture has been an industry in Southeast Asia for millennia. But in parts of Africa and Latin America, it is a relatively new idea, only recently embraced by developing nations. In Kenya, for example, the national economic stimulus plan calls for 48,000 new fishponds to be built in the next two years. Such a massive investment by the Kenyan government demands knowledge in engineering, fisheries research and management, marketing, and food safety. Many of those who authored the government's aquaculture plan were educated through the AquaFish collaborative research support program, and the new ponds are being built under the supervision of AquaFish CRSP-trained Kenyan officers.

"The success of our program relies heavily on the education, training, and hands-on experience that we have received from our partnership with the AquaFish CRSP," said Godfrey Monor, Kenya's Director of Fisheries.

Most of these new ponds will be for tilapia, the most common farmed fish in the world. Unlike salmon that have a checkered reputation as farmed fish, tilapia are not top-of-the-food-chain carnivores. For the same reason that the first farmers raised sheep and not lions, most fish farmers in developing countries raise fish grazers, not predators.

Increasingly, AquaFish researchers are exploring ecosystem models with minimal impact on the surrounding environment. In the Philippines, researchers are studying production of tilapia, shrimp, oysters, and edible seaweeds in integrated ecosystems. In Mexico, AquaFish researchers are studying how to use bacteria to remove a sex-changing hormone from the water in tilapia tanks before the water is discharged into streams and lagoons.

The AquaFish program works in countries where the need is great, and where the challenges can be even greater. Research has been delayed by outbreaks of flu, wiped out by tsunamis, and destroyed by civil war. "We lost our entire operation in Rwanda during the genocides of the 1990s," Egna said. "Some of our research partners were murdered; it was very, very sad."

The research that could be salvaged from Rwanda was later moved to Kenya, where aquaculture is creating new employment opportunities, especially for women. Though fishponds are owned almost exclusively by men, Kenyan women are increasingly involved in operations, including feeding, fertilization and predator control; and women now predominate in processing and marketing fish.

Increased employment for women is part of the focus of an AquaFish project in Cambodia, where research partners are developing new local markets for fish paste made from low-value small fish that would otherwise be used for animal feed. Fish paste in Southeast Asia can be compared to cheese in the U.S and Europe; it comes in many varieties and is used in many regional dishes. Expanding this niche market creates employment for women in the manufacture and sales of these locally distinct "Cambodian cheeses." In addition, AquaFish partners in the Mekong Basin are finding ways to separate pint-size fish species from juveniles of larger, more valuable fish species to protect populations of commercially important wild fish.

The AquaFish program reaches people where and how they live, and is therefore distinctive among most other international aid programs. "Most organizations see aquaculture as a positive choice," Egna said, "but they don't know how to build a system that includes environmental protection and market realities, a system that takes into consideration the microeconomics of family and community."

The AquaFish program exemplifies OSU's outreach to the global community, according to Sonny Ramaswamy, dean of the College of Agricultural Sciences. "Where people have meaningful work and enough to eat, they engage more easily in education and democracy. The AquaFish program connects research, education, and Extension in developing countries, on the ground, for the benefit of local people. It is an idea that has grown out of the land grant tradition and it works."

Read the full story at http://oregonprogress.oregonstate.edu/winter-2011/hatching-dreams-better-life

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Published on *Feed the Future* (http://feedthefuture.gov)

From Best Practices to Best Outcomes in Ghana
August 21, 2012

For over 25 years, Paul Osei Kwame has operated a successful 25-acre farm in the Ashanti Region of Ghana. While Oseibros Farms originally ran on poultry, crops, and maize grit extraction, Osei decided to add aquaculture to his operation in 2008.

He made a wise choice—he now has 20 ponds full of Nile tilapia fingerlings that he sells to other local fish farmers.

Osei's success lies in his belief in the application of science to agricultural production. He wants to "get it right" by learning and applying best management practices in his fishponds.

USAID/GhanaPaul Osei Kwame (right), owner of Oseibros Farms Company Limited, confers with AquaFish CRSP researcher Dr. Daniel Abjei-Boateng of the Kwame Nkrumah University of Science and Technology (KNUST).

His transition began in 2009, when Oseibros Farms participated in a water quality study conducted by Feed the Future's Aquaculture & Fisheries Collaborative Research Support Program [1], housed at Oregon State University. The study led to the development of best management practices for reducing the negative effects of pond discharges into local streams. Osei has enthusiastically adopted the recommendation to lower the frequency of pond draining to both save water and lessen the environmental impact of his farm's pond. "While the best practices help in improving on-farm activities, they also contribute immensely to the effective regulation of waste disposal," Osei says.

The focus of Feed the Future's aquaculture program in Ghana shifted in 2011 from research toward technology dissemination, with the aim of demonstrating how increased fish farm productivity, profitability, and environmental benefits can be simultaneously achieved in the production of Nile tilapia. Oseibros Farms participated as one of six demonstration sites to test two best management practices to lower production costs and fish feed waste.

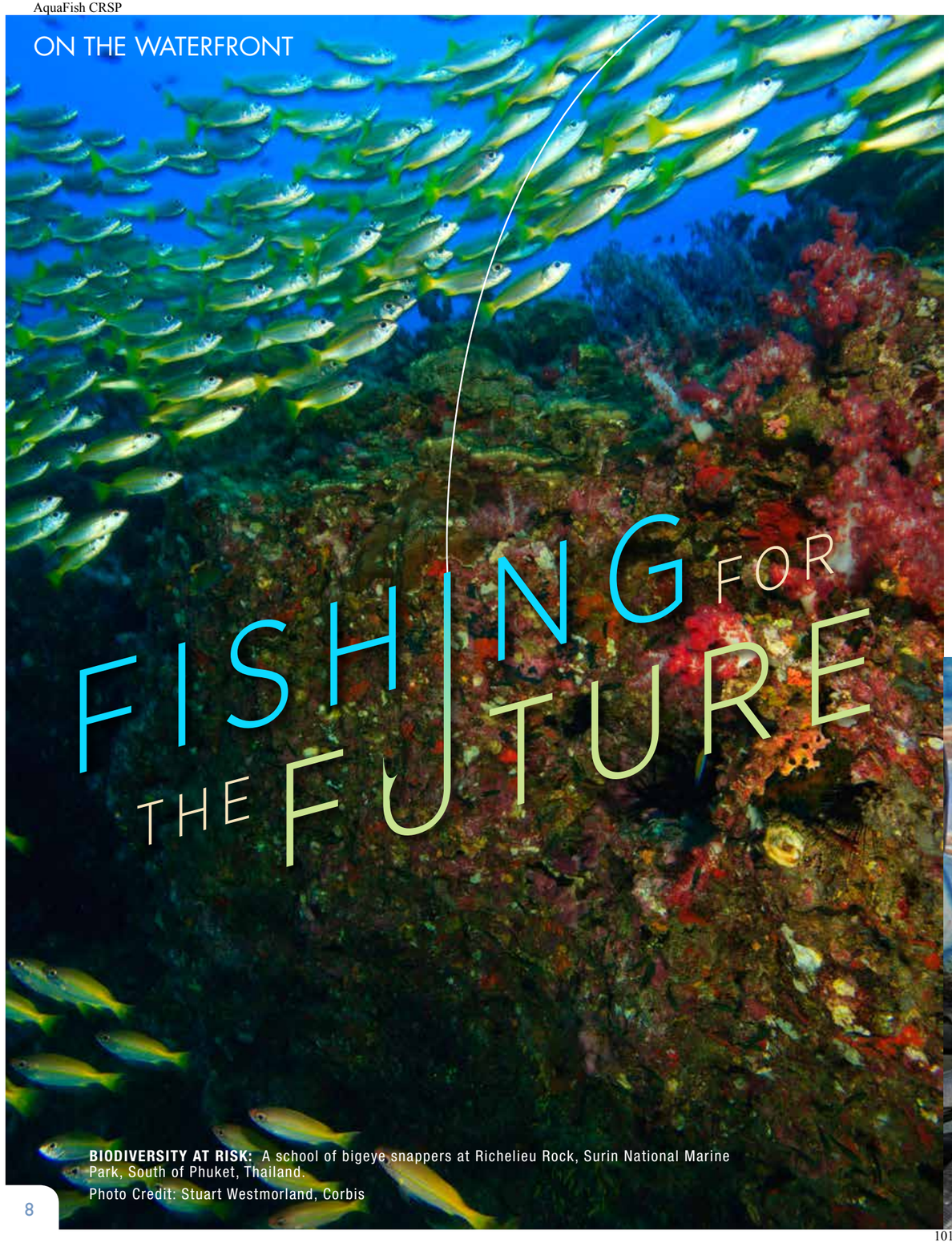
The preliminary results of these best practices have been positive. By replacing sinking fish feed with a type of feed that floats, fish farmers were able to save money on feed costs. The farmers also reduced costs by learning to reuse pond water rather than refilling ponds with new water at the beginning of each new production cycle.

Osei has now fully embraced the Feed the Future model. He has taken on a leadership role in his local fish farming community and provides training on his farm. He also hosts university student interns and sponsors outreach activities for elementary and secondary schools.

Today, with higher profits from cost savings and a commitment to a lighter environmental footprint, Osei is further expanding his aquaculture operations. In the future, he plans to start new fish farms at two other locations and process fresh fish on-site, with an eye toward entering the export market.

ON THE WATERFRONT

FISHING FOR THE FUTURE



BIODIVERSITY AT RISK: A school of bigeye snappers at Richelieu Rock, Surin National Marine Park, South of Phuket, Thailand.
Photo Credit: Stuart Westmorland, Corbis

2012 could be called the year of combating global hunger. Following on the heels of Feed the Future, the U.S. Government's flagship initiative to promote food security which launched in 2010, a number of events this year, including World Water Day, the G-20 Summit, the Rio+20 conference, and World Water Week, have zeroed in on finding solutions to this global problem affecting close to one billion people. Governments and donors alike are beginning to pay attention to the important role that aquaculture and capture fisheries can play in increasing food security and reducing poverty.

Over half a billion people, 95 percent of them from developing countries, derive income from fish, both from capture fisheries (harvesting of fish from freshwater and marine environments) and aquaculture (farming of species such as shellfish, fish, and plants). Approximately 2.6 billion people in developing countries alone rely on fish to meet their basic protein and nutritional requirements. Fish protein is especially critical in poor communities where fish products are often the most inexpensive and easily accessible source of protein. In many countries across Africa, such as Sierra Leone, The Gambia, and Ghana, more than 60 percent of dietary protein comes from fish—more than double the world average per capita consumption.

"I FELT IT WAS IMPORTANT TO ALSO FOCUS ON THE URGENT CHALLENGE THAT CONFRONTS SOME ONE BILLION MEN, WOMEN, AND CHILDREN AROUND THE WORLD EVERY DAY–THE INJUSTICE OF CHRONIC HUNGER AND THE NEED FOR LONG-TERM FOOD SECURITY."

– President Obama on May 18, 2012

JOB CREATORS: A fish seller in Yemen proudly displays his wares. Fish create jobs for over half a billion people, 95 percent of whom are from developing countries.
Photo Credit: Hamed Sanabani

"FOR THOSE WHO CANNOT AFFORD TO BUY FOOD–ESPECIALLY NOT MEAT–FISH OBTAINED THROUGH THE HOUSEHOLD'S OWN EFFORTS (SUBSISTENCE) IS ESSENTIAL."

- USAID/Global Seafood Alliance Report

Moreover, fish supplies essential fatty acids, vitamins, and minerals that are critical to human health, and especially for proper early childhood development. The pressing food security issue is not that there is a lack of fishers, but that fishing must become more sustainable if these billions and their children and grand-children are to thrive.

A Sustainable Alternative?

At present, despite the ubiquity of fish-centered livelihoods, international food security programs tend to focus first on traditional crops from farms on land to help meet the needs of the hungry. This is starting to change with the rapid expansion of the aquaculture industry, which is currently the fastest growing animal food-producing sector in the world, and USAID is now working to ensure that both aquaculture and capture fisheries are better managed. If mismanaged, both capture fisheries and aquaculture can have negative environmental impacts.

With respect to aquaculture, fish are sometimes overfed, leading to excess nutrients that cause algae to bloom. When the algae die and decompose, the ecosystem's oxygen is depleted which can result in large fish kills. If the fish feed contains chemicals like antibiotics, it can further harm the environment. In addition, raising fish in close quarters can sometimes increase the spread of disease.

At their current rate, many capture fisheries are unsustainable. Over 75 percent of global fish stocks are fully fished, over-fished, or already collapsed, making them of serious concern for global food security. Poorly managed fisheries mean that fishers must spend more time

A DELICATE BALANCE: A young girl in Ghana balances a plate of fish on her head. The majority of children in Ghana rely on fish for their essential nutrients.

Photo Credit: Kimie Tanaka

PRECARIOUS PERCHES: Stilt fishermen in Galle, Sri Lanka hold a stilt with one hand while fishing with a rod in the other.

Photo Credit: Tomas van Houtryve, VII Network

and money to bring home smaller and smaller catches. For many of the world's poor, fishing today results in a net economic drain on household income.

However, programs that work to improve capture fisheries and aquaculture management can reform and boost the sustainability of these sectors while increasing the livelihoods of the hundreds of millions of people employed in them. Food security experts are now taking heed of lessons learned and are working to identify new methods to boost fish supplies without compromising overall ecosystem health. They have pioneered ecosystem-based management approaches which, by taking a holistic approach, work to meet the diverse needs of local populations while maintaining ecosystems and conserving natural resources.

Protecting the Environment, Nutrition, and Communities

USAID is a big proponent of the ecosystem approach to fisheries management and is currently working in several countries and regions to build the capacity of decision makers and technical staff to implement it. The Indonesia Marine and Climate Support project, for example, recently trained personnel from local fisheries agencies and the Indonesian Ministry of Marine Affairs and Fisheries on best practices for ecosystem-based fisheries governance. "The trainings were developed to help plan, develop, and manage fisheries by addressing the multiple needs and desires of societies without jeopardizing the options for future generations to benefit from the full range of goods and services provided by marine ecosystems," stated Celly Catharina, Marine Program Specialist for USAID/Indonesia.

Aquaculture can also benefit from a holistic ecosystem-oriented approach. USAID's Aquaculture & Fisheries Collaborative Research Support Program (AquaFish CRSP) and its predecessor CRSPs, have, since 1982, trained fish farmers—including many women—to manage water resources, improve the environment, craft responsible business plans, and generate income in countries across Latin America, Asia, and Africa. CRSPs are research, training, and capacity building programs that are implemented by U.S. universities and their developing country partners. An AquaFish CRSP project in Ghana is exploring new feed and water recycling approaches in order to increase the profit margins of tilapia farming in an environmentally friendly way. Floating fish feeds cut costs by reducing wasted feed while also safeguarding fish populations from the damage caused by overfeeding. Reusing pond water reduces labor and input costs while conserving water.

Aquaculture programs can make a remarkable impact on the lives of women and children. In Nicaragua and Mexico, poor women and children devote hours each day to collecting cockles, shellfish that are a great source of protein and vitamins, but are susceptible to disease when


Photo Credit:
Kimie Tanaka


Photo Credit:
AquaFish CRSP


Photo Credit:
Peg Herring


Photo Credit:
Prum Somany

(Clockwise from top left)

LINING UP: Women sell fish at the market in Senegal.

AN UNCERTAIN HORIZON: Estero Aserradores lagoon in Nicaragua at sunset. Fishing and aquaculture are two of the leading industries in Nicaragua, but they are threatened by overfishing. USAID supports the establishment of protected areas in Nicaragua, which forestall the depletion of fish stocks and protect the environment.

A GROWING LIVELIHOOD: Fish farmers harvest farmed snakeheads for the market in Cambodia as part of USAID's Aquafish CRSP program.

A FULL PLATE: Hundreds of locals work, shop, and buy dried fish for their families at the Cantho market in Vietnam.

"WE WOULD GO OUT TO COLLECT COCKLES AND ONLY GET VERY FEW, AND THOSE WERE VERY SMALL. WE WEREN'T USED TO WORKING IN A TEAM; EVERYONE WAS JUST OUT TO GET WHAT THEY COULD."

– Dionisia Páramo,
resident of Asseradores,
Nicaragua and cockle collector

farmed. The dwindling supplies and quality of the cockles led to long hours spent collecting them, fighting among the cockle collectors, and a growing number of hungry children. "We would go out to collect cockles and only get very few, and those were very small. We weren't used to working in a team; everyone was just out to get what they could," explained Dionisia Páramo, a cockle collector from Aserradores, Nicaragua.

AquaFish CRSP took steps to boost the quality and safety of the cockles by establishing a center to clean them, ensuring that they are free of diseases. This not only makes them safe for local consumption, but also allows the farmers to certify the fish and get a higher price for them. The program additionally supports coastal resource governance and the establishment of no-take zones, which boost overall cockle supplies. This has made a big difference to women like Dionisia in the cockle industry. "We are now organized and us women, we have been empowered. We now lead the conservation efforts for the forest, mangrove, and black cockle. We now respect the no-take zones because we know the areas where the cockles will be breeding," Ms. Páramo said.

Capture fisheries and aquaculture programs do not just foster food security, but also boost health, incomes, and quality of life for millions when carried out in an environmentally friendly way. If well managed, they can be capable of feeding the future. Perhaps 2013 will be the year of the fish.

FOR MORE INFORMATION, VISIT:
CRSP Digest
CRSP Digest on Vimeo
Indonesia Marine and Climate Support Project

5. RESEARCH MANAGEMENT & OPERATIONS

The CRSP model is based on international partnership and collaboration with a goal to provide long-term support to solve food problems and to improve agricultural systems in developing countries. Teams of U.S. and Host Country researchers, administrators, service personnel, and students implement a cohesive program of research, outreach, and training in participating Host Countries and the United States.

From it's inception in 2006, AquaFish CRSP has been managed in a manner to achieve maximum program impacts, particularly for small-scale farmers and fishers, in Host Countries and more broadly. CRSP program objectives addressed the need for world-class research, capacity building, and information dissemination. Specifically, since 2006 AquaFish CRSP has strived to:

The Mission of AquaFish CRSP
is to enrich livelihoods and promote health by cultivating international multidisciplinary partnerships that advance science, research, education, and outreach in aquatic resources. Bringing together resources from U.S. and Host Country institutions, AquaFish CRSP strives to strengthen the capacities of its participating institutions, to increase the efficiency of aquaculture and improve fisheries management in environmentally and socially acceptable ways, and to disseminate research results to a broad audience.

- Develop sustainable end-user level aquaculture and fisheries systems to increase productivity, enhance international trade opportunities, and contribute to responsible aquatic resource management;
- Enhance local capacity in aquaculture and aquatic resource management to ensure long-term program impacts at the community and national levels;
- Foster wide dissemination of research results and technologies to local stakeholders at all levels, including end-users, researchers, and government officials; and
- Increase Host Country capacity and productivity to contribute to national food security, income generation, and market access.

AquaFish CRSP has focused on aquaculture and the nexus between aquaculture and fisheries, targeting high priority constraints facing poorer countries. Over the past twenty years, great progress has been made in increasing fish production through aquaculture, yet challenges still face the sector in terms of pressures from global trade, environmental impacts, water use conflicts, and distribution of and access to benefits. The capture fisheries sector, which supplies the major share of the world's fishery products, is also experiencing great challenges that must be overcome for the sustainable management of fish stocks and livelihood security of fishing communities.

MANAGEMENT ENTITY

Primary management responsibilities for AquaFish CRSP has been vested in Oregon State University, called the "Management Entity" (ME), the institution with the legal status of a juridical body that

administered the award from USAID and managed the total research program. The ME's functions included the following:

- Received and administered USAID award funds for AquaFish CRSP.
- Entered into subcontract agreements with participating U.S. and Host Country institutions for their respective projects.
- Held responsibility for the program and was accountable to USAID for all expenditures.
- Reported on the program and represented AquaFish CRSP in dealings with USAID, and internationally. Through sub-agreements, held participating institutions responsible for programs and accountable for use of funds.
- Developed, with participating institutions, a system for effective management of the program and control and accounting of funds, including matching resources contributed by participating institutions.

The ME nominated a Director to administer AquaFish CRSP. The nomination was approved by USAID. The Director was responsible for technical and scientific oversight and administers AquaFish CRSP through the Management Office. As the decision-making body on fiscal and programmatic matters, the Management Office was advised in this function by the Emerging Issues Panel (EIP) and External Program Advisory Council (EPAC). The Director appointed staff as needed for overall leadership and implementation of AquaFish CRSP. A list of key AquaFish CRSP Management Office personnel since 2006 can be found in Appendix 1.

ADVISORY BODIES

Advisory bodies provided input and recommendations that assist AquaFish CRSP in fulfilling its mission and meeting global thematic goals. The advisory bodies were: the External Program Advisory Council (EPAC); Emerging Issues Panel (EIP); Development Theme Advisory Panel (DTAP); and the Regional Centers of Excellence (RCE). Representatives from industry, grower organizations, feed companies, trade organizations, and other private sector entities could participate in an *ex-officio* capacity on the DTAPs and RCEs. The USAID AOTR had input into the selection of Lead Coordinators and was invited to participate in DTAP and RCE group meetings. Host Country stakeholders could become *ex-officio* members of the RCEs. Lists of advisory body members can be found in Appendix 1.

Figure 5.1 illustrates the relationships between the ME and the internal and external advisory panels as well as the program relationship between USAID and AquaFish CRSP. Table 2.1-1 provides an overview of advisory panel membership, roles, and responsibilities.

The External Program Advisory Council

The External Program Advisory Council (EPAC) was a policy-setting programmatic advisory panel. It was composed of specialists who are external to the program. Panel members were drawn from the international aquatic resources community. The members were selected so that they collectively covered the substance of AquaFish CRSP, including socioeconomic factors that influence research and adoption of technology generated from research. Duties of the EPAC were to:

- Provide advice to the Management Office on global program direction.
- Provide input into AquaFish CRSP RFPs.
- Provide annual critiques of research projects during annual or regional meetings to assist the Management Office in gauging performance.

- Identify gaps and issues emergent from the global portfolio as projects are implemented.
- Participate in the programmatic review process for proposals on an as-needed basis provided there are no conflicts of interest.
- Provide information on potential linkages with others (FAO, WB, NGOs, IARCs, etc.).

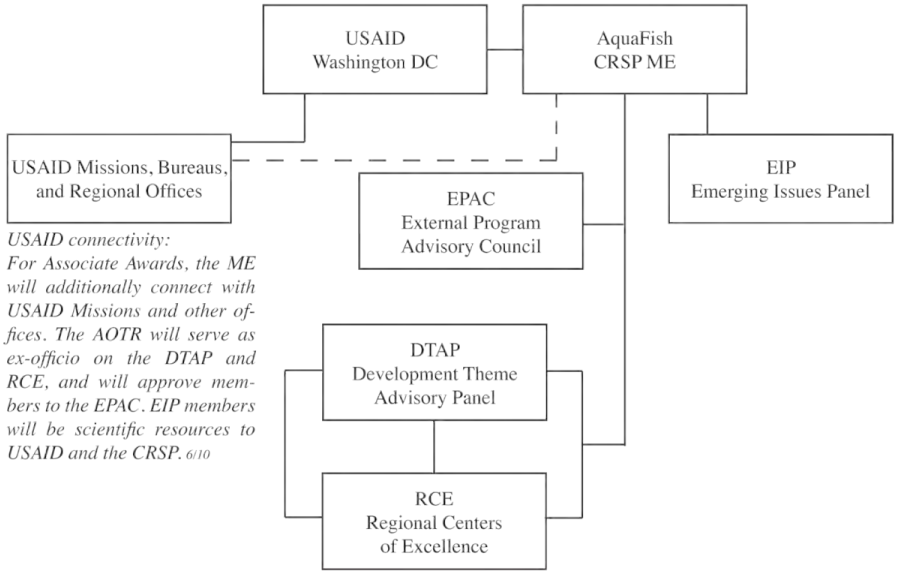


Figure 5.1. USAID and ME Advisory Relationships under the CA/LW Award

Most EPAC members came from government, NGOs, IARCs, and other donor agencies. The ME sought AOTR concurrence for any new EPAC members. EPAC members could rotate off the Council after serving for three years and must resign from the Council if they develop a conflict of interest — for example, participating in a CRSP-funded project activity. The USAID AOTR and AquaFish CRSP Director served as *Ex-officio* members.

The EPAC met as necessary to plan activities and develop recommendations. The EPAC and Management Office jointly planned EPAC meetings. Any action required by the EPAC could be taken by mail ballot or poll by phone. Such consent had the same force and effect as an action duly adopted at a meeting of the EPAC. Annual EPAC critiques were sent to USAID for review, and subsequently made available to program participants. EPAC members did not undertake program evaluations.

The Emerging Issues Panel

The Emerging Issues Panel (EIP) was a non-voting, non-policy setting technical advisory panel that provided scientific advice from across the broad spectrum of aquaculture, fisheries, and water resources sectors to the Management Office. It also provided a scientific resource to USAID. EIP members were Oregon State University faculty and other experts who volunteered their time to serve on the panel. EIP members did not engage in CRSP activities and were not considered CRSP staff. Safeguards were taken to eliminate conflicts of interest.

Development Theme Advisory Panel
Development Theme Advisory Panel (DTAP), headed by the Lead Coordinator, was responsible for reviewing annual reports and investigation work plan changes; recommending project adjustments in cases where research is curtailed for various reasons (e.g., laboratory equipment malfunction; poaching; etc.); performing assessments; and working together to provide quality information for thematic synthesis and lessons learned reporting. The DTAPs also recommended policies for technical hot-issues, e.g., certification for organic standards, biotechnology applications, and toxics standards for fish consumption. At the end of each Fiscal Year, Lead Coordinators were responsible for submitting an overview report for his/her respective DTAP Panel (A, B, C, or D), which collectively summarizes program accomplishments across the fiscal year. The Lead Coordinator's report was based on an annual compilation of DTAP reports submitted by each project, which was prepared by the Management Office.

The four Lead Coordinators that served from FY2006 to FY2012 were:
DTAP A: Maria Haws (University of Hawaii at Hilo)
DTAP B: Kwamena Quagrainie (Purdue University)
DTAP C: Jim Diana (University of Michigan)
DTAP D: Robert Pomeroy (University of Connecticut – Avery Point

Regional Centers of Excellence
Regional Centers of Excellence (RCE) provided technical advice on emerging issues and gaps in the portfolio from a regional perspective. They developed useful materials for USAID Missions, other regional stakeholders and end-users, and gauged opportunities for collaboration based on regional or national needs. The African RCEs also coordinated, synthesized, and reported on activities related to meeting USAID's IEHA goals.

Each RCE was headed by a Lead Coordinator who was selected from the HC Lead PIs in the region (Table 2.6-1). Lead Coordinators (one for each center) took an active role in integrating Associate Award partners into the portfolio and in managing any Associate Awards that fell under its purview. Lead Coordinators also assisted the Management Office in cases where a screening process was required in advance of an *Initial Environmental Examination*.

Table 5.1. AquaFish CRSP RCEs and Lead Coordinators

Region	Lead Coordinator	Institutional Affiliation
East & Southern Africa	Charles Ngugi	Kenyatta University (Kenya)
West Africa	Héry Coulibaly	Direction Nationale de la Pêche (Mali)
Asia	Remedios Bolivar	Central Luzon State University (Philippines)
Latin America & the Caribbean	Wilfrido Contreras	Universidad Juárez Autónoma de Tabasco (Mexico)

PROJECT STRUCTURE

The general framework governing interaction among the participants of AquaFish CRSP was provided in the Leader Award as well as in USAID rules and regulations. More specific requirements were detailed in Memoranda of Understanding (MOU) and subcontracts. Subcontracts were the preferred legal instrument between the ME and another U.S. institution. MOUs were negotiated between U.S. institutions and HC institutions and between units of a single institution.

US Lead Institutions
US Lead Institutions were identified on the basis of their expertise and capacity in specific areas of science and their ability to conduct collaborative research in support of approved objectives. An AquaFish CRSP U.S. Lead Institution was responsible for implementing one or more investigations within one or more regional projects. U.S. Lead Institutions had a subcontract with the ME at Oregon State University (OSU).

Host Country Institutions
Host Country (HC) Institutions were identified on the basis of their expertise and capacity in specific areas of science and their ability to conduct collaborative research in support of approved objectives. An HC Institution partnered with U.S. Institutions on one or more components and activities within a regional project. HC Institutions had a subcontract with U.S. Lead Institutions. An HC Institution may have had sub-contracts with multiple U.S. Lead Institutions.

Project Personnel
Project Personnel comprised the professional staff engaged in the CRSP work in the U.S. and Host Country institutions affiliated with the project. Definitions for key project personnel at US and HC Institutions are:

- **US Lead Project PI**: PI at the US Lead Institution managing the project (1 per project).
- **US Co-PI**: Lead investigator at each US partner institution with a contractual relationship with the US Lead institution (1 per institution).
- **US Investigator**: Researcher working at a US Lead or contractual partner institution (can be 1 or more per institution).
- **US Research Assistant**: Non-student employee assisting with research at a US Lead or contractual partner institution (can be 1 or more per institution).
- **US Collaborator**: Researcher or cooperator offering services through a non-contractual agreement and with no monetary connection to the US Lead or partner institutions (can be 1 or more per institution).
- **HC Lead PI**: PI at the HC Lead Institution for the project (1 per project).
- **HC Co-PI**: Lead investigator at each HC contractual partner institution other than the HC Lead institution (1 per institution).
- **HC Investigator**: Researcher working at an HC Lead or contractual partner institution (can be 1 or more per institution).
- **HC Research Assistant**: Non-student employee assisting with research at an HC Lead or contractual partner institution (can be 1 or more per institution).

- **HC Collaborator**: Researcher or cooperator offering services through a non-contractual agreement and with no monetary connection to the US/HC Lead or partner institutions. (can be 1 or more per institution).

PROJECT PROPOSAL AND AWARD PROCESS

The ME solicited proposals in an open competition with a Request for Proposals (RFP) posted on the AquaFish CRSP website at: aquafishcrsp.oregonstate.edu/rfp.php and disseminated widely through various channels including list serves and targeted web sites. RFPs released in 2006, 2008, and 2009 are included in Appendices 8, 9, and 10, respectively.

Under the direction of the ME, an NSF-style external peer-review panel reviewed the proposals for technical merit and recommended finalists for AquaFish CRSP funding. Proposals that received favorable technical reviews then underwent a programmatic review administered by the ME with input from USAID and advisory groups such as the EPAC. Highly ranked finalist also received USAID Mission concurrence.

The ME entered into contractual agreements with each U.S. Lead Institution selected to participate in the AquaFish CRSP program. The subcontract obligated funds and passed certain authority and responsibility from the ME to the U.S. Lead Institution. Each U.S. Lead Institution was legally bound to adhere to the guidelines and requirements set forth in subcontract. Subcontracts commonly included attachments that contain work plans, budgets, and reporting requirements. By executing the subcontracts, participating institutions certified that they have the institutional and human capacity to perform the work described in the subcontract.

To facilitate technical and fiscal management of subawards, all Core Research Project activities fell into one of two implementation plan periods:

- Implementation Plan FY2007-FY2009
- Implementation Plan FY2009-FY2011

Each Implementation Plan required US Lead Institutions to submit separate work plans and budgets for review. Final investigation reports for work conducted under each Implementation Plan can be found online at http://aquafishcrsp.oregonstate.edu/publications.php.

US Lead Institutions entered into formal relationships with partnering HC Institutions. The relationships between the ME, US Institutions, and HC Institutions as supported by documented MOU or subcontract for Implementation Plan 2007-2009 and Implementation Plan 2009-2011 are illustrated in Figures 2 and 3.

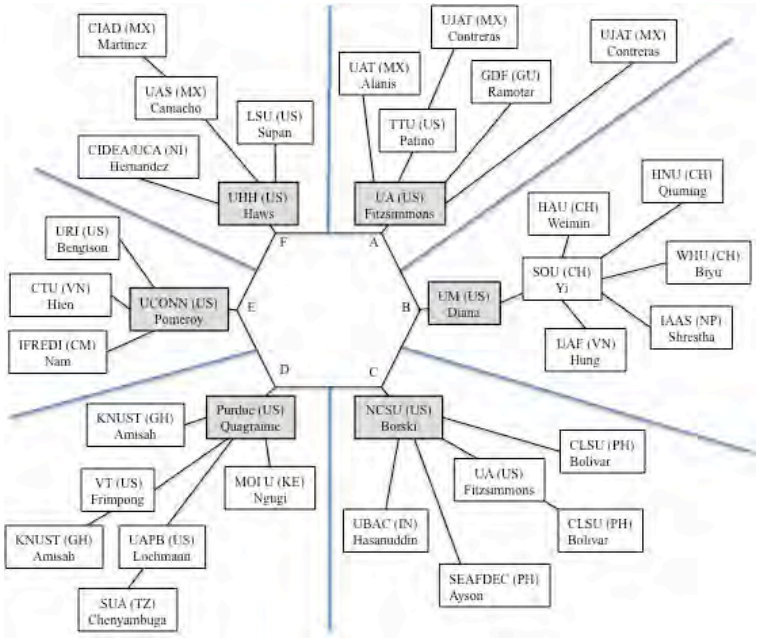


Figure 5.2. *Relationships between the ME, US, and HC Institutions for Implementation Plan 2007-2009 as supported by documented MOU or subcontract.*

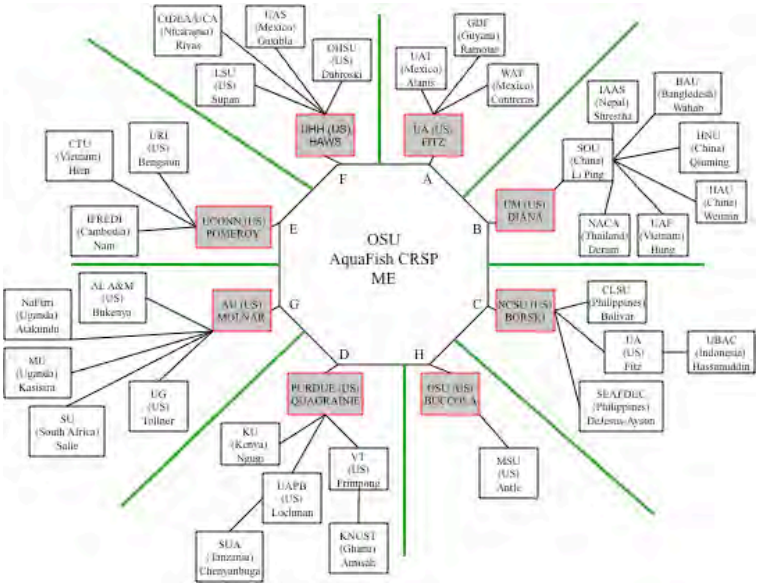


Figure 5.3. Relationships between the ME, US, and HC Institutions for Implementation Plan 2009-2011 as supported by documented MOU or subcontract.

PERFORMANCE REPORTING

Required reports and deliverables were submitted to the Management Office to monitor and evaluate project performance. Two categories of performance reports and deliverables encompassed the outputs whose completion served as the primary measure for evaluating project compliance:

(a) Investigation deliverables and reporting commitments made in the sub-award narrative and codified in the Implementation Plan (IP); and
(b) Project-wide requirements such as Lessons Learned as specified in the Attachment III of the sub-award (see Appendix 7).

Table 5.2 lists the performance reports for which all projects were responsible over the course of each Implementation Plan period. A compliance summary for all 106 investigations funded during Implementation Plans 2007-2009 and 2009-2011 is provided in Table 5.5.

Table 5.2. Schedule for Required Performance Reports Schedule

Report Type	When Submitted	Time Period Covered	Submission Frequency
Quarterly Report	1st, 2nd & 3rd Quarters	FY Quarter	each Quarter
Annual Report	4th Quarter	Cumulative across FY	each FY
DTAP Report	4th Quarter	Cumulative across FY	each FY
Trip Reports	Quarter in which trip occurred	Duration of trip	for each trip
Final Technical Reports	at investigation end	n/a	1x only for each investigation
Lessons Learned	before end of IP period	Cumulative for IP period	1x only during IP period*
Success Story or Policy Brief	before end of IP period	Cumulative for IP period	1x only during IP period*
Aquanews article	before end of IP period	Cumulative for IP period	1x only during IP period*
Outreach Document	before end of IP period	Cumulative for IP period	1x only during IP period*
Quantifiable Economic Benefits Statement	by end of IP period	Cumulative for IP period	1x only during IP period*
Investigation Deliverables†	by end of IP period	IP period	1x only for each specified deliverable

*Submission of these reports was required under each IP; therefore, a total of two were submitted during the 5-year period of this USAID award.

†Deliverables were unique to investigations and included a variety of items such has long-term and short-term training reports, Fact Sheets, BMPs, website postings, policy recommendations, survey reports, etc. For details on publication, acknowledgments, and branding and marking of these outputs, see the Policy and Operating Procedures Manual.

Quarterly/Annual Reports

Quarterly and Annual Reports were required to report progress on a quarterly basis. For the 4th Quarter, the report was cumulative, summarizing progress across the year, and was considered the Annual Report. Quarterly and Annual Reports supply similar types of information, and included:

- Progress reports
- Project personnel updates
- Training updates
- Conferences attended
- Publications submitted, accepted, etc
- Travel update
- Updates on leveraged funding
- Additional information.

DTAP Reports

DTAP Reports were required to be submitted by each project annually. The DTAP indicators were tied to the four AquaFish CRSP global themes (Table 5.3). They provided data that the Management Office used to report on the USAID EGAT indicators. They also provided data to draw upon for measuring performance under the benchmarks for the key development targets of the AquaFish CRSP *Monitoring & Evaluation Plan*. Projects were required to report on each investigation under all applicable indicators for activities and accomplishments for the fiscal year.

Table 5.3 AquaFish DTAP Indicators

DTAP A: **Improved Health and Nutrition, Food Quality, and Food Safety**	A-01	Number of aquaculture products developed to improve food safety or quality
DTAP B: Income Generation for Small-Scale Fish Farmers and Fishers	B-01	Number of new technologies developed
	B-02	Number of institutions with access to technological practices
	B-03	Number of (people) trained in use of technological practices
DTAP C: Environmental Management for Sustainable Aquatic Resources Use	C-01	Number of management practices developed or adopted to improve natural resource management (*includes IPM*)
	C-02	Number of additional hectares under improved technologies or management practices
	C-03	Number of management practices developed to support biodiversity
	C-04	Number of people trained in practices that promoted soil conservation and/or improved water quality
DTAP D: Enhanced Trade Opportunities for Global Fishery Markets	D-01	Number of new markets for aquatic products
	D-02	Number of aquatic products available for human food consumption.

Outreach Documents
Outreach Documents were associated with one or more investigations and were targeted at Host Country stakeholders such as fishers, farmers, vendors, and extensionists. Outreach documents included brochures, fact sheets, manuals (Extension, How-To, etc), podcasts, posters (non-conference), workshop proceedings, and videos.

Lessons Learned
Lessons Learned reported on experiences and events that influenced work progress or accomplishments either positively or negatively and describe the experiences and events as well as their effects on scheduling and work progress. Lessons Learned reports also included, as appropriate, new insights gained, recommendations for future investigation focus, and perspectives that would improve investigation or project success. Lessons Learned reports focused on a given investigation or group of investigations or the entire project.

Success Stories/Policy Briefs
Success Stories or Policy Briefs were intended for a general audience. Success Stories report on investigation or project success, illustrating accomplishments. Policy Brief**s** reported on management recommendations developed for presentation to Host Country policy makers.

Aquanews Article
Aquanews Articles reported on progress and accomplishments of investigation- or project-level work. The articles focused on research, training, or activities that exemplified AquaFish CRSP goals. Articles appeared in the AquaFish CRSP newsletter Aquanews, published quarterly.

Quantifiable Benefits Statement
Quantifiable Benefits Statement reported on the quantifiable economic benefits and their primary beneficiaries that are realized from CRSP information, technologies (including products), or management practices developed by the project during the IP period.

PLANNING & IMPLEMENTATION OF TRAINING AND CAPACITY BUILDING

Participant training was a major means of assisting in the development of high-level skills and institutional leadership and was an essential component of the CRSP's development strategy. Principal Investigators planned short- and long-term training according to HC Institutional needs and gaps in aquaculture and fisheries expertise in the host countries. Each participating lead institution proposed short- and long-term training in its implementation plan, including the number and locations of short-term training events and the number of students to be trained. This information from all the lead institutions was then compiled into the "AquaFish CRSP Training Plan" available online at http://aquafishcrsp.oregonstate.edu/training/.

The following guidelines were used by the lead institutions when planning and implementing training for their projects to ensure efficient delivery with the maximum development impact:

- Long-term training is academic training at the undergraduate and graduate levels.
- Short-term training is non-academic training that does not lead to a degree or certification.

- Alternative funding sources should be sought to provide financial support for students so as to be economical and supplement CRSP support.
- Training HC students should take priority over training students from the U.S., other developing countries, and "USAID-graduate" countries.
- Students should be sent to the institutions that best meet their training needs. Supporting and strengthening HC educational institutions are very important. Whenever possible, HC, regional, and other developing country training institutions should be used for training. However, it is understood that in many cases, CRSP institutions have special advantages for training due to their particular areas of strength and the integrated nature of CRSP research and graduate training.
- Degree training should be equally available to men and women.
- Students conducting thesis research in the U.S. must focus their investigations on areas that contribute to the achievement of the research objectives outlined in their projects' implementation plans.
- The training of U.S. graduate students is also important. Their research should have direct relevance to the objectives of the CRSP project, and the students should have a sincere interest in international development. It is recognized that CRSP research activities provide opportunities for U.S. students to gain international development experience.
- If U.S. students are to be trained, each project should make an effort to train African-American, Hispanic and other U.S. minorities.
- Participant training conducted in the U.S. is limited to fields of study for which training is not available in the HC, regionally, or in a third country; for which U.S. training is cost-effective; or which support other strategic considerations such as the exposure of key leaders to U.S. institutions and practices.
- AquaFish CRSP has no implicit preference for one form of training over another, but it does expect that cost-effective training options, including training in HC or third-country institutions, will be explored before relatively expensive training at U.S. institutions is recommended.
- All feasible steps should be taken to ensure that CRSP-sponsored trainees return to work in their home countries in positions where their training is utilized effectively.

AquaFish CRSP emphasized the training of developing country scientists, technicians, and administrators/managers for three purposes: 1) capacity building for staff at participating HC institutions; 2) strengthening of key development institutions; and 3) establishment of local training capacities.

Gender Strategies were included in all project proposals. AquaFish CRSP set a 50% target for women's participation in training opportunities. Where relatively few women participate, project leaders clarified the circumstances and what initiatives were taken to increase the number of women participants in training programs. Details of the AquaFish CRSP gender strategy can be found online at http://aquafishcrsp.oregonstate.edu/Gender/.

TRAVEL

All travel funded by AquaFish CRSP was in direct support of CRSP activities. The US or HC Lead PIs approving either domestic or international travel must have had funds budgeted for that travel and ensured that the AquaFish CRSP travel approval protocols were followed.

International travel was considered *any travel that crossed any international border* — travel from one Host Country to another, or to a non-Host Country; travel from the Host Country to the U.S.; or travel from the U.S. to a Host Country or non-Host Country. All international travel was pre-authorized by USAID.

Domestic travel within a Host Country, which is funded by AquaFish CRSP, was budgeted by the subcontract. Domestic travel required formal approval from either the US or HC Lead PI. Travel requests were submitted and approved prior to the scheduled trip. Each project was responsible for establishing its own procedures for processing domestic travel requests, e.g., travel request submission schedule, approval hierarchy, etc.

Domestic travel within the US on CRSP business was budgeted by the subcontract or award. Pre-approval by USAID was not required. However, institutional travel requirements still applied for investigators, graduate students, and program personnel. Host Country personnel whose international travel included several U.S. destinations listed all U.S. destinations on the CRSP *International Travel Request Form.*

The Management Office assigned each authorized trip that was listed in the subcontract a unique identifier known as the *Trip Authorization Number*. This number was used in all correspondence related to a given trip, including on the *International Travel Request Form*, in the Trip Report, and in communications with the Management Office regarding a given trip. Data regarding trip authorization, travel request forms, and trip report were maintained in an online database and was accessible to both the MT and project participants.

ACKNOWLEDGMENT AND BRANDING & MARKING

Acknowledgement of AquaFish CRSP Support
CRSP participants acknowledged AquaFish CRSP and USAID support in research reports, outreach materials, promotional media, videos, and any other forms of print, electronic, audio, or mass media used to report CRSP work. As appropriate, disclaimer statements were also include.

Acknowledgment of CRSP support also occurred in research reports, including research manuscripts in a journal, conference proceedings volumes, or other professional publications and included an acknowledgment of AquaFish CRSP funding support, internal AquaFish CRSP Accession Number and the USAID award number in the *Acknowledgments* section of the publication.

Oral presentation at a professional meeting or other meetings where CRSP research was featured, included an acknowledgment of USAID and AquaFish CRSP support in the final slide.

Branding & Marking
AquaFish CRSP communicated research results, program activities, events, educational materials, and opportunities to a variety of audiences that ranged from policymakers, students, and seasoned aquatic resource researchers to host country governments, NGOs, extension agents, hatchery workers, and rural farmers. AquaFish CRSP adhered to USAID branding and marking rules.

All outputs produced by the Management Entity or funded institutions in the U.S. and Host Countries displayed the logos for USAID and AquaFish CRSP alongside the logos for the host institutions. Logos for USAID, AquaFish CRSP, OSU (as appropriate), and the other U.S. and HC institutions were prominently placed. Outputs included the following:

- Print and electronic documents
- Electronic media (videos, podcasts, DVDs, PowerPoint or slide presentations)
- Websites
- Presentations at professional, public, or private meetings, symposia, or conferences
- Press releases
- AquaFish CRSP and its collaborators appropriately marked events financed by USAID, such as training courses, conferences, seminars, exhibitions, fairs, workshops, press conferences, and other public activities with the USAID Identity.

RESEARCH PORTFOLIO OVERVIEW

The overall research context for the projects described in this *Final Report* is poverty alleviation and food security improvement through sustainable aquaculture development and aquatic resources management. Discovery of new information formed the core of projects. Projects also included institutional strengthening, outreach, and capacity building activities such as training, formal education, workshops, extension, and conference organizing to support the scientific research being conducted. Projects focused on USAID-eligible countries and received USAID country-level concurrence prior to award.

Global AquaFish CRSP Project Themes (Goals)

A. Improved Health and Nutrition, Food Quality, and Food Safety
B. Income Generation for Small-Scale Fish Farmers and Fishers
C. Environmental Management for Sustainable Aquatic Resources Use
D. Enhanced Trade Opportunities for Global Fishery Markets

Each project had one AquaFish CRSP theme as its primary focus, but addressed all four themes in an integrated systems approach. The global themes of the CRSP were cross-cutting and addressed several specific USAID policy documents and guidelines.

System Approach and Topic Areas

Under Implementation Plans 2007-2009, 2009-2011, and their respective addenda, 106 investigations were conducted with a distribution by Systems Approach of 51 for *Integrated Production Systems* and 55 for *People, Livelihoods, & Ecosystem Interrelationships* (Table 5.4). Projects included 19 countries, 17 US Universities and 31 HC institutions in formal funded partnerships.

Core Research Projects had work plans (investigations) organized around a number of specific areas of inquiry called Topic Areas. Each project contained between five and eight investigations. Projects focused on more than one topic area in describing aquaculture research to improve diets, generate income for smallholders, manage environments for future generations, and enhance trade opportunities.

Table 5.4. AquaFish Core Research Project Investiations by Systems Approach and Topic Area conducted from FY2007 through FY2012.

SYSTEMS APPROACH	TOPIC AREA	NUMBER OF INVESTIGATIONS COMPLETED
Integrated Production Systems		
	Indigenous Species Development (IND)	14
	Quality Seedstock Development (QSD)	7
	Sustainable Feed Technology (SFT)	13
	Production System Design & Best Management Alternatives (BMA)	17
People, Livelihoods, & Ecosystem Interrelationships		
	Human Health Impact of Aquaculture (HHI)	7
	Technology Adoption & Policy Development (TAP)	11
	Marketing, Economic Risk Assessment, & Trade (MER)	14
	Mitigating Negative Environmental Impacts (MNE)	14
	Watershed & Integrated Coastal Zone Management (WIZ)	5
	Food Safety & Value-Added Product Development (FSV)	4
	Total	106

A systems approach required that each CRSP project integrate topic areas from *Integrated Production Systems* and *People, Livelihoods and Ecosystem Interrelationships.* USAID also encouraged the CRSP to address biodiversity conservation and non-GMO biotechnology solutions to critical issues in aquaculture.

Projects were formed around *core program components*, as identified by USAID:

- a systems approach
- social, economic, and environmental sustainability
- capacity building and institution strengthening
- outreach, dissemination, and adoption
- gender integration

Topic Areas pertained to aquaculture and the nexus between aquaculture and fisheries. Some of the following topic areas overlap and are interconnected. Investigations were categorized under a single topic area that best describes each individual investigation. The text under each topic area is illustrative and not prescriptive. Fisheries-only issues were not funded with core EGAT funds per guidance from USAID.

Topic Areas: Integrated Production Systems

- ***Production System Design & Best Management Alternatives (BMA)***

Aquaculture is an agricultural activity with specific input demands. Systems should be designed to improve efficiency and/or integrate aquaculture inputs and outputs with other agricultural and non-agricultural production systems. Systems should be designed so as to limit negative environmental

impacts. CRSP research should benefit smallholder or low- to semi-intensive producers, and focus on low-trophic species for aquaculture development. Research on soil-water dynamics and natural productivity to lessen feed needs were fundamental to the Aquaculture CRSP; critical new areas of research may be continued. Interventions for disease and predation prevention must adopt an integrated pest management (IPM) approach and be careful to consider consumer acceptance and environmental risk of selected treatments.

- ***Sustainable Feed Technology (SFT)***

Methods of increasing the range of available ingredients and improving the technology available to manufacture and deliver feeds are an important research theme. Better information about fish nutrition can lead to the development of less expensive and more efficient feeds. Investigations on successful adoption, extension, and best practices for efficient feed strategies that reduce the "ecological footprint" of a species under cultivation are encouraged. Feed research that lessens reliance on fishmeal/proteins/oils and lowers feed conversion ratios is desired, as is research on feeds (ingredients, sources, regimes, formulations) that result in high quality and safe aquaculture products with healthy nutrition profiles.

- ***Indigenous Species Development (IND)***

Domestication of indigenous species may contribute positively to the development of local communities as well as protect ecosystems. At the same time, the development of new native species for aquaculture must be approached in a responsible manner that diminishes the chance for negative environmental, technical, and social impacts. Research that investigates relevant policies and practices is encouraged while exotic species development and transfer of non-native fishes are not encouraged. A focus on biodiversity conservation and biodiversity hotspots, as related to the development of new native species for aquaculture is of great interest. Aquaculture can be a means to enhance and restock small-scale capture and wild fisheries resources (Aquaculture-Fisheries Nexus Topic Area). Augmentation of bait fisheries through aquaculture to support capture fisheries is an area of interest, provided there are no net negative environmental effects.

- ***Quality Seedstock Development (QSD)***

Procuring reliable supplies of high quality seed for stocking local and remote sites is critical to continued development of the industry, and especially of smallholder private farms. A better understanding of the factors that contribute to stable seedstock quality, availability, and quantity for aquaculture enterprises is essential. Genetic improvement (e.g., selective breeding) that does not involve GMOs may be needed for certain species that are internationally traded. All genetic improvement strategies need to be cognizant of marketplace pressures and trends, including consumer acceptance and environmental impacts.

Topic Areas: People, Livelihoods, & Ecosystem Interrelationships

- ***Human Health Impacts of Aquaculture (HHI)***

Aquaculture can be a crucial source of protein and micronutrients for improved human health, growth, and development. Research on the intrinsic food quality of various farmed fish for human consumption is needed—this might include science-based studies of positive and negative effects of consuming certain farmed fishes. Patterns of fish consumption are not well understood for many subpopulations. Human health can be negatively impacted by aquaculture if it serves as a direct or indirect vector for human diseases. There is interest in better understanding the interconnectedness of aquaculture production and water/vector-borne illnesses such as malaria, schistosomiasis, and Buruli ulcer and human health crises such as HIV/AIDS and avian flu.

- ***Food Safety & Value-Added Product Development (FSV)***

Ensuring high quality, safe, and nutritious fish products for local consumers and the competitive

international marketplace is a primary research goal. Efforts that focus on reducing microbial contamination, HACCP controls and hazards associated with seafood processing, value-added processing, post-processing, and by-product/waste development are of interest. Consumers and producers alike will benefit from research that contributes to the development of standards and practices that protect fish products from spoilage, adulteration, mishandling, and off-flavors. Certification, traceability, product integrity, and other efforts to improve fish products for consumer acceptance and international markets are desired. Gender integration is important to consider as women are strongly represented in the processing and marketing sectors. (Aquaculture-Fisheries Nexus Topic Area)

- ***Technology Adoption & Policy Development (TAP)***

Developing appropriate technology and providing technology-related information to end-users is a high priority. The program encourages research that results in a better understanding of factors and practices that set the stage for near-term technology implementation and that contribute to the development of successful extension tools and methods. Areas of inquiry can include institutional efforts to improve extension related to aquaculture and aquatic resources management; science-based policy recommendations targeting poor subpopulations within a project area, or more broadly (for example, national aquaculture strategies); methods of improving access to fish of vulnerable populations including children (e.g., school-based aquaculture programs); science-based strategies for integrating aquaculture with other water uses to improve wellbeing, such as linkages with clean drinking water and improved sanitation. Policy initiatives that link aquaculture to various water uses to improve human health are needed. Additionally, social and cultural analyses regarding the impacts of fish farming may yield critical information for informing policy development.

- ***Marketing, Economic Risk Assessment & Trade (MER)***

Aquaculture is a rapidly growing industry and its risks and impacts on livelihoods need to be assessed. Significant researchable issues in this arena include cost, price, and risk relationships; domestic market and distribution needs and trends; the relationships between aquaculture and women/underrepresented groups; the availability of financial resources for small farms; and the effects of subsidies, taxes, and other regulations. Understanding constraints across value chains in local, regional, and international markets is of interest, especially as constraints affect competitiveness, market demand, and how to link producers to specific markets. **(**Aquaculture-Fisheries Nexus Topic Area)

- ***Watershed & Integrated Coastal Zone Management (WIZ)***

Aquaculture development that makes wise use of natural resources is at the core of the CRSP. Research that yields a better understanding of aquaculture as one competing part of an integrated water use system is of great interest. The range of research possibilities is broad—from investigations that quantify water availability and quality to those that look into the social context of water and aquaculture, including land and water rights, national and regional policies (or the lack thereof), traditional versus industrial uses, and the like. Water quality issues are of increasing concern as multiple resource use conflicts increase under trends toward scarcity or uneven supply and access, especially for freshwater. Ecoregional analysis is also of interest to explore spatial differences in the capacities and potentials of ecosystems in response to disturbances. Innovative research on maximizing water and soil quality and productivity of overall watersheds is of interest. Pollution is a huge concern, as over 50% of people in developing countries are exposed to polluted water sources. Additionally, aquatic organisms cannot adequately grow and reproduce in polluted waters, and aquaculture may not only be receiving polluted waters, but adding to the burden. Rapid urbanization has further harmed coastal ecosystems, and with small-scale fisheries and aquaculture operations in the nearshore, integrated management strategies for coastal areas are also important. (Aquaculture-Fisheries Nexus Topic Area)

- ***Mitigating Negative Environmental Impacts (MNE)***

With the rapid growth in aquaculture production, environmental externalities are of increasing concern.

> Determining the scope and mitigating or eliminating negative environmental impacts of aquaculture—such as poor management practices and the effects of industrial aquaculture—is a primary research goal of this program. A focus on biodiversity conservation, especially in biodiversity "hotspot" areas, as related to emerging or existing fish farms is of great interest. Therefore, research on the impacts of farmed fish on wild fish populations, and research on other potential negative impacts of farmed fish or aquaculture operations is needed, along with scenarios and options for mitigation. **(**Aquaculture-Fisheries Nexus Topic Area)

Terminology for Investigations

Each investigation was clearly identified as an experiment, study, or activity, based on the following definitions:

- Experiment**:** An experiment was a scientifically sound investigation that addressed a testable hypothesis. An experiment implied collection of new data by controlled manipulation and observation.
- Study: A study may or may not have been less technical or rigorous than an experiment and may have stated a hypothesis if appropriate. Studies included surveys, focus groups, database examinations, most modeling work, and collection of technical data that did not involve controlled manipulation (e.g., collection and analysis of soil samples from sites without having experiments of hypothesized effect before collection).
- Activity: An activity required staff time and possibly materials but did not generate new information like an experiment or a study. Conference organization, training sessions, workshops, outreach, and transformation and dissemination of information are examples of activities.

Investigations provided a transparent means for evaluating different types of work under the CRSP, be they quantitative, empirical, biologically-based, qualitative, policy-based, or informal. Each project was required to include at least one experiment or study. Projects were also required to include outreach activities such as training, formal education, extension, and conference organizing to supplement the scientific research being proposed. Between FY2006 and FY2012, 38% of the investigations experiments, 37% were studies, and 25% were activities (Figure 5.4).

Environmental Compliance

The following USAID environmental restrictions applied to the projects and the overall program:

- Biotechnical investigations were conducted primarily on research stations in Host Countries.
- Research protocols, policies, and practices were established prior to implementation to ensure that potential environmental impacts are strictly controlled.
- All training programs and outreach materials intended to promote the adoption of CRSP-generated research findings incorporated the appropriate environmental recommendations.
- All sub-awards complied with environmental standards.
- CRSP Projects did not procure, use, or recommend the use of pesticides of any kind. This included but was not limited to algaecides, herbicides, fungicides, piscicides, parasiticides, and protozoacides.
- CRSP Projects did not use or procure genetically modified organisms (GMO).
- CRSP Projects did not use, or recommend for use, any species that were non-endemic to a country or not already well established in its local waters, or that were non-endemic and well established but are the subject of an invasive species control effort.

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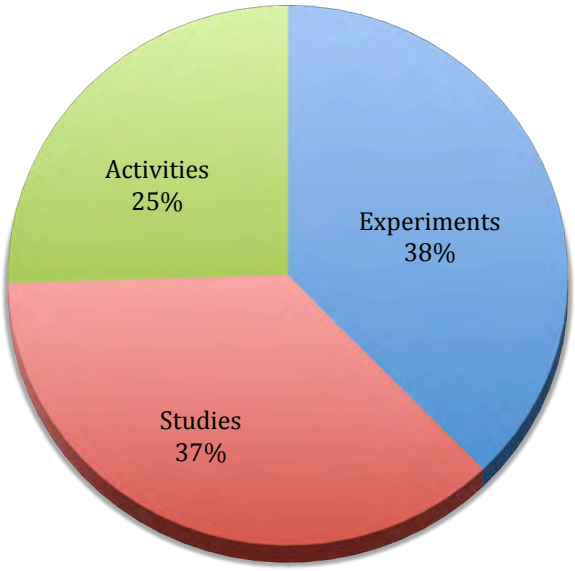

Fig 5.4. Of the 106 investigations conducted from FY2006 to FY2012, 40 were categorized as Experiments, 39 as Studies, and 27 as Activities.

General Research Priorities

All Core Research Projects addressed the following general research priorities:

- Priority Ecosystems: Freshwater and brackish water ecosystems for aquaculture and aquaculture-fishery nexus topic areas. Marine ecosystems were also included in the aquaculture-fishery nexus topic areas.
- Priority Species: Low-trophic level fishes; domesticated freshwater fishes; non-finfishes (e.g., bivalves, seaweeds); aquatic organisms used in polycultures and integrated systems; native species. Food fishes were a priority but species used for non-food purposes (e.g., ornamental, pharmaceutical) could also be included as a priority if they were a vital part of an integrated approach towards food security and poverty alleviation (Figure 5.5).
- Target Groups: Aquaculture farms (small- to medium-scale, subsistence and commercial) and aquaculture intermediaries, policy makers, and others in host countries.
- Key Partners: University, government, non-government, and private sector

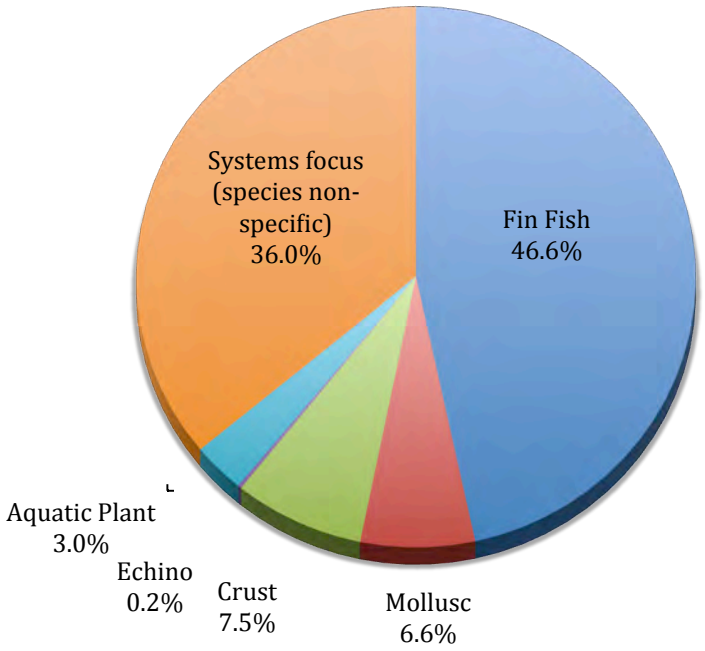

Fig 5.5. Breakdown by species type for all 106 investigations funded from FY2006 to FY2012.

Table 5.5 Investigations Summary & Assessment. AquaFish CRSP investigations conducted under the Implementation Plan 2007–2009 and Implementation Plan 2009–2011 and funded under USAID CA/LWA No. EPP-A-00-06-00012-00.

Code[1]	Investigation Title	Lead Investigator	US Institution[2]	Status[3]	Comments and Clarifications[4]
Implementation Plan 2007–2009					
07BMA02UM[5]	Polyculture of Sahar (*Tor putitora*) with Mixed-Sex Nile Tilapia (*Oreochromis niloticus*)	Shrestha	UM	1	
07BMA03UA	Co-sponsorship of "Second International Workshop on Cultivation and Biotechnology of Marine Algae: An Alternative for Sustainable Development in Latin America and the Caribbean"	Gonzalez-Alanis	UA	1	
07BMA04UH	Training in Best Management Practices for the Production of Molluscs in the States of Nayarit and Sinaloa	Haws	UH	2	
07BMA05UH	Intensive Training and Internship in Bivalve Culture and Shellfish Sanitation	Haws	UH	1	
07FSV01UC	Maximizing the Utilization of Low Value Or Small Size Fish for Human Consumption Through Appropriate Value Added Production Development	So	UC	1	
07HHI01UM	Monitoring and Reducing Microcystins in Tilapias and Channel Catfish Cultured in a Variety of Aquaculture Systems	Song	UM	1	
07HHI02UA	Food Safety Study of Leafy Greens Irrigated with Tilapia	Gonzalez-Alanis	UA	1	

[1] Codes identify each investigation with a unique number following a uniform format. Using the code 07HHI01UM as an example, "07" refers to the Implementation Plan 2007–2009 (the "09" series refers to the Implementation Plan 2009–2011), "HHI" is the acronym for the "Human Health Impacts of Aquaculture" topic area, "01" is the sequential investigation number assigned within the topic area investigation block, and "UM" identifies the lead institution, here University of Michigan.

[2] AU=Auburn University; NC=North Carolina State University; OR=Oregon State University; PU=Purdue University; UA=University of Arizona; UC=University of Connecticut – Avery Point; UH=University of Hawai'i at Hilo; UM=University of Michigan

[3] 1=Successfully completed. 2= Successfully completed in part or with modification (partial completion is typically due to uncontrollable circumstances such as natural disasters, political conflicts, and unexpected obstacles). 3= Incomplete (investigations under IP2009–2011 which have been delayed due to uncontrollable circumstances). 4= Underway (new investigations initiated in 2012 under Implementation Plan 2009–2011).

[4] IP07–09 = Implementation Plan 2007–2009; IP09–11= Implementation Plan 2009–2011.

[5] The BMA series begins with "02" because "01" was originally reserved for an investigation in Bangladesh that did not occur during the Implementation Plan 2007–2009 period.

Code[1]	Investigation Title	Lead Investigator	US Institution[2]	Status[3]	Comments and Clarifications[4]
	Farm Effluents				
07HHI03UH	International Workshop for Aquaculture Sanitation	Haws	UH	1	
07HHI04UH	Regional Workshop on Shellfish Culture and Sanitation	Haws	UH	1	
07HHI05UH	Microbiological Quality of Shellfish Growing Waters and Tissues	Sandoval-Palacios	UH	2	*IP2007–2009, Addendum (2009)* A work plan change was approved to remove 2 study sites due to substandard water quality conditions and to change the lead HC investigator.
07IND01UA	Development of Snook (*Centropomus* spp) Seed Production Technology for Application in Aquaculture and Restocking of Over-Fished Populations	Contreras-Sanchez	UA	1	
07IND02UA	Incorporation of the Native Cichlids Tenguayaca, *Petenia Splendida,* and Castarrica, *Cichlasoma urophthalmus* Into Sustainable Aquaculture in Central America: Improvement of Seedstock and Substitution of Fish Meal in Diets	Contreras-Sanchez	UA	1	
07IND03UH	Spat Collection, Growth Rates and Survival of the Native Oyster Species, *Crassostrea corteziensis* at Santa Maria Bay, Mexico	Rodriguez-Dominguez	UH	2	
07IND04UH	Oyster-Relaying and Depuration in Open Ocean Locations	Rodriguez-Dominguez	UH	2	
07MER01UC	Competition and Impacts Between Use of Low Value/Trash Fish for Aquaculture Feed Versus Use for Human Food	Hap	UC	1	
07MER02PU	Developing Supply Chain and Group Marketing Systems for Fish Farmers in Ghana And Kenya	Quagrainie	PU	1	

Code[1]	Investigation Title	Lead Investigator	US Institution[2]	Status[3]	Comments and Clarifications[4]
07MER03PU	On Farm Verification of Tilapia-Catfish Predation Culture	Lochmann	PU	1	
07MER04NC	Implications of Export Market Opportunities for Tilapia Farming Practices in the Philippines	Jamandre	NC	1	
07MNE01UC	Assessment of Diversity and Bioecological Characteristics of Low Value/Trash Fish Species	So	UC	1	
07MNE02NC	Training in Sustainable Coastal Aquaculture Technologies in Indonesia and The Philippines	Hasanuddin	NC	1	
07MNE03UM	Impact of Introduction of Alien Species on the Fisheries and Biodiversity of Indigenous Species in The Zhanghe Reservoir of China and Tri An Reservoir of Vietnam	Wang	UM	1	
07MNE04UM	Assessing Effectiveness of Current Waste Management Practices for Intensive Freshwater ad Marine Pond Aquaculture in China	Yang	UM	1	
07MNE05UM	Determining the Ecological Footprint of Shrimp Aquaculture Through Life Cycle Analysis of Outdoor Pond Systems	Diana	UM	1	
07MNE06UA	Elimination of MT from Aquaculture Masculinization Systems: Use of Catalysis with Titanium Dioxide and Bacterial Degradation	Contreras-Sanchez	UA	1	
07MNE07UM	Workshop on Aquaculture, Human Health, and Environment	Diana	UM	1	
07QSD01NC	Broodstock Seed Quality and Fingerling Production Systems Rearing for Nile Tilpaia in the Philippines	Bolivar	NC	1	
07QSD02PU	Development of Small-Scale *Clarias* Fingerlings as Bait for Lake Victoria Commercial Fisheries in Western Kenya	Quagrainie	PU	1	
07SFT01UC	Alternative Feeds for Freshwater	Bengtson	UC	1	

Code[1]	Investigation Title	Lead Investigator	US Institution[2]	Status[3]	Comments and Clarifications[4]
	Aquaculture Species				
07SFT02NC	Feeding Reduction Strategies and Alternative Feeds to Reduce Production Costs of Tilapia Culture	Bolivar	NC	1	
07SFT03NC	Alternative Feeding Strategies to Improve Milkfish Production Efficiency in the Philippines	de Jesus-Ayson	NC	1	
07SFT04UA	Utilization of Local Feed Ingredients for Tilapia and Pacu Production	Ramotar	UA	1	
07SFT05UA	Local Ingredients Substituting for Fishmeal in Tilapia and Pacu Diets in Guyana	Ramotar	UA	1	
07SFT06PU	Development of Locally Available Feed Resource Base In Tanzania	Lochmann	PU	1	
07TAP01UC	Feed Technology Adoption and Policy Development for Fisheries Management	Getchis	UC	1	
07TAP02NC	Internet-Based Extension Podcasts for Tilapia Farmers in the Philippines	Bolivar	NC	2	
07TAP03UA	Aquafish CRSP Sponsorship of the Eighth International Symposium of Tilapia in Aquaculture to Be Held in Egypt	Gonzalez-Alanis	UA	1	
07WIZ01PU	Characterization of Pond Effluents and Biological and Physiochemical Assessment of Receiving Waters in Ghana	Frimpong	PU	1	
07WIZ02UH	Determination of Carrying Capacity of the Boca de Camichin Estuary, Mexico, in Reference to Oyster Culture	Calvario-Martinez	UH	2	
Implementation Plan 2009–2011					
09BMA01AU	Evaluation and Improvement of Production Technology in Uganda: Case Studies of Small-Holder Cage Culture in Watershed Reservoirs and as an	Molnar	AU	1	

Code[1]	Investigation Title	Lead Investigator	US Institution[2]	Status[3]	Comments and Clarifications[4]
	Alternative Livelihood for Fishers				
09BMA02AU	Aquaculture Training and Outreach in Uganda and Surrounding Nations	Molnar	AU	1	
09BMA03UM	Incorporation of Tilapia (*Oreochromis niloticus*) and Sahar (*Tor putitora*) into the Existing Carp Polyculture System in Nepal	Shrestha	UM	1	
09BMA04UM	Study of the Effectiveness of a Pond-Based Recirculating System for Shrimp Culture	Lai	UM	1	
09BMA05UM	Development of Indoor Recirculating Culture Systems for Intensive Shrimp Production in China	Jiang and Liu	UM	1	
09BMA06UM	Identifying Best Practices to Improve the Giant River Prawn Industry in Thailand Production Systems	Yuan	UM	1	
09BMA07OR	Assessing the Impacts of CRSP Research: Human Capital, Research Discovery, and Technology Adoption	Buccola	OR	2	
09BMA09NC	Experimental Pond Unit Assessment in Bangladesh	Wahab	NC	4	*IP2009–2011, Addendum III (2012)*
09BMA10PU	Experimental Pond Unit Assessment in Ghana	Frimpong	PU	4	*IP2009–2011, Addendum III (2012)*
09BMA11UA	Experimental Pond Unit Assessment in Kenya/Tanzania	Fitzsimmons	UA	4	*IP2009–2011, Addendum III (2012)*
09BMA12UC	Experiment Pond Unit Assessment in Cambodia	Pomeroy	UC	4	*IP2009–2011, Addendum III (2012)*
09BMA13UH	Experimental Pond Unit Assessment in Nicaragua	Haws	UH	4	*IP2009–2011, Addendum III (2012)*
09BMA14UM	Experimental Pond Unit Assessment in Nepal	Shrestha	UM	4	*IP2009–2011, Addendum III (2012)*

Code[1]	Investigation Title	Lead Investigator	US Institution[2]	Status[3]	Comments and Clarifications[4]
09FSV01UC	Maximizing the Utilization of Low Value or Small Size Fish for Human Consumption by Improving Food Safety and Value Added Product Development (Fermented Fish Paste) Through the Promotion of Women's Fish Processing Groups/Associations in Cambodia	Sochivi	UC	1	
09FSV02NC	Demonstration of Sustainable Seaweed Culture and Processing in Aceh, Indonesia and the Philippines — Opportunities for Women to Improve Household Welfare	Hasanuddin	NC	2	
09FSV03UC	Assessing the Impacts of Sustainable Freshwater Aquaculture Development and Small-Sized/Low-Value Fisheries Management in the Lower Mekong Basin Region of Cambodia and Vietnam	Pomeroy	UC	1	*IP2009–2011, Addendum I (2011)*
09HHI01UH	Co-Management and Bivalve Sanitation for Black Cockles (*Anadara* spp.) in Nicaragua	Hernandez	UH	1	
09HHI02UH	Capacity Building in Aquaculture, Fisheries and Coastal Management for Coastal Women Workshop: "Opportunities for Coastal Women in Fisheries, Aquaculture and Coastal Management"	Gaxiola	UH	1	
09IND01UH	Developing Hatchery Methods for the Mangrove Oyster, *Crassostrea corteziensis* for the Pacific Coast of Mexico.	Gaxiola	UH	1	
09IND02UC	Sustainable Snakehead Aquaculture Development in the Lower Mekong River Basin of Cambodia and Vietnam.	Pomeroy	UC	1	
09IND03UH	Induced Spawning and Larval Rearing of the "Chame" *Dormitator Latifrons* in Laboratory Conditions.	Rodriguez-Montes de Oca	UH	1	

Code[1]	Investigation Title	Lead Investigator	US Institution[2]	Status[3]	Comments and Clarifications[4]
09IND04UH	Stock Assessment of "Chame" *Dormitatir latifrons* in Nayarit and South of Sinaloa Mexico	Rodriguez-Dominguez	UH	1	
09IND05UA	Consolidation of Native Species Aquaculture in Southeastern Mexico: Continuation of a Selective Breeding Program for Native Cichlids and Snook Aquaculture	Contreras-Sanchez	UA	2	
09IND06PU	Development and Diversification of Species for Aquaculture in Ghana	Frimpong	PU	1	
09IND07AU	Prospects and Potential of the African Lungfish (*Protopterus* spp): An Alternative Source of Fishing and Fish Farming Livelihoods in Uganda and Kenya	Walakira	AU	1	*IP2009–2011, Addendum II (2011)*
09IND08UH	Effects of Environmental Conditions on Gills and Gas Bladder Development in Bimodal-Breathers, Gar (*Lepisosteus sp.*), Pirarucu (*Arapaima gigas*) and Bowfin (*Amia calva*)	Dabrowski	UH	1	*IP2009–2011, Addendum II (2011)*
09IND10UH	Developing Feeds for Larval *D. latifrons* (Chame) Larvae	Gaxiola	UH	4	*IP2009–2011, Addendum III (2012)*
09IND11UM	Development of Sustainable Feeds, Improved Stocking Densities, and Salinity Management in Closed Recirculating Systems for Gar (*Atractosteus* spp.) Culture	Diana	UM	4	*IP2009–2011, Addendum III (2012)*
09MER01AU	Market Assessment and Profitability Analysis of Aquaculture Enterprises in Uganda	Bukenya	AU	2	
09MER02PU	Value Chain Development for Tilapia and Catfish Products: Opportunities for Female Participation in Kenya	Quagrainie	PU	1	
09MER03NC	Improving Supply Chain Opportunities for Tilapia in the Philippines	Jamandre	NC	1	

Code[1]	Investigation Title	Lead Investigator	US Institution[2]	Status[3]	Comments and Clarifications[4]
09MER04UC	Value Chain Analysis of Snakehead Fish in the Lower Mekong Basin of Cambodia and Vietnam	Le Xuan	UC	1	
09MER06NC	Value Chain Analysis of Seaweed in Aceh, Indonesia	Hasanuddin	NC	4	*IP2009–2011, Addendum III (2012)*
09MER07PU	Assessment of Tilapia Value Chain in Ghana	Quagrainie	PU	4	*IP2009–2011, Addendum III (2012)*
09MER08UA	Value Chain Analysis–Kenya/Tanzania	Fitzsimmons	UA	4	*IP2009–2011, Addendum III (2012)*
09MER09UC	Value Chain Analysis of Freshwater Small-Sized Fish in Cambodia	Pomeroy	UC	4	*IP2009–2011, Addendum III (2012)*
09MER10UH	Value Chain Analysis for Black Cockles (*Anadara tuberculosa* and *A. similis*)	Haws	UH	4	*IP2009–2011, Addendum III (2012)*
09MER11UM	Value Chain Analysis of Carp Polyculture Systems in Southern Nepal	Shrestha	UM	4	*IP2009–2011, Addendum III (2012)*
09MNE01UM	Invasion of the Red Swamp Crayfish (*Procambarus clarkii*) in China: Genetic Analysis of the Invasion and the Impacts Evaluation	Wang	UM	1	
09MNE02NC	Ration Reduction, Integrated Multitrophic Aquaculture (Milkfish-Seaweed-Sea Cucumber) and Value-Added Products to Improve Incomes and Reduce the Ecological Footprint of Milkfish Culture in the Philippines	de Jesus-Ayson	NC	1	
09MNE03UM	Integrating Environmental Impacts, Productivity, and Profitability of Shrimp Aquaculture at the Farm-Scale as Means to Support Good Aquaculture Practices and Eco-Certification	Diana	UM	1	
09MNE04UC	Developing Management Recommendations for Freshwater Small-Sized/Low Value Fish in the Lower Mekong Region of	So	UC	1	

Code[1]	Investigation Title	Lead Investigator	US Institution[2]	Status[3]	Comments and Clarifications[4]
	Cambodia and Vietnam				
09MNE05UM	The Impact of Fish Stocking on Wild Fish Populations, Fish Production and Aquatic Environment in Irrigation Reservoirs in South Vietnam	Le Thanh	UM	1	
09MNE06UM	Evaluating the Relationship Between Semi-Intensive Aquaculture and Natural Biodiversity	Diana	UM	1	
09MNE07UA	Reaching Fish Farms Through Aquafish-CRSP Technology Transfer: Elimination of MT from Intensive Masculinization Systems Using Bacterial Degradation	Contreras-Sanchez	UA	2	*IP2009–2011, Addendum I (2011)*
09QSD01NC	Nile Tilapia Broodstock Selection, Seed Quality and Density-Dependent Growth in the Philippines	Vera Cruz	NC	1	
09QSD02UA	Sustainable Integrated Tilapia Aquaculture: Aquaponics and Evaluation of Fingerling Quality in Tabasco, Mexico	Contreras-Sanchez	UA	1	
09QSD03UM	Development of Polyculture Technology for Giant Freshwater Prawns (*Macrobrachium rosenbergii*) and Mola (*Amblypharyngodon mola*)	Wahab	UM	1	
09QSD04PU	Evaluation of Performance of Different Tilapia Species.	Chenyambuga	PU	1	
09QSD05PU	Training Program in Propagation and Hatchery Management of tilapia (*Oreochromis niloticus*) and catfish (*Clarius gariepinus*) in Ghana	Amisah	PU	1	*IP2009–2011, Addendum I (2011)*
09SFT01UC	Alternatives Feeds for Freshwater Aquaculture Species	Bengtson	UC	1	
09SFT02PU	Assessment of Integrated Pond-Cage System for the Production of Nile Tilapia for Improved	Quagrainie	PU	1	

Code[1]	Investigation Title	Lead Investigator	US Institution[2]	Status[3]	Comments and Clarifications[4]
	Livelihood of Small-Scale Fish Farmers in Kenya.				
09SFT03UA	Expansion of Tilapia and Indigenous Fish Aquaculture in Guyana Guyana: Opportunities for Women	Ramotar	UA	1	
09SFT04NC	Feeding and Feed Formulation Strategies to Reduce Production Costs of Tilapia Culture	Bolivar	NC	1	
09SFT05PU	Develop Feeding Strategies for *Moringa oleifera* and *Leucaena leucocephala* as Protein Sources in Tilapia Diets	Lochmann	PU	1	
09SFT06NC	Impact Assessment of CRSP Activities in the Philippines and Indonesia	Bolivar	NC	2	*IP2009–2011, Addendum I (2011)*
09SFT07UM	Sustainable Feed and Improved Stocking Densities for Gar (*Atractosteus* spp.) Culture	Diana	UM	1	*IP2009–2011, Addendum II (2011)*
09TAP01UA	Aquaculture & Fisheries CRSP Sponsorship of the Ninth International Symposium on Tilapia in Aquaculture to Be Held in Shanghai, China	Fitzsimmons	UA	1	
09TAP02NC	Internet-Based Podcasting: Extension Modules for Farming Tilapia in the Philippines	Bolivar	NC	2	
09TAP03UC	Development of Alternatives to the Use of Freshwater Low Value Fish for Aquaculture in the Lower Mekong Basin of Cambodia and Vietnam: Implications for Livelihoods, Production and Market	Prum	UC	1	
09TAP04PU	Harnessing the Opportunities and Overcoming Constraints to Widespread Adoption of Cage Aquaculture in Ghana.	Frimpong	PU	1	
09TAP05OR	Assessment of AquaFish CRSP Technology Adoption and Impact	Antle	OR	3	

Code[1]	Investigation Title	Lead Investigator	US Institution[2]	Status[3]	Comments and Clarifications[4]
09TAP06OR	Project Planning Meeting on AquaFish Technology Discovery and Impact Assessment	Buccola	OR	1	
09TAP07PU	Effects of ACRSP and AquaFish CRSP Initiatives and Activities on Aquaculture Development in Kenya	Quagrainie	PU	1	*IP2009–2011, Addendum I (2011)*
					IP2009–2011, Addendum I (2011)
09TAP08AU	Training Trainers For Long Term and Sustained Impact of Pond Aquaculture in Africa	Molnar	AU	3	*IP2009–2011, Addendum II (2011):* Work plan change approved to add 2 Kenyan CAP trainees and revise the schedule for HC training events.
09WIZ01AU	Effects of Watershed–Water Quality–Aquaculture interactions on Quantity and Quality of Water from Small Catchments in South Africa and Uganda	Boyd	AU	2	
09WIZ02AU	Surface Catchment Development and Sustainability Evaluation for Multipurpose Water Supply for Meeting Aquaculture and Other Water Needs	Tollner	AU	1	
09WIZ03UM	Improved Cages for Fish Culture Commercialization in Deep Water Lakes	Diana	UM	1	*IP2009–2011, Addendum I (2011)*

6. CORE RESEARCH PROJECTS

Since 2006, AquaFish CRSP funded eight Core Research Projects with 106 investigations covering all ten thematic Topic Areas. A compilation of Final Investigation Reports (FIRs) is available on the AquaFish CRSP website (http://aquafishcrsp.oregonstate.edu/publications.php). Due to the length and detail of the final reports, they are not printed here. See Appendix 1 for a full list of project participants.

The eight Core Research Projects worked in 15 Host Countries focusing in Africa, Asia and Latin America and Caribbean regions. Aquaculture development holds potential in these regions, where the need is greatest. In Africa, where approximately 26 percent of Africa's children are currently malnourished, aquaculture production has increased by 56 percent in volume and more than 100 percent in value between 2003 and 2007. Despite this growth, Africa accounts for only 2.2% of total global aquaculture production and most sub-Saharan nations remain net food importers. Asia accounts for approximately two-thirds of the world's hunger. In Asia, aquaculture represents about 91 percent of world production and is thus well suited to improve livelihoods and wellbeing in the region. In the Latin America and Caribbean (LAC) Region, approximately 25% of the population lives on less than US$2 a day and approximately 54 million people are undernourished. Growth of aquaculture in the LAC region has been rapid, averaging a 21% annual increase between 1970-2008, however, this growth is largely due to advances in industrial-scale aquaculture aimed at export markets. Aquaculture's role in regional markets remains vastly underdeveloped.

Core Research Project were based in all three global regions:

Africa

Auburn University:
Uganda, South Africa.
Hydrology, Water Harvesting, and Watershed Management for Food Security, Income, and Health: Small Impoundments for Aquaculture and Other Community Uses.

Purdue University:
Kenya, Tanzania, Ghana.
Improving Competitiveness of African Aquaculture through Capacity Building, Improved Technology, and Management of Supply Chain and Natural Resources.

Asia

North Carolina State University:
Philippines, Indonesia.
Improved Cost Effectiveness and Sustainability of Aquaculture in the Philippines and Indonesia.

Figure 1. AquaFish CRSP Host Countries in Africa from 2006 to 2012. All countries participated under the Leader Award, except Mali, which participated through an Associate Award.

Figure 2. AquaFish CRSP Host Countries in Asia from 2006 to 2012.

University of Connecticut - Avery Point: *Cambodia, Vietnam*.
Development of Alternatives to the Use of Freshwater Low Value Fish for Aquaculture in the Lower Mekong Basin of Cambodia and Vietnam: Implications for Livelihoods, Production and Markets.

University of Michigan:
China, Nepal, Vietnam, Bangladesh.
Improving Sustainability and Reducing Environmental Impacts of Aquaculture Systems in China, and South and Southeast Asia.

Latin America/Caribbean

University of Arizona:
Mexico, Guyana.
Developing Sustainable Aquaculture for Coastal and Tilapia Systems in the Americas.

University of Hawaii – Hilo:
Mexico, Nicaragua.
Human Health and Aquaculture: Health Benefits through Improving Aquaculture Sanitation and Best Management Practices.

Global:
Montana State University/Oregon State University:
Global.
Assessing the Impacts of CRSP Research: Human Capital, Research Discovery, and Technology Adoption.

Figure 3. AquaFish CRSP Host Countries in Latin America and the Caribbean from 2006 to 2012.

This section provides an outline of the eight Core Research Projects funded by AquaFish CRSP from inception through FY2012, including a synopsis for each research project, as well as listings of key finding & outcomes, personnel, and investigations.

AFRICA

LEAD US UNIVERSITY: AUBURN UNIVERSITY

HYDROLOGY, WATER HARVESTING, AND WATERSHED MANAGEMENT FOR FOOD SECURITY, INCOME, AND HEALTH: SMALL IMPOUNDMENTS FOR AQUACULTURE AND OTHER COMMUNITY USES

Project Synopsis

This project provided research results that increase the knowledge base on water resource uses that work in the African context. The studies adapted best practices in water use, enterprise development, and fish culture in Uganda and South Africa with regional extension potential. In Uganda, the project built on a three-year intensive USAID-funded effort, FiSH, which brought to the project an extensive network of contacts and institutional knowledge. The train-the-trainers activity supported participation in the Auburn University Certified Aquaculture Professional (CAP) program, followed by a one-month field exercise in the US. The hands-on field experience at the Auburn University Fisheries Research Station allowed the trainers to experience all of the techniques they will be teaching others. Following this advanced trainer program, the trainers held up to two training sessions for others in their home country.

Air breathing fishes potentially have a role in low-management culture systems because dissolved oxygen is not a limiting factor. African lungfish (*Protopterus aethiopicus* and *Protopterus amphibious*) are indigenous fish with good quality flesh, that serve as biocontrol agents against schistosome vector snails, and have some existing level of indigenous culture. Little is known about indigenous practices of management, harvest, and marketing of *Protopterus* spp from farm ponds and water bodies. A preliminary field assessment identified researchable issues, suggested a path toward increased food security, incomes, and nutritional improvement in local populations. Current practices and understandings about the culture and use of lungfish in Uganda and Kenya were assessed.

Key Findings & Outcomes

- In Uganda, CRSP researchers have developed a set of site suitability maps for selecting the location of earthen aquaculture ponds to better capture and manage water. These maps incorporate the following site selection criteria: water requirement, water temperature, soil texture, slope gradient, potential for farm-gate sales, access to local and regional markets, and availability of farm inputs. Major wetland areas are designated as protected sites on the maps. In another component of this work, researchers and extensionists were trained at a CRSP workshop at Makerere University in techniques for advising local farmers in their site selections. This new technology offers a more sustainable approach for community water supply management and natural resource conservation for rural Uganda fish farmers.
- A tilapia cage-culture trial for promoting small-scale fish farming on Lake Victoria is designed as a working enterprise model that will recruit other farmers to this new technology. Members of Uganda's Jinja

United Group Initiative for Poverty Alleviation & Economic Development (JUGIPAED) are participating in the project. Currently, the livelihood of fishers is threatened due to reduced fish catches caused by overfishing and depleted fish stocks in the lake. Local fishers and farmers who adopt the cage culture technology will have an alternative income opportunity. A key aspect of the CRSP work has been to illustrate cage culture as a profitable venture. CRSP investigators provided technical assistance and "partnered" with JUGIPAED on a combined cost-share/research basis. This dual purpose approach offered a hands-on experience to the participating farmers with CRSP mentoring in a successful business model. At the conclusion of the trial, fish yield data showed farmers that the cage culture model can be profitable.

- A 60 m × 80 m pond was constructed at the for demonstration, education, and information dissemination for pond construction and watershed management. The demonstration pond was constructed near Makerere University in Uganda, cost-shared by both Makerere University and a USEPA grant.
- Case studies of farmer groups show that the umbrella organizations under which local fish farmer associations vertically align themselves have important implications for fish farmer production and contribute to the success of local member associations more than general umbrella organizations do. Successful fish farmer associations accept government assistance only when it directly improves their fish farm operations; other farmer groups wait for direct subsidization. Training fish farmers, providing quality information, cost sharing, and advocating for the aquaculture sector, not donor seeking, are the top priorities in productive fish farmer associations.
- Assessment of the status and potential of African lungfish aquaculture in Uganda in seven districts (Kampala, Wakiso, Kumi, Busia, Soroti, Pallisa and Jinja) suggests that farmers, most of whom are women, have an array of indigenous production strategies that may be adapted and propagated to enhance the availability of this marketable species.
- Surveys of Ugandan producers and consumers provide important guidance for enhancing value chains associated with tilapia and *Clarias* in Uganda.
- In Uganda, just under 300 participants attended the 3rd and 4th Annual Fish Farmers Symposium & Trade Fair held in January 2010 and 2011. The events were organized in partnership with the Walimi Fish Farmers Cooperative Society. Topics reflected the requests and interests of event attendees: (1) accessing inputs, return on investment, and quality of service delivery; (2) markets, marketing, and market information; (3) current support services and their accessibility for the aquaculture private sector; (4) feeds and feeding guidelines; (5) enterprise budgets; (6) farmer-based value-addition; and (7) financing. Study tour visits to farms and other associated businesses were introduced by CRSP and have proven a successful outreach tool for information exchange. The popularity of these tours is evidenced in their growth from one tour in 2010 to four tours in 2011, including one offered to Kenyan farmers. Participants have enthusiastically acknowledged the success of this multifaceted annual event as a forum for information exchange, networking, and working out practical solutions to current production challenges.
- The first class of nine master aquaculture trainers from five African countries completed the AU program.

Project Personnel

Auburn University
Joseph **Molnar** - US Lead Project PI
Claude **Boyd** - US Investigator
Karen **Veverica** - US Investigator

Alabama A&M
James **Bukenya** - US Co-PI

University of Georgia,
Bill **Tollner** - US Co-PI

Gulu University, Uganda
Nelly **Isyagi** - HC Co-PI
Alfonse **Opio** - HC Investigator

Makerere University, Uganda
Levi **Kasisira** - HC Lead PI
Monica Karuhanga **Berahu** - HC Investigator
Theodora **Hyuha** - HC Investigator
Peter **Mulumba** - HC Investigator

NaFIRRI, Uganda
Gertrude **Atakunda** - HC Co-PI
John **Walakira** - HC Investigator

Stellenbosch University, South Africa
Khalid **Salie** - HC Co-PI

Project Investigations

For a complete compilation of Final Investigation Reports, please see http://aquafishcrsp.oregonstate.edu/publications.php.

09WIZ01AU - Effects of Watershed-Water Quality-Aquaculture Interactions on Quanitity and Quality of Water from Small Catchments in South Africa and Uganda

09WIZ02AU - Surface Catchment Development and Sustainability Evaluation for Multipurpose Water Supply for Meeting Aquaculture and Other Water Needs

09BMA01AU - Evaluation and Improvement of Production Technology in Uganda: Case Studies of Small-Holder Cage Culture in Watershed Reservoirs and as an Alternative Livelihood for Fishers

09MER01AU - Market Assessment and Profitability Analysis of Aquaculture Enterprises in Uganda

09BMA02AU - Training and Outreach in Uganda and Surrounding Nations

09TAP08AU - Training Trainers for Long Term and Sustained Impact of Pond Aquaculture in Africa

09IND07AU - Prospects and Potential of the African Lungfish (*Protopterus* Spp): An Alternative Source of Fishing and Fish Farming Livelihoods in Uganda and Kenya.

AFRICA

LEAD US UNIVERSITY: PURDUE UNIVERSITY

IMPROVING COMPETITIVENESS OF AFRICAN AQUACULTURE THROUGH CAPACITY BUILDING, IMPROVED TECHNOLOGY, AND MANAGEMENT OF SUPPLY CHAIN AND NATURAL RESOURCES

Project Synopsis

In Tanzania, lower cost feed alternatives were identified from leguminous tree species to replace more costly soybean meal used in tilapia diets. Through training in hatchery techniques and management, Kenyan farmers now have an additional aquaculture enterprise of raising catfish fingerlings and selling them as bait to the longline fishing industry on Lake Victoria. Traders in baitfish traditionally from natural catches are now engaged in fish farming that has enabled year-round supply of baitfish. Training in supply chain management has enabled the development of new market opportunities for foodfish producers in Kenya and Ghana as well as new markets for baitfish producers in Kenya. Farmers have acquired knowledge about the environmental effects of their activities and are therefore implementing broadly focused environmental BMPs on their farms, especially in Ghana. Studies that analyzed consumer preferences for farmed fish have provided valuable information for the development of consumer-driven aquaculture production in Ghana and Kenya.

This project addressed needs related to enhancing capacity in production, value chain, and aquatic resource management in African aquaculture to ensure the long-term impact of aquaculture on rural communities. The vision of this project was an agribusiness-focused aquaculture model for sub-Saharan Africa made possible through physical and human capacity development; new and better technology of fish production; growth of a whole chain of activities from farm to the consumer; development of consumer-driven aquaculture production; development of indigenous species; better management of natural resources; and increased profitability of fish production at the farm level.

Key Findings & Outcomes

- Feed costs remain one of the major constraints to aquaculture development in Africa. Tanzanian researchers found that leaf meal made from two local, native leguminous tree species - *Leucaena leucocephala* and *Moringa oleifera* can replace costly soybean meal in tilapia diets and increase profitability for small-scale fish farmers. Lower cost and local availability of these leaf meals make them a suitable alternative for small-scale farmers.
- In Kenya, one of the environmental issues facing the artisanal fishery of Lake Victoria is the threatened status of the native shark-tooth catfish, which is being depleted by Nile perch fishers who use it for baitfish. Farmers were trained in hatchery technology and business techniques to farm juvenile catfish and sell them as an alternative to wild-caught baitfish. Farmers now successfully sell baitfish in markets along the shores of Lake Victoria. Women bait traders who usually did not have income during the closed season on Lake Victoria have been trained in pond construction and catfish breeding and are now able to farm and supply bait fish throughout the year.

- In Ghana, biological assessment techniques were used to investigate the effects of pond effluent on receiving waters. Ponds in the Ashanti and Brong Ahafo regions of Ghana were found to have poorer water quality. Effects on receiving waters depended on how effluents were managed, including the frequency and volume of releases and the conditions under which effluents were handled before reaching receiving waters. Farmers were therefore trained in environmental Best Management Practices (BMPs) in aquaculture, including water reuse mechanisms, vegetated ditches/canals, settling basins, draining into natural wetlands, and top release of pond water. Farmers are implementing broadly focused environmental BMPs on their farms.
- In Kenya, CRSP researchers have documented production and economic benefits of integrated cage-cum-pond culture techniques, originally developed by Dr. Yang Yi et al. from the ACRSP in Thailand. The cage-cum-pond system results in less waste nutrients being released into receiving waters and can especially useful to small-scale fish farmers who want to grow two crops in one pond. The benefits of this system include better fish growth, lower feed conversion ratios, and higher fish survival.
- Small- and medium-scale fish farmers in Ghana and Kenya were trained on value chain, supply chain management, individual and group marketing, new market development, and distribution and marketing networks. Farmers have successfully accessed urban markets and engaged in collective efforts (commonly called 'clusters') to plan production, and manage supply and sales. Kenyan baitfish farmers are using the cluster farming system to achieve significant improvements in their marketing capabilities and assisting other farmers in adopting the collective model.
- The focus on the development of consumer-driven aquaculture entailed a study of the preferences of consumers in urban Ghana and Kenya for farmed tilapia and catfish in order to enable the aquaculture industry to strategize and respond to demand in the domestic market. Results show Ghanaian consumers prefer smoked and grilled tilapia and catfish while consumers in Kenya prefer fresh and fried forms of tilapia and catfish. The sensory, functional and symbolic attributes of farmed tilapia and catfish, and the socio-demographic features of consumers were also found to be important determinants of consumer preferences in both countries for farmed fish. The results also suggested that health consciousness, secondary education and age of consumers, as well as the color of farmed tilapia, affected the willingness to pay for farmed tilapia in Ghana. In Kenya, the factors that affect consumers' willingness to pay for farmed tilapia include health consciousness, household income, household size, age, urban residence and education of consumers.

Project Personnel

Purdue University,
Kwamena **Quagrainie** - US Lead Project PI
Jennifer **Dennis** - US Investigator

Kwame Nkrumah University of Science & Technology,
Stephen **Amisah** - HC Co-PI

Ministry of Fisheries Development, Kenya
Charles C. **Ngugi** - HC Lead PI
Judith **Amadiva** - HC Co-PI
Sammy **Macharia** - HC Investigator

Moi University, Kenya
Julius **Manyala** - HC Co-PI
John **Makambo** – HC Investigator

Sokoine University of Agriculture, Tanzania
Sebastian **Chenyambuga** - HC Co-PI
Nazael **Madalla** - HC Investigator
Berno V. **Mnembuka** - HC Investigator

University of Arkansas at Pine Bluff
Carole **Engle** - US Investigator
Rebecca **Lochmann** - US Co-PI

Ministry of Natural Resources & Tourism, Aquaculture Division, Tanzania
Kajitanus **Osewe** - HC Collaborator

Virginia Polytechnic Institute & State University
Emmanuel **Frimpong** - US Co-PI

Women in Fishing Industry Project, Kenya
Jennifer **Atieno** - HC Collaborator

Project Investigations

For a complete compilation of Final Investigation Reports, please see http://aquafishcrsp.oregonstate.edu/publications.php.

07MER02PU - Developing Supply Chain and Group Marketing Systems for Fish Farmers in Ghana and Kenya.

07QSD02PU - Development of Small-scale Clarias Fingerlings as Bait for Lake Victoria Commercial Fisheries in Western Kenya.

07WIZ01PU - Characterization of Pond Effluents and Biological and Physiochemical Assessment of Receiving Waters in Ghana.

07SFT06PU - Development of Locally Available Feed Resource Base in Tanzania.

07MER03PU - On Farm Verification of Tilapia-catfish Predation Culture.

09MER02PU - Value Chain Development for Tilapia and Catfish Products: Opportunities for Women Participation

09SFT02PU - Assessment of Integrated Pond-Cage System for the Production of Nile Tilapia to Improve the Livelihood of Small-Scale Fish Farmers in Kenya

09SFT05PU - Development of Feeding Strategies for *Moringa oleifera* and *Leucaena leucocephala* as Protein Sources in Tilapia Diets

09QSD04PU - Performance Evaluation of Different Tilapia Strains and Species in Tanzania

09TAP04PU - Harnessing Opportunities and Overcoming Constraints to Widespread Adoption of Cage Aquaculture in Ghana

09IND06PU - Development and Diversification of Species for Aquaculture in Ghana

09TAP07PU - Effects of ACRSP and AquaFish CRSP Initiatives and Activities on Aquaculture Development in Kenya

09QSD05PU - Training Program in Propagation and Hatchery Management of tilapia (*Oreochromis niloticus*) and catfish (*Clarias gariepinus*) in Ghana

ASIA

LEAD US UNIVERSITY: NORTH CAROLINA STATE UNIVERSITY

IMPROVED COST EFFECTIVENESS AND SUSTAINABILITY OF AQUACULTURE IN THE PHILIPPINES AND INDONESIA

Project Synopsis

This project developed and implemented strategies to improve the cost effectiveness, sustainability and income opportunities of farming finfish, echinoderms, and seaweeds. The project developed feeding strategies and feed technologies that dramatically reduce costs for fish farming, technologies for enhanced breeding and nursery production of tilapia and introduced new polyculture practices to farmers and value-added processing techniques.

Aquaculture in the Philippines and Indonesia is a high food security priority particularly in the light of the countries' rapidly growing populations and their continued dependence on fish protein. The incomes from family farming, however, are generally poor with 43% of small-scale tilapia farmers in Central Luzon, Philippines, falling below the poverty line. The difficult socioeconomic conditions are even more pronounced for fishers in coastal regions where traditional livelihoods have been lost, and many seek transition to milkfish farming, but with some uncertainty. The 2004 tsunami eliminated shrimp-farms in Indonesia, and the livelihoods of entire communities continue to rebuild. CRSP research sought to develop and implement strategies to improve the cost effectiveness, sustainability and income opportunities of farming finfish and seaweeds. Tilapia and milkfish are the two most prominent finfish cultured in the Philippines. They are both low trophic species whose culture is expanding rapidly both in inland and coastal regions. Feed is one of the most costly components of fish farming, representing as much as 80% of total production costs for tilapia and milkfish. Feed wastage and the escalating cost of fishmeal in commercial diets contribute to higher production costs.

Key Outcome & Findings

- CRSP developed reduced feeding strategies and feed manufacturing technologies that dramatically reduce the costs of feeds without impacting farm yield. Reducing the amount of feed applied to ponds by 50% daily, 33% daily, or feeding on alternate days only, reduces feed costs for growing marketable fish by as much as 56%. When fishmeal is replaced in the diet with more sustainable alternative ingredients, costs are reduced by an additional 8%. Reducing the protein concentration of tilapia diets saves an additional 2.5%. If manufacturers produce sinking pelleted rather than floating feeds, costs for farmers can be further reduced by 3.4%. Collectively, the research shows that farmers can save as much as 70% on feeds, which translates into a 33% cost savings in culturing tilapia. Milkfish produced in sea cages or ponds on an alternate day feeding schedule reduces feed costs by 32% and 57% without impacting yields. These realized cost savings with lower nutrient inputs have the added benefit of reducing the

environmental impact and improving the sustainability of farming fish.

- Demand for high-quality tilapia is expected to triple over the next decade. It is critical, therefore, that consistent, high quality seed be available at reasonable costs; this will both increase the profitability of farming and reduce the risks of entry for new farmers. CRSP researchers have established that 8 – 24 month-old broodstock and any of the three primary hatching systems used by nursery operators (artificial incubation units, hapas, and ponds) are suitable for supplying high quality seed and fingerlings for the growout production of tilapia with little impact on gross yield or loss in profits. Appetite, eye color, and social behavior patterns in tilapia now can be effectively used to select broodstock with low susceptibility to stress and higher fecundity.
- There is a strong desire to expand tilapia culture in the Philippines to meet the growing demand for fish products in domestic retail supermarket and fast-food chains. CRSP market analyses indicate an opportunity to increase tilapia production in the Philippines through an expansion of product flowing through fast food and urban grocery markets. Current tilapia production in Central Luzon could be greatly expanded and the increased value of production per hectare has the potential to increase farm revenues even more dramatically. CRSP evaluated the tilapia supply chain and provided recommendations to the government to address the issues and concerns of the various chain players that included hatcheries and nursery operators, fish farmers, processors, traders/consolidators and institutional buyers.
- In Indonesia and the Philippines, interest has heightened in diversifying aquaculture crops, following the realization that intensive shrimp farming practices contributed to the deterioration of water quality in the mangrove coastal habitat. Through a series of workshops in Aceh, Indonesia and the Philippines, CRSP provided training to several farming communities on seaweed polyculture in shrimp and tilapia-milkfish ponds. This included methods for culturing, drying and processing seaweed. Women in the community were trained on preparation methods for using seaweeds and seaweed products (agar for candies and cakes). Over 100 small-scale farmers have adopted seaweed polyculture. A commercial seaweed buyer has committed to purchasing 14 MT a month and is supplying baling equipment and additional drying tables in Aceh. The success of the project is further underscored by the commitment of the government of Indonesia to provide funds for further development of seaweed culture in additional communities.
- The project established the first series of Tilapia Podcasts as a new means to disseminate tilapia culture information to the scientific, business, government and farming communities of the world. The podcast technique and its utility was introduced to farmers, feed manufacturers, the press, students, and government officials through a series of workshops in the Philippines. It was well received as a viable, alternative extension tool for disseminating aquaculture information to the community. The podcast approach is far thriftier, less consumptive of natural resources, and is more far-reaching, easily updated, and efficient than the distribution of printed extension media. To date, 7 podcasts have been produced to illustrate various aspects of tilapia culture, including the effectiveness of feed reduction strategies in providing cost savings for farmers. Interest in the podcasts has been excellent with 285 downloads and 444 hits on the NCSU iTunes server over a 2-month period, indicating they are an effective tool for disseminating tilapia culture technologies worldwide.

Project Personnel

North Carolina State University, USA
Russell **Borski** - US Lead Project PI
Peter R. **Ferket** - US Investigator
Upton **Hatch** - US Investigator
Charles R. **Stark** - US Investigator

University of Arizona
Kevin **Fitzsimmons** - US Co-PI

Aquaculture without Frontiers
Michael **New** - US Collaborator

Australian Centre for International Agricultural Research
Michael **Rimmer** - Collaborator

CNN Aquaculture and Supply Company, Bangkok, Thailand,
May Myat **Noe Lwin** - HC Collaborator

GIFT International Foundation, Philippines
Hernando L. **Bolivar** - HC Collaborator

Central Luzon State University, Philippines
Remedios B. **Bolivar** - HC Lead PI
Wilfred **Jamandre** - HC Investigator
Emmanuel M. **Vera Cruz** - HC Investigator

Institute of Fish Processing Technology, College of Fisheries, University of the Philippines at the Visayas
Rose T. **Mueda** - HC Collaborator

SEAFDEC-AQD, Philippines
Evelyn Grace T. **De Jesus-ayson** - HC Co-PI
Felix G. **Ayson** - HC Investigator
Nelson **Golez** - HC Investigator
Joesette **Gonzaga** – HC Investigator
Anicia **Hurtado** - HC Investigator
Maria Rovilla **Luhan** - HC Investigator

Ujung Batee Aquaculture Center, Banda Aceh, Indonesia
Sugeng Raharjo – HC Co-PI (through Nov 2007)
Hassan **Hasanuddin** - HC Co-PI (from Dec 2007)
Coco **Kokarkin** - HC Investigator

US Department of Commerce-NOAA, USA
Christopher **Brown** - US Co-PI

Project Investigations

For a complete compilation of Final Investigation Reports, please see http://aquafishcrsp.oregonstate.edu/publications.php.

07QSD01NC - Broodstock seed quality and fingerling production systems rearing for Nile tilapia in the Philippines

07SFT02NC - Feeding Reduction Strategies and Alternative Feeds to Reduce Production Costs of Tilapia Culture

07TAP02NC - Internet-based Extension Podcasts for Tilapia Farmers in the Philippines

07SFT03NC - Alternative Feeding Strategies to Improve Milkfish Production Efficiency in the Philippines

07MNE02NC - Training in Sustainable Coastal Aquaculture Technologies in Indonesia and the Philippines

07MER04NC - Implications of Export Market Opportunities for Tilapia Farming Practices in the Philippines

09SFT04NC - Feeding and Feed Formulation Strategies to Reduce Production Costs of Tilapia Culture

09QSD01NC - Nile Tilapia Broodstock Selection, Seed Quality and Density-Dependent Growth in the Philippines

09TAP02NC - Internet-Based Podcasting: Extension Modules for Farming Tilapia in the Philippines

09MER03NC - Improving Supply Chain Opportunities for Tilapia in the Philippines

09MNE02NC - Ration Reduction, Integrated Multitrophic Aquaculture (milkfish-seaweed-sea cucumber) and Value-Added Products to Improve Incomes and Reduce the Ecological Footprint of Milkfish Culture in the Philippines

09FSV02NC - Demonstration of Sustainable Seaweed Culture and Processing in Aceh, Indonesia and the Philippines - Opportunities for Women to Improve Household Welfare

09SFT06NC - Impact Assessment of CRSP Activities in the Philippines and Indonesia

ASIA

LEAD US UNIVERSITY: UNIVERSITY OF CONNECTICUT

DEVELOPMENT OF ALTERNATIVES TO THE USE OF FRESHWATER LOW VALUE FISH FOR AQUACULTURE IN THE LOWER MEKONG BASIN OF CAMBODIA AND VIETNAM: IMPLICATIONS FOR LIVELIHOODS, PRODUCTION AND MARKETS

Project Synopsis

There is increasing competition and conflict between the use of small-size fish for aquaculture feed and for human consumption in the lower Mekong River basin region of Cambodia and Vietnam. The vision of this project was for sustainable freshwater aquaculture development in the Lower Mekong basin region of Cambodia and Vietnam, taking into consideration: the import role that capture fisheries and aquaculture continue to play in the food security, poverty alleviation and economies of both countries; the strong interdependency between capture fisheries and aquaculture; that management of these two fisheries sub-sectors cannot be carried out in isolation of each other; and the increasing competition and conflict between the use of small-size fish for feed and human consumption. The objectives of this project were equally on the aquaculture of carnivorous fish, specifically snakehead (*Channa micropeltes* and *C. striata*), and the management of small-size fisheries resources in the lower Mekong River system.

In the lower Mekong River basin, many capture fisheries resources have been overexploited and, as a result, development of aquaculture has been encouraged to provide protein, income, employment and export earnings in Cambodia and Vietnam. Such a development trend implies that sufficient feed for increased aquaculture production will be available. One primary source of feed is small-size fish harvested from the river system. There is increasing demand and trade for these small-size fish for: (1) human consumption (e.g. fresh, dried); (2) direct feed (e.g. livestock, high value species aquaculture); (3) fish meal production (e.g. poultry, aquaculture); and (4) value-added products (e.g. fish sauce). The price of small-size fish has tripled since 2001 and it is predicted to continue to rise as aquaculture expands. Inevitably, a dangerous spiral has evolved where the demand for small-size fish for aquaculture feed has supported increased fishing pressure on already degraded fisheries resources.

These competing demands have led to conflicts between the use of small-size fish for aquaculture feed and for human consumption. The small-size fish species have traditionally been used as cheap food for people and this reallocation of fish resources to aquaculture has resulted in negative impacts on food security. The economics of the different uses of small-size fish in different localities direct the use of the fish one way or the other. There are also trade-offs between direct food benefits and the indirect employment and income generation opportunities afforded by aquaculture. It has been argued that it would be more efficient and ethical to divert more of the limited supply to human food, using value-added products. On the other hand, food security can also be increased by improving the income generation abilities of poor people, and it can be argued that the large volume of people employed in both fishing and aquaculture has a beneficial effect. This raises some important questions regarding the social, economic and ecological costs and benefits of aquaculture, its sustainability and future trends.

Key Findings & Outcomes

- CRSP work showed that fish used as feed in Vietnam represents 33 species, many of which are commercially important in their juvenile stages.
- CRSP researchers developed weaning methods so that small, hatchery-reared snakehead can be quickly adapted to pelleted diets.
- *Channa striata* snakehead were found to survive as well on pelleted diets in which up to 50% of the fish meal has been replaced by soybean meal as they do on pelleted diets made purely of fish meal.
- Researchers developed diets in which a significant portion of fish meal was replaced as a protein source by soybean meal with added amino acids, taurine, phytase, as well as local products like cassava meal and rice bran. In small-scale field trials, snakehead was successfully raised on three diets: small fish only, fish meal based pelleted diet, and fishmeal plus plant proteins pellet diet. Blind taste testing could not distinguish any significant differences among fish fed three diets.
- A local feed mill was recruited to produce CRSP diets and more than 50 farmers in Dong Thap and An Giang provinces used diets in raising snakehead. Results have shown that while some farmers are beginning to utilize pelleted feed, wider scale feed technology transfer has been limited due to the current comparable cost between pelleted feed and small-size fish.
- CRSP researchers conducted a biological assessment of small-size fish diversity in the lower Mekong River basin and identified over 200 species which were catalogued by Khmer, Vietnamese, and English names. Abundance and catch statistics on small-size fish were collected for study regions in Cambodia, and Vietnam. The proportion of small-sized fish in the total freshwater fish catch was 85% in Cambodia and 96% in Vietnam. In Cambodia, 35% of the catch comprises juveniles of large-sized fish; while for Vietnam it was 51%. Recommendations have been developed for improved management strategies for small-size fish in the lower Mekong River basin in Cambodia and Vietnam.
- Market studies on small-size fish found that they are used for feed (45%), household consumption (21%), sold to traders (15%), and direct sale in local markets (15%). Overfishing small-size fish therefore has negative impacts on wild fish stocks, reduction in food supply, and depletion of juveniles. Market analysis revealed that there is a range of markets in the region for the processed products from small-size fish. In Cambodia, small-size fish are important for poor people as fish paste, smoked fish, and fermented fish and are used for household consumption year round.
- Researchers worked to develop best processing practices to improve and ensure food safety of fermented small-size fish paste products for local consumers and the competitive markets in Cambodia, and have assisted in the development of women fish processing groups and associations.
- The project conducted a market channel and trade analysis of fermented small-sized fish paste in Cambodia identifying both domestic and international markets. In Vietnam, ten market channels for snakehead were identified; wholesalers get 90% of the value and farmers 6.5%.
- In Cambodia, the culture of snakehead has been banned until a better understanding of environmental impacts is gained. CRSP work has focused on developing sustainable snakehead aquaculture of Cambodian strains. Workshops have been held on assessing the impacts of the ban on snakehead aquaculture in Cambodia. A hatchery for breeding indigenous snakehead, including broodstock ponds, nursing/weaning ponds, and live feed (moina production) systems were set up at the Freshwater Aquaculture Research and Development Center (FARDeC). Broodstock of indigenous wild snakehead have been developed.

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Project Investigations

For a complete compilation of Final Investigation Reports, please see http://aquafishcrsp.oregonstate.edu/publications.php.

07MER01UC - Competition and Impacts Between Use of Low Value/Trash Fish for Aquaculture Feed Versus Use for Human Food

07MNE01UC - Assessment of Diversity and Bioecological Characteristics of Low Value/Trash Fish Species

07SFT01UC - Alternative Feeds for Freshwater Aquaculture Species.

07TAP01UC - Feed Technology Adoption and Policy Development for Fisheries Management.

07FSV01UC - Maximizing the Utilization of Low Value or Small-size Fish for Human Consumption Through Appropriate Value Added Product Development.

09SFT01UC - Alternative feeds for freshwater aquaculture species in Vietnam.

09IND02UC - Sustainable snakehead aquaculture development in the Lower Mekong River Basin of Cambodia and Vietnam

09TAP03UC - Development of alternatives to the use of freshwater low value fish for aquaculture in the Lower Mekong Basin of Cambodia and Vietnam: implications for livelihoods, production and market.

09FSV01UC - Maximizing the utilization of low value or small-size fish for human consumption by improving food safety and value added product development (fermented fish paste) through the promotion of women's fish processing groups/associations in Cambodia.

09MER04UC - Value chain analysis of snakehead fish in the Lower Mekong Basin of Cambodia and Vietnam

09MNE04UC - Developing Management Recommendations for Freshwater Small-Sized/Low Value Fish in the Lower Mekong Region of Cambodia and Vietnam

09FSV03UC - Assessing the Impacts of Sustainable Freshwater Aquaculture Development and Small-Sized/Low-Value Fisheries Management in the Lower Mekong Basin region of Cambodia and Vietnam

ASIA

LEAD US UNIVERSITY: UNIVERSITY OF MICHIGAN

IMPROVING SUSTAINABILITY AND REDUCING ENVIRONMENTAL IMPACTS OF AQUACULTURE SYSTEMS IN CHINA, AND SOUTH AND SOUTHEAST ASIA

Project Synopsis

Asia accounts for about 90% of world aquaculture production, and therefore has the greatest potential to impact the environment. Fortunately innovative systems that utilize practical technology can be used to reduce environmental impacts. The purpose of this project was to evaluate the relationship between aquaculture and environmental impacts, with the goal of reducing negative impacts. This work included determining the effectiveness of recirculating systems for shrimp culture, evaluating modified cages for reducing solid and dissolved waste transport to receiving waters, developing polyculture systems that increase nutrient utilization and reduce effluent effects, determining the effects of invasive species on natural communities, and focusing research on detecting and reducing effects of microcystins in receiving water bodies.

One of the major impacts of shrimp culture comes from the effects of effluents released in managing water quality and in harvest. Two systems have been developed to deal with this issue, using indoor and outdoor recirculation and zero exchange with receiving waters. Outdoor systems are capable of managing water quality when using suspended floc methods and removing solid waste from the ponds, while biofilter technology has not yet reached a stage of reliably improving water quality.

Monoculture usually results in waste of costly nutrients and feed, due to the inability of one species of organism to efficiently utilize all of the products derived from feeding. Polyculture can help to solve this by introducing organisms such as filter-feeding fish, as well as predators that may reduce natural recruitment in ponds. In Nepal, CRSP researchers developed combinations of sahar *Tor putitora* and tilapia *Oreochromis niloticus* to produce tilapia using feeds combined with natural productivity, and use sahar to control recruitment of tilapia and produce a second crop. Sahar are important locally as a food fish and are declining in natural waters, so their culture can reduce demand on natural stocks and can also be used to replenish declining populations. Similar work in Bangladesh has utilized freshwater prawns and mola with the intent of prawns being used mostly for sale and mola for family consumption, providing two important outputs.

Key Findings & Outcomes

- CRSP researchers evaluated shrimp systems using Life Cycle Assessment and found that the farming system has the largest environmental impact, and the main methods to improve performance include more efficient feeding methods and culturing shrimp at lower densities. In addition, long distance transport for export also has a major impact, demonstrating that production for local consumption and the reduction of importation of shrimp should be goals of consuming countries.

- Another major issue in Asia, but also in Africa, is expansion of cage culture in lakes and reservoirs. Cages release a large amount of solid and dissolved materials into receiving water bodies. An experimental system using cage liners to collect solid waste performed well in reducing impacts. No changes in water quality near the cages compared to the open reservoir were detected, and the collection of sediments reduced benthic fouling.
- Monoculture usually results in waste of costly nutrients and feed, due to the inability of one species to efficiently utilize all of the products derived from feeding. Polyculture can help to solve this problem. In Nepal, CRSP developed techniques to polyculture sahar (*Tor putitora)* and tilapia using feeds combined with natural productivity. Sahar control recruitment of tilapia and produce a second crop. Sahar are important locally as food fish and are declining in natural waters, so their culture can reduce demand on natural stocks and can also be used to replenish declining populations. Ratios of 33 tilapia to 1 sahar resulted in best performance both in on-station trials and on farms, and the results of this polyculture were extended to local farmers as a means to increase both profit and environmental performance.
- CRSP researchers in Bangladesh studied the polyculture of freshwater prawns and mola with the intent of prawns being used mostly for sale and mola for family consumption, providing two important outputs. Overall production was best when mola were stocked at 1.5 fish/m^2, combined with all male prawn at 3/m^2. Water quality was also improved by polyculture.
- Addressing the competing interests of aquaculture expansion versus natural resource conservation, AquaFish CRSP organized and led a symposium at the September 2011 American Fisheries Society meeting in Seattle, Washington entitled *"The Effects of Semi-Intensive Aquaculture on Biodiversity In Nearshore and Inland Waters*." The 12 invited international experts spoke on a wide range of topics that drive the debate between the benefits and drawbacks of aquaculture relative to natural biodiversity. Symposium topics covered invasive species effects, effluents and eutrophication, antibiotic effects, environmental performance, use of aquaculture feeds, and social and economic impacts. The full proceedings from the symposium can be found on the AquaFish website (http://aquafishcrsp.oregonstate.edu/publications.php). As an outcome of the symposium, a paper co-authored by several participants was developed collaboratively, titled "Responsible aquaculture by 2050: valuing local conditions and human innovations will be key" and submitted to the journal *Bioscience*. Several participants also submitted their contributed papers for publication in various peer-reviewed journals.
- Patterns of invasion of the non-native red swamp crayfish (*Procambarus clarkii*) in Asia from North America were evaluated by DNA extraction using microsatellites and *Cyt b* as markers. It is likely that *P. clarkii* populations in China derived from Japan, rather than North America, however, multiple unobserved introductions and/or cryptic invasion may have occurred.
- Eight small reservoirs in Vietnam include three without stocked fish (Bau Um, Suoi Lai, and Hung Phu Reservoirs in Binh Phuoc Province) and five with aquaculture practices (Dong Xoai; Sa Cat Reservoirs in Binh Phuoc Province; and Cau Moi, Da Ton and Gia Ui Reservoirs in Dong Nai Province) were used to construct Ecopath 5.0 models to evaluate the stocking rate and fisheries carrying capacity for each reservoir. Results indicated the need to more closely manage fish stocking and wild fish populations in reservoirs for better utilization of aquatic resources.
- Under eutrophic conditions in aquaculture ponds, blooms of the toxin-producing cyanobacteria *Microcystis aeruginosa* can develop. Buildup of this blue-green algae degrades water quality and causes harmful levels of microcystin (MC) toxin to develop. The toxin is a secondary metabolite that can be lethal to aquatic animals. When accumulated in fish and shellfish tissue, the toxin also affects the food product's quality and safety for human consumption. Work focused on controlling MC in indoor

recirculating culture systems for shrimp. The red swamp crayfish (*Procambarus clarkii*) and the freshwater prawn *Macrobrachium rosenbergii* were used as test species in experiments to identify the lethal mechanisms of the MC toxin. For the crayfish, the toxin from MC exposure lowers the survival rate of juvenile crayfish and adversely affects the disease immunity of adult crayfish, leading to poor grow-out in culture systems. In the case of prawns, no accumulation of MC toxin in tissues was found. These results point to MC's complexities and the need for continued studies to characterize its mode of action in different aquatic organisms. This information will prove especially critical for developing MC control methods for intensive shrimp production systems.

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Project Investigations

For a complete compilation of Final Investigation Reports, please see http://aquafishcrsp.oregonstate.edu/publications.php.

07BMA02UM - Polyculture of Sahar (*Tor putitora*) with Mixed-sex Nile Tilapia (*Oreochromis niloticus*)

07HHI01UM - Monitoring and Reducing Microcystins in Tilapias and Channel Catfish Cultured in a Variety of Aquaculture Systems.

07MNE03UM - Impact of Introduction of Alien Species on the Fisheries and Biodiversity of Indigenous Species in Zhanghe Reservoir of China and Tri An Reservoir of Vietnam.

07MNE04UM - Assessing Effectiveness of Current Waste Management Practices for Intensive Freshwater and Marine Pond Aquaculture in China.

07MNE05UM - Determining the Ecological Footprint of Shrimp Aquaculture Through Life Cycle Analysis of Outdoor Pond Systems

07MNE07UM - Workshop on Aquaculture, Human Health and Environment

09BMA03UM - Incorporation of tilapia (*Oreochromis niloticus*) and Sahar (*Tor putitora*) into the existing carp polyculture system for household nutrition and local sales in Nepal

09BMA04UM - Study on the effectiveness of a pond-based recirculating system for shrimp culture

09QSD03UM - Development of polyculture technology for giant freshwater prawns (*Macrobrachium rosenbergii*) and mola (*Amblypharyngodon mola*)

09MNE01UM - Invasion of the red swamp crayfish (*Procambarus clarkii*) in China: genetic analysis of the invasion and the impacts evaluation

09BMA05UM - Development of indoor recirculating culture systems for intensive shrimp production in China

09MNE03UM - Integrating environmental impacts, productivity, and profitability of shrimp aquaculture at the farm-scale as means to support good aquaculture practices and eco-certification

09BMA06UM - Identifying best practices to improve the giant river prawn industry in Thailand

09MNE05UM - The impact of fish stocking on wild fish populations, fish production and the ecosystem of irrigation reservoirs in South Vietnam

09MNE06UM - Evaluating the relationship between semi-intensive aquaculture and natural biodiversity

09WIZ03UM - Improved cages for fish culture commercialization in deep water lakes

09SFT07UM - Sustainable feed and improved stocking densities for gar (*Atractosteus* spp.) culture.

LATIN AMERICA AND CARIBBEAN

LEAD US UNIVERSITY: UNIVERSITY OF ARIZONA

DEVELOPING SUSTAINABLE AQUACULTURE FOR COASTAL AND TILAPIA SYSTEMS IN THE AMERICAS

Project Synopsis

Development of sustainable aquaculture systems is a priority for feeding the increasing populations in developing countries in the Americas while protecting fragile ecosystems. CRSP investigations, workshops, scholarships, and conferences kept invention and outreach/extension of improved aquaculture as a consistent focus. Specific aspects included closing the life-cycle of native fishes for restoration efforts and for farming, developing multi-trophic systems applying aquaculture effluents to vegetable production and seaweeds, improving the quality of effluents by removing residual hormones from sex-reversal, international conferences on tilapia and seaweed farming, and developing alternatives to fish meal in practical aquaculture diets.

Much of Central and South America has earned the unwanted distinction of having sacrificed significant areas of coastal mangroves to shrimp farming. CRSP, working primarily with two universities in Mexico and one in Guyana, along with other stakeholders, including farmers, government ministries, NGOs and with USAID, developed alternatives with a focus on more sustainable aquaculture. CRSP worked with several alternative species, especially natives including snook, tenhuayaca, and castarrica, in Mexico and pacu, tambaqui and hassar in Guyana. The research in Mexico was successful in closing the life cycles and developing domesticated populations of all three fishes. The project in Guyana worked with indigenous people in the Rupununi Basin encouraging the use of native species rather than introducing tilapia.

CRSP worked in Mexico and Guyana to improve tilapia farming in areas where the fish had already been introduced and established local populations. Mexican partners at UJAT developed a novel microbial biofilter that effectively removed the trace amounts of residual sex reversal hormone from tilapia hatchery water. CRSP technology has been commercialized and implemented at two private sector hatcheries in Tabasco, along with a focus on integrated farming using tilapia farm effluents to grow vegetables. In Tamaulipas this took the form of greenhouse aquaponics and evaluation of the bacteria that might be transferred from fish to leafy vegetables. In Tabasco, CRSP collaborated with communities of indigenous farmers to install tilapia tanks and use the effluent for irrigation of vegetable plots. In Guyana CRSP research included evaluation and testing of locally available ingredients in order to replace fishmeal in practical aquaculture diets. The focus was on tilapia diets, but the analyses conducted on several ingredients can apply to shrimp, hasar, pacu and other fish diets. CRSP provided workshops for women's cooperatives in Trafalgar Union and Anna Regina, and attracted a large number of women in Annai in the Rupununi Basin.

Key Findings & Outcomes

- Methyltestosterone (MT) is a strong androgen and widely used for tilapia masculinization. In order to decrease risks to humans and the environment associate with residual MT, AquaFish researchers at Universidad Juárez Autónoma de Tabasco, Mexico, isolated and evaluated two bacterial strains (*Pseudomonas aeruginosa and Pseudomonas fluorescens)* that effectively remove residual MT from hatchery water effluent. Researchers have coordinated with industry partners to scale up this technology for commercial adoption.
- CRSP researchers at the Universidad Juárez Autónoma de Tabasco (Mexico) focused efforts to domesticate native fish species for aquaculture production. Building on work undertaken in the Implementation Plan 2007–2009, researchers developed broodstock lines and feeding protocols for larval and adult fish. For example, while snook could spawn in captivity, survival of the larvae was problematic. Efforts emphasized finding the right live feed for the larvae to survival. For the native cichlid species, tenguayaca and castarrica, broodstock selection has advanced to the F_2 generation. This work is representative of the scientific success that CRSP has engendered at the institutional level in HC partner countries. In another aspect of the successful CRSP model, bringing native species into "local" aquaculture is an important step in self-sufficiency, implementing workable approaches to reduce pressures on the often-overfished wild-caught fisheries, and addressing cultural food preferences by bringing traditionally favored food fish into aquaculture.
- Integrating aquaculture and agriculture provides a sustainable production system where nutrients rich effluent from fish culture is used to irrigate and fertilize vegetables. Researchers working with two indigenous communities in Mexico, found "aquaponic" systems produced fish (tilapia) that grew quickly and marketable produce (habanero peppers). Assistance was also provided developing enterprise budgets and value-added processing.
- In Guyana, locally derived copra and shrimp meals are proving successful as lower-cost protein alternatives to fishmeal for tilapia and pacu farmers. Poultry by-products and brewers waste are also showing promise. This work was a collaborative effort between farmers' cooperatives (National Aquaculture Association of Guyana, Trafalgar Union Women's Cooperative for Tilapia) and a local feed mill (Maharaja Oil & Feed Mill) in trainings that focused on improved feed formulations and manufacture techniques. This work was expanded during the 2009-2011 Implementation Plan, during which CRSP trainings for small-holder farmers in rural northern and southern Guyana successfully transferred sustainable feed and production technologies. These trainings targeted individual farmers, small communities, women farmers, a feed mill, and tilapia hatchery. Three workshops were held in an isolated area in southern Guyana to help communities develop small-scale aquaculture, including their own feed production and marketing structure. A demonstration farm that integrates aquaculture with vegetable growing has been set up as a working model for the surrounding communities. The 16 women members of the Trafalgar Women's Cooperative have benefitted from women-focused trainings in aquaculture production basics, tilapia biology, and sustainable feed formulation and feeding regimes. Working together, CRSP investigators have guided these stakeholders towards successful adoption of technologies and practices that will ensure an improved livelihood from aquaculture. Now the potential for a US export market for tilapia and brackish water shrimp exists.
- Organized three International Symposia on Tilapia in Aquaculture (ISTA 7, 8 and 9) in Mexico, Egypt, and China, respectively attracted 1,800 people, over 300 papers presented and published, and 1000 Proceedings distributed.
- Organized and co-chaired the Second International Workshop on the Cultivation and

Biotechnology of Marine Algae at the 2009 World Aquaculture Society Meetings in Veracruz Mexico. The goal of the workshop was to increase awareness and share the skills and experience from the aquaculture industry. Participants included practitioners of algae production for human consumption, commercial producers of phytoplankton used in fish and shrimp hatcheries, researchers producing micro-algae for biofuels and students presenting their research results. The workshop included nine presentations and a panel discussion. Presentations and converted to PDF's for posting on a conference website.

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Project Investigations

For a complete compilation of Final Investigation Reports, please see http://aquafishcrsp.oregonstate.edu/publications.php.

07BMA03UA - Co-sponsorship of "Second International Workshop on the Cultivation and Biotechnology of Marine Algae: An Alternative for Sustainable Development in Latin America and the Caribbean"

07SFT04UA - Utilization of Local Feed Ingredients for Tilapia and Pacu Production

07SFT05UA - Local Ingredients Substituting for Fishmeal in Tilapia and Pacu Diets in Guyana

07IND01UA. Development of snook (Centropomus spp) seed production technology for application in aquaculture and restocking of over-fished populations

07IND02UA - Incorporation of the Native Cichlids, Tenhuayaca, *Petenia splendida* and Castarrica, *Cichlasoma urophthalmus* into Sustainable Aquaculture in Central America: Improvement of Seedstock and Substitution of Fish Meal Use in Diets

07HHI02UA - Food Safety Study of Leafy Greens Irrigated with Tilapia Farm Effluents

07TAP03UA - AquaFish CRSP Sponsorship of the Eighth International Symposium on Tilapia in Aquaculture to be Held in Egypt

07MNE06UA - Elimination of MT from Aquaculture Masculinization Systems: use of Catalysis with Titanium Dioxide and Bacterial Degradation

09TAP01UA - Aquaculture & Fisheries CRSP Sponsorship of the Ninth International Symposium on Tilapia in Aquaculture to be held in Shanghai, China

09SFT03UA - Expansion of Tilapia and Indigenous Fish Aquaculture in Guyana: Opportunities for Women

09QSD02UA - Sustainable Integrated Tilapia Aquaculture: Aquaponics and Evaluation of Fingerling Quality in Tabasco, Mexico

09IND05UA - Consolidation of Native Species Aquaculture in Southeastern Mexico: Continuation of a Selective Breeding Program for Native Cichlids and Snook Reproduction in Captivity

09MNE07UA - Reaching the Farms Through AquaFish CRSP Technology Transfer: Elimination of MT from Intensive Masculinization Systems Using Bacterial Degradation

LATIN AMERICA AND CARIBBEAN

LEAD US UNIVERSITY: UNIVERSITY OF HAWAI'I AT HILO

HUMAN HEALTH AND AQUACULTURE: HEALTH BENEFITS THROUGH IMPROVING AQUACULTURE SANITATION AND BEST MANAGEMENT PRACTICES

Project Synopsis

Poor women and children in coastal LAC are highly dependent upon natural resources extraction, often in the form of bivalve shellfish and other mangrove resources. Improved natural resources management and development of sustainable alternative livelihoods for local communities and fishers is critical, particularly where lack of alternatives may prompt desperately poor people to turn to over-exploitation of resources, the drug trade or immigration. This project targeted coastal communities in Sinaloa and Nayarit, Mexico, and one of the most impoverished areas in Nicaragua to improve shellfish sanitation, develop community-based co-management of resources and start small shellfish growing businesses. Considerable advances were also made in developing a new, native fish for aquaculture (*Dormitator latifrons*), which offers potential as a low-cost, low-tech aquaculture species for Latin America.

Project research, training and outreach activities were designed to add value to existing integrated coastal zone management programs (developed under previous USAID initiatives) for three large estuarine complexes in Mexico and Nicaragua. These sites and the target populations were chosen due to their biodiversity conservation value, the presence of extremely poor stakeholders reliant upon over-exploited natural resources, and the high number of impoverished women and children standing to benefit from this work. The overall goal was to increase capacity to implement best management practices in aquaculture sanitation as a means to improve human health through disease prevention, improve product quality and safety, and improve food security.

These efforts developed bivalve culture to increase utilization of indigenous species that are low on the food chain, have low technology requirements and are high value. Bivalves provide valuable ecological services and require improved management of their fisheries throughout the LAC region. An effective method of a community-based co-management for the black cockle fishery in Nicaragua has been developed and this model is now being replicated for the other troubled bivalve fisheries in Latin America. Additionally, this project contributed to the expansion of native bivalve aquaculture by developing hatchery methods and extending results to oyster farming groups in two Mexican States. The members of these participating groups are largely women, and their extended families. Researchers also studied a native fish species ("chame", *Dormitator latifrons*) found throughout Pacific Latin America that holds tremendous potential for aquaculture. Chame can be successfully grown on combination of low-cost, low-protein foods, thus lessening the need to buy expensive feeds with high levels of fishmeal.

Key Findings & Outcomes

- Chame (*Dormitator latifrons*), a fish low on the trophic chain, is a popular aquatic food for poor communities throughout the Latin American region. Its use as a source for

fishmeal and the dependence on wild-caught juveniles for aquaculture are depleting native supplies. CRSP researchers developed techniques for controlled reproduction in captivity, which will open sources for domesticated broodstock, with the first successful spawning and rearing of chame. These research accomplishments represent significant steps towards the development of broodstock to supply fingerlings for chame aquaculture.

- A two-part workshop on aquaculture sanitation for researchers, practitioners, and community stakeholders was conducted at Universidad Autónoma de Sinaloa–Culiacán in September 2008. Part I included a conference (19 presentations) and a one-day field trip for 36 stakeholders to a pilot site in Santa Maria Bay (Altata) for shellfish polyculture with oyster, pen shell, and shrimp. The Altata site is now targeted for "shellfish growing water classification" by the State of Sinaloa and the Mexican Federal Government. Part II was conducted in Santiago Ixcuintla (Nayarit). Thirty-nine attendees participated in the conference (12 presentations) and two field visits to Pozo Chino and Boca de Camichin, both major oyster growing areas. Pozo Chino is now targeted for "shellfish growing water classification" by the State of Nayarit and the Mexican Federal Government.
- Forty-three attendees, representing educational, private sector and governmental institutions, participated in the Regional Workshop on Shellfish Culture & Sanitation held 28–30 September 2009 at Universidad Autónoma de Sinaloa – Culiacán. Attendance by representatives of the Aquatic Sanitation Committees (ACS) for five of the Mexican States on the Pacific Coast was significant due to the ACS role in providing extension services to shrimp and bivalve producers. The workshop offered a networking opportunity for the various stakeholders. In this respect, the group's issuance of the "Declaration of Culiacán" — a public manifesto expressing the needs of the sector and requesting specific actions from industry and responsible government agencies — can be seen as a successful example of a newly established linkage.
- In the Aserradores Estuary of Nicaragua, 66 families have participated in the CRSP community-based co-management program for the native black cockle (*Anadara* spp.) fishery. This program offers a more effective management system to the traditional seasonal ban from April to July. CRSP has worked closely with these families, involving them in monitoring activities and management of the boundary markers for the no-take areas. To date, CRSP's accomplishments at the community level can be measured by the success of the community partners and cockle collector cooperatives in managing healthy cockle populations under the no-take area model. Other evidence of success is in the steps the Nicaraguan government has taken to test the community co-management approach in two other estuarine communities dependent on cockles.
- CRSP researchers have established that the current standing stock of oysters (~736 MT) cultured in the Boca de Camichin Estuary on the Pacific Coast of Mexico is below the maximum sustainable limit projected by the study (~1100 MT). The finding was presented to the Boca de Camichin management committee, a multi-institutional-governmental organization that is developing and implementing a management plan for the area. Based on recommendations, the Mexican government imposed a ban on establishing new oyster farms, which will ensure a sustainable oyster industry within the carrying capacity of the estuary.
- *Crassotrea corteziensis* is an important native oyster species in the Mexican State of Nayarit where it forms the basis of a thirty year old industry. This industry is based on wild spat collection, which has been primarily successful only in the State of Nayarit, limiting production in other regions. CRSP researchers from Autonomous University of Sinaloa in Mexico developed hatchery methods to produce *C. corteziensis* eyed-larvae. This hatchery-based method will benefit oyster farmers through higher and more reliable seed production.

- Two regional workshops were held in Nicaragua and Mexico for 127 participants from Nicaragua, Mexico, Honduras and El Salvador to exchange experiences and knowledge in the fields of aquaculture, fisheries management and coastal management. These workshops were designed to highlight the achievements of women's groups and included topics ranging from cockle fisheries management strategies, hatchery and culture methods for mangrove molluscs, ornamental species production, crab picking,and value-added/handicraft enterprises.

Project Personnel

University of Hawai'i at Hilo
Maria **Haws** - US Lead Project PI
Armando **Garcia Ortega** - US Investigator
William **Steiner** - US Investigator
Sharon **Ziegler-chong** - US Investigator

CIAD, Mexico
Omar **Calvario Martinez** - HC Co-PI

CIDEA-UCA, Nicaragua
Agnes **Saborio** – HC Co-PI (to Jun 2008)
Carlos **Rivas Leclair** - HC Co-PI (from Jul 2008)
Osejo **Baca** - HC Investigator
Eufrecia Cristina **Balladares** - HC Investigator
Juan Ramon **Bravo** - HC Investigator
Andres Ernesto **Brenes Altamirano** - HC Investigator
Nelvia **Hernandez Del Socorro** - HC Investigator
Rosa Angela **Osejo** - HC Investigator
Erik Jose **Sandoval Palacios** - HC Investigator

Louisiana State University
John **Supan** - US Co-PI

Ohio State University
Konrad **Dabrowski** - US Co-PI

Universidad Autonoma de Sinaloa-Culiacan, Mexico
Lorena Irma **Camacho** - HC Investigator
Eladio **Gaxiola Camacho** - HC Lead PI
Ambrocio **Mojardin Heraldez** - HC Investigator

Universidad Autonoma de Sinaloa-Mazatlan, Mexico
V. Patricia **Dominguez Jimenez** – HC Investigator
Guillermo **Rodriguez Dominguez** - HC Co-PI
Gustavo **Rodriguez Montes De Oca** - HC Investigator
Jose Cristobal **Roman Reyes** - HC Investigator
Miguel Angel **Sanchez Rodriguez** - HC Investigator
Olga **Zamudio Armenta** - HC Investigator

University of Alaska
Quentin **Fong** - US Collaborator

Project Investigations

For a complete compilation of Final Investigation Reports, please see http://aquafishcrsp.oregonstate.edu/publications.php.

07IND03UH - Spat Collection, Growth Rates and Survival of the Native Oyster Species, *Crassostrea corteziensis* at Santa Maria Bay, Mexico.

07IND04UH - Oyster-relaying and Depuration in Open-water Locations

07WIZ02UH - Determination of Carrying Capacity of the Boca Camichin Estuary in Reference to Oyster Culture

07HHI03UH - International Workshop for Aquaculture Sanitation

07HHI04UH - Regional Workshop on Shellfish Culture and Sanitation

07BMA04UH - Training in Best Management Practices for the Production of Molluscs in the States of Nayarit and Sinaloa

07HHI05UH - Microbiological Quality of Shellfish Growing Waters and Tissues

07BMA05UH - Intensive Training and Internship in Bivalve Culture and Shellfish Sanitation

09IND01UH - Developing hatchery methods for the mangrove oyster, *Crassostrea corteziensis* for the Pacific Coast of Mexico

09IND03UH - Stock assessment of "Chame" *Dormitator latifrons* in Nayarit and South of Sinaloa México

09IND04UH - Induced spawning and larval rearing of the "chame" *Dormitator latifrons* in laboratory conditions

09HHI01UH - Co-management and bivalve sanitation for black cockles (*Anadara* spp.) in Nicaragua

09HHI02UH - Capacity building in aquaculture, fisheries management and coastal management for coastal women. Workshop: Opportunities for Coastal Women in Fisheries, Aquaculture and Coastal Management

09IND08UH - Effects of environmental conditions on gills and gas bladder development in bimodal-breathers, gar (*Lepisosteus* sp.), pirarucu (*Arapaima gigas*) and bowfin (*Amia calva*).

GLOBAL

LEAD US UNIVERSITY: OREGON STATE UNIVERSITY

ASSESSING THE IMPACTS OF CRSP RESEARCH: HUMAN CAPITAL, RESEARCH DISCOVERY, AND TECHNOLOGY ADOPTION

Project Summary

This project set out to characterize and assess the impact of CRSP research in terms of research discovery and technology adoption. The project addressed a central problem encountered when assessing CRSP and many other agricultural research projects: the wide variety of - and complex systems relationships among - CRSP investigations and consequent complications in characterizing and assessing the investigations as a whole. Investigation heterogeneity within AquaFish CRSP is manifold, including the variety of investigation goals (human capital formation, research, outreach), the variety of outcomes (aquaculture profitability, human health, ecosystem quality), and the variety of their technological and cultural settings. Such variation complicates issues already present in program assessment, such as the difficulties in distinguishing program influences from other factors affecting impact and adoption.

Although monitoring and evaluation mechanisms and benchmarks for key development indicators were built into AquaFish CRSP from inception, the structure for collecting assessment data specifically required for this project were not established and were therefore added after the investigations were partially completed. Because situations of this nature are often unavoidable, an effective assessment plan must be able to utilize data that is available. The current synthesis project has succeeded in: (a) conducting a detailed examination of AquaFish CRSP project- and investigation-level settings, objectives, and goals; (b) assembling a list of the quantifiable study inputs and outputs of each AquaFish CRSP project and investigation; (c) conducting a review of the literature on probability elicitation and Bayes probability updating, useful for developing the methods we will use to elicit investigations' probabilistic output information; and (d) opening communication with AquaFish PIs in order to assemble investigations' input data.

Project Personnel

Oregon State University
Steve **Buccola** - US Lead PI
Rolf **Fare** – US Investigator

Montana State University
John **Antle** - US Co-PI*
Roberto **Valdivia** - US Investigator

Project Investigations

For a complete compilation of Final Investigation Reports, please see http://aquafishcrsp.oregonstate.edu/publications.php.

09BMA07OR - Assessment of AquaFish CRSP Discoveries
09TAP05OR - Assessment of AquaFish CRSP Technology Adoption and Impact
09TAP06OR - Project Planning Meeting on AquaFish Technology Discovery and Impact Assessment

7. PARTNERSHIPS & NETWORKS

AquaFish CRSP worked with partners to share expertise, engage stakeholders, and obtain matching or supplementary funds. We have developed and maintained linkages among universities and government ministries, departments of agriculture, and the private sector around the world.

Core Research Projects were encouraged to foster linkages with organizations including US minority-serving institutions, non-governmental organizations (NGOs), national agricultural research institutions, other CRSPs, international centers, private businesses, and others. Proposals that linked Host Country researchers from one CRSP site to another CRSP site were also encouraged. Proposals, work plans, and project budgets were developed collaboratively between Host Country and US researchers, as were operational decisions such as budgeting, overall priority setting, and other collaborative activities related to the CRSP. US PIs actively established and maintained effective working relationships with the ME and other CRSP US and Host Country PIs and program participants. AquaFish required that at least 50% of Core Research Project funds be expended in or on behalf of the Host Country or region.

In addition to forming linkages through Core Research Projects, AquaFish CRSP also looked to advisory bodies such as the RCEs to establish and maintain linkages in Latin America/Caribbean, West Africa, East and Southern Africa, and Asia.

Listed below are institutions, NGOs, and organizations that have participated as partners with AquaFish CRSP since inception in 2006. Asterisks (*) indicate US and Host Country PI affiliations and direct funding recipients through subcontracts and MOUs. Entities with affiliations based on financial support via travel reimbursement or personal services agreements, or other shorter-term funding arrangements are not included in this group. Linkage through Associate Awards are also indicated (†).

US Partners

Alabama A&M University*
American Soybean Association
AmeriSci International
Auburn University*
Coastal Resources Center-University of Rhode Island
Cornell University
Cultural Practice LLC
Delaware State University
Fish Farmacy
Fisheries Industry Technology Center-University of Alaska
Florida International University
Global Aquaculture Alliance
Goosepoint Oyster Inc.
Louisiana State University*
Montana State University*
National Oceanic and Atmospheric Administration--International Sea Grant
North Carolina State University*
Ohio State University*
Oregon State University*†
Oxfam America
Pacific Shellfish Growers Association
Partners of the Americas
Peanut CRSP
Purdue University*†
Shrimp Improvement Systems
Sustainable Management of Watershed CRSP
Texas A&M University
Texas Parks & Wildlife Department
Texas Tech University*
U.S. Food & Drug Administration
University of Arizona*
University of Arkansas at Pine Bluff*
University of Connecticut*
University of Georgia*
University of Hawaii-Hilo*
University of Michigan*
University of Rhode Island*
University of Texas
US Department of Commerce-NOAA

US-Mexico Aquaculture TIES Program
USAID Sustainable Coastal Communities & Ecosystems Program
Virginia Polytechnic Institute & State University*†
World Wildlife Fund*

International Partners
Aquaculture without Frontiers (USA)
Australian Centre for International Agricultural Research
International Development Research Centre (Canada)
International Institute for Fisheries Economics and Trade
International Water Management Institute (IWMI) of the Consultative Group on International Agriculture Development (CGIAR)†
Lake Victoria Environmental Management Project (Kenya, Tanzania, Uganda, Rwanda, Burundi)
Network of Aquaculture Centers in Asia (Thailand)
United Nations Food & Agriculture Organization (Italy)
United Nations Food & Agriculture Organization, Regional Office (Ghana)
United Nations Food & Agriculture Organization in Asia-Pacific (Cambodia)
USAID Farmer-to-Farmer Program, Guyana
USAID GTIS Programme (Guyana)
USAID SUCCESS Program (USA)
US-Mexico Aquaculture TIES Program
World Aquaculture Society (USA)
WorldFish Center (Malaysia)

Australia
Australian Center for International Agricultural Research
University of Tasmania

Bangladesh
Bangladesh Agricultural University*

Brazil
Sao Paulo State University
Aquaculture Center, Jaboticabal
Centro de Acüicultura, UNESP

Cambodia
Cambodia Molecular Genetic Group, Health Scientific Research Centre University Health Sciences
Freshwater Aquaculture Research & Development Center
Department of Fisheries, Mekong River Commission-Aquaculture/Fisheries Projects
Department of Fisheries, Post-Harvest Technologies & Quality Control of Fisheries Administration
Fisheries Administration in Cambodia
Inland Aquaculture Extension & Productivity Improvement Project
Inland Fisheries Research and Development Institute*
Prek Leap National School of Agriculture
Royal University of Agriculture

China
China Aquatic Products Processing & Marketing Association
Guizhou Normal University
Hainan University*
Tongwei Co. Ltd
Wuhan University*
Zhanghe Reservoir Fisheries Management Company
Haoshideng Shrimp Farm
Huazhong University*
Huiting Reservoir Fisheries Management Company
Sichuan Aquacultural Engineering Research Center
Shanghai Ocean University*† (Formerly Shanghai Fisheries University)

Costa Rica
University of Costa Rica

Ecuador
Ecocostas

Egypt
Academy of Scientific Research & Egyptian Universities
Central Laboratory for Aquaculture Research
Egyptian Society of Agribusiness
Ministry of Agriculture & Land Reclamation

Ghana
FAO-Ghana
Fisheries Department, Ministry of Food & Agriculture
Kwame Nkrumah University of Science and Technology*†
Ministry of Agriculture Fisheries Directorate
Water & Sewage Company
Water Research Institute's Aquaculture Research Development Center

Guatemala
San Carlos University

Guyana
USAID/GTIS Program

Von Better Aquaculture
Anna Regina Fish Culture Station
Guyana Department of Fisheries*
Guyana School of Agriculture
Maharaja Oil Mill
Mon Repos Aquaculture Center, Department of Fisheries
Trafalgar Union Women's Cooperative
University of Guyana
USAID Farmer-to-Farmer Program
National Aquaculture Association of Guyana

Honduras
Zamorano University

Indonesia
Indonesian Department of Fisheries
Ladong Fisheries College
Ujung Batee Aquaculture Center*

Kenya
FishAfrica†
Kenya Business Development Services
Kenya Marine & Fisheries Research Institute
Kenyatta University*†
Ministry of Fisheries Development-Kenya Department of Fisheries†
Moi University*†
National Investment Center
Sagana Aquaculture Center
Women in Fishing Industry Project

Lebanon
American University of Beirut

Malaysia
WorldFish Center

Mali
Direction Nationale de La Pêche †
Comite Estatal de Sanidad Acuicola de Sinaloa
Ministry of Livestock and Fisheries (Ministère de l'Èlevage et de la Pêche)
Rural Polytechnic Institute for Training & Applied Research
The Permanaent Assembly of Chambers of Agriculture (APCAM)
University of Bamako
USAID Mali

Mexico
Comite Estatal de Sanidad Acuicola de Sinaloa
Cooperativa Pesquera San Ramon
Federation of Shrimp Cooperatives
Instituto Nacional de Investigaciones Forestales y Agropecuarias
Instituto Sinaloense de Acuacultura
Mariano Matamoros Hatchery
Research Center for Food & Development*
Universidad Autónoma de Tamaulipas*
Universidad Autónoma de Sinaloa–Culiacán*
Universidad Autónoma de Sinaloa–Mazatlán*
Universidad Juarez Autonoma de Tabasco*
Secretariat of Agricultural Development for the State of Tabasco
The Autonomous University of Sinaloa-Mazatlan
Women's Oyster Culture Cooperatives of Puerto Penasco
Instituto Sinaloense de Acuacultura
Sinaloa State Fisheries Department
Women's Oyster Culture Cooperatives of Nayarit

Nepal
Institute of Agriculture & Animal Science*
Rural Integrated Development Society

Nicaragua
Center for Research of Aquatic Ecosystems-Central American University (CIDEA-UCA)*
Nicaraguan Ministry of the Environment

Philippines
Bureau of Fisheries and Aquatic Resources*
Central Luzon State University*
Department of Agriculture
Genetically Improved Farmed Tilapia Foundation International, Inc
Mindanao State University
South East Asian Fisheries Development Center - Aquaculture Division
Southeast Asian Fisheries Development Center-Aquaculture*
University of the Philippines at the Visayas (Institute of Fish Processing Technology)
West Visayas State University

South Africa
Department of Water Affairs & Forestry
Stellenbosch University*
Water Research Commission

Tanzania
Kingorwila National Fish Center
Mbegani Fisheries Development Centre
Ministry of Natural Resources and Tourism-Aquaculture Division*†
Nyegezi Fisheries Institute
Sokoine University of Agriculture*†
Tanzania Fisheries Research Institute
University of Dar-es-Salaam

Thailand

CNN Aquaculture and Supply Company
Department of Fisheries
FAO in Asia-Pacific
Network of Aquaculture Centers in Asia*†

Netherlands
Intervet-Schering Plough Animal Health
Tilapia International Foundation

Uganda
Blessed Investment Fish Farm
Gulu University*
Jinja United Group Initiative for Poverty Alleviation & Economic Development
Makerere University*
Namuyenge Mixed Farmers Ltd
National Fisheries Resources Research Institute-Aquaculture Research and Development Center*
Source of the Nile Fish Farm
Walimi Fish Cooperative Society Ltd

United Kingdom
UK Department for International Development
University of Stirling

Venezuela
BIOTECMAR C.A.

Vietnam
Can Tho University*
Dong Nai Fisheries Company
Nong Lam University

8. CAPACITY BUILDING

Aquaculture and fisheries are an integral component of the health, wealth, and livelihoods of many coastal and inland communities. In the face of population growth, there is a rising demand for food fish and continued pressure on already exploited capture fisheries. The aquaculture and fisheries sectors must co-exist to ensure the survival of communities relying on them for employment and income generation, food security, and international market access for fish-based commodity products.

Sustainable aquaculture development and improved fisheries management face numerous critical constraints that must be addressed in order to sustainably increase productivity. In all cases, critical constraints facing sector and policy development in developing countries closely mirror issues in developed countries, including: policies, financing, water and land access, water quality, institutional and emerging issues, access to technical expertise, and food safety and processing. It is necessary to build human and institutional capacity, creating a knowledge base for good governance, codes of practice, and best management practices (BMPs), which will ultimately enhance the sustainability of aquaculture and fisheries.

One of the key objectives of AquaFish CRSP was to build and strengthen the capacities of institutions and individuals through training and outreach activities. A participatory process involving public-private partnerships engaged Host Country stakeholders in an international network and provide them critical information for self-governance. AquaFish CRSP capacity building efforts benefited stakeholders in the US and participating Host Countries through the transfer of knowledge and technology and through the dissemination of information about best management practices and increased economic opportunities, ultimately increasing the sustainability of aquaculture and fisheries in all regions.

Strategy for Maximizing Training and Capacity Building

The CRSP enterprise engages the services of many professionals and institutions to achieve success. This synergistic participation benefited from building additional expert capacity throughout the AquaFish CRSP network. This network involved world-class scientists, technical support staff, and graduate and undergraduate students. Training and capacity building efforts ensured equitable access to individuals of both sexes and an understanding of the societal benefits of involving women colleagues in training opportunities. Therefore, a target of 50% was set for participation by women in all training activities. The intent of AquaFish CRSP was to create equal opportunities for men and women to participate in and benefit from the Program's research, training, educational, or other activities. AquaFish CRSP training and capacity building initiatives were also designed in a manner that benefits targeted stakeholders in both the US and Host Countries. Effective short- and long-term training and capacity building focused on four specific levels of engagement: Institutional, Researcher, Extension Services, and End-Users (e.g., farmers and fishers).

Increasing Institutional Capacity: CRSP efforts to develop Host Country institutional capacity were designed to result in highly competent local research capability – networked globally – but ultimately using Host Country nationals to design and implement internationally accepted research and outreach programs. Many Host Country universities and government laboratories did not have the infrastructure or supplies to address key issues confronting the aquaculture and fisheries management sectors and need assistance. As an example, through involvement in an ongoing CRSP project, Moi University in Kenya has become a regional leader in watershed assessments, including participatory analysis and GIS. Closing the digital divide between US universities and participating Host Country institutions will enhance

communication and dialogue. AquaFish CRSP served as a catalyst for rapid adoption of enabling technologies in many Host Country institutions, including online bulletin boards, distance learning courses, and other virtual communities of practice that link researchers, policy makers, and development practitioners struggling with similar issues. These modern outlets allowed ongoing discussion of critical issues while providing tremendous opportunity for program cost savings by decreasing the number of face-to-face meetings required.

Every institution of higher learning involved with CRSP activities benefited from the experience of international engagement. The CRSP has engaged the participation of several postsecondary minority-serving institutions, including Historically Black Colleges and Universities, Hispanic-Serving Institutions, Asian American and Pacific Islander Serving Institutions, and Tribal Colleges and Universities. Nurturing such relationships remained a priority for Oregon State University and AquaFish CRSP.

Increasing Researcher Capacity: AquaFish CRSP accepted only those research proposals that fostered collaborative research between US and Host Country scientists. This mentored approach ensured a synergistic relationship that led to a highly trained Host Country staff capable of managing research programs that involved proposal development, peer-review, financial transparency, project implementation, data analysis and synthesis, and outreach and dissemination through appropriate outlets and end-users. In addition, networking with international colleagues and publishing research findings in internationally recognized outlets are of utmost importance for the development of professional careers and for fostering long-term relationships based upon credible scientific capabilities, both among and between developed and developing countries. To this end, AquaFish CRSP sponsored conference sessions, pre-conference professional awards, symposia proceedings development, and student poster awards at various aquaculture, fisheries, and aquatic resource management meetings. These efforts also represented an important component of the overall AquaFish CRSP dissemination strategy.

Increasing Extension Services Capacity: A high priority of AquaFish CRSP extension efforts involve short-term “train-the-trainer” workshops to ensure that a core group of exceptional individuals will be present in all Host Countries to provide extension activities well beyond the grant period of AquaFish CRSP. Previous Aquaculture CRSP experience in Kenya and elsewhere has demonstrated that involvement of new extension agents in short-term farm-level workshops soon after their own training ensures retention of newly acquired knowledge. This train-the-trainer strategy has been maintained throughout AquaFish CRSP.

Increasing End-User Capacity: AquaFish CRSP researchers and extension specialists became aware of leading fish farmers and fishers in local villages. These individuals tended to be more open to attend short-term training workshops and adopted innovative technologies. Cultivating lead farmers to be active participants in the AquaFish CRSP enterprise ensured that CRSP research remained relevant to local needs. By interacting with farmers and having them articulate ongoing problems and work, lead farmers collaboratively worked with researchers to develop economically feasible and socially acceptable solutions. In addition, community leaders that served as role models were capable of reaching out to those end-users who did not see direct benefit of attending short-term training workshops but could gain from adopting available technologies.

Training Definitions

Training under AquaFish CRSP was defined as a learning activity conducted in a setting predominantly intended for teaching and imparting certain knowledge and information to the participants, with formally designated instructors or lead persons, learning objectives, and outcomes. It involved the transfer of knowledge, skills, or attitudes (KSAs) through structured learning and follow-up activities, or through less structured means, to solve problems or fill identified performance gaps. Trainings consisted of long-term academic degree programs, short- or long-term non-degree technical courses in academic or in other

settings, non-academic seminars, workshops, on-the-job learning experiences, observational study tours, or distance learning exercises or interventions.

Long-term training was defined as academic training lasting six months or more, including but not limited to degree programs. Long-term training typically included training intended to culminate in a BS, MS, or PhD degree (or equivalent), but could also include training leading to a high-school diploma, a technical certificate or Associates Degree (e.g., at a community college or technical school), or post-doctoral studies. Direct involvement in AquaFish research projects provided Host Country and US students with opportunities for training and experience, ensuring positive impacts on international development.

Short-term training was defined as non-academic training that lasted less than six months and did not lead to a degree or technical certificate. Short-term training typically included training provided through short-courses, seminars, workshops, internships, and observational study tours. Workshops typically focused on training Host Country extension specialists, local farmers and fishers, producers, fisheries officers, policy makers, and NGOs.

Capacity Building Benchmarks

AquaFish CRSP endeavored to build local capacity in aquaculture and aquatic resource management and ensure long-term program impacts at local and national levels through strategic informal and formal training opportunities. The following benchmarks provided a means to track program performance with respect to capacity building targets.

Benchmarks:

Year 1: (a) An additional year of the highly successful Host Country Principal Investigator Exchange Project continued to exchange information on cichlid aquaculture to additional countries including two IEHA countries; (b) the jointly funded NOAA Sea Grant Technical Assistance program continued; (c) gender integration strategies adopted within all sub-awards; (d) Regional Centers of Excellence established to reflect AquaFish CRSP regions for research activities (i.e., Asia, Africa, and Latin America and the Caribbean); and (e) formal Memoranda of Understanding adopted between all US and Host Country partners.

Years 2-5: (a) partnerships strengthened among US and Host Country universities, NGOs, NARS, and USAID Missions through Associate Awards; (b) at least 100 students educated through formal long-term training opportunities in US, Host Country, and Regional universities; (c) equal numbers of women and men trained through short- and long-term training opportunities; (d) numerous train-the-trainer workshops convened to provide Host Countries with highly skilled extension specialists; and (e) biotechnology and biodiversity training activities conducted as identified.

Strengthen human and institutional capacities, both in our collaborating Host Countries and in the US, have been achieved this largely through short-term (non-degree) and long-term (degree) programs, but also through other channels, including mentoring staff, students, and other participants as well as providing them with opportunities for professional growth through participation in regional and international conferences, symposia, and other meetings.

CORE RESEARCH PROJECT TRAINING PLANS

The 2009-2011 Training Plan was published online and outlines the training goals of each Core Research Projects under AquaFish CRSP. Each project was required to include a plan for outreach and dissemination in their proposals. The complete outreach and dissemination plan for each project has been excerpted from the 2009-2011 Training Plan and presented below. Complete work plans for each project, including all investigations, are available in the 2007-2009 and 2009-2011 Implementation Plans.

Auburn University

Lead US Principal Investigator: Joseph Molnar

HYDROLOGY, WATER HARVESTING, AND WATERSHED MANAGEMENT FOR FOOD SECURITY, INCOME, AND HEALTH: SMALL IMPOUNDMENTS FOR AQUACULTURE AND OTHER COMMUNITY USES

This project sought to identify best practices in water use, enterprise development, and fish culture and contributed to a legacy of trained individuals capable of leading and guiding aquaculture development as part of watershed management. Studies addressed a broad range of water management, production, credit, and extension issues in Uganda and South Africa with the intent and potential to extend findings and training to other countries. In Uganda, the project built on a three-year intensive USAID-funded effort to build an aquaculture industry that brought to the project an extensive network of contacts and institutional knowledge. Auburn University had a strong network of women scientists and extension professionals as Host Country Partners. Some Host Country partners had a sustained record of meaningful impact in the aquaculture sector in their own and neighboring countries. Others were new to aquaculture, bringing a multidisciplinary approach to the broader context of watershed management.

Outreach and Dissemination Plan

(Excerpted from the 2009-2011 AquaFish CRSP Training Plan)

The results of this research will be used by other investigators in this project by providing data for validating models related to water storage in small ponds or complexes of small ponds. The findings will reveal the potential of small pond water harvesting for rural water supply. Environmentalists and water management agencies will be interested in a water capturing system that has less impact on downstream flow. Report detailing possible impacts of land use on cage culture; and of land use and cage culture on biodiversity and quality of water for different uses.

Surface Catchment Development and Sustainability Evaluation for Multipurpose Water Supply for Meeting Aquaculture and Other Water Needs

Potential benefits will be quantified by studying successful existing operations as controls, and using them as a basis for encouraging other sites with similar or more desirable physical situations. The software suite and instructional modules will encourage building of local capacity through enhancing analysis skills of Host Country personnel for water supply development. Outreach workshops for each country, leaving behind a software suite of tools customized for the individual location.

Evaluation and Improvement of Production Technology in Uganda: Case Studies of Small-Holder Cage Culture in Watershed Reservoirs and as an Alternative Livelihood For Fishers

The case studies will document demonstrations of first efforts to move fishers to aquaculture on Lake

Victoria. The main target groups are individual farmers and rural communities. Financial aid institutions, potential farmers with access to watershed ponds, and government agencies in the East Africa region will have reliable data-based management recommendations for cage fish farming. Report detailing case studies of small-scale cage fish culture to identify approaches to farmer recruitment, participation, and technical support that can be used by other donors and the Government of Uganda for its poverty alleviation programs.

Market Assessment and Profitability Analysis of Aquaculture Enterprises in Uganda
Recommendations on the most profitable practices, levels of income stream that would yield higher returns and samples of developed. The main target groups are individual farmers and rural communities. Participating fish farmers will directly benefit. Enterprise budgets and cash flow projections for fish culture enterprise scenarios.

Training and Outreach in Uganda and Surrounding Nations
Supervised demonstrations conducted by fish farmer disseminated through a series of training events The main target groups are individual farmers and rural communities. Participating fish farmers will directly benefit. Training event in Uganda that will involve farmers from Tanzania and Kenya.

The relatively large number of Ugandan collaborators, who, in turn have their own networks in the engineering, extension and outreach and agribusiness departments have planned a concerted effort in outreach and dissemination. Although electronic media will be used, it is not the main means of dissemination of information because much of the ultimate target group will have little or no access to electronic information systems. Most of the work will be conducted in the field and on farms, so there will be much direct contact with farmers. The cage sites will keep a visitors log. Specific field days will be held as well. The AquaFish CRSP project will have access to the predecessor project's FISH database of more than 1,000 trainees, which includes fish farmers and new and prospective fish farmers as a starting point for farmer contacts. The local newspapers will also be contacted to run features; for which they will receive a press release written by AquaFish CRSP investigators. The table below indicates the types and numbers of people who will be reached by direct means: seminars, workshops, and field days.

All visiting researchers from the US will present at least one seminar at a university, to which government agency reps will also be invited. The Annual Fish Farmers Symposium and Trade Show of 2010 and 2011 which normally has 150 to 250 participants will be one of the key dissemination points for the study results. It will also be the basis for receiving the 20 regional representatives. The 2009 symposium will help disseminate information on fish farming but will be too early to disseminate results from AquaFish CRSP but can generate interest and foster collaboration among the symposium participants. Note that donors often attend these meetings and therefore will be made aware of how they can buy in to AquaFish CRSP.1 Participation of local governments and development agencies is central to studies 2 and 3 listed above and study 4 will provide much of the economic information necessary for the development agencies to make informed decisions regarding financing assistance for fish farmers. All training material and copies of seminars and other presentations will be accessible on the websites of the collaborating partners. In addition, the work will be mentioned on the Aquaculture Network for Africa site (ANAF), and appropriate links supplied.

North Carolina State University

Lead US Principal Investigator: Russell Borski

IMPROVED COST EFFECTIVENESS AND SUSTAINABILITY OF AQUACULTURE IN THE PHILIPPINES AND INDONESIA

North Carolina State University's project developed and implemented strategies to improve the cost

effectiveness, sustainability and income opportunities of farming fish in the Philippines and Indonesia and the subsequent livelihood of their people. A cluster of integrated investigations assessed key areas of research and outreach that formed a natural extension of the activities and accomplishments during IP 2007-2009 with AquaFish CRSP. Methods were developed to reduce farming costs for tilapia and milkfish, extensive supply chain analyses were conducted to specifically address the marketing opportunities and constraints of expanding tilapia products to reach more lucrative retail supermarkets, integrative/polyculture systems were assessed to reduce environmental impacts of farming fish while providing additional products for market and home consumption, a series of short Tilapia Podcasts were developed for disseminating current culture practices and cost-saving strategies to the farming community of Central Luzon, and training was provided on the harvest and processing of seaweeds in the Philippines and Aceh region of Indonesia.

Outreach and Dissemination Plan

(Excerpted from the 2009-2011 AquaFish CRSP Training Plan)

The research and outreach activities proposed should help develop high quality seed; practical methods for selecting broodstock with high fecundity; and feed reduction, formulation and manufacturing processes to improve overall management and cost efficiency of Nile tilapia culture. A portion of this work will be done on farm in Central Luzon and in cooperation with a local Filipino feed manufacturer. The NCSU project believes that directly working with farmers and their suppliers and incorporating their ideas is the best approach to extending effective management options to them. Other aspects of the proposed research will be conducted at the Freshwater Aquaculture Center (FAC) of Luzon State University (CLSU), the primary research/extension center supporting tilapia aquaculture in the Philippines and the training and education of students in the region. Farmers frequently visit this facility and routinely interact with faculty, staff and students to gain the latest news on tilapia culture. A workshop will also be held in the second year at CLSU to provide hands on, practical instruction to farmers and feed manufacturers on cost effective feeding efforts and better feed formulation and manufacturing processes for tilapia culture. Podcasting as a mode of communicating news and technical developments is the wave of the future. This project intends to produce a series of short podcasts so tilapia farmers and the research and extension community can gain the latest practical news on tilapia farming.

This project will also conduct a supply-chain analysis on the opportunities and constraints for producing tilapia products for the domestic supermarket and fast-food chains in the Philippines. This will involve numerous interviews with government, business, farmers and other stakeholders, which will aid in disseminating protocols for improving production efficiency of tilapia throughout Luzon Philippines.

Additional studies with scientists at SEAFDEC, the premier center for fisheries/aquaculture research and extension in Southeast Asia, should aid in improving production efficiency of milkfish and development of integrative culture systems to reduce the ecological footprint of milkfish farming. SEAFDEC staff will introduce the integrated system to farming communities through season-long training programs using their cages as a demonstration facility. Therefore, 30 or more seaweed and milkfish farmers, representative of 4 communities, will be directly trained on sustainable culture of milkfish. It is anticipated that information pertaining to milkfish will be published through a SEAFDEC technical report/outreach manual. Other outreach activities proposed in this project will utilize the expertise of scientists at SEAFDEC and Ujung Batee Aquaculture Center, the primary government research and training facility in Aceh province of Indonesia, to conduct various workshops on management, harvest and processing of seaweeds in Indonesia and the Philippines. This will include a series of 7 workshops for farmers and the community. With an estimated 30 individuals attending each workshop the seven workshops proposed in this project will incorporate the direct participation of ~200 farmers from four communities. One of the activities will target women for improving household welfare and entrepreneurship opportunities through training in processing and preparation of seaweed for home use

and production of value added candies and desserts.

Finally project results will be reported in peer-reviewed scientific journals, by way of podcasts, and through presentations at the annual World Aquaculture Society and regional aquaculture meetings, and as CRSP progress and final reports.

Purdue University

Lead US Principal Investigator: Kwamena Quagrainie

IMPROVING COMPETITIVENESS OF AFRICAN AQUACULTURE THROUGH CAPACITY BUILDING, IMPROVED TECHNOLOGY, AND MANAGEMENT OF SUPPLY CHAIN AND NATURAL RESOURCES

The overall goal of this project was to develop physical and human capacity for the aquaculture industry in sub-Sahara Africa through new and better technology of fish production, better management of the natural resources, development of indigenous species, and appropriate response to market demands for fish products. In Kenya, investigations focused on the development of a farmed fish market information system and fish feeding efficiencies to enhance productivity in open ponds. In Tanzania, studies were conducted to test the effects of different diets and feeding regimes on growth performance of Nile tilapia, an important local protein source in Tanzania. Studies in Ghana looked at the opportunities and challenges of adopting cage culture as an alternative production system and the development of alternative species with emphasis on indigenous species to provide guarantees against potential biodiversity degradation. Results from the various investigations helped to vitalize rural aquaculture entrepreneurship by building capacity and creating a larger market for rural aquaculture producers. Results will also help to provide additional employment and income generation that will create demand for additional products and thus support the growth of other rural economic activities.

Outreach and Dissemination Plan

(Excerpted from the 2009-2011 AquaFish CRSP Training Plan)

Each of Purdue's investigations has an outreach activity to disseminate findings from the various studies to the stakeholders. Outreach and dissemination strategies will focus on enhancing the human, institutional, and structural capacity in the Host Countries. Project outreach activities will incorporate the active engagement of stakeholders, knowledge dissemination, and information sharing.

Purdue will continue outreach and dissemination efforts with government institutions, and non-governmental agencies in the Host Countries. Specifically, they will continue outreach and dissemination activities with the following partners:

1. Ministry of Natural Resources & Tourism, Aquaculture Development Division, Tanzania
2. Fisheries Directorate - Ministry of Agriculture, Ghana
3. Environmental Protection Agency, Ghana
4. Ministry of Fisheries Development, Kenya
5. Women in Fishing Industry Project, Kenya

Knowledge generated from the various studies and investigations will be disseminated through formal and informal presentations at the local level such as on-farm trials, regional, and national conferences and seminars, farmer's education and extension education meetings, and through publications. Publications would include research articles in peer-reviewed journals, and extension publications in local languages. Technical reports and refereed articles documenting results will be made available to stakeholders at the conclusion of the project. To engage policy makers, politicians will be invited to organized seminars and workshops, and also taken on tours to project sites. This strategy has worked in Kenya, and has attracted the attention of government with a budget allocation of $14.5 million for aquaculture development during

the 2009/2010 financial year. To keep the USAID mission offices in the respective countries properly informed, this project will continue to adopt the AquaFish CRSP Ambassador program. Visiting US PIs and Host Country PIs will continue to visit USAID mission offices for discussions on potential areas of collaboration on AquaFish CRSP projects. All reports and published materials from this project will be made available to USAID mission offices, government offices, non-governmental agencies, and the respective universities and agencies that have a stake in aquaculture and natural resources. Host Countries will also promote AquaFish project activities on various campuses and highlight accomplishments to administrators.

University of Arizona

Lead US Principal Investigator: Kevin Fitzsimmons

DEVELOPING SUSTAINABLE AQUACULTURE FOR COASTAL AND TILAPIA SYSTEMS IN THE AMERICAS

The University of Arizona project focused on the use of polyculture, domestication of native species, and integration of aquaculture with agriculture, as a means to more sustainable and profitable aquaculture in Mexico and Guyana. Research included examining the use of locally produced protein sources for the replacement of fishmeal in tilapia, pacu, and shrimp diets; developing effective management strategies of YY supermale and GIFT strain tilapia stocks; and integrating aquaculture and agriculture (hydroponics, vegetables, and field crop culture). Increased farm efficiency and training in handling of aquaculture products will improve household nutrition, income, and overall welfare. These improvements in the welfare of the rural poor will help both the residents of the Host Country and reduce the need for citizens of the Host Countries to migrate to other countries in search of improved circumstances.

Outreach and Dissemination Plan

(Excerpted from the 2009-2011 AquaFish CRSP Training Plan)

Within each investigation, University of Arizona has identified a number of workshops, training sessions, conferences, and presentations. These are all part and parcel of a larger outreach and extension plan suffusing the entire project. Essentially the hope is to use the research results and educational activities to shift whole sectors of the aquaculture industry towards significantly more sustainable and profitable practices. To begin, there are a large number of undergraduate and graduate students who will be involved with the projects and will be provided with hands-on experiences with new species and techniques. Next, the plan is to include the students in all aspects of field research, presentations, workshops, conferences, and symposia. Not only does this provide the students with valuable experiences, but farmers also benefit from the energy, enthusiasm, and knowledge of the students.

The intern program that UA developed, supporting almost a dozen students from Mexico to work on US tilapia farms, is a prime example. The US farmers have frequently commented on the contributions (technical and social) of the students. The students have welcomed the practical applications of their academics and lab research. Upon their return, several of the interns have been recruited to work on fish farms in Mexico where they have management positions and have now applied both their AquaFish research experiences as well as the practical farm experience.

Including students in the planning and implementation of workshops, field days, short courses, and major conferences also facilitates the diffusion of information and research results to the farmers and to extension, research, and even regulatory professionals. As it is not likely possible to directly transfer research findings to every individual farm, we will use all the tools available. Using web tools, training early adopters, as well as direct interactions with farmers will extend findings and other technical materials by training trainers. There will also be frequent interactions with the extension specialists in Tabasco to share research and development findings. Ms. Ramotar also serves as the primary extension

person for aquaculture in Guyana, so a dual role will be served.

Women will be especially considered in outreach activities. Invitations to workshops and other events will be proffered to women and women's groups to ensure a significant, if not a plurality, of women in attendance. Considering the role of women both in farming and family nutrition, we believe their participation carries a double weight and value. The role of the women's cooperative at Trafalgar Union will be important in Guyana. There is also a women's farming cooperative in Annai that will benefit from workshops there.

The UA project has prepared to have a significant presence in the field with a plethora of workshops, field days, training programs and demonstrations. The scientists and students will also participate in local, national, and international meetings to both present our results and to gather additional information to share with our clientele. This project recognizes that farmers are often the drivers of innovation and that one of our responsibilities will be to help guide innovation toward sustainability and away from short-term profitability that will be a disservice in the long run.

University of Connecticut at Avery Point

Lead US Principal Investigator: Robert Pomeroy

DEVELOPMENT OF ALTERNATIVES TO THE USE OF FRESHWATER LOW VALUE FISH FOR AQUACULTURE IN THE LOWER MEKONG BASIN OF CAMBODIA AND VIETNAM: IMPLICATIONS FOR LIVELIHOODS, PRODUCTION AND MARKETS

The focus of this project was the sustainable freshwater aquaculture development in the Lower Mekong basin region of Cambodia and Vietnam, taking into consideration the balancing of social, economic and environmental/natural resource needs and implications. This vision took into account that the main driver of this project is the continued expansion of aquaculture and its dependency on capture fisheries for low value/trash fish for feed. It also recognized that: capture and culture fisheries continue to play an important role in the food security, poverty alleviation and economies of both countries; the strong interdependency between capture fisheries and aquaculture; management of these two sub-sectors cannot be carried out in isolation of each other; there is increasing intra-regional trade; and there is increasing competition and conflict between the use of low value/trash fish for feed and human consumption. This project undertook investigations examining the management of low value/trash fish fisheries, development of alternative feeds and feeding strategies, outreach and feed technology adoption, market and trade development, and value-added product development.

Outreach and Dissemination Plan

(Excerpted from the 2009-2011 AquaFish CRSP Training Plan)

There will be two audiences for the information and assistance from this project – (1) End-users: commercial and small-scale aquaculturists; and (2) Host Country decision makers, researchers, and extension agents. Each audience group has their own unique outreach needs that will be addressed. The outreach and dissemination activities to be undertaken in this project will be part of the overall approach of the project rather than for each individual investigation.

For the end-users, the outreach activities to be undertaken will involve training to improve farm-made feeds, feed and feeding strategies and understanding the cost and benefits of using alternative feeds diets. Activities will also include raising awareness of the advantages and disadvantages of pellet and low value fish as feed. Emphasis will be given to capacity building, communication and extension of knowledge in ways that are relevant to both commercial-scale and small-scale aquaculturists. Methods to be used will include formal and informal workshops and training sessions, one-on-one consultations, development of "best practice" guidelines, and manuals. Methods will be a mix of those employed by the US Sea Grant

extension-research model and the farming systems research approach. All outreach activities and materials will be produced in the local language. Extension staff in each country will undertake the outreach activities with support from university and government researchers/ scientists. In addition to these methods, it is acknowledged that better coordination and exchange of information and experiences is becoming increasingly necessary, as is the need to engage all relevant stakeholders, including poor households, in more inclusive dialogues. Involving people requires a shift in extension thinking away from technology towards a more flexible people-centered and participatory approach using innovative communication mechanisms. This approach will involve using participatory research techniques, which involves researchers and extension agents working and learning with local farmers, and has the aim of facilitating local capacity to analyze, plan, take action, and monitor and evaluate according to local needs. Farmers will be trained to extend new feed and feeding strategies to other farmers. On-farm trials of new feeds and feeding technologies will also be undertaken. The utilization of participatory approaches will allow for better meeting the needs of the aquaculturists.

For Host Country decision makers, researchers, and extension agents, the outreach activities will focus on raising understanding and awareness of the status, trends and utilization of low value/trash fish in aquaculture for planning and management; and development of knowledge and skills to work with aquaculturists to improve farm-made feeds, feed and feeding strategies and understanding the cost and benefits of using alternative feeds diets. Government support should focus on understanding and working with poorer rural households, which will provide a necessary balance to more commercially oriented aquaculture. Extension staff will be trained to be more gender sensitive and to include both men and women in trainings. Methods to be used will include training and workshops, involvement in on-farm and off-farm research and trials, and reports.

Several project outreach activities will help in meeting the CRSP information dissemination targets. The project will have an outreach activity, Investigation 3 in this phase of the project; it will emphasize on-farms trials in the research; training manual will be produced; there will be several workshops; and there will be intra-regional diffusion of results. Investigation 4 will disseminate best practice guidelines for fermented fish products.

The USAID Cambodia and Vietnam missions will continue to be briefed on the project by the PI and HC-PI and consulted throughout the project life. The USAID mission staff will be invited to important meetings and workshops of the project. They will be informed of visits by the PIs. They will receive a briefing on the project results to the end of the project.

University of Hawaii at Hilo

Lead US Principal Investigator: Maria Haws

HUMAN HEALTH AND AQUACULTURE: HEALTH BENEFITS THROUGH IMPROVING AQUACULTURE SANITATION AND BEST MANAGEMENT PRACTICES

Through research, training and outreach activities, this project aimed to add components of aquaculture research, development and training to existing integrated coastal zone management programs for three large estuarine complexes in Mexico and Nicaragua. Design of the research activities was based on extensive prior needs assessments, which included feasibility studies, management plans and previous research findings. The overall goal was to increase capacity to implement best management practices in aquaculture sanitation as a means to improve human health through disease prevention and product quality and safety. Improving food security through multiple strategies was also a theme for this work. This project also sought to further current efforts to develop indigenous species in Mexico and Central America focusing on bivalves such as clams, oysters and scallops as a low-impact alternative to shrimp

aquaculture and to more directly benefit poor coastal communities. A thriving bivalve fishery and aquaculture industry in Mexico and Nicaragua that yields safe, high quality products will create jobs, improve food security, and reduce the incidence of shellfish-borne illnesses. Development of the chame fish will add an easily cultured native species to the array of possibilities for small-scale fish culture along the Pacific Coast of Latin America. Training and extension in general food safety and quality for all aquaculture products built capacity among producers and vendors to reduce risks and improve the value of their products. Additionally, this work contributed to improving national capacity in Mexico and Nicaragua by training professionals to increase their knowledge in these fields.

Outreach and Dissemination Plan

(Excerpted from the 2009-2011 AquaFish CRSP Training Plan)

All components of this work involve multiple forms of outreach such as training, extension visits, demonstrations, publications and outreach campaigns. In all three sites (Nayarit, Sinaloa and coastal Nicaragua) some form of management committee has been constituted for each of the estuary areas and members will be involved in this work and kept informed to further dissemination and use of findings for improved ecosystems management. Outreach in the form of training, site visits, demonstrations and participation in workshops is also planned for direct interactions with end-user groups such as fishers, women's groups, aquaculture farmers, youth and other marginalize groups interested in the topics. Close linkages with federal/national and state institutions such as regulators, educators and extension agents from other agencies are also routinely maintained by the team as part of the current CRSP work to develop alternative, co-management fisheries methods, shellfish sanitation plans and aquaculture development. Outreach will also be conducted to USAID missions in both countries and the global USAID/EGAT team through meetings, written reports, invitations to visit the research sites and contributions to the CRSP and USAID/SUCCESS newsletters. Although SUCCESS is not continuing support to its field sites, support is likely to continue to disseminate lessons learned and new methods, including a “Learning Event” to be held for USAID in March 2010. Particularly for the bivalve co management and the chame development, this global outreach is important so that other countries and regions can benefit from prior CRSP and SUCCESS work.

Deliverables from this work will include at least one technical report from each investigation, 3 contributions to the CRSP newsletter, compiled training materials to be distributed or made available to all stakeholders including the CRSP network, and all work will be posted to the various participating institution's websites in English and Spanish. Work will also be published in the form of peer-reviewed journal articles and presentations will be made at the World Aquaculture Society Meetings in 2010 and 2011. Other presentations will be made at national and regional meetings.

Outreach events specifically targeting women (including young women ages 12-18) are planned for Nicaragua and Mexico (Investigation #5).

University of Michigan

Lead US Principal Investigator: James Diana

IMPROVING SUSTAINABILITY AND REDUCING ENVIRONMENTAL IMPACTS OF AQUACULTURE SYSTEMS IN CHINA, AND SOUTH AND SOUTHEAST ASIA

The University of Michigan project completed a collaboratively defined series of studies with Host Country counterparts in China, Nepal, Thailand, Bangladesh, and Vietnam. The investigations were defined largely by the Host Country scientists, in consultation with their university and government colleagues in each country. In Nepal, work was done to add sahar as a biological control to limit natural reproduction of tilapia. This produced a cash crop of its own as well as allowed for tilapia culture without extensive hatchery systems to produce sex-reversed fish. In China, studies focused on improving shrimp

aquaculture using indoor recirculating systems technology, life cycle assessment of shrimp, and invasion dynamics of red swamp crayfish. In Bangladesh, polyculture of prawns and mola, an important indigenous fish, allow small scale farmers to benefit nutritionally as well as economically. Biodiversity in reservoirs and the effects of introduced species on native fauna was studied in Vietnam. Work was also conducted on improving prawn culture management in Thailand, Bangladesh, and Vietnam. Overall, these investigations spanned a wide variety of university participants, countries, subjects, and methodologies. This breadth was very important to both the aquaculture community and to the vitality of our research group. These studies provided further information to fine tune aquaculture systems throughout the world, and will result in considerable improvement in aquaculture practice throughout the region.

Outreach and Dissemination Plan

(Excerpted from the 2009-2011 AquaFish CRSP Training Plan)

The University of Michigan project has considerable experience in moving aquaculture research to farmers by development of outreach materials, by training of farmers and extension agents, and by involvement of the NGO community. UM will continue such technology transfer with the present proposal. Each Host Country university has a mission to provide training to farmers as well as to extension and government agents on the research done by their faculty, or in this case under AquaFish CRSP. The main avenue for such training has been short courses at the host institutions. UM will continue these short courses with the current research and have even planned a workshop as part of the enclosed investigations. Deliverables in this area include one workshop to be conducted on prawn culture in 2011 in Thailand, and one on polyculture and family nutrition, to be held in Nepal in 2011. This workshop will deliver information on prawn farming and environmental impacts to farmers, private companies, communities, and government officials.

One important means to multiply technology transfer is to include those already providing such service in each of the Host Countries. For example, in Bangladesh UA has worked closely with Caritas, a charitable organization that extends aquaculture systems to poor farmers. Current technology has been tested against theirs to help them improve their own extension methods and materials. As a result, they are most interested in the knowledge generated from studies conducted within the CRSP, and will work with UA to help extend that knowledge through the NGO community and also to their beneficiaries. This work will collaborate with an NGO in Nepal for the on-farm trial and workshop to present the results of experiments to the NGO community following the culmination of investigation 1. Additionally, NACA is included as one of the participants, and through their network of centers considerable outreach throughout Asia should be gained. In support of this outreach, four fact sheets and one briefing on our proposed research will be produced.

Finally, in the research field, it is important to provide information to the research community to better inform them on possible improvements in aquaculture systems. The UA project has an extensive history of publishing materials under previous CRSP in peer-reviewed journals, in trade journals like the Global Aquaculture Advocate, and in books. This extension is equally important in the development of new knowledge, and the focus will be maintained on research publication. There have also been special efforts to present early results at local, regional, and international meetings on aquaculture, especially being conscious of involving all Host Country personnel in these presentations. As one past example, UA co-sponsored the cage culture symposium held in Hangzhou, China in 2006, where U.S. and Host Country personnel made a number of presentations. Deliverables in this area will include the presentation of research results to regional and international research communities at the Asian Fisheries Society and the World Aquaculture Society. There will also be a block of presentations at the WAS meeting in February 2010, and plan to present at the AFS meeting in 2010 as well.

Oregon State University/Montana State University
Lead US Principal Investigator: Steven Buccola
ASSESSING THE IMPACTS OF CRSP RESEARCH: HUMAN CAPITAL, RESEARCH DISCOVERY, AND TECHNOLOGY ADOPTION

The impact assessment project aimed to develop improved methods for assessing the discoveries arising from AquaFish CRSP experiments, studies, and activities, and apply the methods to demonstrate how the CRSP has produced new knowledge and human capital. This project also sought to develop "minimum data" (MD) methods of assessing the adoption and impact of AquaFish CRSP discovered technologies, and apply the methods to quantify impacts in terms of sustainability indicators: fish farm and trader income, environmental quality, human health, gender, and other social outcomes. Two investigations attempted to assess discoveries and technology adaption and impact through studies, surveys, focus groups, quantitative modeling, and other social science methods. The third investigation brought together host-country participants to review assessment methods relevant to Investigations #1 and #2.

Outreach and Dissemination Plan
(Excerpted from the 2009-2011 AquaFish CRSP Training Plan)
Under the auspices of both the above Investigations, two annual workshops will be carried out for AquaFish CRSP's US principal investigators and for as many HC investigators as feasible. These workshops will be held in conjunction with the AquaFish CRSP annual meetings. Identification of participants will be coordinated with the AquaFish US PIs.

The First Annual Workshop, at the 2010 AquaFish Annual Meeting, will: (a) help clarify quantifiable forms of CRSP investigations' intended technological discoveries; (b) elicit prior and posterior probabilities of these CRSP discoveries; (c) help identify CRSP technologies suitable for impact assessment; and (d) identify impact assessment leaders (IALs) for each investigation selected for assessment. The Second Annual Workshop, at the 2011 AquaFish Annual Meeting, will: (a) continue eliciting posterior probabilities of CRSP discoveries; (b) report results and provide technical support to IALs; (c) discuss appropriate sensitivity analyses and present results; and (d) plan for completion and dissemination of results. Personnel in both Investigation #1 and #2 will attend the conference in Seattle, as detailed in Investigation #3.

By its nature, this project will be collaborative with the other seven projects in AquaFish CRSP. Assessment efforts like the present one are similar to those at other CRSPs – such as the IPM CRSP – and at such CGIARs as the International Food Policy Research Institute. There will also therefore be communication with, and feedback from, assessment researchers at these institutions. In particular, this work will be useful for the design of future USAID CRSPs.

Because the focus will be on factors contributing to successful research and outreach activities for small and medium-sized fish farmers, the findings will be of interest to policy makers at national and local levels in the investigations' Host Countries.

The results will most immediately be disseminated to AquaFish CRSP principal and HC investigators, as the assessments will be directed to and arise from their own work. These communications will be in the form of structured questionnaires, the two planned workshops at the annual AquaFish CRSP meetings, email and telephone conversations, and the final project report. The final report will provide the PIs and HC investigators much of the information they will need to communicate with the in-country farmers, interest groups, and policy makers of whom we would not be aware. The report also will be a principal basis for communicating results to AquaFish CRSP. In addition, scholarly journal articles will be written and presentations made for various CRSP and professional audiences.

SHORT-TERM TRAINING UNDER AQUAFISH CRSP

During the program's initial five years (2006-2011), AquaFish CRSP Core Research Projects conducted 181 short-term training sessions in which 6348 participants were trained.[1] Among these trainees, 2103 were women, constituting 33.1% of all individuals trained and 4245 were men (66.9%). A full listing of these trainings is provided in Table 8.4 at the end of this section. A country breakdown of these events is shown in Figure 8.1.

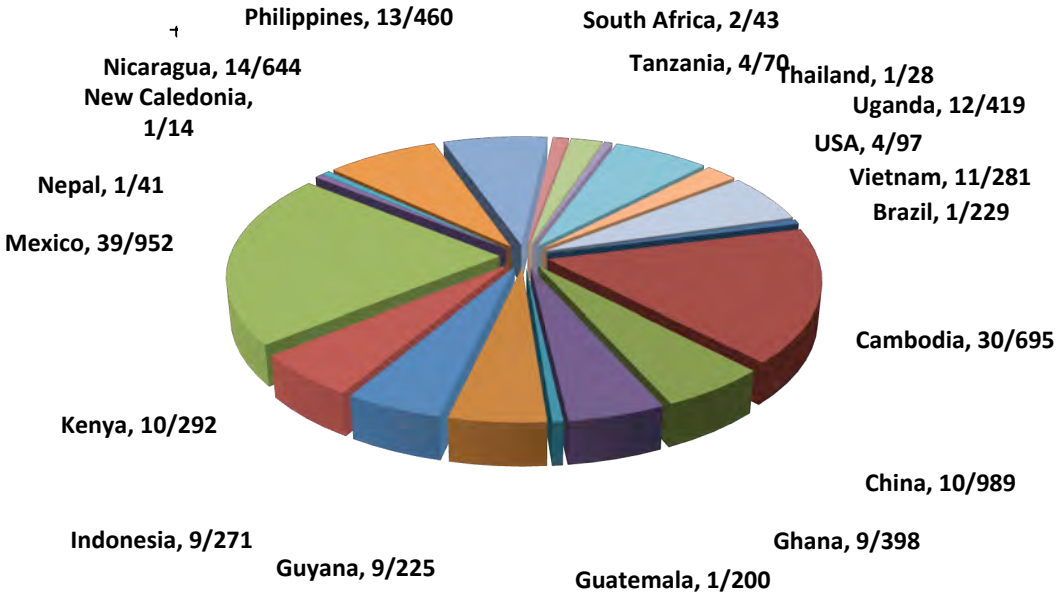

Figure 8.1. Numbers of events and participants in AquaFish CRSP short-term training events from 2006 to 2011, by country where held.

[1] Data provided in this report reflect the best information available to date, i.e., data drawn from AquaFish CRSP training databases and project reports received as of December 15, 2011.

Short-Term Training by Year

The numbers of short-term training events conducted by seven Core Research Projects and the program Management Office are shown in Figures 8.2 and 8.3. Figure 8.2 shows the numbers of events conducted each year and in total, by project, whereas Figure 8.3 shows the number of events conducted by each project and the total number conducted by the program, by fiscal year.

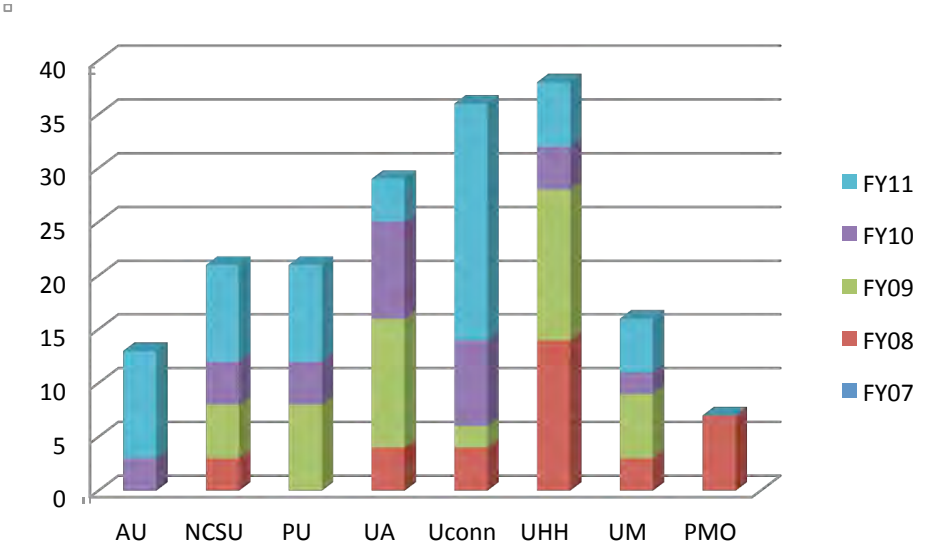

Figure 8.2. Numbers of short-term training events conducted by each AquaFish CRSP project, by fiscal year and in total. The first workshops conducted by the Core Research Projects took place during the second year of the program, FY08.

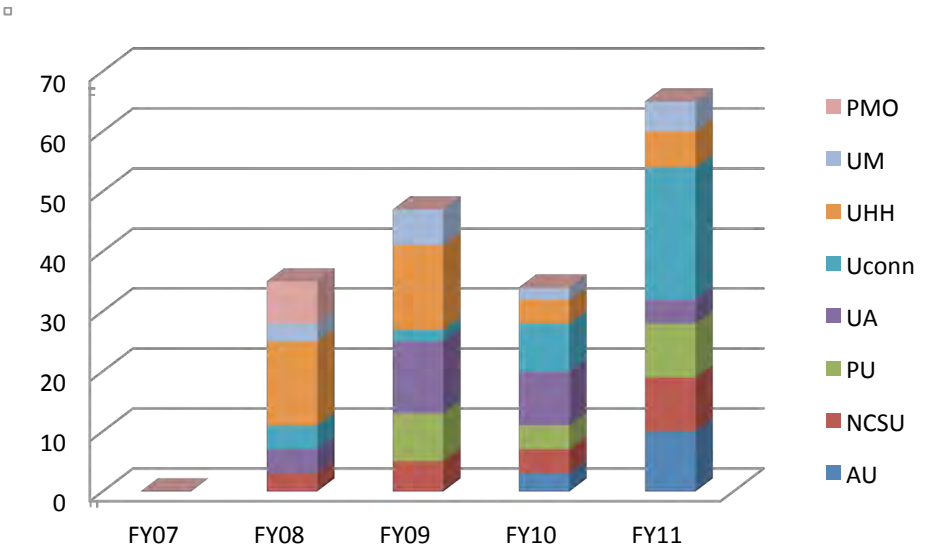

Figure 8.3. Numbers of short-term training events conducted during each fiscal year of program, by project and in total.

Gender Distribution in Short-Term Training

Of the 6348 participants trained over the life of the program, 2103 (33.1%) were women and 4245 (66.9%) were men. Table 8.1 shows the gender distribution by country.

Table 8.1. Numbers and percentages of women trainees participating in AquaFish CRSP short-term trainings from 2006 to 2011, by countries where events were held.

Country	Trainee Total	Number of Women	% Women
Brazil	229	83	36.2
Cambodia	695	227	32.7
China	989	278	28.1
Ghana	398	73	18.3
Guatemala	200	40	20.0
Guyana	225	114	50.7
Indonesia	271	73	26.9
Kenya	292	82	28.1
Mexico	952	407	42.8
Nepal	41	16	39.0
New Caledonia	14	1	7.1
Nicaragua	644	286	44.4
Philippines	460	194	42.2
South Africa	43	12	27.9
Tanzania	70	20	28.6
Thailand	28	14	50.0
Uganda	419	108	25.8
USA	97	7	7.2
Vietnam	281	68	24.2
Total	6348	2103	33.1

The lower percentages of women trained in short-term events in some countries reflects the traditional roles played by men and women in the aquaculture and fisheries sectors. Higher percentages of women trainees in some countries (e.g., Mexico—90% women trainees; Nicaragua—65% women trainees) reflect concerted efforts in the respective projects to focus trainings on activities or skills in which women have traditionally been involved or to include more women in trainings in activities in which men have traditionally been the main participants.

On a *regional* basis, 1222 individuals were trained in Africa (295 women [24.1%] and 927 men [75.9%]), 2779 were trained in Asia (871 women [31.3%] and 1908 men [68.7%]), and 2250 were trained in Latin America and the Caribbean (930 women [41.3%] and 1320 men [58.7%]). In addition, 97 individuals were in short-term events held in the US, including 7 women [7.2%] and 90 men [92.8%].

The gender distribution of short-term trainees in each of the AquaFish CRSP Core Research Projects from 2006 to 2011 is shown in Figure 8.4. No short-term events were held during FY07 because it was the

start-up year of the program. Women's participation was highest in the UHH project, with an overall average of 43.2%, and reaching a peak of 67.4% in FY11.

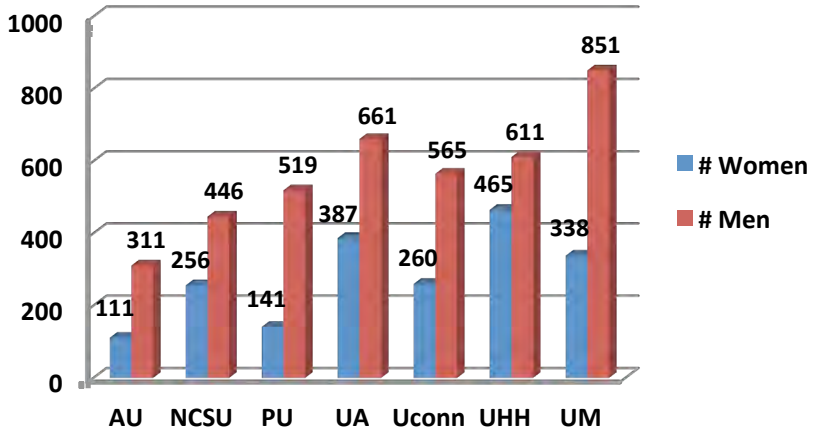

Figure 8.4. Numbers of women and men trainees in AquaFish CRSP short-term training events, 2006-2011, by Core Research Project.

Short-Term Training for Participants from IEHA Countries

During the life of the program, 1143 IEHA-country nationals received training in 33 short-term events , representing 18.0% of all short-term participants in the program. Trainings of IEHA participants took place under the Purdue and Auburn core projects and the program Management Office, with 9 events being held in Ghana (390 IEHA participants), 10 events in Kenya (291 IEHA participants), 1 event in South Africa (1 IEHA participant), 12 events in Uganda (414 IEHA participants), and 1 event in the US (6 IEHA participants). Seventeen of these events were held by Purdue University, 13 were held by the Auburn University project, and 3 were organized by the program Management Office under its HCPI Exchange Project (Phase II).

AQUAFISH CRSP LONG-TERM TRAINING

Since the AquaFish CRSP's inception in 2006, a total of 320 degree students of 25 different nationalities have received program support, including 166 men and 154 women (51.9 and 48.1 % respectively).[2] The distribution of these students by nationality is shown in Figure 8.5 and Table 8.2. For a full listing of students supported over the life of the program, see Table 8.5 at the end of this section.

[2] Students supported by the seven AquaFish Core Research Projects and the Program Management Office.

Degrees Sought by AquaFish CRSP Students
Student enrollment in various types of long-term training programs supported under AquaFish is shown in Figure 8.6. One hundred fifty-two students were seeking bachelor's degrees (47.5%), 131 students were seeking master's degrees 40.9%), and 33 students were seeking doctorates (10.3%). Four students (1.3%) were pursuing "other" programs, including 2 certificates, 1 high-school diploma, and 1 post-doc program.

Gender Distribution of Long-Term AquaFish CRSP Students
Overall the program supported the education of 154 women and 166 men between 2006 and 2011, resulting in a ratio very close to 50:50 (48.1 and 51.9%, respectively).The numbers and percentages of women students supported by each of the AquaFish projects and the Program Management Office are shown in Table 8.3.

Long-Term Training in IEHA Countries
Thirty-three of the long-term trainees who received AquaFish CRSP support during the program period were from IEHA countries (Kenya, Ghana, Uganda, and Nigeria). Among these 33 students, 15 (45.5%) were women and 18 (54.5%) were men. Eleven of these students (33.3%) were seeking BS degrees, including 5 women (45.5%) and 6 men (54.5%). Nineteen (57.6%) were seeking MS degrees, including 9 women (47.4%) and 10 men (52.6%), and 3 (30.3%) were seeking PhD degrees (both men).

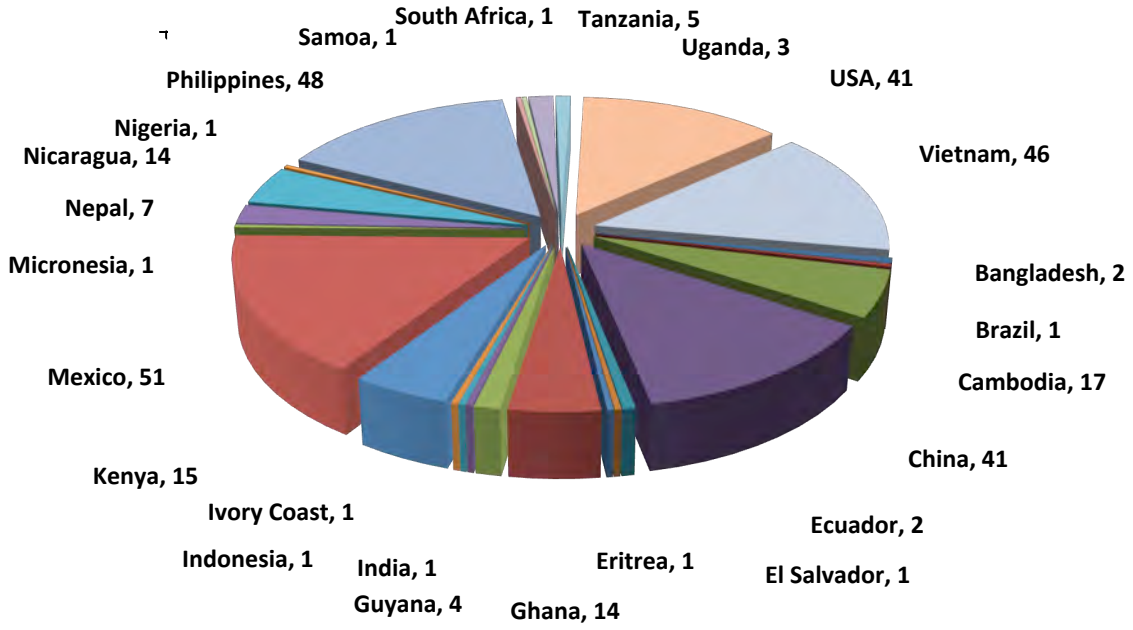

Figure 8.5. Numbers of students supported by AquaFish CRSP from 2006 to 2011, by nationality.

Table 8.2. Numbers, percentages, and genders of long-term students supported by AquaFish CRSP from 2006 to 2011, by nationality.

Nationality	Number of Students	Percent of All Students	Number of Men	% Men	Number of Women	% Women
Bangladesh	2	0.6	1	50.0	1	50.0
Brazil	1	0.3	1	100.0	0	0.0
Cambodia	17	5.3	8	47.1	9	52.9
China	41	12.8	18	43.9	23	56.1
Ecuador	2	0.6	2	100.0	0	0.0
El Salvador	1	0.3	1	100.0	0	0.0
Eritrea	1	0.3	1	100.0	0	0.0
Ghana	14	4.4	7	50.0	7	50.0
Guyana	4	1.3	2	50.0	2	50.0
India	1	0.3	1	100.0	0	0.0
Indonesia	1	0.3	0	0.0	1	100.0
Ivory Coast	1	0.3	0	0.0	1	100.0
Kenya	15	4.7	8	53.3	7	46.7
Mexico	51	15.9	32	62.7	19	37.3
Micronesia	1	0.3	1	100.0	0	0.0
Nepal	7	2.2	4	57.1	3	42.9
Nicaragua	14	4.4	7	50.0	7	50.0
Nigeria	1	0.3	1	100.0	0	0.0
Philippines	48	15.0	17	35.4	31	64.6
Samoa	1	0.3	0	0.0	1	100.0
South Africa	1	0.3	0	0.0	1	100.0
Tanzania	5	1.6	3	60.0	2	40.0
Uganda	3	0.9	3	100.0	0	0.0
USA	41	12.8	17	41.5	24	58.5
Vietnam	46	14.4	31	67.4	15	32.6
Total	**320**	**100.0**	**166**	**51.9**	**154**	**48.1**

The distribution of these students by core AquaFish project is shown in Table 8.3.

Table 8.3. Numbers and percentages of women in long-term training programs in AquaFish CRSP Core Research Projects and the Program Management Office from 2006 to 2011.

US Lead Institution	Total Students	# of Women	% Women
Auburn University	**3**	**1**	**33.3**
North Carolina State University	**64**	**38**	**59.3**
Purdue University	**38**	**18**	**47.4**
University of Arizona	**36**	**11**	**30.6**
University of Connecticut–Avery Point	**51**	**22**	**43.1**
University of Hawaii at Hilo	**55**	**27**	**49.1**
University of Michigan	**58**	**26**	**44.8**
Oregon State /Montana State	**4**	**3**	**75.0**
Program Management Office (OSU)	**11**	**8**	**72.7**
Total	**320**	**154**	**48.1**

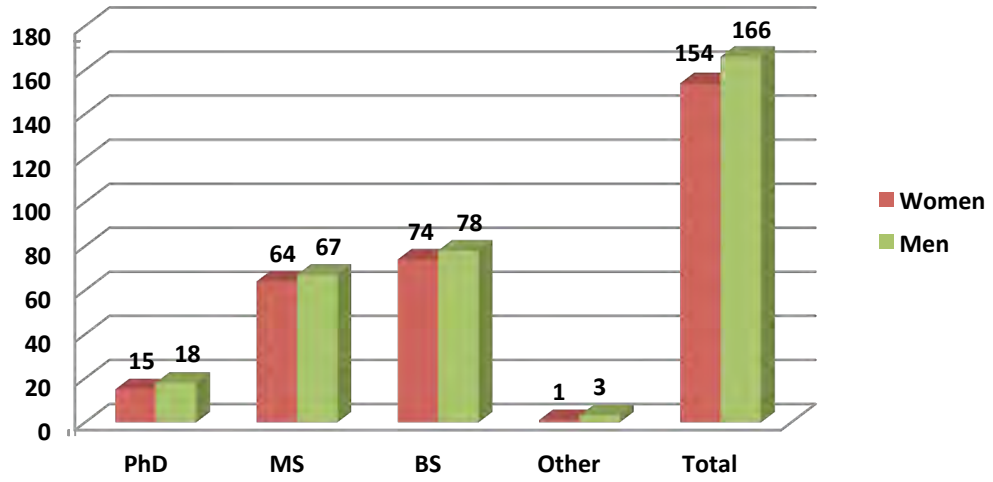

Figure 8.6. Numbers of AquaFish CRSP students seeking BS, MS, PhD, and "other" degrees from 2006-2011, disaggregated by gender. Students classified as "other" were seeking certificates of completion at an agriculture school or a high school, or were in a post-doc program.

OUTCOMES AND IMPACTS OF AQUAFISH CAPACITY BUILDING EFFORTS

AquaFish CRSP achieved a number of notable capacity building accomplishments, both through its Core Research Projects and through centrally funded activities.

- As of the end of FY11, a total of 320 long-term students had received long-term training support over the course of the program. The majority of these students (279 students, or 87.2% of all students) were Host Country nationals studying in their home countries or in the US.

- Overall, AquaFish CRSP trained 154 women (48.1%) and 166 men (51.9%).

- Near parity of men and women in long-term training was achieved despite the challenges of bringing women into aquacultural production, particularly in countries where they have traditionally been involved mainly in post-harvest activities. The increasing role of women graduates in academic, entrepreneurial, and governmental positions, as well as their increased visibility in trainings and through community and regional involvement, is helping to influence the enrollment of women students in degree programs.

- Each of the eight Core Research Projects laid out a gender inclusivity strategy and conducted a gender-focused investigation as part of its Implementation Plan for the period from 2009 to 2011. This has helped improve opportunities for women in situations where women's participation in training activities had been lower in years past.

- Short-term trainings have been designed to integrate stakeholders at all levels, thereby removing barriers such as those between farmers/fishers and extension agents/fisheries officers. Trainings have also been designed to empower trainees to "train" their counterparts. Some examples from among the 181 short-term training events conducted by the Core Research Projects from 2006 to 2011 are as follows:
  - ⇒ The earliest AquaFish CRSP workshops were associated with Phase II of the *"HCPI Exchange Project on Tilapia and Native Cichlid Technologies."* Four exchange visits were conducted under this project (South Africa, Ghana, Vietnam, and Brazil), each including a seminar in which participants shared information about the development and status of tilapia or cichlid culture in their home countries. The host PI for each visit also conducted a tour of relevant aquaculture facilities in their countries, with an eye towards showing systems and technologies that had proven successful in their country. Following completion of the exchange visit series, the participants also conducted "Echo-Seminars" back at their home institutions to share their experiences and new knowledge with institutional personnel, farmers, extension personnel, and other interested parties. (CRSP HCPI Exchange Project) (FY08)
  - ⇒ In Mexico, the UHH project created opportunities for the various stakeholders to establish linkages by targeting two workshops on sanitation and shellfish culture at a wide audience of stakeholders. This integrated approach helped to open communication channels among stakeholders, a positive step toward strengthening the important working relationships among farmers, policy makers, service providers, researchers, and business. (CRSP Investigation Codes 07HHI03UH; 07HHI04UH) (FY09)
  - ⇒ In Kenya, successful baitfish farmer trainees helped train other farmers interested in baitfish production and the cluster enterprise system. They also assisted the Women in Fishing Industry

Project, a collaborating project, in training women in pond construction and catfish breeding. (CRSP Investigation Code 07QSD02PU) (FY09)

⇒ In Guyana, members of the Trafalgar Union Women's Cooperative for Tilapia participating in a feed formulation workshop were able to broaden the reach of the training by transferring their experience to fellow members of the cooperative. (CRSP Investigation Code 07SFT04UA)(FY09)

⇒ In Cambodia, a Training of Trainer workshop was held for 21 farmers, Fisheries Officers, and Extension Agents to train them in alternative formulated feed practices for snakehead farming. Farmers and government trainees were expected to play an instrumental role in transferring this sustainable feed technology in the second phase of the University of Connecticut – Avery Point project on sustainable fisheries and aquaculture in the Lower Mekong River Basin. (CRSP Investigation Code 07TAP01UC) (FY09)

⇒ In Vietnam, a 2010 on-site training course on snakehead breeding and weaning, including hatchery set up, broodstock development, feed formulation, and feed strategies for FARDeC staff/project assistants took place at Can Tho University. This training provided Cambodian researchers with skills to begin a snakehead breeding program after their return to FARDeC (CRSP Investigation Code 09IND02UC)(FY10)

⇒ In the Philippines, women from two coastal villages in Tigbauan, Iloilo, and four coastal communities in Guimaras were trained in a series of workshops on milkfish postharvest procedures such as de-boning. The workshops provided instructions on how to make value-added milkfish products in order to get better prices for the fish. This could be a stand-alone business opportunity or could be linked as a downstream activity in an integrated milkfish production system. To this end, women from the Guimaras communities also are being assisted in setting up a small business by linking up with a microfinance company as a development partner. (CRSP Investigation Code 09MNE02NC) (FY10)

⇒ In Mexico, a workshop on integrated aquaculture/agriculture focused on describing the benefits and sustainability of using aquaculture effluents to irrigate and fertilize grain and vegetable crops. Aspects of plant nutrition, soil science, water chemistry, fish nutrition, fish husbandry, harvest techniques, and marketing were covered, and a demonstration project in the village of Guerero was visited. Discussions focused on water and nutrient delivery, drainage, sun angles, shade problems, and harvest plans. (CRSP Investigation Code 09QSD02UA)(FY10)

⇒ In Guyana, a three-day workshop was held at Bina Hill, near Annai, in Region 9. This workshop was directed towards the indigenous Amerindian community in the inland region of Guyana, focusing on the production of native fish species. Workshop topics included the capture and feeding of broodstock, pond construction and maintenance, preparation of local ingredients for a fish diet, and formulation and manufacture of ingredients into a diet. Harvesting, processing, and marketing of the locally grown fish to local, domestic, and even international markets were also discussed. The final two days of the workshop were spent discussing processing, shipping, and international markets for farmed fish and shrimp from Guyana to seafood markets in Trinidad and Florida. Representatives from many villages, who will serve as trainers to extend the information to their respective village members, were invited to attend the workshops. (CRSP Investigation Code 09SFT03UA)(FY10)

⇒ In Uganda, the CRSP project led by Auburn University co-sponsored the 4th Annual Fish Farmers Symposium & Trade Fair held in Kampala from 11-13 January 2011. The event was organized in partnership with WAFICOS—the Walimi Fish Farmers Cooperative Society. Presentations included topics focusing on operating fish ponds and farms as businesses, feeds and feeding, and farmer's experiences both in making profits and selling fish at a loss. Study tours to farms and related businesses were available to participants and proved to be successful as an outreach tool. Participants enthusiastically acknowledged the value of this multifaceted annual event as a forum

for information exchange, networking, and working out practical solutions to current production challenges. (CRSP Investigation Code 09BMA02AU)(FY11)

⇒ In the Philippines, a workshop on reduced feeding strategies ("Workshop on Tilapia Feeding Strategies and Feed Manufacturing: Meeting Global Challenges") was organized by the North Carolina State University Project and attended by over 60 tilapia farmers, feed manufacturers, representatives of local and regional Filipino government agencies, and university students. Feed costs are the highest single production cost farmers face, so strategies that reduce the amount of feed used without significantly reducing production can be extremely valuable to them. CRSP research has identified several such strategies, and the project used this event as a way to share information about them. The event, held at Central Luzon State University on 11-12 August 2011, was featured on a local news channel and videos are available on YouTube. Farmers are already adopting these new technologies and realizing increased profits. (CRSP Investigation Codes 09SFT04NC and 09SFT06NC) (FY11)

⇒ In Ghana, a workshop on "Propagation and Hatchery Management of the Nile Tilapia (*Oreochromis niloticus*) and African Catfish, (*Clarias gariepinus*), in Ghana," organized by the CRSP's Purdue project, was held at Akosombo on 14-16 December 2010. Training farmers and potential farmers in the basic techniques of aquaculture, thereby providing them with essential knowledge and skills, often leads to a ripple effect in information diffusion and technology transfer. This training focused specifically on practices needed by small- and medium-scale Ghanaian farmers to successfully produce Nile tilapia and African catfish fingerlings. Participants requested a regular schedule of trainings to reach new farmers and for areas not included in the Ashanti and Eastern regional focus of the CRSP trainings. (CRSP Investigation Code 09QSD05PU) (FY11)

⇒ In Cambodia, the University of Connecticut incorporated a comprehensive impact assessment component into its project to evaluate the combined accomplishments of its CRSP work to date. Under this component the project held 13 workshops during FY11 to prepare project personnel in data collection and assessment methods to apply to their activities including 1) sustainable approaches to snakehead aquaculture and its value chain, 2) policy framework for sustainably managing the aquaculture-capture fisheries interactions, 3) management recommendations for protecting the small-sized fishery in the lower Mekong River Basin, and 4) standards for fish paste processing. (CRSP Investigation Code 09FSV03UC) (FY11)

⇒ In the Aserradores Estuary of Nicaragua, 66 families have participated in the CRSP community-based co-management program for the native black cockle (*Anadara* spp.) fishery. This program offers a more effective management system than the traditional seasonal ban. CRSP has worked closely with these families, involving them in monitoring activities and management of the boundary markers for the no-take areas. On 21-22 October 2010, the University of Hawaii, Hilo project organized a forum ("Forum for Defense of the Mangrove Ecosystem to Assure Biodiversity and Food Security for the Cockle Collecting Communities") at the University of Nicaragua-Leon to continue this effort. To date, CRSP's accomplishments at the community level are spreading — the successful outcomes community partners and cockle collector cooperatives are experiencing with community-managed no-take areas are serving as a model for other estuarine communities dependent on cockles. Another measure of success is the steps the Nicaraguan government has taken to test the community co-management approach in two other communities. (CRSP Investigation Code 09HHI01UH) (FY11)

⇒ In Thailand, the University of Michigan partnered with the Network of Aquaculture Centres in Asia-Pacific (NACA) to present a workshop for farmers and managers to review the current status of prawn farming and educate them on how to minimize the environmental impacts from farming practices ("Identifying Best Practices for Giant River Prawn Industry"). This workshop was held from 8-10 August 2011. Surprisingly, the workshop revealed that farmers had already willingly changed their practices in response to a 2006 evaluation conducted by the CRSP: The

intensive monoculture system used by 96% of prawn farmers in 2005 has reversed, with polyculture now practiced by an estimated 80% of farmers. Best practices based on an integrated culture with shrimp and lower density of prawns has allowed farmers to retain and reuse their water rather than discharge it. This and other substantial culture changes as well as voluntary adoption of better environmental performance methods illustrates the strength of the CRSP development approach. (CRSP Investigation Code 09BMA06UM) (FY11)

⇒ The third in a series of CRSP trainings for small-holder farmers in rural Guyana was conducted by the University of Arizona-led project on 12 November 2010. This series of trainings has targeted individual farmers, small communities, women farmers, a feed mill, and a tilapia hatchery, successfully transferring sustainable feed and production technologies to them. The workshops have been organized to help communities develop small-scale aquaculture, including their own feed production and marketing structures and demonstration farms that integrate aquaculture with vegetable growing. The demonstration farms then serve as working models for surrounding communities. Working together, CRSP investigators have guided these stakeholders towards successful adoption of technologies and practices that will ensure an improved livelihood from aquaculture.(CRSP Investigation Code 09SFT03UA) (FY11)

CRSP CO-SPONSORED CONFERENCES AND EVENTS

Participation in regional and international conferences provided a venue for CRSP researchers and students to share ideas, network with world-class scientists, and present research findings. Through this participation, CRSP personnel gained access to technical information on aquaculture and fisheries topics as well as opportunities to meet other professionals conducting research, providing training, or carrying out extension activities. Participation in these events is of the utmost importance for professional development and for fostering long-term scientific relationships among colleagues in developed and developing countries. Participation by CRSP students allowed them to present the results of their thesis research and establish connections that will help them continue their professional careers. When possible, AquaFish CRSP co-sponsored conferences, symposia, student awards, and other relevant events to increase these benefits for its researchers and students. CRSP efforts in this area also increased the visibility of the program, and thus constituted an important component of the overall AquaFish CRSP capacity building strategy. Highlights of significant CRSP conference involvement include the following:

- CRSP Annual Meetings: The AquaFish CRSP Management Office organized and facilitated AquaFish CRSP Annual Meetings each year during its life, usually timed to coincide with major international aquaculture or fisheries conferences such as those held by the World Aquaculture Society (WAS) and the American Fisheries Society (AFS), among others. Annual meetings were thus held in:
  - ⇒ 2007: San Antonio, TX, February. Joint meeting for Aquaculture and AquaFish CRSP personnel. Prior to *Aquaculture 2007*, the International Triennial Meeting of the World Aquaculture Society (WAS), the National Shellfisheries Association, and the American Fisheries Society Fish Culture Section.
  - ⇒ 2008: Busan, Korea, May. Prior to *World Aquaculture 2008* (WAS).
  - ⇒ 2009: Seattle, WA, February. Prior to *Aquaculture America 2009* (WAS).
  - ⇒ 2010: San Diego, CA, February. Prior to *Aquaculture 2010* (WAS).
  - ⇒ 2011: Shanghai, China, April. In association with the *9th Asian Fisheries and Aquaculture*

Forum and the *9th International Symposium on Tilapia in Aquaculture* (ISTA 9)
US and Host Country partners, external evaluators, and AquaFish ME staff were in attendance at these meetings. The meetings provided opportunities to share research progress, exchange ideas on regional integration of projects, discuss gender equity and training, and discuss other AquaFish business. Coordination with major conferences provided the opportunity to present CRSP research findings to a broader audience.

- Other events over the life of the program:
  - ⇒ The CRSP ME co-sponsored the 2008 conference "Achieving a Sustainable Future: Managing Aquaculture, Fishing, Trade and Development," organized by the International Institute of Fisheries Economics & Trade (IIFET) and held in Nha Trang, Vietnam, 22-25 July. This conference covered a wide range of fisheries and aquaculture topics, including aquaculture development, farm management, sustainability, and markets, and fisheries management, policy, and economics, among many others.
  - ⇒ Through the University of Arizona project, AquaFish CRSP co-sponsored the *8th International Symposium on Tilapia in Aquaculture* (ISTA8) held in Cairo, Egypt on 12–14 October 2008. There were approximately 500 attendees, of which one-fifth were women. Many US and HC tilapia researchers from Africa, Asia, and Latin America attended the symposium. Papers for the 112 technical presentations are included in the 2-volume symposium proceedings.
  - ⇒ The *2nd International Workshop on the Cultivation and Biotechnology of Marine Algae* was held on 29 September at the 2009 World Aquaculture Society Meetings in Veracruz Mexico. Oral and poster presentations covered a range of topics from biology, biodiversity, alginic acid extraction, feed alternatives, industrial applications, culture and production, and growth models. The workshop was successful in providing the opportunity for researchers to develop linkages. As immediate outcomes, a similar workshop was held at the November 2009 Asia-Pacific Aquaculture Meeting in Kuala-Lumpur, Malaysia and plans were made for a Guyana workshop in 2010.
  - ⇒ A full-day session at *Aquaculture America 2009* (AA09), in Seattle, Washington, USA on 16 February, 2009, brought together 12 presentations covering Asia, Africa, and South and Central America. The session's topic *"International Aquaculture Development for the Poor"* naturally drew presentations on CRSP research, but also drew good presentations from other international efforts. A capacity audience (approximately 100 scientists) came away with an indication of the breadth of aquaculture research and development underway in poorer countries. The session was organized by the AquaFish Management Office and chaired by CRSP Director Dr. Hillary Egna.
  - ⇒ The University of Michigan's investigation *"Workshop on Aquaculture, Human Health, and Environment,"* held 7–10 July 2009, brought together faculty, students, and staff from other project institutions as well as the World Wildlife Fund to review their project progress, discuss future plans, and consider the relationship between their research program and needs within China, Nepal, and Vietnam. Attendees ranked research priorities as follows: (1) water quality and effluents; (2) microcystins, and (3) in a three-way tie — (a) sediment management, (b) species introductions and impacts on indigenous species, and (c) quality of seed in hatchery management. These priority areas were used in the preparation of cross-regional proposals for the University of Michigan's Continuation Plan for research under the AquaFish CRSP Implementation Plan 2009-2011.
  - ⇒ The CRSP Director organized a full-day session at *Aquaculture 2010* (San Diego, CA, USA, 1-5 March 2010), bringing in 26 presentations covering Asia, Africa, and South and Central America. The session's topic *"Optimizing small-scale aquaculture for the poor: In Honor of Yang Yi"* highlighted presentations from CRSP research, but also included a number of excellent presentations on other international efforts.

⇒ The Auburn University CRSP project organized the *Third Annual Fish Farmers Symposium and Trade Fair*, in partnership with the Walimi Fish Farmers Cooperative Society (WAFICOS) in Kampala, Uganda in January 2010. The theme was *"Dealing with the Challenges of Building an Aquaculture Industry."* An optional one-day field tour to aquaculture-related establishments included farms, feed mills, and fish-net manufacturing plants. There were a total of about 158 participants to the symposium. The proceedings were compiled into a CD for distribution locally in Uganda. The proceedings were uploaded onto the SARNISSA website (www.sarnissa.org) and the AquaFish CRSP website (http://symposium.x10hosting.com/).

⇒ AquaFish CRSP co-sponsored the 2010 International Institute of Fisheries Economics & Trade (IIFET) conference, *"Economics of fish resources and aquatic ecosystems: balancing uses, balancing costs,"* held on 13-16 July 2010 in Montpellier, France. The conference brought participants together to focus on the theme of the multi-functionality of fisheries and aquatic ecosystems, with particular emphasis on the developing world.

⇒ AquaFish CRSP also co-sponsored *TILAPIA 2010* in Kuala Lumpur, Malaysia on 27-29 October 2010. This three-day event attracted a global audience of tilapia experts, from fish farmers and processors to importers/exporters and government officials to address issues of relevance to the industry, such as industry situation and outlook, production and processing, markets and marketing, and technological developments and related issues. In total, the conference attracted 240 delegates from 34 countries.

⇒ The *International Symposium on Aquaculture and Fisheries Education* (ISAFE), held in Bangkok, Thailand on 27-30 November 2009, was co-sponsored by AquaFish CRSP. The symposium brought educators and scientists together around the theme of *"The Future of Aquaculture and Fisheries Education,"* to discuss emerging needs for aquaculture and fisheries education and to promote collaboration among organizations involved in education and outreach.

⇒ AquaFish CRSP co-sponsored the *9th Asian Fisheries and Aquaculture Forum* (9AFAF) of the Asian Fisheries Society (AFS) held on 21-25 April 2011, in Shanghai, China. The CRSP Director served on the scientific committee at this forum, which brought together leading aquaculture and fisheries scientists and key commercial stakeholders from all over the world to discuss important issues pertaining to sustainable aquatic resource production, utilization and management in the Asia-Pacific.

⇒ AquaFish CRSP also co-sponsored the *Ninth International Symposium on Tilapia in Aquaculture* (ISTA 9), held 22-25 April 2011, in Shanghai, China. This was the ninth of the highly successful series of symposia that brings together tilapia scientists and culturists to review the latest discoveries in tilapia nutrition, physiology, reproductive biology, genetics, ecology, improvements in production systems, and other fields related to tilapia and their use in aquaculture. The symposium had a special emphasis on best management practices, quality control, new product forms, international trade, and opening new markets for farmed tilapia products. ISTA 9 was held in conjunction with the 9th Asian Fisheries and Aquaculture Forum (9AFAF), Fourth ISSESR, and GAF3.

⇒ As part of AquaFish CRSP involvement in and support of the 9AFAF and ISTA9 conferences in Shanghai in April 2011, the CRSP Director again organized and chaired a full-day session on *Accelerating Aquaculture Development in Poorer Countries*, bringing together 18 presentations covering research and outreach efforts in Asia, Africa, and South and Central America. A capacity audience came away with an indication of the breadth of aquaculture research and development underway in poorer countries.

⇒ The CRSP organized and chaired a symposium on *The Effects of Semi-Intensive Aquaculture on Biodiversity In Nearshore and Inland Waters*, held during the 2011 American Fisheries Society conference ("New Frontiers in Fisheries Management and Ecology: Leading the Way in a Changing World") in Seattle, USA, from 4-8 September 2011. This session, held on 8

September, included 13 presentations by invited professionals both in and outside of the CRSP, and was co-chaired by Director Dr. Hillary Egna and long-time CRSP Lead PI Dr. James Diana of the University of Michigan.

AQUAFISH GRADUATE STUDENT PROFILES

Graduate Student Profile: Gladys Kuria
(Aquanews, Volume 25, Number 2/Fall 2010)

While it was a fond taste of fish that initially got Gladys Kuria fired up about aquaculture, press further and she'll tell you there is much to love about the industry. In her native home of Kenya, for instance, aquaculture has been known to generate jobs, provide food security, and improve nutrition. Her interest in science propelled Gladys to earn her undergraduate degree in Fisheries and Aquatic Science at Moi University in 2009. She is continuing on to pursue a masters degree with a concentration in aquaculture at Moi University under the guidance of her major professor, Dr. Charles Ngugi. Not only is this university known for its competence in teaching, the Cheploilel Campus at Moi University is the only university in Kenya that offers a masters program in aquaculture.

Her thesis work investigates the effects of stocking density on growth, survival and yield performance of Nile tilapia (*Oreochromis niloticus*) in an integrated cage-cum-pond culture system. This system integrates cage culture with semi-intensive pond culture where an artificial diet is fed only in the cages. Any feed that passes through the cage mesh that would otherwise be deemed "wasted" in turn serves as a source of food for the fish in the open ponds. Feed waste contributes to economic loss and nutrient loading in aquaculture systems, greatly challenging the success of small-scale commercial fish farming. Feed "recycling" in this system effectively addresses this problem by increasing the efficiency of food utilization.

The study is being conducted at Mwea Aqua Fish Farm (MAFF) in nine 1m2 cages within a 1300m2 earthen pond and stocked with hand-sexed male tilapia fingerlings (approximately 65 g) from the MAFF hatchery. The pond is stocked with 4 fish per m2, and the cages have been randomly allotted three treatments with three stocking densities of 50, 75, and 100 fish per m3. The study is currently underway with daily water quality testing and monthly fish growth monitoring. The intended outcome of this research is to identify opportunities to improve fish yield in culture systems that are economically feasible for the farmers. Gladys has the unique opportunity of directly applying her research methods to improve current operations run by small-scale fish farmers in Kenya. Says Kuria, "They are expected to adopt the finding to increase fish yield, generate more income, and in the long run improve their livelihood."

Having worked with AquaFish CRSP for over a year, Kuria identifies working with and training local farmers who are participating in the on-farm trials as some of the most enjoyable experiences in her work with the CRSP. "I am interested in community development", Kuria adds, "giving back to the community through extension services and helping farmers to write proposals that could provide funding for various activities that would be of help to them." Kuria plans to continue her studies in a PhD program, which will prepare her for a career in

researching and lecturing on topics in aquaculture. In addition to one day becoming a professor in aquaculture, she ultimately dreams of establishing a fish farm of her own.

"The poor perception of aquaculture in Kenya's recent past has made it difficult to promote its development, as most potential investors are not convinced that aquaculture can be a profitable enterprise", states Kuria. "However, the government is recognizing that the subsector can play a key role in poverty alleviation of rural populations". Kuria is particularly thankful to the CRSP for supporting aquaculture in Kenya through research and funding of various projects, and for providing many students with the opportunity to get involved in this burgeoning field. Says Kuria, "They have given many students from developing countries—including me—a remarkable chance to further their studies"

Graduate Student Profile: Alejandro Macdonal-Vera
(Aquanews, Volume 26, Number 1/Winter 2011)

Alejandro Macdonal-Vera has strong ties with Universidad Juarez Autonoma de Tabasco (UJAT). Not only is he a former AquaFish supported graduate student at the university, where he completed his Masters degree in Environmental Science, but UJAT is also where he hopes to one day establish himself as a fulltime professor. Judging by Alejando's dedication to projects that stand to improve the economy of rural aquaculture producers in the region, this seems like a natural fit.

The university upholds the mission to "prepare professionals with broad expertise in their area of study to fulfill the needs of Tabasco and the country at large." It was here that Alejando—Alex to friends and colleagues – discovered a rich diversity of aquaculture studies and the regional application of related research activities. He completed his Masters degree, evaluating the polyculture of red tilapia and shrimp in the Southeast State of Sinaloa, and continues to be plugged in to both the socioeconomic and conservation aspects of aquaculture development in his native home of Mexico.

There is no doubting Alex's expertise in the field of aquaculture. To date, he has amassed a total of 13 years in the industry, and has contributed his skills in a range of investigations. Under the guidance of his major professor, AquaFish CRSP Host Country Principal Investigator Dr. Wildfrido Contreras Sanchez, Alex is currently working on two investigations in collaboration with AquaFish CRSP, the first of which is an investigation of selective breeding programs for native cichlid and snook aquaculture. This project is a continuation of the earlier breeding program initiated in 2007 using wild castarrica (*Rocio octofasciata*) and tenhuayaca (*Petenia splendida*) broodstock, from which the first generation of selected native fish was obtained. Alex has been involved in the successful sex-reversal and breeding of these native cichlids, as well as in the progress leading to induced spawning and reproduction of snook species. Continuing the selective breeding programs of these species will provide cultivators – primarily poor farmers – with native fish seed stock that exhibit better growth characteristics, promoting conservation of an economically important natural resource.

Alex is also involved in an investigation on sustainable integrated aquaponics and the evaluation of fingerling quality in Tabasco, Mexico. Continuing research will focus on improvements in the production of juvenile tilapia for growers. A comparative experiment on growth performance and cost of production of several strains of tilapia will provide farmers with unbiased information from which they can make decisions on purchasing economically viable fingerings. Alex and the AquaFish team at UJAT are also developing a method to eliminate methyl-testosterone used in

masculinization systems for tilapia sex-reversal (see Aquanews Fall 2010).

"I have enjoyed sharing my knowledge and experience with producers about management technique of diverse culture species," Alejandro says about his work with the CRSP. He is pleased to see new methodologies developed from his research subsequently implemented by producers in the region. It is his hope that his research will provide quality fingerlings to producers, and help repopulate native water bodies with economically important snook and native cichlids.

Graduate Student Profile: Boamah Yaw Ansah
(Aquanews, Volume 26, Number 2/Spring 2011)

Having grown up in Apam, Ghana, Boamah Yaw Ansah is witness to the early stages of aquaculture in his home country, which is largely comprised of small-scale, semi-intensive operations in earthen ponds. Fisheries constitutes an important sector in Ghana's national economic development, but depletion of resources has made it difficult for commercial fishing to meet the demands of Ghana alone. Fish production from aquaculture is expected to help, but its contribution to the national economy has not been disaggregated and its relative importance is generally unrecognized.

Within the last decade or so, there has been a growing enthusiasm about fish farming on Ghana's Volta Lake. "Aquaculture is still in the nascent stages in Ghana," says Ansah. "However, the huge potential of the industry in the country is obvious, considering the deficit in fish production demand." Ansah hears that potential knocking loudly on Ghana's door, and he wants to open it up and let it flourish. It seems fitting, considering aquaculture had the same effect on Ansah himself. Ansah's first love was water quality management. After getting involved in an internship with the Water Resources Commission (WRC), he chose to study Fisheries and Watershed Management at the Kwame Nkrumah University of Science and Technology (KNUST) in Ghana. Before long Ansah discovered that aquaculture studies effectively merged his interest of watershed management and low impact ecosystem services with his growing interest in food security. To Ansah, it seemed possible that aquaculture could address these critical issues affecting his home country. Ansah went on to get his Master's degree at Virginia Polytechnic Institute & State University with funding support from AquaFish CRSP and KNUST, which he completed in 2010. In February 2011, he recieved the Norman E. Borlaug Leadership Enhancement in Agriculture Program (LEAP) Fellowship.

Today, Ansah is as passionate as ever about the potential of aquaculture in Ghana. He is now working towards his PhD in Fisheries and Wildlife Conservation at Virginia Tech with his major professor Dr. Emmanuel Frimpong on a project titled "Enhancing profitability of small-scale aquaculture farm operations through resource management and environmental best management practices." This is a new "Feed the Future" (FtF) project with Purdue University under a collaboration between Dr. Kwamena Quagrainie at Purdue and Dr. Hillary Egna at Oregon State University. In addition to Ghana, this project also involves work in Kenya and Tanzania. Two examples of Best Management Practices (BMPs) considered for tilapia production in Ghana are water re-use and utilization of floating feeds. Part of this FtF project aims to assess the impacts of these two aquaculture BMPs on water quality, farm profitability, and social welfare among Ghanaian fish farmers. Data will be obtained from bi-weekly measurement of fish growth rates and water quality at cooperating farms throughout Ghana. Field work, Ansah says, is one of his favorite components of the work. "The most enjoyable experience is returning to Ghana every summer and travelling through local communities."

But what influences the adoption of BMPs among fish farmers? Innovation Diffusion is a type of decision making that occurs through a

series of communication channels over a period of time among members of a similar social system. New innovations or practices can be rejected at any point throughout the five stages of adoption, defined as knowledge, persuasion, decision, implementation, and confirmation. Ansah has identified three different techniques that facilitate diffusion of new innovations or practices among fish farmers: demonstrations, workshops, and farmer-to-farmer training. His dissertation will investigate the relative effectiveness of these Innovation Diffusion Techniques, and assess the impact that BMP adoption has on the supply of ecosystem services.

To date, farmers have been selected to participate in the study and farm demonstrations have commenced. The first three regional workshops are scheduled to begin in July, at which time surveys will be administered before, during, and after to ascertain the status quo proportion of farmers using the BMPs. Ansah hopes that the results will be applicable to the entire sub-Saharan African region, where the cultivation of tilapia in earthen ponds is ubiquitous. But its immediate utility in Ghana is certainly tenable. "This study will provide important data for Ghana's forthcoming fisheries and aquaculture policy document," says Ansah. "Effective Innovation Diffusion Techniques will also be available, which will guide future extension efforts on BMP adoption and adaptation to local conditions." But as Ansah proclaims, it's not only about increasing production. "Aquaculture ought to prevent environmental impacts – commonly water quality issues – that have pervaded aquaculture adoption in the past," he states. Adoption of BMPs could be just the ticket that Ghana needs to realize aquaculture's full potential in the country.

Borlaug Leap Fellows Attend World Food Prize 2010
(Aquanews, Volume 25, Number 2/ Summer 2010)

Two AquaFish CRSP graduate students, having received the Borlaug LEAP Fellowship, will participate in the World Food Prize 2010 this fall. The Prize acknowledges improvements in global food security drawing on what can be accomplished in the future. Nhuong Van Tran (Vietnam) and Rafael Martinez-Garcia (Mexico) were rewarded LEAP Fellowships for demonstrating strong promise as leaders in agriculture related fields.

SOU-CRSP Yang Yi Young Scientist Travel Fund
(Aquanews, Volume 25, Number 1/Spring 2010)

The Yang Yi Travel Award was established this year in memory of Dr. Yang Yi (1963-2009) with the SOU-CRSP Yang Yi Young Scientist Travel Fund. The award is expected to support excellent young scientists from one of the Asian partner institutions to present their research at the World Aquaculture Society conferences. Zexia Gao from Huazong Agricultural University was awarded the first award.

Graduate Student Profile: Zexia Gao
(Aquanews, Volume 25, Number 1/Spring 2010)

The first winner of the SOU-CRSP Yang Yi Young Scientist Travel Fund Award, Zexia Gao had the opportunity to travel from China to the US to attend the AquaFish CRSP Annual Meeting and Aquaculture 2010 conference in San Diego, California this March. At the conference, Zexia presented at the Finfish Genetics Session on her research with yellow cheek carp and had the chance to interact with aquaculture researchers from around the world.

Zexia is currently a PhD candidate in a joint education program with Huazhong Agricultural University (HAU) and the Ohio State University (OhSU). Her dissertation, "Analysis on sex determination mechanism and sex-related DNA markers in bluegill sunfish (Lepomis macrochirus)," will potentially improve our understanding of the underlying basis for sex determination of monosex male populations of bluegill. Working under her two major professors, Weiman Wang from HAU and Han-Ping Wang from OhSU, Zexia hopes to complete her degree in September 2011.

Exposed to aquaculture at an early age, Zexia grew up in Sichuan, China where her father was a fish farmer. As fish became a central part of her life, Zexia developed a love for seafood and a fascination with biology, ecology, and fish behavior. Her interest in the natural world led her to HAU's notable Life Sciences Department, where she completed her undergraduate degree in aquaculture in June 2007.

Zexia has been involved in AquaFish CRSP work in China over the last two years. Her first CRSP investigation experience, "Assessing the effectiveness of current waste management practices for intensive freshwater aquaculture in China" ended in 2009. With waste management as one of the major issues under the AquaFish CRSP topic area, "Mitigating Negative Environmental Impacts", this project produced information about proper stocking densities and suitable waste mitigation techniques. It also included a social aspect in which a series of interviews and questionnaires revealed that Chinese tilapia and carp farmers appear to realize the importance of water quality and environmental impacts. Zexia sees this awareness as an indication of a positive step toward the development of a more sustainable aquaculture industry in China.

Zexia has been involved with two of the more recent AquaFish CRSP projects in China. Continuing with the theme of mitigating negative environmental impacts in the waste management project, she is now working on an investigation that is comparing water quality parameters during the grow-out phase of traditional and improved cages in order to estimate a carrying capacity for commercial aquaculture cages in deep water lakes in China. Another investigation is more related to Zexia's own PhD work in fish genetics. This project is studying the impacts of the rapid invasion of red swamp crayfish (Procambarus clarkii) in China through changes in the population genetic structure.

With the rapid growth of China's aquaculture industry in recent years, Zexia recognizes the need for the development of cleaner and more efficient practices. While China contributes a high percentage of the global fish supply, the aquaculture industry faces a multitude of challenges. Zexia is encouraged by new developments in Chinese legislation regarding water quality, and hopes that the Chinese aquaculture industry can someday produce a more sustainable seafood product.

In her two years working with AquaFish CRSP, Zexia values the international connections that she has made. Her experience working with researchers from around the world has provided her the opportunity to learn about the different aquaculture issues in other countries. This exposure to diverse research questions has been her most enjoyable experience with AquaFish CRSP. Once she finishes her PhD, Zexia hopes to continue her career as an aquaculture researcher.

Graduate Student Profile: Gifty Anane-Taabeah
(Aquanews, Volume 25, Number 2/Summer 2010)

Gifty Anane-Taabeah has been working with AquaFish CRSP at Virginia Polytechnic Institute and State University (Virginia Tech) since 2009 under the guidance of her major professor, Dr. Emmanuel Frimpong. In 2008, Gifty received her Bachelor of Science degree in Natural Resource Management from Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi, Ghana southeast of her hometown of Berekum in the Brong Ahafo

Region. At Virginia Tech, she is currently working to complete her Masters of Science degree in Fisheries Science with the hopes of gaining the experience and knowledge necessary to one day influence the management of fisheries and aquatic resources in Ghana.

Gifty's research, "Harnessing Opportunities and Overcoming Constraints to Widespread Adoption of Cage Aquaculture in Ghana," is part of the AquaFish CRSP Project with Purdue University, "Improving Competitiveness of African Aquaculture Through Capacity Building, Improved Technology, and Management of Supply Chain and Natural Resources." The Purdue Project has established long-standing partnerships in Ghana, providing Gifty with a history of AquaFish CRSP research there and a comprehensive baseline for her work.

Gifty will analyze data from the Ghanaian community through interviews and questionnaires about the constraints and opportunities of adopting cage aquaculture. Once the data are compiled and evaluated, Gifty and the research team hopes to provide recommendations for an aquaculture policy review in Ghana.

Gifty first realized the importance of aquaculture during her undergraduate work at KNUST and has since made aquaculture a part of her life. In Ghana, she has seen the industry grow over the past decade. "However", she says, "the contribution of aquaculture to total fish production in Ghana [remains] insignificant".

Gifty identifies several obstacles preventing aquaculture from continuing to progress, including the lack of inexpensive locally manufactured feeds and lack of quality seed. She hopes her graduate research at Virginia Tech will "provide a platform to influence decisions in management and fisheries of aquatic resources in Ghana". She adds, "This [research] should help speed up the adoption rate of cage aquaculture in Ghana and ultimately increase the fish production for local consumption".

Through her work at Virginia Tech and with AquaFish CRSP, Gifty plans to gain a comprehensive understanding of the theoretical and practical aspects of fisheries science to support her long-term goal of a career in fisheries and aquaculture research. "I enjoy working with different people both in workshops and field work", Gifty says about her work with the CRSP. "I hope to combine my research with training other students in my research area".

Graduate Student Profile: Jeanne Coulibaly
(Aquanews, *Winter 200*)

Originally from the city of Abidjan, Côte d'Ivoire, Jeanne Coulibaly is currently pursuing her doctorate degree at Purdue University in Agriculture Economics. Having obtained her undergraduate degree in biology and veterinary medicine from the University of Cocody in her hometown and the School of Veterinary Medicine in Dakar, Senegal, in 2006 Jeanne was awarded a Norman Borlaug LEAP fellowship to investigate dairy cattle and milk marketing in rural Côte d'Ivoire. Carrying this experience with her, she is now investigating "Optimal Marketing Strategies for Fish Famers in Kenya and Ghana" under AquaFish CRSP. Her major professors at Purdue are Dr. William Masters and CRSP US Lead Principal Investigator, Dr. Kwamena Quagrainie.

In the Côte d'Ivoire, fish represent an integral part of the animal protein diet for a majority of consumers. With increasing pressures on the capture fisheries, fish stocks are rapidly declining and aquaculture is emerging as a sustainable industry for meeting the increasing demand for fish. These realities in the Côte d'Ivoire have drawn Jeanne to aquaculture and have led to her involvement with AquaFish CRSP research.

Jeanne's research focuses on developing the marketing organization of the aquaculture industry in order to encourage the growth and vitality of the industry. In Ghana and Kenya, where Jeanne's research is based, the majority of aquaculture production is small-scale, reliant on the on-farm sale of fish. These farmers thus face many challenges, such as high transactions

costs, low returns, and lack of market incentives. To foster the growth of these farms and increase the revenue for the farmers, Jeanne states that "Ghana and Kenya should include linking small-scale commercial farmers into the market chain of the established commercial aquaculture, capture fisheries and seafood markets through organized and collective marketing efforts." In her thesis work, Jeanne has focused on four objectives: 1) developing an aquaculture supply chain framework for farm-raised fish, 2) training small- and medium-scale fish farmers in the management of this supply chain, 3) building synergies between fish producers and fish vendors in order to improve product and service delivery, and 4) equipping farmers with the skills for group marketing, developing new markets, developing distribution and market networks, and identifying value-added opportunities.

In addressing these goals, Jeanne has developed a questionnaire that will be used to survey all the stakeholders that she is targeting to help guide her to their specific needs. She then plans to organize workshops on supply chain management, pricing strategies, and quality and cost effectiveness in post harvest value chains. Utilization of study groups for case-study opportunities will provide practical experience in value chain management. The development of brochures and manuals with information gained in the research will allow Jeanne's findings to continue aiding in the development of market strategies even beyond the time frame of her work.

With an expected completion date in January 2010, Jeanne plans on visiting Ghana and Kenya in the spring or summer of 2009. She expects her "research to result in a design of some efficient marketing strategies that will help famers to be more integrated into the marketing chain in order to enhance their welfare." Jeanne has a great interest in international development and plans to work in this sector so that she may help in addressing problems of poverty, market participation, and the sustainable management of natural resources.

Graduate Student Profile: Margareth M. Kibodya
(Aquanews, Summer/Fall 2009)

Margareth M. Kibodya is a graduate student from Tanzania, studying at the Sokoine University of Agriculture (SUA). She is currently working under AquaFish CRSP Host Country principal investigator Sebastian Chenyambuga to assess the potential uses of two local plants as a protein source in aquaculture feed. Her thesis work, *Assessment of Moringa oleifera and Leucaena leucocephala as Protein Supplements in Tilapia (Oreochromis niloticus) Diets*, will contribute directly to the AquaFish CRSP project with Purdue University, "Improving Competitiveness of African Aquaculture through Capacity Building, Improved Technology, and Management of Supply Chain and Natural Resources." The two plants, *M. oleifera* and *L. leucocephala*, could make aquaculture feed more readily available and allow for improved profits for small-scale farmers. Margareth's work will not only help to provide a more reliable source of feed, it could also help foster the growth of aquaculture in Tanzania.

Originally from the town of Iringa in the central part of Tanzania, Margareth graduated from Open University of Tanzania in 2006 with her bachelor's degree in Zoology. Due to her interest in fisheries and natural resources, Margareth started her work at SUA hoping to enhance the capacity of fish farming in her home country. Margareth's research has recently been completed, finding that *M. oleifera* and *L. leucocephala* can supplement soybean meal in fish diets at levels up to 25%. She is now in the process of finalizing her work.

With aquaculture growth in Tanzania limited in part by the availability of reliable feed sources, Margareth's research is helping to bring a broader awareness to the aquaculture community. In response, Margareth has noticed that aquaculture activities are being more widely embraced and new fishponds are emerging. Margareth hopes that her research will continue the expansion of aquaculture throughout

Tanzania enhancing local economies through the use of their available resources.

Graduate Student Profile: Ravi Lal Sharman
(Aquanews, Spring 2009)

In November of 2008, Nepalese student Mr. Ravi Lal Sharman successfully completed his Master's degree in aquaculture from the Institute of Agriculture and Animal Sciences (IAAS) at the Rampur campus in Chitwan, Nepal. Having been inspired by AquaFish CRSP Project Leader Dr. Madhav Kumar Shrestha, Ravi decided to work on an AquaFish CRSP project looking at polyculture systems involving sahar and mixed-sex Nile tilapia. Ravi's thesis work, which started in 2007, specifically investigated the "Effect of sahar (*Tor putitora*) stocking on recruitment control, growth and production of mixed-sex Nile tilapia (*Oreochromis niloticus*) under a pond culture system."

It has become clear to Ravi that Nepal has great potential for aquaculture development. The country has vast amounts of natural water resources, a great diversity of high-value indigenous fish species, thousands of hectares of irrigated land, man-made ponds, and numerous wetlands and ditches. If these resources can be properly exploited and made productive through aquaculture, the benefit could be great for the country on many levels. However, Nepal currently lacks a number of essential elements for sustainable aquaculture development, preventing the full realization of their potential in this sector. The research of Ravi's major professor, Dr. Shrestha, incorporates Ravi's thesis work into the overall scope of the project to ultimately develop a polyculture system for sahar and Nile tilapia. Sahar is a very popular, high-value indigenous game fish in Nepal, whose numbers are currently declining due to fishing pressures.

Nile tilapia is the most important freshwater aquaculture species in Nepal. The polyculture system under development would use the sahar, which becomes piscivorous in high densities, to provide a production control method on the prolific breeding tendencies of mixed-sex Nile tilapia cultures. Culturing the two fish together would not only functionally improve the tilapia culture process, but would also supply an additional fish product for sale. Offering an alternative to the typical monoculture of mixed-sex Nile tilapia, this system has the potential not only to spur a whole new industry of small-scale culturists in Nepal, but could also help reduce fishing pressure on the already stressed wild sahar stocks.

Prior to his involvement with this AquaFish CRSP research, Ravi earned his bachelor's degree in agriculture from IAAS, where he received the Nepal Animal Science Association (NASA) Scholarship in 1996. The scholarship was in recognition of excellent performance in the Livestock Production and Management elective under the Department of Animal Science. After completing his Bachelor's degree in 1997, Ravi worked seven and a half years on a number of fishery development programs as a Fisheries Development Officer with the Directorate of Fisheries Development in the Nepalese Department of Agriculture. His primary responsibilities were in fisheries program planning, fisheries technology extension, program supervision and monitoring, fisheries technology verification, and fish seed production.

Having now completed his Master's program at IAAS, Ravi plans to return to his duties as a Fisheries Development Officer until he can secure funding for his PhD. He hopes to apply his new knowledge of aquaculture for the benefit of Nepalese fish farmers. Ravi hopes to inspire others like himself to continue following their interests and achieving their goals.

Graduate Student Profile: Nhuong Van Tran
(Aquanews, Summer/Fall 2009)

With a diverse background in agriculture and aquaculture sciences, Nhuong Van Tran was recently awarded a Borlaug Leadership Enhancement in Agriculture Program (LEAP) Fellowship. Based at the University of California, Davis, this fellowship program is funded by USAID to enhance the quality of thesis research by graduate students from developing countries who show strong promise as leaders in agriculture related fields. The fellowship will allow Nhuong to conduct research for his PhD dissertation at Auburn University under the mentorship of his committee co-chairs, Dr. Conner Bailey and Dr. Norbet Wilson, and AquaFish CRSP Lead PI from the University of Connecticut, Dr. Robert Pomeroy. In collaboration with Dr. Pomeroy, Nhuong will be able to integrate his research with the AquaFish CRSP project in Cambodia and Vietnam, which focuses on enhancing trade opportunities for global fishery markets. Nhuong will also work with researchers at the WorldFish Center and The Research Institute for Aquaculture no.1 (RIA1) in Vietnam.

A Vietnamese student from Nghe An, Nhuong completed a BSc in aquaculture engineering, an MSc in Natural Resource Economics, and has over ten years of research experience with RIA1. In 2004 he received a grant from the International Institute for Fisheries Economics and Trade (IIFET) with supporting funds from the Aquaculture CRSP. This grant allowed Nhuong to attend the biennial IIFET conference in Tokyo to present the research he had been working on. It was this experience that inspired Nhuong to pursue his graduate studies in the US. When he received a three-year fellowship from the Ford Foundation in 2006, he started at Auburn University in the Department of Agriculture Economics & Rural Sociology in pursuit of a PhD in Agriculture Economics, an MS in Rural Sociology, and a statistics minor.

Nhuong's dissertation research entitled, "Impacts of Food Safety and Environmental Standards on Seafood Supply Chains from the South: Evidence from Vietnam," investigates the relationships between new food standards and the seafood industry of Vietnam. Approximately 90% of the exports from Vietnam go to countries in the North such as the US and Japan, where concerns for personal health and sustainability are increasing with regard to seafood production and consumption. These concerns are being realized in the form of new food safety and environmental standards for seafood in the global market. While these standards are intended to protect consumer health and improve the sustainability of seafood production, Nhuong realizes that they can also become non-tariff barriers (NTBs) to trade, potentially hurting small-scale aquaculture producers and seafood processors. Nhuong will complete his fieldwork in Vietnam, where he will conduct a series of surveys and interviews with over 100 fish farmers and other stakeholders in the seafood industry. Looking at this issue from a Northern perspective and from the Vietnamese perspective will help Nhuong understand whether these food standards will act as NTBs or serve as a catalyst to improve seafood and environmental quality in Vietnam and other similar regions.

In regards to his LEAP Fellowship, Nhuong says, "This fellowship will give me an excellent opportunity to use theories and knowledge that I learned from developed countries in diverse situations in developing countries, and to apply research instruments, methods, and innovative tools to analyze, evaluate, and address problems related to agricultural and rural development in Vietnam. I believe that my fellowship with the Borlaug LEAP Program will have practical impacts at a policy level in the Government of Vietnam to support sustainable agriculture development."

University of Arizona Research Team Wins EPA P3 Award
(Aquanews, Summer/Fall 2009)

In April 2009, a team of interdisciplinary student researchers at the University of Arizona received the U.S. Environmental Protection Agency's People, Prosperity and Planet (EPA P3) award for their project "Development of Sustainable Integrated Aquaculture Systems with Assessment of Environmental, Social, and Economic Implications." Supported by AquaFish CRSP Lead US Principal Investigator Kevin Fitzsimmons, the team of three UA graduate students includes Mauricio Torres-Benavides, and AquaFish CRSP funded students Rafael Martinez-Garcia and Kyle VanderLugt.

The EPA P3 competition involves two phases that culminate with a final judging at the Annual National Sustainability Design Expo in Washington DC. With a focus on benefitting people, promoting prosperity, and protecting the planet, the competition encourages participants to apply technology in innovative ways to address environmental sustainability issues in both the developed and the developing world. This year $75,000 was awarded to each of the six teams with the best designs to help them to implement their projects in the field and in the marketplace.

The winning UA design is a hybrid hydroponics system, which the team named "re-circulating integrated agriculture aquaculture" (RIAA). With a 97% water conservation rate, RIAA combines aquaculture with agriculture, using the nutrient rich aquaculture effluents from fishponds to fertilize and grow crops. As the nutrient rich effluent water irrigates the crops, nitrogen and phosphorous are taken up by the plants and the nutrient-depleted water is collected from the runoff and re-circulated back into the fishponds.

With the success of their award winning system, the UA team has the opportunity to further develop their design and take it into the marketplace. Through ties with AquaFish CRSP, the team has made contact with researchers at the University of Tabasco (UJAT) in Mexico and will be taking the RIAA system to the rural community of Tacotalpa. The project is in the preliminary steps of its implementation stage. This summer the team visited their sites in Mexico to further assess feasibility. They also met with researchers from UJAT at the World Aquaculture Society Conference in Veracruz, Mexico. The team hopes that their design will provide the community with a sustainable agro-aqua system, which will avoid the need for inorganic fertilizers in their crops and supply a treatment mechanism for their aquaculture effluents. Furthermore, the new technologies can help to create new jobs and further develop the local economy.

Table 8.4. Short-term trainings conducted by AquaFish CRSP during the life of the program, sorted by fiscal year and project. The first workshops were conducted during FY 2008, the second year of the program.

Project	Event Name	Investigation Code	Country	Start Date	End Date	# of Trainees	% Women
Fiscal Year 2008							
NCSU	Workshop: Shrimp and Gracillaria Culture, New Trends for a Changing World	07MNE02NC	Indonesia	May/01/2008	May/02/2008	39	12.8
NCSU	Workshop on Shrimp and Gracilaria Culture: New Trends for a Changing World	07MNE02NC	Philippines	August/29/2008	August/30/2008	29	55.2
NCSU	Workshop	07MNE02NC	Indonesia	April/29/2008	April/30/2008	34	17.6
OSU	Site Visits to South Africa, Ghana, Vietnam, and Brazil on the Culture of Cichlids	HCPI Phase II	Philippines	March/26/2008	March/26/2008	29	37.9
OSU	HCPI Exchange Visit Seminar, South Africa	HCPI Phase II	South Africa	October/25/2007	October/25/2007	21	23.8
OSU	HCPI Exchange Visit Seminar, Vietnam	HCPI Phase II	Vietnam	December/08/2007	December/08/2007	20	25.0
OSU	HCPI Exchange Echo-Seminar, South Africa	HCPI Phase II	South Africa	April/24/2008	April/24/2008	22	31.8
OSU	HCPI Exchange Echo-Seminar, Kenya	HCPI Phase II	Kenya	December/17/2007	December/18/2007	42	28.6
OSU	International Workshop on Tilapia and Other Cichlids Culture	HCPI Phase II	Brazil	February/18/2008	February/19/2008	229	36.2
OSU	HCPI Exchange Visit Seminar, Ghana	HCPI Phase II	Ghana	November/01/2007	November/01/2007	63	34.9
UA	Tilapia culture, masculanization, and safe handling of MT	07MNE06UA	Mexico	September/09/2008	December/15/2009	34	29.4
UA	Local Feed Ingredients Workshop	07SFT04UA	Guyana	August/15/2008	August/15/2008	29	31.0
UA	Local Feed Substitutes Workshop	07SFT05UA	Guyana	August/14/2008	August/15/2008	31	58.1
UA	Local Feed Substitutes	07SFT05UA	Guyana	June/16/2008	June/16/2008	25	80.0
Uconn	Cambodia Project Orientation Meeting		Cambodia	February/25/2008	February/27/2008	5	40.0
Uconn	Cambodia, Vietnam and US Aquafish CRSP Project Orientation Meeting		Cambodia	May/26/2008	May/27/2008	12	41.7
Uconn	Local fisheries staff and IFReDI researchers Training	07MNE01UC	Cambodia	June/16/2008	June/17/2008	25	24.0
Uconn	Project Inception Workshop	07TAP01UC	Cambodia	June/13/2008	June/13/2008	40	17.5
UHH	Meeting with oyster producers	07WIZ02UH	Mexico	November/30/2007	November/30/2007	19	5.3
UHH	First monitoring of organic material	07WIZ02UH	Mexico	November/30/2007	December/01/2007	5	20.0
UHH	Second monitoring of organic material	07WIZ02UH	Mexico	March/08/2008	March/08/2008	5	40.0
UHH	First field trip to sampling area	07WIZ02UH	Mexico	April/19/2008	April/19/2008	3	33.3
UHH	Third monitoring of organic material	07WIZ02UH	Mexico	May/16/2008	May/16/2008	5	40.0
UHH	Fourth monitoring of organic material	07WIZ02UH	Mexico	June/19/2008	June/19/2008	5	40.0
UHH	International workshop on bivalve culture and sanitation	07HHI03UH	Mexico	September/22/2008	September/24/2008	47	23.4
UHH	International Workshop for Bivalve Culture and Sanitation	07HHI03UH	Mexico	September/25/2008	September/26/2008	89	31.5
UHH	Community meeting to introduce and organize project	07HHI05UH	Nicaragua	August/18/2008	August/18/2008	23	95.7

UHH	Monitoring of water and Anadara spp.- tissues in six sites at the Estuary of Aserradores, Chinandega, Nicaragua.	07HHI05UH	Nicaragua	August/29/2008	August/29/2008	7	100.0
UHH	Monitoring of water and Anadara spp.- tissue in six sites at the Estuary of Aserradores, Chinandega, Nicaragua.	07HHI05UH	Nicaragua	September/24/2008	September/24/2008	7	100.0
UHH	Intensive training and internship in bivalve culture and shellfish sanitation	07BMA05UH	USA	May/08/2008	May/17/2008	8	50.0
UHH	Oyster Relay and Depuration Community Meeting	07IND04UH	Mexico	September/22/2008	September/24/2008	14	21.4
UHH	Monitoring of water and Anadara spp.- tissue in six sites at the Estuary of Aserradores, Chinandega, Nicaragua	07HHI05UH	Nicaragua	August/29/2008	November/26/2008	227	2.2
UM	Tilapia-Channel Catfish Microcystins Workshop	07HHI01UM	China	March/01/2008	August/30/2009	5	60.0
UM	Tilapia Waste Management Workshop	07MNE04UM	China	June/16/2008	June/16/2008	100	27.0
UM	Shrimp Waste Management Workshop	07MNE04UM	China	September/16/2008	September/16/2008	200	26.0

Fiscal Year 2009

NCSU	On-site Lecture Forum on Kappaphycus	07MNE02NC	Philippines	November/10/2008	November/11/2008	47	34.0
NCSU	Tilapia Podcast Workshop	07TAP02NC	Philippines	January/12/2009	January/13/2009	84	34.5
NCSU	Workshop on Seaweed Culture and Tilapia-Shrimp Polyculture	07MNE02NC	Philippines	January/15/2009	January/16/2009	47	42.6
NCSU	Soft-shell crab farming training	07MNE02NC	Indonesia	July/21/2009	July/21/2009	17	
NCSU	Soft-shell crab farming training	07MNE02NC	Indonesia	July/23/2009	July/23/2009	42	
Purdue	Fish Farmers Workshop: Development of Small Scale Fingerlings as Baitfish	07QSD02PU	Kenya	June/14/2009	June/14/2009	27	22.2
Purdue	Training in Fish Supply Chain and Marketing of farmed Fish	07MER02PU	Ghana	June/22/2009	June/22/2009	25	36.0
Purdue	Catfish Bait Producers Training	07QSD02PU	Kenya	January/21/2009	January/21/2009	23	13.0
Purdue	Catfish Bait Producers Training	07QSD02PU	Kenya	January/23/2009	January/23/2009	33	27.3
Purdue	Catfish Bait Producers Training	07QSD02PU	Kenya	March/10/2009	March/10/2009	11	9.1
Purdue	Catfish Farmers Training	07QSD02PU	Uganda	April/08/2009	April/11/2009	11	9.1
Purdue	Plant-Based Feed Farmers Training	07SFT06PU	Tanzania	November/25/2009	November/26/2009	15	40.0
Purdue	Post-Production Farmer's Workshop	07QSD02PU	Kenya	June/14/2009	June/15/2009	27	22.2
Purdue	Fish Farmers Workshop: Training in Fish Supply Chain and Marketing	07MER02PU	Kenya	June/15/2009	June/15/2009	30	26.7
UA	Tropical Fish Culture	07IND02UA	Mexico	August/15/2009	November/15/2009	33	51.5
UA	Tilpaia culture, masculinization, and safe handling of MT	07MNE06UA	Mexico	August/25/2009	August/27/2009	10	40.0
UA	Recirculation in Aquaculture	07IND01UA	Mexico	July/09/2009	July/09/2009	33	42.4
UA	Recirculating Aquaculture	07HHI02UA	Mexico	September/22/2009	September/24/2009	27	33.3
UA	Tilapia culture, masculinization, and safe handling of MT	07MNE06UA	Mexico	August/11/2009	August/13/2009	20	65.0
UA	MT Analysis: Sampling and analysis by ELISA methods	07MNE06UA	Mexico	August/15/2009	November/15/2009	4	75.0
UA	Native Gar and Cichlids Farmers Training	07IND02UA	Mexico	September/30/2009	October/02/2009	19	15.8

UA	Marine Algae Aquaculture	07BMA03UA	Mexico	September/29/2009	September/29/2009	75	53.3
UA	Snook Age Determination	07IND01UA	Mexico	July/08/2009	July/08/2009	21	28.6
UA	Larval culture and grow-out of fat snook juveniles	07IND01UA	Mexico	July/10/2009	July/10/2009	35	42.9
UA	Histological determinaation of gonadal development on teleost fish	07IND01UA	Mexico	July/11/2009	July/11/2009	32	37.5
UA	Tilapia Nutrition and Feeds Workshop	07SFT04UA	Guyana	June/18/2009	June/18/2009	31	71.0
Uconn	Farmers Training of Trainers Workshop	07TAP01UC	Cambodia	September/10/2009	September/10/2009	26	42.3
Uconn	Farmer Field School Training	07TAP01UC	Cambodia	September/24/2009	September/24/2009	21	38.1
UHH	Prospeccion para colecta de semilla de ostion	07IND03UH	Mexico	October/18/2008	October/18/2008	3	0.0
UHH	Second field trip to sampling area	07WIZ02UH	Mexico	October/05/2008	October/05/2008	3	33.3
UHH	Monitoring of water and Anadara spp.- tissue in six sites at the Estuary of Aserradores, Chinandega, Nicaragua.	07HHI05UH	Nicaragua	October/22/2008	October/22/2008	6	100.0
UHH	Spat collection visit to culture sites	07IND04UH	Mexico	October/18/2008	October/18/2008	20	65.0
UHH	Farm visits and spat collection	07IND04UH	Mexico	October/24/2008	October/24/2008	15	66.7
UHH	Regional Workshop on Bivalve Culture and Sanitation	07HHI04UH	Mexico	September/28/2009	September/29/2009	43	16.3
UHH	Data collection	07IND04UH	Mexico	November/19/2008	November/19/2008	15	66.7
UHH	Data collection	07IND04UH	Mexico	December/19/2008	December/19/2008	10	70.0
UHH	Data collection	07IND04UH	Mexico	January/30/2009	January/30/2009	10	70.0
UHH	Data collection	07IND04UH	Mexico	February/25/2009	February/25/2009	15	66.7
UHH	Data collection	07IND04UH	Mexico	March/27/2009	March/27/2009	15	66.7
UHH	Wrap-up workshop	07IND04UH	Mexico	May/29/2009	May/29/2009	25	64.0
UHH	Community Meeting: Monitoring of Water and Cockle Tissue	07HHI05UH	Nicaragua	April/15/2009	August/13/2009	18	27.8
UHH	Monitoring of water and Anadara spp.- tissue in six sites at the Estuary of Aserradores, Chinandega, Nicaragua.	07HHI05UH	Nicaragua	January/22/2009	March/17/2009	19	26.3
UM	Alien-Indigenous Species Workshop-China1	07MNE03UM	China	March/12/2009	March/12/2009	108	39.8
UM	Alien-Indigenous Species Workshop-China2	07MNE03UM	China	May/30/2009	May/30/2009	93	40.9
UM	Alien-Indigenous Species Workshop-Vietnam1	07MNE03UM	Vietnam	July/25/2009	July/25/2009	25	16.0
UM	Carp Polyculture Waste Management Workshop	07MNE04UM	China	May/22/2009	May/22/2009	100	22.0
UM	Workshop on Aquaculture, Human Health, and the Environment	07MNE07UM	China	July/07/2009	July/09/2009	24	0.0
UM	Shrimp Waste Management Workshop 2	07MNE04UM	China	March/01/2009	March/01/2009	250	24.8

Fiscal Year 2010

AU	Watershed Workshop	09WIZ02AU	Uganda	July/06/2010	July/07/2010	16	18.8
AU	2010 Study Tour	09BMA02AU	Uganda	January/15/2010	January/15/2010	30	23.3

AU	2010 Fish Farmers Symposium	09BMA02AU	Uganda	January/13/2010	January/15/2010	181	23.8
NCSU	Women Training on Post-Harvest & Marketing of Milkfish 1	09MNE02NC	Philippines	April/16/2010	April/16/2010	13	100.0
NCSU	Financial Feasibility of Seaweed harvest/processing workshop-Aceh 2	09FSV02NC	Indonesia	August/05/2010	August/15/2010	37	32.4
NCSU	Women Training on Post-Harvest & Marketing of Milkfish 2	09MNE02NC	Philippines	April/29/2010	April/29/2010	15	100.0
NCSU	FAO Experts Workshop on On Farm Feeds and Feeding Management in Aquaculture	09MNE02NC	Philippines	September/13/2010	September/15/2010		
Purdue	Aquaculture and Environment Workshop	07WIZ01PU	Ghana	November/24/2009	November/25/2009	56	14.3
Purdue	Farmer & Extension Training	07MER03PU	Tanzania	November/25/2009	November/26/2009	15	40.0
Purdue	Experimental Design and Analysis	09IND06PU	Ghana	July/28/2010	July/30/2010	20	15.0
UA	Native Gar and Cichlids Training	07IND02UA	Mexico	October/06/2009	October/08/2009	15	33.3
UA	Tilapia Aquaculture in Guyana	07SFT04UA	USA	October/13/2009	October/13/2009	1	0.0
UA	Tilapia in the South Pacific	07TAP03UA	New Caledonia	December/08/2009	December/12/2009	14	7.1
UA	Nicovita Tilapia Session	07TAP03UA	Guatemala	December/02/2009	December/03/2009	200	20.0
UA	Foothills Forum	07TAP03UA	USA	January/24/2010	January/24/2010	80	0.0
UA	Aqauculture for Rural Poor-1	09SFT03UA	Guyana	August/05/2010	August/08/2010	40	32.5
UA	Aqauculture for Rural Poor-2	09SFT03UA	Guyana	September/21/2010	September/21/2010	33	45.5
UA	Bioflocs Workshop	09MNE07UA	Mexico	September/06/2010	September/10/2010	35	48.6
UA	Integrated Aquaculture-Agriculture	09QSD02UA	Mexico	August/13/2010	August/18/2010	35	40.0
Uconn	Stakeholder Review Workshop	07TAP01UC	Cambodia	December/04/2009	December/04/2009	35	20.0
Uconn	Final National Workshop	07MNE01UC	Cambodia	December/28/2009	December/28/2009	31	19.4
Uconn	Alternative Feeds Workshop	07SFT01UC	Cambodia	December/08/2009	December/08/2009	30	16.7
Uconn	Fish Feed Technology	07TAP01UC	Cambodia	June/27/2010	June/27/2010	30	40.0
Uconn	Information/Communication Monitoring & Evaluation Workshop	07TAP01UC	Cambodia	June/28/2011	June/28/2011	41	43.9
Uconn	Impact Assessment Seminar	07TAP01UC	Cambodia	June/27/2011	June/27/2011	41	43.9
Uconn	Snakehead Alternative Feed	09SFT01UC	Cambodia	June/09/2010	June/09/2010	30	40.0
Uconn	Snakehead Breeding and Weaning	09IND02UC	Vietnam	June/14/2010	June/26/2010	4	0.0
Uconn	Log book-Fish Measurement	09TAP03UC	Cambodia	June/26/2010	June/26/2010	30	40.0
Uconn	National Meeting: Prahoc Production Standards	09FSV01UC	Cambodia	June/14/2010	June/14/2010	72	43.1
UHH	Mollusc Production BMPs Workshop-1	07BMA04UH	Mexico	November/21/2009	November/21/2009	15	20.0
UHH	Mollusc Production BMPs Workshop-2	07BMA04UH	Mexico	December/05/2009	December/05/2009	13	23.1
UHH	Requirements for Commercialization and Export	09HHI01UH	Nicaragua	March/27/2010	March/27/2010	32	93.8
UHH	Requirements for Food Safety and Quality	09HHI01UH	Nicaragua	March/19/2010	March/19/2010	28	67.9
UM	Sahar-Tilapia Polyculture Farmers Workshop	07BMA02UM	Nepal	December/18/2009	December/18/2009	41	39.0
UM	Alien-Indigenous Species Workshop-Vietnam2	07MNE03UM	Vietnam	December/24/2009	December/24/2009	30	16.7

Fiscal Year 2011

AU	Student Data Collectors Training	09BMA01AU	Uganda	October/01/2010	October/01/2010	5	40.0

AU	Cage Culture Farmer Training 1	09BMA01AU	Uganda	January/01/2011	January/01/2011	10	40.0
AU	Cage Culture Farmer Training 2	09BMA01AU	Uganda	March/01/2011	March/01/2011	10	40.0
AU	2011 Fish Farmers Symposium	09BMA02AU	Uganda	January/11/2011	January/13/2011	115	31.3
AU	2011 Study Tour 1	09BMA02AU	Uganda	January/14/2011	January/14/2011	10	20.0
AU	Kenyans Study Tour	09BMA02AU	Uganda	January/31/2011	February/04/2011	11	27.3
AU	2011 Study Tour 2	09BMA02AU	Uganda	January/14/2011	January/14/2011	11	18.2
AU	2011 Study Tour 3	09BMA02AU	Uganda	January/14/2011	January/14/2011	9	11.1
AU	CAP Training at AU	09TAP08AU	USA	July/26/2011	August/26/2011	8	37.5
AU	In-country Training - Tettey	09TAP08AU	Ghana	September/09/2011	September/14/2011	6	16.7
NCSU	Tilapia Feeding Strategies and Feed Manufacturing	09SFT04NC	Philippines	January/18/2011	January/19/2011	47	31.9
NCSU	Culture of Seaweeds & Milkfish	09MNE02NC	Philippines	January/26/2011	January/27/2011	28	25.0
NCSU	Cage Culture of Milkfish & Other Marine Fishes	09MNE02NC	Philippines	February/21/2011	February/21/2011	27	22.2
NCSU	Seaweed Culture	09FSV02NC	Philippines	February/22/2011	February/22/2011	28	71.4
NCSU	Nutrition & Seaweed Handling	09FSV02NC	Indonesia	July/27/2011	July/27/2011	21	19.0
NCSU	Seaweed Harvest/Processing-Aceh 1	09FSV02NC	Indonesia	July/24/2011	July/25/2011	29	10.3
NCSU	Candy/Dessert Workshop 1	09FSV02NC	Indonesia	July/26/2011	July/26/2011	45	95.6
NCSU	Processing Methods Workshop 1	09FSV02NC	Indonesia	July/28/2011	July/28/2011	7	0.0
NCSU	Workshop on Tilapia Feeding Strategies and Feed Manufacturing: Meeting Global Challenges	09SFT06NC	Philippines	August/11/2011	August/12/2011	66	39.4
Purdue	Value Chain Opportunities for Women	09MER02PU	Kenya	November/24/2010	November/26/2010	19	78.9
Purdue	Pre-On-Farm Trial workshop	09SFT02PU	Kenya	October/16/2010	October/16/2010	39	28.2
Purdue	Post On-Farm Trial workshop	09SFT02PU	Kenya	July/08/2011	July/08/2011	41	26.8
Purdue	Cage culture workshop	09TAP04PU	Ghana	February/24/2011	February/26/2011	13	15.4
Purdue	Indigenous Species Culture	09IND06PU	Ghana	July/14/2011	July/14/2011	151	12.6
Purdue	Training Program at WRI-ARDEC	09QSD05PU	Ghana	December/14/2010	December/16/2010	25	16.0
Purdue	Training Program at PAC - Propagation and Hatchery Management of the Nile Tilapia	09QSD05PU	Ghana	July/12/2011	July/13/2011	39	12.8
Purdue	Farmer Training: Tilapia Diet Formulation	09SFT05PU	Tanzania	September/06/2011	September/07/2011	20	20.0
Purdue	Farmer Training: Improved Tilapia Species Culture	09QSD04PU	Tanzania	September/08/2011	September/09/2011	20	20.0
UA	Aqauculture for Rural Poor-3	09SFT03UA	Guyana	November/12/2010	November/12/2010	14	64.3
UA	Rockview Lodge Workshop	09SFT03UA	Guyana	June/15/2011	June/16/2011	9	0.0
UA	Trafalgar Union Workshop	09SFT03UA	Guyana	June/20/2011	June/20/2011	13	61.5
UA	Aquaponics Workshop	09QSD02UA	Mexico	September/20/2011	September/24/2011	100	50.0
Uconn	Value Chain Analysis-Vietnam 1	09MER04UC	Vietnam	March/27/2011	March/27/2011	6	50.0
Uconn	Practical Feed for Snakehead	09SFT01UC	Vietnam	November/04/2010	November/04/2010	34	14.7
Uconn	Impact Assessment Methodologies-Cambodia	09FSV03UC	Cambodia	May/03/2011	May/04/2011	49	20.4
Uconn	Impact Assessment Methodologies-Vietnam	09FSV03UC	Vietnam	April/28/2011	April/29/2011	53	26.4

Uconn	Value Chain Analysis-Vietnam 2	09MER04UC	Vietnam	April/28/2011	April/28/2011	6	50.0
Uconn	Value Chain Analysis-Cambodia 1	09MER04UC	Cambodia	March/27/2011	March/29/2011	7	57.1
Uconn	Value Chain Analysis-Cambodia 2	09MER04UC	Cambodia	May/23/2011	May/24/2011	7	57.1
Uconn	Management Recommendations for small-sized fishery-Cambodia	09MNE04UC	Cambodia	May/11/2011	May/12/2011	37	24.3
Uconn	Management recommendations for small-sized fishery-Vietnam	09MNE04UC	Vietnam	July/08/2011	July/08/2011	27	29.6
Uconn	Impact Assessment trainings - Cambodia 1	09FSV03UC	Cambodia	January/03/2011	February/04/2011	15	33.3
Uconn	Impact Assessment Trainings - Cambodia 8	09FSV03UC	Cambodia	June/05/2011	June/07/2011	9	33.3
Uconn	Assessment impact trainings – Cambodia	09FSV03UC	Cambodia	July/20/2011	July/22/2011	24	8.3
Uconn	Impact Assessment Training - Cambodia 2	09FSV03UC	Cambodia	January/06/2011	January/07/2011	9	44.4
Uconn	Impact Assessment Trainings - Cambodia 3	09FSV03UC	Cambodia	January/10/2011	January/11/2011	14	35.7
Uconn	Impact Assessment Trainings - Cambodia 4	09FSV03UC	Cambodia	January/13/2011	January/14/2011	8	37.5
Uconn	Impact Assessment Trainings - Cambodia 5	09FSV03UC	Cambodia	February/14/2011	February/15/2011	9	33.3
Uconn	Impact Assessment Trainings - Cambodia 6	09FSV03UC	Cambodia	February/17/2011	February/18/2011	10	30.0
Uconn	Impact Assessment Trainings - Cambodia 7	09FSV03UC	Cambodia	February/24/2011	February/25/2011	11	45.5
Uconn	Impact Assessment Trainings - Cambodia 9	09FSV03UC	Cambodia	June/09/2011	June/11/2011	9	33.3
Uconn	Impact Assessment Trainings - Cambodia 10	09FSV03UC	Cambodia	June/12/2011	June/14/2011	8	50.0
UHH	Regional Workshop for Women 1	09HHI02UH	Mexico	September/03/2011	September/04/2011	30	90.0
UHH	Regional Workshop for Women 2	09HHI02UH	Nicaragua	July/26/2011	July/27/2011	127	60.6
UHH	Community Meeting: Population Monitoring	09HHI01UH	Nicaragua	November/03/2010	November/04/2010	45	91.1
UHH	Forum on Mangrove Ecosystem Biodiversity & Food Security	09HHI01UH	Nicaragua	October/21/2010	October/22/2010	64	59.4
UHH	Sign Re-installation for Black Cockles Management	09HHI01UH	Nicaragua	November/19/2010	November/19/2010	16	75.0
UHH	Community Meeting on Cockle Population Monitoring	09HHI01UH	Nicaragua	October/30/2010	October/30/2010	25	48.0
UM	Invasive Species Impacts in Reservoirs 1	09MNE05UM	Vietnam	July/29/2011	July/29/2011	42	33.3
UM	Water Quality Management Training for Farmers	09BMA05UM	China	August/08/2011	August/08/2011	34	8.8
UM	Identifying Best Practices for Giant River Prawn Industry	09BMA06UM	Thailand	August/08/2011	August/10/2011	28	50.0
UM	Invasive Species Impacts in Reservoirs 2	09MNE05UM	Vietnam	August/01/2011	August/01/2011	34	20.6
UM	Safety and health culture technique of intensive shrimp pond culture	09BMA04UM	China	May/31/2011	May/31/2011	75	37.3

9. GENDER INTEGRATION

Gender inequality occurs in many areas including economic growth, education, information technology, and legal rights. Even though the advancement of women is essential to successful development and lasting progress at the individual, household, community, and global levels, the marginalization of women is still widely prevalent. Over 800 million women are economically active worldwide, undertaking critical roles in industry, agriculture, manufacturing, and services, but their ability to effectively participate in economic growth is seriously constrained by their limited access to opportunities and resources. Women's unemployment rates remain high relative to those of men, and when employed, they are paid less than men for the same work. Limitations on women's legal rights are evident in unequal access to government forums and local decision-making bodies and in restrictions on land and property ownership. Increased education for girls results in reduced birth rates, increased agricultural activity, and higher family incomes, yet worldwide, 60 million girls remain out of school. Additionally, deeply held beliefs about technology being a traditionally male field prevent women from equal access to information and communication technologies.

Gender inequality is also an issue in the aquaculture and fisheries sectors. In small-scale capture fisheries, typical gender roles play out with men owning boats and doing the fishing while women remain in charge of the processing and sales. In aquaculture, women are often found in the most vulnerable positions as fry catchers, laborers, and in low paying processing plants. The roles of men and women in aquaculture and fisheries are dynamic and often defined by region. For example, women in Cambodia, Democratic Republic of the Congo, Thailand, and in indigenous communities in Latin America are often involved in boat fishing and in some cases even own boats while some men in Asian countries control sales. Regardless of gender roles, wealthier men and women dominate the value chains. The poorer men and women have less bargaining power and are more vulnerable to fluctuations in supply and demand.

In addition to increased productivity and efficiency in the fisheries and aquaculture sectors, development programs need to identify and address elements of larger social and economic dimensions that are the root of complex development issues. Men and women need equal access to assets and opportunities such as financial capital, knowledge of new production systems and skills, markets outside of regional gender boundaries, and stakeholder groups and meetings. Providing equal opportunities for men and women is necessary for advancing economic and social development, not only in fisheries and aquaculture, but also for individuals, households, and communities.

PROGRAM STRATEGY

AquaFish CRSP was dedicated to improving gender equality in the aquaculture and fisheries sectors and in the CRSP arena. Gender integration was implicit and interwoven into targets, benchmarks, and indicators throughout the AquaFish CRSP Monitoring and Evaluation Plan, as requested by USAID in its RFA. The intent of AquaFish CRSP was to create equal opportunities for men and women to participate

in the Program's research, training, educational, or other activities. The following benchmarks provided a means to track program performance with respect to its gender integration strategy and targets.

Gender Integration Benchmarks

Year 1:

(i) Require that all funded projects address gender inclusiveness within their planned scope of work.
(ii) Seek out USAID review of projects' gender inclusiveness plans and respond by improving plans prior to project implementation.
(iii) Promote the participation of women in formal and informal education and training opportunities provided through the CRSP. The CRSP has set a 50% benchmark for training women in formal and informal education. In addition, the 50% benchmark applies to attracting and retaining women scientists and administrators in all CRSP activities, as project researchers, advisory group members, and managers. (Continue all years)

Years 2-5:

(i) Collect disaggregated gender data from individual research and outreach projects funded by the CRSP.
(ii) Analyze disaggregated data on an annual basis to gauge gender inclusiveness success and take appropriate action as indicated through data analysis.
(iii) Involve field projects in monitoring and evaluating gender integration as the program progresses with time. Evaluate the effects of specific projects on gender and ensure that any possible negative effects due to gender bias are mitigated.
(iv) Focus one component of a lessons learned and synthesis assessment specifically on the social context and impact of CRSP research and outreach activities on the lives of women.
(v) Tailor specific extension and technical services related to sustainable aquaculture and aquatic resource management to women producers.
(vi) Engage extension specialists sensitive to diversity issues and access to resources of underrepresented groups and women will be included as an integral part of their delivery team to ensure women farmers and fishers feel welcome in CRSP training opportunities.

Core Research Project Strategies

AquaFish CRSP required that all funded projects address gender integration within their planned scope of work. All projects were required to have a *Gender Inclusivity Strategy* in their proposals. Projects included a procedure for monitoring and evaluating gender integration as the project progresses with time. Researchers also evaluated the effects of specific projects on gender and ensure that any possible negative effects on gender are mitigated. In addition, each project included at least one outreach activity within an investigation that focused on increasing participation by women.

The *Gender Inclusivity Strategy* of each of the eight AquaFish CRSP Core Research Projects, excerpted from the submitted proposals, are provided below. The complete *Gender Integration Activities,* including details on implementation and schedule, are available in the 2009-2011 Implementation Plan.

AUBURN UNIVERSITY
Lead US Principal Investigator: Joseph Molnar

Gender Inclusivity Strategy excerpted from the submitted proposal:
HYDROLOGY, WATER HARVESTING, AND WATERSHED MANAGEMENT FOR FOOD SECURITY, INCOME, AND HEALTH: SMALL IMPOUNDMENTS FOR AQUACULTURE AND OTHER COMMUNITY USES

Gender Inclusivity Strategy

African women's struggle for equal political and labor rights intensified in the late 19th century and continues today (FAO 1994). Information technology can offer significant opportunities for virtually all girls and women in developing countries, including poor women living in rural areas. Although to date most of the women accessing information technology have been from the educated elite, poor women in development countries can overcome the constraints that presently prevent their access and can use IT to meet their basic needs and exercise their fundamental rights. Technological and social solutions exist to the constraints that presently keep poor women from using information technology. Most of these solutions have been tested in pilot projects. However, virtually none yet have easily replicable business models (Hafkin and Taggart 2001). Conscious of these gendered aspects of the digital divide, the project will provide information resources in ways that facilitate access by women farmers and NGO staff, and by seeking to enhance women's access to fish culture training opportunities.

For example, Uganda had one of the larger Gross Domestic Products (GDP) in Africa. Yet much of its wealth was concentrated in the hands of a minority of the population, leaving two-thirds of the population poor and 90 percent of the population below the poverty line. In the early 1990s, approximately half of females were literate compared to males. It was estimated that roughly 65 percent of females and 72 percent of males were attending primary school, and 18 percent and 19 percent, respectively, were attending secondary school. Rural populations, especially girls, were considerably less represented in education programs. Given these findings, this project will endeavor to achieve gender inclusivity by seeking gender parity in the recruitment of graduate students and the equal inclusion of women in farmer training.

Most of the Ugandan investigators in this project have worked with the USAID FISH project from 2005 through 2008. Women made up more than 1/3 of training participants in the FISH project. The last Fisheries Training Institute (FTI) internship program finished in 2008 had 33% female interns. Dr. Nelly Isyagi and Karen Veverica have been cited by women hatchery managers in Uganda as their best role models. The FAO regional office has recognized that Ugandan women in fish farming are a model to be followed. Training registers will be kept for all sites and other related training efforts. Data will be disaggregated by gender and by home district. The FISH project training registers which, in 2008, included 243 women and 387 men will be used to disseminate information on training opportunities and advertise the open days at cage sites. Women will form active participants and beneficiaries in the cage culture field trials.

The status of rural women varies depending on the position assigned to them in the different rural economies, which are neither homogenous nor static (FAO 1994). The conditions governing rural women's participation in productive activities are related to the gender-based division of labor. With regards to land ownership and how it is related to work, the smaller the holding, the more work they have to do: women's workload is lighter on the larger holdings. Woman's subordinate status is even more

marked in the rural areas where many of the customary rules, more widely observed there, are prejudicial to women. The implications for women's access to land differ depending on whether or not the rules governing marriage regimes embody the concepts of "marital authority", of consensual unions, or, again, of wives or companions included among the forced heirs. Although the objectives of this project are not to directly address these disadvantageous conditions, we do intend to promote the participation of women in training programs, seek the interest and sponsorship of women's groups in promoting fish culture, and in general to work to counter the traditional presumptions and bias that often limit the benefits of aquacultural development efforts that women accrue. Following these general understanding, we have specific practices that we will implement.

Nelly Isyagi and the other Ugandan co-PIs have combined experience of very successful inclusion of women in fish farming activities. They have practice a rather low-key approach because they feel that showing an obvious bias towards women is often counterproductive. It makes the men resentful, encourages a form of cheating in which "token women" are included just so someone's criteria can be met, and it risks attracting women who merely look for special treatment. The Ugandan women on the project propose to do what they normally do because it works. So, what IS it? This is how they describe their approach:

1. Show we are watching

Just the fact that women's participation is enumerated is often sufficient impetus to include women. For example, when my counterpart and I trained extension agents in Rwanda, we included a line in the report form for the agents to tell how many women-owned fish ponds they assisted. Just having that line encouraged the agents to try to get some women to work with. When we would visit the extension agents, they always asked us is we wanted to see the women's group. After a while, they began seeking out more women, because the extension agents found out that they were much easier to work with than men.

2. Setting the example

I do harvesting and construction work myself, my female counterparts do all types of fish farming work and by example, we show that this work is OK for women to do. One place where some of the training will take place is SoN fish farm. Two of our former trainees are the women in charge of the cage operation. We provide encouragement to all good workers and trainees, and many of these are indeed women.

3. Discuss women's needs with employers

After initially encouraging the first fish farmer to hire a young woman, many farm owners began realizing how valuable women are, especially in their hatcheries. Many owners now call us and say: "I need a girl to work in my hatchery". We often have to advise owners what they should do to attract women to work on their farms.

4. Women as owners

There are currently women fish farm owners and other women in business with whom we deal. However, we do not single out women to work with, we just pick the best prospects; same for recommending people for employment. Perhaps these women owners feel more comfortable asking for our help. Many have told us this.

In terms of the cage farming groups (study 3), the selection will be made based upon who can get credit or other help to pay for the inputs. Although it would be ideal to have at least one group be women, we cannot give additional funding to them. However, one of the groups that may be in position to participate is an orphanage, which has three young women trained in fish farming. Study 3 is, in fact, a study in outreach. The question is not about fish production, it is about how easy/difficult it is to transfer the technology to rural farmers. There will be a detailed case study for each group, with their own trials and

tribulations noted. Overall, the project will utilize its resources and motivated staff to ensure that the project meaningfully recruits and involves women in project activities.

Gender Integration Activity
Auburn University submitted their proposal before the requirement of an outreach activity focusing on women was implemented. However, it is clear from their Gender Inclusivity Strategy that women students and farmers will be recruited and trained throughout the project and particularly in the *Training and Outreach in Uganda and Surrounding Nations* investigation.

NORTH CAROLINA STATE UNIVERSITY
Lead US Principal Investigator: Russell Borski

Gender Inclusivity Strategy excerpted from the submitted proposal:
IMPROVED COST EFFECTIVENESS AND SUSTAINABILITY OF AQUACULTURE IN THE PHILIPPINES AND INDONESIA

Gender Inclusivity Strategy
This project involves three female Host-Country Principal Investigators, who play a leading role in setting priorities and management of the project at Central Luzon State University and SEAFDEC ADQ. Several of the graduate and undergraduate students are also female. We consider gender seriously and work to balance gender in our activities both in the Host Country as well as the United States. The central Host Country PI is an accomplished scientist and has served senior administrator roles at CLSU. One of the PIs is the Head of Research at SEAFDEC. We firmly believe that female role models are crucial to attracting women into research, outreach, and farming activities. We continue to commit considerable effort in incorporating females into our activities, with high priority on participation of women at Host Country institutes. As examples, we propose to provide a season-long training program on an integrative milkfish culture system using farmers' cages as demonstration facilities. All SEAFDEC staff on this project and several seaweed farmers, for which a majority are women, will aid milkfish producers in maintaining the community-based integrated culture systems. This should foster and expand the role of women in traditionally, male-dominated fish farming activities. Additionally, we will conduct skills development workshops for training women on milkfish processing to develop value-added products, which should supplement livelihoods and foster entrepreneurship. In Indonesia, we plan training workshops targeted for women to demonstrate methods of using seaweed agar to make candy and desserts, which could provide in-home business options and improve household welfare. These capacity building seafood processing activities should not only provide supplemental income to women, but will establish a core nucleus of women in the community who can serve as trainers for others, sustaining women's involvement in aquaculture endeavors.

We will also survey commercial farms, workshop participants and community organizations in the Host Countries to ascertain and limit any potential constraints to the participation of women and minority ethnic groups in our workshops. Our research will also support experiences for undergraduates and graduate students where we expect, based on our track record, females to play a role.

The Lead PI is actively involved in the Women in Science and Engineering program and the Wolfpack Women in Science organization - a North Carolina organization that promotes an increase in the number

of women entering the sciences in their first year as well as increasing the retention rates of these women in science related fields. He has previously mentored several participants in the program. Out of the 15 students trained by the Lead PI in the past 5 years, over half have been women. He currently mentors the female Ph.D. student and an undergraduate student who will be involved in the research proposed here. Although not financially supported in the proposed studies, he will include additional independent research projects for women through the Howard Hughes and Beckman Foundation research experiences for undergraduate programs. Female students and technical staff have participated in our studies and are among our intended beneficiaries of the proposed project. We anticipate that of the approximate 30 students involved in this project that almost two-thirds will be female.

Gender Integration Activity

Title: DEMONSTRATION OF SUSTAINABLE SEAWEED CULTURE, PROCESSING AND UTILIZATION IN ACEH, INDONESIA AND THE PHILIPPINES – OPPORTUNITIES FOR WOMEN TO IMPROVE HOUSEHOLD WELFARE

PURDUE UNIVERSITY

*Lead US Principal Investigator: Kwamena **Q**uagrainie*

Gender Inclusivity Strategy excerpted from the submitted proposal:
IMPROVING COMPETITIVENESS OF AFRICAN AQUACULTURE THROUGH CAPACITY BUILDING, IMPROVED TECHNOLOGY, AND MANAGEMENT OF SUPPLY CHAIN AND NATURAL RESOURCES

Gender Inclusivity Strategy

This proposal recognizes that providing for equal opportunities for women 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 on a holistic household and family economy. The intent of this project is to ensure that no one is excluded from participating in the training, or educational activities and opportunities proposed herein 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, consumers, program personnel, students, etc), we will actively recruit women to

participate in these activities. We have demonstrated this inclusivity in the past through the selection of participants in AquaFish CRSP programs we have offered as well as in the selection of students supported in graduate programs in Ghana, Kenya and Tanzania. One of special mention is the partnership in Kenya that AquaFish CRSP has established with Women in Fishing Industry Project (WIFIP) based along the shores of Lake Victoria. Through this partnership, we are actively engaging women in fish farming / aquaculture to provide additional household income to support the women during the annual fishing ban on Lake Victoria, when income is at its lowest. This kind of arrangement with women groups will be actively sought in Tanzania and Ghana as well.

We shall not apologize for deliberately going out of our way to select participants with more women representation in this project. Past experience shows that similar projects have had more impact when women are represented and are provided with opportunities to advance themselves.

An effort will be made to recruit qualified female graduate students from the Host Country for all long-term training in graduate studies. In selecting workshop and other short term training participants, efforts will be made to seek a 50:50 gender ratio or give a higher priority to females. We expect the inclusion of gender to closely reflect the proportions of gender among practicing fish farmers in the study regions. On-farm trials will also focus on including female-headed households to encourage women participation in generating research and extension based-information. We will endeavor to include additional females in the project personnel, and more especially seek partnerships with female NGOs in the respective Host Countries.

Gender Integration Activity

Title: VALUE CHAIN DEVELOPMENT FOR TILAPIA AND CATFISH PRODUCTS: OPPORTUNITIES FOR WOMEN PARTICIPATION

UNIVERSITY OF ARIZONA

Lead US Principal Investigator: Kevin Fitzsimmons

Gender Inclusivity Strategy excerpted from the submitted proposal:
DEVELOPING SUSTAINABLE AQUACULTURE FOR COASTAL AND TILAPIA SYSTEMS IN THE AMERICAS

Gender Inclusivity Strategy

One of the goals of our project will be to provide additional opportunities for women on the academic and technical sides of aquaculture as well as the production aspects. Women in academic and technical positions serve as valuable role models, in addition to their technical assistance, for women in production aquaculture. Women in technical positions often have an ability to relate better to the women we have targeted in our outreach programs.

Additional efforts must still be expended to provide women in academic and technical aspects with the training and opportunities to be successful. Some of our direct plans include women in these key roles:

1. Pamila Ramotar, Principal Investigator for Guyana
2. Sidraton Naim and Maira Juarez, two of our three graduate associates on the project
3. Trafalgar Union, women's aquaculture cooperative in Guyana
4. Womens farming cooperatives in Annai and Anna Regina, Guyana

5. Arlette Hernández-Franyutti, one of the researchers at UJAT

We have also recruited a number of female graduate and undergraduate students at Arizona, UAT and UJAT to work on these investigations. We think these efforts are especially important to improve the professional capacity of women in aquaculture science.

A second goal is to provide more training and outreach to women in the production aspects of small-scale aquaculture. To bring more women into small-scale aquaculture and to better support those already tending small farms, we will work with our Host Country partners to develop teaching materials that will directly address women working on small fish farms. We will also include women in the teaching of the workshops, calling upon some of our recent female graduates and women currently in research in Mexico and Guyana. Of course we will also attempt to have at least 50% of attendees to workshops be qualified women.

The women's cooperative at Trafalgar Union in Guyana will be a focus of the Guyana project. We will conduct workshops and assist with hands-on training with these women who have already organized and begun to stock ponds and cages. We hope to use their experience as a model for other women's groups to consider the potential for aquaculture, especially as an adjunct to the vegetable farming that is common in rural Guyana (and Mexico and many other tropical countries). We expect that the women will be able to generate sales from fish while at the same time using effluents to irrigate and fertilize their vegetable gardens. This will allow them to have income from the fish while also saving funds that otherwise would have been spent for chemical fertilizers. Auto-consumption of fish will also improve overall household nutrition. As women are most frequently the person who determines the contents of each meal, the ability to increase the amount of fish and vegetables in the family's meals is within their responsibility.

With aquaculture's record as the fastest growing sector in agriculture, the inclusion of women at all levels can be a model for other sectors and allow for a more equitable distribution of the benefits from this industry. We expect that training provided to women will have the most direct impact on improving family nutrition and income.

Gender Integration Activity

Title: EXPANSION OF TILAPIA AND INDIGENOUS FISH AQUACULTURE IN GUYANA: OPPORTUNITIES FOR WOMEN

UNIVERSITY OF CONNECTICUT AT AVERY POINT
Lead US Principal Investigator: Robert Pomeroy

Gender Inclusivity Strategy excerpted from the submitted proposal:
DEVELOPMENT OF ALTERNATIVES TO THE USE OF FRESHWATER LOW VALUE FISH FOR AQUACULTURE IN THE LOWER MEKONG BASIN OF CAMBODIA AND VIETNAM: IMPLICATIONS FOR LIVELIHOODS, PRODUCTION AND MARKETS

Gender Inclusivity Strategy

In Cambodia and Vietnam, both men and women are actively involved in aquaculture. Men are primarily involved in decisions of fish species to be raised, timing for stocking, buying fingerlings, netting and harvesting. Women are often involved in daily feeding such as gathering grass and manure and feeding fish by rice bran. Women are also involved in small-scale processing, fish sauce production and trading of fish. While women are invariably involved in many of the stages of aquaculture, targeting of women in extension is often problematic. Training activities and meetings often take place during the day when women are busy with household activities. Women may not travel between villages and do not have long periods of time available to attend training. In Vietnam, it was found that when women were involved in training in aquaculture, women were allowed to take more decisions in the management of aquaculture as a result of their acquired knowledge. According to the rural women, their husbands encouraged them to take more decisions in aquaculture management and this strengthened their position in the family.

Gender issues in aquaculture can be seen from two perspectives. One is from an instrumental perspective. The other is from an empowerment perspective. Instrumental perspective sees women as a vital force in aquaculture development, and focuses on the need to assist women so that they can be more involved and more effective in aquaculture activities. From this viewpoint, women's access to credit, training and extension services are important to enable them to improve their skills and knowledge and increase the yield. The empowerment perspective challenges existing gender relations through development projects, including aquaculture activities. This perspective sees that improvement in women's situation cannot be achieved without the empowerment of women, that is, by changing gender power relations in the household and in society.

Women will be targeted in both the research and outreach activities of the project. Women will be involved in on-farm research activities as many carry out feeding activities. Women will also be included, and specifically targeted, in both informal and formal education and training outreach activities. Extension specialists will be trained be more gender sensitive and to include both men and women in training.

In better understanding aquaculture production systems, this project will undertake a survey on the role of women. This survey, based on a sample of both commercial-scale and small-scale aquaculture households, will allow for a better understanding of women's role and participation in various aquaculture activities. The survey will also provide baseline data for a gender relations approach to assess if the projects have improved women's socio-economic and political position in their homes and communities, including sharing of work and decision-making. The survey will determine whether gender equal relationships have been achieved through aquaculture, whether women's choices have increased, and whether women's self-esteem and self-confidence have improved so that they can be in charge of their own lives. Women being able to access knowledge and information, to make decisions regarding household investment and

expenditure, as well as to have decision-making power in the community, are some of the indicators to judge advancement in this aspect.

It should be noted that Investigation 4 will focus on women fish processors in Cambodia. The overall objective of this investigation is to work with women to improve and ensure food safety and value added of fermented fish paste products for local consumers and the competitive markets in Cambodia and the development of women fish processing groups/associations.

Gender Integration Activity

Title: MAXIMIZING THE UTILIZATION OF LOW VALUE OR SMALL-SIZE FISH FOR HUMAN CONSUMPTION BY IMPROVING FOOD SAFETY AND VALUE ADDED PRODUCT DEVELOPMENT (FERMENTED FISH PASTE) THROUGH THE PROMOTION OF WOMEN'S FISH PROCESSING GROUPS/ASSOCIATIONS IN CAMBODIA

UNIVERSITY OF HAWAII AT HILO

Lead US Principal Investigator: Maria Haws

Gender Inclusivity Strategy excerpted from the submitted proposal:
HUMAN HEALTH AND AQUACULTURE: HEALTH BENEFITS THROUGH IMPROVING AQUACULTURE SANITATION AND BEST MANAGEMENT PRACTICES

Gender Inclusivity Strategy

Efforts are made to assure gender balance in all components of this work. Women's groups are directly involved in all three sites and the primary stakeholders this work is directly applicable to are largely female. For example, the cockle collectors in Nicaragua are primarily female heads of households and children. In Mexico, the primary targeted stakeholder group in Santa Maria Bay are 10 women's fishers groups. In Boca Camichin, oyster farms are family-operated and women participate in all phases of oyster culture, and are predominant in the post-harvest activities. Prior collection of demographic data from the

five study sites in two countries indicates that at least 70% of the participating stakeholders are female. The PI is female as are two of the Co-Pis; all are experienced in outreach and training strategies that assure the full inclusion of both genders. Additionally, monitoring and evaluation of the project demographics and outcomes will be conducted to assess gender balance and representation and to guide corrective actions if necessary.

Gender Integration Activity

Title: CAPACITY BUILDING IN AQUACULTURE, FISHERIES MANAGEMENT AND COASTAL MANAGEMENT FOR COASTAL WOMEN

UNIVERSITY OF MICHIGAN

Lead US Principal Investigator: James Diana

Gender Inclusivity Strategy excerpted from the submitted proposal:
IMPROVING SUSTAINABILITY AND REDUCING ENVIRONMENTAL IMPACTS OF AQUACULTURE SYSTEMS IN CHINA, AND SOUTH AND SOUTHEAST ASIA

Gender Inclusivity Strategy

Our proposed work in Southeast Asia includes a variety of cultures and is conducted with a variety of collaborators. A large number of the graduate students working on this research in the past were women, and the research themes have included specific issues relating to female roles on farms and surveys of male/female roles in aquaculture. Currently, two among nine PIs in this project are women (actually, a third woman is a PI in the special cage culture proposal as well), and many of the students (at least 57%) and technicians (almost 50%) we have used in conducting this research are women. We do not have a proposed list of students to be incorporated in this research from the US and HC institutions, but the only student identified so far (Ling Cao) is female. We will work to identify additional women scientists at each institution involved in the AFCRSP project and to include them in future research plans, especially at the level of HCPI.

Women play an important role in aquaculture and in nutrition of poor families. We are conducting research targeted at this segment of the population and hope to encourage women to further their part in aquaculture development. We have intentionally proposed research to bring both income and food security to poor, small-scale fish farmers. For the on-farm trials in Nepal, we will closely work with an NGO (Rural Integrated Development Society-Nepal), which has been promoting Women in Aquaculture for many years. As a result, most farmers involved in the on-farm trial will be women.

We will also hold a workshop at the end of this study, targeted exclusively on women. For the workshop in Thailand, we will invite 30%-50% women participants. Women may have difficulties attending workshops due to their responsibilities in the home, so it is important to do more than just invite them to attend. We will work with our HCPIs to identify these barriers and make appropriate plans to overcome them in our workshops. Such changes may include the location of workshops, the length of time involved, and special arrangements that can be developed to allow female participation.

Gender Integration Activity

Title: INCORPORATION OF TILAPIA (*OREOCHROMIS NILOTICUS*) AND SAHAR (*TOR PUTITORA*) INTO THE EXISTING CARP POLYCULTURE SYSTEM FOR HOUSEHOLD NUTRITION AND LOCAL SALES IN NEPAL (PRODUCTION SYSTEM DESIGN AND BEST MANAGEMENT ALTERNATIVES/ EXPERIMENT)

OREGON STATE UNIVERSITY/MONTANA STATE UNIVERSITY
Lead US Principal Investigator: Steven Buccola

Gender Inclusivity Strategy excerpted from the submitted proposal:
ASSESSING THE IMPACTS OF CRSP RESEARCH: HUMAN CAPITAL, RESEARCH DISCOVERY, AND TECHNOLOGY ADOPTION

Gender Inclusivity Strategy

Two of the three graduate students at Oregon State University who are scheduled to work on this project are women from a project Host County; the other is a man. Gender breakdowns of the HC personnel with whom we will work in the Host Countries will depend upon who is found most effective in performing the relevant data-collection tasks. They will be selected through consultation with the US and HC PIs. Because we are not familiar with the HC personnel at this time, we will rely heavily on the US and HC PIs for those identifications. The PIs in turn are operating under their own approved gender identification strategies.

As discussed in the methodology section of Investigation 2, the impact assessment will identify gender and other potential social impacts of technologies, and discuss with collaborators methods to incorporate gender and other social impacts into impact assessments. To the extent that data are available or can be acquired in the course of the project, gender and other social impacts will be incorporated into the impact assessments carried out by the project. Collaborators will review methods to identify gender impacts in future projects, collect data, and implement gender impact assessments in future projects.

Gender Integration Activity

Title: ASSESSMENT OF AQUAFISH CRSP TECHNOLOGY ADOPTION AND IMPACT

10. SYNTHESIS

The ME's vision for AquaFish CRSP brought together highly creative and knowledgeable people in functional advisory groups. These advisory groups provided linkages to the broad global community engaged in aquaculture and fisheries development issues. This innovative structure evolved from past ACRSP structure, as originally envisioned by BIFAD (Board for International Food & Agricultural Development). Technical advisory groups (RCE and DTAP) were responsible for synthesizing information across regions and themes and a Synthesis Project was responsible for providing metadata analysis and broad evaluative syntheses. Also included in this section is a knowledge and data management project that was initiated to serve as a common data clearing house for all current and historical CRSPs. These synthesis activities provided a means of increasing the impact of the AquaFish CRSP mission and allowed for both monitoring and evaluation and effective communication of program accomplishments.

DEVELOPMENT THEMES ADVISORY PANEL SYNTHESIS:

Development Themes Advisory Panel (DTAP) provided technical advice on emerging issues and gaps in the portfolio from a thematic perspective. Lead coordinators of the thematic panels assisted the ME to integrate cross-cutting needs identified by USAID, and add additional emphases such as conserving biodiversity and using biotechnology approaches cautiously. The lead coordinators were also responsible for reviewing annual reports, reviewing project adjustments in cases where research is curtailed for various reasons (e.g., laboratory equipment malfunction; poaching; etc.), and work together to provide quality information for thematic synthesis and lessons learned reporting.

The following summaries report on Core Research Project accomplishments from FY2008 through FY2012, which were measured by the impact indicators associated with each of the four Development Themes Advisory Panels (DTAP). Projects did not submit DTAP Reports for FY2007 since during this first year of the award, they were in the early stages of investigation start-up. Tables 1 to 8 in Appendix 3 summarize indicator metrics for eight of the 10 indicators. Since the DTAP training indicators (B03 and C04) are covered in *Capacity Building*, they are not included here.

DTAP A: Improved Health and Nutrition, Food Quality, and Food Safety of Fishery Products

Maria Haws (University of Hawai'i at Hilo), Lead Coordinator

Undernourishment is a worldwide problem among the poor. It affects all ages and plays a major role in perpetuating poverty. Some of the world's most vulnerable demographic segments are particularly dependent upon aquaculture and fisheries for food. These same groups are also the most vulnerable to foodborne illnesses and economic losses when products harbor pathogens or are affected by decomposition or contamination. Estimates of physical and economic losses of aquatic products due to poor production and post-harvest practices range from 10% on a global basis to 50% in Africa and other

impoverished regions. Food quality and safety reflect production and management practices as well as environmental quality. Improving these factors by directly training stakeholders is crucial for improving food security as well as increasing economic benefits.

AquaFish CRSP researchers in Africa, Asia, and Latin America made significant advances in improving the quality and safety of aquatic products and reducing losses. Their broad approach successfully introduced new technologies and species for small-holder aquaculture and post-harvest value-added processing, trained stakeholders in food safety and quality standards for aquatic products, developed production systems to ensure a family food supply from aquatic products, opened new income-generating opportunities along the value-chain, and helped protect fisheries through sustainable management plans. CRSP has also focused on women as the primary players in many of these activities.

The University of Connecticut-led CRSP project in Vietnam and Cambodia made significant advances in developing integrated aquaculture and fishery management plans to prevent overexploitation of the fishery for low-value fish in the Lower Mekong River Basin. A major food source for the poor, this fishery is the starting point for the fermented fish paste known as prahoc, a key element in the region's diet. Largely a household-based industry of women processors, prahoc production has been lacking in food safety and quality standards. To address this situation, CRSP Cambodian researchers trained women processors in practices and standards, which follow international food safety and quality protocols. These first steps will lead to regional adoption of production standards and improved marketing opportunities.

Sanitation is an emerging issue for populations vulnerable to shellfish-borne diseases caused by ecosystem degradation. In the Pacific Coast estuaries of Mexico and Nicaragua, CRSP researchers with the UH project have focused on production of food-safe native oysters and cockles using a community-run management model based on depuration techniques and no-take zones. As adoption of these practices spread, shellfish growing grounds can be certified, thereby opening new markets. Poor families will benefit from a safe food supply that they sustainably manage and, once certified, can sell in speciality markets. In other human health focused work, the UM project in Asia developed a relatively inexpensive technique to control infestations of the microcystin toxin-producing cyanobacteria in tilapia and catfish aquaculture. Food safety and quality were also the focus of other work in Asia on good practices and eco-certification of farmed shrimp.

DTAP B: Income Generation for Small-Scale Fishers and Farmers
Kwamena Quagrainie (Purdue University), Lead Coordinator

Locally-adaptable technologies improve livelihoods both by maximizing productivity and opening new market opportunities, particularly in impoverished communities with limited resources. These technologies represent a key factor for ensuring food security when growing sustainable aquaculture and fisheries sectors for stakeholders at all levels of the value chain. CRSP capacity building through new technology development — from the research stage through on-farm trials to transfer and adoption — focused on efficiencies in fish production management, sustainable feed technologies, improved health and safety of aquatic products, advancing the aquaculture of native species, and effective outreach with internet-based tools. These technologies related to the whole value chain from production input to post harvest.

Fish feed represents from 40–80% of operational costs in aquaculture. Sustainable feed technologies offer stakeholders cost-effective alternatives for lowering overall production expenses and ensuring a minimal environmental impact from fish culture. Replacing fish meal in fish feeds also addresses issues of food security and natural resource management in regions where poor populations, who rely on low-value fish as food, compete with the feed industry for these aquatic resources. In Tanzania, the PU Project

developed a tilapia fish feed formulated with protein derived from the leaf meals processed from local forage tree species. Other feed technologies developed by the UA and UC Projects replaced fishmeal with lower cost local protein sources derived from plant or meat by-products (e.g., rice bran, copra or shrimp meals). To lower tilapia production costs through more efficient feed utilization, the NC Project devised reduced feeding strategies that it is transferring to farmers through a novel podcasting program.

Culture systems such as cage culture and polyculture improve production efficiencies, minimize economic risks, and promote sustainable resource management. As an alternative technology suitable for ponds, lakes, and reservoirs, cage aquaculture has several advantages: a low capital outlay and scalable production from subsistence level to commercial ventures as well as feed reduction and waste control. The cage-cum-pond system for raising tilapia and catfish tested in Kenya offered small-scale fish farmers opportunities to enhance revenues (PU Project). First-time Ugandan farmers learned basic aquaculture techniques and enterprise management in the testing of cage culture on Lake Victoria (AU Project). In Ghana where cage aquaculture has seen increased adoption, CRSP efforts were targeted at strategies for removing constraints to its adoption (PU Project). In Asia, a deep-water cage production model with regional applicability was successfully tested (UM Project). In the Philippines, researchers developed a cage culture system for the integrated multi-trophic polyculture of milkfish-seaweed-sea cucumber that both accomplishes nutrient recycling and expands production capacity (NC Project). UM researchers in Bangladesh developed a prawn-carp-mola polyculture system that produces fish for home consumption and high-value prawns for market whereas in Nepal, on-farm trials have established the optimal sahar-tilapia-carp polyculture system for best economic returns.

Other work focused on improving shellfish sanitation and expanding the culture of native species. UH researchers worked closely with impoverished Pacific Coast communities in Mexico and Nicaragua to train them in open-water depuration techniques and no-take zone protocols for improved food safety of the native oysters and cockles that serve as a major protein source. Adoption of these technologies will also improve income potential from expanded domestic markets for higher-priced, food-safe shellfish. Research showed promise in bringing important native species into aquaculture to increase marketing opportunities: snakehead in Cambodia; chame, native cichlids, and snook in Mexico; and African bony-tongue, Claloteid catfish, and African snakehead in Ghana. Advances in CRSP domestication technologies included induced spawning, management of early life stages, identification of nutritional requirements, and optimal feeding strategies.

In addition to introducing podcasting as an outreach and training tool, CRSP employed other information technologies to improve livelihoods. In Kenya, cluster farmers participating in the PU Project tested a pilot Farmed Fish Marketing Information System (FFMIS) that taps into existing market information systems to allow timely access to markets. In Uganda, AU researchers trained extension personnel in software approaches for managing water use by farmers and other community stakeholders.

CRSP partnered with women-run cooperatives and organizations to promote gender equity. Women benefited from the adoption of post-harvest, value-added technologies such as milkfish and seaweed processing (NC Project), catfish-baitfish aquaculture and marketing (PU Project), shellfish sanitation technologies (UH Project), sustainable feed formulations using local plant and animal by-products (UA Project), and fermented fish paste processing practices (UC Project).

DTAP C: Environmental Management for Sustainable Aquatic Resources Use
James S. Diana (University of Michigan), Lead Coordinator

CRSP focused on sustainable natural resource management in the production of aquatic products. Culture practices were designed to minimize environmental impacts associated with water use and management,

nutrient loads in outflows, and biodiversity effects from overfishing or introduction of alien species into native ecosystems. In employing these practices, AquaFish CRSP had two sustainable resource use goals: (1) develop end-user aquaculture and fisheries systems that increase productivity and enhance trade while contributing to responsible resource management; and (2) increase Host Country capacity for building food security, income generating opportunities, and market access.

Practices to effectively control aquaculture effluents were a major focus of CRSP natural resource management. A 2011 UM workshop on freshwater prawn culture in Thailand illustrated the economic and environmental successes enjoyed by farmers who adopt CRSP best practices. By integrating shrimp into the prawn culture, lowering prawn density, and controlling feed inputs, Thai farmers are now reusing pond water rather than discharging it. Other CRSP projects have focused on the improved control of solid and dissolved matter resulting from aquaculture systems.

Successes in eliminating effluent discharge are expected with a variety of CRSP technological advances. Reducing waste load and improving feeding efficiency were goals of integrated milkfish-seaweed and shrimp-seaweed polyculture systems in the Philippines and Indonesia to remove nitrogen and phosphorus from receiving waters (NC project); and deep water cage culture that employed filter-feeding fish in surrounding cages to consume waste feed and fecal matter caught in sediment traps (UM Project). Aquaponic systems tested in Mexico and Guyana for growing vegetables also offer a beneficial agricultural use for the nutrients contained in aquaculture effluent. Reduced feeding strategies applied in tilapia aquaculture in the Philippines (NC Project) and pelleted, reduced fishmeal feed for snakehead (UC Project) have shown significant success in changing local practices that will contribute to lowered waste production. CRSP management practices for waste control also helped Ghanaian farmers economize with efficient use of feed and fertilizer inputs and feeding regimes (PU Project). A UM Project made significant steps toward establishing good practices for raising eco-certified shrimp relative to effective energy use, nutrient dynamics, and effluent quality.

CRSP technologies to minimize environmental impacts from fish culture included techniques developed by the UA Project to eliminate potentially harmful methyltestosterone from tilapia masculinization systems and to treat aquaculture effluents used as irrigation water with low-cost UV systems. Other environmentally sustainable technologies included pond-based recirculating aquaculture systems with solid waste removal and water quality controls (UM Project) and aquaponics technologies (UA Project) for operating integrated agriculture-aquaculture systems in rural areas of Mexico and Guyana.

CRSP's environmental focus also targeted water use and fisheries management. Modelling and software tools developed for best practices to manage watersheds, water harvesting, and siting and constructing ponds help stakeholders reduce water loss and protect wetlands and water quality as aquaculture expands in Uganda (AU Project). Development of integrated management plan for aquaculture and capture fisheries in the Mekong River Basin will protect the viability and biodiversity of the small indigenous species fishery on which the rural poor depend for food (UC Project). In Mexico, carrying capacity studies have led to establishment of sustainable management practices that regulate oyster farm size and new farm entries in the Boca de Camichin estuary (UH Project). An evaluation of the effects of stocked fish in reservoirs located in China and Vietnam (UM Project) will help assess the impact of alien introductions on indigenous species and define an appropriate role for future stocking. Similarly, knowledge of the expansion of red swamp crayfish provides a better model of the threats invasive species pose to native fauna in Asia and elsewhere (UM Project).

CRSP work to preserve biodiversity of native species was focused both on bringing important native species into aquaculture and reducing the pressure on wild fish stocks. Stakeholders benefited in food security and market opportunities. In Nepal, raising the highly-prized native sahar in a tilapia-carp polyculture system has resulted in improved production management, new fish crops, and reduced

pressure on wild sahar populations. In addition, a proportion of the sahar produced were restocked into natural waters to re-establish wild populations. Similar research focused on farming native African fish species in Ghana, sustainably managing native oyster and black cockle fisheries in Mexico and Nicaragua, and bringing chame, snook, and native cichlids into aquaculture. This work reduces pressure on threatened wild fish stocks while opening new aquaculture opportunities.

DTAP D: Enhanced Trade Opportunities for Global Fishery Markets
Robert Pomeroy (University of Connecticut-Avery Point), Lead Coordinator

AquaFish CRSP was successful in promoting development of domestic and international markets for new aquatic products produced in aquaculture and sustainable fisheries. Marketability of products and the ability of stakeholders along the value chain to benefit from new income opportunities are important components of the framework for ensuring the food security of poor farmers, fishers, and their families. In the CRSP work to improve livelihoods, gender equity was at the forefront with an emphasis on including women in the value chain while improving their opportunities in producing marketable, value-added products.

CRSP advances in development of products for human consumption covered a range of accomplishments. Experimental work by UH researchers showed promise for culturing chame in Latin American. Not only can this indigenous fish provide a relatively low-cost food for the poor but the farmed product will reduce pressures on overfished wild populations. In Nepal, farmed sahar, a highly prized native fish, is now in production in a CRSP-designed tilapia-carp polyculture system (UM Project). Two other products of polyculture were in testing stages. UM researchers fine-tuned the polyculture of high-value prawns with carps and mola. The mola provide a nutritious food for the farm family's home consumption with no adverse effect on the marketability of the prawns and carps. Similarly, addition of seaweed to coastal tilapia-shrimp polyculture in Indonesia and the Philippines provided farmers a new income source (NC Project).

CRSP has also opened avenues for improving or making new processed products that promise more lucrative market opportunities for cottage industries largely populated by women processors. Women who participated in NC Project trainings can now process marine seaweed from coastal polyculture systems into seaweed pickles, agar-based candies, and other products for sale in local markets. Other NC Project trainings taught Philippine women how to produce value-added milkfish products. In Cambodia, UC Project researchers worked with women on improved health and safety standards for making fermented fish paste (prahoc). Adoption of these standards will improve food quality and also lead to new export market opportunities for prahoc meeting international food safety standards.

The integrated approaches that are fundamental to the CRSP model helped to establish a framework for new markets. Sustainable snakehead aquaculture systems using CRSP-developed low fishmeal feed have been adopted in Vietnam. As snakehead aquaculture expands in the region, the CRSP value-chain analyses will aid in market development both domestically and internationally. In the Philippines, an analysis of tilapia supply chain efficiency in domestic and international markets identified new market opportunities along with recommendations for best management practices that will favourably impact the supply chain. Management guidelines for (1) supply chain and (2) group marketing in Kenya and Ghana help famers more successfully enter urban markets (PU Project). In Uganda, a market assessment by the AU Project established a baseline for addressing obstacles faced by smallholder farmers to successfully enter domestic markets.

REGIONAL CENTERS OF EXCELLENCE SYNTHESIS

The ME established the Regional Centers of Excellence (RCEs) to synthesize findings across regions and from leveraged activities such as Associate Awards. Through annual reports and other communications with the Management Team, RCEs provided technical advice on emerging issues and gaps in the portfolio from a regional perspective. Centers were charged to develop useful materials for Missions, other regional stakeholders and end-users, and gauge opportunities for collaboration based on regional or national needs. Five centers were formed: Asia (two centers), East and Southern Africa, West Africa, and Latin America and the Caribbean (LAC).

Coordinators for the three original RCEs were selected at the May 2007 *Orientation Meeting & Pre-Synthesis Workshop* held in Washington, DC. In FY2011, two new RCEs were created: (1) the original RCE-Africa was reassigned to East and Southern Africa and a new RCE-West Africa was formed; and (2) an additional RCE-Asia was formed. The AOTR concurred with the Lead Coordinator selections:

- **RCE-East & Southern Africa** (formerly RCE-Africa)**:** Charles Ngugi (Kenya, PU Project)
- **RCE-West Africa** (as of FY2011)**:** Héry Coulibaly (Mali, Permanent Assembly of the Chambers of Agriculture)
- **RCE-Asia:** Remedios Bolivar (Philippines, NC Project)
- **RCE-Asia** (as of FY2011): Yuan Derun (Thailand, UM Project)
- **RCE-LAC:** Wilfrido Contreras-Sanchez (Mexico, UA Project)

RCE–East & Southern Africa

Charles N. Ngugi (Ministry of Fisheries Development, Kenya), Lead Coordinator

The East Africa Regional Center of Excellence (RCE) was successful in building community among all CRSP participants; identifying potential additional partnerships with the public and private sectors, NGOs, USAID, and others; and bridging the knowledge gap from local/regional perspectives to global development outcomes. The RCE facilitated networking with African scientists through SARNISSA, NEPAD, ANAF, and World Aquaculture Society meetings, conferences, and exchange forums by (1) fostering personal contacts/relationships; (2) networking with AquaFish CRSP HC PIs in Kenya, Uganda, and Tanzania; (3) promoting farmer-to-farmer exchange programs; (4) reviewing regional proposals; and establishing collaborative research and institutional linkages.

The RCE's approach to promoting aquaculture in Africa has been to assist member countries in investigating aspects of aquaculture development and to test and demonstrate methods and approaches that are socially and economically viable as well as technically feasible. The program's results have been prominent, especially with the outputs in extension methodology development and application in Nigeria, Ghana, Kenya, Mali, Malawi, Uganda, Tanzania, and Zambia, among a host of other countries in Africa.

Major problem areas observed in the region include the following:

- Ineffective or non-existent policies
- Inadequate infrastructure
- Poor extension support
- Unavailability of inputs (including seed, feed, and credit)

The RCE established links and contacts with senior officers in government and in international organizations in these countries:

- Ghana: FAO Africa Representative John Moehl on information exchange.
- Kenya: The Ministry of Fisheries Development. The RCE Coordinator was invited to several meetings to discuss the Aquaculture Stimulus Program and the Aquaculture Development Plan.
- Kenya: Meetings were held with the USAID Mission in 2009 and 2010 to discuss AquaFish CRSP involvement in Africa (Kwamena Quagrainie and Charles Ngugi) and to establish collaboration mechanisms with USAID to expedite aquaculture development in Africa (Nancy Gitonga of the African Union and Charles Ngugi).
- Malawi: The RCE attended the 2009 SARNISSA Stakeholders Workshop on building research coalitions among public research and private sector producers to develop fundable programs of action research around key technological problems facing the aquaculture sector in sub-Saharan Africa.
- Tanzania: The Assistant Director of Fisheries, a member of ANAF, attended the 2010 ANAF meeting in Jinja (Uganda) and the RCE linked him to FAO and SARNISSA.
- Uganda: The RCE established a linkage with the Kajanssi Research Centre and the Uganda Commissioner for Fisheries, who attended the ANAF meeting in Jinja.
- Regionally: The RCE plays a key role in SARNISSA and provides a vital link to AquaFish CRSP. Through SARNISSA, the RCE has established contacts with over 1,800 stakeholders who are enrolled members of SARNISSA.
- Regionally: The RCE facilitated regional networking by developing posters, aquaculture fact sheets, and teaching modules in collaboration with University of Stirling under the UK DFID-funded "Research into Use" program through Farm Africa's AquaShops pilot projects in Western Kenya.

Women generally play a major role in the production, processing and marketing of fish and fish products in Africa. The RCE endeavored to implement intervention strategies that assist and improve the lives of women relating to equality and empowerment. The RCE has established excellent working relationships in Kenya and Tanzania with private operations and NGOs such as Women in the Fishing Industry Programme (WIFIP) working in the areas of fisheries, aquaculture and the environment. WIFIP is based in Western Kenya and has been working on education and training of women and other vulnerable groups in the fishing industry for the last eight years.

The RCE also organized an e-workshop in Kisumu and Kirinyaga in March 2011 to introduce Kenyan farmers to the use of the internet as a source of aquaculture literature and information. The objective of this annual SARNISSA Stakeholders Workshop was to build research coalitions among fish farmers who plan on using the internet to source aquaculture information on production and marketing.

The RCE has made every effort to source leverage funds from USAID missions, EU, CIDA, DFID, and government ministries, among others, in support of aquaculture development for the region. Currently there are ongoing FAO/ TCP aquaculture projects in Uganda, Kenya, and Ghana. Recent undertakings include FAO support for aquaculture development in Ghana, USAID funding in Uganda, World Fish Center funding in Malawi, the NEPAD/Comesa project at Bunda College in Malawi, EU-SARNISSA funding for Cameroon, Malawi, and Kenya, and the UK DFID/Farm Africa Aqua Shops project in Western Kenya.

To assist fish farmers in sourcing quality feeds, the RCE made efforts to encourage commercial fish feed production in the region. Ugachick feed is now available to Kenya farmers and is being distributed by the Ministry of Fisheries Development under the Economic Stimulus Program.

RCE–West Africa
Héry Coulibaly, Lead Coordinator
(Technical Advisor, Permanent Assembly of the Chambers of Agriculture, Mali)

In 2010. Dr. Héry Coulibaly was selected to serve as the Lead Coordinator of the newly formed West Africa RCE.

From 12 - 14 October 2010, the West Africa Lead Coordinator participated in a regional workshop entitled *Securing Sustainable Small-Scale Fisheries: Bringing together responsible fisheries and social development- Regional Workshops (AFRICA)*, held in Maputo, Mozambique. The workshop was organized by the FAO Committee on Fisheries (COFI) and included representatives from Burkina Faso, Cameroun, Congo, Ivory Coast, Gambia, Chad, Guinea, Morocco, Mali, Mozambique, Mauritania, Mauritius, Nigeria, Sierra Leone, Tanzania, Togo, and COREP—the Regional Fisheries Committee for the Gulf of Guinea. During the workshop, contacts were made with representatives from Burkina Faso, Congo, Mauritania, Togo, and COREP. Detailed reviews of the aquaculture situations in Mauritania, Burkina Faso, Congo, and Togo were presented and a COREP representative gave a regional overview.

Some constraints to aquaculture development mentioned in the presentations included:

- Lack of water, especially in the Sahelian parts of the region
- Lack of integration of aquaculture development with agricultural development
- Failure to take public perceptions of aquaculture into account in planning
- Lack of national strategies for aquaculture development
- Lack of technological knowledge/insufficient training
- Inadequate staffing, especially senior officers
- Lack of aquacultural research experience among responsible institutions, especially with regard to rice-fish culture
- Insufficient supplies of tilapia fingerlings
- Poorly developed post-harvest handling systems
- Competition between aquaculture and animal husbandry for the use of available local feed ingredients
- Lack of locally produced fish feeds
- Unavailability of financing (loans) to begin fish farming operations

Women's roles in much of the region are on the post-harvest side, i.e., trading, processing, and marketing. However, in some areas they also participate in pond harvesting. In Mali, the construction of a central fish market (with financing from Japan) will make it possible for 60 women wholesalers to market fish with better equipment and under improved hygienic conditions. Japanese financing also provided for the construction of fish markets for fish saleswomen in Koulikoro, Kangaba, and Kati. Three other fish markets that have been built in Kayes, Bafoulabé, and Mahina will benefit commercial fish women. These were built within the framework of the *Senegal River Basin Multi-Purpose Water Resources Development Project*, with financing from the *International Development Association* (IDA). Three market-gardening perimeters are already arranged within the framework of the same project for the women of fishermen to enable them to produce vegetables during closed fishing periods. Two additional fish markets will be built (in Tombouctou and in Gao) for the fish saleswomen within the framework of the *Development Project of the Water Resources and of Durable Management of the Ecosystems of the Basin of the River Niger* (PDREGDE) of the ABN, also with financing from the IDA, and another project to develop marketing space for women is being planned.

In Mali, the aquaculture industry continued to expand with several large farms coming online, including Segou where rice-fish culture in being tested in up to 60 plots in the administrative area of the *Office du Niger*. Fish Farmer Seydou Toé, considered to be one of the success stories of the AquaFish CRSP Mali

Project, continues to produce *Clarias* fingerlings for sale and is looking into new ways of producing tilapia fingerlings. He continues to use the team he formed to build ponds for private individuals. The Koulikoro and Bamako Regional Offices of the DNP continue to support private individuals in the realization of their ponds.

RCE–Asia

Remedios B. Bolivar (Central Luzon State University, Philippines), Co-Lead Coordinator

While aquaculture offers an array of opportunities for income generation and job creation in the region, there are gaps that need to be resolved to sustain the continuous growth of aquaculture:

- Markets: marketing of some aquaculture products should be looked into to encourage stakeholders to invest in aquaculture. A new market niche must be established in aquaculture production.
- Technologies: technologies appropriate for each region must be identified. No technology is universally applicable, just as there is no universal fish for culture.
- Technology transfer: a strategy for technology dissemination is an essential ingredient to increase production in aquaculture. Regional and inter-regional cooperation provides the basic mechanism for technology transfer.
- Training and extension: most countries in the region lack effective training and extension mechanisms, so the establishment of effective services is of special significance. Also, standardization of the fisheries curricula in academic institutions to conform to international standards.
- Applied research: research areas that will have direct effects on the needs of the fish farmers must be given priority. Examples include the following:
    (a) Development of aquaculture technologies that are appropriate for rural development
    (b) Entrepreneurship in aquaculture
    (c) Development of competitiveness of the aquaculture industry
    (d) Enhancement of capability building in emerging technologies
- Sustainable aquaculture: A regional network is needed to assess the sustainability of aquaculture practices and to deal with current issues affecting sustainability such as climate change, growing interest in organic aquaculture products, and introduction of genetically engineered into aquaculture.

Although aquaculture operations are dominated by men, there is now a growing trend in participation of women in aquaculture. Women have proved to be competent in adopting new aquaculture technologies, but their role is very much restricted and often ignored. In the Philippines, women are well represented in many fisheries organizations, even occupying key positions. A handful of women operate tilapia hatchery businesses as well as grow-out operations. In rural areas, women are engaged in fish processing such as fish smoking and drying, which become a part of their livelihood. In aquaculture and fisheries academic programs, women have established their niches as effective and competent professors/mentors and researchers/scientists. At CLSU, a Gender and Development (GAD) Coordinator has been actively conducting value-added processing trainings for women in the region to provide them with the skills to produce value-added products that will bring additional household income. Similarly, the Bureau of Fisheries and Aquatic Resources re-created a seven-member Gender and Development Focal System in 2010 to advise BFAR on gender issues and implement gender programs.

Gender equity issues in aquaculture and fisheries which need to be addressed include the following:

- Training of women in the various aspects of aquaculture operations
- Protection of women working in fisheries in far-flung areas

- Establishment of cooperatives involved in post-harvest related activities, which will encourage women to go into such endeavors
- Initiate programs to empower women in fisheries undertakings

RCE-Asia has also been active in networking with private farms, providing financial support for undergraduate and graduate student academic/research training and student participation in scientific conferences, and setting up linkages with other public institutions. A recent partnership was established between CLSU and Mindanao State University to study feeding strategies in cage culture of Nile tilapia. In October 2010, the RCE Lead Coordinator served as a bronze sponsor in the *Tilapia 2010 Third International Technical and Trade Conference and Exposition on Tilapia*, held in Kuala Lumpur, Malaysia.

RCE–Asia
Yuan Derun, (Network of Aquaculture Centres in Asian-Pacific (NACA), Thailand), Co-Lead Coordinator (since 2011)

Notable developments in Asian aquaculture. Asian aquaculture is facing some emerging challenges, including (1) voluntary or compulsory compliance with increasingly stringent aquatic food safety and quality requirements and environmental regulations, (2) increasing production costs due to price increases for raw materials, (3) imbalance of profit distribution along value chains and economic viability, (4) climate change impacts, and (5) erroneous public perceptions of the aquaculture production process, food safety and biodiversity.

In the immediate future, low-cost production of low-trophic fish such as carps and tilapia will still dominate the aquaculture sector. White shrimp culture will also continue to prevail with a high possibility of the return of *Penaeus monodon* culture and sustained growth of striped catfish (*Pangasianodon hypophthalmus*) culture. New aquaculture development may focus on (1) improvement of productivity, profitability, economic viability of small farming systems; (2) improvement of aquaculture certification schemes and product traceability; (3) enhancement of small-scale farmer education and development of farming clusters; and (4) institutional intervention to promote communication and dialog among stakeholders to sustain ethical aquaculture trade. Fast growth and expansion may be seen in culture-based fisheries, use of small static water bodies for cage culture, and marine culture.

AquaFish CRSP in Development Process. Observations during travels in the region in 2010–2011 strongly suggest that CRSP research has benefited the majority of small-scale farmers in Asia with its innovative and locally applicable research results that have played a significant role in accelerating growth of the region's aquaculture sector. CRSP is well recognized as one of most sustainable research projects with great positive impacts on aquaculture by researchers, university teachers and students, government officers and development agencies. Impacts of CRSP can be felt in almost all aspects of regional aquaculture development, including improvement of current aquaculture systems, new system development, food quality and safety, environment protection, and conservation of biodiversity. For example, decade-long research by Aquaculture CRSP led to the establishment of pond fertilization theories and practical procedures for aquaculture. The adoption of CRSP technologies and practices has resulted in improved productivity of traditional Asian integrated systems, polyculture, and semi-intensive monoculture. A series of CRSP aquaculture technologies developed for tilapia have also contributed remarkably to the increase of tilapia production over the last two decades.

CRSP communication nodes in Asia. One of the most important achievements of CRSP was its regional communication network established through various project activities including collaborative research, support for formal degree education, conferences, CRSP annual meetings, extension workshops, seminars and others. The network was the primary driving force by which to disseminate CRSP research results

and spread CRSP influence in the region. The communication nodes in Asia may be categorized into three groups, (1) CRSP researchers and associates who have been directly involved in CRSP projects, (2) teachers and alumni of higher education institutions and researchers from research institutes who have served as CRSP country hosts, (3) government officers, extension workers, NGO staff members, and individuals from private sectors who have been directly or indirectly involved in CRSP activities. These CRSP communication nodes will likely continue to play roles in maintaining the CRSP appearance and extending CRSP influence in the region.

RCE-LAC

Wilfrido Contreras-Sánchez (Universidad Juárez Autónoma de Tabasco, México), Lead Coordinator

Connecting with researchers and stakeholders on a regional basis both in Mexico and across the greater LAC region was the primary focus of RCE-LAC activities. Dr. Contreras-Sánchez partnered with Aquaculture CRSP colleague Dr. Maria Célia Portella at the Centro de Acüicultura, Universidade Estadual Paulista in Brazil to broaden the RCE's reach in South America. Their efforts were successful in building collaborations with public institutions and private enterprises and strengthening public-private bonds that support regional development. Drawing on their AquaFish CRSP affiliation and research, they were also able to leverage funding to expand their aquaculture research focus. Among their accomplishments were:

- Leveraging funds from INAPESCA-Mexico totaling $305,000 USD for three projects to build snook and gar hatcheries and snook live feed facilities and to support common snook juvenile grow-out experiments. The projects involve collaborations with private farms and a Mexican fishermen's cooperative.
- Partnering with the Mexican non-profit Fundación Vigas to support regional development through a sustainable aquaculture project involving native and introduced aquatic species such as snooks, amberjacks, and oysters.
- Establishing an international network promoting gar culture and conservation in the Americas. Colleagues at the National University of Costa Rica were invited UJAT to participate in a gar restoration project in Costa Rica's Caño Negro reserve which shares a border with Nicaragua.
- Establishing an international snook network for US and LAC researchers to promote collaborative research projects among members.
- Leveraging over $270,000 USD from Brazilian public sources — National Council for Scientific and Technological Development, Sao Paulo Research Foundation, and the Brazilian Innovation Agency (Research and Project Financing) — to support graduate fellowships and research activities (including sustainable fish culture in Africa).
- In 2011, Dr. Maria Célia Portella was elected President of the Latin American & Caribbean Chapter of the World Aquaculture Society. In her role, she has a direct connection with the larger LAC aquaculture research community.
- US institutions have invited UJAT to collaborate on research projects in the Gulf of Mexico: Nicholls State University (gar research), Texas A&M University (red snapper population and fishery status) and University of Texas at Brownsville (Atlantic sharpnose shark population studies)

RCE-LAC has had a strong commitment to increasing the involvement of women in aquaculture. Its strategies include: (1) hiring women undergraduate and graduate students in research projects, (2) submitting projects where women's groups are responsible for maintaining small aquaculture facilities, and (3) promoting meetings to encourage women in aquaculture at the national and the international level. UJAT has also begun a "Women in Science" program to promote the involvement of women in research projects. At UNESP, Dr. Portella advises six women graduate students in aquaculture. During the WAS 2011 Conference in Natal, Brazil, she also chaired the "Women in Aquaculture" session featuring talks by

women scientists from Brazil, Chile, India, Portugal, Australia, and Norway about their personal experiences and thoughts on the role of women in aquaculture.

Dr. Contreras-Sánchez submitted an information document to the USAID Missions in Mexico and Central America to detail AquaFish CRSP involvement and commitments in the region and the role of the RCE. Short staffing at the Mexico Mission has hindered regular communication with CRSP. A 2011 visit by US Embassy personnel to UJAT as well as an invitation to Dr. Contreras-Sánchez to give a talk to American investors working in Mexico suggests a more promising future relationship. Dr. Portella is expanding the information document for submission to South American Missions.

Constraints to Development in the Region

Constraints to aquaculture development in the region include the following:

- Lack of mid- to long-term planning
- Lack of government investment
- Poor communications between researchers and producers
- Lack of good quality extension agents
- Resistance to change in production methods
- Cost of fish production is high (driven mainly by feed prices)
- Lack of sanitation and certification processes for shellfish products
- Fingerling production is concentrated in a few hands
- MT use is limited because it is either banned or unavailable
- Aquaculture pollution is becoming a growing issue, generating restrictions

Research Priorities

The LAC has identified the following as priorities for research in the near future:

- Low-cost production systems/species
- Evaluation of sustainability in aquacultural processes
- Environmental studies in two directions:
    - Impacts of aquacultural practices
    - Vulnerability and risk assessment
- Marketing
- Evaluations of the status of key fishery populations and the impacts of fishing pressure
- Effects of environmental and climate changes on fish populations
- Research on sustainable fisheries
- Basic biology and ecology of fish species used
- Impacts of species introductions on native species

SYNTHESIS PROJECT SUMMARY

The ME also engaged in synthesizing achievements during this reporting period. ME activities included: compiling, verifying, and summarizing indicator reports submitted by DTAP Lead Coordinators; compiling, verifying, and summarizing USAID indicator metrics submitted by US Lead Project PI; reporting against AquaFish's own Key Development Indicator and Benchmarks (see Section 12). ME synthesis activities included producing Success Stories, Activity Briefs, Diving Deep Briefs, Brochures, and Fact Sheets.

In addition the work mentioned above conducted by Management Office personnel, the ME also initiated the Synthesis Project (SP) in late FY2008 to provide a quantitative assessment of the research and training activities associated with the 38 investigations in the *Implementation Plan 2007–2009*, characterizing and statistically assessing the factors affecting the knowledge generated in AquaFish CRSP investigations from a systems viewpoint. This work was intended to provide the ME with statistically sound guidelines by which to evaluate CRSP accomplishments and provide a baseline by which to determine best approaches for establishing minimum dataset sizes to reduce duplication and streamline data collection.

As viewed at the outset, the wide variety of and complex systems relationships among CRSP investigations as well as the consequent problems in characterizing and assessing 38 investigations as a whole presented challenging structural problems for the Synthesis Project. The investigation spread encompassed 12 countries with differences in research activities and geographic complexity, as well as a variety of investigation goals (human capital formation, research, outreach), a variety of outcome-types (aquaculture profitability, human health, ecosystem quality), and a variety of technological and cultural settings.

During FY2009–FY2010, work largely focused on developing a combined data gathering and analytical framework that accommodated the heterogeneity of the CRSP investigations. This first-stage work included: (1) developing the groundwork by which to enumerate expected benefits; (2) developing a procedure to examine average relationships between expected investigation benefits and inputs and the likely reasons why those relationships vary across investigations; and (3) develop a set of data-gathering questionnaires that apply to controlled experiments and surveys. With the preliminary characterization framework in place, the SP held a project meeting at the 2010 AquaFish CRSP Annual Meeting in San Diego, California for a trial-run use of the questionnaires and individual sessions with each of the seven project teams. Based on these preliminary discussions as well as the US Project Lead PI's (Dr. Steve Buccola) direct view of ongoing investigations during his September 2010 trip to CRSP sites in China, Vietnam, and the Philippines, the SP was able to further refine the data gathering and analytical methodology. The October 2010 meeting with HC collaborators in Seattle, Washington consolidated these refinements and dealt with specific data gathering issues unique to each project, particularly with respect to the two output questionnaires.

Following the Seattle meeting, the SP improved the quantitative model and analyzed the data sets submitted by HC collaborators. The AquaFish CRSP Annual Meeting in Shanghai, China in April 2011 provided a final opportunity to review the data sets with HC collaborators. For analyzing the training component of investigations, the SP obtained data from the ME's databases and project reports. To address data poverty issues in the training data, the SP used non-parametric methods for the training input/output analysis. Findings for training under both Implementation Plans are reported in the final investigation report for 09BMA07OR.

For the data collected with the research output questionnaires, the SP statistically assessed the factors affecting the knowledge generated in AquaFish CRSP investigations. A mean-absolute-deviation utility functional form allowed decomposing knowledge into two independent effects: (1) the difference (mean surprise) between the prior expectation of the research outcome and its posterior or statistical mean, and (2) the outcome's statistical variance (accuracy). The former spoke to the research's ability to shift the *location* of the probability distribution of possible study outcomes, and the latter to its ability to improve the *tightness* of that distribution. The decomposition permitted separate examination of research inputs' effects on these two distinct knowledge dimensions as well their effects on net or total knowledge. In both the SP and 09BMA07OR, the Bayesian value of sample information was used as the knowledge measure for the statistical assessment of factors affecting the knowledge generated in CRSP

investigations. The final investigation report for 09BMA07OR contains a detailed review of the models and procedures used in the SP's quantitative assessment.

The SP was envisioned as a preliminary undertaking to measure AquaFish CRSP accomplishments with robust statistical methods. A major challenge faced by the project was building an analytical framework to accommodate the wide variety of investigations with broad research diversity and variable geographic profiles. Within this perspective, the Synthesis Project has built a preliminary analytical framework on which to design future assessment projects for evaluating AquaFish CRSP research and training successes.

CRSP KNOWLEDGE AND DATA MANAGEMENT (KDM) PROJECT

Cultural Practice, LLC was awarded a subcontract through Oregon State University in July 2011, to fund the initial work on the "CRSP Council Knowledge and Data Management Project," a CRSP-wide effort to combine the wealth of information accumulated by all CRSPs into a single information clearinghouse/ database. The report below is printed as submitted (with some copy edits) from the final report submitted by Cultural Practice, LLC, August 2011.

Final Report for Oregon State University
April 2011 – June 2012
Submitted by Cultural Practice, LLC
Submitted by Deborah Rubin and Susan Johnson

This report summarizes the accomplishments and activities carried out under contract no. RD011G-I between Oregon State University and Cultural Practice LLC. Some of the activities related to the larger CRSP Digest project which is funded by other US universities are also mentioned here with an indication of this leveraged funding.

Background

The Collaborative Research Support Program (CRSP) model has been a highly successful mechanism for international development, research, and capacity building. Created in response to Title XII of the US Foreign Assistance Act, CRSPs utilize the strengths of universities to meet the goals of its core donor, the United States Agency for International Development (USAID). The wealth of information and knowledge generated by the CRSPs has made it challenging to synthesize and disseminate information in a cohesive, unified manner.

The CRSP Council Knowledge and Data Management Project (aka the CRSP Digest Project) was established to inventory the materials the CRSPs have produced, consolidate information about the results generated, analyze available information across several different themes, and produce a series of products for outreach and dissemination to a wide audience of stakeholders in the development community, including but not limited to USAID.

AquaFish CRSP took the lead in establishing a joint CRSP effort to coordinate CRSP information. The Knowledge Data Management Project featured three activities: 1) Knowledge Management and Database Development; 2) Synthesis and Analysis; and 3) Outreach and Dissemination.

Activity 1: Knowledge management database development. Development of a web-based platform for CRSP information was the primary activity for this project. The objective was to develop the first ever all-CRSP website supported by a comprehensive all-CRSP database. The website was conceived as a portal for CRSP informational materials, research reports, and synthetic pan-CRSP analyses for a range of targeted audiences, including staff members at USAID, other development practitioners, and the general public. The CRSP Digest website and database enables CRSP participants to find key documents and access relevant data needed to respond to requests by USAID on a timely basis. Cultural Practice serves as a repository for the information and is available to anticipate, respond to, and manage USAID requests for information.

Activity 2. Synthesis and analysis. This activity is focused on producing reports that provide analysis of research across CRSPs and produce new perspectives on the impact of CRSP research. As information is gathered, catalogued, and summarized, specialists at Cultural Practice and their consultants are preparing analytical papers on CRSP research that showcase CRSP achievements. Specific themes that were initially proposed included but are not limited to: Food Security and Nutrition, Natural Resources and Conservation of Biodiversity, Gender, and Capacity Building.

Activity 3: Outreach and dissemination. In the third activity, the aim is to raise awareness and knowledge of the CRSP programs, individually and collectively, within the development community. In concert with the documentary and web-based activities presented above, the interactive aspects of outreach and dissemination are critical. Outreach products were specifically targeted for the intended audience and mechanisms for dissemination were varied. In this activity, knowledge generated by CRSP research is being effectively used by and communicated to stakeholders throughout the wider development world.

Description of Activities

Activity 1: ***Knowledge management website/database.*** The project subcontracted with a private company, OpenBox9, to design and create a website that provides a one-stop shop for information about current and historical CRSPs, their training and research accomplishments, updates on activities and events, success stories, and resources about the CRSPs. The Cultural Practice (CP) team worked closely with the OpenBox9 consultants to develop the website structure and look.

Development of the website began with a survey of CRSP Directors and other CRSP staff to gather input on the website function and design. A preliminary design of the website was presented to the CRSP Directors in October 2011 at the CRSP Council meeting in Iowa.

The website features sections on “About the CRSPs” with links to current and past CRSP pages, “Key Topics” with ten cross-CRSP subjects (capacity building, climate change, gender, food security, health and nutrition, innovation, markets, natural resource management, policy, and productivity). The “Resources” section offers comprehensive searchable databases on CRSP graduates, projects, and publications. The “Events & Announcements” section provides an interactive calendar and frequently updated information about current events, jobs, new publications, and funding opportunities. “News” provides information on the latest CRSP developments. The home page features different research activities and other stories about CRSP accomplishments.

The website was conceived to be database driven. The search function on the website interlinks the databases for more robust results. Three databases have been developed: Training, Publication, and Projects. Each database provides a comprehensive record of all CRSPs in a standardized format. Selected information in each database is searchable through the website. However, more detailed data is being

collected and stored in the database at Cultural Practice which can be used to respond to information requests and to be used in various analytical reports.

Other data bases will be completed under other CRSP funding, including one on CRSP partners, CRSP participants, and an historical look at funding levels, including leveraged funding.

As of 30 June 2012, 6,350 CRSP publications; 3,791 long-term degree trainees; and nearly 400 projects have been catalogued in the databases for a total of nearly 10,550 entries. The databases include information on all of the projects under AquaFish (including the investigations), BASIS/AMA, and SANREM, as well as projects from all of the remaining CRSPs' most recent phases. Degree training data has been entered for all current and historical CRSPs. Data entry will continue with leveraged funding support.

The website is linked to both a CRSP Vimeo web channel and a YouTube channel. The Vimeo channel showcases videos produced by the CRSPs and has links to individual CRSP channels. The Vimeo channel allows for full-length videos to be uploaded and available to the public. The popular site "YouTube" restricts uploaded videos to a maximum playtime of 15 minutes. A CRSP YouTube home page was also developed and is used to post clips of videos and direct viewers to the full-length videos at the Vimeo CRSP Channel.

Prior to launching the public site, CRSP Directors and staff were again invited to review and provide comments on a "beta" site. Eighteen staff from eight CRSPs participated in three website tours led by the Cultural Practice team. The tours provided an overview of the different pages of the website and the status of the information in the database. Feedback on the site's content and functionality was incorporated into the final revisions of the site and contributed to enhancing the content of the site. Openbox9 provided training to the Cultural Practice team on maintenance of the site and developed a website maintenance manual.

It was anticipated that the website would be launched within the initial six months of the project, however, due to the complexity of the project, the formation of the site took longer, and the website (crsps.net) was launched on 28 June 2012. An email announcement was sent to over 550 development professionals both in the US and abroad. The email was sent to all CRSP Directors and USAID AORs as well as Congressional staff, USAID and USDA staff, and development professionals at other organizations both in the US and overseas.

A Google analytics account was established to track the visits and use of the website. Immediately following the launch, between 28-30 June, there were a total of 150 visitors from ten countries.

Lessons Learned and Challenges.

- Database development: One of the most difficult aspects of the project has been designing the training, project, and publications databases using a common reporting framework to accurately reflect the accomplishments of the different CRSPs. There was no uniform structure to or definition of the categories of data and, in addition, the level of detail of the data varied across the different CRSPs. For example, the shifts in USAID reporting requirements means that not all CRSPs had correct data on the sex of degree participants or kept records of advisors, country of students' origin, and other information. Definitions of what constituted a "project" or a "partner" were also quite diverse.

- Synthesis/Analytical reports: The vast amount of information produced by CRSP research provides a challenge for the consultants hired to work on the synthesis or analytical reports. They were not able to start as early as initially envisioned because the documents were not yet compiled in manner that

was easily accessible. This is becoming less of a problem as more information is available through the website.

• Budgeting: Initial estimates of the balance among different types of direct costs proved to be somewhat off the mark. The use of electronic transmission for much of the project's communication meant that the proposed budget for postage was too high, and the costs for website development were also lower than expected. The balance was put into costs for consultants, which turned out to be higher than the initial estimates.

ACTIVITY 2: Synthesis and analysis. The project proposed conducting a careful study of CRSP research papers and reports including, but not limited to, CRSP-produced papers, policy briefs, or other materials; relevant peer-reviewed publications and scholarly reports prepared by CRSP researchers; relevant related materials; and other media (e.g., newspapers, websites, and films); as well as possible discussions or meetings with other key informants. Based on these reviews, analytical papers that showcase CRSP achievements would be prepared for a range of diverse audiences. The reports would be at a high level of quality, appropriate for scholarly and public audiences. It was anticipated that these reports would vary in length, depending on the subject, from about 25 to 50 pages. In addition, shorter pieces would also be prepared (e.g., a two-sided single sheet summary). The priorities for the themes under which different analytical reports would be developed by or in consultation with CRSP Directors as appropriate. Initially, it was anticipated that the following four themes would be considered during the first year under funding provided by the larger groups of CRSPs:

- Food Security and Nutrition,
- Natural Resources and Conservation of Biodiversity,
- Gender, and
- Capacity Building.

These topics were illustrative only and in the end, the report prepared under the OSU contract addressed the intersection of collective action and natural resource management. Technical consultants were hired to provide insight for specific analytical report themes.

During this first year of activity, Dr. Scott Bode, Natural Resource Management Consultant and Dr. Kimberly Swallow completed the analytical report entitled "Strengthening Collective Action in Communities to Build Sustainable and Profitable Agricultural Systems: Examples from the CRSPs." Dr. Bode was a Natural Resources Advisor at USAID from 2001-2008. From 2008-2011, he managed the natural resources and governance component of a US$13.2 million USAID-funded program in Sierra Leone. More recently he has consulted on a variety of projects for ICRAF, World Cocoa Foundation, and Chemonics International. Dr. Kimberly Swallow is a research consultant specializing in African economic development. She has a Ph.D. in Development Studies from the University of Wisconsin-Madison. She has conducted mixed methods research on institutional arrangements governing households' access to natural resources for feeding cattle in the coconut-cassava agro-ecological zone of coastal Kenya and on land administration regimes in different countries.

The report takes a look at one of the less prominent aspects of CRSP research the intersection of collective action and natural resource management. The report looks at case studies from the IPM, AquaFish, SANREM, and Global Livestock CRSPs as well as project examples from other CRSPs. All the examples included significant impacts on food security and livelihoods, increasing resilience of vulnerable populations, and maintaining or improving environmental conditions. The report concludes that collective action has been a central factor in achieving results.

ACTIVITY 3: Outreach and dissemination. Dissemination and outreach is a core component of the project and the project has utilized varied mechanisms and products to reach a broad set of audiences. The initial focus was on collecting information and developing interesting stories that highlight successes within the CRSPs. A range of products was proposed and outreach materials were developed for specific audiences.

The project worked in concert with CRSP Directors and staff to improve dissemination of CRSP information to targeted audiences. Informational products were developed and designed for popular press, government leaders and development professionals. The proposed products were: Short, two-pagers that provide concise information on topics of interest; Multiple targets ranging from USAID to local University press; A CRSP-wide electronic quarterly newsletter; Organizing seminars, poster sessions, etc. at large events (i.e., World Food Prize or "Day on the Hill").

• ***Newsletter.*** For this contract, the deliverable was to provide a mock-up of an all-CRSP newsletter. During the time period of the contract, with funding from other CRSPs, two newsletters were prepared and distributed. The first inaugural issue of the all-CRSP newsletter was completed and disseminated both electronically and in print. The newsletter, "CRSP Digest," provides readers with highlights and information about the Collaborative Research Support Programs. It is anticipated that the newsletter will reach a wide audience including development practitioners, government officials, students, and scholars as well as USAID staff. The inaugural issue included articles on a new sorghum variety released by INTSORMIL in El Salvador, the external evaluation report results for the Peanut CRSP, the new deputy director of the Dry Grain Pulse CRSP, USAID's Africa RISING inception workshops, and tributes to the former Soil Management CRSP Director and CTO who recently died. Additionally, the newsletter included reports on meetings and conferences held by BASIS/AMA CRSP and the Horticulture CRSP and recent book and video releases by SANREM, Livestock Climate Change, and AquaFish CRSPs. The newsletter was distributed at the BIFAD meetings in April 2012 to a wide range of development practitioners. The second edition of the CRSP Digest newsletter featured articles on AquaFish work with value chains, the Peanut CRSP research on mycotoxin, and gender intergration across CRSPs as well as reports on CRSP meetings and conferences. The newsletter was electronically distributed to 543 development practitioners, government officials, students, and scholars as well as USAID staff.

• ***Fact Sheets.*** Six new overall CRSP flyers were prepared and distributed. Outreach materials were written and developed for distribution at both the World Food Prize event and BIFAD meeting (see below). Deliverables include brochures and flyers on the following topics: the CRSP Approach, Title XII and the CRSPs, the CRSP Digest Project, Feed the Future and the CRSPs, CRSPs Partners, and Human/Institutional Capacity Building. See Publication section below for a complete list of publications produced during the project timeframe.

• ***Events.*** The CRSP KDM project organized, participated in or assisted with three events during the course of this project time period.

- *World Food Prize*. The first event, the World Food Prize (WFP), was held 12 – 14 October 2011 in Des Moines, Iowa. An exhibit booth was secured for displaying CRSP publications. Information on CRSP successes and achievements was available to over 1,000 participants at the WFP. The "Learning from Success" informational booth provided individual CRSP brochures as well as six new overall CRSP flyers prepared and distributed by the KDM project (see publication section for complete list). Deborah Rubin and Caitlin Nordehn staffed the booth and were available to answer questions and provide further information to WFP participants. Over 80 non-CRSP development professionals signed up to be on the CRSP mailing list. Success stories that were already written were reprinted for the event. A "Learning

from Success" banner was designed for the exhibit. Preparation was also made for presentations at the CRSP Directors meeting and the public BIFAD meeting to be held prior to the World Food Prize. The CRSP Digest project team prepared a powerpoint slide presentation for the CRSP Directors presentation at the BIFAD/CRSP private meeting.

- *CRSP Review and BIFAD meeting*. The CRSP Directors meetings with the BIFAD-commissioned review team were held 11-12 April 2012 in Washington D.C. The CRSP Directors and CRSP representatives presented on topics ranging from the comparative strengths of the CRSPs to capacity building by the CRSPs to impacts of the CRSPs. The CRSP Digest team assisted USAID, BIFAD, and APLU with information about the CRSPs, Title XII and other related topics. The team also assisted in writing, editing, and preparation of the presentation materials and handouts, designing templates for the electronic materials. The review meetings were followed by a public BIFAD meeting on April 13, 2012. Deborah Rubin and Caitlin Nordehn from Cultural Practice LLC attended the review and the BIFAD meetings. Materials from both meetings were posted to the CRSP Council BaseCamp account, which functions as an internal website for document storage, messaging, and planning space for the CRSP Management Entity Staff.
- *Information session on the Hill.* The CRSP Digest team organized an informational session with staff representing members participating in both House and Senate Agriculture Committees at the Rayburn House Office Building. The session was held 5 June 2012 and was attended by four of the ten CRSP Directors. The focus of the session was on the CRSP contributions to food security, including how they are engaging with the U.S. Government's Feed the Future initiative. The session was well attended by congressional staff and interns from both the House and Senate. USAID and USDA staff members and some representatives of US universities and the Association of Public Land-grant Universities were also in attendance. On behalf of the larger CRSP community, CRSP Directors Irv Widders (Pulse CRSP), Beth Mitcham (Horticulture CRSP), Shana Gilette (LCC CRSP), and Tim Williams (Peanut CRSP) described how the CRSP approach embodies many desirable traits of collaborative and multidisciplinary work. The presentations also noted how CRSP research benefits US agriculture. Time was allotted for discussion and Q&A. Hard copies of the CRSP Digest publications were distributed including a new all-CRSP brochure and the latest issue of the CRSP Digest newsletter.

Achievements

All project deliverables were completed for the CRSP Knowledge and Data Management (aka CRSP Digest) Project. In addition, with leveraged support, additional publications were produced and events were organized and facilitated. Achievements include:

- Developed and launched CRSP website, crsps.net. The public launch took place on June 28, 2012. The former CRSP Council website (crsps.org) domain name was also transferred to crsps.net so that entering either address will bring a user to the main crsps.net website.
- The website houses three comprehensive databases on Training, Projects, and Publications. As of 30 June 2012, 6,350 CRSP publications; 3,791 long-term degree trainees; and nearly 400 projects have been catalogued in the databases for a total of nearly 10,550 entries. Another data base containing information on CRSP partners has been drafted and is in the process of being finalized.
- Established Google analytics account for monitoring and evaluation of website use.
- Produced one 30-page thematic analytical report on natural resources and the conservation of biodiversity entitled "Strengthening Collective Action in Communities to build sustainable and profitable agricultural systems: Examples from the CRSPs."

- Completed one-page summary of analytical report.
- Developed database of over 550 development community stakeholders for distribution of outreach products.
- Prepared and published, in hard copy and uploaded to the website, fact sheets and additional flyers on topics including capacity building, the CRSP approach, Feed the Future, and Title XII. Three of these were AquaFish deliverables.
- Completed six "Learning from Success" publications on topics including value chains, gender gaps, agricultural productivity, and capacity building. All of these have been uploaded to the website.
- Produced two issues of the "CRSP Digest" Newsletter.
- Organized, facilitated, or assisted in three events: World Food Prize, BIFAD-commissioned CRSP review, and an informational session on the Hill.
- CRSP Digest staff also participated in meetings in Malta and Bangkok funded by other CRSPs and supported presentations by other CRSP representatives at USAID.
- Established social media and other media accounts/channels for dissemination of CRSP information including Twitter, Facebook, Feedburner, Linked In, Vimeo, and YouTube.

PUBLICATIONS:

Bodie, S. and K. Swallow. 2012. *Strengthening Collective Action in Communities to Build Sustainable and Profitable Agricultural Systems: Examples from the CRSPs.*

CRSP Digest Newsletter, Vol. 1, No. 1, Winter 2012. 8-page newsletter.

CRSP Digest Newsletter, Vol. 1, No. 2, Spring 2012. 8-page newsletter.

CRSP Brochure. 8-panel gate-fold general brochure.

The CRSP Digest Project: Learning from Success. Two-page flyer.

The Collaborative Research Support Program (CRSP) Approach. Two-page flyer.

Degrees of Progress: The shape and impact of CRSP training programs for higher education. Two-page flyer.

"Famine Prevention and Freedom from Hunger": A look at Title XII legislation and the Collaborative Research Support Programs. Two-page flyer.

Harnessing Science to "Feed the Future": The CRSP contribution to achieving food security and improving nutrition status. Four-page flyer.

Putting the "Collaborative" in CRSP: Cultivating diverse international partnerships to improve livelihoods. Four-page flyer.

Addressing Food Security through CRSP Commodity, Policy, and Market Research. Two-page "Learning from Success" publication.

AquaFish CRSP Strengthens Fish Value Chains for Men and Women Fish Farmers. Two-page "Learning from Success" publication.

Building the Technical and Institutional Capacity to Feed the World. One-page "Learning from Success" publication.

CRSP Research Increases Agricultural Productivity. One-page "Learning from Success" publication.

Reducing the Gender Gaps in Agriculture: The Experiences of IPM, Peanut and SANREM CRSPs. Two-page "Learning from Success" publication.

Strengthening Value Chains to Benefit Small Producers. One-page "Learning from Success" publication.

In addition, the CRSP Digest team prepares the website text for crsps.net.

11. ASSOCIATE AWARDS

USAID Leader-with-Associate (LWA) awards allow for the provision of additional, non-core funding to carry out activities that fit within the broader program description of the Leader Agreement. Such additional funding comes in the form of an "Associate Award," which might be provided by a USAID Mission or by USAID/Washington. In the case of AquaFish CRSP, two such awards have been received since program inception. The first of these was an award given by the USAID/Mali Mission for aquaculture and fisheries work in Mali, and the second was an award given by USAID/Washington for work being conducted under the Strategic Investment in Rapid Technology Dissemination (SIRTD) program for work in Ghana, Kenya, and Tanzania, all of which are named as focus countries under the Feed the Future (FtF) initiative.

LEAD US UNIVERSITY: OREGON STATE UNIVERSITY

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

Associate Award Number AID-OAA-LA-10-00006

Full reports for this Associate Award can be found online at the CRSP website (http://aquafishcrsp.oregonstate.edu/publications.php)

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 CRSP 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 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.

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.

Collaborating Institutions

The primary institutions involved in this project have included the following:

- AquaFish CRSP, Oregon State University, USA
- Purdue University, USA
- Virginia Polytechnic Institute and State University, USA
- Ministry of Fisheries Development, Kenya
- Kenyatta University, Kenya
- Moi University, Kenya
- Kwame Nkrumah University of Science and Technology, Ghana
- Sokoine University of Agriculture, Tanzania
- Ministry of Natural Resources and Tourism, Tanzania

Results Achieved

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.

LEAD US UNIVERSITY: OREGON STATE UNIVERSITY

AQUATIC RESOURCE USE AND CONSERVATION FOR SUSTAINABLE FRESHWATER AQUACULTURE AND FISHERIES IN MALI

Cooperative Agreement # 688-A-00-07-00044-00
Leader with Associates Award EPP-A-00-06-00012-00

Full reports for this Associate Award can be found online at the CRSP website
(http://aquafishcrsp.oregonstate.edu/publications.php)

Introduction

The AquaFish CRSP *Mali Project*, "Aquatic Resource Use and Conservation for Sustainable Freshwater Aquaculture and Fisheries in Mali," was funded through an award received from USAID/Mali under the "Leader with Associates" (LWA) award that established AquaFish CRSP in 2006. The project spanned a period of 39 months (1 October 2007 through 31 December 2010), including a 3-month no-cost extension approved on 15 September, 2010. The no-cost extension allowed the project to complete a final fisheries planning training activity and prepare this final report.

The overall goal of the Mali Project has been to increase the productivity and income of fish producers (farmers and fishers) in targeted areas of Mali. To achieve this, the project has focused its efforts on these three thematic areas:

- Pond Culture—Advancing Sustainable Freshwater Aquaculture Practices and Technologies (Theme Leaders Charles Ngugi, Héry Coulibaly, and Boureima Traoré)
- Rice-Fish—Promoting Sustainable Rice-Fish Aquaculture in Irrigated Systems (Theme Leaders Liu Liping, Héry Coulibaly, and Alhassane dit Sandy Touré)
- Fisheries Planning—Building Community and Consensus towards a Fisheries Management Plan (Theme Leaders Nancy Gitonga, Héry Coulibaly, and Soumaïla Diarra)

More specific goals of the project have been to:

- Facilitate access and adoption of improved aquaculture production technologies in targeted areas to increase and diversify the incomes of farmers
- Build the capacity of the Government of Mali to develop and disseminate relevant technologies
- Identify appropriate strategies for the implementation of integrated rice and fish farming in target areas
- Help develop an appropriate fisheries management plan to ensure long-term viability and sustainability of capture fisheries in the target area
- Help establish linkages useful for further development of aquaculture and fisheries in Mali

The Mali Project has taken a South-South approach to development by bringing the scientific expertise and practical experience of CRSP partners from Host Countries with more fully developed aquaculture industries to bear on the three primary theme areas of the project in Mali.

Collaborating Institutions

The primary institutions involved in this project have included the following:

- AquaFish CRSP, Oregon State University, Corvallis, Oregon, USA (Lead US Institution)
- Direction Nationale de la Pêche, Bamako, Mali (Lead Mali Institution)
- Ministère de l'Élevage et de la Pêche, Bamako, Mali
- Moi University, Kenya (Theme I Lead Institution through 2009)
- Kenyatta University, Kenya (Theme I Lead Institution beginning 2010)
- Shanghai Ocean University, Shanghai, China (Theme II Lead Institution)
- FishAfrica, Nairobi, Kenya (Theme III Lead Institution)

Results Achieved

In keeping with the project's primary goal of making improved technologies available to our selected target audiences, a total of 20 workshops were conducted across our three theme areas during the thirty-nine month project period. These workshops covered a wide-range of aquaculture and fisheries topics, including pond site selection, pond construction, pond management, up-to-date techniques for rice-fish culture, fish transportation, catfish propagation and care of fry, best management practices, post-harvest technologies, and lake survey techniques, and also included 3 stakeholders workshops to discuss the results of the Lake Sélingué frame survey (see below) and begin developing a plan for co-management of that lake. A total of 358 participants took part in these workshops.

Field testing and demonstrations were also conducted to complement workshop activities and provide guided, hands-on experience to farmers. Two sets of on-farm trials were conducted by the pond culture team and one set of rice-fish demonstration plots were set up and run under the supervision of the rice-fish team. Through the application of improved management practices and supervision by project leaders, farmers participating in the on-farm trials realized yields of up to 9000 kg/ha in a six-month period (18,000 kg/ha/yr), a substantial increase over the estimated average productivity of ponds at the beginning of the project (1500 kg/ha/yr). In the rice-fish demonstrations, after approximately four months of culture one farmer harvested 115 kg of fish from a rice paddy just 840 m^2 in area (equivalent to 1369 kg/ha), bringing in welcome additional income for the family.

Several activities not specified in the work plan were catalyzed by this project and are worth noting. Upon completion of the first and second sets of on-farm trials, it was decided to run a third set, beginning near the original end-date of the project and to be completed after the project end-date under the supervision of DNP technical staff. One of our pond culture trainees, who speaks neither French nor English, has been instrumental in setting up catfish hatching systems in at least three locations and is now producing catfish fingerlings and selling them to other farmers. In addition, he has himself become a trainer, having led at least four pond construction training sessions for 90 people in Bougouni, Segou, Sanankoroba, and Gao during the final year of the project. He is also in demand as a consultant, having received over 120 people seeking fish farming advice at his farm, with 16 of these having started to build ponds of their own. After observing the results of the project's rice-fish demonstrations, at least 22 new farmers in the Baguineda area decided to modify their fields to include fish during the 2010 growing season.

Our fisheries planning activities included conducting the first ever frame survey of Lake Sélingué, preceded by two workshops to train those who would be conducting the survey. This not only produced a valuable baseline dataset for evaluating the fishing capacity of the lake, but also resulted in the creation of a cadre of individuals trained in the survey techniques used, so that they now have the capacity to conduct future surveys on this lake or others. Following analysis of the survey data, two stakeholders' workshops

were held to discuss the results of the survey and the implications of those results for future fishery management. The project's final fisheries planning activities were a study tour for four Malians conducted at Lake Victoria, Kenya, to observe how co-management (participation of both government and local stakeholders in developing and carrying out management plans), is being successfully practiced at this lake, followed by a final workshop with Lake Sélingué stakeholders to discuss the findings of the Lake Victoria study tour and continue the management planning process for the lake.

The work of the AquaFish CRSP Mali Project has thus set the stage for further development of the aquaculture and fisheries sectors in Mali. Fish farmers have received previously unavailable technical information that will enable them to expand the area under aquaculture production as well as increase their productivity per unit area. Fishers in Lake Sélingué have been brought into the management planning process, and technical staff of the Direction Nationale de la Pêche now have the skills needed for conducting additional frame surveys in the future, whether at Lake Sélingué or elsewhere. Rice farmers in Baguineda and other areas have seen how irrigated rice fields can be modified to accommodate a crop of fish, which many of them are now doing. Both rice farmers and fish farmers have learned how to produce more fish in their respective areas, thus bringing in added food and income to support their families.

12. MONITORING & EVALUATION

The Monitoring and Evaluation (M&E) Plan was formalized in the *AquaFish CRSP 2nd Annual Report.* It functioned under two sets of internal impact indicators — (1) theme-driven DTAP indicators and (2) key development target indicators tied to the USAID research, capacity building, information dissemination, IEHA (President's Initiative to End Hunger In Africa), and gender integration targets for the CRSPs. Additional detail cross referencing internal AquaFish CRSP indicators to the applicable EG and FtF (Feed the Future Initiative) indicators can be found in the Annual Reports posted at http://aquafishcrsp.oregonstate.edu/publications.php [1].

DTAP INDICATORS

The DTAP indicators were tied to the four AquaFish CRSP global themes. They were developed by the MT in consultation with the US and HC Lead PIs in the May 2007 *Pre-Synthesis & Orientation Meeting* and updated in May 2008 at the Annual Meeting and in June 2009 by the DTAP B Lead Coordinator. The current set of DTAP indicators under which Core Research Projects reported from FY 2007 through FY 2012 are listed below.

DTAP A: Improved Health and Nutrition, Food Quality, and Food Safety of Fishery Products
A-01: Number of aquaculture products developed to improve food safety or quality

DTAP B: Income Generation for Small-Scale Fishers and Farmers
B-01: Number of new technologies developed
B-02: Number of institutions with access to technological practices
B-03: Number of (people) trained in use of technological practices

DTAP C: Environmental Management for Sustainable Aquatic Resources Use
C-01: Number of management practices developed or adopted to improve natural resource management
C-02: Number of hectares under improved natural resource management
C-03: Number of management practices developed to support biodiversity
C-04: Number of people trained in practices that promote soil conservation and/or improved water quality

DTAP D: Enhanced Trade Opportunities for Global Fishery Markets
D-01: Number of new markets for aquatic products
D-02: Number of aquatic products available for human food consumption

[1] Indicators for the USAID Economic Growth & Trade program form the EG 5.2 (Agriculture Sector Productivity) set under which AquaFish CRSP reports. This set also includes indicators relating specifically to the FtF initiative.

Appendix 4 provides a compilation of DTAP reports submitted by of the seven AquaFish CRSP Core Research Projects, which were actively engaged in research from FY 2006 to FY 2012. Since short-term training data were collected under a separate internal reporting mechanism, indicators B-03 and C-04 are included in the short-term training compilation.

KEY DEVELOPMENT TARGETS: INDICATORS & BENCHMARKS

AquaFish CRSP measured achievements in meeting key development targets through a set of internal indicators. The benchmarks provide a means to explore measures of performance different from those measured by the more quantitative DTAP or USAID indicator metrics. The Targets and Benchmarks tracked below are consistent with those approved in the Program Description of the USAID CA/LWA for this CRSP.[2] Year 1 Benchmarks cover 2006–2007. Benchmarks for Years 2–5 are appended to show progress through Implementation Plan 2009-20011.

This conceptual framework helped ensure that targets and benchmarks were adequately addressed across the AquaFish CRSP global portfolio for facilitating feedback and continuous learning in order to improve processes and outcomes. We report on the four key development targets of research, capacity, information dissemination, and IEHA. As the fifth target, gender strategy ensured strong programmatic commitment toward gender inclusion through plans implemented at both the project and program level. Gender was both integrated into the four other targets and highlighted independently.

Benchmarks were fully met and illustrative examples of the associated project accomplishments are listed in the summary below.

Research Target

Produce sustainable end-user aquaculture and fisheries research results that increase productivity, enhance international trade opportunities, and contribute to responsible aquatic resource management.

"Program-wide Research Indicators (refers to p.13 under Technical Approach in the CA/LWA Program Description):

(1) Developed and adopted innovative technologies that increase profitability and environmental stewardship in aquaculture and fisheries.
(2) Addressed biodiversity conservation issues to ameliorate threats to biodiversity and developed technologies and strategies to protect biodiversity habitat and populations.
(3) Continuously funded research projects that meet the expectations of external peer-review panels.
(4) Conducted appropriate biotechnology research to develop technologies that increase farm productivity.
(5) Engaged local stakeholders in research design, implementation, and results reporting through active participation in stakeholder meetings.
(6) Published AquaFish CRSP research in regional, national, and international peer-reviewed journals."

Year 1 Benchmarks. Status: Successfully completed

(a) Request for Proposals approved by USAID and widely advertised, and submitted proposals externally peer-reviewed.

[2] The Targets and Benchmarks were again approved as part of the AquaFish CRSP M&E Plan in 2008.

RFP process through proposal finalist selection was completed on 31 March 2007.

(b) Favorably reviewed proposals have activities initiated.
Project work began in May 2007 with attendance at the Presynthesis & Orientation Meeting, formation of the advisory technical panels, and training on indicators, IEE, gender, and POP (Program Operating Procedures).

Years 2–5 Benchmarks. Status: Successfully completed.

- 1 innovative aquaculture and fisheries technology or strategy developed and disseminated throughout each region:
The following examples of technologies and strategies are illustrative of project achievements that have more than met this benchmark:

Africa: *Kenyan farmers who participated in Purdue University's group marketing and supply chain project (07QSD02PU/07MER02PU) are marketing their farmed baitfish in markets along the shores of Lake Victoria. One highly successful group marketing cooperative, the Vihiga (Bidii) Fish Farmers Group is promoting the market cluster model and has taken the initiative to train other fish farmers in this marketing strategy. It has also partnered with the Women in Fishing Industry Project, a local Lake Victoria NGO that helps women identify income generating opportunities, to train women to become baitfish farmers.*

Cage culture technology is in the process of transfer in Uganda and Kenya. Ugandan farmers were part of a trial that offered them a new livelihood with tilapia cage culture on Lake Victoria where the effects of overfishing has threatened their ability to earn a livelihood (09BMA01AU). This hands-on training project is preparing them in production and business techniques that will ensure their success as farmers and models to others who wish to adopt this new technology. Three groups of Kenyan farmers have been trained in a cage-cum-pond tilapia culture system including hands-on experience in constructing cages. These farmers have taken this technology back to their communities where it will help bring others to fish farming (09SFT02PU).

Asia: *As a result of the multifaceted approach of the University of Michigan project work in Asia, there have been significant achievements in transferring technologies and strategies for sustainable environmental management of various components of aquaculture and fisheries systems. With information from an assessment of the impacts of alien fish stocking on wild fish populations in reservoirs, CRSP researchers in Vietnam developed environmental management plans for stocking rate and fisheries carrying capacity, to guide a sustainable approach to protecting the biodiversity of wild fisheries management and aquaculture in reservoir systems (07MNE03UM/09MNE05UM). For pond aquaculture, two new technologies were transferred: (1) effluent reduction measures for pond aquaculture (07MNE04UM) and (2) an environmentally benign treatment to remove toxin-producing, blue-green algae blooms (07HHI01UM) that develop in aquaculture ponds.*

New sustainable feed technology work has promising benefits for fish farmers in the Philippines, Cambodia, and Vietnam (lower Mekong River Basin). Filipino tilapia farmers can save on feed costs with reduced feeding strategies — a delayed supplemental feeding by 45–75 days, alternate- day feeding, or daily subsatiation feeding at 50% or 67% (07SFT02NC/09SFT04NC). Transfer of this technology took place through trainings and podcasts (09TAP02NC/ 09SFT06NC) and was tested in milkfish aquaculture systems (09MNE03NC). CRSP researchers have developed a pelleted feed for snakehead with reduced fishmeal content

(07SFT01UC/09SFT01UC) that has undergone successful on-farm trials (09TAP03UC) and is now being adopted by Vietnamese farmers. Adoption of this new sustainable feed technology will realize cost reductions with the lower cost feed that is formulated with local protein sources such as rich bran to replace a portion of the higher priced fishmeal.

Latin America: *Based on AquaFish CRSP recommendations developed from carrying capacity studies in the Boca Camichin Estuary, the Mexican government has imposed a ban on new oyster farms to control water quality and aquatic diseases. By including oyster producers in the monitoring work, AquaFish CRSP researchers developed an effective community-based collaboration with rural stakeholders. Through community meetings, local oyster producers have learned culture and sanitation techniques that will improve harvests of oysters safe for human consumption (07WIZ02UH). Similarly in Nicaragua, CRSP investigators have trained communities that depend on the cockle fishery in Aserradores Estuary in the no-take zone management approach that will ensure a healthy shellfish population balance and improved sanitation of the harvested cockles (07HHI05UH/09HHI01UH). This successful model is being tested by the Nicaraguan government in two other communities as a possible alternative to the current closed season management technique that has proven unsuccessful.*

Researchers in Mexico have successfully developed a sustainable control measure to eliminate methyltestosterone (MT) residue from hatchery treatment water (07MNE06UA). In the use of MT to sex reverse young fingerlings, disposal of contaminated water has become a significant problem for hatcheries and large farms that use the male hormone to create monosex tilapia fingerlings. This new MT-elimination technology makes use of bacteria that have been experimentally shown to degrade the MT residue that builds up in treatment water. They are inoculated onto the biofilter component of the treatment tank's water filtration system where they feed on the MT residue that they capture from water as it is filtered through. One added advantage of the bacteria is their proven probiotic contribution towards improving fish productivity. A commercial scale-up trial is underway with a private hatchery partner (09MNE07UA). Farmers and hatchery managers have also been trained in the beneficial probiotic effects of bacteria when used as bioflocs in aquaculture.

(b) AquaFish CRSP activities remain locally appropriate by receiving regular input through the Regional Centers of Excellence and Development Theme Advisory Panels.

The RCEs have been active in establishing regional linkages with NGOs, governmental and academic institutions, and stakeholder groups. These linkages have served to promote information exchanges and technology sharing among researchers, policymakers, government officers, and local stakeholders. They have also established strong regional networking links that enable regular information sharing and promote regional capacity building, including opportunities for student training and exchanges. RCE emphasis on empowering students and funding their participation in trainings and conference attendance has further strengthened the long-term training goals of the Core Research Projects. These activities have helped the MT and project leaders in assessing needs for research and activities under the continuation plans and in add-on investigations.

The DTAP Lead Coordinators have played an instrumental role in evaluating work plan changes under the Implementation Plan 2007–2009 and new investigation approaches in add-on investigations under the Implementation Plan 2009–2011. They have also provided substantive feedback to the MT through the DTAP impact reporting and overview of research accomplishments (Lead Coordinator Reports), which has guided the MT reviews of the continuation plans, add-on investigations, and other research activities.

(c) Measured increases in farm productivity, farmer incomes, market access, and export value achieved following adoption of AquaFish CRSP recommendations and technologies.

Training and outreach for technologies and management recommendations improved the aquaculture and fisheries economic sectors for various levels of stakeholders. Stakeholders have participated in research activities (University of Arizona, University of Connecticut – Avery Point, University of Hawai'i at Hilo, University of Michigan, and projects), provided input into the development of management practices and policy recommendations (North Carolina State University, Purdue University, University of Connecticut, and University of Michigan projects), participated in regional events where they can interact with other stakeholders and service sector personnel (Auburn University and University of Hawai'i projects), and actively trained fellow stakeholders (Purdue University and University of Arizona projects).

The following examples illustrate project achievements that have and will continue to lead to measured increases for stakeholders in productivity, incomes, market access, and product export value:

Farm/Fishery Productivity

- *adoption of practices to mitigate pollution of receiving waters from aquaculture pond effluents (China: 07MNE04UM; Ghana: 07WIZ01PU) and methyltestosterone residues (Mexico: 07MNE06UA/09MNE07UA).*
- *adoption of management practices or technologies to improve production efficiencies and/or lower costs: catfish fingerling aquaculture (07QSD02PU), tilapia-catfish polyculture (07MER03PU); an integrated cage-cum-pond culture system 09SFT02PU), Nile tilapia seedstock (07QSD01NC/09QSD01NC), and tilapia aquaculture (07SFT02NC/09SFT04NC).*
- *implementation of management plans to control alien species introduction in freshwater reservoirs in Vietnam and China as a step to maintain sustainable aquaculture and wild fisheries (07MNE03UM/09MNE05UM)*
- *improved implementation of fishery management plans to control carrying capacity (native oysters: 07WIZ02UH); to maintain sustainable production outputs (black cockles: 07HHI05UH/09HHI01UH); to protect the freshwater fishery for small-sized fish in the Lower Mekong River Basin from overfishing for animal and fish feed uses (07MNE01UC/09MNE04UC); and to sustainably manage aquacultural water use and quality in watersheds and wetland areas of Uganda (09WIZ01AU/09WIZ02AU).*
- *improved production capabilities and business stability for small-scale farmers undertaking cage culture on Lake Victoria in Uganda (09BMA01AU)*
- *opened income opportunities with new aquaculture species and culture systems: tilapia-sahar polyculture for women in Nepal (07BMA02UM/09BMA03UM); seaweed-fish-mollusc-shrimp polyculture and soft-shell mud crab aquaculture for shrimp farmers in the Philippines and (Banda Aceh, Indonesia (07MNE02NC/09FSV02NC)*

***Farmer Income**: Farmers, processors, and vendors benefiting from improved productivity of aquatic products as listed above will see increases in income. Improved income opportunities include the following:*

- *sustainable feed technologies will lower a major contributor to production costs and thereby improve profit margins for farmers —*
  1. ***locally available protein replacement for fishmeal**: 07SFT01UC/09SFT01UC; 07SFT04UA/07SFT05UA/09SFT03UA; 07SFT06PU/09SFT05PU)*
  2. ***feeding reduction strategies**: 07SFT02NC/09STF04NC; 07SFT03NC/09MNE02NC*
- *new aquatic products will open production and market opportunities*
  1. ***products with improved health and safety**: producers and vendors of native cockles (07HHI05UH/09HHI01UH) and oysters (07IND03UH/07IND04UH/09IND01UH) can improve their income opportunities when hatchery-raised seed becomes available to*

support expanding production interest — particularly among coastal women — and demand for depurated products develops in local shellfish markets;

2. ***new aquatic species available for aquaculture****: research success with breeding snook, native cichlids, and chame in captivity will open the way for new aquaculture opportunities for native fish species in Latin America (snook and native cichlids (07IND01UH/07IND02UA/09IND05UA) and chame (09IND03UH);*
3. ***new products for small-holder farmers and processors****: trainings in seaweed polyculture systems and processing techniques address sustainable production methods have opened new income opportuntities for coastal communities in the Philippines and Indonesia — 200 farmers have incorporated seaweed into their culture systems (07MNE02NC/09FSV02NC); research on an integrated multitrophic milkfish-seaweed-sea cucumber aquaculture system and processing trainings will open income opportunities for Filipino farmers and women processors of value-added milkfish products (09MNE02UC).*

Market Access*:*

- *Baitfish farmers are now successfully selling at six well-established market locations along the shores of Lake Victoria (07QSD02PU/07MER02PU).*
- *Ghanaian farmers who adopt the supply chain/group marketing model will have more opportunities in urban markets (07MER02PU).*
- *A market for depurated cockles is beginning to grow as demand for this "safer" aquatic shellfish product spreads by word-of-mouth (07HHI05UH).*
- *Market opportunities for women are expanded through trainings in value-added product processing and marketing (09MER02PU; 09FSV01UC; 09FSV02NC; 09MNE02NC; 09HHI02UH) and value chain opportunities (09MER01PU).*

Export Value*:*

- *Tilapia farmers in the Philippines who adjust production to meet the specific requirements of export markets will have expanded income opportunities (07MER04NC/09MER03NC).*
- *An export market for sales of brackishwater shrimp to the US will open a new product opportunity for Guyanese aquaculture (09SFT03UA).*
- *Markets for processed fish products in Cambodia will expand as women processors adopt best management practices for improved safety and quality in the production of fermented fish paste and fish sauce (07FSV01UC/09FSV01UC).*

(d) Threats to biodiversity resulting from aquaculture activities ameliorated and biologically significant areas positively impacted.

Management recommendations to control alien species introductions in freshwater reservoirs as well as the effects of associated aquaculture systems will protect native species diversity in the reservoirs and help ensure a sustainable wild fishery in Vietnam and China (07MNE03UM/09MNE05UM). In Kenya, the successful development of catfish-baitfish aquaculture offers an alternative source of baitfish to Nile perch fishers on Lake Victoria, thereby protecting the threatened wild catfish fishery that serves as an important food source for the rural poor (07QSD02PU). Development of cage culture aquaculture by small-scale Ugandan farmers will both offer new income opportunities and help to address overfishing in Lake Victoria where wild fish stocks are declining (09BMA01AU). Success in development of snook aquaculture will help relieve pressures on the wild fishery of this important native Latin American species (07IND01UA/09IND05UA). A multifaceted research has assessed the current status of wild chame stocks native to Mexico (09IND04UH) and developed techniques for captive breeding as a first step toward chame aquaculture (09IND03UH). Stock assessments will lead to management guidelines to protect this important native fishery in the coastal LAC countries of the Pacific Rim while aquaculture will provide a sustainable source for the competing interests of human food

and fishmeal industries. A no-take management zone approach adopted by communities in the Aserradores Estuary along the Pacific Coast of Nicaragua will help preserve the sustainable production status of the native black cockle fishery, which serves as an important food and income source for the poor (09HHI01UH).

Several sustainable feed technology investigations targeted reduction of fishmeal in aquaculture feed as both a cost-savings measure and sustainable practice to reduce pressures on wild-caught fish used for fishmeal (07SFT01UC/09SFT01UC; 07SFT02NC/09STF04NC; 07SFT03NC; 07SFT06PU/09SFT05PU; 07SFT04UA/07SFT05UA/09SFT03UA). The move away from fishmeal serves to protect local and international wild-caught fisheries that have been supplying fishmeal inputs to the animal feed industry (e.g., small, low-value fishery in the Mekong River).

The Director and US Lead PI Jim Diana (University of Michigan) organized and led a symposium entitled "The Effects of Semi-Intensive Aquaculture on Biodiversity In Nearshore and Inland Waters" at the September 2011 American Fisheries Society meeting in Seattle, Washington. The presentations by 12 invited speakers from the international aquaculture community and an open-discussion forum highlighted the status of a range of issues from the benefits of aquaculture for protecting and improving biodiversity to biodiversity challenges associated with aquaculture systems.

(e) Cost-effective biotechnology appropriate for use in developing countries developed.

Innovative biotechnologies will bring cost efficiencies to methyltestosterone (MT) residue control and fish growth performance monitoring and translate into improved productivity in aquaculture systems. The development of an MT-elimination system based on bacterial degradation (07MNE06UA) will help tilapia hatcheries address a major environmental impact issue associated with hormone-based masculinization systems. Commercial adoption of this technology at a large Mexican hatchery is underway (09MNE07UA). Tests for IGF-I gene expression are in use as tools for measuring fish growth performance and stress responses in work to establish protocols for broodstock selection and seed production to improve this aspect of production efficiencies (07SFT02NC/07SFT03NC /09QSD01NC).

(f) Continuous academic output of AquaFish CRSP data as publications within recognized journals and presentations provided at regional, national, and international forums.

AquaFish CRSP researchers have published over 150 scientific articles since the start of the program and have submitted a significant number of articles for peer-review publication. They have also presented their work in a wide array of international, national, and regional conferences and symposia, taught academic seminars, and participated in professional workshops and meetings.

Capacity Building Target

Focus AquaFish CRSP investments on building local capacity in aquaculture and aquatic resource management and ensuring long-term program impacts at local and national levels through strategic informal and formal training opportunities. Integrate items related to gender.

"Capacity Building Indicators – Regional (refers to p.13 under Technical Approach in the CA/LWA Program Description):

(1) Forged professional and managerial relationships between US and Host Country researchers and institutions.
(2) Established track record of successful formal long-term training of Host Country and US students and researchers.

(3) Delivered relevant short-term training opportunities that provide positive Host Country societal benefits beyond the life of AquaFish CRSP.
(4) Identified gender issues in aquaculture and fisheries and adopted gender program-wide integration policies."

Year 1 Benchmarks. Status: Successfully Completed

(a) An additional year of the highly successful Host Country Principal Investigator Exchange Project continued to exchange information on cichlid aquaculture to additional countries including two IEHA countries.

Phase II exchange visits to South Africa and Ghana (October 2007), Vietnam (December 2007), and Vietnam (February 2008) were conducted.

(b) The jointly funded NOAA Sea Grant Technical Assistance program continued

The Director and Jim Murray, Deputy Director of NOAA/Sea Grant discussed model cases in Korea and finalized the exchange visit for Paul Olin, Director of the California Sea Grant Extension Program. Three Lead US PIs (James Diana, Maria Haws, and Robert Pomeroy) actively engaged in management of their regional Sea Grant Programs, and have networked CRSP efforts into Sea Grant on a regional basis.

(c) Gender integration strategies adopted within all sub-awards

All six projects adopted a strategy consistent with the CRSP integrated approach; USAID (Julie Swanson) reviewed all six projects and met with PIs during the May 2007 orientation meeting.

(d) Regional Centers of Excellence established to reflect AquaFish CRSP regions for research activities (i.e., Asia, Africa, and Latin America and the Caribbean)

Three RCEs were established and the Director appointed, with USAID consultation, Lead Coordinators at the May 2007 orientation meeting.

(e) Formal Memoranda of Understanding adopted between all US and Host Country partners

MOUs and/or Subcontracts are completed for all projects that began in Year 1 with the exception of University of Arizona's MOUs and subcontracts that are still in process.

Years 2-5 Benchmarks. Status: Successfully Completed

(a) Partnerships strengthened among US and Host Country universities, NGOs, NARS, and USAID Missions through Associate Awards.

Partnerships were fully developed for each of the seven core projects. An additional RCE was added for Africa giving a more comprehensive regional coverage — RCE-West Africa and RCE-East & Southern Africa — and enabled the Lead Coordinators to focus more directly on their specific regional issues. The RCEs built linkages and partnerships with USAID Missions and with regional and international organizations and institutions. The three-year Associate Award with the USAID Mission in Mali (1 October 2007– 30 September 2010) for an aquaculture and fisheries project concluded on 31 December 2010. A new USAID SIRTD Associate Award was initiated in FY2011 for a three-year project in Ghana, Kenya, and Tanzania to promote adoption of innovations and Best Management Practices that will improve production and economic efficiencies of small-holder producers.

(b) At least 100 degree students enrolled through formal long-term training opportunities in US, Host Country, and Regional universities.

Since program inception, 320 students from 25 countries were enrolled in long-term academic programs associated with Core Research Projects and the Management Office. Of these students, 41 were from the US and 223 were Host Country nationals.

(c) Equal numbers of women and men trained through short- and long-term training opportunities.

Short-Term Training*: A total of 6,348 individuals received short-term training since program inception in 2006. Women comprised a total of 2103 or 33.1% of the trainees.*

Long-Term Training*: Of the 320 students receiving long-term or degree training, 154 (48.1%) are women.*

(d) Numerous train-the-trainer workshops convened to provide Host Countries with highly skilled extension specialists

Short-term trainings were designed to integrate stakeholders at all levels, thereby removing barriers between farmers/fishers and extension agents/fisheries officers, etc. An additional component was the empowerment of trainees to "train" their counterparts. Successes of this integrated approach are exemplified by the catfish farmer trainings in Kenya (07QSD02PU), feed formulation trainings in Guyana (07SFT05UA), shellfish sanitation workshops (07HHI03UH, 07HHI04UH) and shellfish management trainings (09HHI02UH/09HHI01UH).

Other trainings specifically designed as Train-the-Trainer included the following:

- *07BMA05UH: intensive training and internship on bivalve culture and sanitation*
- *07IND01UA: international workshop on snook biology for professionals (4 trainings)*
- *07IND02UA: tropical fish culture for students*
- *07MNE06UA: technical workshop for extensionists and students on MT elimination (2 trainings)*
- *07TAP01UC: farmers training of trainer workshop on alternative feed for snakehead aquaculture*
- *09IND02UC: on-site training on snakehead breeding and weaning for researchers*
- *09IND06PU: experimental design and analysis for aquaculture*
- *09QSD02UA: integrated aquaculture-agriculture for a rural farmer's cooperative (training of student trainers)*
- *09SFT03UA: basic aquaculture and aquaponics for the rural poor (training local farmer as community trainers) (2 trainings)*
- *09TAP08AU: Certification of Aquaculture Professionals training at Auburn University for eight African candidates from Ghana, Kenya, Tanzania, and Uganda.*
- *09WIZ02AU: watershed workshop for researchers and extensionists*

The University of Connecticut (09FSV03UC) incorporated a comprehensive impact assessment component into its project to evaluate the combined accomplishments of AquaFish CRSP work. Thirteen trainings were held in FY2011 to prepare project and collaborating government personnel in uniform data collection and assessment methods for the following activities:

- *Sustainable approaches to snakehead aquaculture and its value chain*
- *Policy framework for sustainably managing the aquaculture-capture fisheries interactions*
- *Management recommendations for protecting the small-sized fishery in the lower Mekong River Basin*
- *Standards for fish paste processing*

(e) Biotechnology and biodiversity training activities conducted as identified.

Examples illustrating training activities that focused on biotechnology and biodiversity are listed below.

Biotechnology short-term trainings:

MT elimination (07MNE06UA/09MNE07UA): 4 workshops
Biotechnology of marine algae (07BMA03UA): 1 workshop

Biodiversity short-term trainings:
Seaweed-fish-mollusc-shrimp polyculture and seaweed harvest/processing trainings (07MNE02NC/09FSV02NC): 10 workshops
Tilapia-sahar polyculture (07BMA02UM): 1 workshop
Alien species introductions (07MNE03UM/09MNE05UM): 5 workshops
Native cichlid farmer trainings (07IND02UA): 3 workshops
Native oyster culture trainings (07IND03UH): 1 workshop
Native black cockle management trainings (09HHI01UH): 4 workshops

Information Dissemination Target:

Disseminate AquaFish CRSP research results to foster broad application of results among local stakeholders within governmental and non-governmental organizations, as well as for end-users.

"Information Dissemination Indicators – Regional (refers to pp.13-14 under Technical Approach in the CA/LWA Program Description):

(1) Successful diffusion of AquaFish CRSP research results and technologies between countries within a region having comparable social and environmental conditions.
(2) Increased awareness of local stakeholder constraints and opportunities related to responsible aquaculture and fisheries management.
(3) Applicable extension activities associated with each research project conducted to ensure wide dissemination of research results
(4) AquaFish CRSP results and technologies for farm operations adopted and policies for responsible aquatic resource management created.
(5) Applicable technologies developed and adopted by the US and other countries' aquaculture and fisheries sectors."

Year 1 Benchmarks. Status: Successfully Completed

(a) Dissemination efforts have continued through *Aquanews*, EdOp Net, and a new searchable online publication database.

Publication services continued uninterrupted during the transition from the former ACRSP into the first year of AquaFish CRSP: quarterly issues of Aquanews (Vol. 22, Nos. 1-3; Vol. 23, No.1); 12 monthly issues of EdOp Net; CRSP Notices of Publication for 22 peer-reviewed research reports by CRSP researchers.

(b) The importance of extension evident through integration of at least one outreach activity within each funded project.

The RFP institutionalizes the integration of research and outreach by requiring proposals to contain at least one outreach investigation and to include an Outreach and Dissemination Plan. Proposals were revised as necessary to include one or more outreach activities prior to being approved as core projects.

(c) Research adoption encouraged by prioritizing the use of on- and off-farm trials to conduct research.

On- and off-farm trials and other types of field trials were included as appropriate within each project to promote research adoption as follows:

- *07BMA02UM: tilapia-sahar stocking density trial in collaboration with the Rural Integration Development Society*
- *07HHI01UM: on-farm microcystin controls and consultation with farmer cooperators*
- *07HHI02UA: aquaculture effluent-irrigation trial with farmer cooperator*
- *07HHI05UH: test marketing of depurated black cockle*
- *07IND01UA: farm trials to assess tranferability of experimental snook aquaculture*

- *07IND03UH: women's oyster cooperatives involved with spat collection*
- *07IND04UH: active participation by community members in oyster depuration trials*
- *07MER03PU: on-farm trials using small-scale farmers' ponds*
- *07SFT05UA: on-farm trial of experimental diets using local ingredients.*

Years 2-5 Benchmarks. Status: Successfully Completed

(a) Intra- and inter-regional diffusion of AquaFish CRSP results and technologies accomplished.

On a regional basis, short-term trainings and workshops successfully transferred research results, management practices, technologies, and recommendations to the various levels of stakeholders from rural farmers to policymakers. Professional-level workshops and CRSP-sponsored conferences (e.g., Workshop on Marine Algae, ISTA8 and ISTA9, Workshop on Aquaculture, Human Health and Environment, the Fish Farmers Symposium & Trade Show (2010 and 2011), AFS Symposium: The Effects of Semi-Intensive Aquaculture on Biodiversity In Nearshore and Inland Waters) have served as vehicles for the diffusion of results and technologies beyond the areas targeted by AquaFish CRSP investigations. Through their promotion of linkages and collaborative networks, the RCEs also actively contributed to inter-regional diffusion.

(b) Training manuals with local and regional scopes published following completion of AquaFish CRSP research projects.

Outreach materials with local and regional scope that were developed and are currently available include the following printed materials and podcasts:

- *07TAP02NC: Tilapia podcast (1 in English) — Book reviews*
- *07MNE04UM: BMPs for Effluent Control in Aquaculture transferred in trainings*
- *07QSD02PU: Fact Sheets on Pond Production: Pond Fertilization, Pond Liming, Feeding, Stocking & Harvesting*
- *07MER02PU: Extension Brochure: Marketing Strategies for Smallholder Fish Farmers in Sub-Saharan Africa*
- *07MER02PU: Extension Manual: Forming an Effective Fish Farmers' Cooperative in Sub-Saharan Africa*
- *07SFT06PU: Manual for Hand Sexing of Tilapia*
- *07WIZ01PU: BMPs for pond aquaculture transferred in training*
- *09IND06PU: Indigenous Species Brochure*
- *09MNE02NC: Milkfish Processing*
- *09OSD05PU: Fish Life Cycle & Reproductive Strategies*
- *09TAP02NC: Tilapia podcasts (4 in English and 2 in Tagalog) — Reduced Feeding Strategies*
- *09TAP04PU: Information Sheet on Constraints and Opportunities for Cage Culture in Ghana*

(c) At least 30 workshops convened over the course of the 5-year AquaFish CRSP.

Since inception, 181 workshop/trainings have been held across the seven Core Research Projects during the first five years of AquaFish CRSP.

IEHA Country Involvement Target:

Expand AquaFish CRSP science and technology efforts in IEHA Host Countries to increase local capacity and productivity thereby contributing to national food security, income generation, and market access.

IEHA Indicators – Within each participating IEHA Host Country (refers to p.14under Technical Approach in the CA/LWA Program Description):

(1) Development and adoption of innovative technologies that increase profitability and environmental stewardship in the context of aquaculture and fisheries.
(2) Students enrolled in formal long-term training programs within Host Country, Regional, and US universities;
(3) Increased awareness of stakeholder constraints and opportunities related to responsible aquaculture and fisheries management.
(4) Applicable extension activities associated with each research project conducted to ensure wide dissemination of research results.
(5) AquaFish CRSP results and technologies adopted for farm operations and policies for responsible aquatic resource management created.
(6) Increased farm income and local economic growth through enhanced market access in project areas."

Year 1 Benchmarks. Status: Successfully Completed

(a) Formal strategy initiated to maximize locally appropriate results in participating IHEA Host Countries.

The Purdue University IEHA project was designed to improve competitiveness by empowering small holders and developing local economies and markets through capacity building, improved technology, and management of supply chain and natural resources.

(b) Sites selected and formal connections established with suitable research institutions and government departments within each IHEA Host Country.

The Purdue University IEHA project negotiated MOUs and establishing linkages.

(c) The Africa Regional Center of Excellence has representation from IEHA countries to design research and outreach activities.

The RCE Lead Coordinator has established initial linkages within IEHA countries.

Years 2-5 Benchmarks. Status: Successfully Completed

(a) Formal linkages, collaborative research, and outreach activities fostered between US universities and IEHA site institutions.

The Purdue University project conducted research in the two IEHA countries of Ghana and Kenya has formally partnered with Moi University (Kenya), Kenyatta University (Kenya), Kwame Nkrumah University of Science & Technology (Ghana), Water Research Institute-Aquaculture Research Development Center (Ghana), Fisheries Directorate (Ghana), and Virginia Polytechnic Institute & State University (US). These linkages encompass collaborative research on nine investigations under Implementation Plans 2007–2009 and 2009–2011. Outreach activities in Kenya and Ghana included 17 trainings and production of (1) Fact Sheets covering stocking and harvesting, feeding, pond liming, and pond fertilization, (2) BMPs for Pond Aquaculture, (3) an Extension Brochure "Marketing Strategies for Smallholder Fish Farmers in Sub-Saharan Africa" and an Extension Manual, "Forming an Effective Fish Farmers' Cooperative in Sub-Saharan Africa," (4) a farmer brochure "The Life Cycle and Reproductive Strategies of the Nile Tilapia (Oreochromis niloticus)," (5) information brochure "Indigenous Species for Aquaculture Development in Ghana," and (6) an information sheet on "Constraints and Opportunities in Cage Aquaculture in Ghana."

The Auburn University project, conducted research in Uganda, has formerly partnered with three Ugandan institutions — Gulu University, Makerere University, Uganda National Fisheries Resources Research Institute — and Alabama A&M University (US), University of Georgia (US), and Stellenbosch University (South Africa). Outreach activities in Uganda included 11 trainings as well as a US-based short course at Auburn University (Certification of Aquaculture Professionals) for six IEHA students, two each from Ghana, Kenya, and Uganda. Five study

tours conducted in 2010 (1 study tour) and 2011 (4 study tours) as outreach activities of the Fish Farmers Symposium offered participants the opportunity for information exchange with proprietors and workers at fish farms and associated businesses in the growing aquaculture sector of Uganda.

In August 2010, the RCE-Africa was expanded to encompass two centers that will be better able to serve the specific regional and geographic needs of West versus East and Southern Africa. Through these two RCEs as well as other efforts by CRSP researchers, collaborations and linkages have been developed with FAO, African Union, SARNISSA, NEPAD, ANAF, FishAfrica, local NGOs (e.g., Women in Fishing Industry Project – Kenya), government agencies (e.g., Uganda Commission for Fisheries), regional agencies (Lake Victoria Fisheries Organization) and the USAID Missions in Ghana, Kenya, Uganda, and Mali. Collaborative research has also been pursued by the RCE-East & Southern Africa through other funding sources.

(b) Long-term research projects addressed specific needs of each IEHA Host Country.

Bringing Kenyan farmers into a successful farming enterprise to raise catfish fingerlings for sale as baitfish for Nile perch fishers has addressed needs of several stakeholders: fish farmers for whom the group marketing clusters ensure a viable business enterprise; baitfish traders who can depend on a steady supply of farmed fish to sell to fishers; rural communities along the shores of Lake Victoria whose livelihoods and food security depend on a sustainable catfish fishery protected from overexploitation with the availability of farmed catfish fingerlings. Investigations under the Implementation Plan 2009-2011 addressed specific needs of stakeholders: (1) expanding income-earning opportunities for women fish traders to other components of the fish value chain, including aquaculture; (2) helping small-holder farmers to maximize aquaculture efficiencies and income generation with an integrated pond-cage system for catfish and tilapia.

Development of BMPs for aquaculture farmers in Ghana will help ensure cost-effective production practices that will reduce feed waste and effluent output from ponds into receiving waters. With training in improved fish production and propagation methods, Ghanaian farmers and hatchery managers can improve cost efficiencies. CRSP researchers also worked towards improving aquaculture opportunities for Ghanaian farmers through a collaborative effort with the government to set standards for cage culture on Lake Volta and by conducting research to expand the number of fish candidates for culture, concentrating on native species.

The Auburn University project in focused on farmer training at the local and regional levels through the annual Fish Farmers Symposium & Trade Show and the small-holder cage culture study on Lake Victoria. These trainings were designed to expand production and job opportunities for stakeholders. Interregional farmer exchanges between Uganda and Kenya encompassed in the Farmer-to-Farmer Study Tour and the Kenyan baitfish investigation offer opportunities for stakeholders to learn and benefit from each other's experiences. In the area of water quality and water management in aquaculture, strategies have been developed to help guide farmers in pond siting and water usage that will best utilize water resources, ensure stable water supplies, and maintain ecosystem complexity and promote biodiversity.

(c) Diffusion of knowledge facilitated between separate research projects ongoing within each IEHA Host Country.

Kenyan farmers visited fish farm facilities in Uganda in a collaborative training conducted in FY09 (07QSD02PU) and participated in both the 2011 Fish Farmers Symposium & Trade Fair and six-day study tour of Ugandan fish farms and associated enterprises. Kenyan researchers served as partners on the Associate Award Project in Mali, benefiting that project with their expertise that has been built over the long term through CRSP research activities. In Uganda, the

Annual Fish Farmers Symposium & Trade Show provided a national opportunity for Uganda farmers to network and exchange knowledge while also benefitting from the event's extension and outreach programs. The Farmer-to-Farmer Study tours mentioned above for Ugandan and Kenyan farmers afforded opportunities for local and inter-regional exchanges.

The HCPI Phase II Project (FY2008) involved Ghanaian and Kenyan researchers in a regional exchange in Africa.

(d) A measured increase in farm productivity, farmer incomes, market access, and export value has followed adoption of AquaFish CRSP recommendations and technologies in project areas.

The following example illustrates the multi-faceted achievements of AquaFish CRSP work: Catfish farmers who have adopted baitfish culture practices and become members of group marketing clusters have improved pond productivity by following AquaFish CRSP management practices. Their total production of catfish fingerlings has reached 250,000 fry/fingerlings since 2006, when production was virtually non-existent. Since CRSP's initiation of this farmed baitfish program, survival rate of fingerlings has increased from less than 10% to 50% representing an increase in productivity of 400%. Six baitfish market centers have been opened along Lake Victoria, and baitfish farmers have recorded about 50% increase in sales. Most baitfish farmers have recorded about 65% increase in farm income from baitfish production. (07QSD02PU/02MER02PU; FY2009 data).

Gender Integration Strategy

AquaFish CRSP is dedicated to improving gender inclusiveness in the Aquaculture and Fisheries sectors, and in the CRSP arena. Gender Integration is implicit and interwoven into in the above "target" benchmarks and indicators requested by USAID in its 2006 RFA. Additional explicit guidance, in the form of an improvement plan, was established for CRSP operations.

Year 1 Initiatives. Status: Successfully Completed

- Require that all funded projects address gender inclusiveness within their planned scope-of-work.

  The RFP requires that all projects have a strategy for integrating and addressing gender (a Gender Strategy). Strategies for gender inclusiveness have been incorporated into revisions to the proposals.

- Seek out USAID review of projects' gender inclusiveness plans and respond by improving plans prior to project implementation.

  The ME submitted revised proposals with gender inclusiveness plans to USAID in June 2007. Proposal revisions addressed USAID suggestions prior to receiving funding, and prior to implementation.

Years 2–5 Initiatives. Status: Successfully Completed

(a) Collect disaggregated gender data from individual research and outreach projects funded by the CRSP.

Data for short-term and long-term training activities are disaggregated and are covered in the Capacity Building sections of this report.

(b) Analyze disaggregated data on an annual basis to gauge gender inclusiveness success and take appropriate action as indicated through data analysis.

Since program inception, the analysis has shown that long-term training participants comprise 51.9% men and 48.1% women. Of the 6,348 short-term training participants from FY2006 to FY2012, 37.4% were women and 62.6% were men. In order to improve opportunities for women's participation in short-term training events, each of the Core Research Projects had a

gender inclusivity strategy and a gender focused investigation under the Implementation Plan 2009-2011. The gender-focused investigations are as follows:

- *Demonstration of Sustainable Seaweed Culture and Processing in Aceh, Indonesia and the Philippines - Opportunities for Women to Improve Household Welfare (09SFV02NC)*
- *Value Chain Development for Tilapia and Catfish Products: Opportunities for Women Participation (09MER02PU)*
- *Expansion of Tilapia and Indigenous Fish Aquaculture in Guyana: Opportunities for Women (09SFT03UA)*
- *Maximizing the Utilization of Low Value or Small-sized Fish for Human Consumption by Improving Food Safety and value-Added Product Development (Fermented fish paste) through the Promotion of Women's Fish Processing Groups/Associations in Cambodia (09FSV01UC)*
- *Capacity building in aquaculture, fisheries management and coastal management for coastal women. Workshop: Opportunities for Coastal Women in Fisheries, Aquaculture and Coastal Management (09HHI02UH)*
- *Incorporation of tilapia (Oreochromis niloticus) and Sahar (Tor putitora) into the existing carp polyculture system for household nutrition and local sales in Nepal (09BMA03UM)*

In the Auburn University Project, gender integration was a feature at all levels of the project with a significant role taken by women investigators (Nelly Isyagi, Monica Karuhanga Berahu, Theodora Hyuha, and Gertrude Atukunda) and an overall emphasis on engendering the training and mentoring of women into all sectors of the aquaculture economy.

(c) Involve field projects in monitoring and evaluating gender integration as the program progresses with time. Evaluate the effects of specific projects on gender and ensure that any possible negative effects due to gender bias are mitigated.

Disaggregated gender data were reported for all long- and short-term trainings as well as for field trials. Gender of all US and HC staff was also reported. Each Core Research Project had a gender integration strategy that outlined steps to increase the number of, and mitigate bias against, female participation. Work under the Implementation Plan 2009-2011 included at least one activity in each project focusing specifically on gender issues as listed above.

(d) Focus one component of a lessons learned and synthesis assessment specifically on the social context and impact of CRSP research and outreach activities on the lives of women.

The second RFP (May 2009) specifically required new projects to design and implement an activity focusing on women as follows:

> ***Technical Considerations for Award of a CRSP Project*** *(p. 6, Items 3 & 5):*
> *3. Proposals must include at least one experiment or study. Proposals must also include at least one outreach activity that focuses on women.*
> *5.* Investigations must integrate gender to the extent possible to meet program targets. Overall, proposals will include a gender inclusiveness strategy(RFP website: Gender Inclusivity Strategy). **The existing strategy can be revised or resubmitted if it is still applicable to the work proposed. If resubmitting the gender strategy from 2007-09, additional details for incorporating gender will need to be apparent in the new investigations.**

(e) Tailor specific extension and technical services related to sustainable aquaculture and aquatic resource management to women producers.

Examples illustrating completed activities tailored specifically for women stakeholders are listed below:

- *Community-level shellfish culture and sanitation trainings: collaboration with women's producer organizations/cooperatives (07HHI04UH, 07IND03UH) and focus on women participating in community trainings (07HH05UH, 07IND04UH, 07WIZ02UH, 09HHI01UH, 09HHI02UH)*
- *Tilapia-Sahar polyculture: collaboration with RIDS-Nepal to include 50% women in the farmer training (07BMA02UM/09BMA03UM)*
- *Women processors: assessments of utilization and processing practices for small, low-value fish from the Mekong River fishery include a specific focus on the role of women (07FSV01UC/09FSV01UC)*
- *Women's Cooperative: collaborative assistance of the Trafalgar Women's Cooperative in the feed formulation trainings associated with the sustainable feed studies in Guyana and their assistance in developing small-scale aquaculture in poor rural areas (07SFT04UA/07SFT05UA/09SFT03UA)*
- *Women's Training on post-harvest processing and value-added product development (09MNE02NC/09FSC02NC)*
- *Targeted trainings for women: Requirements for food quality and safety in cockles, no-take zone management and monitoring, ecosystem management (09HHI01UH)*
- *Shellfish sanitation standards: trainings for women in Nicaragua and Mexico (09HHI02UH)*
- *Value-chain opportunities for women: collaboration with the Women in Fishing Industry Project to train women fish traders working in the Lake Victoria region in other income-generating opportunities along the fish value chain (e.g., aquaculture) (09MER02PU)*

(f) Engage extension specialists sensitive to diversity issues and access to resources of underrepresented groups and women will be included as an integral part of their delivery team to ensure women farmers and fishers feel welcome in CRSP training opportunities.

Each Core Research Project had a gender integration strategy that outlined steps to increase the number of women who participated in short-term trainings and enrolled in long-term degree programs: (1) female researchers and students were given positions as workshop presenters to establish connections with women trainees, (2) constraints limiting attendance in workshops were addressed (e.g., more flexibility in workshop location and scheduling), (3) extension specialists were trained to be more gender sensitive, (4) women were invited to participate in on-farm trials, (5) women's producer cooperatives were actively sought out to collaborate with AquaFish CRSP researchers, and (6) research focus and strategy took into account women's roles as food providers and preparers as well as their key positions in production and marketing.

(g) Promote the participation of women in formal and informal education and training opportunities provided through the CRSP. The CRSP has set a 50% benchmark for training women in formal and informal education. In addition, the 50% benchmark applies to attracting and retaining women scientists and administrators in all CRSP activities, as project researchers, advisory group members, and managers.

Projects were committed to promoting the participation of women at all levels from target populations to top-level researchers. Women were well represented in CRSP management, Advisory Groups, and in the group of Principal Investigators and collaborators. Women were the focus of stand-alone studies that were included in the portfolio to reflect a gendered perspective.

USAID IMPACT REPORTING

AquaFish CRSP reported under USAID's various impact reporting frameworks to achieve outcomes that have meaning for stakeholders, including Missions, HC decision makers, and end-users. The cumulative indicator reports filed with USAID for this reporting period (FY 2007 to FY 2012) are presented in this section.

USAID-EG Indicator Reporting

From inception to FY2012, AquaFish CRSP reported under USAID-EG 5.1 (Table 12.1) and 5.2 (Table 12.2) Agriculture Sector Productivity indicators. Appendix 3 provides supporting data for the technologies, practices, products, and markets reported under the technology indicators — 5.2-H(8), 5.2-I (9), and 5.2-J (10).[3]

Table 12.1. AquaFish CRSP FY2007-2012 USAID-EGAT/EG Indicator Report: Agriculture Enabling Environment.

Indicator number	4.5.1 Agriculture Enabling Environment (reported on FY07-08 only)	FY07-12 Cumulative actuals
4.5.1-12	Number of policies/regulations/administrative procedures analyzed as a result of USG assistance.	2
5.4.1-11	Number of individuals who have received USG supported short-term agricultural enabling environment training - Female	10
5.4.1-11	Number of individuals who have received USG supported short-term agricultural enabling environment training - Male	10
5.4.1-11	Number of individuals who have received USG supported long-term agricultural enabling environment training - Female	4
5.4.1-11	Number of individuals who have received USG supported long-term agricultural enabling environment training - Male	4
	Number of policy studies undertaken with USG assistance (Custom Indicator)	1

[3] Metrics are based on the best available data at the time of the 29 September 2011 reporting date.

Table 12.2. AquaFish CRSP FY2007-2011 USAID-EGAT/EG Indicator Report: Agriculture Sector Productivity

Indicator number	Updated number	4.5.2 Agriculture Sector Productivity	FY07-12 Cumulative actuals
5.2-14	5.2 -J (10)	Number of new technologies or management practices under research as a result of USG assistance.	164
5.2-16	5.2-H (8)	Number of new technologies or management practices made available for transfer as a result of USG assistance.	89
5.2-15	5.2-I (9)	Number of new technologies or management practices being field tested as a result of USG assistance.	80
5.2-17	5.2-B (2)	Number of additional hectares under improved technologies or management practices as a result of USG assistance.	9,983
5.2-19	5.2-M(13)	Number of rural households benefiting directly from USG interventions	1,002/yr
5.1-18		Number of vulnerable households benefiting directly from USG interventions	94
5.2-20	5.2-K(11)	Number of producers organizations, water users associations, trade and business associations, and community-based organizations (CBOs) receiving USG assistance	33
5.2-21		Number of agriculture-related firms benefiting directly from USG supported interventions.	28
5.2-28		Number of women's organizations/associations assisted as a result of USG interventions.	16
5.2-22	5.2-L (12)	Number of public-private partnerships formed as a result of USG assistance.	46
5.2-26	5.2-G(7)	Number of individuals who have received USG supported short-term agricultural sector productivity training - Female	1,995
5.2-26	5.2-G(7)	Number of individuals who have received USG supported short-term agricultural sector productivity training - Male	3,783
5.2-27	5.2-F(6)	Number of individuals who have received USG supported long-term agricultural sector productivity training - Female	372
5.2-27	5.2-F(6)	Number of individuals who have received USG supported long-term agricultural sector productivity training - Male	387
		Number of partner organizations benefiting (Custom Indicator)	28

13. LESSONS LEARNED

The lessons learned presented below are from an overall program perspective. Lessons learned from the Associate Awards are included here to the extent that they affected AquaFish CRSP program management.

Transitioning from ACRSP to AquaFish CRSP

During the period when Aquaculture CRSP and AquaFish CRSP overlapped, the ME found it challenging to run the two CRSPs simultaneously without benefiting from hoped-for economies of scale. Labor was fully utilized on the ACRSP and could not easily be extended to the new AquaFish CRSP effort. Periods of closedown and startup are incredibly labor intensive, and both require the use of trained staff with broad institutional memories. The transition between Aquaculture CRSP to AquaFish CRSP also presented challenges regarding new directions in research and new partners to assimilate. It was clear early on that prior experience with training participants in the CRSP "way" of real collaboration, strictly involving HC colleagues in all choices and decisions, helped when integrating new partners under AquaFish CRSP during Spring and Summer of 2007. We were fortunate that project finalists in 2007 had a mix of prior CRSP experience: two with a lot of prior CRSP experience, two with only a passing familiarity, and two newcomers. What was missing at the onset of AquaFish CRSP was an immediate sense of strong relationship bonds. One could readily observe those bonds in the old ACRSP. Indeed, the EPAC commented in Texas at the CRSP annual meeting that the sense of family was palpable and that the Director had achieved a wonderful goal of bringing together so much diversity harmoniously. The whole was much larger than the sum of its parts and by the end of AquaFish, after five years together, we found that the sense of community had returned.

Streamlining the Administration of Associate Awards

The integration of Associate Awards into the overall program should be done in a mindful manner. Increasing Management Office staffing to administer extra projects and assimilating such projects more completely into the overall AquaFish program are two ways to improve the management of Associate Awards in the future. The consensus among AquaFish CRSP management and advisory groups at the 2009 Annual Meeting was to treat future Associate Awards more similarly to Core Research Projects - adhering to technical peer-review, organizational, and reporting (i.e., DTAP indicators) requirements. We heeded this lesson with the SIRTD Associate Award and required all tasks to: (1) be written as "investigations" that undergo external peer-review; (2) add to the DTAP metrics; (3) and conform with core CRSP guidelines. With the Mali Associate Award this was impossible due to the last minute nature of the 2007 RFA.

This CRSP and others have observed that the use of associate awards to fund activities that are consistent with the Leader Award are administratively burdensome. The benefits of the additional resources programmed through Associate Awards rather than increased in core funding are offset by: (1) additional transactions costs to each CRSP; (2) parasitizing core resources (or leveraging off oneself); and (3) dissolution of researchers' time to band-aid pressing issues of the day at the expense of longer term discoveries. Most worrisome is that piecemeal funding of CRSPs could signal a redirection away from the time-tested successful CRSP model -- capacity building hand-in-hand with discovery.

Accepting New Money with Restrictions and Limited Time

On 14 July 2009, USAID released an RFA in the form of a letter to the ME for additional activities under the CRSP. The Director submitted a proposal in September 2009 and following negotiation with USAID/OAA, the *Modification of Assistance* of the CA/LWA was signed by USAID on 25 September 2009. These new funds ($3.92 million) were programmed in FY 2010 and FY 2011. The purpose of the new funding was to promote the extension of CRSP technologies and assess the impacts and communicate the importance of CRSP research. Although new program requirements associated with this funding were less than desirable (including major changes to *Section A.10 – Substantial Involvement*, a request to report on Aquaculture CRSP which was not active at the time, and a requirement to submit annual Work Plans), we recognized the need for this work and greatly appreciated that resources were made available to achieve USAID's stated goals. Receipt of the supplemental $3.92 million funding did, however, present challenges resulting from USAID's request to restrict funding to non-research projects and the requirement that the additional funds be spent by 29 September 2011 (a two-year time period). Fortunately we had established good working relationships with subcontracting partners who were able to respond quickly to emergency RFPs and could absorb and program awards in a short period of time.

Value of Timely Notice for Extensions

A NCE moving the Leader Award end date from 29 September 2012 to 31 March 2013 was approved and signed by USAID at the very late date of 21 September 2012. The late execution of this action required fast-action by the ME and subcontracting institutions to ensure that established subawards were not terminated. The fact that subawards (and their subawards) were not terminated is a testament to the solid working relationships between the ME and partnering institutions. The cost of re-establishing severed contractual relationships in the US and abroad incurs obvious administrative costs associated with preparing and reviewing the actual documentation. Perhaps more importantly, however, is the cost associated with time lost on the ground, where breaks in contracts could lead to pay/personnel redistribution (e.g. PIs and other skilled people leaving) and resource redistribution (e.g. lab and field research space). People and resources reassigned to non-CRSP projects may become unavailable for CRSP work once contractual ties are mended. Lost to many originating contracts officers and administrators is the fact that downstream subcontracts will seldom be extended until the upstream parent award is extended. Any delayed action from the funding source is magnified by the time the terminal subaward is amended. It may take many months before any extension is authorized at Host Country Institutions – a lag-time that is often underappreciated.

Third-Country Training

Third-Country Training can provide exceptionally good benefits for stakeholders in developing areas. In-person observations of successes (and sometimes failures) in other countries, complemented with face-to-face discussions with practitioners in those countries, often provide a far better educational experience than reading reports or listening to conference presentations from afar. This truth has been demonstrated in several AquaFish CRSP projects. One example was from the Mali Associate Award project, in which outstanding contributions to aquaculture and fisheries development efforts were made by Malians after receiving CRSP-sponsored training in China and Kenya. On their return to Mali, participants were instrumental in developing rice-fish culture demonstrations and constructing simple catfish hatchery facilities, in serving as leaders in subsequent trainings of farmers and extension personnel, and in providing support to other agencies working in these development areas in Mali. Their contributions proved to be significant factors in the successes achieved by the project and continue to impact the development of the aquaculture and fisheries sectors in Mali.

Indicator Reporting

The combined sets of internal DTAP and USAID EGAT indicators were valuable tools for quantifying accomplishments. However, the USAID indicator component did not work as smoothly as hoped nor did it offer recognizable benefits to the CRSP investigators who were the principal data gatherers. Last

minute changes in USAID indicators and the associated rushed data gathering, as was the case with the FY 2010 set (announced on 21 October 2010), should not be expected to generate robust metrics. The changing annual landscape of USAID indicators also threatened consistency in comparative assessments of results across years. Host Country and US investigators supported impact assessment but were less sure of the value of indicators because the inconsistent reporting process and with no apparent tangible returns for their efforts. CRSP investigators had an equal need for the same data with which they assessed progress and accomplishments and also drew upon to guide subsequent steps in their research and development approaches. From the perspective of what indicators should have been, but unfortunately were not, the lessons learned were that indicator reporting should have been integrated directly into the CRSP investigation workplans with pre-approved indicators that applied through the duration of the investigation and offered metrics that were useful both for USAID and the investigators who worked to improve aquaculture and fisheries systems in their countries. Fortunately this CRSPs own DTAP metrics and Key Development Benchmarks, which were an internal set of indicators, provided better feedback to the CRSP on performance and served as more useful tools for assessing project impacts.

More Efficient Contracting Mechanisms

AquaFish CRSP's US Lead Universities typically moved CRSP funding to collaborating HC Institutions through cost-reimbursement contracts. Moving forward, the AquaFish CRSP ME would consider the use of fixed-price contractual agreements between US Lead Institutions and HC Institutions as a reimbursement method to directly link payment to receipt of deliverables and/or performance. Under this system, HC Institutions would receive payment upon timely receipt of predetermined deliverables or meeting predetermined performance benchmarks. Further, as stated in the FAR 16.2, fixed-price contracts would provide "maximum incentive for the contractor to control costs and perform effectively and imposes a minimum administrative burden upon the contracting parties." All HC partners would still be held to the same standards, rules, and regulations that were enforced by AquaFish CRSP and USAID.

Cost Share

Meeting matching requirements for CRSP became a challenge for almost every US university. In the CRSP model, cost share is a fundamental dimension of all programs as it helps stretch limited federal dollars with State and other non-federal sources of funds, and leverages experienced faculty and resources from the US university community. At cost-sharing rates of 35% for US universities in the CRSP including the Management Entity, all US universities are being tested in meeting their minimum commitments. A combination of factors contributed to this problem, with the present shortfalls in almost all State economies leading the reasons. Most CRSP US universities were funded through State dollars, and with greater accountability of professors' salaries demanded by the States, less was truly available for external programs. Moving forward, this CRSP will re-evaluate cost-sharing rates to prevent undue hardship on US partners while still ensuring institutional buy-in and maximizing program value.

Maintaining ME Capacity

The ME was relied upon for all manners of things from USAID, project participants, and more generally from the international aquaculture arena. While expecting and achieving efficiencies by doing more electronically and on-line, the need for staff contribution is often underestimated. Trained, knowledgeable staff were always needed to answer non-routine questions from project participants, USAID, and elsewhere. Indeed, the number and variety of questions from USAID increased considerably over the past years. In itself, the increased frequency and need for immediate communications with USAID was not a bad thing, and could indeed be a pathway toward better communication overall. But MEs need to build internal capacity and devote necessary resources to handle the upsurge.

Online Reporting and Management

AquaFish CRSP utilized a web-based project management system that was put in place in 2009. Built on a network of relational databases, the successful and highly functional system served as the data entry

point for project progress and administrative information. Customized report forms were accessed on a secure webpage unique to each project. Investigators made use of a number of on-line reporting features (e.g., training and trip databases), reviewed the status of project work (e.g., workshops completed), and viewed project contractual documents (e.g., subcontract). Although the Management Office faced several technical challenges to implementation (e.g. the end user's choice of browser), with appropriate technical guidance from the ME and the continued evolution of web-based communication tools, we are confident online reporting and data management will become a more effective and more efficient means of project management.

Value of Cooperation Among All CRSPs

USAID funds a diverse portfolio of CRSPs, ten in all, covering researchable priorities for crops and animals and the systems they are grown in around the world. All CRSPs are organized to reduce poverty, hunger and environmental degradation in various regions, commodities, and systems. In order to get work done on the ground, however, CRSPs differentiate into focus areas around fish, fisheries products, aquatic ecosystems, livestock, dry grains, pulses, peanuts, sorghum, millet, vegetables, fruits, natural resources management, markets, nutrition, integrated pest management, and so on. Our CRSP focused on aquaculture and fisheries in following the CRSP mission of achieving outcomes by improving incomes, feeding vulnerable populations, enhancing food security, and conserving precious natural resources.

For many years, USAID has asked CRSPs to work more closely and effectively together. During this reporting period, two important steps were taken to bring these ten CRSPs together.

- The first was to combine the wealth of information CRSPs have accumulated over the years in an information clearinghouse. AquaFish CRSP led the way in contracting with a private sector company— Cultural Practice LLC— in a new CRSP Council Knowledge Management Project (http://crsps.net). With help from the Knowledge Management Project leader, Dr. Deborah Rubin of Cultural Practice LLP, as of June 2012 nine CRSPs have contracted with CP LLC.
- The second step in aggregating efforts across CRSPs occurred in July 2011 when the CRSP Council held its first-ever "Council-USAID Partners Meeting" overseas. Because Uganda hosted nine CRSPs at the time, it proved a practical place to convene the CRSPs along with their USAID Washington partners in a face-to-face meeting with USAID and CRSP counterparts in Africa. Connections between CRSPs were strengthened, with Aquafish CRSP considering plans to work with other CRSPs on the ground to share technologies and leverage investments.

Past inter-CRSP research projects have not created the desired synergies, which is no surprise given their non-overlapping scientific foci; the CGIAR centers also experience this problem. Researchers galvanize around issues of common interest. Yet with these two examples above, we saw true milestones met in CRSPs working better together where they can. The CRSP meeting overseas and the KM project are but two steps CRSPs have taken to create synergies. Cross-CRSP connections among researchers on the ground, administrators in the MEs, and evaluation experts in the private sector are changing the landscape in which all CRSPs operate.

14. PLANNING FOR THE FUTURE & ALIGNMENT WITH THE FEED THE FUTURE INITIATIVE

Great progress has been made over the past twenty years in increasing fish production through aquaculture, yet challenges still face the sector in terms of pressures from global trade, environmental impacts, water use conflicts, and distribution of and access to benefits. At the same time, the capture fisheries sector, which supplies half of the world's fishery products, is experiencing great challenges that must be overcome for the sustainable management of fish stocks and livelihood security of fishing communities. AquaFish CRSP stressed technologies that do not demand inappropriate technologies, do not necessitate disease treatment (i.e., good water quality management lowers disease incidence), and do not require genetic manipulation of animals. Future areas of inquiry will address critical constraints and emerging issues, for which AquaFish CRSP has built synergies and can avoid duplication with other development efforts.

CRITICAL CONSTRAINTS

Sustainable aquaculture development and improved fisheries management continues to face numerous critical constraints that must be addressed in order to sustainably increase productivity.

- Policies: Investors must be assured that they are operating within a framework of enabling governmental policies and support.

- Financing: Interested parties must have access to appropriate levels of capital financing to establish and expand individual business operations within broader industry development.

- Access to land and water: Entrepreneurs must have access to land, either through ownership or community cooperatives for pond construction and operation. In coastal and lake regions, operators must possess the rights to use the water column for grow-out. Appropriate resource management (e.g., watershed management and integrated coastal zone management) is also necessary to address the concerns of multiple users to minimize the effects of competition for limited space and water resources.

- Human Capacity Development: A capable cadre of aquaculture and fisheries professionals able to train the next generation well, and in the meantime also provide reliable, high quality information to the sector is critically needed. How will this fastest growing sector of agriculture (aquaculture has grown about 8% per year in the past 25 years) survive the onslaught of charlatans who dole out inferior products (seed and feeds, for example) and poor advice? A continuous pipeline of knowledgeable aquaculture researchers and professionals will help shape the ability of a country to frame its own research questions.

- Water quality: Fishery harvesters and aquaculture operations must have access to adequate quantity and high quality, unpolluted water sources for successful survival and growth of aquatic species. Inland and

coastal/estuarine aquatic ecosystems are experiencing increasing pressures and therefore depend upon responsible watershed management to ensure the long-term existence of adequate water supplies that are deemed suitable for human consumption and ecosystem use, including the aquaculture and fisheries sectors. Also important are the environmental impacts from aquaculture operations and their effects on water quality.

- Institutions and emerging issues: Aquaculture and fisheries must have the support of national research institutions to develop appropriate technologies for optimal systems and practices. Assistance must be provided for research that focuses on emerging issues related to: species diversification for aquaculture production (including low trophic species, indigenous biodiversity conservation, and potential for non-food aquaculture species); ecosystem-based fisheries management; integrated systems development for cost-effective production (including cage culture for inland, nearshore, and open ocean environments, recirculating aquaculture, and polyculture); fisheries stock assessment; species nutrition and sustainable feed development that reduces dependency on fish meal and oil as feed ingredients; post-harvest losses; the source and fate of contaminants in aquaculture feed; the application of biotechnology to increase efficiency, economic growth, nutritional value, environmental quality; algal systems development; and other previously discussed topics.

- Access to technical expertise: Farm managers must have access to technical expertise and guidance through appropriately designed extension and outreach programs that address gender integration in order to remain competitive.

- Food safety, post harvest, and processing: For export market potentials to be realized, producers must ensure quality control that also meets standards of importing nations. Technical issues associated with food safety, quality, certification and niche labeling (e.g., eco-labeling), and traceability could otherwise serve as non-tariff trade barriers and prevent market access for many developing countries. Post-harvest losses in developing countries can be as high as 30%. Increasing production to compensate for anticipated post-harvest losses is highly inefficient. Post-harvest losses and related sustainable cooling technologies for these highly perishable products are areas where there can be great sectoral improvements for local and transnational markets.

- Climate Change: Aquaculture, like agriculture and other human activities, will feel the effects of long-term climate effects. Among the myriad challenges: Sea level rise will affect the world's coastal aquaculture operations, most of which are in poorer countries. Temperature changes will test the resiliency of domesticated varietals. Challenges exist to understand the adaptive range of these species, and also to develop cultivation techniques for new species. The shifting distribution of global freshwater supplies will pose challenges on the aquaculture industry, on small farmers, and on the marketplace.

- Water resources conflicts: Managing sustainably in an integrated water use (landscape/waterscape) system. Water use conflicts are predicted to grow over the next 20 years. Most of the world's poor have little or no access to safe drinking water or sanitation. Aquaculture and fisheries share the water resources sector with these and other uses that pollute, withdraw, and have higher immediate priorities. Especially for freshwater resources, aquaculture and fisheries needs must be better understood for integration into broader national and regional water use frameworks. Development interventions have a responsibility to tie into an integrated approach, both through watershed planning, and through policy and governance. In addition, water- and vector-borne diseases, such as schistosomiasis and malaria, can be associated with poor management of aquaculture farms.

- Fast pace of technology change: Technology and demand are driving new trends on the aquaculture frontier. These include offshore aquaculture, recirculating systems, eco-labeling, genetically modified organisms, novel molecular vaccines, biodiversity conservation, geothermal aquaculture, and the growth of non-food aquaculture for the pharmaceutical, medical, biofuel, aquarium, and computer industries. These trends may gain in popularity and must be taken into account in the global marketplace, where products grown in poorer countries will compete. Critical issues in the fishery sector include the continuing destruction of the world's coral reefs, new set-asides for marine sanctuaries, oil and gas drilling, ocean pollution, dead zones, and numerous other issues that will increasingly affect who fishes and where.

ALIGNING AQUAFISH CRSP WITH THE FEED THE FUTURE INITIATIVE.

Stopping the unsustainable exploitation of aquatic resources by developing good water management strategies at regional, local, and national levels and promoting equitable access is part of the Millenium Declaration. It was also a guiding principal of the AquaFish CRSP. Giving the poor better access to well managed water resources can help eradicate poverty. USAID's Bureau for Food Security (BFS) recognizes the impact poverty has on livelihoods, health, and ecosystems in aligning strategies and goals with Feed the Future, the U.S. government's global hunger and food security initiative.

The overarching goal of FtF 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 two primary objectives of FtF are: 1) accelerate inclusive agriculture sector growth; and 2) improve nutritional status (especially of women and children). The 2010 Ftf Guide states coordinated investments in agricultural production (e.g., in extension services and training) can increase the incomes of at least 40 million people, including 28 million people who are currently living on incomes of less than $2 per day, and 13 million people living in extreme poverty on less than $1.25 per day. As women are more likely to reinvest income in the welfare of their children, FtF- targeted investments in women are predicted to yield benefits across generations.

The vision for AquaFish CRSP was to create global partnerships that develop sustainable solutions in aquaculture and fisheries for improving health, building wealth, conserving natural environments for future generations, and strengthening poorer societies' ability to self-govern in ways that respect the sanctity of all. AquaFish CRSP focused on research and on creating multiplier effects for farm level income and worked with partners to scale up CRSP technologies for broader impacts.

Ftf recognizes that research on production systems, post-harvest value chains, risk and vulnerability reduction, and other areas can significantly increase productivity gains and farm income above and beyond producer level production. The returns from new research in agriculture are potentially quite large, especially when applied in conjunction with the direct investments in producer level production, markets, and nutrition. These effects and a range of other indirect but measurable benefits – including increased technical and institutional capacity, favorable policy environments, and the expansion of recipient countries' own public and private investments – are anticipated to accelerate sustainable, country-driven development, poverty reduction, and improved nutrition.

The FtF initiative came into being at the end of AquaFish CRSPs life and was therefore not built into the

CRSPs original programming. In 2010 when FtF was publicly released, AquaFish had already programmed its final USAID allocation (FY10 funds). Nonetheless, there were natural synergies between the core work CRSP did and the FtF Initiative. AquaFish activities fell primarily under the following FtF objective: 3.3.1 Inclusive Agriculture Sector Growth. Gains in productivity can be driven by a number of factors, including improved access to agricultural inputs and knowledge, more efficient use of land and labor, conducive policy environments, and improved management of natural resources. AquaFish CRSP's work also addressed Ftf's objective 3.3.2 Improved Nutritional Status by improving diet quality and diversity through the addition of animal source protein and micronutrients commonly found in fish.

AquaFish CRSP efforts focused on small-scale agricultural producers, high quality seed, and best management practices. Increased access to inputs was coupled with strategies that helped ensure their safe and sustainable use. Investments aimed for women to have equal access to affordable inputs and improved techniques and technology. Our technologies were tailored to local conditions that supported national research institutes and built local research capacity, including training local researchers and technicians.

The CRSP additionally supported Ftf objectives in *Expanding Markets and Trade* through the development and dissemination of market information for producers and enterprise owners, including activities that focused 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, and understanding value chains, AquaFish aimed to make markets work better for women and men agricultural producers and extend the reach of nutritious foods.

Working regionally across Africa, Asia and Latin America holds the promise of strengthening regional coordination and can add value to activities at the country level. Our program was consistent with FtF goals in its focus on accelerating inclusive agriculture sector growth through improved aquacultural productivity, expanding markets and trade, and increasing economic resilience in vulnerable rural communities. Improvements in nutritional status are expected by increasing access to diverse and high quality, animal source foods. The ability to access and utilize food must remain stable and sustained over time. Paying attention to cross cutting themes of gender, environment (climate change), and natural resources management is expected to result in good nutrition for all family members.

APPENDIX 1. PROGRAM PARTICIPANTS

Management Team

Oregon State University, Corvallis, Oregon USA

Hillary Egna	Director & Lead Principal Investigator
Ford Evans	Research Projects Manager (December 2008 to present)
Bernard Kepshire	Research Projects Manager (December 2007–June 2008)
Karl Kosciuch	Research Projects Manager (November 2006–March 2007)
Jim Bowman	Outreach and Capacity Building Coordinator (Part-time, April 2007- May 2012); Mali Project Associate Award Coordinator (Part-time, January 2008 – December 2010)
Laura Morrison	Synthesis and Reporting Coordinator (November 2007 - April 2012)
Lisa Riefke	Training & Gender Coordinator (Part-time, April 2010 – present)
Shawn Hayward	Web Manager (September 2010 – present, formerly CRSP student)
Dwight Brimley	Office/Business Manager (September 2006 - July 2010)
Cindi Claflin	Office Specialist (April 2010 - present)
Patty Heublein	Office Specialist (October 2008–December 2009)
Stephanie Ichien	Research Program Assistant (Part-time, January 2011- present)
Claire Schrodt	Program Analyst (Part-time, November 2010 - present)

United States Agency for International Development

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Harry Rea	Agreement Officer's Technical Representative

Advisory Bodies

External Program Advisory Council

Christine Crawford	University of Tasmania, Australia
Jason Clay (Aaron McNevin –proxy)	World Wildlife Fund, Washington, DC
Nathanael Hishamunda	FAO, Rome, Italy
Marcia Macomber	CGIAR Challenge Program on Water & Food, Sri Lanka

Ex-Officio Members

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Hillary Egna	Oregon State University

Development Themes Advisory Panel: Lead Coordinators

Maria Haws	DTAP A	University of Hawai'i at Hilo
Kwamena Quagrainie	DTAP B	Purdue University
James Diana	DTAP C	University of Michigan
Robert Pomeroy	DTAP D	University of Connecticut–Avery Point

Regional Centers of Excellence: Lead Coordinators

Charles Ngugi	East & Southern Africa	Kenyatta University, Kenya
Héry Coulibaly	West Africa	Direction Nationale de la Pêche, Mali (From August 2010)
Remedios Bolivar	Asia	Central Luzon State University, Philippines
Wilfrido Contreras-Sanchez	LAC	Universidad Juárez Autónoma de Tabasco, Mexico
Yuan Derun	Asia	Network of Aquaculture Centres in Asia-Pacific, Thailand (From June 2011)

Emerging Issues Panel

Oregon State Univeristy	*Discipline*	*Position*
Aaron Wolf,	Water policy and resource conflicts	Geography Program
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Michael Morrissey	Seafood science	Director of the Astoria Seafood La
Michael Campana	Hydrology	Director of the Institute for Water
Flaxen Conway	Fishing community outreach	Oregon Sea Grant and Sociology I
Robert T. Lackey	Fisheries management and policy	US Environmental Protection Age
David Noakes	Fish culture and fish biology	Director of the Oregon Hatchery R
Gil Sylvia	Marine resource economics	Superintendent of the Coastal Oreg Sciences Center

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Julius Manyala	HC Co-PI	Moi University (from October 2010)
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Central Projects

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APPENDIX 2. 2007 - 2011 LEVERAGED FUNDING

Funding from non-AquaFish CRSP leveraging for the five fiscal years 2007 to 2011 is presented below as reported through Quarterly, Annual, and Regional Centers of Excellence (RCE) Reports. Funding sources include grants, training, travel support, equipment, facilities, and other forms of provided services and supplies. Leveraged support is in addition to US non-Federal cost share and Host Country institution match.

US Lead Institution	Reported for Quarter Ending, RCE report, or by HCPI	Amount ($)	Funding Source
University of Arizona			
	2008 Annual Report	$9,500	Universidad Juàrez Autònoma de Tabasco
	2008 Annual Report	$70,000	National Commission for Fisheries (CONAPESCA)
	October 2007		AID Mission
	December 2008	$27,370	USAID/GRIS – Guyana
	December 2008	$25,000	USDA Foreign Ag Service, (ISTA8)
	December 2008	$10,000	Intervet Schering Plough (ISTA8)
	December 2008	$10,000	American Soybean Association, (ISTA8)
	December 2008	$100,000	Egypt Center for Aquaculture Research – Dept of Agriculture
	June 2009	$2,132	Farmer to Farmer – Guyana
	June 2010	$1,200	All Tech
	FY 2010 RCE	$16,260	Universidad Juàrez Autònoma de Tabasco
	FY 2010 RCE	$60,000	Fundacion Produce
	FY 2010 RCE	$120,000	Universidad Juàrez Autònoma de Tabasco
	March 2011	$10,000	Intervet Schering Plough
	April 2011 (HCPI)	$60,000	National Council for Science and Technology
	April 2011 (HCPI)	$672,300	Universidad Juàrez Autònoma de Tabasco
	April 2011 (HCPI)	$41,200	National Institute for Aquaculture & Fisheries
	June 2011	$10,000	Intervet Schering Plough
	June 2011	$15,000	Guyana Trade and Investment Support
University of Michigan			
	December 2007	$99,158	Graham Environmental Sustainability, UM
	June 2009	$13,000	National Agricultural Research and Development Fund (Nepal)
	June 2010	$16,055	Aquaculture Without Frontiers – UK
	April 2011 (HCPI)	$11,696	Shanghai Ocean University
	April 2011 (HCPI)	$1,400	Shanghai Ocean University
	April 2011 (HCPI)	$27,000	Shanghai Agriculture Administration
	August 2011 (HCPI)	$34,500	National Natural Science Foundation of China
	2008	$21,900	Shanghai Municipal Science and Tech. Commission [i]
	2009	$11,700	Shanghai Municipal Education Commission [ii]
North Carolina State University			
	December 2008	$20,000	Bourlag LEAP Fellowship, USAID
	March 2009	$64,701	NC SeaGrant Fisheries Resource Grant
	March 2009	$1,700	NPEDA (India)
	June 2010	$211,612	United States Department of Agriculture
	March 2011	$93,608	North Carolina Sea Grant

US Lead Institution	Reported for Quarter Ending, RCE report, or by HCPI	Amount ($)	Funding Source
Purdue University			
	September 2007	$8,000	Virginia Tech
	September 2007	$9,000	World Bank
	June 2009	$25,000	SARNISSA
	September 2010	$10,000	PEO International Women's Peace Scholarship Fund
	April 2011 (HCPI)	$302,000	Kwame Nkrumah University of Science and Tech.
	April 2011 (HCPI)	$66,000,000	Kenyan Government [iii]
University of Connecticut			
	April 2011 (HCPI)	$5,000	Mekong River Commission (MRC) and Nagao Natural Environment Foundation (NEF)
	April 2011 (HCPI)	$10,000	Nagao Natural Environment Foundation and Cambodian Government
	April 2011 (HCPI)	$36,000	Inland Fisheries Research & Development Institute (IFReDI)
University of Hawaii at Hilo			
	June 2008	$250,000	US State Department
	December 2008	$300,000	European Union, grant to CIDEA/UCA (Nicaragua)
	March 2009	$25,000	European Union
	December 2009	$3,000	State Committee for Aquaculture Sanitation of Sinaloa (CESASIN)
	December 2009	$2,000	David Nisbet of Goosepoint Oysters
	April 2011 (HCPI)	$73,200	University of Hawaii at Hilo
	September 2011	$10,000	CIDEA Foundation
Auburn University			
	March 2010	$2,000	Auburn University (Travel)
	June 2010	$4,500	Alabama Agricultural Land Grant Alliance
	December 2010	$4,000	USAID National Agricultural Development Project
	March 2011	$9,602	US Environmental Protection Agency
	June 2011	$4,000	Alabama Land Grant Alliance
Regional Centers of Excellence			
	April 2011	$141,800	National Council for Science and Technological Development
	September 2011	$1,190	Mindanao State University
	Total	**$69,163,284**	

[i] Prior year funding of 150,000 Yuan reported August 2011. Converted using 9/30/08 exchange rate of 6.8431.
[ii] Prior year funding of 80,000 Yuan reported August 2011. Converted using 9/30/09 exchange rate of 6.8262.
[iii] Kenya Economic Stimulus Program. This leveraged funding is split across two years ($16 million in year one and $50 million in year two) and was obtained through Aquaculture and AquaFish CRSP activities dating back to 1997.

APPENDIX 3: MONITORING & EVALUATION TABLES FOR FISCAL YEARS 2008–2011*

* The DTAP framework was codified in FY2007, therefore DTAP indicators were first reported by the Core Research Projects in FY2008. The DTAP indicators were utilized through FY2011, which was the final year of full funding prior to the NCE granted in FY2012.

Table 1. AquaFish Investigation Indicator Reports for DTAP A01: Number of aquaculture products developed to improve food safety or quality.

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	A01 Report Text
Implementation Plan 2007–2009					
07FSV01UC Low-Value Fish Product Development	1	1	N/A	N/A	BMPs for low-value/small fish processed, value-added products with improved food quality and safety under preparation for transfer in FY10 via 07TAP01UC.
07HHI01UM Microcystin Control	1	1	N/A	N/A	Product development of microcystin-free fish will progress as technology is adopted.
07HHI05UH Depurated Cockles	1	1	N/A	N/A	Depurated cockle product (2 species sold together) in market testing for adoption in FY10 as certified product.
07IND04UH Oyster Depuration	1	—	N/A	N/A	Relay and depuration technology trials for native oyster.
Implementation Plan 2009-2011					
09BMA03UM Sahar Polyculture	N/A	N/A	—	1	Farmed sahar (local indigenous fish) raised in polyculture is under development and on-farm testing. Availability of farmed sahar will provide improved nutrition to local households.
09FSV01UC Fish Paste Product Development	N/A	N/A	1	1	Improved fermented fish paste products with improved quality and safety under research and development
09FSV02NC Seaweed Processing	N/A	N/A	1	2	Seaweed products with improved quality: (1) candy/desserts made from agar (2) pickled seaweed
09IND01UH Native Oyster Hatchery	N/A	N/A	1	1	Hatchery seed of native oyster for shellfish with improved health and safety
09IND03UH Chame Spawning & Larval Rearing	N/A	N/A	1	1	Development of chame product with improved quality and safety associated with spawning/larval rearing technologies
09MNE03UM Good Practices & Eco-Certification	N/A	N/A	—	1	Eco-certified shrimp with improved health and safety: in progress, but we expect that at least one of our studied methods will improve food quality by reducing needs for chemical control

Table 1. AquaFish Investigation Indicator Reports for DTAP A01: Number of aquaculture products developed to improve food safety or quality.

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	A01 Report Text
09QSD03UM Prawn-Mola Polyculture	N/A	N/A	—	2	The development of mola culture as part of a freshwater prawn polyculture system will add a new product to the market that addresses nutritional needs of smallholders. (The prawns will be raised for the export market.)

Table 2. AquaFish Investigation Indicator Reports for DTAP B01: Number of new technologies developed

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B01 Report Text
Implementation Plan 2007–2009					
07BMA02 UM Sahar-Tilapia Polyculture	—	—	1	N/A	Tilapia-sahar polyculture system with sahar density at 0.125 fish per square meter under adoption by cooperators.
07BMA04 UH Shellfish BMPs	—	—	2	N/A	Training in BMPs to improve shellfish production and sanitation for farmers and vendors: (1) Oyster culture methods (2) shellfish sanitation
07HHI01U M Microcystin Control	—	2	N/A	N/A	Two new effective treatments developed and tested: (1) chitosan-modified clay and (2) PAC-modified clay. Transfer of chitosan-modified clay as more environmentally friendly to 5 researchers. Adoption will spread via researchers in FY10.
07HHI02U A Aquaponics with Tilapia Effluent	—	1	N/A	N/A	Aquaponics system for leafy greens irrigated with tilapia effluent developed and tests conducted to evaluate levels of bacteria on lettuce.
07HHI05U H Depurated Cockles	1	1	1	N/A	Depuration technology trials for 2 native cockles (*Anadara* sp.) (FY08-FY09). Market for depurated cockles building due to spread by word-of-mouth of improved quality and safety with depurated product (FY10).
07IND02U A Native Cichlid Culture	—	2	1	N/A	Developing technology for genetic improvement and alternative feeding of native cichlids (FY09) (1) Families of *Cichlosoma urophthalmus* have been selected from three different locations and placed in hapas for grow-out. *Petenia splendida* adults are in breeding tanks and family selection is in progress; (2) substitution of fishmeal for poultry meal. Farmer training in biology and culture technology for tropical gar and native cichlids (FY10)
07IND03U H Spat Collection	1	1	N/A	N/A	Technology development for women oyster growers of spat collection and grow out of native oyster in Santa Maria Bay.
07IND04U H Oyster Depuration	1	1	N/A	N/A	Relay and depuration technology trials for oyster conducted at 2 sites.

Table 2. AquaFish Investigation Indicator Reports for DTAP B01: Number of new technologies developed

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B01 Report Text
07MER03PU Tilapia-Catfish Predation Culture	—	1	4	N/A	Farmer cooperators field testing research-based extension recommendations for mixed-sex tilapia-catfish predation polyculture to improve profitability (FY09). Training for small-farmers in production and management practices (FY10) (1) Pond preparation and construction (2) Fish management practices (3) Hand-sexing (4) polyculture of tilapia and catfish
07MNE06UA MT Elimination	—	3	N/A	N/A	Development of clean tilapia masculinization technologies: (1) MT degradation by TiO2 (transfer in FY10); (2) bacterial degradation; (3) MT measurement using ELISA.
07QSD01NC Tilapia Seedstock	—	1	N/A	N/A	Qualitative assessment of different hatching systems for Nile tilapia fry production and fingerling growout. Transfer of recommended technology in FY10.
07QSD02PU Catfish-Baitfish Farming	—		2	N/A	Post-production training in marketing: (1) Marketing plan for baitfish farm clusters (2) Finance management
07SFT01UC Snakehead Feed Technology	—	4	N/A	N/A	Alternative feed technologies for 2 species of snakehead under research & development: (1) Weaning of hatchery-raised snakehead (2) Pelleted feed for hatchery-raised *C. striata* (3) Pelleted feed for hatchery-raised *C. micropeltes* (4) Rice bran substitution as protein source for fishmeal in mixed fish-soybean-cassava meal
07SFT02NC Feeding Strategies for Tilapia	—	3	N/A	N/A	Technologies under development and field testing: (1) IGF-I assay as a biomarker for tilapia growth status (biotechnology) (2) Reduced feeding strategies to reduce costs for producing Nile Tilapia in ponds (3) Fishmeal replacement with food by-products
07SFT03NC Feeding Strategies for Milkfish	—	2	N/A	N/A	Technologies under development and field testing: (1) Reduced feeding strategies to lower costs for producing milkfish in tanks (transfer in FY10) (2) IGF-I assay to test milkfish growth status in progress (biotechnology: development and testing in FY10)

Table 2. AquaFish Investigation Indicator Reports for DTAP B01: Number of new technologies developed

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B01 Report Text
07SFT04UA Local Feed for Tilapia & Pacu	—	5	N/A	N/A	Local ingredients as fishmeal feed replacement for Tilapia and Pacu: In Transfer Stage (FY09-10): (1-2) Copra meal and shrimp meal are now being used in some production diets at several farms. In Development & Testing Stage: (3) Poultry by-products (testing in FY09-FY10; transfer in FY10) (4) Brewers waste (testing in FY09-FY10) (5) Palm nut oil cake (development stage into FY10)
07SFT05UA Fishmeal Substitution	—	2	N/A	N/A	Feed formulation and manufacture of local ingredient substitutes: (1) Under development: new feed formulation technology for copra meal, shrimp meal, and brewers wastes. (testing and transfer in FY10) (2) Under adoption (FY09-10): on-farm diet formulations and manufacture methods with hammer mill and compression pelleting equipment.
07SFT06PU Locally Available Feed for Tilapia	1	1	N/A	N/A	Alternative feed technology under development: local plant species as low-cost alternatives to soybean meal in fish feed: *Moringa oleifera* and *Leucaena leucocephala* leaf meals found effective when supplemented with soybean as protein source. Testing underway of commercial formulation by feed mill (FY09). Transfer to farmers scheduled for FY10 (November 2009).
07TAP01UC Feed Technology Adoption	—	—	2	N/A	Technology transfer in Farmer Training: (1) sustainable feed alternatives for snakehead (2) sustainable fish feeding practices
07TAP02NC Tilapia Podcast	—	1	N/A	N/A	Developed and 9 introduced *Tilapia Cast* as internet-based extension podcast for tilapia farmers. 2 additional podcasts scheduled for production and transfer in FY10.
07WIZ01PU Ghana Water Quality	—	—	3	N/A	Transfer in training of technologies/management practices to minimize waste and contamination of receiving waters from pond effluent and non-native species: (1) Effluent Management (2) Feeding and nutrients (3) Prevention of farm fish escape
Implementation Plan 2009–2011					
09BMA01AU Cage Culture	N/A	N/A	1	2	Cage Culture technology trial for Small-Holder Farmers -- 2 cages (FY10-FY11) 2. Developed demand feeding practices using automatic feed in South Africa (FY11)
09BMA03UM Sahar Polyculture	N/A	N/A	1	1	On farm development of polyculture technology for sahar-tilapia-carp for best ratio of predator to prey in economic and ecological terms.

Table 2. AquaFish Investigation Indicator Reports for DTAP B01: Number of new technologies developed

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B01 Report Text
09BMA04UM Pond-Based RAS	N/A	N/A	1	1	Pond-based RAS (Recirculating Aquaculture System) system for shrimp with solid waste removal and water quality controls
09BMA05UM Indoor RAS	N/A	N/A	2	2	1. Indoor RAS (Recirculating Aquaculture System) for shrimp: control of water quality and micro-organisms (e.g., cyanobacteria) 2. Floc-based aquaculture system
09FSV01UC Fish Paste Product Development	N/A	N/A	—	2	Under transfer, Best Practices and Standards for processing Fish Paste Products: 1. Quality & Safety Processing Guidelines 2. Packaging & Labeling Standards
09FSV02NC Seaweed Processing	N/A	N/A	1	2	(1) Improved seaweed drying method using racks (FY10) (2) Value-added seaweed processing technologies for agar to make candy/desserts and for industrial grade agar and carrageenan (FY11)
09IND01UH Native Oyster Hatchery	N/A	N/A	1	1	Larviculture of native oyster
09IND02UC Snakehead Aquaculture	N/A	N/A	1	1	Snakehead for aquaculture: induced spawning in captivity
09IND03UH Chame Spawning & Larval Rearing	N/A	N/A	2*	2	Indigenous species development of Chame for aquaculture: 1. Spawning technology successfully tested 2. Larval rearing technology under development
09IND04UH Chame Stock Assessment	N/A	N/A	—	1	Indigenous species development of Chame: Management Technology: Age-determination technology

Table 2. AquaFish Investigation Indicator Reports for DTAP B01: Number of new technologies developed

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B01 Report Text
09IND05UA Cichlids & Snook	N/A	N/A	5	5	Native Species Aquaculture Technologies -- experimental protocols for: 1. Selective Breeding of Cichlid broodstock 2. Establishing Fat snook and common snook broodstock lineages from wild and hatchery raised juveniles 3. Snook spawning in captivity 4. Identify native plankton as feed during early snook development 5. Determine gene expression of enzymatic activity in different snook life stages
09IND06PU New Species for Aquaculture	N/A	N/A	3	3	Aquaculture potential of 3 native African species in Ghana: *Heterotis niloticus*, *Chrysichthys maurus*, and *Parachanna obsucura* 1. Testing optimal protein levels in feed for *Heterotis niloticus* 2. Testing optimal protein levels in feed for *Chrysichthys maurus* 3. Ascertaining life history and growth performance of *Parachanna obsucura*
09MNE01UM Red Swamp Crayfish	N/A	N/A	—	1	Model to characterize invasive spread of red swamp crayfish in China. Model is being tested
09MNE02NC Milkfish Feed Inputs	N/A	N/A	3*	4	Improved Ecological Footprint Technologies for Milkfish (FY10-FY11): 1. On-farm demos of integrated, multitrophic aquaculture of milkfish-seaweed-sea cucumber in cages and pens 2. Alternate day feeding 3. Initial reduced feed ration (7.5 - 4% body weight) (FY11) 4. Value-added processing of milkfish (deboning and marination) training for women
09MNE07UA MT Elimination Technology	N/A	N/A	—	4	MT Elimination Technologies for transfer in on-farm trials: 1. Reducing MT dose for masculinization of tilapia fry 2. Charcoal filtration of MT treatment water 3.MT elimination with bioflocs of MT-degrading bacteria 4. Probiotic use of bacteria to foster MT-treated fish growth & survival
09QSD01NC Tilapia Seedstock Development	N/A	N/A	5	5	Tilapia Broodstock & Seed Production Technologies: 1. Social and physiological responses to stress as potential indicators for broodstock selection 2. Broodstock social condition effects on seed production - 3. Social condition effects on fingerling growout performance 4. Stocking density effects on growth and stress responses 5. IGF-I and cortisol tests as growth indicator (under testing)
09QSD02UA Aquaponics &Tilapia	N/A	N/A	3	3	Aquaponics and Tilapia strain selection technologies: 1. Aquaponics-aquaculture for control of pond wastes 2. Enterprise model for cost-benefits 3. Tilapia strain evaluation protocol

Table 2. AquaFish Investigation Indicator Reports for DTAP B01: Number of new technologies developed

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B01 Report Text
09QSD03UM Prawn-Mola Polyculture	N/A	N/A	1	1	Small-scale prawn-mola polyculture for market (prawn) and home consumption (mola and carp species)
09QSD04PU Tilapia Performance	N/A	N/A	—	4	Aquaculture technologies for improved tilapia species for small-scale aquaculture production: 1) Testing growth performance of Nile tilapia (*Oreochromis niloticus*) 2) Testing growth performance of Wami tilapia (*Oreochromis hornorum*) 3) Testing growth performance of Jipe perege (*Oreochromis jipe*) 4) Testing growth performance of Ruvuma perege (*Oreochromis placidus ruvumae*)
09QSD05PU Propagation & Hatchery Mgmnt	N/A	N/A	—	5	Training in 1) Sex reversal to produce all-male tilapia 2) Production of broodstock catfish through pituitary extracts and injection 3) Safe transportation of fingerlings from hatchery to production units 4) Water quality monitoring in the hatchery 5) Preparation of hormonal feed for test reversal in juvenile fish
09SFT01UC Alternative Feed	N/A	N/A	3	3	Snakehead pelleted feed trials: 1. *Channa micropeltes*: Survival and growth 2. *C. striata*: Survival and growth 3. Trials for Cambodia farmers-Replacement of fishmeal from marine vs. freshwater fish (Companion to 09TAP03UC)
09SFT02PU Pond-Cage System	N/A	N/A	1	9	Integrated pond-cage technology for small-scale tilapia farmers to reduce feed cost and manage pond waste (FY10). Technologies (FY11) 1) Pond Design and construction 2) Pond culture including fish pond management 3) Rice and fish culture integration 4) Catfish hatchery design and construction 5) Catfish breeding and propagation 6) Fish feed formulation 7) Tilapia fingerling transportation 8) Catfish fingerling feeding and growth 9) Fish value addition- marketing strategy (fresh, smoked, frozen, filleted, sun dried or deep fried)

Table 2. AquaFish Investigation Indicator Reports for DTAP B01: Number of new technologies developed

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B01 Report Text
09SFT03UA Guyana Aquaculture	N/A	N/A	3*	3	Aquaculture Technologies 1) Integrated inland farming-aquaculture for small-scale farmers and women 2). Standardized aquaculture feed with local ingredients to reduce fishmeal 3) Brackish water shrimp production
09SFT04NC Tilapia Feed Strategies	N/A	N/A	4	8	Tilapia Least-Cost Feed Formulation Technology (FY11) and Feed Reduction (FY10-FY11) Strategies: 1. Feed reduction strategies = 4 (delayed onset; alternate day; 67% and 50% subsatiation (counted as 4 different feeding strategies) 2.Formulation Strategy: reduce fishmeal component by replacing with agricultural by-product protein sources;2/3 (already demonstrated through research and being transferred and also conducting workshop training with feed manufacturers) 3.Formulation Strategy: reduced crude protein (26% from 31%) in normal fishmeal tilapia diet 4.Formulation Strategy: reduced crude protein (26% from 31%) and fishmeal free tilapia diet 5. Manufacturing Specification: pellet durability and water stability
09SFT05PU Leaf Meal Feeding Strategies	N/A	N/A	3	3	Sustainable Feed Technology studies using lower-cost, locally available ingredients: 1. Plant-based protein substitutes in feed 2. Feeding regime 3. Digestibility test with Chromium (III) oxide marker
09SFT06NC Impact Assessment	N/A	N/A	—	4	Transfer of aquaculture technologies to small-scale farmers: 1. Feed reduction strategies for tilapia 2. Alternative feed practices for milkfish 3. Value-added processing for milkfish 4. Integrative culture systems for milkfish
09TAP02NC Tilapia Podcasts	N/A	N/A	1	1	Extension podcast technology: modules on tilapia reduced feeding regimes (09SFT04NC) for international community of tilapia farmers and extension and research community; uploaded so anyone can access technologies developed and shown in podcasts
09TAP03UC Low-Value Fish Alternatives	N/A	N/A	1	1	Snakehead feed adoption pilot with on-farm trials in Vietnam and Cambodia: Farmer adoption in three Vietnam provinces. Technology transfer via outreach for the pelleted feed developed in 09SFT01UC
09TAP04PU Cage Culture in Ghana	N/A	N/A	1	1	Assessment of Cage Culture technology: strategy to remove constraints. New trainees learned to build cages and adopt cage aquaculture technology

Table 2. AquaFish Investigation Indicator Reports for DTAP B01: Number of new technologies developed

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B01 Report Text
09WIZ01AU Multiple Water Use	N/A	N/A	1	2	Rural watershed management for multiple uses--cage culture and non-aquacultural applications (FY10) 1. Developed methodology for trout farming in irrigation reservoirs in South Africa (under development) (FY11) 2. Developed floating garden technique for producing vegetables in floating styrofoam containers placed near trout cages (FY11)
09WIZ02AU Water Management	N/A	N/A	1	1	Software approaches for water management for multiple uses
09WIZ03UM Fish Cage Culture	N/A	N/A	1	2	1.Deep water cage production model with polyculture fish system under performance evaluation (FY10-FY11). 2. Development of a mass balance model for phosphorus in cage culture systems (FY11).

Table 3. AquaFish Investigation Indicator Reports for DTAP B02: Number of institutions with access to technological practices

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B02 Report Text
Implementation Plan 2007–2009					
07BMA02UM Sahar-Tilapia Polyculture	—	1	N/A	N/A	**Organizations** Rural Integrated Development Society (NGO) - Nepal (RIDS)
07HHI02UA Aquaponics with Tilapia Effluent	—	5	N/A	N/A	**Organizations** (1) UAT; Universidad Autonoma de Tamaulipas (EDUC/RES) (2) SAGARPA; Secretaria de Agricultura Ganaderia, Recursos naturales y Pesca. (GOVT) (3) DIF; Desarrollo integral de la familia (GOVT: Youth at Risk program) (4) State of Tamaulipas; Gobierno del Estado de Tamaulipas (GOVT) (5) Farmers cooperatives: not available
07HHI04UH Shellfish Regional Workshop	12	12	N/A	N/A	**Universities** (1) FACIMAR-UAS; (2) UAS-Culiacan; (3) Universidad Tecnológica de la Costa Nayarit; (4) UNAM **Government** (1) ConsejoEstatal de Ciencia y Tecnología); (2) CESAIBC (ComiteSanidad Acuic.BC); (3) IAES (Instituto de Acuac. Edo.Sonora; (4) InstitutoPolitecnicoNacional-Acuacultura; (5) COSAES (ComiteSanidad Acuic.Son); (6) CIAD Mazatlan; (7) CECASIN; (8) ConsejoEstatal de Ciencia y Tecnología)
07HHI05UH Depuration of Cockles	3	3	N/A	N/A	**Educational:** CIDEA/UCA **Government**: Ministry of the Environment (MARENA); Municipal government
07IND03UH Spat Collection	8	8	N/A	N/A	**Govt. institutions:** CIAD, CESASIN, 3 municipal govt. **Universities:** UAS, Universidad Tecnológica de la Costa Nayarit, UNAM
07IND04UH Depuration	—	6	N/A	N/A	**Government institutions:** CIAD, CESANAY, Municipal govt. **Universities:** UAS, Universidad Tecnológica de la Costa Nayarit, UNAM
07MNE02NC Sustainable Coastal Aquaculture	—	14	N/A	N/A	(1) Ujung Batee Aquaculture Center - Government, (2) SEAFDEC - Government, (3) BFAR - Government, (4) MFARMC - Municipal Fisheries and Aquatic Resources Management Council, LGU -local government unit; (5) BFARMC - Barangay Fisheries and Aquatic Resources Management Council, LGU; (6) FAC/CLSU- University; (7) Aquaculture without Frontiers - NGO; (8) IFC - NGO; (9) ACIAR - Government; (10) NACA; (11) Caritas Czech Republic; (12) PRGI ; (13) ADB ETESP - Asian Development Bank; (14) (GIFT - Foundation)
07MNE06UA MT Elimination	—	1	N/A	N/A	**Organizations:** Universidad Juarez Autonoma de Tabasco

Table 3. AquaFish Investigation Indicator Reports for DTAP B02: Number of institutions with access to technological practices

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B02 Report Text
07MNE07UM Workshop on Aquaculture, Human Health & Environment	—	7	N/A	N/A	**Professional Research Transfer: Workshop on Aquaculture Human Health & Environment** **Organizations and institutions**: (1) Shanghai Ocean University; (2) World Wildlife Fund; (3) Institute of Agriculture & Animal Science, Nepal; (4) Directorate of Fisheries Development, Nepal; (5) Nong Lam University, Vietnam; (6) Hainan University, China; (7) Huazhong Agricultural University
07QSD01NC Tilapia Seedstock	—	4	N/A	N/A	(1) (CLSU-Fisheries Aquaculture Center; CLSU – University; (2) GIFT – NGO; (3) BFAR - Government; (4) Genomar - NGO)
07SFT02NC Feeding Strategies for Tilapia	—	3	N/A	N/A	**Organizations** (1) CLSU - University, (2) SEAFDEC-government, (3) BFAR
07SFT03NC Feeding Strategies for Milkfish	—	1	N/A	N/A	**Organizations** SEAFDEC
07SFT04UA Local feed for Tilapia & Pacu	—	5*	N/A	N/A	**Organizations** (1) Ministry of Agriculture-Fisheries Office (GOVT) (2) University of Guyana (EDUC/RES) (3) National Aquaculture Association of Guyana (NGO) (4) GTIS (GOVT) (5) Trafalgar Union Women's Cooperative for Tilapia
07SFT05UA Fishmeal Substitution	—	3	N/A	N/A	**Organizations** (1) Ministry of Agriculture-Fisheries Office (GOVT) (2) University of Guyana (EDUC/RES) (3) National Aquaculture Association of Guyana (NGO)
07SFT06PU Locally Available Feed for Tilapia	1	1	N/A	N/A	**Organizations** Ministry of Natural Resources & Tourism, Aquaculture Development Division
07TAP01UC Feed Technology & Fisheries Mgmnt	—	17	N/A	N/A	**Organizations: Educational & Government** (1-10) Vietnam Provincial Department of Agriculture and Rural Development in 10 provinces (An Giang, Cantho, Ben Tre, Bac Lieu, Dong Thap, Soc Trang, Long An, Kien Giang, Tien Giang, Hau Giang); (11) Research Institute for Aquaculture #2, Cantho University, (12) Ministry of Agriculture and Rural Development Sub-Department of Aquaculture; (13-16) Cambobia Department of Fisheries provincial offices (Kompong Cham, Prey Veng, Kandal, Siem Reap); (17) Department of Fisheries.
07TAP02NC Tilapia Podcast	—	2	N/A	N/A	**Organizations**: CLSU (university), SEAFDEC (government)
07WIZ01PU Water Quality	—	8	N/A	N/A	**Organizations**: (1) Kwame Nkrumah University of Science and Technology (KNUST); (2) University of Ghana; (3) University of Cape Coast; (4) Water Resources Research Institute; (5)Institute of Aquatic Biology; (6) Water Resources Commission; (7) the Fisheries Directorate - Ministry of Agriculture; (8) Environmental Protection Agency.

Table 3. AquaFish Investigation Indicator Reports for DTAP B02: Number of institutions with access to technological practices

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B02 Report Text
07WIZ02UH Mexico Carrying Capacity	—	6	N/A	N/A	**Government institutions:** CIAD, CESANAY, Municipal govt. **Universities:** UAS, Universidad Tecnológica de la Costa Nayarit, UNAM
Implementation Plan 2009–2011					
09BMA01AU Cage Culture	N/A	N/A	3	3	**Producer Group** Jinja United Group Initiative for Poverty Alleviation and Economic Development (JUGIPAED) **Agricultural Firm** UgaChick Company **Institutions & NGOs** National Agricultural Advisory Services
09BMA02AU Training & Outreach	N/A	N/A	1	1	**Producers Assn** Walimi Fish Farmers Cooperative Society (WAFICOS)
09BMA03UM Sahar Polyculture	N/A	N/A	2	2	**Women's Organizations** Rural Integrated Development Society (NGO) - Nepal (RIDS) Women in Aquaculture
09BMA04UM Pond-Based RAS	N/A	N/A	4	1	**Institutions & NGOs (FY10)** Hainan University, Shanghai Ocean University, and University of Michigan **Agricultural Firm (FY10-FY11)** Haoshideng shrimp farm
09BMA05UM Indoor RAS	N/A	N/A	3	1	**Agricultural Firm** Blue sea Aquaculture Development Company
09BMA06UM Prawn Best Practices	N/A	N/A	4	1	**Institutions & NGOs** Network of Aquaculture Centres in Asia, Shanghai Ocean University, and University of Michigan (FY10) Department of Fisheries (Thailand) (FY10-FY11)
09FSV01UC Fish Paste Product Development	N/A	N/A	30	6	**Cantonments (FY10)** 24 Provincial Fisheries Cantonments **Govt (FY10-FY11)** Central Fisheries Administration; Ministry of Mine Industry and Energy (MIME); Ministry of Commerce (MoC); Ministry of Public Health (MOH); Ministry of Agriculture Forestry and Fisheries **Women's Organizations (FY10-FY11)**

Table 3. AquaFish Investigation Indicator Reports for DTAP B02: Number of institutions with access to technological practices

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B02 Report Text
					Women Fermented Fish Paste Group/Association
09FSV03UC Assessing Impacts	N/A	N/A	—	3	**Govt** Provincial fisheries departments in AnGiang province; Dong Thap province; Prey Veng province
09HHI01UH Black Cockle Management	N/A	N/A	7*	7	**Govt** Ministry of the Environment; Ministry of Forestry, **CBO** Aserradores estuary community group representing 66 families **Institutions & NGOs** Autonomous University of Leon; LIDER Foundation, Mesoamerican Biological Network & Conservation Chapter of Nicaragua; Foundation of Friends of Rio San Juan (FUNDAR) in southern Nicaragua
09HHI02UH Workshop for Coastal Women	N/A	N/A	—	5	**Govt** Sinaloa State Aquaculture Sanitation Committee (CESASIN); Nayarit State Aquaculture Sanitation Committee (CESANAY) **Producers Group, Women's Organization & CBO** Oyster growing cooperative from Boca de Camichin (Mexico); Women's oyster growing cooperative at Bahia Santa Maria (Mexico); Nicaraguan Community groups
09IND01UH Native Oyster Hatchery	N/A	N/A	2	4*	**Institutions (FY10)** Marine Science Centers (FACIMAR) in Mazatlan and Sinaloa **Govt (FY11)** Sinaloa State Aquaculture Sanitation Committee (CESASIN); Nayarit State Aquaculture Sanitation Committee (CESANAY) **Producers Group, Women's Organization (FY11)** Women's oyster growing cooperative at Bahia Santa Maria; Oyster growing cooperative from Boca de Camichin

Table 3. AquaFish Investigation Indicator Reports for DTAP B02: Number of institutions with access to technological practices

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B02 Report Text
09IND02UC Snakehead Aquaculture	N/A	N/A	4	4	**Govt** Ministry of Agriculture; Forestry & Fisheries of Cambodia; Fisheries Administration; Department of Aquaculture Development **Institutions & NGOs** Freshwater Aquaculture Research and Development Center (FARDeC)
09IND03UH Chame Spawning & Larval Rearing	N/A	N/A	1	3	**NGOs (FY10-FY11)** Ecocostas (NGO-Ecuador) **Govt (FY11)** Sinaloa State Aquaculture Sanitation Committee (CESASIN); Nayarit State Aquaculture Sanitation Committee (CESANAY)
09IND04UH Chame Spawning & Larval Rearing	N/A	N/A	3	2	**Producer Orgs (FY10)** Fishers groups in Nayarit and Sinaloa (2) **Govt (FY10-FY11)** Sinaloa State Aquaculture Sanitation Committee (CESASIN) (State Government); Nayarit State Aquaculture Sanitation Committee (CESANAY) (State Government)
09IND05UA Cichlid/Snook Selective Breeding	N/A	N/A	—	2	**Govt** Mariano Matamoros Hatchery **Cooperative** Cooperativa Pesquera San Ramon
09IND06PU New Species Development	N/A	N/A	8*	7	**Govt, Institutions & NGOs Govt (FY10-FY11)** Water Research Institute, Fisheries Commission, University of Cape Coast, Savannah Agricultural Research Institute, University of Ghana, University for Development Studies, International Water Management Institute (FY11); KNUST (FY10) **Producer Orgs (FY10)** Fish Farmers Association
09MER01AU Aquaculture Enterprises	N/A	N/A	—	1	**Producer Group** Walimi Fish Farmers Cooperative Society (WAFICOS)
09MER02PU Value Chain	N/A	N/A	3	2	**Govt & Institutions** Ministry of Fisheries Development (FY10-FY11) Moi University; Kenyan Marine Fisheries Institute (FY10) **NGOs (FY11)** Women in Fishing Industry Project (WIFIP)

Table 3. AquaFish Investigation Indicator Reports for DTAP B02: Number of institutions with access to technological practices

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B02 Report Text
09MER04UC Value-Chain Analysis	N/A	N/A	25	11	**Govt, Institutions & NGOs (FY10))** Government fisheries department, research centers, extension, NGOs, and private sector **Govt, Institutions & NGOs (FY11)** Ministry of Agriculture and Rural Development (Vietnam), Vietnam: Provincial fisheries departments of An Giang, Dong Thap, Cantho and Vinh Long provinces Fisheries Administration (Cambodia), Cambodia: Provinces of Kandal, Prey Veng, Kampong Chhnang, Siem Reap, Battambang
09MNE02NC Milkfish Feed Inputs	N/A	N/A	6	18	**Producers Organizations:** 4 fishers organizations from different coastal villages in Guimaras (FY10-FY11) 2 Communities (Buyuan, Pararanorte), 28 women (all women) (FY10) **Microfinance/Development Institute (FY11)** Taytay sa Kauswagan, Inc. **Private/Public Group (FY11)** Panabo Mariculture Park; **Government (FY11)** 7 Regional Fisheries Training Center of the Bureau of Fisheries and Aquatic Resources **Academic (FY11)** Mindanao State University-Tawi-tawi Campus, Zamboanga State College of Marine Science and Technology; University of Philippines-Visayas; Iloilo State College of Fisheries; Mindanao State University-Marawi Campus
09MNE04UC Management Recommendations	N/A	N/A	25	11	**Govt, Institutions & NGOs (FY10)** Research centers, government fisheries department, non-government organizations, and inter-governmental organizations **Govt, Institutions & NGOs (FY11)** Vietnam: Ministry of Agriculture and Rural Development; Provincial fisheries departments of An Giang, Dong Thap, Cantho and Vinh Long provinces Cambodia: Fisheries Administration; Provinces of Kandal, Prey Veng, Kampong Chhnang, Siem Reap, Battambang

Table 3. AquaFish Investigation Indicator Reports for DTAP B02: Number of institutions with access to technological practices

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B02 Report Text
09MNE07UA MT Elimination Technology Transfer	N/A	N/A	—	1	**Ag Firms:** Pucte del Usumacinta (fish farm)
09QSD01NC Tilapia Seedstock Development	N/A	N/A	—	2	**Research Entity:** GIFT Foundation International; Genomar; **Government:** Bureau of Fisheries and Aquatic Resources
09QSD02UA Aquaponics &Tilapia	N/A	N/A	6	6	**Govt & NGOs** SAGARPA: Secretaria de Agricultura Ganaderia, Recursos naturales y Pesca; DIF: Desarrollo integral de la familia: Youth at Risk program (FY11) Mariano Matamoros Hatchery ; WorldFish (FY10-FY11) UJAT; UAT (FY10) **Ag Firms & Producers Org** Lacadon Village Farmers Cooperative (FY10) Commercial Tilapia Farm (FY10-FY11)
09QSD03UM Prawn-Mola Polyculture	N/A	N/A	1	1	**NGOs** Caritas (NGO - to help with training women in production techniques)
09QSD04PU Tilapia Performance	N/A	N/A	4	3	**Govt, Institutions & NGOs** Tanzania Fisheries Research Institute; Ministry of Livestock and Fisheries Development (FY10-FY11) Kingolwira Fish Farming Centre (FY11) Sokoine University of Agriculture (FY10) **Producers Organizations (FY10)** Farmers Association
09SFT01UC Alternative Feed	N/A	N/A	20	20	**Govt, Institutions & NGOs** Staff at research centers and government fisheries departments in An Giang and Dong Thap provinces, WWF-Vietnam
09SFT02PU Pond-Cage System	N/A	N/A	4	1	**Govt, Institutions & NGOs** Kenyan Marine Fisheries Institute (FY10-FY11) Moi University; Ministry of Fisheries Development (FY10) Ministry of Agriculture-Fisheries Office (FY10) **Women's Orgs (FY10)** Women in Fishing Industry Project

Table 3. AquaFish Investigation Indicator Reports for DTAP B02: Number of institutions with access to technological practices

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B02 Report Text
09SFT03UA Guyana Aquaculture	N/A	N/A	6*	5	**Govt, Institutions & NGOs** University of Guyana; National Aquaculture Association of Guyana; GTIS (FY10-FY11) Ministry of Agriculture-Fisheries Office (FY10) **Women's Organization (FY10-FY11)** Trafalgar Union Women's Cooperative **Ag Firm (FY10-FY11)** Maharaja Oil & Feed Mill
09SFT04NC Tilapia Feed Formulation and Feed Reduction Strategies	N/A	N/A	3	4	**Agricultural Firm** Santeh Feed Company in Philippines (FY10-FY11) Cargill (US) - Philippines; Feed World (FY11) **Research Entity (FY11)** GIFT Foundation International **Govt, Institutions & NGOs (FY10)** Central Luzon State University, North Carolina State University
09SFT05PU Leaf Meal Feeding Strategies	N/A	N/A	3*	4*	**Govt, Institutions & NGOs** Tanzania Fisheries Research Institute;, Ministry of Livestock and Fisheries Development (FY10-FY11) Kingolwira Fish Farming Centre (FY11) Sokoine University of Agriculture (FY10) **Ag Business (FY11)** International Tanfeeds Ltd
09TAP01UA ISTA 9	N/A	N/A	2	6	**Govt, Institutions & NGOs** Shanghai Ocean University (FY10) Asian Fisheries Society (FY10-FY11) China Aquatic Products Processing and Marketing Association; Tilapia International Foundation; Office of Rural Affairs - Shanghai Municipal Agricultural Commission; Global Times(FY11)
09TAP02NC Tilapia Podcasts	N/A	N/A	9	—	**Govt, Institutions & NGOs** BBAP/Ujung Batee; Univ Arizona; North Carolina State University; Aquaculture without Frontiers; SEAFDEC AQD; ACIAR **Communities:** 3 communities in Aceh, Indonesia
09TAP03UC Alternatives for Low-Value Fish	N/A	N/A	3	3	**Govt, Institutions & NGOs (FY11)** Staff of research centers and government fisheries department in An Giang and Dong Thap provinces and WWF-Vietnam **Communities (FY10)** Farmer adoption (farmers in three Vietnam provinces adopted use of feed)

Table 3. AquaFish Investigation Indicator Reports for DTAP B02: Number of institutions with access to technological practices

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	B02 Report Text
09TAP04PU Cage Culture in Ghana	N/A	N/A	5	12	**Govt, Institutions & NGOs** Fisheries Commission; Water Research Institute; University of Ghana; University of Cape Coast; Savannah Agricultural Research Institute; University for Development Studies (FY10-FY11) KNUST (FY10) Ministry of Agriculture-Fisheries Directorate; FAO Regional Office (FY11) **Communities: (FY11)** Fish Farmers
09TAP08AU Training Trainers	N/A	N/A	—	2	Seminars on pond construction focused at trainers and service providers. Attendance was registered from the 1. University of Agricultural Engineering, Busitema 2. The Fisheries Training Institute
09WIZ01AU Multiple Water Use	N/A	N/A	2	2	**Institutions & NGOs** 1.Water Research Comm'n (DWAF-South Africa) 2. Department of Water Affairs & Forestry (DWAF-South Africa)
09WIZ02AU Water Management	N/A	N/A	1	1*	**NGOs (FY10-FY11)** Sustainable Management of Watershed (SUMAWA)
09WIZ03UM Fish Cage Culture	N/A	N/A	7	3	**Govt, Institutions & NGOs** Guizhou Normal University (FY10-FY11) Huazhong Agricultural University; Wuhan University; Shanghai Ocean University; University of Michigan (FY10) **Agricultural** Firms (FY10-FY11) Tongwei Corporation Luo Dian Spark Eco Aquaculture Company

Table 4. AquaFish Investigation Indicator Reports for DTAP C01: Number of management practices developed or adopted to improve natural resource management

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	C01 Report Text
Implementation Plan 2007–2009					
07HHI02UA Aquaponics with tilapia effluent	—	3	N/A	N/A	Aquaponics on-farm practices (under testing): (1) gravity to irrigate from ponds (2) hose to better use the effluents. (3) Recirculating aquaculture to utilize resources more efficiently
07MER01UC Low-value fish for feed or food	—	1	N/A	N/A	Policy framework for aquaculture/capture fisheries interactions, sustainable management of low value fish, and food security in the lower Mekong River basin (Economic component of management strategy). For FY10 transfer, see TAP01UC (C-01). Companion study to 07MNE01UC.
07MNE02NC Sustainable coastal aquaculture	—	1	N/A	N/A	Management Practices transferred via Trainings: (1) Seaweed polyculture for sustainable coastal pond aquaculture of shrimp and fish to reduce pollution in ponds and preserve coastal habitat; (2) Softshell crab aquaculture techniques as alternative to shrimp farming (added as an extra training in July 2009)..
07MNE04UM Waste Mgmnt Practices	1	2	N/A	N/A	Evaluating waste streams in freshwater and marine aquaculture and evaluate alternative uses of waste products in China (FY08). Two effective practices identified from surveys for outreach: (1) stocking density and (2) aeration as means to improve water quality and eliminate the need for flushing ponds (FY09).
07MNE05UM Shrimp Culture impacts	1	2	N/A	N/A	Determining sustainability of flow through and reuse systems for shrimp culture (FY08). Optimum practices identified in assessment: (1) moderate stocking density and (2) aeration, reducing effluent and electricity use.
07QSD02PU Catfish-Baitfish Farming	—	5	N/A	N/A	Management Practices under adoption: (1) Catfish fry/fingerling production and artificial propagation techniques; (2) Predator control for better growth and higher survival; (3) Pond construction techniques; (4) Construction of simple hatcheries for catfish propagation; (5) Pond management techniques and pond dynamics.
07SFT02NC Feeding Strategies for Tilapia	—	1	N/A	N/A	On-farm feed reduction management strategy for reducing costs of culturing tilapia in ponds. Feed ration reduction through delayed, alternate-day, or subsatiation feeding or a combination does not significantly alter growth of tilapia, but reduces feed requirements of fish and amount of nutrient input into ponds. Reported as technology in B-01. See also C-03.
07TAP01UC Feed Technology & Fisheries Mgmnt	—	1	N/A	N/A	One set of BMPs for fish feeding developed to be transferred in FY10 (see B-01) Transfer of 2 management recommendations for managing abundance and catches of low value fish at national/subregional levels developed in 07MER01UC and 07MNE01UC (C-03) to provincial level fisheries

Table 4. AquaFish Investigation Indicator Reports for DTAP C01: Number of management practices developed or adopted to improve natural resource management

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	C01 Report Text
					departments and extension agents in FY10.
07WIZ01PU Ghana Water deQuality	—	3	N/A	N/A	Management practices to minimize waste and contamination of the environment: (see C-03) BMPs under development for waste control: (1) Improving feed and fertilizer source/uses and bacteriological quality on farms; (2) Feeding regimes to minimize waste in ponds and receiving waters; (3) Improving harvesting practices, effluent releases and production water reuse
07WIZ02UH Mexico Carrying Capacity	—	1	N/A	N/A	Study provided estimates of the carrying capacity of the Boca de Camichin area by which to establish limits on oyster farm size to help prevent negative impacts on water quality and aquatic diseases. Finding presented to the Boca de Camichin management committee. Government has imposed a ban on establishing new oyster farms.
Implementation Plan 2009–2011					
09BMA01AU Cage Culture	N/A	N/A	2	2	Cage culture practices for small-holder farming in Lake Victoria: 1. Set of Practices for farming trout in cages 2. Set of Practices for harvest and post-harvest handling of fish. Reported in FY10 as Production and Enterprise techniques to improve resource management
09BMA06UM Prawn Best Practices	N/A	N/A	—	1	Set of current management practices and practices for giant river prawn aquaculture to improve water quality and production
09FSV01UC Fish Paste Product Development	N/A	N/A	2	—	Best Practices and Standards for Fish Paste Products: 1. Quality & Safety Processing Guidelines 2. Packaging & Labeling Standards (Develop the prahoc quality and safety guidelines, standardize packaging and labeling for fish paste)
09HHI01UH Black Cockle Management	N/A	N/A	1	1	Assessment of no-take zone management practice to regulate sanitation of black cockles and improve fishery in production and cockle size
09IND02UC Snakehead Aquaculture	N/A	N/A	1	1	BMPs for snakehead farming: Feeding practices designed to maintain water quality and developed for use by researchers in current experimental stage to bring snakehead into aquaculture using a pelleted alternative feeding system.

Table 4. AquaFish Investigation Indicator Reports for DTAP C01: Number of management practices developed or adopted to improve natural resource management

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	C01 Report Text
09IND04UH Chame Stock Assessment	N/A	N/A	1	1	Assessment of chame fishery on Mexican Pacific Coast for development of management recommendations for currently unregulated fishery
09MNE01UM Red Swamp Crayfish	N/A	N/A	1	1	Model to characterize invasive spread of red swamp crayfish in China will lead to improved resource management.
09MNE03UM Good Practices & Eco-Certification	N/A	N/A	—	3	Best practices for shrimp production to improve environmental performance based on testing of 3 culture management systems: (1) moderate density stocking vs (2) high density stocking in flushed ponds and (3) outdoor recirculating ponds.
09MNE04UC Management Recommendations	N/A	N/A	1	1	Recommendations for managing capture fisheries of small-sized, low-value fishery through use of formulated snakehead feed in aquaculture
09MNE05UM Fish Stocking in Reservoirs	N/A	N/A	—	1	By food web modeling, strategies for management practices on natural food web interactions will be better known, thus improving natural resources management.
09QSD03UM Prawn-Mola Polyculture	N/A	N/A	3	3	Small-scale prawn-mola polyculture: testing 3 practices to determine the best returns for one practice in economic and ecological terms: 1. Growth & Production performance based on gender ratios 2. Stocking density 3. Grading & size selective harvest
09SFT02PU Pond-Cage System	N/A	N/A	—	6	Management practices for integrated cage cum pond polyculture system: 1. Management of fish in Static ponds 2. Cage –cum – Pond practices 3. Pond fertilization and water quality maintenance 4. Feeding fish with live feed 5. Transport of fish in cans, polythene bags and aeration 6. Integrating rice, livestock with fish
09WIZ01AU Aquaculture Interactions	N/A	N/A	—	2	Watershed management practices for managing water harvesting and land use pattern as part of model development. 1. Construct ponds on former cropland to avoid destruction of Fynbos vegetation. 2. Do not construct ponds on wetlands.

Table 4. AquaFish Investigation Indicator Reports for DTAP C01: Number of management practices developed or adopted to improve natural resource management

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	C01 Report Text
09WIZ02AU Water Management	N/A	N/A	—	2	Best management practices (including software tools) for pond construction and water management to protect wetlands and water quality. 1. Evaluate soil in construction area to avoid high water loss through seepage. 2. Make ponds as deep as possible to reduce land area and minimize surface area; storage volume ratio to reduce evaporation loss.
09WIZ03UM Fish Cage Culture	N/A	N/A	—	1	Deep water cage production model with polyculture fish system: Reduction of ecological footprint by reduction of nutrient and sediment loading in receiving waters:

Table 5. AquaFish Investigation Indicator Reports for DTAP C02: Number of hectares under improved natural resource management

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	C02 Report Text
Implementation Plan 2007–2009					
07FSV01UC Low-Value Fish Product Development	—	250	N/A	N/A	Hectare estimate for fishers who have adopted practices for low-value fish resource management
07HHI04UH Regional workshop	—	—	365	N/A	Oyster famers adopting shellfish culture and sanitation practices: Bahia Santa Maria 120 ha Boca de Camichin 195 ha Altata 50 ha
07HHI05UH Nicaragua depuration	—	150	N/A	N/A	150 ha for participants in experiments and training whose sites spread throughout the estuary which is 492,900 ha (measured)
07IND03UH Mexico spat collection	—	120	N/A	N/A	120 ha is being farmed
07MER01UC Low value fish for feed or food	—	500	N/A	N/A	Hectare estimate for fishers and farmers who have adopted practices for maintaining sustainable aquaculture/capture fisheries interactions
07MER03PU Tilapia-Catfish Predation Culture	7	—	N/A	N/A	Farm hectares being evaluated for better production systems in Tanzania.
07MNE01UC Low-Value Fish diversity	—	500	N/A	N/A	Hectare estimate for fishers who have adopted community-based, low-value fishery management practices
07MNE02NC Sustainable coastal aquaculture	—	20	3	N/A	Farms using seaweed polyculture to grow shrimp or fish
07MNE04UM Waste Mgmnt Practices	150	200	40	N/A	FY08: Estimate of 150 ha-equivalent ponds being evaluated for better waste management systems. FY09: Estimate of 200 ha for 200 trainees who adopted practices, each with a farm size of 1 ha. FY10: Better waste management for marine and freshwater aquaculture systems in China. Practices include use of settling ponds, co-culture of seaweeds, use of polyculture, and filtration.

Table 5. AquaFish Investigation Indicator Reports for DTAP C02: Number of hectares under improved natural resource management

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	C02 Report Text
07MNE06UA MT Elimination	—	1	2	N/A	Hectare estimate for hatcheries using MT elimination technology in aquacultural masculinization systems (local to Mexico or Central American region), including estimate for farmers who procure all-male fingerlings from hatcheries
07QSD02PU Catfish-Baitfish Farming	—	3*	4	N/A	FY09: 67 fish farmers have a combined total of 3.4 hectares of ponds being used for catfish fingerling production FY10: Estimate of additional ponds being used for catfish fingerling production.
07SFT01UC Snakehead Feed Technology	—	50	N/A	N/A	Hectare estimate for farmers who have adopted alternative feed strategy promoted in outreach materials.
07SFT02NC Feeding Strategies for Tilapia	7	1453	N/A	N/A	FY08: Farm hectares being converted to alternative feeding strategies. FY09: Farms using alternate feeding strategies for Nile tilapia culture.
07SFT06PU Locally available feed for tilapia	—	—	2	N/A	FY10 Target: 2 ha estimate for farmer trainees who will adopt alternative plant protein feed for tilapia and other feeding strategies to minimize adverse effects on water quality
07TAP01UC Feed Technology & Fisheries Mgmnt	—	100	N/A	N/A	FY09: Hectare estimate for farmers who have adopted alternative feed technology and feed practices transferred in farmer trainings = 100 ha FY10: Hectare estimate for farmers who are expected to adopt practices promoted by the implementation of an Aquaculture Development Policy = 750 ha
07WIZ01PU Ghana water quality	—	—	51	N/A	51 ha for which farmers will adopt BMPs for controlling aquacultural effluent
07WIZ02UH Mexico carrying capacity	—	195	N/A	N/A	Entire Boca de Camichin area is 195 ha and all is under improved management as the result of this investigation
Implementation Plan 2009–2011					
09BMA03UM Sahar Polyculture	N/A	N/A	—	10	Based on Average farm size in Nepal of 0.5, and an adoption by 20 trainees, 10 ha will be under improved management practices in FY11.
09BMA04UM Pond-Based RAS	N/A	N/A	—	60	Based an the average farm size of 3 ha and adoption by 20 trainees, 60 ha will be under improved management practices in FY11.

Table 5. AquaFish Investigation Indicator Reports for DTAP C02: Number of hectares under improved natural resource management

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	C02 Report Text
09FSV02NC Seaweed Processing	N/A	N/A	10	5	Estimate that 10 ha of farms are using drying racks and will increase in FY11
09HHI01UH Black Cockle Management	N/A	N/A	—	27	Management practices to protect native black cockle fishery Total ha of mangroves in Aserradores that is partially protected by community vigilance: 2,628 ha
09MNE02NC Milkfish Feed Inputs	N/A	N/A	—	10	Estimate of improved hectares through adoption of reduced feed inputs for milkfish production and integrated milkfish culture with testing underway at a mariculture park.
09MNE03UM Good Practices & Eco-Certification	N/A	N/A	—	6	Estimate of 100 fact sheets being distributed for government and private farms, with about 20% adoption for 6 ha of improved farms
09MNE04UC Management Recommendations	N/A	N/A	—	50	Fishery under improved management of freshwater small-sized/low value fish in the Lower Mekong region due to CRSP recommendations
09QSD02UA Aquaponics &Tilapia	N/A	N/A	2	1	Hectares under improved management practices
09QSD04PU Tilapia Performance	N/A	N/A	—	2	Farms using improved tilapia culture practices
09QSD05PU Propagation & Hatchery Mgmnt Training	N/A	N/A	—	25	Farms/hatcheries using hatchery management technologies/practices (Approximately 50 trainees with an average farm size of 0.5ha)
09SFT01UC Alternative Feed	N/A	N/A	5	30	Farms utilizing sustainable feed practices
09SFT02PU Pond-Cage System	N/A	N/A	—	8	Farms using integrated pond-cage system in 3 reservoirs (2ha, 3ha, and 3ha) total 8 hectares
09SFT03UA Guyana Aquaculture	N/A	N/A	2	4	Maharaja Hatchery and ponds, Annai and Bina Hill projects
09SFT04NC Feed Strategies	N/A	N/A	2180	3200	Farms using up to 3 different alternate feeding strategies to reduce costs of Nile tilapia culture. Estimate of 15% the first year and an additional 5% of total hectares of tilapia pond culture in a portion of Central Luzon Philippines

Table 5. AquaFish Investigation Indicator Reports for DTAP C02: Number of hectares under improved natural resource management

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	C02 Report Text
09SFT05PU Leaf Meal Feeding Strategies	N/A	N/A	—	5	Farms using leaf-meal based feeds and feeding strategy
09WIZ01AU Aquaculture Interactions	N/A	N/A	—	32	Hectares under CRSP best management practices developed for pond construction:
09WIZ03UM Fish Cage Culture	N/A	N/A	10	110	Conservative estimate that about 100 ha of reservoir will be in the area of improved deep-water cages

Table 6. AquaFish Investigation Indicator Reports for DTAP C03: Number of management practices developed to support biodiversity

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	C03 Report Text
Implementation Plan 2007–2009					
07BMA02UM Sahar-tilapia polyculture	—	1	N/A	N/A	Optimal management practice for sahar density: 0.125 fish per square meter. Under adoption by cooperators.
07MNE01UC Low value fish diversity	—	1	N/A	N/A	Recommendation to fisheries managers in Cambodia and Vietnam on management strategies to protect important fish juvenile spawning areas (Biological component of management strategy).
07MNE03UM Controlling alien species	2	2	N/A	N/A	Evaluating effect on biodiversity with introduction of aquaculture species (icefish in China and tilapia in Vietnam) in reservoirs.
07QSD02PU Catfish-Baitfish Farming	1	1	N/A	N/A	Developing aquaculture of catfish fingerlings as baitfish to replace collection of wild catfish for Nile perch fisheries in Lake Victoria.
07WIZ01PU Ghana water quality	1	1	N/A	N/A	BMP for biodiversity conservation: responsible stocking and species translocation practices to prevent aquatic invasive and nuisance species spread and problems of homogenization of fish assemblages.
Implementation Plan 2009–2011					
09MER04UC Value-Chain Analysis	N/A	N/A	1	—	Recommendations to reduce pressure on wild-caught small-value fish by using feed alternatives for snakehead aquaculture
09MNE05UM Fish Stocking in Reservoirs	N/A	N/A	1	1	Evaluating the impacts of stocked fish on wild fish may result in the elimination of stocking in small reservoirs, which would improve the environment for natural biodiversity.
09WIZ02AU Water Management	N/A	N/A	—	1	Best management practice (including software tools) to by-pass water downstream to protect stream biodiversity

Table 7. AquaFish Investigation Indicator Reports for DTAP D01: Number of new markets for aquatic products

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	D01 Report Text
Implementation Plan 2007–2009					
07FSV01UC Low-Value Fish Product Development	—	1	N/A	N/A	Recommendations on market channel and trade and economic aspects of processed low value fish, value added products (fish paste and fish sauce) for local and international trade. Transfer to government scheduled for December via mechanisms set up in 07TAP01UC.
07HHI05UH Nicaragua: depurated cockles	—	1	N/A	N/A	Depurated cockles undergoing market testing. Adoption of certified, depurated label expected in FY10.
07IND03UH Mexico: spat collection	—	—	1	N/A	FY10 Target: Local test-marketing of cultured native oyster delayed to FY10 due small-sized oysters caused by to El Nino effects.
07MER02PU Supply Chain & Group Marketing	—	2	N/A	N/A	Management guidelines for (1) supply chain and (2) group marketing developed for fish farmers in Kenya and Ghana to enter urban markets. Transfer of extension manual (supply chain) and brochure (group marketing) in FY10.
07MER04NC Tilapia Export Markets	—	1	N/A	N/A	Currently investigating new markets for tilapia and what's needed to enter markets
07QSD02PU Baitfish Farming	—	1	N/A	N/A	Six market locations along Lake Victoria for farmers to sell cultured catfish-baitfish to traders.
Implementation Plan 2009–2011					
09MER01AU Aquaculture Enterprises	N/A	N/A	—	1	Market assessment for aquaculture products to improve market structure and producer access
09MER02PU Value Chain Development	N/A	N/A	—	1	Farmed Fish Marketing Information System (FFMIS) technology under development for use by fish farmers

Table 7. AquaFish Investigation Indicator Reports for DTAP D01: Number of new markets for aquatic products

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	D01 Report Text
09MER03NC Tilapia Supply Chain	N/A	N/A	2	2	Supply chain efficiency analysis with recommendations to lead toward tilapia market development and growth: export and domestic markets
09MER04UC Value-Chain Analysis	N/A	N/A	2	2	Value-chain analysis to develop aquaculture and market opportunities for snakehead and small-value fish: export and domestic markets
09MNE03UM Good Practices & Eco-Certification	N/A	N/A	—	1	Eco-certified shrimp as market-based tool to minimize negative environmental impacts

Table 8. AquaFish Investigation Indicator Reports for DTAP D02: Number of aquatic products available for human food consumption

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	D02 Report Text
Implementation Plan 2007–2009					
07BMA02UM Sahar-Tilapia polyculture	—	1	N/A	N/A	Cultured sahar are now available for human consumption by farmers but sahar has not yet reached the market.
07FSV01UC Low-Value Fish Product Development	—	1	N/A	N/A	BMPs for low-value/small fish processed, value-added products with improved food quality and safety under preparation for transfer in FY10 via 07TAP01UC.
07HHI01UM Microcystin control	—	1	N/A	N/A	Product development of microcystin-free fish will progress as technology is adopted. See B-01.
07HHI05UH Nicaragua: depurated cockles	—	1	N/A	N/A	Depurated cockle product (2 species sold together) in market testing for adoption in FY10 as certified product.
07IND03UH Mexico: spat collection	—	1	N/A	N/A	FY10 Target: Local test-marketing of cultured native oyster delayed to FY10 due small-sized oysters caused by to El Nino effects.
07MNE02NC Sustainable coastal aquaculture	—	2	N/A	N/A	FY10 Target: Product development initiated with trainings on seaweed (agar) and soft shell crab culture. Product availability expected in FY10.
07SFT01UC Snakehead Feed Technology	—	1	N/A	N/A	Consumer food choice tests under development for FY10 to test product potential of snakehead fed on alternative plant-based diet.
Implementation Plan 2009–2011					
09BMA03UM Sahar Polyculture	N/A	N/A	1	1	Farmed sahar (local indigenous fish) raised in polyculture
09FSV01UC Fish Paste Product Development	N/A	N/A	1	1	Processed fish paste products with improved quality and safety
09FSV02NC Seaweed Processing	N/A	N/A	2*	4	New seaweed products (human and non-human uses): 1. Candy/desserts made from agar (FY10-FY11) 2. Pickled seaweed (FY10-FY11) 3. Industrial grade agar (FY11) 4. Carrageenan raw product (FY11)

Table 8. AquaFish Investigation Indicator Reports for DTAP D02: Number of aquatic products available for human food consumption

Investigation Code	FY08 DTAP Actual	FY09 DTAP Actual	FY10 DTAP Actual	FY11 DTAP Actual	D02 Report Text
09IND01UH Native Oyster Hatchery	N/A	N/A	—	1	Hatchery seed of native oyster for shellfish with improved health and safety for oyster production
09MNE02NC Milkfish Feed Inputs	N/A	N/A	3	3	Products of milkfish culture and integrated milkfish polyculture: (1) Value-added milkfish product: deboned and marinated milkfish products (2) seaweed (3) sea cucumber
09QSD03UM Prawn-Mola Polyculture	N/A	N/A	—	2	Polyculture system under development to produce 2 products: 1. Prawn from all male monosex prawn culture for export. 2. Fish for household consumption: Mola and two carp species (catla and silver carp)
09SFT03UA Guyana Aquaculture	N/A	N/A	—	1	Brackish water shrimp species being farmed is new in aquaculture and new to export market

USAID – DTAP INDICATORS CROSS-REFERENCING

The AquaFish CRSP DTAP and Key Development Target Indicators are specifically tailored for assessing program-specific achievements, impacts, targets, and benchmarks. Tables 9 to 13 cross-reference these program indicators with USAID's broader, more general EG and FtF Indicators listed below:

Agriculture Program Element Indicators (EG 5.2 Agriculture Sector Productivity)

- **5.2-J(10):** Number of new technologies or management practices under research as a result of USG assistance.
- **5.2-I(9):** Number of new technologies or management practices being field tested as a result of USG assistance.
- **5.2-H(8):** Number of new technologies or management practices made available for transfer as a result of USG assistance.
- **5.2-E(5):** Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance — Female.
- **5.2-E(5):** Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance — Male.
- **5.2-B(2):** Number of additional hectares under improved technologies or management practices as a result of USG assistance.
- **5.2-M(13):** Number of rural households benefiting directly from USG interventions — Female.
- **5.2-M(13):** Number of rural households benefiting directly from USG interventions — Male.
- **5.2-K(11):** Number of producers organizations receiving USG assistance
- **5.2-K(11):** Number of water users associations receiving USG assistance
- **5.2-K(11):** Number of trade and business associations receiving USG assistance.
- **5.2-K(11):** Number of community-based organizations (CBOs) receiving USG assistance.
- **5.2_New:** Number of producers organizations who have adopted new technologies or management practices as a result of USG assistance.
- **5.2_New:** Number of water users associations who have adopted new technologies or management practices as a result of USG assistance.
- **5.2_New:** Number of trade and business associations who have adopted new technologies or management practices as a result of USG assistance.
- **5.2_New:** Number of community-based organizations (CBOs) who have adopted new technologies or management practices as a result of USG assistance.
- technologies or management practices as a result of USG assistance

- **5.2-:** Number of agriculture-related firms benefiting directly from USG supported interventions (formerly 5.2-22).

- **5.2-:** Number of women's organizations/associations assisted as a result of USG interventions (formerly 5.2-28).

- **5.2-L(12):** Number of public-private partnerships formed as a result of USG assistance.

- **5.2-G(7):** Number of individuals who have received USG supported short-term agricultural sector productivity or food security training – Female.

- **5.2-G(7):** Number of individuals who have received USG supported short-term agricultural sector productivity or food security training – Male.

- **5.2-F(6)**: Number of individuals who have received USG supported long-term agricultural sector productivity or food security training – Female.

- **5.2-F(6)**: Number of individuals who have received USG supported long-term agricultural sector productivity or food security training –Male.

- **New**: Value of new private sector investment in the agriculture sector or food chain leveraged by FtF implementation.

- **FtF-IR4**: Number of jobs attributed to FtF implementation (disaggregated by gender, ag vs non-ag).

Cross-Referencing

AquaFish CRSP and USAID's EG and FtF indicators[1] do not have a one-to-one correspondence. In most cases, the USAID indicators apply only in part and usually form a mixed combination for a given AquaFish CRSP program indicator.

The following USAID FY 2010 indicators, which were just recently issued on 21 October 2010 and for which there are no corresponding AquaFish CRSP indicators, are not included in the cross-referencing:

5.2-E(5): Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance — Female & Male.

5.2_New: Number of producers organizations, water user associations, trade and business associations, and community–based organizations (CBOs) who have adopted new technologies or management practices as a result of USG assistance.
New: Value of new private sector investment in the agriculture sector or food chain leveraged by FtF implementation.

FtF-IR4: Number of jobs attributed to FtF implementation (disaggregated by gender, ag vs non-ag).

[1] USAID indicators for which there is no number assignment under the new FtF system are listed here with their FY 2009 indicator number assignment (i.e., 5.2-21 and 5.2-28).

Tables 9 to 13 illustrate (1) how the AquaFish CRSP indicators are an extension of USAID's indicator set and (2) how general features of the USAID set can be encompassed within a specific AquaFish CRSP indicator. Where there is no correspondence between the two indicator sets, the USAID indicator cell is marked "NA" (Not Applicable).

Table 9. AquaFish CRSP Development Themes

USAID EG 5.2 Indicators[2]	AquaFish CRSP Impact Indicators
5.2-J (10) 5.2 -I (9) 5.2-H (8)	**DTAP A**: **Improved Health and Nutrition, Food Quality, and Food Safety of Fishery Products** *A-01: Number of aquaculture products developed to improve food safety or quality*
5.2-J (10) 5.2 -I (9) 5.2-H (8) 5.2-M (13) 5.2-K (11) 5.2-21 5.2-L (12) 5.2-G (7) 5.2-F (6) 5.2-28	**DTAP B: Income Generation for Small-Scale Fishers and Farmers** *B-01: Number of new technologies developed* *B-02: Number of institutions with access to technological practices*[3] *B-03: Number of (people) trained in use of technological practices*
5.2-J (10) 5.2-I (9) 5.2-H (8) 5.2-B (2) 5.2-K (11) 5.2-21 5.2-G (7) 5.2-F (6) 5.2-28	**DTAP C: Environmental Management for Sustainable Aquatic Resources Use** *C-01: Number of management practices developed or adopted to improve natural resource management* *C-02: Number of hectares under improved natural resource management* *C-03: Number of management practices developed to support biodiversity* *C-04: Number of people trained in practices that promote soil conservation and/or improved water quality*
5.2-J (10) 5.2-I (9) 5.2-H (8)	**DTAP D: Enhanced Trade Opportunities for Global Fishery Markets** *D-01: Number of new markets for aquatic products* *D-02: Number of aquatic products available for human food consumption*

Table 10. AquaFish CRSP Research Targets

USAIDEG 5.2 Indicators	AquaFish CRSP Research Indicators
5.2-J (10) 5.2-I (9) 5.2-H (8) 5.2-M (13) 5.2-K (11) 5.2-21 5.2-L (12) 5.2-G (7) 5.2-F (6)	(1) Developed and adopted innovative technologies that increase profitability and environmental stewardship in aquaculture and fisheries.

[2] Cross referencing for the AquaFish CRSP DTAP indicators is at the thematic level.

[3] To broaden the reporting capability, the term "institution" in DTAP B-02 was defined to include two categories: (1) organizations of all types, e.g., public entities, NGOs, cooperatives, businesses; and (2) rural communities.

Table 10. AquaFish CRSP Research Targets

USAIDEG 5.2 Indicators	AquaFish CRSP Research Indicators
5.2-28	
NA	(2) Addressed biodiversity conservation issues to ameliorate threats to biodiversity and developed technologies and strategies to protect biodiversity habitat and populations.
NA	(3) Continuously funded research projects that meet the expectations of external peer-review panels.
5.2-J (10)	(4) Conducted appropriate biotechnology research to develop technologies that increase farm productivity.
5.2-M (13) 5.2-K (11) 5.2-21 5.2-L (12) 5.2-28	(5) Engaged local stakeholders in research design, implementation, and results reporting through their active participation in stakeholder meetings.
NA	(6) Published AquaFish CRSP research in regional, national, and international peer-reviewed journals.

Table 11. AquaFish Capacity Building Targets

USAIDEG 5.2 Indicators	AquaFish CRSP Capacity Building Indicators
5.2-J (10) 5.2-I (9) 5.2-L (12)	(1) Forged professional and managerial relationships between US and Host Country researchers and institutions
5.2-F (6)	(2) Established track record of successful formal long-term training of Host Country and US students and researchers.
5.2-H (8) 5.2-M (13) 5.2-K (11) 5.2-21 5.2-L (12) 5.2-G (7) 5.2-28	(3) Delivered relevant short-term training opportunities that provide positive Host Country societal benefits beyond the life of the AquaFish CRSP.
5.2-28	(4) Identified gender issues in aquaculture and fisheries and adopted program-wide, gender-integration policies.

Table 12. AquaFish CRSP Information Dissemination Targets

USAIDEG 5.2 Indicators	AquaFish CRSP Information Dissemination Indicators
NA	(1) Successful diffusion of AquaFish CRSP research results and technologies between countries within a region having comparable social and environmental conditions.

Table 12. AquaFish CRSP Information Dissemination Targets

USAIDEG 5.2 Indicators	AquaFish CRSP Information Dissemination Indicators
NA	(2) Increased awareness of local stakeholder constraints and opportunities related to responsible aquaculture and fisheries management.
5.2-H (8) 5.2-G (7)	(3) Applicable extension activities within each research project conducted to ensure wide dissemination of research results.
5.2-H (8) 5.2-G (7)	(4) Adoption of AquaFish CRSP results and technologies for farm operations and policies created for responsible aquatic resource management.
5.2 -J (10) 5.2-I (9) 5.2-H (8) 5.2-M (13) 5.2-K (11) 5.2-21 5.2-L (12) 5.2-G (7) 5.2-28	(5) Applicable technologies developed and adopted by the US and other countries' aquaculture and fisheries sectors.

Table 13. IEHA Country Involvement Targets

USAID EG 5.2 & IEHA Indicators	AquaFish CRSP IEHA Indicators
5.2 -J (10) 5.2-I (9) 5.2-H (8) 5.2-M (13) 5.2-K (11) 5.2-21 5.2-L (12) 5.2-G (7) 5.2-28	(1) Development and adoption of innovative technologies that increase profitability and environmental stewardship in the context of aquaculture and fisheries.
5.2-F (6)	(2) Students enrolled in formal long-term training programs within Host Country, regional, and US universities.
NA	(3) Increased awareness of stakeholder constraints and opportunities related to responsible aquaculture and fisheries management.
5.2-H (8) 5.2-G (7)	(4) Applicable extension activities associated with each research project conducted to ensure wide dissemination of research results.
5.2-H (8) 5.2-L (12) 5.2-G (7)	(5) AquaFish CRSP results and technologies adopted for farm operations and policies for responsible aquatic resource management created.
NA	(6) Increased farm income and local economic growth through enhanced market access in project areas.

APPENDIX 4. ACRONYMS

ABW	Average Body Weight
ACIAR	Australian Centre for International Agricultural Research
ACRSP	Pond Dynamics/Aquaculture CRSP
AFCRSP	Aquaculture & Fisheries CRSP
AIT	Asian Institute of Technology, Thailand
ANAF	Aquaculture Network for Africa
AOP	Advanced Oxidation Process
APEC	Asia-Pacific Economic Cooperation
AQD	Aquaculture Department (SEAFDEC), Philippines
AquaFish	Aquaculture & Fisheries CRSP
ASEAN	Association of Southeast Asian Nations
ATA	American Tilapia Association
AU	Auburn University, Alabama
AwF	Aquaculture without Frontiers, USA
BAU	Bangladesh Agricultural University
BFAR	Bureau of Fisheries & Aquatic Resources, Philippines
BFS	Bureau of Food Security (USAID)
BIFAD	Board for International Food & Agricultural Development
BIOTECMAR	Cultivos & Biotecnologíca Marina C.A., Venezuela
BMA	Production System Design & Best Management Alternatives
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BOMOSA	Boku, Moi and Sagana Aquaculture project
BSE	Bovine Spongiform Encephalopathy
BW	Brackish Water
CBA	Cost Benefit Analysis
cDNA	complementary DNA (Deoxyribonucleic acid)
CESASIN	Comite Estatal de Sanidad Acuicola de Sinaloa (Sinaloa State Committee for Aquaculture Sanitation), Mexico
CETRA	Centro de Transferencia Tecnológica para la Acuacultura (Center for Aquaculture Technology Transfer), Mexico
CFU	Colony Forming Units
CG	Compensatory Growth
CGIAR	Consultative Group on International Agricultural Research
CI	Conservation International, Mexico
CIAD	Centro de Investigación de Alimentos y Desarrollo (Research Center for Food & Development), Mexico
CIDEA-UCA	Centro de Investigación de Ecosistemas Acuáticos de la Universidad Centroamericana (Center for Research on Aquatic Ecosystems-Central American University), Nicaragua
CIFAD	Consortium for International Fisheries & Aquaculture Development
CIMMYT	International Wheat & Maize Improvement Center, Mexico
CLAR	Central Laboratory for Aquaculture Research, Egypt
CLSU	Central Luzon State University, Philippines
COD	Chemical Oxygen Demand
COMESA	Common Market for Eastern and Southern Africa
CP	Crude Protein
CP, LLC	Cultural Practice, Limited Liability Company
CPSR	Cooperativa Pesquera San Ramón (San Ramón Fisheries Cooperative), Mexico
CRC/URI	Coastal Resources Center/University of Rhode Island
CRSP	Collaborative Research Support Program
CTU	Can Tho University, Vietnam
DA-BFAR	Department of Agriculture–Bureau of Fisheries & Aquatic Resources, Philippines
DASP	Department of Animal Sciences & Production, SUA
DFID	Department for International Development (England)
DO	Dissolved Oxygen

DOF	Department of Fisheries
DPN	Direction Nationale de la Pêche, Mali
DTAP	Development Theme Advisory Panel
DWAF	Department of Water Affairs & Forestry (South Africa)
EC	*E. coli*
ECP	Eye Color Pattern
EG	Economic Growth Indicators, USAID
EGAT	Bureau for Economic Growth, Agriculture, & Trade (USAID)
EPA	US Environmental Protection Agency
EPT	*Ephemeroptera*, *Pleocoptera* and *Trichoptera*
EU	European Union
FtF	Feed the Future (USAID)
FAC	Freshwater Aquaculture Center, Central Luzon State University, Philippines
FACIMAR	Facultad de Ciencias del Mar, Universidad Autónoma de Sinaloa
FACT	Foreign Assistance Coordination & Tracking System (USAID)
FAO	Food & Agriculture Organization, United Nations
FAQ	Frequently Asked Questions
FARDeC	Freshwater Aquaculture Research & Development Center, Cambodia
FCR	Food (Feed) Conversion Ratio
FD	Department of Fisheries, Kenya
FDA	US Food & Drug Administration
FDAP	Fisheries Development Action Plan, Cambodia
FiA	Fisheries Administration, Cambodia
FISH	The FISH Project (Fisheries Improved for Sustainable Harvest), Philippines
FIU	Florida International University
FSV	Food Safety & Value-Added Product Development
GESAMP	Joint Group of Experts in the Scientific Aspects of Marine Environmental Protection, FAO
GIFT	Genetically Improved Farmed Tilapia
GIFT	Genetically Improved Farmed Tilapia Foundation International Inc., Philippines
GIS	Geographic Information System
GLM	Generalized Linear Model
GMO	Genetically Modified Organism
GnRHa	Gonadotropin Releasing Hormone Analogue
GOP	Government of Philippines
GTIS	Guyana Trade & Investment Support Project
HACCP	Hazard Analysis & Critical Point Control
HC	Host Country
HCPI	Host Country Principal Investigator
HHI	Human Health Impacts of Aquaculture
HIV/AIDS	Human Immuno Virus/Acquired Immune Deficiency Syndrome
HPLC	High Performance Liquid Chromatography
HSD	Hepatosomatic Index
IAAS	Institute of Agriculture & Animal Science, Nepal
IARC	International Agricultural Research Center(s), CGIAR
ICLARM	International Center for Living Aquatic Resources Management (= The WorldFish Center), Malaysia
IDRC	International Development Research Centre, Canada
IEHA	Presidential Initiative to End Hunger in Africa, USA
IFReDI	Inland Fisheries Research & Development Institute, Cambodia
IIFET	International Institute for Fisheries, Economics & Trade
IGF-I	Insulin-like Growth Factor-I
IGO	Inter Governmental Organization
IPM	Integrated Pest Management
IR	Intermediate Results indicators (USAID)
ISA	Sinaloa Institute for Aquaculture, Mexico

ISD	Indigenous Species Development
ISSC	Interstate Shellfish Sanitation Conference
ISTA	International Symposium on Tilapia in Aquaculture
IWMI	International Water Management Institute
JUGIPAED	Jinja United Group Initiative for Poverty Alleviation & Economic Development
KBDS	Kenya Business Development Services, USAID
KNUST	Kwame Nkrumah University of Science & Technology, Ghana
KSh	Kenya Shillings
LAC	Latin America & Caribbean Regions
LC/MS	Liquid Chromatography/Mass Spectrometry
LCA	Life Cycle Assessment
LCCA	Life Cycle Cost Analysis
LEAP	Norman E. Borlaug Leadership Enhancement in Agriculture Program
LHRHa	Luteinizing Hormone-Releasing Hormone analogue
LLC	Limited Liability Company
LMB	Lower Mekong Basin
LST	Lauryl Sulfate Tryptose
LSU	Louisiana State University
MAFF	Ministry of Agriculture, Forestry and Fisheries, Cambodia
MARENA	Nicaraguan Ministry of the Environment
MC	Microcystins
ME	Management Entity
MER	Marketing, Economic Risk Assessment & Trade
MNE	Mitigating Negative Environmental Impacts
MOU	Memorandum of Understanding
MRC	Mekong River Commission
mRNA	messenger RNA (Ribonucleic Acid)
MSU	Michigan State University
MT	17α-Methyltestosterone
MT	Management Team
NAAG	National Aquaculture Association of Guyana
NACA	Network of Aquaculture Centers in Asia, Thailand
NaFIRRI	National Fisheries Resources Research Institute (Uganda)
NARS	National Agricultural Research System (of Host Countries)
NB	Nota Bene, note well
NC	North Carolina State University
NCE	No Cost Extension
NCSU	North Carolina State University
NEPAD	New Partnership for Africa's Development
NGO	Nongovernmental organization
NIC	National Investment Center, Kenya
NL	Notochordal
NO_2-N	Nitrite Nitrogen
NOAA	National Oceanographic & Atmospheric Administration, USA
NPRS	National Poverty Reduction Strategy, Cambodia
NSF	National Science Foundation, USA
NSSP	National Shellfish Sanitation Program
OSU	Oregon State University
PACRC	Pacific Aquaculture & Coastal Resources Center/University of Hawai'i at Hilo
PD/ACRSP	Pond Dynamics/Aquaculture CRSP
PDF	Portable Document Format
PDI	Pellet Durability Index
PI	Principal Investigator
PLNSA	Prek Leap National School of Agriculture
PMP	Program Monitoring Program

PO	Phenyl Oxidase
POD	Peroxidase
PRCA	Participatory Rural Communication Appraisal
PU	Purdue University, Indiana
QSD	Quality Seedstock Development
RCE	Regional Center of Excellence
RFA	Request for Assistance
RFP	Request for Proposals
RIA	Radioimmunoassay
RIDS-Nepal	Rural Integrated Development Society-Nepal
RRA	Rapid Rural Appraisal
SARNISSA	Sustainable Aquaculture Research Network in Sub-Saharan Africa
SEAFDEC	South East Asian Fisheries Development Center
SEDPIII	Third Five-Year Socioeconomic Development Plan, Cambodia
SEMARNAT	Secretariat of Natural Resources, Mexico
SFT	Sustainable Feed Technology
SGR	Specific Growth Rate
SL	Standard Length
SO	Superoxide Dismutase
SOU	Shanghai Ocean University, China
SPE	Solid Phase Extraction
SPSS	Statistical Package for Social Science
SR	Sex Reversed
SS	Salmonella-Shigella
SUA	Sokoine University of Agriculture, Tanzania
SUCCESS	Sustainable Coastal Communities & Ecosystems (EGAT/USAID)
SUMAWA	Sustainable Management of Watershed CRSP
TAN	Total Ammonia Nitrogen
TAP	Technology Adoption & Policy Development
THC	Total Hemocyte Counts
TIES	Training, Internships, Education & Scholarships Program (USAID-Mexico)
TN	Total nitrogen
TNC	The Nature Conservancy, USA
TOC	Total Organic Carbon
TP	Total phosphorus
TSS	Total suspended solids
TTU	Texas Tech University, Lubbock
UA	University of Arizona
UAPB	University of Arkansas, Pine Bluff
UAS	Universidad Autónoma de Sinaloa (Autonomous University of Sinaloa), Mexico
UAS-C	Universidad Autónoma de Sinaloa–Culiacán, Mexico
UAS-M	Universidad Autónoma de Sinaloa– Mazatlán, Mexico
UAT	Universidad Autónoma de Tamaulipas (Autonomous University of Tamaulipas), Mexico
UBAC	Ujung Batee Aquaculture Center, Banda Aceh, Indonesia
UCA	Universidad Centroamericana (Central American University), Nicaragua
UC	University of Connecticut – Avery Point
UG	University of Georgia
UHH	University of Hawai'i at Hilo
UJAT	Universidad Juárez Autónoma de Tabasco (Autonomous University of Juarez, Tabasco), Mexico
UM	The University of Michigan
UNESP	Universidade Estadual Paulista (São Paulo State University), Brazil
URI	University of Rhode Island
US	United States
USA	United States of America

USAID	United States Agency for International Development
USEPA	US Environmental Protection Agency, USA
USG	United States Government
UV	Ultraviolet
VT	Virginia Polytechnic Institute & State University
WAFICOS	Walimi Fish Cooperative Society Ltd, Uganda
WAS	World Aquaculture Society
WIFIP	Women in Fishing Industry Project, Kenya
WIZ	Watershed & Integrated Coastal Zone Management
WRC	Water Research Commission, South Africa
WWF	World Wildlife Fund, USA
XLD	Xylose Lysine Desoxycholate

APPENDIX 5:
AQUAFISH CRSP PUBLICATIONS

The following publications are by current AquaFish CRSP participants on their CRSP-sponsored research. Some of the publications before 2009 may be attributable in part to the Aquaculture CRSP. In the period from 2006-2008, the Aquaculture CRSP was operational on a no-cost extension and ran concurrently with the AquaFish CRSP.

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APPENDIX 6: EXTERNAL EVALUATION REPORT ON THE AQUACULTURE & FISHERIES CRSP

External Evaluation Report on the Aquaculture & Fisheries Collaborative Research Support Program (Cooperative Agreement No. EPP-A-00-06-00012-00)

A Report Submitted to the Bureau of Food Security, USAID

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NOTE: Includes an appendix with the AquaFish CRSP's response to this evaluation report

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List of Acronyms

ACRSP — Aquaculture CRSP
AquaFish CRSP or AquaFish -- Aquaculture & Fisheries CRSP
AU — Auburn University
BFS – Bureau for Food Security
BMP — Best management practice
FAC -- Freshwater Aquaculture Center
CGIAR — Consultative Group on International Agricultural Research
CLSU — Central Luzon State University
CRSP — Collaborative Research Support Program
EGAT — Bureau for Economic Growth, Agriculture and Trade
EPAC — External Program Advisory Council
FAO — Food and Agriculture Organization of the United Nations
FDA – Food and Drug Administration
FtF — Feed the Future
GIFT — Genetically Improved Farmed Tilapia
GOK — Government of Kenya
HCC — Host country collaborator
HAACP — Hazard Analysis & Critical Control Point
HBCU — Historically black colleges and universities
HC — Host country
IP—Implementation Plan
IPS — Integrated Production Systems
LAC — Latin American and the Caribbean
ME — Management Entity
MT – Management Team
NACA — Network of Aquaculture Centers in Asia, Thailand
NCSU — North Carolina State University
NFFTC — National Freshwater Fisheries Technology Center, Bureau of Fisheries and Aquatic Resources
NOAA – National Oceanic and Atmospheric Administration
NSF – National Science Foundation
OSU — Oregon State University
PDA — Pond Dynamics/Aquaculture CRSP
PI — Principal investigator
PIRE — Partnerships for International Research and Education
PLEI — People, Livelihoods and Ecosystems Interrelationships
RCE — Regional Centers of Excellence
SARNISSA –Sustainable Aquaculture Research Network in Sub-Saharan Africa
SEAFDEC –South East Asian Fisheries Development Center
UHH — University of Hawaii-Hilo
USDA – United Stated Department of Agriculture

USFWS – United States Fish and Wildlife Service
USG — United States government

Executive Summary

The mission of the Aquaculture & Fisheries Collaborative Research Support Program (AquaFish CRSP) is to enrich livelihoods and promote health by cultivating international multidisciplinary partnerships that advance science, research, education and outreach in aquatic resources. The AquaFish CRSP was awarded to Oregon State University on September 29, 2006 after an open national competition for the Management Entity (ME) and is different from the former Aquaculture CRSP in both organization and theme. Phase I activities took place between 2007 and 2009 and Phase II from 2009-2011. The AquaFish CRSP operates under a Leader with Associates (LWA) Cooperative Agreement that differs from the previous grant. Two Associate Awards have been received since 2007. The first was a USAID mission sponsored project in Mali on aquaculture and fisheries and the second was a USAID/Washington-funded award to scale-up technologies in Ghana, Kenya and Tanzania to support the Feed the Future Initiative.

The AquaFish CRSP is an integrated and widely diversified research and development program organized around four global themes (goals): 1) improved health, nutrition, food quality, and food safety; 2) income generation for small-scale fish farmers and fishers; 3) environmental management for sustainable aquatic resources use; and 4) enhanced trade opportunities for global fishery markets. The investigations are aligned under two topic areas-- Integrated Production Systems (IPS) and People, Livelihoods and Ecosystems Interrelationships (PLEI). Seven U.S. institutions participate in this program and currently conduct about 67 research-related investigations in collaboration with 10 additional U.S. institutions, and 31 host-country institutions located in 16 countries. The structure of the program mirrors the organizational purpose of land grant universities insofar as its investigations are conducted to address the three integrated pillars of research, teaching and outreach.

The Management Team that is led by Dr. Hillary Egna is professional and efficient in actively directing the programmatic activities of AquaFish CRSP. The Director, Dr. Egna, has 26 years of managerial experience and demonstrates forward-thinking strategic vision about research and programmatic actions. The ME has mentored and provided critical assistance to begin a new program with many new host countries (HCs) and principal investigators (PIs) for an effective transition into a new CRSP. The RFP for AquaFish projects was an open competitive process with broad national distribution of the RFP through various communication networks to reach interested institutions throughout the US. Proposals were selected for funding using a rigorous National Science Foundation style external scientific peer review process. A second RFPA was released to solicit additional projects in the Africa region that also underwent an external peer review before awards were made. The MT provided some match-making assistance with historically black colleges and universities (HBCU) with aquaculture expertise to encourage their participation. To assure country-level development relevancy, all funded projects were vetted with country USAID missions for concurrence.

The research portfolio consists of a broad scope of topics and science areas that address specific HC priorities in development outcomes for resource limited farmers and fishers. There are about 105 investigations (experiments, studies and activities) representing a large breadth of work. US PIs assist HC PIs in developing research objectives and plans aligned with AquaFish global themes based on HC problem statements. There is progressive transfer of US-based research and training expertise to HC

conditions in many science areas including nutrition and feeds, breeding and reproduction, systems development, shellfish development, social science and water and soils management. The areas of study represent many critical and contemporary issues with increasing integration of social science and supply and value chain studies for broader multidisciplinary solutions to development constraints. There is a strong emphasis to integrate outreach into all research studies that establishes an end-point directly linked to quantifiable impact indicators that align with the four AquaFish global themes.

Most of the research is solution-focused applied research with the aim to move science to practice with best management plans (BMPs) and on-farm short-(1-2 years) and medium-term (3-5 years) improvements linked to development goals. The basic research includes some biotechnology investigations (Philippines) with molecular genetics and pioneering work in new and emerging species with limited knowledge about basic biology, physiology, nutrition and reproduction. These are generally longer-term (6-10 years) investments with more uncertain outcomes of commercialization or farmer adoption of new species. The program is well balanced between "experiments" with testable hypotheses (38% of investigations), "studies," quantitative and qualitative (36% of investigations) and "activities," including outreach and information dissemination (26%).

AquaFish CRSP is aligned with the FtF initiative although it came into being at the end of the CRSP's life. There are natural synergies between the core work of the AquaFish CRSP described previously, and the FtF Initiative. In assessing the alignment of currently programmed work into the FtF Initiative (reference is the 2010 Guide), activities fall primarily under the following FtF objective: 3.3.1 Inclusive Agriculture Sector Growth. Gains in productivity can be driven by a number of factors, including improved access to agricultural inputs and knowledge, more efficient use of land and labor, enabling policy environments, and improved management of natural resources. AquaFish CRSP's work also addresses FtF objective: 3.3.2 Improved Nutritional Status by improving diet quality and diversity through the addition of highly nutritious animal source protein and micronutrients commonly found in diverse aquaculture and capture fishery products. The Program also aligns with BIFAD Title XII objectives related to pro-poor technologies and enabling policies through engagement with land-grant and other US university expertise and capacity to address global food and hunger needs through sustainable aquaculture development globally.

The AquaFish CRSP should be renewed based upon strong and demonstrated performance in research, outreach and development contributions, its alignment with FTF, and also because it is well managed. Since many of the topics central to the program are long-term by nature, the renewal should be for five years and not four. Well-reasoned and informed decision needs to be made on investment in new species given that they may not develop into economically viable value-chains. Overall, the evaluation team found few problems with AquaFish and none of which pose a significant obstacle for continued science and development impacts.

Recommendations

Recommendations proposed by the review team are structured around the key elements of the scope of work.

Research

1. AquaFish CRSP should continue to capitalize on previous investments in research and discovery through outreach and farmer training programs and accelerate development outcomes with regional and global collaborators.
2. Findings on reduced feed studies in Philippines and cost-saving findings for tilapia production should be explored for application in other parts of Asia, Africa and Latin America. Findings on reduced feed studies in Philippines were explored to document impact and penetration on farms and whether there is potential for broader application generally. Close management of feed inputs represents key opportunity to reduce input costs. Reducing culture intensity may be a more profitable management strategy in some, but not all conditions.
3. CRSP should be extended to five rather than four years based on previous experience in achieving grand challenge development outcomes and after consultations with the HC and US PIs. The Program is expanding into new countries and accelerating technology transfer in established locations. The timeline from research and discovery to development outcomes for targeted end-users requires a long-term investment as well as new approaches and partnerships and integration of practical information and communication technologies to expand and accelerate broader impacts.
4. AquaFish should continue future collaborative projects in select non-FtF countries because of sustained experience and demonstrated outcomes with numerous HC institutions. There are promising opportunities for non-FtF and FtF country collaborations to accelerate development outcomes and facilitate new capacity building for FtF countries in the same region. The development model can be replicated with proven country-level experiences and the continuity of successful long-term invaluable collaborations; some examples are Mexico, Philippines and Thailand.
5. There is increasing interest in marine aquaculture, including seaweed and shellfish that are important globally in many coastal countries. This may be an area of future investment with new US and HC PIs as well as new collaborative networks.
6. The use of genetic/genomic tools for measurement and production improvements is developing rapidly and insuring some training in these disciplines is critical for enhancing production efficiencies and applications of cutting-edge science.
7. New species selection criteria should assess the current state of knowledge and a feasible research timeline to achieve program development outcomes. Accelerated technology transfer may be achieved by connecting needed expertise across the global AquaFish CRSP program in the US and HCs.
8. Future work on air-breathing fish and native species should focus on the species with clear potential to meet development goals and not solely scientific inquiry. This area of research often involves long-term fundamental work that may be leveraged with basic-science focused

programs, like National Science Foundation PIRE in the US. The concern is for over-investment in native species, with very limited, if any small enterprise application in the future

9. It is reasonable to argue that the AquaFish CRSP (and early versions) developed the knowledge infrastructure that allowed this transformation to take place especially in the Government of Kenya campaign to "Grow Fish, Sell Fish, and Eat Fish". This example should be emphasized across the CRSPs and USAID as a model relationship for emulation.
10. Many projects originate at local or community levels and require subsequent scale-up efforts for broader impacts in more communities with opportunities for adoption.
11. Achieving large-scale country level impacts in aquaculture development requires long-term investment and relevant problem-solving research strategies to address knowledge gaps and development bottlenecks.
12. Research questions persist that require more investigation and pioneering breakthroughs under local conditions for development, some of these should keep the focus more basic and less outreach oriented.
13. Caution is urged to not over-promote or recommend protocols, practices or technologies that have not been fully evaluated under small and medium-farmer conditions and cost-benefit analysis to facilitate adoption for clearly proven farm-level benefits. A method or recommendation that appears appropriate for specific conditions in one country (reduced feeding strategies in Philippines) or region may not apply to other locations for many different reasons until fully evaluated at different farm or system levels.
14. Certainly in regions with growing aquaculture capacity and production, baseline studies on product availability, product forms and economic impact of aquaculture would be of value for future impact assessments related to AquaFish CRSP investments.
15. Already AquaFish CRSP has invested in the coordination of research on the biology and production of aquaculture species with enterprise and social impact evaluations, and this coordination is critical and requires continued emphasis.
16. Several production-oriented projects will benefit from follow-up economic, marketing or other socioeconomic factors impeding scale-up with more cost-benefit analysis data for new technologies and practices. This rationale is based not only on country level needs but broader scale-up and potential applications at country, regional and global levels. The findings from an EGAT Associate Award focused on scale-up and dissemination of AquaFish technologies and practices in three African FtF countries will provide more insights on scale-up strategies and opportunities.
17. The program may benefit by integrating a human health and nutrition project. Fisheries products offer highly nutritious protein for people of all ages with special emphasis on vulnerable children and pregnant women. In many rural areas with a scarcity of high quality animal protein, diets can be supplemented with local farmed fishery products.

Gender Integration

1. Gender visibility in the program can be enhanced by including gender integration as one of the global themes or as people's participation and gender inclusivity.

2. Gender integration strategy should be streamlined to address the gender concerns and women's participation in aquaculture and fisheries sector in the context of agricultural livelihood development.
3. AquaFish CRSP should identify a process to continually provide advisory support to the PIs in developing gender strategy and implementation of gender inclusivity activities.
4. AquaFish CRSP can establish accountability with gender budgeting approach as a monitoring mechanism.
5. Research in marketing, consumption patterns, labor allocation and value chain analysis should strive to adopt gender responsive paradigms.
6. AquaFish CRSP documents that across the HC program sites women are largely involved in postharvest phase aquaculture and fisheries sector. Hence, AquaFish CRSP should consider strategies for improving opportunities for women in postharvest phase both for income generation and household consumption.
7. Gender responsive monitoring and evaluation of AquaFish CRSP gender interventions would strengthen the gender integration efforts that have been initiated in the current phase as well as contribute to the knowledge base of gender strategies in agriculture production systems.

Short-term training and outreach

1. Review the effectiveness of large events touted as short-term training to improve the capacity building outcome.
2. Continue to explore options to obtain co-sponsorship with such agencies that have food security and commercial interest in aquaculture development.
3. Require that a system is put in place to follow up on the impact of short-term trainings among the farmer participants.
4. Expand options to improve and innovate south-south linkages in short term capacity building initiatives.

Network Development

1. It would be essential to broaden the horizon of AquaFish CRSP by bringing in development professionals and scientists who provide research support in socio-economic analysis.
2. Explore strategies to strengthen and support RCEs to develop multi-national regional leadership in initiatives such as regional network development, outreach and aquaculture policy oriented research and communication.
3. A concerted effort has to be made to keep an open door approach to integrate new partners and multidisciplinary and multi-sector expertise.
4. The inclusion of private sector participation should be encouraged throughout AquaFish program planning activities.
5. Explore support to build grass-root networks, and business oriented networks of aquaculture farmers trained by CRSP to strengthen farmer-to-farmer technology transfer opportunities.
6. Strengthen collaborations with international and regional organizations, institutions and agencies that have aquaculture research and development mandates for development outcomes that leverage unique strengths, such as FAO, ASARECA, ANAF, WorldFish and NACA.

7. To broaden the awareness and understanding of AquaFish CRSP activities in the US, electronic communications that include, *Aquanews,* can be expanded to reach more US government agencies with interests and programs linked to international aquaculture, including USDA, State Department, USFWS, NOAA and FDA. New US benefits may develop from these communication linkages. New collaborative opportunities may develop from communication outreach to more strategic regional and global programs with direct or indirect interests in international aquaculture development
8. The use of modern and fast-evolving information and communication technologies can be valuable tools to support learning and new knowledge objectives. The program should carefully assess the integration of appropriate options including CD, DVDs, online training modules, podcasts and other platforms with region-level HC input on needs, access, cost, preferences and real value to targeted end-users.

Relationship with USAID

1. USAID should conduct an external evaluation in year 4 in any future 5-year implementation plan to assess impacts and progress on completing stated project objectives. The evaluation helps direct future continuity and sustainability of effort for performance efficiencies and leveraging of HC and US research and training capacities.
2. Any future planned external evaluations of the AquaFish should be conducted at a time that facilitates direct engagement with US as well as HC participants to gain more knowledge of both perspectives about the program and current on-the-ground outcomes and accomplishments.

Management Entity

1. The ME should invest in developing an active advisory structure to participate in annual program assessments and management assistance from an objective external perspective. The ME should revisit this concept and determine whether it should be strengthened or whether an alternative advisory group should be developed.
2. The ME should carefully consider adding a position of Assistant Director to handle day-to-day and routine management roles that will enable the Director to focus on strengthening the global role of the CRSP as well as creating new synergistic regional and global partners to expand and accelerate development outcomes. Any new Associate Award adds to the ME work load as well. More time can be dedicated to strategic thinking, planning and actions to further leverage country level outcomes to regional scales and seek more effective south-south collaborations. Any increase in ME staffing and costs need to be fully justified based on a work load assessment, clear administrative functions, anticipated new productivity and overall program benefits.
3. An Assistant Director should be considered for the program following the development of job description that differentiates tasks between the current Director (Egna), Research Projects Manager (Evans) and the Assistant Director position.
4. Future programs may wish to consider the appropriate level of cost share and USAID should also be cognizant of the burden placed on host-country collaborators and some smaller US universities in raising the cost share.

Section I: Scientific and Technical Assessment Overview

This report is divided into three major sections. The first section provides an overview of the scientific approach of the Aquaculture & Fisheries Collaborative Research Support Program (AquaFish CRSP) and key findings. The second section develops a more detailed analysis of the project portfolio and issues associated with capacity building. The third section presents the management review. Several appendices are provided with additional information.

Organizational Structure: Integrated Research, Training and Outreach

The mission of the Aquaculture & Fisheries Collaborative Research Support Program (AquaFish CRSP) is to enrich livelihoods and promote health by cultivating international multidisciplinary partnerships that advance science, research, education and outreach in aquatic resources. The AquaFish CRSP was awarded to Oregon State University on September 29, 2006 after an open national competition for the Management Entity (ME) and is different from the former Aquaculture CRSP in both organization and theme. Phase I activities took place between 2007 and 2009 and Phase II from 2009-2011 as described in their respective implantation plans (IP). The AquaFish CRSP operates under a Leader with Associates (LWA) Cooperative Agreement that differs from the previous grant. Two Associate Awards have been received since 2007. The first was a USAID mission sponsored project in Mali on aquaculture and fisheries and the second was a USAID/Washington-funded award to scale-up technologies in Ghana, Kenya and Tanzania to support the Feed the Future Initiative.

The AquaFish CRSP is an integrated and widely diversified research and development program organized around four global themes (goals): 1) improved health, nutrition, food quality, and food safety; 2) income generation for small-scale fish farmers and fishers; 3) environmental management for sustainable aquatic resources use; and 4) enhanced trade opportunities for global fishery markets[1]. The investigations are aligned under two topic areas-- Integrated Production Systems (IPS) and People, Livelihoods and Ecosystems Interrelationships (PLEI). These two topic areas can be further divided into four topic areas for the IPS theme and six topic areas for PLEI. Seventeen U.S. institutions participate in this program and currently conduct about 67 research-related investigations in collaboration with 31 host-country institutions located in 16 countries[2]. A complete listing of the projects is listed in Appendix 8. The investigations can be further subdivided into three types: “experiments” that are structured around a testable hypothesis(es); “studies” that are less formal research, and sometimes descriptive; and “activities” that are outreach, communication and dissemination of findings from experiments or studies.

The structure of the program mirrors the organizational purpose of land grant universities insofar as its investigations are conducted to address the three integrated pillars of research, teaching and outreach.[3]

[1] See Appendix 8 for a list of the projects and investigations.
[2] Aquafish CRSP worked in a maximum of eighteen countries in the first phase.
[3] Hillary Egna, director of the AquaFish CRSP, first made this reference more broadly towards all CRSP programs but it is especially applicable to this CRSP.

This paradigm is exploited for the sake of organizing the report but with slight modification. Within the research category, some investigations are being conducted in pre-applied research on domestication but the majority are in applied science and adaptive research. Teaching and training activities will be captured through a description of the support provided to long-term trainees while outreach is captured through short term training, extension projects, technology transfer and information dissemination activities.

Management Team Leadership

Oregon State University (OSU) serves as the Management Entity (ME) of the AquaFish CRSP. Within OSU, the AquaFish CRSP Management Team (MT), led by Dr. Hillary Egna, is responsible for providing technical and programmatic leadership as well as the day-to-day administrative management of the CRSP. The MT is supported by OSU's Office of Sponsored Programs and the College of Agricultural Sciences.

The MT is professional and efficient in actively directing the programmatic activities of the AquaFish CRSP. The MT has mentored and provided critical assistance to begin a new program with many new host countries (HCs) and principal investigators (PIs) for an effective transition into a new CRSP. The Request for Proposals (RFP) for AquaFish CRSP projects was an open competitive process with broad national distribution of the RFP through various communication networks to reach interested institutions throughout the US. Proposals were selected for funding using a rigorous National Science Foundation style external scientific peer review process. A second RFP was released to solicit additional projects in the Africa region that also underwent an external peer review before awards were made. The MT provided some match-making assistance with historically black colleges and universities (HBCU) with aquaculture expertise to encourage their participation. To assure country-level development relevancy, all funded projects were vetted with country USAID missions for concurrence.

The Director, Dr. Hillary Egna, has 26 years of managerial experience and demonstrates forward-thinking strategic vision about research and programmatic actions. The MT stimulates new ideas such as pioneering work with air-breathing fish in response to future environmental variations in drought-stricken areas. The MT created the concept for Regional Centers of Excellence (RCEs) to build new regional linkages, promote networking opportunities and expand and accelerate outcomes from project results. Technical leadership is evidenced by active roles in organizing and chairing technical sessions at international conferences and invitation by the Food and Agriculture Organization of the United Nations (FAO) for a special workshop on 'Future Direction for Gender in Aquaculture and Fisheries Action, Research and Development.' The MT accelerated technology transfer and development outcomes with China-Mali-Kenya south-south collaboration for new rice-cum-fish enterprises for smallholders in Mali. The MT has redefined research projects with outreach components focused on end-users and solutions to farm-level conditions. The MT has integrated gender inclusivity at the project level for desired outcomes. The MT instituted a HC PI exchange program to create new synergies for a collective global community through sharing information and regional experiences to accelerate technology transfer opportunities between CRSP projects with regional-scale lessons learned.

The MT is a highly engaged and effective leadership unit that has fostered a global network of more than 300 collaborators, partners and stakeholders. The MT created an innovative online reporting system for US and HC principal investigators to input data and information needed for tracking, reporting and reimbursement purposes. This reporting tool is highly praised by the PIs and facilitates timely and efficient reporting and MT responses for data calls from USAID. To support communications and outreach the MT requires each research project prepare an article for the program's newsletter, *Aquanews*, which summarizes progress and significant findings in plain language.

The MT has done an excellent job of building on foundational work of earlier CRSP investments that date back to 1982 with an invaluable legacy of HC and US collaborators and highly productive institutional partners. Some previously trained HC students are now new HC PIs and some former US co-PIs are now new PIs in AquaFish CRSP. Strategic investments created HC capacities with facilities, equipment and specially trained human resources that are leveraged into new investigations, broader partnerships and effective long-term development programs. Previous projects demonstrated the effectiveness and success of the CRSP model throughout the world and positioned many US institutions for key leadership roles in international development projects. The accumulation of lessons learned and on-the-ground grassroots experience served to avoid pitfalls and duplication of effort with improved efficiencies and performance as evidenced by the results and outcomes for the current phases of AquaFish CRSP.

Previous global-scale work and new partners in AquaFish CRSP have enabled the program to broaden its collaborations with regional entities like NACA, SEAFDEC, and SARNISSA that capture the collective strengths of each program in common alignment of improving aquaculture and fisheries for small-scale farmers and fishers. The collaborations create new networks for communication of AquaFish CRSP project results and new multidisciplinary collaborations across regional and global programs that accelerate common development priorities and outcomes. In Asia, Africa and Latin America, former ACRSP foundational research and discovery work are now accelerating development outcomes from uptake by farmers through outreach and farmer training programs.

The review team noted that the researchers were very supportive of Dr. Egna's intellectual leadership of the program and extremely grateful for the development of online tools to facilitate the reporting requirements inherent to the CRSP structure. Oregon State University administration is supportive of Dr. Egna and facilitates her work within the university structure. The Director is an effective ambassador for the program both at her institution and in regional and global agricultural development forums.

Innovation and Contribution to Feed the Future (FtF)[4]

The design of the AquaFish CRSP pre-dated the advent of the FtF initiative by nearly four years. In 2010 when FtF was launched, the AquaFish CRSP was entering the final year of its five year cooperative agreement. Therefore, FtF was not integrated into the CRSP' original program design and planning. That said, there are natural synergies between the CRSP's core work and the FtF Initiative. In assessing the alignment of currently programmed work into the FtF Initiative, activities fall primarily under the

[4] Dr. Hillary Egna contributed to the substance of this section with a written contribution.

following FtF objective: 3.3.1 Inclusive Agriculture Sector Growth[5]. Gains in productivity can be driven by a number of factors, including improved access to agricultural inputs and knowledge, more efficient use of land and labor, enabling policy environments, and improved management of natural resources. The CRSP's work also addresses FtF objective: 3.3.2 Improved Nutritional Status by improving diet quality and diversity through the addition of highly nutritious animal source protein and micronutrients commonly found in diverse aquaculture and capture fishery products.

AquaFish CRSP additionally supports FtF objectives in *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 and supply and value chain analyses. Greater access to market information can increase the ability of small-scale agricultural producers to participate in domestic and higher-value added export markets. By improving post-harvest market infrastructure, and understanding value chains, AquaFish aims to make markets work better for women and men agricultural producers and extend the reach and benefit of nutritious foods.

Working regionally across Africa, Asia and Latin America holds the promise of strengthening regional coordination and can add value and new synergies to activities at the country level. The program is consistent with FtF goals in its focus on accelerating inclusive agriculture sector growth through improved aquacultural productivity, expanding markets and trade, and increasing economic resilience in vulnerable rural communities. Improvements in nutritional status are expected by increasing access to diverse and high quality animal source foods.

Paying attention to cross cutting themes of gender, environment (climate variability), and natural resources management is expected to result in sustainable production systems and good nutrition for all family members. The AquaFish has collaborative projects in numerous FtF countries including; Nepal, Bangladesh, Cambodia, Mali, Ghana, Kenya, Uganda, Tanzania and Nicaragua. A 2010 Associate Award is focused on FtF objectives with funding to scale-up AquaFish research and outreach to capture measurable development impacts in Kenya, Ghana and Tanzania. This USAID/Washington-funded associate award demonstrates the direct alignment of the program with FtF priorities and will elevate the role of aquaculture and the CRSP to support this USG global agricultural development initiative.

The Program also aligns with BIFAD Title XII objectives related to pro-poor technologies and enabling policies through engagement with land-grant and other US university expertise and capacity to address global food and hunger needs through sustainable aquaculture development globally.

There is considerable concern by several long-term US and HC partners that the geographical orientation of FtF will lead to the non-renewal of activities if they are a not targeted FtF countries. Many of these nations provide a key regional resource for desired development outcomes and can facilitate scale-up and transfer of improved practices and technologies in target countries. For example research in Mexico is used in Nicaragua and research in the Philippines and China contributes to

[5]See the *Feed the Future: Global Research Strategy.* Available: http://www.feedthefuture.gov/sites/default/files/resource/files/FTF_research_strategy.pdf

practical problem-solving in Cambodia and Bangladesh. In a few cases, the lack of one-to-one correspondence between FtF-targeted countries and AquaFish CRSP host countries has caused considerable anxiety among partners. Yet there is ample evidence that host country research is useful in facilitating "south-south" scientific exchange for development objectives for example with the Mali project and its linkages to China and Kenya.

Key Messages from the Technical Analysis

The research portfolio consists of a broad scope of topics and science areas that address specific HC priorities in development outcomes for resource limited farmers and fishers. There have been about 100 investigations (experiments, studies and activities) representing a large breadth of work. US PIs assist HC PIs in developing research objectives and plans aligned with AquaFish global themes based on HC problem statements. There is progressive transfer of US-based research and training expertise to HC conditions in many science areas including nutrition and feeds, breeding and reproduction, systems development, shellfish development, social science and water and soils management. The areas of study represent many critical and contemporary issues with increasing integration of social science and supply and value chain studies for broader multidisciplinary solutions to development constraints. There is a strong emphasis to integrate outreach into all research studies that establishes an end-point directly linked to quantifiable impact indicators that align with the four AquaFish global themes.

Most of the research is solution-focused applied research with the aim to move science to practice with BMPs and on-farm short (1-2 years) and medium-term (3-5 years) improvements linked to development goals. The research includes some biotechnology investigations (Philippines) with molecular genetics and pioneering work in new and emerging species with limited knowledge about basic biology, physiology, nutrition and reproduction. These are generally longer-term (6-10 years) investments with more uncertain outcomes of commercialization or farmer adoption of new species.

The quality and depth of research are directly linked to HC infrastructures and capacities as well as applications of US-based research to HC development constraints and new opportunities. AquaFish research has resulted in numerous significant findings or breakthroughs. Examples include: integration of seaweed culture into traditional shrimp ponds in Indonesia and the Philippines with new value-added seaweed for export markets and seaweed food specialty products for domestic consumption; native snakehead hatchery development in Cambodia; new feeds development with local ingredients in Guyana and Tanzania; new alternative cost-saving feed and feeding strategies in Philippines; replacement or reduction of fish meal in aquafeeds with local ingredients in Cambodia and Vietnam; and increased survival and economic viability of farmed baitfish in Kenya as an alternative to wild-harvested baitfish. These areas of research are contributing to public goods evidenced by field testing, on-farm demonstrations and direct outreach and uptake by farmers and small businesses.

The linkage of science to policy can have significant implications for country-level transformations in AquaFish global themes and USAID priorities. Several projects are directly impacting new enabling policies including: new shellfish management protocols in Nicaragua and Mexico; renewed farming of native snakehead in Cambodia; and ban on introduced non-native species in reservoirs in China. In Kenya the AquaFish has developed a foundation of science-based BMPs and ongoing human capacity

building of researchers, extension officers and government policy-makers who are critical elements to implement a new national aquaculture development and stimulus initiative. HC aquaculture expertise and CRSP leveraging with FAO development interests are directing long-term planning and development activities. New investments in properly sited, designed and constructed ponds and a wave of new farmers will benefit from CRSP training and extended expertise. This level of integration of key CRSP program activities into national aquaculture planning accelerates development outcomes and the return to AquaFish CRSP programmatic investments. New methods of propagating native snakehead in Cambodia and new pelleted feeds for snakeheads that reduce the use of small fish important for human consumption in the Mekong River Basin have significant transnational policy implications for both Cambodia and Vietnam.

Some areas of research are likely on longer-term discovery trajectories with uncertain outcomes. This includes assessing domestication and commercial potential of new native species in Latin America (cichlids), Africa (bony-tongue catfish) and new innovative research on emerging air-breathing fish in each region that adapt to high densities and poor water quality conditions including drought areas. In the case of Mexico, farming of native gar is now a reality for some rural communities and local markets after about 10 years of investments by AquaFish CRSP and other local programs. Work continues to refine fingerling production, feeding, density levels and genetic selection to improve farming efficiencies.

Some research occurs at the nexus of aquaculture and fisheries with some species (snook in Mexico) under domestication assessment with potential as a farmed product and/or for public stock enhancement as well as cockle (shellfish) work in Nicaragua and native oyster hatchery research in Mexico.

There are several new ongoing studies that offer insightful findings and groundwork for future global-level collaborative research. They are 1) value chain analysis training for uniform data collection across regions and 2) a global-style experimental pond unit assessment to develop baseline of characteristics and strengthen research capacity for future work (Bangladesh, Ghana, Kenya, Tanzania, Cambodia, Nicaragua and Nepal).

There is increasing interest in marine aquaculture, including seaweed and shellfish that are important globally in many coastal countries. This may be an area of future investment with new US and HC PIs as well as new collaborative networks.

Section II: Scientific Portfolio and Contribution to Development Public Goods

The research portfolio is broad consisting of 50+ areas of inquiry or projects with several add-ons. Each research project has an integrated outreach element intended to inform, demonstrate and assess the application of results by targeted small-holder farmers or resource-limited fishers. The overall depth of work is adequate for the stage of research conducted and the rigor is confirmed by the scientific peer review process used by MT to assess each project investigation before funding. Seventy-four percent of investigations are research oriented and this is nearly equally divided between experiments with testable hypotheses and qualitative and descriptive studies. The breadth is adequate in that it connects research to outreach activities to inform and improve practices or lives of targeted end-users. Twenty-six percent of investigations specifically support farmer and extension outreach, communication and training activities. The planned studies are aligned with overall global themes and a system approach to achieve development outcomes.

The areas of study represent many critical and contemporary issues in global aquaculture development with increasing integration of social science supply and value chain studies for multidisciplinary solutions to development constraints. Most research is solution-focused applied research aimed to move science to practice with BMPs and on-farm improvements. The depth appears to be adequate based on numerous research breakthroughs, significant targeted development outcomes and completion of project objectives that leverage US and HC PI resources. Rigor and integrity are stressed by the ME and external peer-reviews help validate the quality of proposed research work plans. Numerous publications of project results in scientifically peer-reviewed literature indicate sound experimental methods.

AquaFish takes the extra step of synthesis and translation of research findings in the form of fact sheets, often including local language versions, and summary articles in *Aquanews* that is disseminated among the global network of more than 300 individuals.

The MT has done an excellent job of balancing research and implementation activities with the integration of an outreach element in all research projects to emphasize the critical importance of implementing activities toward development outcomes. The scope and extent of the implementation work depends on the type of research and verification of findings for relevant application by end-users. The on-farm trials and verification work supported by the CRSP are important steps between research and technology transfer. The need for research is critical to provide the foundation of knowledge and understanding of biological processes and aquatic systems and the connection with successful aquaculture operations. Programmatic emphasis is problem-solving applied research that addresses HC stakeholder real-world issues and some fundamental or basic research, for example, air-breathing fish and pioneering studies on the propagation potential of economically-valuable native species with limited knowledge of basic biology.

The environmental stewardship and sustainability theme is strongly supported and leveraged with previous work and showing on-farm impacts. For example Thailand farmers are now co-producing prawns and shrimp at lower densities with less water replacement and reduced impact on the

environment based on earlier CRSP research findings. Farmers in Africa are also learning of water conservation practices and improved fish production by not draining ponds at harvesting as traditionally done in the past.

To preserve biodiversity and prevent the introduction of non-native species, investment has targeted identification of native species that need basic knowledge on reproductive physiology and feeding prior to developing economically relevant culturing techniques. Development and implementation of biotechnological approaches has so far focused on measurement of hormone levels in blood. The use of genetic/genomic tools for measurement and production improvements is developing rapidly and insuring some training in these disciplines is critical for enhancing production efficiencies and applications of cutting-edge science.

There is an opportunity to focus on barriers to implementation through social science research to accelerate technology transfer and outreach. Already AquaFish CRSP has invested in the coordination of research on the biology and production of aquaculture species with the business and social impact evaluations, and this coordination is critical and requires continued emphasis.

"Basic" Science needed for Aquaculture Innovation

AquaFish CRSP is making investment in innovative pioneering research on new emerging native and air-breathing fish species with potential as farmed aquaculture species. Limited knowledge exists on their propagation and control of life cycle but favorable characteristics include survival in poor water quality conditions (lungfish in Uganda); chame (Mexico) and gars (Latin America) and promise for smallholders in drought-stricken areas of Africa, their adaptability to high densities and good growth. Investigators have produced new breakthroughs in spawning and experimental growth trials. Investigations in the Philippines employ biotechnology methods using a molecular biomarker to assess fecundity and growth performance in milkfish and tilapia. Basic feasibility and assessment studies in several countries on native species as potential farmed species are forward thinking and generating new basic knowledge.

Areas for Improvement

Biotechnology is identified as one AquaFish research area. Biotechnology offers new molecular-based tools and applications that can transform traditional research in areas of genetic improvement and breeding. HC research capacity can be strengthened with new capacity for cutting-edge research methods and equipment. Presently, AquaFish has limited biotechnology-related research. The Program may find practical applications of biotechnology to accelerate research solutions for development outcomes in the future. US PIs have trained some HC participants in biotechnology research for next generation research capacity.

There is a need and trend to diversify aquaculture species with many policy preferences for new or emerging native species over non-native or introduced species because of aquatic biodiversity and ecosystem conservation concerns. In addition farmed native species are being developed to reduce demand and pressures from native wild stocks that are over-harvested and impacted by natural habitat changes (Kenya, Nepal, and Mexico). Most research with new native species is at an early stage of domestication assessment and propagation under farming conditions. These areas of research should

be monitored carefully for additive results that support continued funding as well as market demand and enterprise potential. In the US there are numerous freshwater and marine species under investigation for commercial potential that has spanned 20—30 years with limited or no enterprise development. The evidence with most new and emerging aquaculture species suggests 10 or more years for farming applications with more effort to directly benefit limited-resource enterprises compared to well-financed large commercial operations. Few international development programs can sustain funding for this period of time and that positions AquaFish CRSP in a unique development role, should funding be maintained. New species selection criteria should assess the current state of knowledge and a feasible research timeline to achieve program development outcomes. Accelerated technology transfer may be achieved by connecting needed expertise across the global AquaFish CRSP program in the US and HCs.

Applied and Adaptive Research for Transformational Change

The majority of the research portfolio is applied research. There are numerous projects that have achieved significant breakthroughs in outcomes and progress to move science to practical applications that directly benefit targeted end-users. A real opportunity for broader impact is the regional application of country-level studies as well as inter-regional or larger global-scale benefits.

Significant Accomplishments in Applied Aquaculture Research

Research in the Mekong River Basin (Cambodia and Vietnam) has identified the importance and diversity of small fish in the diets of the poor in rural areas and increasing demand for the same fish as feed for snakeheads. The policy and fisheries resource issue is being addressed with transformational development of new hatchery capacity and breeding of native snakehead in Cambodia as a farmed source instead of wild harvested source and new sustainable pelleted feed technology for snakeheads with 50% less small fish (Cambodia and Vietnam). By shifting feeding away from small fish to a pelleted feed, pressure upon captured feed is reduced. This is important as these fish stocks are an important food and nutritional resource for the poor. Research is informing policy decision to lift the ban on snakehead farming in Cambodia.

Several advancements have been made in the area of feeds and feeding. Small farmers in the Philippines are realizing cost savings in feeding tilapia and milkfish as a result of AquaFish collaborative research that has resulted in a partnership with a local feed mill for commercial application. Studies revealed that reduced feeding is profit enhancing. In Tanzania, research has focused on using *Leucaena* and *Moringa* leaves as a replacement feedstock for soybean meal. This is in an early stage of research.

In Kenya, several decades of research in collaboration with the Aquaculture and AquaFish CRSPs have resulted in investments by the Government of Kenya (GOK) to support aquaculture development (described in detail later and in the trip report by Jeff Silverstein). It is reasonable to argue that the AquaFish CRSP (and early versions) developed the knowledge infrastructure that allowed this transformation to take place especially in the GOK campaign to “Grow Fish, Sell Fish, Eat Fish”. This example should be emphasized across the CRSPs and USAID as a model relationship for emulation. The relationship successfully stimulated broader investigations in fisheries and aquaculture through the

development of cultured baitfish (*Clarias)* for the Lake Victoria Nile perch fishery. This development has reduced the negative impact of harvesting fingerlings for the longline fishery.

Work in Mexico on native oysters resulted in construction of the first oyster hatchery of indigenous species and successful culturing and spawning techniques with superior qualities for tropical conditions compared to an introduced non-native species.

In Indonesia, a seaweed polyculture with shrimp combined with capacity building, led to innovation in processing seaweed and food science. Methods for manufacturing new products were developed and markets identified for value-added food products with export potential. This research followed a value-chain analysis that identified production benefits from the polyculture–seaweed improves shrimp production and line culture kelp produced a higher quality product—that then spilled over into additional species, e.g. soft shelled crabs.

In Ghana, CRSP relationships have contributed to transformational change through the development of private tilapia hatcheries to propagate and sell fingerlings rather than reliance upon government hatcheries. New economic opportunities were stimulated as a result of CRSP training and capacity building through devolution from government dependence to private sector growth. On the production side, the AquaFish CRSP demonstrated why farmers should not drain ponds at harvest but retain water at harvest through a set of best management plans (BMPs).

Policy Research for an Enabled Aquaculture Environment

In Nicaragua, a community-based policy support initiative for no-take zones for blood cockles was developed in collaboration with a local community over a period of four years and this had led to broader coastal zone management plans. This policy initiative builds upon previous UHH research to work towards certified shellfish products by addressing sanitation and human health concerns to meet HAACP standards. In this example AquaFish CRSP was part of a larger group of programs and donors in including the European Union.

In Mexico, AquaFish CRSP developed extension capacity to sustainably manage oyster farms and determined the maximum carrying capacity of these farms. This new policy to capped growth in the industry and also provided opportunities to work with native oysters as opposed to imported non-native species.

And as described above, production activities in Cambodia and Vietnam have been driven by policy bans to limit capture fisheries and aquaculture of snakehead so there is a close relationship between the two areas. This can also be said for the work in Indonesia where market potential and biodiversity concerns led the diversification of production systems.

Gender Analysis and Integration

The AquaFish CRSP, following USAID program review that identified a lacuna in gender integration approaches in research and activities, has been responsive by adopting program wide gender inclusivity

strategies[6]. The External Program Advisory Council (EPAC) review in 2010 focused on a gender integration strategy at the request of the MT. The RFP for proposals to participate in the AquaFish CRSP program has required that each participating university's proposal include the following: an overall gender inclusivity strategy; gender focused approaches in the technology transfer and dissemination interventions; and standalone gender focused investigation or activity. CRSP PIs participated in a USAID supported gender training program that focused on USAID guidelines for gender integration in funded projects. Following this workshop, PIs were tasked to develop gender inclusive sub-project design. As a result of setting a framework for gender integration, each subproject in the program presents a gender integration strategy and gender focused activity or activities. Across the AquaFish CRSP it is evident that efforts were made to include gender responsive approaches in outreach and research as standalone activities, and a commitment to address gender concerns is documented.

The AquaFish CRSP also strived to achieve the USAID requirement of 50% women's participation in sponsored training activities with considerable success but with variance among the participating universities and host countries. Yet, increasing women in graduate degrees is a work in progress with men showing slight advantage over women. Women's participation in short term training varied, depending on the technical subjects offered in the training and the PI's commitment to encourage women. For example, training related to fishery product preparation counted 100% women as trainees. The AquaFish CRSP also highlights the importance of women in science and promotes the issue in relevant forums. Participation of women as PIs, investigators, extension specialists and trainees is encouraged but still participation barriers persist due to the traditions of the CRSP and culture of participating countries. A few examples of standalone gender integration activities are: integration of gender concerns in value chain analysis; training of women in seaweed processing and developing commercial quality fish paste; training women in oyster culture and cockle collection and processing and training women in tilapia production and cage culture. There were efforts to partner with local women NGOs to target women for project driven interventions. The findings of current studies in progress and emerging efforts to develop sex-dis-aggregated data would add to a knowledge base on gender in agriculture production systems. The AquaFish CRSP has demonstrated a commitment to gender integration mandate in the current phase and made investment in program wide strategy with valuable outputs.

Areas for Improvement

PI's face constraints due to inadequate access to gender expertise in their respective institutions to develop gender responsive project design, and a lack of sustained gender advisory services. This may be explained by the nature of the CRSP scientist composition that does not include social scientists (other than economists) with expertise in people's participation and gender. Gender inclusive strategy statements as presented are too broad and not always tailored to reflect the technical focus of the AquaFish CRSP and also too ambitious for the given time frame. Thus, in some instances, the link

[6] See: Miller, Raymond J. and Deborah S. Rubin. "Effective Management for Collaborative Research Support Programs: Issues and Opportunities." November 2003.

between the strategy and the proposed AquaFish activities are not well demonstrated. The sustainability of women NGOs and collaborative interventions is a concern since US and HC institutional commitment to adopt, apply and sustain gender strategy is nascent and women's access to continued technology support is uncertain. The challenges ahead are: sustaining and expanding these initial investments, providing sustained technical support to scale up the activities, establishing accountability with gender budgeting approach as a monitoring mechanism, identifying additional funds, developing sustained commitment among investigators and participating institutions to buy in to gender inclusiveness strategies and institutionalization of gender strategies.

Impact Assessment Research

A non-competed impact assessment project was commissioned by the MT to provide broad assessment of program activities. The proposal was peer-reviewed. The proposal was reviewed and awarded to Oregon State University and Montana State University[7] economists. In addition to this project, a few projects are incorporating impact assessment into their activities (University of Connecticut, Purdue University). Project-embedded activities are on-going while the impact assessment project has been completed.

Several investigations were undertaken in the commissioned impact assessment project. After review of project reports, very little was learned from these studies overall. Described within the report are numerous explanations for the failure to meet the stated objectives and it is difficult to evaluate the reasons for the failure. Some explanations provided by host country participants indicate that the project investigator was not familiar with aquaculture and the approach was not appropriate (see Appendix 3 for comments from host country participants). The lead investigator indicates that the required data was not received from the country participants to conduct the analysis despite an organized session on the topic at the 2009 Annual meeting. Irrespective of where the problem lies, there is limited insight into the economic or human welfare impact the program has had outside of the case study visits to the Philippines and Kenya and the phone interview on Mexico described later in this report and in the appendices.

Areas for Improvement

The lead reviewer agrees with one of the impact assessment investigators that impact assessment was not integrated into most projects at the outset. Adding on impact studies to an ongoing project violates a key principle of impact measurement that a baseline be established prior to any intervention. There are several opportunities to initiate impact assessment activities. Research activity in Tanzania is still in a discovery stage, the work in Ghana is started but some activities are just building momentum. These are just two examples where strict impact assessment protocols could be established so that rigorous adoption studies could be conducted in the future. This is fundamental for identification of welfare-enhancing benefits consistent with FtF objectives. Projects may wish to follow the example of the University of Connecticut that has attempted to integrate impact analysis into their project with a

[7] The Montana State University economist became a faculty member of Oregon State University during the implementation.

dedicated scientist to train on technical topics. This will require broadening of team members in many projects.

Overall, this is a critical failure of the MT that is only tempered by the fact that thorough monitoring of project performance was conducted. The MT has kept good monitoring records of the projects, described later in the report, but this does not substitute for impact assessment. The MT should reach out to the aquaculture economics community for expertise in conducting analyses in the future. Many qualified individuals can be found on editorial and advisory boards of *Aquaculture Economics and Management* and *Marine Resource Economics.*

The Outcomes of a Strategic Vision over the Past Phases

The MT, working with US and HC PIs, organizes workshops and technical sessions at many international fora. These events help to achieve several elements critical to staying current and visionary in planning for the CRSP. Through these workshops, PIs get the opportunity to critically discuss their findings with colleagues. MS and PhD students present research in an international setting, and connections that will help them continue their professional careers are established. For all participants, including the CRSP director, innovative ideas and new strategic directions can be discussed and developed. These conferences are important for informing the ME and for the development of professional careers and for fostering long-term relationships based upon credible scientific capabilities, both among and between developed and developing countries. They provide a platform for sharing ideas, networking with world-class scientists, publishing research findings and strengthening the connections of the ME to the research and development community. CRSP efforts in this area also increase the visibility of the program and contribute to AquaFish CRSP information exchange. As a specific example, for the April 2011 Asian Fisheries Society meeting in Shanghai, China, the CRSP Director served on the scientific steering committee and co-organized sessions in the co-convened Ninth International Symposium on Tilapia in Aquaculture (ISTA 9) and the 9th Asian Fisheries and Aquaculture Forum (9AFAF). In addition there was full day session on *Accelerating Aquaculture Development in Poorer Countries*, organized and chaired by the AquaFish CRSP director.

The MT stimulated new ideas and applications of aquaculture such as pioneering work with air-breathing fishes in each region, understanding there may be unique qualities of these fishes to withstand environmental changes and stressors, high densities and poor water quality, associated with global climate change, for example. Such forward thinking programs demonstrate a mechanism by which the ME has suggested broad ideas to the CRSP community for further development.

The priority for incorporating biotechnology into the research portfolio reveals the CRSP Director's acknowledgement of the importance of bringing in a forward-looking methodology. The use of biotechnology is possibly best reflected in the Philippines where blood borne hormones are being measured with sensitive molecular methods as indicators of body growth and growth potential. This has been well supported by the CRSP and has led to opportunities for HC students (graduates) to further their professional development with modern molecular technologies.

There are numerous examples where the research activities and follow-on studies demonstrate a strategic sequencing. An excellent example is the work in Vietnam and Cambodia with the US PI Pomeroy. The work on replacing low value small "trash fish" in the diets for snakehead with pelleted feeds including larger proportion of plant proteins (investigations 07SFT01UC, 09SFT01UC) has fit well with the projects to develop indigenous snakehead species in Cambodia (09IND02UC). Investigations 07FSV01UC and 09FSV01UC develop value-added products from the small species that are being spared inclusion in fish feeds. Not only is the research strategically sequenced, but the collaboration across HCs has been promoted by involving Vietnam and Cambodia PIs in related projects to domesticate broodstock and train hatchery reared fish to take pelleted feed.

The oyster dynamics evaluation in Mexico led through the UHH PI (07IND03UH) led strategically into the follow-on hatchery practices project (09IND01UH). Development of capacity for oyster spat production and a microalga rearing has been achieved, though additional training and improved water treatment facilities appear to be needed for establishing long-term impacts and success.

Work on breakdown of methyl-testosterone by bacterial degradation in Mexico (07MNE07UA, 09MNE07UA) is a strategic project that could have broad worldwide impacts with the increasing reliance on masculinized tilapia worldwide. This research requires follow-up.

An example of CRSP project sequencing and strategic development from a broader perspective is exemplified by the Kenyan projects. The program in Kenya began in 1997 with cooperative research and training at Sagana Aquaculture Research and Development Center. A shorthand evaluation of the program evolution might be: Pond Dynamics/Aquaculture CRSP (PDA) was mostly basics of improving production beyond 1000kg/ha (or even above 100kg/ha). This required improved pond construction, pond management, water quality management, and record keeping. The Aquaculture CRSP (ACRSP) evolved to training and extension network development-thinking of aquaculture as a business. The AquaFish CRSP has led to development of value chains, marketing, networking and cluster development as well as identification of critical resource needs, specifically feed and genetically defined fish stocks, and environmental issues to address with best management practices (BMPs).

CRSP trained, and in many cases MS holding scientists, form a critical extension group of trainers and farmers (e.g. Mr. Kiama-Green Algae Farms; Enos and Jedidah Were-Jewlett Ltd., James Mugo-Mwea Fish Farms). These people, CRSP- trained and now involved in providing training through the CRSP are foundational to further growth and strength. The Aquaculture program at Moi University, built over 15 years by Prof. Charles Ngugi and others, is deep. It is currently building links with animal science and business schools to improve the commercial development of aquaculture enterprises. AquaFish CRSP continues to be critical source of specific projects against background of increased government funding for aquaculture. This example of the strategic development, based on central CRSP values of long-term relationships has yielded excellent development outcomes.

Moving Forward: Strategic Positioning in Aquaculture Science and Development

Advances and challenges are continuous for incremental and transformational improvements in poverty alleviation and improving livelihoods in rural communities in countries and regions with limited capacity for aquaculture research and outreach. Numerous projects have established strong HC collaborations with leveraged and expanded research capacities of facilities and trained professionals and students as specialized centers for long-term aquaculture research support and delivery of important public goods. A new project, *Experimental Pond Unit Assessment*, aims to establish a uniform research direction for basic work needed to develop small-scale aquaculture and customized management practices for diverse production systems (Uganda, Bangladesh, Ghana, Tanzania, Cambodia, Nicaragua, and Nepal). Contemporary and foundational research project areas that can contribute more impact if continued for another five years are aligned with production system design and best management alternatives; sustained feed technologies; quality seedstock development; human health impacts of aquaculture; food safety and value-added products development; technology adoption and policy development; marketing, economic risk assessment and trade; watershed and integrated coastal zone management; and mitigating negative environmental impacts.

Numerous projects have completed experimental work and transitioned into more outreach for end-user or use of new tools and technologies. Several short-term projects have ended with no continuation needed. Numerous projects have generated preliminary data that require field-testing or additional work to validate farm or business applications. Several production-oriented projects will benefit from follow-up economic, marketing or other socioeconomic research to identify factors impeding scale-up with more cost-benefit analysis data for new technologies and practices. This rationale is based not only on country level needs but broader scale-up and potential applications at country, regional and global levels. The findings from an EGAT Associate Award focused on scale-up and dissemination of AquaFish technologies and practices in three African FtF countries will provide more insights on scale-up strategies and opportunities.

Many projects originate at local or community levels and require subsequent scale-up efforts for broader impacts in more communities with opportunities for adoption. Numerous projects generate new knowledge, technologies, practices and tools with regional and global application that can be assessed by the global AquaFish community to leverage collective expertise across regions. Development-scale success linked to both creating and benefitting from HC capacity building require long-term sustainable collaborations as new science discoveries continuously improve next generation practices at the farm-level. AquaFish is influencing the actions of US and HC research enterprises to align sciences with global development outcomes and new pro-poor policy interventions.

Achieving large-scale country level impacts in aquaculture development require long-term investment and relevant problem-solving research strategies to address knowledge gaps and development bottlenecks. Numerous projects are developing preliminary data and information that show promise for application and uptake by targeted communities. Often the desired outcomes and application of results research require additional time for field verification, demonstration, and training before reaching a

larger community. Many projects are at a stage of scaling-up, and effective outreach methods and productive collaborators in research, extension and communities of farmers and fishers would be well timed. Research questions persist that require more investigation and pioneering breakthroughs under local conditions for development, some of these should keep the focus more basic and less outreach oriented.

There is a spectrum of conditions not only across the CRSP but even within countries involved with the CRSP, so it is impossible to generalize and state whether greater emphasis should be placed on outreach and scaling up. Nevertheless, there are clearly projects that would benefit from such an emphasis. For example, the cluster development projects in Kenya, best exemplified by the Bidii cluster (Vihiga) growing catfish fingerlings for use as bait in the Lake Victoria capture fishery. The Bidii cluster is one of four clusters that were attempted. The other three have not had the same success. It seems there is a real opportunity to invest further on outreach and attempt to scale successes more reproducibly. Certainly in regions with growing aquaculture capacity and production, baseline studies on product availability, product forms and economic impact of aquaculture would be of value.

In the Philippines the reduced feeding work is apparently being picked up and tested in many production settings, and the feed developed has been adopted by a major feed manufacturer. Greater focus on outreach and measurement of impact on farm would be appropriate. In addition, these methods are being transferred to milkfish and even marine species as a means of scaling the work. The physiological mechanism for how or why reduced feeding may work in such systems has not been developed, so maintaining the detailed research focus on this level of investigation is appropriate before looking toward outreach.

Interviews with US PIs suggest that several projects will end with the current Implementation Plan because of completion with no continuation plans or HC factors. The program model using HC input to identify local problems and focus areas of research is sound with the important consideration that feedback represents a synthesis of broader stakeholder input from targeted end-users for the program and is not solely investigator-driven. The inclusion of private sector participation should be encouraged throughout AquaFish program planning activities. The direct linkage of development goals and specific end-user needs and priorities in a local situational context should guide levels of effort and facilitate impacts. Future funds should be directed to high performance projects with sound assessments for furthering development impacts from follow-up or next generation projects sequentially planned from past foundational work and experience. Projects with 5 years of clearly limited accomplishments or severely constrained HC conditions should be discontinued in favor of strengthening core capacities and centers of excellence for small-farmer aquaculture research and technology development in each region.

AquaFish CRSP focuses on problem-solving applied research for evidence-based improved practices and technologies and this approach should continue as the major portion of the research portfolio. A smaller portion of the portfolio should fund basic or fundamental research, including biotechnology research and training, aimed at transformation breakthroughs to support development goals and targeted end-users. Few international development programs can sustain long-term funding for basic

research and associated human capacity building of next generation scientists with graduate level training. The scale of effort can be expanded to match the extent of constraints at a multi-country level, such as, production system design and best management alternatives; sustained feed technologies; quality seedstock development; human health impacts of aquaculture; food safety and value-added products development; technology adoption and policy development; marketing, economic risk assessment and trade; watershed and integrated coastal zone management; and mitigating negative environmental impacts.

Shellfish aquaculture is an area for potential expansion in coastal areas where artisanal fishing communities are concentrated with a need for expanded economic opportunities. More countries can benefit from sanitation, resource management and policies, culture methods and water quality certification capacity for new product development and marketing opportunities. Nicaragua and Mexico are case studies. The same applies to new seaweed crops and integrated trophic polyculture systems developed in Indonesia and the Philippines. The work in Cambodia and Vietnam is transformational in potential changes in snakehead farming policy in Cambodia and new small fishes management policy in the Mekong River Basin and new pelleted feeds for snakeheads. The core research area of sustained feed technologies cut across all regions and offers future opportunities to reduce feed costs, improve feed strategies (Philippines) and incorporate local and available low-cost alternatives to traditional aquafeeds. Understanding and fulfilling nutritional requirements of economically important species are critical to long-term sustainable development. New tools and applications for aquaculture development planning in inland and coastal areas, proper site selections, and efficient multiple uses of water resources with integrated aquaculture production will become increasingly important. Improved environmental management is a continuous field of research as pressures mount for increased production efficiencies, multiple uses of water and practical pollution mitigation of effluents. Projects in China and Thailand are improving production system operations and performance and these are key leaders in the aquaculture industry. They are not targeted FtF countries but they can provide important research findings for FtF countries.

AquaFish has a unique global research network that can be mobilized for innovative approaches for expanding impacts within and between regions. The south-south collaborative model of accelerated adoption of new rice-cum-fish systems in Mali and integration of new seaweed crops in Indonesia offer expanded opportunities. Research with indigenous species development is often linked with high value over-fished or depleting wild fishery stocks seeking a farmed alternative and supporting biodiversity and ecosystem conservation goals by prohibiting the introduction of non-native species. Farmers benefit from diverse choices of cultured fish and new market opportunities. Research time lines are generally long-term for enterprise level development outcomes. Careful ex-ante impact assessment of the benefits of this line of research needs to be conducted to avoid chasing the “next” new specie. While we encourage continuation, we stress that “depth” in a few high potential species should be pursued and not “breadth.” A commitment needs to be made to a few species and which ones they are should come from a strategic retreat and careful consideration of the risk/reward calculus. In addition, this type of work should seek out non-traditional partners such as those active in the NSF PIRE program.

Work in Africa covers a wide spectrum of development with CRSP impacts being seen in the increasing production from aquaculture in Kenya from less than 1000 metric tons/year in 2005 to nearly 20,000 metric tons/year in 2011 (personal communication, Sam Macharia-Kenyan Ministry of Fisheries); compared to Mali, a relatively new entrant in aquaculture production; or Ghana where private investment has been quite extensive surrounding the Lake Volta region. The experimental pond unit assessment (EPUA) project started under the AquaFish CRSP involving many of the HC's (Uganda, Bangladesh, Ghana, Tanzania, Cambodia, Nicaragua, Nepal and Kenya) has enabled initiation of best management practice (BMP) studies on water conservation practices and feeding practices. The overall goal of this EPUA approach is to establish a uniform research direction for basic work needed to develop small-scale aquaculture. Future AquaFish CRSP programs should draw upon the EPUA results to further develop methodology for customizing management practices for any given aquaculture system. In Kenya work has started on two of more than 10 BMPs identified for development and on-farm trials with the Kenyan HC PIs.

Feed availability is a critical issue for all the HC partners, so technologies for developing quality feeds with locally available ingredients, and fish species that can thrive on these diets is a direction already entered into by Tanzania, Uganda, Kenya and others, and requires increased focus in the future.

Another aspect that was emphasized by US and HC investigators was the interest in improved genetic stocks. There is great need for improved genetic material and the use of, and interest in, the GIFT tilapia developed by the WorldFish Center in a good example. Nevertheless the training in genetic improvement seems limited and practices such as "bringing in fresh blood" and outbreeding with unknown material to "minimize inbreeding" without evidence of inbreeding problems, do not have strong theoretical or practical support. Work on genetic improvement is a basic need, and already represents a real value added enterprise for some farmers, and could be extended to more.

The involvement of HC universities in the CRSP varies, however to the extent that long term relationships are established the CRSP has had critical capacity building impacts with positive effects on the universities in a number of countries, from supporting top graduate students, training farmers, extension and research specialists, and contributing to the ranks of university faculty. The CRSP projects form the basis of graduate student theses research in many instances. Furthermore the multifaceted approach of the AquaFish CRSP looking at fish production, product demand and marketing, clustering developments has influenced the University partners' long term planning, for example in Kenya, Moi University is currently in the process of establishing more formal ties among the Aquaculture and Fisheries school, the Business School and the Animal Sciences department to make their programs more comprehensive and relevant for commercial aquaculture development.

Long-term Training: Part of the Technical Contribution

The AquaFish CRSP has done an excellent job of annually documenting the number of long-term trainees fully or partially supported by the program. According to their database as of December 2011, a cumulative total of 325 long-term trainees, with most of the students coming from host-country institutions have enrolled in degree or non-degree programs since AquaFish CRSP inception. These students have received either partial or full funding from the program. At the current time,

approximately 188 students are enrolled illustrating the importance of partial funding and leveraged resources for student support.

Each annual report provides detailed information on long-term (and short-term) trainees that is not duplicated in this evaluation[8]. To summarize, the program has largely funded host-country students who have attended U.S. and non-U.S. universities. Mexico, China and Vietnam combined provide over 50% of the students. As expected, the majority of students specialize in aquaculture production sciences. There is a near balance between male and female trainees. It is commendable to note that Borlaug LEAP fellows have been selected from AquaFish CRSP HC participants attesting to the qualifications.

AquaFish CRSP Short-term Training and Capacity Building

AquaFish CRSP investment in short term training aims to reach stakeholders in aquaculture and fisheries in HCs through partnership with PIs. AquaFish CRSP had supported large number of events to reach diverse stakeholders in aquaculture system. Short term training is under 6-months' duration. Short term trainings include seminars, workshops, short-courses, and internships. Workshops focus on training host country extension specialists, fisheries officers, local fish farmers, processors, vendors, small business owners, and NGOs.

Since the inception in 2006 AquaFish CRSP projects have held over 200 short-term training sessions with over 6,500 participants, including approximately one-third women trainees. CRSP program maintains an extensive sex–disaggregated data base on short term training. The data base is comprehensive giving relevant information related to event name, organizer, PIs, participants list and cosponsors, if any. The lower percentage of women trained in short term events in some countries are attributed to the type of aquaculture or fisheries activities and gender differentiated activities and interest in the social context. A higher percentage of women in some countries is made possible by targeting training in issues that are relevant to women's roles as well as encouraging women to enter training events that have been dominated by men.

Most of the trainings were directly funded by AquaFish CRSP with a few host country institutions as co-sponsors such as Wuhan University and Institute of Hydrology CAS, China; DNP/Mali; University of Stellenbosch/SA; National Council of Science and Technology, Brazil; Ministry of Fisheries Development, Nairobi, Kenya; USAID Business Development Services, Kenya; and Moi University, Eldoret, Kenya. Most topic foci were on aquaculture science and development. Valuable south-south linkages were through HC investigators knowledge sharing (HCPI Information Exchange Project) and training of African rice farmers in Asia in rice-fish production systems. There were 284 individuals from Initiative to End Hunger in Africa (IEHA) focus countries who received training in 2009 representing 22.7 percent of all short term trainees. These short term trainings for skill building and sharing of information provide an opportunity to continually support learning to enhance the human capital in aquaculture sector. The intensive

[8] See pp.34-38 in the 2007 Annual Report, pp.65-67 in the 2008 Annual Report, pp.101-104 in the 2009 Annual Report, pp.116-119 in the 2010 Annual Report, and pp.116-118 in the 2011 Annual Report for detailed information.

hands-on master trainer program of two highly selected participants from each of four African countries at Auburn University strengthens future HC capacity to lead training programs for farmers, extension officers and other interested parties. The integration of online training modules as a training tool should be evaluated for HC training needs and any potential broader application if demonstrated to be cost-effective.

Innovative training programs using distance learning techniques are being used. Auburn University is leading this work and it is unclear, since it is too early to evaluate because the training is not complete, whether this mechanism is successful. Some participants were having difficulties accessing online modules. It appeared that this material could not be shared via DVD due to intellectual property concerns and this was causing difficulties. A thorough assessment of this activity needs to be conducted so it can be determined whether it is scalable to a broader set of participants. Any problems need to be identified to determine whether they can be addressed since this type of training is being used widely in some low income nations. If this program is a carefully guarded fee-for-service training, then consideration should be whether the program is cost-effective for AquaFish CRSP or whether a public good version should be developed.

Areas for Improvement

There is no evidence of systematic follow up on the trickle down of learning gains from the short term training at farmers' level. So there is a possibility the events would be quantifiable project outputs, but not necessarily would they result in a capacity building outcome.

Given the growing interest in aquaculture development and export oriented production goals in HCs, CRSP events could have been co-sponsored by other public and private sector entities.

Global Network for Aquaculture Development: Institutional Collaborations

The core mission of CRSP is to build a network of U.S. and developing country scientists as a foundational research driven knowledge base and support innovations in aquaculture development. In the current AquaFish CRSP implementation, an earlier vision of the research network has expanded to include diverse stakeholders in aquaculture sector development. Hence the project achieves the goal of building a network for aquaculture development. The AquaFish CRSP program is structured in a model of collaboration between US lead universities and institutional partners in developing countries with a few exceptions (South Africa and Thailand). Oregon State University, the seven lead sub-award US universities and their ten US university partners are currently linked with institutional partners in 16 countries located across Africa, East Asia, and Latin America. There are efforts underway to expand linkages in South-Asia. The project claims a network of 300 institutions including PIs, investigators and collaborators in the core projects and HC projects. The institutional partnerships in HC includes, beyond academic and research institutions, a wide range of national and regional institutions that provide research and development leadership in aquaculture sector. Beyond the network of scientists, through the investment in long-term training at degree level, AquaFish CRSP has network of scholars in the US and HC who contribute to aquaculture development. Finally the CRSP support to short term training builds HC local networks of participants with potential to collaborate on specific aquaculture and fisheries initiatives. Hence, it could be stated that AquaFish CRSP fulfills the mission of building a global

network for aquaculture development; nevertheless also see the discussion on expanding the information dissemination in the *web-presence, communication and monitoring* section below. The program network/outreach structure is formatted as Regional Centers of Excellence fostering leadership roles to coordinate and expand regional initiatives in aquaculture research and development as well as to promote regional networks. RCEs are grouped as Asia, East and Southern Africa, West Africa, Latin America and the Caribbean. AquaFish CRSP has taken initiatives to build/strengthen linkages with NGOs (women's NGOs in Africa); government agencies (Fishery Ministries in Asia, Africa, LAC and key regional institutions (SEAFDEC, NACA). AquaFish CRSP efforts to cosponsor national and international fishery and aquaculture events also contribute to building networks for outreach and information dissemination.

Areas for Improvement

AquaFish CRSP, like all other CRSPs with long standing mature institutional partnerships, presents a potential of exclusivity in CRSP and there may not be room for new actors.

Given the initial mission of CRSP as one of promoting a network of scientists not necessarily development professionals, the network is dominated by production scientists.

Research Investment

The initial total value of the AquaFish CRSP LWA Cooperative Agreement when it was awarded to Oregon State University on September 29, 2006 was $8.9 million. The total value was increased to $12.82 million in 2009. As of September 30, 2010, the full amount of $12.82 million had been obligated. On September 8, 2011, the CRSP received a no-cost extension through September 29, 2012. On May 3, 2012 the total value of the Leader Award was increased by $1.9 million and that full amount was obligated, but because this occurred so recently, the $1.9 million is not included in Table 1 below. The CRSP has received two Associate Awards since 2007. The first was a three-year $750,000 award from USAID/Mali for a project in Mali on aquaculture and fisheries and the second was a $1.1 million three year award from USAID/Washington to scale-up technologies in Ghana, Kenya and Tanzania to support the Feed the Future Initiative.

Of the $12.82 million awarded to AquaFish CRSP since 2006, 65% ($8.3 million) was allocated to 7 competitively awarded core research projects (Table 1). Approximately 14% was allocated to central research, outreach, impact, and capacity building projects, and approximately 15% allocated to management. Approximately 30% of the funds allocated to research projects has not been invoiced but is encumbered (data provided by the MT).

In FY2011, AquaFish CRSP received a no-cost extension through September 29, 2012, to allow students in degree programs to reach completion, to allow completion of work currently underway, and to facilitate a smooth transition between the existing 5-year Aquaculture and Fisheries CRSP award and any future 5-year award.

The AquaFish CRSP has been successful at leveraging additional funding for its activities. The three most recent annual reports document these awards. In 2009, approximately US$0.624 million was leveraged relative to the US$3.16 budget or a 1:5 leverage ratio (20%). In 2010, approximately US$0.442 million

was leverage or a 1:7 ratio (14%). Both years are inferior to the 1:1 leverage ratio targeted by research management.

Table 1. Budget summary of the AquaFish CRSP by expenditure center

Description	*IP 2007-2009 Allocation*	*IP 2009-2011 Allocation*	*Total Funds Allocated*	*Available balance as of last invoice**
Research Projects				
Competed Core				
University of Arizona	$400,401	$743,516	$1,143,917	$270,866
University of Michigan	$428,800	$1,060,279	$1,489,079	$361,983
North Carolina State University	$339,828	$864,902	$1,204,730	$384,606
Purdue University	$434,823	$931,000	$1,365,823	$362,894
University of Connecticut	$458,441	$715,447	$1,173,888	$338,445
University of Hawaii	$300,000	$732,526	$1,032,526	$403,964
Auburn University		$916,513**	$916,513	$376,675
Subtotal			*$8,326,476*	*$2,499,433*
Non-Competed				
Montana State University & Oregon State		$439,502	$439,502	$0
Cultural Practices LLC		$100,000	$100,000	$46,440
Indirect on first $25,000 per subaward			$93,375	$0
Personal Services Contracts			$141,500	$0
Total Research Projects	**$2,362,293**	**$6,503,685**	**$9,100,853**	**$2,545,877**
Central Research, Outreach, Impact and Capacity Building Projects				
Capacity Building			$930,459	$0
Synthesis Project			$600,000	$0
Communications			$224,514	$0
Total Central Research			**$1,754,973**	**$0**
Management				
Management			**$1,964,174**	**($55,332)**
TOTAL from Inception through September 29 2012			**$12,820,000**	**$2,490,545**

Source: Management Team
*Invoices and invoiced period only apply to subcontracted projects, all other balances include encumbrances.
**Programmed funding pending contract .

However, in 2011, AquaFish leveraged US$69.0 million largely due to a $US66.0 million Government of Kenya economic stimulus program for investment in a national aquaculture development. The annual report does not state how much of this money was used to support or AquaFish CRSP activities per the concept of "leveraging." While it is commendable to acknowledge the formative role that the previous aquaculture CRSPS and AquaFish played in the development of the research infrastructure in Kenya, attributing a causal relationship between the two would be difficult to do since the counterfactual is impossible to construct. Certainly there is a correlation between the two.

Nonetheless, if this large government expenditure is not taken into consideration, approximately US$2.98 was leveraged according to the 2011 annual report. This figure generates a 1:1 leverage ratio (approximately 101%) of the budget. Over the program, US$4.04 million has been leveraged or approximately 32% of the budget. Despite this low overall ratio, it requires stating that the overall cost-share by participants was 58%. Combining the cost share and the leveraged funds together (US$9.16 million) and juxtaposing this against the research budgets (net of management costs) generates a healthy leverage ratio of 1:1.21 or 84% of research expenditures and 1:1.4 ratio, or 71%, of the total budget. In addition to these figures are two leader with associate awards that could be considered as examples of leveraging.

Research Productivity and Impact

The AquaFish ME provided a list of 129 publications produced by scientists affiliated with the program. Using this list as a base, the publications were systematically reviewed for citations using the citation indexing software Publish or Perish (PoP)[9]. A total of 96 papers (or about fourteen per year) were located and their citations tabulated.

We could not locate all papers provided by the ME in PoP. Three publications were deleted from the original list because of repetition, and thirty-two documents were not found by POP due to the type of document. Fourteen publications were not captured in this count and peer-reviewed manuscripts in the Proceedings for the Ninth International Symposium on Tilapia Aquaculture (2011). The different documents that were not found include seven papers that were presented at Symposiums during 2006, eight articles that were submitted to the trade magazine *Global Aquaculture Advocate*, five papers were published in foreign languages (Vietnamese , Spanish, and Portuguese), and thirteen papers published in non-western journals (primarily Asian) in 2010.

Figure 1 describes the trend in publications of documents found, and not found by PoP, as well as the cumulative number of citations of the papers that were located. For those publications that have global access (they can be found in Google Scholar), the first three years show and increasing trend follow by a rapid decrease after 2010. Excluding the publications that were not found in 2006 and including all other publications (found and not found) for the following years, we see an increasing trend that falls considerable during the last two years. This fall in publications translates into a diminishing marginal citation trend towards the end of the period of study.

[9] Harzing, A.W. (2007) **Publish or Perish**, available from http://www.harzing.com/pop.htm

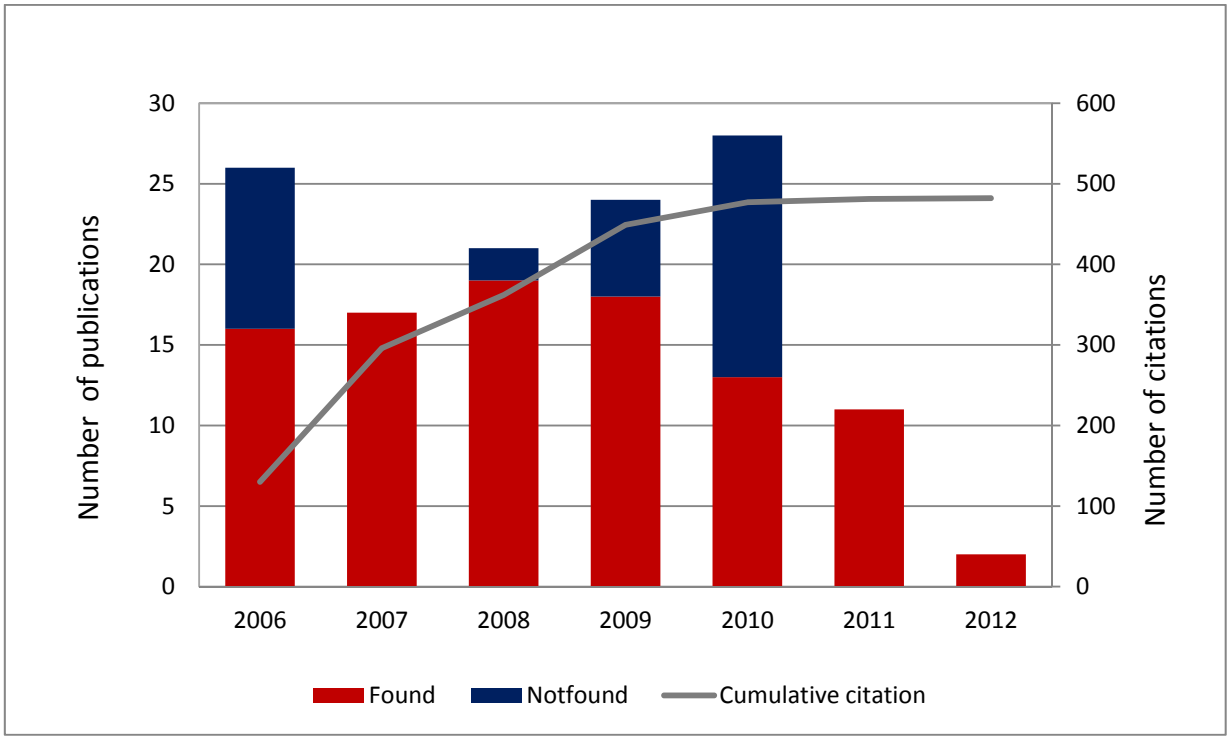


Figure 1. Number of publications found and not found by *PoP* per year, and cumulative citations from 2006 to February 2012

If the papers are grouped by number of citations that PoP was able to locate (Figure 2), what we observe that 55% of the total number of publications had 0, 1 or 2 citations. There are eight papers however that have been influential, reporting fifteen or more citations. The majority of the papers that have been influential relate with the Asian projects that AquaFish CRSP sponsors.

Rigor and integrity are stressed by the ME and external peer-reviews help validate the quality of proposed research work plans. Numerous publications of project results in scientifically peer-reviewed literature indicate sound experimental methods. The research portfolio is aligned to address and has made significant contributions in fulfilling the AquaFish goal,' *to develop more comprehensive, sustainable, ecological and socially compatible, and economically viable aquaculture systems and innovative fisheries management systems in developing countries that contribute to poverty alleviation and food security.'* The integration of outreach activities to all research projects encourages and facilitates development outcomes on farms and in rural communities. The integration of effective outreach components can shorten the time from discovery to application, enable co-development of practical solutions with farmers, and solve adoption barriers to achieve broader impacts.

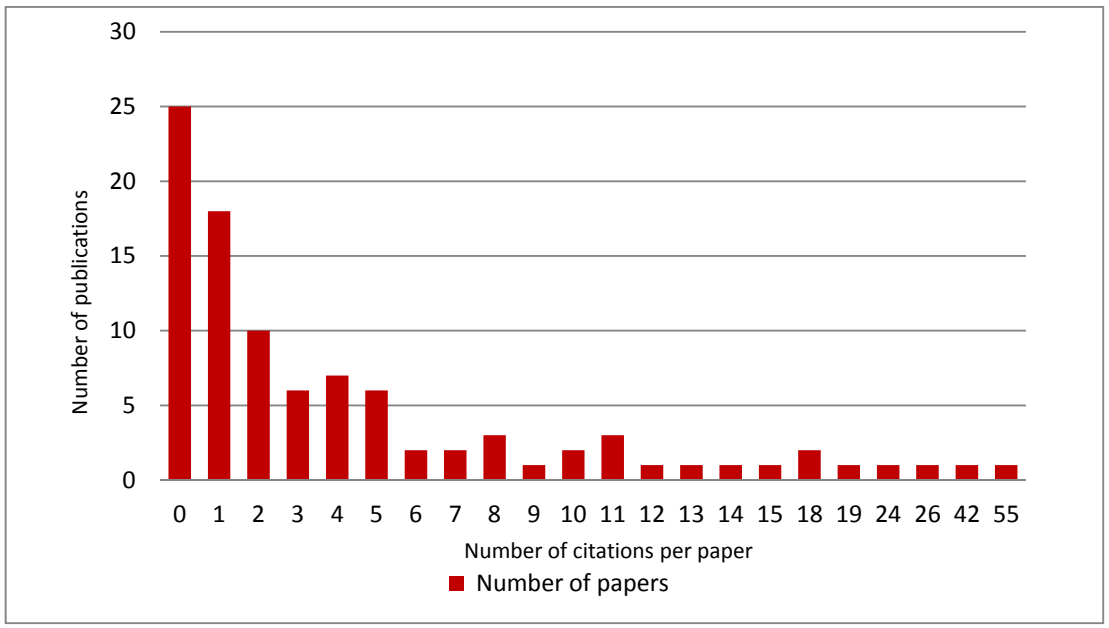


Figure 2. Frequency distribution of the number of citations per paper 2006- February 2012

The depth appears to be adequate based on numerous research breakthroughs, significant targeted development outcomes and completion of project objectives that leverage US and HC PI resources. The Program or US PIs have recruited strategic partnerships among US institutions to add depth and expertise as needed for specific projects.

All projects were vetted through local USAID missions and priorities were identified by HC stakeholders and considered in designing and planning project studies. The research is solution-focused to advance knowledge and understanding to support and stimulate aquaculture development among small and medium farms. The aquaculture-fisheries nexus projects in Vietnam, Cambodia and Mexico have policy-implications. The Mexico snook project at this stage can mature toward commercial aquaculture and/or public stock enhancement programs based on future propagation successes and policy decisions by HC. In numerous countries fish of traditional economic value in local markets sourced from artisanal or commercial capture fisheries are under stress from overfishing and/or habitat degradation with an increasing food security need for sustainable sources of farmed fish of the same or new substitute species.

With decades of international aquaculture development experience and a consultative global aquaculture network, AquaFish has the institutional knowledge to identify strategic major research themes and topics that align with AquaFish and USAID goals. They are reflected in the major research topics of production system design and best management alternatives; sustained feed technologies; quality seedstock development; human health impacts of aquaculture; food safety and value-added products development; technology adoption and policy development; marketing, economic risk assessment and trade; indigenous species development; watershed and integrated coastal zone management; and mitigating negative environmental impacts that address contemporary global aquaculture development areas. No changes are recommended. The Program may benefit by

integrating a human health and nutrition project. Fisheries products offer highly nutritious protein for people of all ages with special emphasis on vulnerable children and pregnant women. In many rural areas with a scarcity of high quality animal protein, diets can be supplemented with local farmed fishery products.

Input from Host-Country Collaborators

Dr. Egna indicated that the AquaFish network extended to over 300 collaborators but we were not able to draw information on the AquaFish CRSP from this entire network. Instead, we drew upon a subset of participants who were the most important and conducted two types of conversations: face-to face interviews, host-country visits, a telephone interview, and an online survey with quantitative, qualitative and open-ended responses.

Face-to-Face Interviews with Host-Country Collaborators and PI's

The team was able to conduct site visits to Kenya and the Philippines. Both countries were selected because they had been long-term participants in AquaFish and previous aquaculture-related CRSPs. They provide examples of the cumulative impact of aquaculture-related CRSP investment and the evolution of their projects within the CRSP structure and their respective countries. The aquaculture industries in Kenya and the Philippines are reaching a mature state and thus they provide a model for other nations developing their own industries.

Kenya Site Visit and Interviews

CRSPs have trained over 1500 fish farmers and the results have led to the whole spectrum of production from farmers with few resources available and improvement marginally above subsistence production to entrepreneurial growers that have increased pond area, intensified management and record keeping. The cluster project near Lake Victoria (Bidii project, Vihiga cluster) is one of the pinnacle achievements with a cooperative group of over 80 farmers that has developed a catfish fingerling production system and generated a new product of catfish fingerlings as bait for the capture fisheries on Lake Victoria.

Program evolution from PDA CRSP to ACRSP to AquaFish CRSP in shorthand could be, PDA was mostly basics of improving production beyond 1000kg/ha (or even above 100kg/ha)-this meant improved pond construction, pond management, water quality management, and record keeping. ACRSP evolved to training and extension network development-thinking of aquaculture as a business. AquaFish CRSP has led to development of value chains, marketing, networking and cluster development as well as identification of critical resource needs, specifically feed and genetically defined fish stocks, and environmental issues to address with best management practices (BMPs).

Future directions for CRSP work would be in research-feed and seed are major priorities; training in value chain development, baseline marketing studies, product development, cluster development; funding for continued education. The need for training of new faculty members was also mentioned by several extension officers as a need. A complete trip report is presented in Appendix 7.

Philippines Visit and Interview

In the Philippines CLSU (Central Luzon State University) has been a program partner since the early 1990s. Such a long standing collaborative research partnership is much valued. AquaFish CRSP partnership has been a catalyst to undertake research in new areas to expand the knowledge of aquaculture in wide ranging topics such as species, pond management, reproduction, feed mix and feed management. The research support for feed management studies resulted in findings that encourage farmers to adopt different feeding routines and have shown economic benefits to the farmers to cut costs in production. The AquaFish CRSP is housed in the Freshwater Aquaculture Centre (FAC) and is also linked to the College of Fisheries. Hence, the research and teaching interactions facilitate applying AquaFish CRSP research in teaching and involving students in research. AquaFish CRSP has supported university level education for the Filipino students both at graduate and undergraduate level. The research funded by AquaFish CRSP has contributed to faculty development with award winning research. The AquaFish CRSP supported short term training of people involved in aquaculture such as farmers, women, extension professionals and professionals. These examples demonstrate the AquaFish CRSP contribution to capacity building in the Philippines.

AquaFish CRSP partnership with SEAFDEC (South East Asian Fisheries Development Center) opens up research and outreach initiatives with a regional organization that has an extensive collaborative network in the South East Asia Region including World Fish Center and FAO. It is a constructive collaboration, since the organization has the mandate to undertake research that benefits small farmers and women in fishing households. AquaFish CRSP-CLSU collaborates with National Freshwater Fisheries Technology Center in the Bureau of Fisheries and Aquatic Resources (NFFTC) and it supplies fingerlings to centers all across the Philippines for distribution to farmers. The GIFT (Genetically Improved Farmer's Tilapia) Foundation project is a partner in the AquaFish CRSP-NCSU-CLSU program in the Philippines. GIFT project is funded by a seed company that provides loans for farmers to buy fingerlings and feed where CRSP scientists provide technology support. CLSU's linkages with the Philippines research, technology development and educational organizations offer a national network to draw expertise in aquaculture development. The SEAFDEC as a regional center brings to the project an extensive network of countries that have demand for fish and fishery products and regional institutions with expertise to promote fisheries and aquaculture. The combined expertise in CLSU and SEAFDEC institutional network can make a valid contribution to aquaculture development in SEA and holds potential to provide regional leadership in aquaculture and fisheries research and development.

The PIs were briefed about the FtF agenda by the CRSP director from ME-OSU; hence CRSP partners are aware that the Philippines are not a country included in FtF framework. PIs and administrators raised a concern about their continued collaboration with AquaFish CRSP. The PIs acknowledge the importance of undertaking impact assessment at the country project level on their own initiative. The need for high capital investment to develop aquaculture as a productive farm enterprise, and finding a niche in a fresh fish market dominated by commercial firms, deters entry of women in the production phase of aquaculture sector. A complete trip report is presented in Appendix 6.

Phone Interview with Dr. Wilfrido Contreras-Sanchez, Universidad Juarez Autonoma de Tasbasco, Mexico

An interview with one collaborator from Mexico was conducted by phone. Since there are multiple collaborators in Mexico, this interview should not be construed to cover all investigations. Gary Jensen had the opportunity to speak directly with Dr. Contreras-Sanchez on June 4, 2012 to obtain first-hand, current information and host country perspective on the importance and performance of AquaFish CRSP. He emulates the value of long-term sustainable collaborative work that began with his PhD training at Oregon State University in 1998 with completion of a degree in 2001 and current role as HC PI as well as leader for the AquaFish CRSP Regional Center of Excellence for Mexico and Central America.

AquaFish CRSP funding in Mexico since 1999 enables research and outreach activities that would otherwise be impossible for husbandry methods for several high value native fish species with new choices for small farmers and training rural indigenous people about advances and opportunities for food security with appropriate local technologies. Funds have been instrumental for building research capacity and supporting many BS and MS students with thesis options using aquaculture studies. The level and quality of human resource capacity building and career-long skills and training in aquaculture extend into long-term benefits in private and public sectors. AquaFish CRSP research findings are integrated into curricula and student classroom training on contemporary topics such as the latest discoveries to control the life cycle of native cichlids, gar and snook. AquaFish CRSP sponsors HC participation and US experts in new international networks and forums for native snook and native cichlid aquaculture and new synergies among research enterprises in Central and South America.

The ME created the innovative HC PI exchange program that assembled representatives from Asia, Africa and Latin America to visit other regions to learn first-hand from counterparts, farmers and others about different methods, species, approaches and successes in international aquaculture development. The exchanges accelerated learning with new ideas as well as strengthened a collective global AquaFish CRSP community for long-lasting collaborations. AquaFish CRSP funding has enabled sustainable work on native species unlike other institutions that have ceased work with lack of support or focused on popular non-native tilapia species. Work on native species is intended to relieve over-harvest pressures and preserve biodiversity of native genetic stocks. Next steps include refinement of feeds, genetic improvement and larval rearing of native gar, a new protocol for effective degradation of androgen steroid from effluents of tilapia hatcheries based field testing results, improve larval rearing of native snook for future farming and stock enhancement. The HC values the focus of program on integration of gender and outreach to rural and poor communities that might otherwise not be implemented and benefits unrealized. Some notable successes include introduction of gar aquaculture and uptake by private hatcheries for fingerling production and others for grow-out for local markets, use of effluents from fish systems to irrigate habanero peppers and new value-added products, new manual for spawning and larval rearing of native snook funded by Mexican government, and life cycle management of new native cichlids for rural indigenous communities. The work on gar has spanned 10 years and studies with androgen steroid began in 1998.

More work is needed in cost-analysis of new methods and practices and obtaining farm level economic impact data from AquaFish CRSP investments and development outcomes. There is strong

communication and collaboration among HC and US PIs who serve as valuable resources in project planning but also sources of information and referrals to US expertise on topics of HC interest. The HC institution cites the AquaFish CRSP in annual reports and has provided additional funds for an experimental facility for snook propagation.

Online Survey of Host-country Collaborators

An online survey consisting of closed-ended and open-ended responses was sent to 24 non-U.S. based host country collaborators (HCCs) from a list compiled by the ME A copy of this survey and the results is found in Appendix 3. The survey was administered from May 3 to May 19, 2012. An initial email was sent to all collaborators with follow-up reminders every second day. Only eighteen host country collaborators responded to the survey so representation of their responses must be viewed with caution. Rather than presenting this material statistically, it is described qualitatively due to limited responses.

Most questions asked for responses on an ordered Likert scale where the first class indicated “not important” while the fifth class indicated “very important.” When possible, classes were used to designate ordered quintiles. The questionnaire was organized to identify geographical and scientific background, the relative importance of aquaculture in their countries and then shift to questions on scientific collaboration. The distribution of responses is presented in the Appendix 3.

Half of the responses came from Asian collaborators, 23% from African and 18% from Latin American and the Caribbean and the remainder declared as “other.” Eighty-two percent of the respondents were from production fields with the remaining three from the social science, human health and “other” fields. All respondents indicated that aquaculture was very important or important to their country. Seventy-one percent of the respondents indicated that they allocate more than 60% of the professional time to aquaculture research.

In terms of scientific interaction, the responses suggest that HCCs play a very important role in setting research priorities, scientific methods and in taking leadership for developing written outputs including reports and scientific publications. Open-ended responses indicated that the relationships are very valuable and collegial and that South-South relationships and other methods of information and technology exchange should continue to be encouraged.

Financially, the importance of AquaFish CRSP funding was concentrated with 88% respondents indicating that it covered “nearly all” or “all” of their research costs. Only one individual indicating that AquaFish CRSP contributed very little to their research budget and many others cited it as “very important”, indicating it covered 81-100% of their research activities. More than 47% of all responses indicated that AquaFish CRSP funding was of “average” or “very important” significance to their research program. Forty-one percent of the respondents indicated that they could not conduct research on these topics without AFCSRP funding.

Sixteen of the 17 respondents indicated that gender integration strategies have added value to their research and development activities but only 50% indicated that specific funds were allocated to gender research and activities. Fifty-three percent of collaborators indicated that they conduct formal impact

assessment of their activities but nearly 90% indicated that the outreach requirements of the project have improved the productivity of target farmers.

It appears that complying with financial reporting requirements and administrative requirements is roughly equal to, or easier than, other projects the respondents work with. Again, the numbers of respondent are too few to make any general statements. Review of the comments in Appendix 3 may assist in gaining an appreciation of HCCs' concerns and accolades.

Section III: Management Assessment

This section focuses on Oregon State University's management of the AquaFish CRSP.

Challenges facing the ME and MT

The MT has faced a number of important challenges during the current five year phase. At OSU, office space constraints have impeded work. Their long-time office in Snell Hall was condemned after a flood and moving to new space has contributed to a loss of momentum. The university has shifted from having dedicated administrative support to a model of "business centers" that are shared between numerous departments and/or offices. Since most of the AquaFish CRSP's administrative support needs are esoteric (meaning international, USAID or federal government-specific rather than Oregon-specific) processing of financial and administrative documents is difficult. Dr. Egna indicated that support for grant writing is lacking. During our meeting with the MT, we asked if she had considered moving to another organization more conducive to the CRSP's needs, but the discussion was not pursued.

The MT is short on staff. Dr. Egna indicated that an Assistant Director needs to be added in order to accommodate a perceived increase in workload that partially originates with USAID, their information needs, and potential associate awards. OSU supports nearly 100% of Dr. Egna's salary for work on CRSP activities and on CRSP-related OSU responsibilities. The need for additional staff should be evaluated with respect to the expected benefits.

As noted above, OSU administration considers Dr. Egna a valued colleague and she serves on numerous high profile committees for the university. Dr. Egna indicated that "Overall, it would be fair to say 90-95% of my time is related to CRSP, international development, and USAID work." The team observed that she is engaged in several university committees.

Programmatically, AquaFish CRSP suffered from the deaths of important international and U.S. contributors. In Mexico, a flood at the HC research station caused the loss of experiments and a 6-7 month delay in research outputs. The political crisis in Kenya caused a loss of data and trauma to key personnel. And an earthquake in China retarded progress.

Advisory Boards and Linkages to USAID

The ME and MT initiated a number of innovative boards to advise on program development. Despite the best intentions of these initiatives, not all have been successful.

External Program Advisory Council

AquaFish CRSP has taken an innovative approach to constructing its advisory board. Many CRSPs draw from administrators from participating institutions for membership but the AquaFish CRSP has developed an advisory board composed of external experts from outside institutions. The External Program Advisory Council (EPAC) was formed to fill this role. At the outset of the program, the EPAC was composed of participants from international organizations such as the Food and Agriculture Organization of the United Nations, CGIAR, World Wildlife Fund and national fisheries organizations.

According to the cooperative agreement, the role of EPAC is to "provide advice to the ME on global program direction; provides input into AquaFish CRSP Requests for Proposals; provides annual critiques of research projects during annual or regional meetings to assist the ME in gauging performance; identifies gaps and issues emergent from the global portfolio as projects are implemented…….The EPAC is a policy-setting programmatic advisory panel. Annual EPAC critiques are sent to USAID for review, and subsequently made available to program participants." While this approach to managerial oversight is novel and innovative, it appeared to lose functionality towards the end of the second phase. While funding may have been an issue, interest among participant may have also contributed to its effectiveness. Reports provided by EPAC tend to be short and superficial. An oversight/advisory board is a critical tool for the management entity and is required for effective program implementation, monitoring, redirection and function. The MT should revisit this concept and determine whether it should be strengthened or whether an alternative advisory group should be developed.

Internal: Development Theme Advisory Panel, the Regional Centers for Excellence and Emerging Issues Panel

In addition to EPAC, the MT formed internal advisory panels. The Development Theme Advisory Panel (DTAP) was formed to provide technical advice on emerging issues in aquaculture and determine whether these issues could be addressed through the AquaFish CRSP activities. Initially four DTAP panels were formed (on nutrition, income, environment and trade) and led by coordinators who were lead PIs from U.S. institutions. These appeared to become "hijacked," as stated by Dr. Egna, to channel information from the projects into reporting on USAID indicators.

A second internal advisory structure was formed to coordinate geographically-related program issues. These "Regional Centers of Excellence" or RCEs provide technical insight into Asia-, Africa- and Latin America and the Caribbean-specific issues. They act to coordinate regional activities and to provide an interface with other organizations as well as USAID missions. The RCEs appear to have functioned well and provided the selected leaders with a level or responsibility that was constructive to the program. These centers offer an opportunity expand host country input into AquaFish CRSP programming that may lead to new resources in the future. This type of participation is valuable by broadening governance.

The final internal advisory panel was the "Emerging Issues Panel" (EIP). The EIP was designed to provide insight and scientific to the MT on issues affecting the forefront of aquaculture and aquaculture research. The panel was designed to consist of OSU faculty volunteers who were not part of the AquaFish CRSP's activities. The EIP functioned initially but when the team interviewed project PI's,

many responded “what is the EIP?”. There is record of a meeting held in 2006 but no mention thereafter. As mentioned above, annual program reviews do not describe EIP activities so we are unable to evaluate their contribution to the MT.

Relationship to USAID

AquaFish CRSP has benefited from a stable long-term relationship with the Agreement Officer’s Representative (AOR). Harry Rea is a trained aquaculturalist who can contribute to scientific discussion and evaluate research and annual reports for their scientific content. He indicated that Dr. Egna has been diligent in consulting the AOR and that his concerns and criticisms were taken into consideration for programmatic development. He acknowledged a constructive rapport with the ME. The AOR was complimentary about the intellectual leadership of the MT, financial management of the program by OSU and the responsiveness of the ME and MT to information requests. Given the technical expertise of the AOR and the long-term relationship, this may be one of the closest relationships between USAID and any of the CRSPs. Other CRSPs would benefit from a similar type of relationship between the AOR and the CRSP, and USAID should invest in such relationships.

Award Processing and Administration

The ME indicated that the 35% cost share has posed considerable difficulties since many institutions had problems in raising this amount. At the same time, the Dr. Egna indicated that their proposal to host the ME set this amount because they felt it was needed to, among other things, add value to the overall program, encourage institutional buy-in at all levels, and provide a mechanism for PI support at subcontracting institutions be competitive in the bid process. While it is understandable that the cost share poses a difficulty, it does not absolve the MT of partial responsibility for the difficulty. Nonetheless, future programs may wish to consider the appropriate level of cost share and USAID should also be cognizant of the burden placed on host-country collaborators in raising the cost share.

The cost reimbursable structure of the sub-awards from the ME to sub-awardees has produced a chronic problem in the flow of funds to HCCs and US institutions. This is understandable and only compounded by the differing levels of financial management between HCCs, US universities, Oregon State University and USAID. A simple alternative is the movement away from cost reimbursable contract to performance based contracts, clear deliverables. Some universities have advance fund to HCCs in front of contracts in order to initiate research but not all universities will do this.

The MT reported that the financial management system at OSU underwent a drastic reorganization midway through the program. This reorganization, and a new accounting system, took approximately two years to get up to speed, according to Dr. Egna. On a positive note, OSU financial administration and the Director of the Office of Sponsored Programs, Patricia Hawk, indicated that the MT provides “some of the best scopes of work for subcontracts” and that Dr. Egna was “conscientious” and “knowledgeable of the intricacies of USAID requirements.” Audits have been favorable and indicate very strong compliance with export control mechanisms.

The AquaFish CRSP, and especially Dr. Egna, is deeply respected by OSU administration. Administrators described Dr. Egna as a “tough” and “tenacious” individual who works long hours to get the work done.

They value her as a colleague who is a strong advocate for the CRSP model, the AquaFish CRSP program, and someone who has raised the level of visibility of international programs at the university. They remarked that Dr. Egna is a good corporate citizen and representative of OSU who has made a strong contribution to graduate programming, cross-university engagement of departments and has generated broad exposure and visibility of OSU among other universities. By raising the profile of the ME to a university "center" the administration has had to commit resources to it and these resources have acted as cost-share.

Web Presence and Monitoring

The external face of the AquaFish CRSP, as presented through their webpage, is polished and professional (see http://aquafishcrsp.oregonstate.edu/.) The website provides a range of information including technical and scientific reports, forward linkages to additional information, current news and announcements and programmatic documents. The design is crisp and up-to-date and should be used as seen as a model for other CRSP websites.

Nevertheless, the visibility, reputation and achievement of the AquaFish CRSP is not well disseminated beyond the CRSP community, US PI's and HC PI's and perhaps a few additional satellite target groups. There are exciting research and outreach activities that are of interest to the broader aquaculture community. This lack of exposure within the domestic US aquaculture community and possibly in HC beyond the CRSP participants does suggest an opportunity for the CRSP to expand communication efforts going forward. Targeted outreach through information hubs such as the USDA NIFA managed Aquacontacts distribution, and NOAA Aquaculture Newsletter are two potential outlets. According to the MT, "AquaFish CRSP has broad international exposure and dissemination of achievements through a variety of electronic outlets, including listservs hosted by SARNISSA and IIFET, ACDI/VOCA, and others, as well as social media linkages through Facebook. Both international and domestic electronic distribution of material also occurs independently though partner institution outlets or other nodes (such as links through ISTA's website, SARNISSA's website, and podcast links through NCSU). Our website serves as an effective outreach and exposure tool. Over 100 non-CRSP websites link to it." A key element of future outreach efforts should be pointed evaluation of what/who the AquaFish CRSP community encompasses and how to target communication. Our evaluation team felt that there is a potential to continue to broaden the community, including additional university programs, public programs and private sector interests, too. This broader exposure may lead to broadening the stakeholder/support base for the project, increase the pool of talented science and development experts on which the CRSP draws and heighten the visibility and impact of successful projects.

The management team provided a copy of website traffic from Google Analytics from May 2010 to April 2012. The site was visited 24,655 times by 10,255 unique viewers. About 12,500 visits were from users looking for the site or redirects from the PDA CRSP website. 7,239 visits were from referrals from the Google search engine. A copy of the web traffic report is presented in Appendix 4.

In addition to these information sources, the website works as an interface between the MT and the project researchers accessible only though a password protected gateway. These web provides a very efficient method for the investigators to submit reports, check the status of missing documentation,

access more restricted project documentation, procedures manuals and other internal AquaFish CRSP documentation. What impressed the reviewers was the ease at which investigators could access the sites and provide the MT with the requisite documentation, the logical organization of the interface and its overall power to reduce administrative burden to both the MT and investigators. As mentioned above, this interface could be used as a model for other CRSP looking to streamline and reduce investigators' administrative time. Appendix 5 provides a screenshot of the interface for a specific project. This monitoring tool is effective and indicative of a thorough and comprehensive approach developed by the MT. This interface contributes to the monitoring of program activities. Overall, monitoring is excellent.

Communication

To expand the programs visibility, the Director implemented a targeted communications project "Telling the ACRSP and AquaFish Story" in 2009 with OSU's Extension and Experiment Station Communications. The MT has developed several communication pieces to explain AquaFish (and ACRSP) research and outreach activities to lay audiences using print and multimedia. The communication pieces were prepared to the highest level of quality and convey the program in a straightforward manner. These pieces have been distributed to global audiences using traditional story-placement strategies and they have also been on YouTube at a dedicated channel (http://www.youtube.com/user/aquafishcrsp?feature=results_main). Viewings of the videos placed on YouTube range in the hundreds with only one video indicated more than 1,000 views as of May 25, 2012. Taking advantage of such resources as this and focusing on developing outreach channels, both within HC's and within the US, as discussed above, would be an opportunity to reinforce and disseminate the good work and high quality communication pieces that have already been developed.

Even with this project, enhancing AquaFish CRSP's visibility should continue to be a focus going forward. There are exciting research and outreach activities that are of interest to the broader aquaculture community. Leaders of the aquaculture community (who happen to be on this review) do not see the AquaFish CRSP's profile in U.S. based aquaculture networks. Maybe to reach this user group, the project ought to investigate joining listservs, blogs or other networks to publicize AquaFish CRSP. This could also act to broaden interest in future RFPs. In addition, it appeared that private industry in the US was a limited partner of AquaFish CRSP, either in an advisory role, consultative or as a valued consumer of AquaFish CRSP information.

Appendix 1. Statement of Work for the External Evaluation

SCOPE OF WORK

External Evaluation of the Aquaculture & Fisheries CRSP

Award Number: EPP-A-00-06-00012-00

Purpose

The purpose of this evaluation of the Aquaculture & Fisheries Collaborative Research Support Program (AquaFish CRSP) is to assess program performance, to identify program successes and areas of concern, to provide recommendations to help program implementers improve program effectiveness, and to inform the U.S. Agency for International Development (USAID) on future programming and support of the AquaFish CRSP. As the program has now been ongoing for five years, this evaluation will serve to inform USAID on whether to extend the AquaFish CRSP as it currently exists, to suggest significant modifications to the program, or to not continue funding.

Background

The AquaFish CRSP Cooperative Agreement was awarded on September 30, 2006 to Oregon State University which serves as the Management Entity (ME). The AquaFish CRSP is one of the ten current CRSPs that are supported by USAID's Bureau for Food Security. The CRSPs are U.S. university-implemented agricultural research, training and capacity building programs that support USAID's development goals and objectives.

The AquaFish CRSP is developing more comprehensive, sustainable, ecologically and socially compatible, and economically viable aquaculture systems and innovative capture fisheries management systems that contribute to poverty alleviation and food security in developing countries through integrated research, training, outreach and capacity building activities. The CRSP was designed to improve livelihoods and promote health by cultivating international multidisciplinary partnerships that advance science, research, education, and outreach in aquatic resources by bringing together resources from U.S. and Host Country institutions. The CRSP strives to strengthen the capacities of participating institutions, to increase the efficiency of aquaculture and improve fisheries management in environmentally and socially acceptable ways, and to disseminate research results to a broad audience. The AquaFish CRSP aims to create and nurture strong global partnerships that develop sustainable solutions in aquaculture

and fisheries for improving health, building wealth, conserving natural environments for future generations and strengthening poorer societies' abilities to responsibly self-govern. These goals are accomplished through a global integrated, multidisciplinary, cross-cutting research and outreach program that increases aquaculture productivity, enhances environmental stewardship, supports women through gender integration, prevents the further degradation of aquatic ecosystems, and increases domestic and export market opportunities, thereby increasing food security, economic well-being, and standards of living for citizens in participating host countries.

To implement the program, Oregon State University has worked with 16 other US universities (Auburn, Connecticut at Avery Point, Michigan, North Carolina State, Hawaii at Hilo, Arizona, Purdue, Ohio State, Arkansas at Pine Bluff, Louisiana State, Texas Tech, Virginia Tech, Rhode Island, Georgia and Alabama A & M, and Montana) as well as 29 partners in 17 host counties.

AquaFish CRSP projects that have been implemented during the past five years include:

- Improved cost effectiveness and sustainability of aquaculture in the Philippines and Indonesia;
- Developing sustainable aquaculture for coastal and tilapia systems in the Americas (Guyana and Mexico);
- Improving sustainability and reducing environmental impacts of aquaculture systems in China, and South and Southeast Asia (China, Nepal, Bangladesh and Vietnam);
- Human health and aquaculture: Health benefits through aquaculture sanitation and best management practices (Nicaragua and Mexico);
- Development of alternatives to the use of freshwater low value fish for aquaculture in the Lower Mekong Basin of Cambodia and Vietnam;
- Improving competitiveness of African aquaculture through capacity building, improved technology, and management of supply chain and natural resources (Ghana, Kenya and Tanzania);
- Hydrology, Water Harvesting, and Watershed Management for Food Security, Income and Health: Small Impoundments for Aquaculture and Other Community Uses (Uganda and South Africa).

Additional details can be found at http://aquafishcrsp.oregonstate.edu).

Scope of Work

The CRSPs operate under initial five-year cooperative agreements. It is recognized that some research programs need more than five years to achieve the full scope of the potential from research efforts, and USAID and target beneficiaries will benefit more fully from continuation of programs where specialize technical expertise has been developed. Good performance during the first five-year period and continued relevance of the CRSP to the overall Agency portfolio and development priorities, and the availability of funds are necessary for considering a justification for a program extension. In particular, this means that the CRSP should also fit well with the Feed the Future (FtF) research agenda.

This evaluation will provide USAID and the ME with constructive feedback on the past performance and management of the AquaFish CRSP, but more importantly review plans for future endeavors and make recommendations regarding a possible five-year extension of the CRSP including a prioritization of activities that should be implemented during an extension or suggest significant modifications to the program, or not continue funding.

The evaluation will focus on progress the AquaFish CRSP is making towards achieving its stated research and development results. It will also consider how the CRSP is currently aligned with FtF, as well as consider research goals going forward for improved alignment with FtF. The evaluation will be completed by a small team of multi-disciplinary experts over the next three months. This External Evaluation Team (EET) will be composed of individuals who are specialists in areas relevant to the CRSP, but who are not affiliated with the program and do not have a conflict of interest. The ME will review this scope of work and the proposed candidates prior to the evaluation.

The planned evaluation will assess the CRSP's performance through review of project documents, a visit to the ME, and correspondence/communication with participants and stakeholders. The EET will gather findings and produce conclusions and recommendations to USAID based on the CRSP's progress up to the time of the evaluation. The EET will also recommend adjustments in implementation and research goals, if necessary, and ways in which the ME can better guide its partners to reach project objectives.

Areas of Evaluation: The EET will evaluate the CRSP in the following areas by responding to the questions below.

I. Technical Review

A. Technical Leadership

1. What are examples of technical leadership displayed by the ME?
2. What are examples of technical leadership displayed by the individual project Principle Investigators (PIs)?
3. How can the AquaFish CRSP be better aligned with FtF going forward? What suggestions do you have for aligning the AquaFish CRSP's goals and objectives, and projects with FtF? What suggestions do the ME and current PIs have?
4. If the AquaFish CRSP is extended for four years, versus five years, what effect will his have on capacity building, particularly the long-term degree training prospects for the program?
5. How has he CRSP cultivated a pipeline of students for long-term degree training opportunities? Have PIs and/or the ME been successful in cultivating/selecting the right students? What else, if anything, could be done to ensure that the long-term training is targeting the right individuals/institution?
6. How and with what results has gender been taken into consideration in research design, training and outreach strategies at the research activity level?
7. How does the ME facilitate engagement of the research activities or themes to other development programs in regions where the CRSP is active?

8. How well has the ME facilitated the participation of new partners? Give examples of how program RFAs are designed and how opportunities are advertised and made available for new PIs.
9. Are the levels of effort, award size and research project duration sufficiently balanced to allow the CRSP to achieve program goals and objectives?
10. What have been the significant accomplishments in terms of research, outreach, and dissemination?
11. How has the ME built on earlier investments?
12. What can be done to capitalize on these - to broaden or accelerate progress?
13. How does the ME continue to be forward thinking about research ideas and plans associated with the CRSP?

B. Research activities

1. Please describe whether the depth, breadth, and rigor of the research and development activities have been sufficient to allow the CRSP to achieve its stated goals and objectives.
2. In what ways are the research activities strategically sequenced to ensure targeted development outcomes with in a known period?
3. How relevant are the research activities to USAID's current FtF research strategy (see alignment document)? Are the Missions or other operating units (i.e., other Washington-based offices) aware of and have they sought to access the CRSP's technical, training and outreach expertise? Give examples.
4. Which projects are likely to make the most progress towards fruition if another five years is granted? Are they scalable for greater impact?
5. Do the results achieved to date and the expected outputs justify greater emphasis (effort and investment) on outreach and scaling-up for impact if another five year renewal is granted? Why or why not?
6. If another five years is granted, how should the program focus its efforts to achieve a greater level of effort or extend farther towards impact? Should there be a focus on fewer high performing activities? Should there be a different mix of activities along the research continuum? Which ones need to be refocused or discontinued? Among the projects making significant progress, which ones are scalable for a greater impact?

C. Program Focus

1. In general, comment on the depth versus breadth of the program.
2. What are the synergies across research activities that warrant the number of research activities in the portfolio? Have the activities been of sufficient depth to make an impact on the state-of-the-art or to apply existing knowledge to real life problems? Give examples.
3. Please comment on the quality and depth of the research and the relevance of the work to provide solutions to aquaculture and fisheries development problems? How could the major themes or topics be refined to increase impact?
4. How well has the ME balanced the research and implementation activities given the amount of funding provided? Please provide some direction or focus on how much emphasis should occur within the AquaFish CRSP portfolio on basic research, applied research, and implementation.
5. How does the AquaFish CRSP respond to Title XII's objectives?

D. Collaboration, capacity building and outreach
   1. What are some examples of partnerships and collaboration between host country and the U.S. PIs? How have they been effective at building the capacity of local researchers, policy makers and practitioners?
   2. Compared to the research activities of the CRSP, what has been the level of effort and investment in training and institutional capacity building? Has it been effective? How can impact of capacity building be captured (and measured) more effectively?
   3. What outreach strategies have been integrated into project design to increase likelihood of uptake and utilization of research results? What have been the most effective strategies for outreach at the country level?
   4. What have been the outreach efforts at the regional or "global" level?
   5. How has the ME communicated its activities to the global community through:
      a. Hosted events, peer-reviewed journals and published work?
      b. USAID Missions and other operating units?
      c. Other donors and partners such as the World Bank, IFC, IFAD/FAO, other bilateral development agencies, etc. How might the management entity better capture "impact" of their efforts at this level?

II. Administrative Review

A. What have been the roles/functions of the advisory committees and the administrative leadership? How cost effective has each been? Could they be more efficient? How?

B. What has been the substantial involvement and contribution of the USAID AOR?

C. What was the process for sub-award selection? How effectively did the process yield a high quality, relevant portfolio of activities? How consistent was it with the requirements of the cooperative agreement?

D. Program Management:
   1. What have been the challenges for the ME and how have they responded?
   2. How has the ME promoted and maximized values such as collaboration, capacity building, and outreach among sub-awardees?
   3. How have activities been reviewed?
   4. What systems are in place to keep research activity on track according to the CRSP's goals?
   5. In general, what has been the management style of the ME regarding PIs and sub-awardees? How could it be improved?
   6. How have management problems been addressed?

E. Financial Management:
   1. Have there been any problems regarding financial issues as perceived by CRSP participants at various levels (ME, Principle Investigator, Researchers, & in-country Collaborators)? How have problems been resolved?
   2. Have vouchers been processed in a timely way so as to minimize pipeline issues or payment lags?

F. Monitoring and Evaluation (M&E):
   1. What types of M&E have been undertaken by the ME?

2. Are the indicators used effective at capturing and communicating the outcomes and impacts of research activities? Are there appropriate indicators for the stage in the "research continuum"?
3. Have baselines, if necessary, been established? When?
4. Are data collected valid and of proper quality for reporting?
5. Have indicators capturing impacts and outcomes on higher levels been developed?

Evaluation Methodology: The evaluation will be based on a review of project documents, meetings, interviews and attendance at a CRSP meeting, if there is one planned during the evaluation period. The EET members will interact with the ME, program leaders and host-country stakeholders, as well as other relevant regional or global development and research communities. The evaluation will consist of the following steps:

A. The EET will schedule an internal team planning meeting (face-to-face or via phone) with the USAID Agreement Officer's Representative (AOR) and other USAID staff as needed. In this meeting and in a desk review the evaluators will ascertain the relevance of all the individual projects to the overall objectives of the CRSP. Evaluators will be familiar with a number of documents before the meeting, including the CRSP agreement, program operations and other documents, annual reports; original research activity proposals and work plans for Years 1-5. All of these, as well as other CRSP documents will be provided by the CRSP ME, and will constitute materials necessary for the Desktop Review. During this phase, the EET will review documentation relevant to the Areas of Evaluation, may conduct phone interviews with the ME, Principle Investigators and other stakeholders. The purpose of the Desktop Review is to provide background and determine the necessary and reasonable travel, site visits and in-person and virtual interviews required to properly execute the evaluation.
B. The EET will then discuss with the AOR an Evaluation Work Plan outlining the necessary interviews, travel to visit the ME and U.S. universities, and to attend a CRSP meeting, if there is one planned during the evaluation period, and time required to successfully complete the evaluation. If needed, a visit to one or more host countries may also be scheduled.
C. Conduct the evaluation.
D. Upon completion of the evaluation, the EET will submit a draft evaluation report to the AOR. The report should include recommendations for enhancing the performance and impact of the CRSP. It shall also make recommendation regarding a possible five-year extension of the CRSP as follows:
    a. Refinement of program themes or topics covered by the CRSP;
    b. Number and depth of activities in the CRSP's portfolio;
    c. Type of activities relative to the research and development continuum;
    d. Improving/expanding impact;
    e. Major organizational or procedural changes.

Evaluation Report: The EET will submit its draft report on or about June 1, 2012 after the field work is completed. This report will address the specific items mentioned in this SOW and any other relevant issues the EET feels should be addressed. The draft will be submitted electronically in MS Word format

to the CRSP AOR. USAID will share the draft with the ME for comments and to correct any erroneous or inaccurate information. USAID will then return comments and suggestions for consideration to the EET by June 15. The final revised report should be submitted to USAID no later than June 30. All comments should be sufficiently addressed. The report should be submitted in MS Word format to the USAID CRSP AOR An oral presentation (face-to-face or via phone) of the team's findings and recommendations will also be made to USAID and the ME. The following is a suggested outline for the report:

I Title Page
II Table of contents
III List of Acronyms
IV List of Tables
V List of Figures
VI Executive Summary
VII Findings and conclusions
  A. Responses to each item in the SOW
VIII Recommendations
IX Appendices
  A. Statement of work
  B. Itinerary
  C. List of Persons Contacted
  D. List of Materials reviewed

Level of Effort and Time Frame: The level of effort for the entirety of this scope of work will consist of no more than 30 person days for the Team Leader and up to 20 days for the other EET members over a period from on/about April 1 to June 30, 2012. The USAID Agreement Officer's Representative (AOR) will be available to the team as a resource person but will not contribute directly to preparation of the report.

Team Composition and Qualifications

The technical areas of focus of the CRSP require that expertise on the panel will be appropriate for the CRSP being evaluated. Team members must have the expertise necessary to evaluate the program and to address the evaluation questions. The team members must familiarize themselves with USAID's priorities and objectives in the economic growth sector, and particularly the USG Feed the Future research strategy. USAID will designate one team member as team leader.

Administrative/management review member (1): A senior administrator with a minimum of ten years experience managing multifaceted international development research and/or university-based programs. The preferred candidate will be familiar with both university-based programs and USAID (or other donor) funded programs. The Team Leader should a background agricultural/resources economics, aquaculture, fisheries, or rural development. The candidate would also have (1) demonstrated capacity to conduct program evaluation; (2) an understanding of USAID's foreign

assistance goals, and its particular objectives related to collaborative research, agricultural development and food security; and (3) the ability to analyze issues and formulate concrete recommendations orally and in writing.

Technical team members (3): Must be recognized experts on international development related to agriculture and/or rural development with expertise in the focus area of the AquaFish CRSP. Team members will be chosen from those who have experience in such areas as aquaculture, fisheries, animal sciences, and/or agricultural/resource economics. Technical team member candidates will also have demonstrated (1) capacity to conduct program evaluation; (2) thorough understanding of research methodology; (3) experience in effectively conducting outreach and dissemination to policymakers, development practitioners and/or the private sector; (4) the ability to analyze issues and formulate concrete recommendations orally and in writing. At least one team member should be familiar with gender issues in aquaculture and fisheries.

3/21/12

Appendix 2. Itineraries

All Evaluation Team Members-Portland, OR and Corvalis, OR 22-26 April 2012

USAID External Review Team Meeting, Portland Meetings

April 22, 2012

Team members travel to Portland, OR

April 23, 2012

8:00AM Team members meet for discussion

1:00PM-3:30PM Meet with AquaFish PI's and ME

3:30PM-6:30PM Meet with individual PIs

April 24, 2012

8:00AM-1:00PM Meet with individual PIs

PM- Travel to Corvalis, OR

USAID External Review Team Meeting, OSU Site Visit

Wed 25 April 2012

815a: Team meets Hillary Egna at Java Café, Library

830 - 945a: Extension and Experiment Station Communications

422 Kerr Admin

Peg Herring, Unit Head, EESC

Tiffany Woods, Science Writer

950-1045a: VP Research Office

Kerr Admin A312 (tower portion of the building just before the Graduate School offices)

Rich Holdren, Associate Vice President for Research

Pat Hawk, Director, Office of Sponsored Programs

11a-12p: CAS (College of Agricultural Sciences)

Strand 134 (first floor, south side of bldg)

Larry Curtis, CAS Associate Dean

1215p Lunch with Hillary Egna and Management Team

130-630p Meeting with Hillary Egna and Management Team, Strand Ag Hall

Depart for Portland

Revathi Balakrishnan Visit to the Philippines May 18-25

May 18-19 –Travel to the Philippines

May 20 (Sunday) – Met by Mr. Eddie Boy Jaminez Technology Transfer specialist, CFA and Dr. Bing Ayson SEAFDEC CRSP Investigator Preliminary discussion on CRSP linkage and focus in the PHLP. Purpose of reviewer visit in the context of CRSP USAID focus on CRSP purpose and impact during travel

May 21 (Monday AM) – Meetings with Dr. Remedios B. Bolivar and Dr. Bing Ayson at the CLSU-CFA ; Mr. Tereso A. Abella, Ph.D. Director, Freshwater Aquaculture Centre; Mr. Ruben C. Sevilleja, Ph.D. the President of the University and the CRSP scholars met were: Revelina Velasco, Roberto Miguel Sayco, Jamaica Mendoza, Sherwin Celestino, and Agnelee Romero.

Tour of facilities of institutions ons who are partners with AquaFish CRSP –CLSU and meeting the staff: National Freshwater Fisheries Technology Center, Bureau of Fisheries and Aquatic Resources, DOA -Ms. Jude Danting and Ms. Evelyn H. Zafra and GIFT project - Genetically Improved Farmed Tilapia, (-Mr. Ruben A Reyes, Feedmix Specialist II .

PM : Continued discussions with Dr. Bolivar and Dr. Ayson.

Visit to Aquaculture farm near CLSU in Munoz and discussions with farmer about his practices and economic returns on the enterprise

Tour of the CLSU campus facilities

May 22 (Tuesday) – Travel with Dr. Bing Ayson**,** Mr. Eddie Boy Jaminez Technology Transfer and CLSU graduate student. Discussions in travel with Dr. Bing. Breakfast stop at SAN Fernando; Visit to farms: 2 contract farmers in aquaculture and one commercial aquaculture farm

May 23 (Wednesday) – CLSU meetings with Dr. Bolivar and Dr. Ayson. Seeing departure of Dr. Bing Ayson in Domestic airport. Departure related tasks.

May 24—Return to the U.S.

Jeff Silverstein Visit to Kenya May 19-25

Day 1 (May 21) Nairobi and depart for Kisumu, visit farms

Day 2 (May 22) Arrive Kisumu and visit fingerling producers

Day 3 (May 23)to Eldoret visit tilapia producers, teaching facilities, Moi University

Day 4 (May 24) visit farms, back to Nairobi depart for U.S.

Appendix 3. Host Country Collaborator Survey Responses (copied from Adobe PDF response file)

Summary
Survey Name:
AquaFish CRSP Collaboration
Offering Name:
Collaborators 1
Offering Date:
5/3/12 to 5/19/12
Statistics
Started: **17** out of **24**
Opted out before starting: **0**
Completed: **17**
Drop outs after starting: **0**
Average completion times:
Average Time To Complete Survey: **1 day 50 minutes 26 seconds.**
Average Time Spent Before Quitting: **Not enough information.**

Question 1
Have you engaged in a collaborative research/development activity with a AquaFish CRSP collaborator during the current project (either Phase I or Phase II between 2007 to the present)? If no, you will directed to the closing page of the survey.

- Yes: 17 (100%)
- No: 0 (0%)
- N/R: 0 (0%)

Question 2
Which geographical area of the world are you located?

- Eastern & Southern Africa: 3 (17.65%)
- West Africa: 1 (5.88%)
- Central America & Caribbean: 2 (11.76%)
- South America: 1 (5.88%)
- South Asia: 1 (5.88%)
- Southeast Asia: 8 (47.06%)
- Other: 1 (5.88%)
- N/R 0 (0%)

Question 3
Please tell us your scientific or development area of expertise.

- Production science (e.g., breeding, physiology, feeds, aquaculture systems, pond dynamics, etc.): 14 (82.35%)
- Social science (agricultural economics, sociology, gender, etc): 1 (5.88%)
- Post harvest (storage etc.): 0 (0%)
- Food science (nutrition, food safety, new product development): 0 (0%)
- Human health: 1 (5.88%)
- Technology transfer (extension): 0 (0%)
- Other: 1 (5.88%)
- N/R: 0 (0%)

Question 4

4.1 How important is seafood (fish, shellfish, crustacean) consumption in your local diet?

- Not very important: 0 (0%)
- Somewhat, but below average: 0 (0%)
- Average: 2 (11.76%)
- Important: 8 (47.06%)
- Very important: 7 (41.18%)
- N/R: 0 (0%)

4.2 How important is aquaculture production in your country?

- Not very important: 0 (0%)
- Somewhat, but below average: 0 (0%)
- Average: 3 (17.65%)
- Important: 3 (17.65%)
- Very important: 11 (64.71%)
- N/R: 0 (0%)

4.3 How important is aquaculture trade (with other neighboring countries) to your country?

- Not very important: 0 (0%)
- Somewhat, but below average: 2 (11.76%)
- Average: 1 (5.88%)
- Important: 8 (47.06%)
- Very important: 6 (35.29%)
- N/R: 0 (0%)

4.4 What is future outlook and importance for growth over the next 5 years?

- Not very important: 0 (0%)
- Somewhat, but below average: 0 (0%)
- Average: 0 (0%)
- Important: 6 (35.29%)
- Very important: 11 (64.71%)
- N/R: 0 (0%)

Question 5

5.1 How much of your work/research time do you allocate to aquaculture research, studies and activities on an annual basis(including the time you allocate to AquaFish activities)? If you study human health issues and not only aquaculture, you can substitute "health" for aquaculture. Please differentiate "research" from administration, teaching etc.

- Not important (<20%): 0 (0%)
- Somewhat important (21-40%): 2 (11.76%)
- Average (41-60%): 3 (17.65%)
- Important (61-80%): 10 (58.82%)
- Very important (81-100%): 2 (11.76%)
- N/R: 0 (0%)

5.2 About how much time do you allocate specifically to AquaFish experiments, studies or activities on an annual basis?

- Not important (<20%): 0 (0%)
- Somewhat important (21-40%): 6 (35.29%)
- Average (41-60%): 6 (35.29%)
- Important (61-80%): 4 (23.53%)
- Very important (81-100%): 1 (5.88%)
- N/R: 0 (0%)

5.3 How important is the financial contribution from AquaFish to your experiments, studies and activities? In other words, what percentage of your research budget is funded by AquaFish?

- Not important (<20%): 1 (5.88%)
- Somewhat important (21-40%): 3 (17.65%)
- Average (41-60%): 3 (17.65%)
- Important (61-80%): 3 (17.65%)
- Very important (81-100%): 7 (41.18%)
- N/R: 0 (0%)

Question 6

Have gender integration strategies added value to AquaFish program development and implementation (Ex. research findings, technology adoption, human consumption etc.)?

- Yes: 16 (94.12%)
- No: 1 (5.88%)
- N/R: 0 (0%)

Question 7

Please add any comments you might have on gender integration.

- We always consider gender integration interventions in our AquaFish CRSP program; e.g. thesis research students; researchers' activities; fish farmers, fishers and fish processing activities; trainings.
- We have select students participating in AquaFish program based on female/male balance 50/50.
- Gender integration is one of the most important aspects of AquaFish CRSP, emphasized in all its research and development activities.
- Ministry of Fisheries Development policy recognizes importance of development of Fish Farmers Clusters and role of youth and women in aquaculture. Women are active in Value chain and fish trade.
- In Central America there is little involvement of women in aquacultural activities; however, the role of women in aquaculture is increasing, in our projects we insist on participation of women.
- Since culture is dominated by men, women have been trained in proper feeding management, as well as value addition and post harvest methodologies.
- We make it a point that women have key roles in the research. In our student support, we involved greater number of women.
- In my activity, to increase pond production, benefit option of farmers, that potencial to including the participation of women (Harvesting, Handling process and culture because it is easy for women and men to work together.
- Female co-workers assisted much with data capturing and creating order in research methodology and systematics.
- Generally, female students and scientists outreached male counterparts in many aspects such as experiment design, writing and active response on tasks once they got chance to perform.
- Involvement of female student in research and women participants in farmers field experiments.
- Gender integration has facilitated our research efforts involving women who are mainly involved in processing of aquaculture and in the marketing and economics of aquaculture products.

- In all our projects have participated in a balanced way either men or women

Question 8
Is there a specific allocation of funds for gender integration interventions in your AquaFish CRSP program?

- Yes: 8 (47.06%)
- No: 8 (47.06%)
- N/R: 1 (5.88%)

Question 9
Please add any comments to the question on budget allocation and gender activities.

- At least 20-30% of the total budget.
- Part of the budget is dedicated towards training which targets women who are establishing aquaculture farms in their communities as a source of income. They're provided with technical/practical advice
- Needed, but a rigid pre-set division of the fund specifically for a research or development activity may not always be necessary, unless the activity aims to deal with gender issues.
- A training workshop conducted in Kenya as part of the project from Oct 2009 to Sep 2011. The workshop and value chain intervention strategies were under investigation one with a stand alone
- We focus primarily in the inclusion of women in training and research.
- The project has funds allocated for workshops for both men and women (on updates in culture technologies) as well as workshops for women on value addition and post-harvest methodologies.
- Gender integration had become part and parcel of doing the experiments
- Training for women on the handling of seaweed for making candy, cake, dessert and some cooking product.
- I propose it should be ring-fenced and specific-driven in project terms of reference and outputs.
- 50% of funds for students are aimed at women students; and about half the budget overall involves women. Continuous funding support on women students attracted excellent candidates.
- No specific budget allocations are made for gender integration but we have operated largely with gender sensitivity in mind and providing funding where appropriate and necessary.
- No, there isn't any allocation of funds to that purpose.

Question 10
Do you undertake formal impact assessment of the field interventions in AquaFish CRSP?

- Yes: 9 (52.94%)
- No: 7 (41.18%)
- N/R: 1 (5.88%)

Question 11
Please add any comments on impact assessment activities undertaken.

- We have implemented the activity entitled "Assessing the impacts of sustainable freshwater aquaculture development and small-sized fisheries management in the Lower Mekong basin".
- Assessment on bait fish production for better Management of Lake Victoria and Development impacts of long term aquaculture training programme in Kenya
- A separate group has been commissioned to do the impact assessment. However, host country collaborators attended a workshop on impact assessment and should have some knowledge to do self asessment
- Through the initiative of a principal investigator, we did an impact assessment study on the use of
- feeds by tilapia farmers in a major tilapia producing region in the country
- 1. positive environment impact of water quality for shrimp culture 2. implementing how women used the seaweed for making cake variation.
- It should be incorporated pre-project planning and implementation.

- Honestly, impact assessment since 2010 was not a success, because of lack of economists' understanding on aquaculture field research and practices, and on primary data collection
- Production improvement by technology and awareness by partcipating fish farmers,
- No formal impact assessments of activities have been undertaken but we have considerable capacity building of farmers, extensionists, researchers and gender through various AquaFish training program
- Yes, We've done impact evaluations
-

Question 12
How effective has the integration of an outreach component to research projects been to reach, educate and improve production practices of farmers?

- Very effective: 8 (47.06%)
- Moderately effective: 7 (41.18%)
- Somewhat effective: 2 (11.76%)
- Not effective at all: 0 (0%)
- N/R: 0 (0%)

Question 13
How would you describe your input into setting the research objectives, hypotheses and development goals of your project?

- Poor, minimal input: 0 (0%)
- Weak, below average but positive: 0 (0%)
- Average, we shared equally setting the objectives: 8 (47.06%)
- Good, I provided more input into setting the objectives: 4 (23.53%)
- Excellent, I led setting the objectives: 4 (23.53%)
- N/R: 1 (5.88%)

Please add any comments you might have on setting the research objectives, hypotheses and development goals of your project.
Research objectives and proposals were once output of workshops and final proposals and research goals were prioritized from the participants' votes
We discuss with our colleagues the objectives and goals that I consider are priority for the region, providing information for the decision making process.
It is excellent that I could set up the objectives of our projects because the project objectives will contribute to achieve the objectives of our research institute in the country as well as in the region.
We always have a very interactive, demand-driven and participatory approach to setting our research prioroties and agenda. We collaborate with our counterparts also in the USA and try to set achievable and workable objectives in a development-oriented context. We have always strived to circulate and refine our research to answer specific problems. Being in Ghana places me in a position to validate the assumptions underlying our hypothesis with stakeholders.
All time i set research objectives and write research project then other partner review them.
We try to share equally all the settings
I have been the HC PI who generates research objectives based on the priorities of our country
Exchange of ideas (mostly through email) was the hallmark of the development of the concept and writing of the proposal for this project.
Still needed share objectives of the project to make useful for the farmers.

Question 14
How would you describe your input into setting the research methods used to reach your research objectives and /or test your hypotheses?

- Poor, minimal input on methods: 0 (0%)
- Weak, below average but positive: 0 (0%)
- Average, we shared equally setting the methods: 7 (41.18%)
- Good, I provided more input into setting the methods: 4 (23.53%)
- Excellent, I led setting the methods: 5 (29.41%)
- N/R: 1 (5.88%)

Please add any comments you might have about role in setting the research methods used to reach your research objectives and /or test your hypotheses.

- We discussed research objectives and methods with US lead PI and host country PI, based on field visits and consultation with local experts
- I always involve in setting up the research methods as this is a very important activity to achieve the research objectives. I always discuss with researchers and research assistants who involve in the projects to set up the research methods.
- These result from a shared and participatory approach which is demand-driven by our stakeholders. My input is derived from direct interactions with stakeholders and we share these with our collaborators and these are refined along the line to meet all requirements.
- We've always tried to accomplish our objectives
- After setting research hypotheses and objectives, I take lead in methodology based on
- available resources and expected adoption of technologies
- Decisions on the research methodologies to use in the conduct of the research as well as strategies to adopt in the outreach activities were reached through exchange of ideas.
- Sure, the method is very dependent on field situation combine with some references.

Question 15
Please describe your role in writing AquaFish research publications/reports. Reports include annual reports, research reports, working papers, conference papers, book chapters and manuscripts.

- I initiate and lead writing research publications/ reports on AquaFish activities: 2 (11.76%)
- I share writing research publications/reports equally with the PI and others on AquaFish activities: 8 (47.06%)
- I contribute to writing research publications/reports on AquaFish activities: 6 (35.29%)
- I do not contribute to writing research publications/reports on AquaFish activities: 0 (0%)
- Other: 0 (0%)
- N/R: 1 (5.88%)

Question 16
If you have any ideas to share on how could your research and development collaboration could be improved, please describe in the space below. Please do not include financial or administrative issues as these will be discussed in the next section.

- I am very happy with the current AquaFish CRSP management. The collaboration mechanisms have been effective and very successful. In the future South-South collaboration may be promoted.
- I believe that the strategies we have implemented are very efficient.
- Sharing and communicating research knowledge, information, human capacity among research partners could improve research and development collaboration.
- Research and development could be improved through greater involvement of women in aquaculture research and production. Females involved in aquaculture research remain fairly restricted.
- Improved methods of disseminating technologies developed by AquaFish will be key to adoption
- Perhaps more exchange visits?

Question 17
Relative to the project objectives, is AquaFish financing sufficient to meet the project objectives?

- Insufficient to meet objectives (<20%): 0 (0%)
- It somewhat covers the cost (21-40%): 0 (0%)
- It covers around half of research costs (41-60%): 2 (11.76%)
- It nearly covers the research cost (61-80%): 9 (52.94%)
- It fully covers research costs (81-100%): 6 (35.29%)
- N/R: 0 (0%)

Please add any comments you may:

- We collaborate with the using costs of the labs
- AquaFish financing requires a cost share of 50% and sometimes it barely just covers that and where needed we are able to leverage funds elsewhere to cover it.
- AquaFish CRSP financing is sufficient to meet the project objectives as we have set up the project objectives and budget.
- My institution cover other costs
- It nearly covers the research cost for the "AquaFish CRSP" activity. On Question 18: Essentially, I could not conduct research on the "AquaFish CRSP" topics without it. But AquaFish CRSP funds less than 20% of all my research activities.
- 1. AquaFish projects are usually engine of my internal projects, due to the excellent international network and interdisciplinary methods; 2.We have very good opportunity to apply for leveraging funds from some host countries based on AquaFish research outcomes; 3. some employees don't claim salary from the project since they are full time professors
- Based on RFP guidelines leverage funding does cover the 20% mainly from host countries
- It cover for fully activity, its not include salary or honorarium, this is enough and useful for farmers and research need only.

Question 18
How important is AquaFish funding to conducting your research/development activities?

- Essential, I could not conduct research on these topics without it: 7 (41.18%)
- Very important, it funds 61-80% of my research costs: 4 (23.53%)
- Important--it contributes around 41-60% of my research budget: 4 (23.53%)
- Somewhat important--it contributes around 21-40% of my research budget: 1 (5.88%)
- Not important, it funds less than 20% of my research activities: 1 (5.88%)
- Other: 0 (0%)
- N/R 0 (0%)

Question 19
How difficult is it to comply with financial reporting requirements implemented by the program to receive funds and/or reimbursements?

- Very difficult: 0 (0%)
- Difficult: 3 (17.65%)
- Similar to other projects: 6 (35.29%)
- Easier than most projects: 3 (17.65%)
- Not a problem at all: 5 (29.41%)
- N/R: 0 (0%)

Question 20
Overall, how would you rate the administrative requirements set up by the program to comply with USAID guidelines?

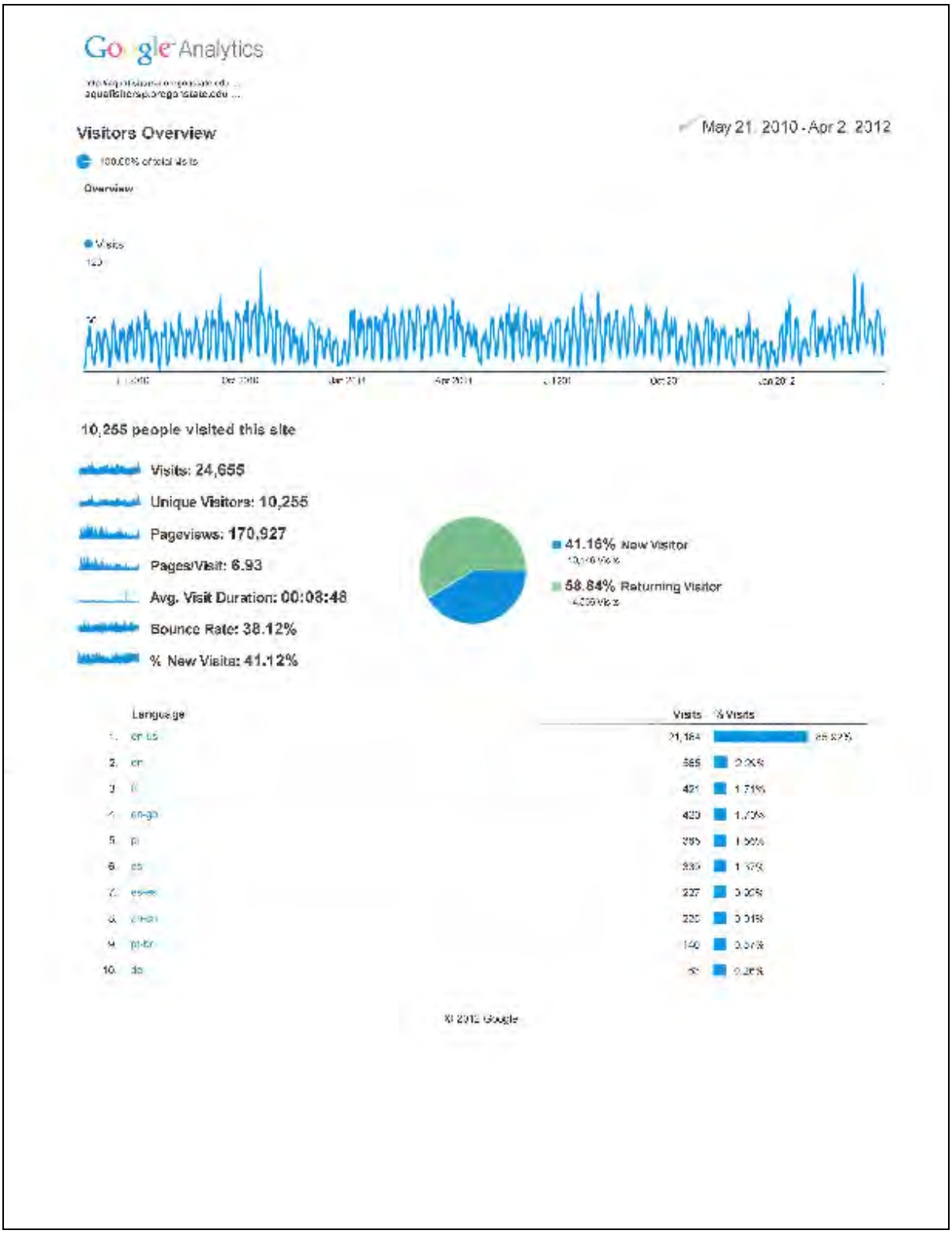
- The most burdensome of all projects I am involved with: 0 (0%)
- Much more burdensome than other projects: 3 (17.65%)
- About average relative to other projects: 7 (41.18%)
- Easier than most projects: 7 (41.18%)
- N/R: 0 (0%)

Question 21
Please add any additional comments that you would like to share regarding financial management of your project from the perspective of a host-country collaborator/investigator.

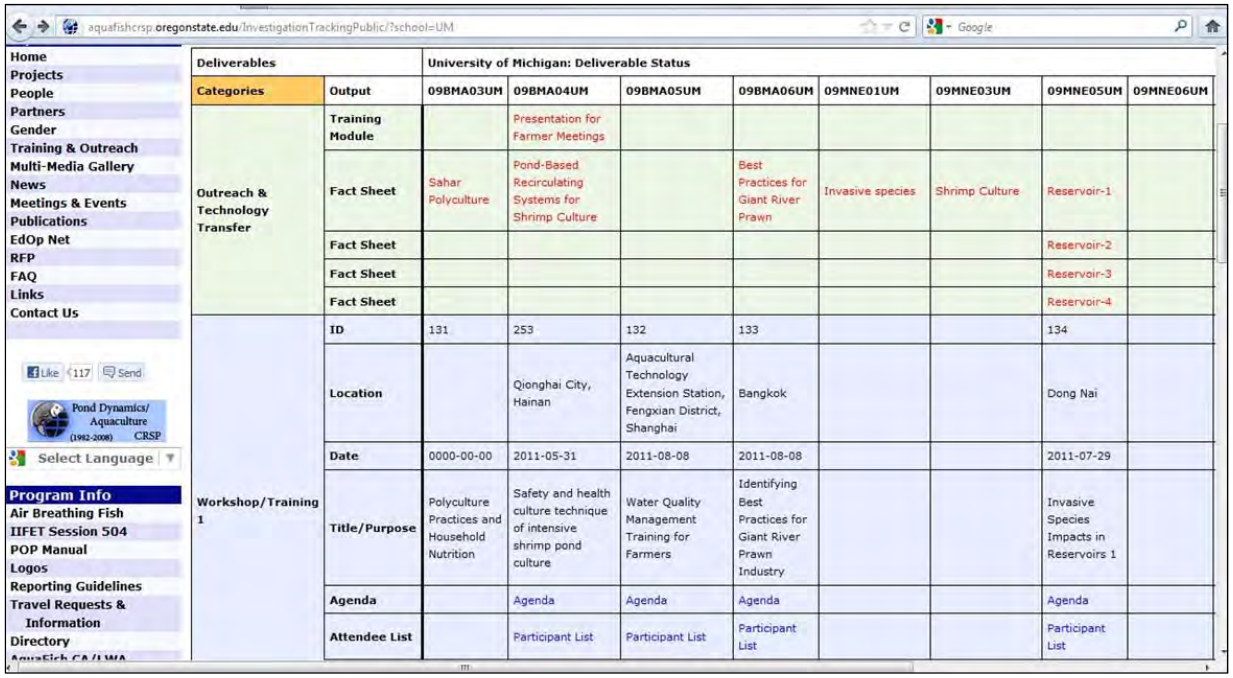
- When many investigators are involved in the research, the financial support for the investigators is reduced.
- The financial management of the project has been so convenient and excellent. It was not a problem at all.
- Operating within the university financial regulations, AquaFish funds are managed through the university Finance Office and under the financial regulations of Ghana.
- It take lots of time to prepare and approve the contacts, and to receive funds and reimbursements. Please simplify these processes/procedures.
- Financial management for AquaFish is relatively easy, doubts are easily clarified and inquiries solved promptly.
- Efficient, transparent, and easy to work with.
- My employer has adopted a good financial system, when fund reaches, the financial officer will break down the items according to proposal budget. Each item has its limitation thus you can't exceed
- Difficulties are with protocols in HC institutions. Reporting procedures have improved over the 15 years I have been a PI. Delay in receiving funds does however affect project implementation.
- The budgeting system is easier, and also reporting is clear. Because there is not budget line system that make difficult to revise if any changing in the field base on need requesting.

- End of Survey -

Appendix 4. Google analytics report from May 2010 to April 2012 (click to enter Adobe PDF file; also on file with AOR)



Appendix 5. Screen shots of the Investigator interface on the AquaFish CRSP website



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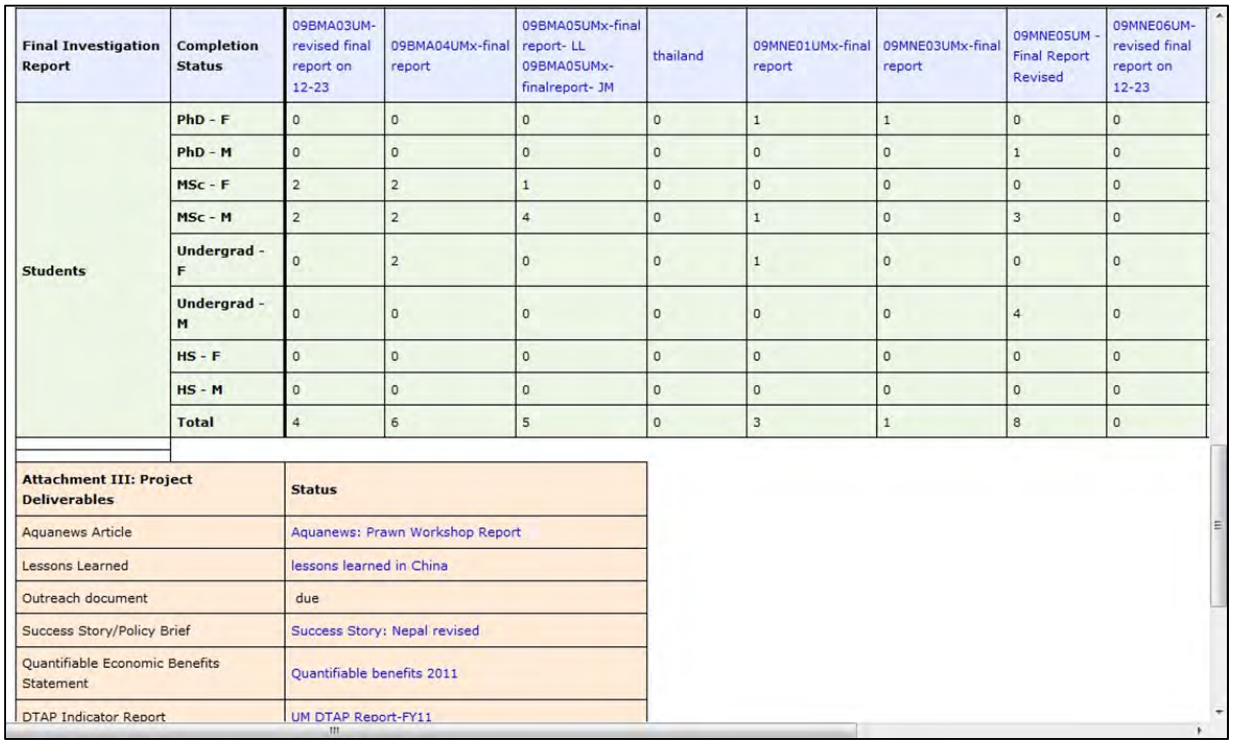
Program Info
Air Breathing Fish
IIFET Session 504
POP Manual
Logos
Reporting Guidelines
Travel Requests & Information
Directory

Deliverables		University of Michigan: Deliverable Status							
Categories	Output	09BMA03UM	09BMA04UM	09BMA05UM	09BMA06UM	09MNE01UM	09MNE03UM	09MNE05UM	09MNE06UM
Outreach & Technology Transfer	Training Module		Presentation for Farmer Meetings						
	Fact Sheet	Sahar Polyculture	Pond-Based Recirculating Systems for Shrimp Culture		Best Practices for Giant River Prawn	Invasive species	Shrimp Culture	Reservoir-1	
	Fact Sheet							Reservoir-2	
	Fact Sheet							Reservoir-3	
	Fact Sheet							Reservoir-4	
Workshop/Training 1	ID	131	253	132	133			134	
	Location		Qionghai City, Hainan	Aquacultural Technology Extension Station, Fengxian District, Shanghai	Bangkok			Dong Nai	
	Date	0000-00-00	2011-05-31	2011-08-08	2011-08-08			2011-07-29	
	Title/Purpose	Polyculture Practices and Household Nutrition	Safety and health culture technique of intensive shrimp pond culture	Water Quality Management Training for Farmers	Identifying Best Practices for Giant River Prawn Industry			Invasive Species Impacts in Reservoirs 1	
	Agenda		Agenda	Agenda	Agenda			Agenda	
	Attendee List		Participant List	Participant List	Participant List			Participant List	

Figure 3. Screen shot for tracking page for investigations with hyperlinks to documents



Final Investigation Report	Completion Status	09BMA03UM-revised final report on 12-23	09BMA04UMx-final report	09BMA05UMx-final report- LL 09BMA05UMx-finalreport- JM	thailand	09MNE01UMx-final report	09MNE03UMx-final report	09MNE05UM - Final Report Revised	09MNE06UM-revised final report on 12-23
Students	PhD - F	0	0	0	0	1	1	0	0
	PhD - M	0	0	0	0	0	0	1	0
	MSc - F	2	2	1	0	0	0	0	0
	MSc - M	2	2	4	0	1	0	3	0
	Undergrad - F	0	2	0	0	1	0	0	0
	Undergrad - M	0	0	0	0	0	0	4	0
	HS - F	0	0	0	0	0	0	0	0
	HS - M	0	0	0	0	0	0	0	0
	Total	4	6	5	0	3	1	8	0

Attachment III: Project Deliverables	Status
Aquanews Article	Aquanews: Prawn Workshop Report
Lessons Learned	lessons learned in China
Outreach document	due
Success Story/Policy Brief	Success Story: Nepal revised
Quantifiable Economic Benefits Statement	Quantifiable benefits 2011
DTAP Indicator Report	UM DTAP Report-FY11

Figure 4. Screen shot of student tracking and ME deliverables

Appendix 6. Trip report to Philippines prepared by Revathi Balakrishnan

Report of AquacultureFish CRSP Evaluation Site Visit to the Philippines

Reviewer: Revathi Balakrishnan, AquaFish CRSP Evaluation Team Member
Travel Dates: May 19 to 24, 2012
Country: The Philippines

1.0. Purpose: The Philippines is one of the AquaFish CRSP partners in the current phase of CRSP (2007-2011 Work Plan) that is under review. Hence, a site visit was conducted to meet with program partners and review the field work supported by the AquaFish CRSP. The site visit was made to gain insights into the activities and collaborative network to achieve the CRSP mission from the host country investigators and institutional partners.

2.0. Program: The visit was made to the Central Luzon State University at Munoz, Nueva Ecija and the various partner institutions in the proximity that support AquaFish CRSP activities and aquaculture culture farmers who participate in the CRSP activities. The primary contacts for the review were the Philippines PIs namely, Dr. Remedios B. Bolivar, Freshwater Aquaculture Center, CLSU and Evelyn Grace Ayson, from South East Asian Fisheries Development Center- Aquaculture Development (SEAFDEC AQD), Iloilo, Philippines, who travelled to CLSU to participate in the review. The reviewer also met Mr. Ruben C. Sevilleja, Ph.D. the President of the University, and Mr. Tereso A. Abella, Ph.D. Director, Freshwater Aquaculture Centre as well as a few graduates who were funded by AquaFish CRSP for their studies. The reviewer held discussions with partners in the CRSP network namely, National Freshwater Fisheries Technology Center, Bureau of Fisheries and Aquatic Resources, DOA (Ms. Jude Danting and Ms. Evelyn H. Zafra) and GIFT project - Genetically Improved Farmed Tilapia, (Mr. Ruben A Reyes, Feedmix Specialist II) . Visits were made to four tilapia farms; one in the vicinity of CLSU and three in Pampanga area and these are on-farm trial farmer-cooperators. Mr. Eddie Boy Jimenez (research associate) facilitated the visit to visit tilapia farms in Pampanga. The CRSP scholars met were: Revelina Velasco, Roberto Miguel Sayco, Jamaica Mendoza, Sherwin Celestino, and Agnelee Romero.

3.0. Major Findings:

This section presents the salient findings and the view of the HC institutional leaders and principal investigators in the host country.

3.1. AquaFish CRSP and HC Research:

- CRSP support has been a catalyst to undertake research in new areas to expand the knowledge of aquaculture in wide ranging topics from species, pond management, feed mix and feed management that had some direct benefit to farmers.
- CRSP support averages $ 8000/per PI and that is a reasonable amount to support research in the Philippines and thus is a valuable investment to encourage new areas of research –such as value chain analysis.

- The research support for feed management studies resulted in findings that encourage farmers to adopt different feeding routines and have shown economic benefits to the farmers to cut cost in production.
- Researchers funded by CRSP have published award winning research to support their careers while contributing to aquaculture knowledge base.
- The research in NCSU feed development has resulted in the feed formula being used by a private feed company SANTEH in the commercial feed preparation that is sold to the farmers. CLSU researchers now buy the feed from the private company.
- The CLSU institutional set up for AquaFish CRSP is such that its research facilitates flow of research findings between research and teaching. The CRSP is housed in the Freshwater Aquaculture Centre and is also linked to the College of Fisheries. Hence the research and teaching interactions facilitate use of CRSP research in teaching and involving students in research.
- AquaFish CRSP–CLSU also facilitates research by US scholars in an international site to expand knowledge base in aquaculture. It also provides a site for HC graduate student research such as the one done by Impact Assessment Project's CRSP supported student research (Steve Buccola's student research).
- CRSP partnership with SEAFDEC creates links in research and outreach initiatives in a regional institution that has a collaborative network of institutions in the South East Asian Region with a potential to open up opportunities for south-south collaboration.
- CRSP partnership with SEAFDEC is productive in both production and postharvest research, since the organization has the mandate to undertake research that benefits small farmers and women in fishing households.
- The PIs concern about using chicken waste for feeding the fish illustrates the relevance of cultural differences in aquaculture development. According to the Philippines PIs there is nothing of chicken that is wasted in the Philippines and thus the concept of using chicken waste is not a realistic in the Philippines.

3.2. AquaFish CRSP and HC Capacity Building:

- According to the CFA administrator, CRSP has contributed to faculty development through support for research.
- CRSP has supported university level education for the Filipino students both at graduate and undergraduate level. A few of the students are currently employed in the Freshwater Aquaculture Center at CLSU. One of the students has been a Borlaug scholar and is very positive about the support she received through AquaFish CRSP.
- At the initiative of CLSU PI Dr. Bolivar the CRSP support was provided to UG students on the rationale that the pipeline for graduate studies is possible only by training undergraduates.
- Though many students have been trained by CRSP there is no systematic follow up on the placement of students and thus their current contribution to aquaculture sector (academic,

industry, government, NGO or extension) is not quantifiable. The tradition of following up the alumni is not a common activity in CLSU.

- Generally, farmer centered extension is weak in the Philippines. AquaFish CRSP has supported extension activities in their fishery sector.
- The Philippines program records an impressive number of short term training of various groups supported by AquaFish CRSP (technical professionals, farmer's groups and extension professionals). Women's participation is rather high in these training programs. However there is no follow up on the trainees to document the use of training in field situation. One has to assume that trickle down of knowledge to practice is happening.

3.3. AquaFish CRSP and HC Technology Transfer:

- The GIFT (Genetically Improved Farmer's Tilapia) project is a partner in the AquaFish CRSP-NCSU-CLSU program in the Philippines. The GIFT project is funded by a seed company that provides loans for the farmers to buy fingerlings and feed. GIFT is the facilitator between the farmer and the seed company to arrange for the flow of funds and fingerlings to the farmers, and acts as an agent between the farmers and the seed company (BAF). AquaFish CRSP scientists collaborate with the GIFT project on feed trails and technology support.
- National Freshwater Fisheries Technology Center in the Bureau of Fisheries and Aquatic Resources (NFFTC) is a collaborator with AquaFish CRSP-CLSU. NFFTC supplies fingerlings to centers all across the Philippines for distribution to the farmers.
- Hence, quantifying the CRSP supported training/technology transfer outcome presents a challenge to the Philippines site since there are many institutions (both government and private sector) in the region that are involved in freshwater aquaculture research and outreach (fingerlings distribution, feed supply and loans for farmers and basic advisory services). Many private sector aquaculture farms are vertically integrated and employ contract farmers to produce tilapia. These Seed companies and commercial tilapia farms cosponsor the CLSU events that are also supported by AquaFish CRSP –CLSU.
- Among the farmers visited one was in Munoz, near the university was a student of the PI and has a successful aquaculture farming operation along with his wife who is a faculty member in CLSU. The wife also has a training program for women in fisheries. The link between the farmer (multiple pond owner and operator) and CLSU is through technology advice. He had also worked in the US in a Tilapia farm in California. Hence the farm could be a showcase farm with a relatively well qualified farm family. It takes him four to five years to recover the initial investment in pond construction and stocking. The sale is through a buyer who has transport to take live fish to the market.
- A farm in Pampanga was facing a loss since the tilapia stock was dying due to fungus infection in the water; and the accompanying CLSU research associate and the feed company representatives were advising them, but the dead tilapia stock had to be destroyed. The water from the main river feeds into ponds and thus infection from one pond can enter all the ponds on both sides of the river according to the accompanying PI from SEAFDEC.

- Another farm in Pampanga was a contract farm where the tilapia and shrimp fingerlings are grown together in a hatchery pond to be fed later into the growing pond. A single farmer with the family help manages the many ponds. He has adopted the variable feed management advised by CLSU. The ponds belong to an owner with means to buy land and build ponds. The farmer is employed and supervised by a manager. The farmer gets a salary and 10 % of catch and the manager gets 5% of the catch. The buying agents bring boats with equipment to take the live fish to the market.
- A fourth farm is a commercial large scale tilapia farm and the owner has his own hatchery. The ponds are fed with chickens waste (droppings) by building chicken coups over the pond and also use commercial feeds. They also use the commercial feed.
- The need for high capital investment to develop aquaculture farm as a productive farm enterprise, and finding a niche in a market for fresh fish dominated by commercial firms, deters entry of women in the production phase of aquaculture sector. Women do not enter given the resource access constraints faced by rural women. But postharvest sector (processing of tilapia, milk fish, drying and smoking fish for market) holds promise for the entry of women in the aquaculture sector.
- Podcasting is being tested as ICT based information dissemination in local languages to promote aquaculture technology using the Facebook mode. But the true cost of podcasting and constraints to effective use are not fully recognized by the investigators. In all the farms visited perhaps one commercial scale farmer may have the technology sophistication to use this mode of communication. Additionally, the costs of paying for the download and data use are borne by the receiving farmer. The farmer bears the cost of information reception while the project promotes it as free information access to the farmers.

3.4. AquaFish CRSP–HC Aquaculture Network

- CLSU has been a program partner since the phase of Pond Dynamics and Aquaculture CRSP and thus has long a standing collaborative research partnership. This partnership is valued by the University and the Director of the CFA. CRSP–CLSU participation has contributed to the development of tilapia industry and small farm tilapia producers.
- CLSU is placed in the area that is promoted as the tilapia capital (along with being the rice granary of the Philippines). This places AquaFish CRSP activities in an area where aquaculture based livelihood is important both as a commercial enterprise and for employment opportunities.
- Many centers with mission to promote research, extension and learning on fishery and aquaculture are clustered in and around CLSU. These are NFFTC, College of Fisheries, and GIFT project. NFFTC is under the Bureau of Fisheries and Aquatic Resources of the Department of Agriculture and thus links to country wide centers promoting aquaculture initiatives.
- Collaboration with CLSU, which is a state university, provides opportunities to draw interdisciplinary faculty into research.
- In the current phase the program includes SEAFDEC, a regional center for fisheries development that is an intergovernmental organization established in December 1967 for the purpose of

promoting sustainable fisheries development in the region. Its current Member Countries are Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam. It collaborates with regional bodies that promote fisheries in the region. The organization maintains ASEAN-SEAFDEC strategic partnership initiatives. It had been providing leadership regionally and with the AquaFish CRSP in south –south Collaboration. It has linkages with FAO fisheries programs as well as with the World Fish center.

- It is concluded that CLSU and SEAFDEC together offer combined expertise to build regional leadership in the aquaculture development. CLSU has linkages with national research, technology development and educational organizations that offer a national network to draw expertise in aquaculture development. The SEAFDEC as a regional center brings to the project an extensive network of countries that have demand for fish and fishery products and regional institutions with expertise to promote fisheries and aquaculture. The combined expertise in these institutions can make a valid contribution to aquaculture development in SEA and can provide regional leadership in aquaculture and fisheries research and development. But a note of caution is that building south-south collaboration through a US project as a catalyst will present collaboration challenges.
- SEFDEC works with a regional university having expertise in social science to support women in aquaculture postharvest intervention (training and technical advice) and there are also private groups with whom SEFDEC collaborates to train women.
- CLSU has women in fisheries group to support gender integration interventions.
- The Philippines has been successful in using gender mainstreaming and women's empowerment strategies in the postharvest sector and women have room for participation in training and professional fields. Hence there could be lessons in the Philippines which could be adapted/adopted to improve women's participation in this sector within SEA region.

3.5. AquaFish CRSP and HC Project Stakeholder Perceptions

- The PIs were briefed about the FtF agenda by the CRSP director from ME-OSU. Hence they are aware that the Philippines is not a country included in FtF framework. Hence this concern was raised by the PIs and administrators.
- The PIs stated that the technical leadership for the project given to the Philippines investigator should be the responsibility of the investigator. ME's primary responsibility is to coordinate the project among the countries that participate, facilitate macro management including data base management and communication.
- The Philippines PIs were pleased with support provided by ME and have not had any issues in project administration.
- An area of concern is the fund flow as advance from the project on a reimbursement basis. The CFA had been supportive and providing funds to keep the project moving. The primary reason was the personal rapport between the director and the PI in CLSU. But at the CLSU administration level it would be helpful if the funds from the University were forthcoming as advance to keep the activities moving. Personal credit cards are being used at times of crunch.

- The country research projects were submitted by the Philippines PIs and the NCSU as the lead university packages them for submission in response to RFA from ME.
- CRSP is a close knit family, however the Philippines program was open to bringing in a new partner in SEAFDEC in the current phase and is open to inviting new stake holders.
- The AquaFish CRSP gender strategy was developed in NCSU and no consultation was held with the Philippines PIs in shaping the AquaFish CRSP gender strategy.
- The PIs did not understand the OSU –Impact assessment exercise and were not aware of any outputs.
- The PIs acknowledge the importance of undertaking impact assessment at the country project level on their own initiative.
- The CLSU PI had been a participant in AquaFish CRSP program for 12 years and values the interaction with scientists in the network.
- The SEFDEC PI is finding her niche among the AquaFish CRSP group who had been together for years as a team before her arrival.

Appendix 7. Trip report to Kenya prepared by Jeffrey Silverstein

Jeffrey Silverstein May 30, 2012

Trip report Kenya May 21-23, 2012, and discussion with Dr. Charles Ngugi in Baltimore, MD 18 May 2012.

General Impressions The work of the CRSP projects going back to PDA CRSP could be very broadly characterized as:
CRSPs have trained over 1500 fish farmers and the results have lead to the whole spectrum of production from farmers with few resources available and improvement marginally above subsistence production to entrepreneurial growers that have increased pond area, intensified management and record keeping. ACRSP evolved to training and extension network development-thinking of aquaculture as a business. AquaFish CRSP has led to development of value chains, marketing, networking and cluster development as well as identification of critical resource needs, specifically feed and genetically defined fish stocks, and environmental issues to address with best management practices (BMPs).
A CRSP-More practical, extension training, record keeping, aquaculture as business
AquaFish CRSP-Production systems, marketing, clusters-more sophisticated research on resource needs.

The people trained through CRSP programs form the foundation of aquaculture in Kenya, extension officers, Ministry officers, keystone farmers. Moi University continues to be a hub of basic and applied research and extension services. Over the past 4-5 years tilapia production is stated to have grown from 1000MT/year to nearly 20,000MT/year. I don't know how reliable these figures are.

The Investment by the Government of Kenya can be traced to CRSP efforts. CRSP provided many of the trained aquaculture specialists for extension and ministry, including quite senior officials such as Dr. Charles Ngugi. FAO funded work also leveraged CRSP work around cluster development. Following the 2008 Gov't crash, the government identified 7 sectors for development through the Kenyan Business Development Services, broadly referred to as Economic Stimulus Funds and Fish Farming Enterprise Program. Aquaculture was identified as having the most potential for success, largely because of the groundwork laid by CRSP, FAO and other projects. The government funding went to digging ponds, 300 ponds (300m2 per pond) in each of 160 constituencies (48,000 ponds).

The ongoing relationship between the Government of Kenya (GOK) investments and the CRSP project was described to me as the USAID funding performs a backstopping and targeted role. The GOK funds are building ponds, building hatcheries, funding fingerling production, while the CRSP funds education, training, and specific research projects (e.g. on farm BMP trials).

Future directions for CRSP work would be in research-feed and seed are major priorities; training in value chain development, baseline marketing studies, product development, cluster development;

funding for continued education. The need for training of new faculty members was also mentioned by several extension officers as a need.

Monday 21 May 2012-Nairobi vicinity (Central Region)

Sagana National Aquaculture Research, Training and Development Center Bethuel Omolo

Mr. Kiama-Green Algae Highland fish farm

James Bundi Mugo "JB" at Mwea Fish Farms

Gladys Kuria-M Sc.student from Moi University-met at hotel in Nairobi

Tuesday 22 May 2012-(Lake Victoria) Kisumu area

Kisumu Staion of Fisheries Development Office

Met with Michael Obadha (Regional Director of Fisheries-includes aquaculture), George Owiti (Principal fisheries officer(PFO)-Kisumu region), Rodrick Kundu (Fisheries Specialist), Norman Munalla and Stefen Djao (PFO's). All received Master's; George through Auburn U., others through Moi University with CRSP support.

Visit to Jewlett Enterprises-Enos and Jedida Were

Wednesday 23 May 22, 2012-(Western) Eldoret area

Visit to Moi university –Met with David Lusega, Julius Manyala (very involved with projects)

Monday 21 May, met Sammy Macharia and Judy Amadiva at the hotel before 9am. The ministers and deputy ministers of Fisheries were all out of country on business trips, so we went directly to visit Sagana National Aquaculture Research Center. There we met with Bethuel Omolo, Asst. Director of Fisheries. We discussed the long history of CRSP at **Sagana, this is where it all began in 1997** with the CRSP**. Focused initially on pond construction**. Over the next 2 days, everyone I met who had come through Sagana (which was everyone) talked about the **formative experience of hand digging ponds at Sagana**. Pre CRSP there were projects with Belgian development groups, however one difference that was pointed out was the **early and consistent contact between CRSP and Government of Kenya-keeping a National focus, not regional or local**. Current CRSP work under a no-cost relates to BMPs (Feed and Water Use). Currently Sagana Research Center employs 53 people (with Government and CRSP funds).

Visited Mr. Kiama at Green Algae Highland fish farm also in Sagana region. He has worked in pond construction with the CRSP for many years, originally training with CRSP instructors he is now a key resource and trainer for the CRSP. Highly diversified operation, producing ornamental goldfish and carp, selling small aquaria to hold ornamental fish, catfish fingerling and broodstock production, tilapia

production. He also digs ponds for other farmers, and does considerable consulting with CRSP and government programs and independently. When we were at Mr. Kiama's farm, we saw a newly dug 1cubic meter pond for raising catfish fingerlings at very high density based on technology he learned of from Indonesian farmers brought in by the government (Ministry of Fisheries). Not sure if this system will work, but Mr. Kiama is very resourceful and entrepreneurial. Mr. Kiama called himself "a child of the CRSP" said he owes everything to the CRSP.

Mwea Farms-met James Bundi Mugo (JB), farm manager. Earned BS and MSc degrees through CRSP, currently participating in BMP evaluations of feed and water use. Previously MSc student, Gladys Kuria, did cage cum pond study at Mwea farms. This farm also earns money through consulting activities, provide tours to new and learning fish farmers for a fee. JB has also traveled as a trainer on the CRSP workshop to Mali. Mwea farms will produce all-male tilapia fingerlings, previous all-male trials performed with hand (visually) sexed all-male tilapia. Interesting side point-JB runs on farm experiments for his own management information. Currently doing a study (1 factor, four ponds) comparing fingerling production under repeated partial harvest conditions or with a single end of season harvest. This is unpaid research being conducted to improve farm management and productivity in the future. I cite this as an example of capacity building and expertise this scientifically trained farm manager brings to the job.

Gladys Kuria-MSc student from Moi University (on business in Nairobi-had chance to meet). Conducted cage-cum-pond study with tilapia (all-male tilapia in cages, mixed sex in ponds). In addition to 10 month spent on the Mwea farm building cages, learning operations and conducting her experiment, she attended international conference in Malawi and made scientific presentation, did extensive work with youth groups in three communities (Kikuyu, Thika and Nyeri communities) to do fish farming in reservoir systems. She especially enjoyed working with farmers in community groups. Considers aquaculture an attractive opportunity for women as farmers and as career professional (research, extension, Ministry work).

Tuesday 22 May-flew to Kisumu, to Regional Director of Fisheries (Michael Obadha) office. Several programs with interest in aquaculture (Kenyan Business Development, Government stimulus program, AquaFish. Obadha and several others during the visit suggested that no more CRSP funds are needed for digging ponds-this is a technology that has been well developed and transferred by the CRSP. Other info picked up from discussions with extension folks:

- break-even yield [including paying farmers for their time] = 5.5 MT/ha/yr
- minimum economic farm size = 1,200 m2, minimum economic pond size 300 m2
- average farmer yield = 6.3 MT/ha/yr
- market size 200-250 g @ $3-5/kg ($2.50 is break even)

Continued on to Jewlett Enterprises run by Jedida and Enos Were. On farm there was production of chickens, ducks, geese, sheep (for weed control), sales of bottled gas, aquaculture nets and equipment. Trained by CRSP (both Enos and Jedida) and continue to consult with CRSP doing trainings domestic and international. The primary focus of this farm is fry and fingerling production of both tilapia (all male fry production) and catfish. Enos is engaged in genetic improvement as well, selecting for growth and fillet yield. Last year Jewlett farms supplied over 4 million tilapia fingerlings through government programs,

to farmers. Quote from Enos “CRSP made me what I have become”. Enos Were focused on intensification of production, interested in aeration to increase carrying capacity of ponds. Busy consulting business, at least 10 calls/day on farming techniques.

Wednesday 23 May to Eldoret, Moi Universityhub of aquaculture development in Kenya. International (Regional) center-students in Aquaculture from Uganda, Tanzania, Mali and Ghana in addition to Kenya. Training students for jobs in Ministry, farm managers, National Museums (conservation), banks (experts in fish farms for investing/loan purposes) etc. Heavily involved in USAID supported cluster concept. Started 4 clusters (Bidii has been highly successful, 3 others much slower to gel). Moi becoming Chepkoilel University. School of Aquatic Sciences joining with Animal Production and Business Services.

Appendix 8. Project listing and descriptive information

Project PI, Titleand Theme	*Institution*	*Investigations*
Russell Borski	**North Carolina State University**	1. 09QSD01NC Nile Tilapia Broodstock Selection, Seed Quality and Density-Dependent Growth in the Philippines
IMPROVED COST EFFECTIVENESS AND SUSTAINABILITY OF AQUACULTURE IN		2. 09SFT04NC Feeding and Feed Formulation Strategies to Reduce Production Costs of Tilapia Culture
THE PHILIPPINES AND INDONESIA		3. 09TAP02NC Internet-Based Podcasting: Extension Modules for Farming Tilapia in the Philippines
AQUAFISH PROJECT THEME		4. 09MER03NC Improving Supply Chain Opportunities for Tilapia in the Philippines
INCOME GENERATION FOR SMALL-SCALE FISH FARMERS AND FISHERS		5. 09MNE02NC Ration Reduction, Integrated Multitrophic Aquaculture (milkfish-seaweed-sea cucumber) and Value-Added Products to Improve Incomes and Reduce the Ecological Footprint of Milkfish Culture in the Philippines
		6. 09FSV02NC Demonstration of Sustainable Seaweed Culture and Processing in Aceh, Indonesia and the Philippines - Opportunities for Women to Improve Household Welfare
		7. 09SFT06NC Impact Assessment of CRSP Activities in the Philippines and
Kevin M. Fitzsimmons	**University of Arizona**	
University of Arizona		1. 09TAP01UA Aquaculture & Fisheries CRSP Sponsorship of the Ninth International Symposium on Tilapia in Aquaculture to be held in Shanghai, China
PROJECT TITLE		2. 09SFT03UA Expansion of Tilapia and Indigenous Fish Aquaculture in Guyana: Opportunities for Women
DEVELOPING SUSTAINABLE AQUACULTURE FOR COASTAL AND TILAPIA		3. 09QSD02UA Sustainable Integrated Tilapia Aquaculture: Aquaponics and Evaluation of Fingerling Quality in Tabasco, Mexico
SYSTEMS IN THE AMERICAS		4. 09IND05UA Consolidation of Native Species Aquaculture in Southeastern Mexico: Continuation of a Selective Breeding
AQUAFISH PROJECT THEME		5. 09MNE07UA Reaching the Farms Through AquaFish CRSP Technology Transfer: Elimination of MT from Intensive Masculinization Systems Using Bacterial Degradation
ENVIRONMENTAL MANAGEMENT FOR SUSTAINABLE AQUATIC		
RESOURCES USE		
James S. Diana	**University of Michigan**	1. 09BMA03UM Incorporation of tilapia (Oreochromis niloticus) and Sahar (Tor putitora) into the existing carp polyculture system for household nutrition and local sales in Nepal
PROJECT TITLE		2. 09BMA04UM Study on the effectiveness of a pond-based recirculating system for shrimp culture
IMPROVING SUSTAINABILITY AND REDUCING ENVIRONMENTAL IMPACTS OF		3. 09QSD03UM Development of polyculture technology for giant freshwater prawns (Macrobrachium rosenbergii) and mola (Amblypharyngodon mola)
AQUACULTURE SYSTEMS IN CHINA, AND SOUTH AND SOUTHEAST ASIA		4. 09MNE01UM Invasion of the red swamp crayfish (Procambarus clarkii) in China: genetic analysis of the invasion and the impacts evaluation
AQUAFISH PROJECT THEME		5. 09BMA05UM Development of indoor recirculating culture systems for intensive shrimp production in China
ENVIRONMENTAL MANAGEMENT FOR SUSTAINABLE AQUATIC RESOURCES USE		6. 09MNE03UM Integrating environmental impacts, productivity, and profitability of shrimp aquaculture at the farm-scale as means to support good aquaculture practices and eco-certification
		7. 09BMA06UM Identifying best practices to improve the giant river prawn industry in Thailand
		8. 09MNE05UM The impact of fish stocking on wild fish populations, fish production and the ecosystem of irrigation reservoirs in South Vietnam
		9. 09MNE06UM Evaluating the relationship between semi-intensive aquaculture and natural biodiversity
		10. 09WIZ03UM Improved Cages for Fish Culture Commercialization in Deep Water Lakes
		11. 09SFT07UM Sustainable feed and improved stocking densities for gar (Atractosteus spp.)
Maria Haws	**University of Hawai'i at Hilo**	1. 09IND01UH Developing hatchery methods for the mangrove oyster, Crassostrea corteziensis for the Pacific Coast of Mexico
PROJECT TITLE		2. 09IND03UH Induced spawning and larval rearing of the "chame" Dormitator latifrons in laboratory conditions
HUMAN HEALTH AND AQUACULTURE: HEALTH BENEFITS THROUGH		3. 09IND04UH Stock assessment of "Chame" Dormitator latifrons in Nayarit and South of Sinaloa México
IMPROVING AQUACULTURE SANITATION AND BEST MANAGEMENT PRACTICES		4. 09HHI01UH Co-management and bivalve sanitation for black cockles (Anadara spp.) in Nicaragua
AQUAFISH PROJECT THEME		5. 09HHI02UH Capacity building in aquaculture, fisheries management and coastal management for coastal women. Workshop: "Opportunities for Coastal Women in Fisheries, Aquaculture and Coastal Management
IMPROVED HEALTH AND NUTRITION, FOOD QUALITY, AND FOOD SAFETY		6. 09IND08UH Effects of environmental conditions on gills and gas bladder development in bimodal-breathers, gar (Lepisosteus sp.), pirarucu (Arapaima gigas) and bowfin (Amia calva)
Robert S. Pomeroy	**University of Connecticut-Avery Point**	1. 09SFT01UC Alternative feeds for freshwater aquaculture species in Vietnam.
PROJECT TITLE		2. 09IND02UC Sustainable snakehead aquaculture development in the Lower Mekong River Basin of Cambodia and Vietnam
DEVELOPMENT OF ALTERNATIVES TO THE USE OF FRESHWATER LOW VALUE		3. 09TAP03UC Development of alternatives to the use of freshwater low value fish for aquaculture in the Lower Mekong Basin of Cambodia and Vietnam: implications for livelihoods, production and market.
FISH FOR AQUACULTURE IN THE LOWER MEKONG BASIN OF CAMBODIA AND		4. 09FSV01UC Maximizing the utilization of low value or small-size fish for human consumption by improving food safety and value added product development (fermented fish paste) through the promotion of women's fish processing groups/associations in Cambodia.
VIETNAM: IMPLICATIONS FOR LIVELIHOODS, PRODUCTION AND MARKETS		5. 09MER04UC Value chain analysis of snakehead fish in the Lower Mekong Basin of Cambodia and Vietnam
AQUAFISH PROJECT THEME		6. 09MNE04UC Developing Management Recommendations for Freshwater Small-Sized/Low Value Fish in the Lower Mekong Region of Cambodia and Vietnam
ENHANCED TRADE OPPORTUNITIES FOR GLOBAL FISHERY MARKETS		7. 09FSV03UC Assessing the Impacts of Sustainable Freshwater Aquaculture and Small-Sized/Low-Value Fisheries Management in the Lower Mekong Basin Region of Cambodia and Vietnam
Kwamena Quagrainie	**Purdue University**	1. 09MER02PU Value Chain Development for Tilapia and Catfish Products: Opportunities for Women Participation
PROJECT TITLE		2. 09SFT02PU Assessment of Integrated Pond-Cage System for the Production of Nile Tilapia for Improved Livelihood of Small-Scale Fish Farmers in Kenya
IMPROVING COMPETITIVENESS OF AFRICAN AQUACULTURE THROUGH		3. 09SFT05PU Develop Feeding Strategies for Moringa oleifera and Leucaena leucocephala as Protein Sources in Tilapia Diets
CAPACITY BUILDING, IMPROVED TECHNOLOGY, AND MANAGEMENT OF SUPPLY		4. 09QSD04PU Evaluation of Performance of Different Tilapia Species
CHAIN AND NATURAL RESOURCES		5. 09TAP04PU Harnessing the Opportunities and Overcoming Constraints to Widespread Adoption of Cage Aquaculture in Ghana
AQUAFISH PROJECT THEME		6. 09IND06PU Development and Diversification of Species for Aquaculture in Ghana
INCOME GENERATION FOR SMALL-SCALE FISH FARMERS AND FISHERS		7. 09QSD05PU Training Program in Propagation and Hatchery Management of tilapia (Oreochromis niloticus) and catfish (Clarias gariepinus) in Ghana
		8. 09TAP07PU Effects of ACRSP and AquaFish CRSP Initiatives and Activities on Aquaculture Development in Kenya
Joe Molnar	**Auburn University**	
PROJECT TITLE		1. 09WIZ01AU - Effects of Watershed-Water Quality-Aquaculture Interactions on Quanitity and Quality of Water from Small Catchments in South Africa and Uganda
HYDROLOGY, WATER HARVESTING, AND WATERSHED MANAGEMENT FOR FOOD SECURITY, INCOME,		2. 09WIZ02AU - Surface Catchment Development and Sustainability Evaluation for Multipurpose Water Supply for Meeting Aquaculture and Other Water Need
AND HEALTH: SMALL IMPOUNDMENTS FOR AQUACULTURE AND OTHER COMMUNITY USES		3. 09BMA01AU - Evaluation and Improvement of Production Technology in Uganda: Case Studies of Small-Holder Cage Culture in Watershed Reservoirs and as an Alternative Livelihood for Fishers
		4. 09MER01AU - Market Assessment and Profitability Analysis of Aquaculture Enterprises in Uganda
		5. 09BMA02AU - Training and Outreach in Uganda and Surrounding Nations
		6. 09TAP08AU - Training Trainers for Long Term and Sustained Impact of Pond Aquaculture in Africa
		7. 09IND07AU- Prospects and Potential of the African Lungfish (Protopterus Spp): An Alternative Source of Fishing and Fish Farming Livelihoods in Uganda and Kenya
		8. Training Trainers for Long Term and Sustained Impact of Pond Aquaculture in Africa: Additional Participants from Kenya
Steve Buccola	**Oregon State University**	1. 09BMA07OR Assessment of AquaFish CRSP Discoveries
		2. 09TAP06OR Assessment of AquaFish CRSP Technology Adoption and Impact
		3. 09TAP07OR Project Planning Meeting on AquaFish Technology Discovery and Impact Assessment
CRSP Council		CRSP Council Knowledge Management and Communication Project
	Oregon State University	Telling a Compelling Story about ACRSP and Aquafish CRSP Impacts

Appendix 9: AquaFish CRSP Response to the External Evaluation Report Dated 06/28/12

AquaFish CRSP heartily thanks USAID/BFS, particularly Harry Rea, Rob Bertram, and Saharah Moon Chapotin, for organizing and initiating this review. Coming as it did after the program more or less ended on a no-cost extension in its 6th year, the review did not elicit a feeling of too little too late, but rather a collective sigh of relief. After all, AquaFish CRSP's many participants had been waiting for this scheduled review since 2009 when it was expected per USAID's award document.

AquaFish CRSP was reviewed from April to June 2012, under a shadow cast by some projects having ended, some researchers having gone on to other research, and some management staff having been laid off. That the effects of this CRSP's work and its key relationships sustained such a hiatus in funding* is a testament to the strength of the CRSP model and the positive work AquaFish participants do in making a difference. USAID/BFS recognized this situation, yet the review report barely mentions it. On top of the list of AquaFish's comments is that the review report needs to be digested with a good dose of situational reality. CRSP management, administrators, external advisors, researchers, faculty, businesspeople, farmers, extension agents, and students soldiered on amicably and cooperatively under considerable external stress. More importantly is that they donated their time and resources to this review. As well, their gracious universities, institutions, and organizations deserve our thankfulness in going well beyond the call of duty to boost USAID's investments.

AquaFish CRSP recognizes the review team who, in about two months, amassed a great deal of information about our complex program and tried to translate it into useful suggestions. This was an ambitious undertaking, and the reviewers are to be acknowledged for upholding the schedule and carving out time for three site visits: to Oregon, Kenya, and the Philippines.

AquaFish CRSP agrees with the majority of the reviewers' findings. It was gratifying to read this positive report with so many glowing commendations. AquaFish is proud of its many achievements since 2006, when this new program in aquaculture and fisheries was competitively awarded. AquaFish CRSP has made great strides --starting from scratch 5 ½ short years ago-- growing to encompass an engaged community of over 300 people who are willing to volunteer their time and resources to help this program get an extension for another 5 years. The report may have overreached in its attempt to tie this new CRSP to the old PD/A CRSP. In 2006, none of the former CRSPs PIs, researchers, or management (save the Director) were involved in AquaFish. Eventually, after a widely advertised, externally competed and reviewed proposal process, about 20% of former PD/A CRSP US PIs became AquaFish Lead Project PIs. In the US especially, this new CRSP has opened its doors to seek out new talent and institutions.

**USAID eventually obligated funding to the ME at OSU on 3 May 2012, well after effects of the NCE were felt.*

CRSP management and researchers themselves offered up frank self-reflection that formed the basis for many of the report's recommendations, and some of the criticisms. AquaFish appreciates the findings that do not place blame but advance an agenda of collaboratively developed partnerships in fisheries and aquaculture worldwide. In the following text, CRSP researchers and management respectfully disagree with some of the data and findings in the report, focusing on those that were errors of omission, contained inaccuracies, or were misrepresentations. This report is no different from most reviews in containing its share of subjective bias. Recognizing bias and the bases for alternative interpretations makes for a more balanced assessment.

Network Development and Visibility (pp. xi, 33, 34)
AquaFish appreciates that the review team recognized that the program achieves its stated CRSP goal of building a network of U.S. and developing country scientists to support innovations in aquaculture development. AquaFish CRSP has a wealth of linkages with international institutions including FAO, ANAF, WorldFish, and NACA in addition to affiliations with over 170 institutions and companies worldwide. That CRSP comes up among the top hits on a web search for 'aquaculture' is one demonstration that this program enjoys considerable visibility. Why then isn't the AquaFish CRSP a household word in the US? The reviewers used to the US aquaculture scene may be unaware that AquaFish CRSP is not part of a group typically marketed domestically such as the USDA RACs and NOAA Sea Grant Programs. Although AquaFish overlaps with both of these groups, for example, in its membership and leadership, it is primarily marketed internationally as is the case with all of the other CRSPs, and for that matter USAID.'

AquaFish exposure is further enhanced through co-sponsoring international conferences and student awards, and by organizing and chairing technical sessions at various events. CRSP is prominently credited for its co-sponsorships. Under-recognized in the report is that CRSP researchers regularly communicate and disseminate findings in the literature and at conferences. Whether this credit extends beyond the individuals to the program is a different matter and difficult to police, even though the MT does mandate through contract USAIDs - CRSPs branding and marking policy, and works with CRSP participants to understand the importance of getting the CRSP name out. Again, this chronic problem of visibility is one that USAID and all CRSPs are working on together to resolve. Largely motivated by AquaFish CRSP, in the past year the CRSP Council began an initiative to enhance the visibility of all CRSPs, while creating a common clearinghouse for information.

Impact Assessment Research (p.12)
In 2010 the Management Team commissioned an Impact Assessment (IA) project to supplement impact assessment work already being conducted by three of the seven core research projects. The MT agrees with the report that very little was learned from the peer reviewed, non-competed IA project; however, additional context is required to understand its shortcomings.

The IA project proposal received high marks from an external technical review panel consisting of four leading agriculture/aquaculture economists prior to USAID and MT approval. The work was deemed feasible and lack of baseline was not considered a fatal flaw. Further, the proponents, also well-known agriculture economists, were aware that limited impact assessment baselines were integrated into each investigation but nevertheless were

eager to conduct this work. Other salient facts are that USAID approved the proposal after reviewing it along with external reviewer comments, and the EPAC and Lead Project PIs were also given an opportunity to provide feedback and input into the project.
The report suggests that the MT did not reach out to the aquaculture economics community for conducting analyses; however, it is important to note that AquaFish CRSP did seek out such expertise. In September of 2009 USAID commissioned work focusing on, among other things, impact assessment work. The time horizon for implementing this work was narrow given that AquaFish was slated to end within two years. The MT initially sought out economists from both current AquaFish institutions as well as economists from other institutions to compete for the work. The MT did its due diligence in reaching out to the aquaculture economics community, getting reviews done, and obtaining USAID approval in a transparent manner and suggests that any failures occurred for other reasons.

Leveraged Funding (p.22)

As noted by the Review Team, AquaFish CRSP has been successful at leveraging additional funding. Overall, AquaFish CRSP has leveraged nearly $6 for every USAID dollar spent. Unfortunately the report is internally inconsistent regarding treatment of some of the funds leveraged by AquaFish CRSP. It is unclear why the reviewers chose to exclude funds leveraged by the Government of Kenya (GoK) for its Economic Stimulus Program (ESP) in several analyses, when the reviewers themselves recognized that CRSP "developed the knowledge infrastructure that allowed this transformation to take place especially in the GoK campaign to 'Grow Fish, Sell Fish, Eat Fish'" (p 9). The report continues, stating, "This example should be emphasized across the CRSPs and USAID as a model relationship for emulation." The Kenyan Secretary of Fisheries concurs, and has verified that CRSP was highly responsible for this leveraging.

It is also worth noting that AquaFish US Project PIs and Co-PIs are highly regarded researchers and educators in their fields and secure, on average, $590,000 per year from non-CRSP sources. Additional funding sources included USDA, NIH, NOAA, USAID, NSF, as well as private and international sources such as the World Bank, DANIDA, the MacArthur Foundation, and the David and Lucile Packard Foundation. These impressive data came to light in the past week thanks to a survey conducted by the Horticulture CRSP on behalf of the CRSP Council (see http://aquafishcrsp.oregonstate.edu/researcher_survey).

In summary, AquaFish CRSP is poised to move ahead into another successful five years. Let us hope that this review was not in vain, and that the BIFAD review of all CRSPs generates the same positive buzz, allowing not only this CRSP but others to pass into their next 5-year phase. Recommendations from this report can be woven into an extended program in aquaculture and fisheries. The many loyal AquaFish participants whose work is lauded in this report are standing by eagerly awaiting the opportunity to continue their and USAIDs important work.

Additional specific comments on the External Evaluation Report

List of Acronyms
• The list of acronyms contains errors.

Page viii
• An impact assessment study was completed to demonstrate that almost 50% of 58 farmers surveyed in the Philippines are adopting some form of reduced feeding strategy. The surveys also show that costs are reduced for farmers that adopt the new strategies (ref: Final Technical Report for investigation 09SFT06NC).

Page ix
• No examples or evidence from CRSP support the notion that CRSP is prematurely extending results. This sentence seems to reflect a general precautionary measure not specific to CRSP.

Page x
• Misleading statement. From inception, AquaFish has maintained a gender-disaggregated database for all trainees and participants. The MT maintains, and has posted online, gender integration strategies developed by this CRSP and all subcontracting partners, which include women's participation. This CRSP has been recognized for its forward-thinking approach to gender integration, gender data collection, gender budgeting, and overall capacity building. The surveys of host country researchers presented in this report show attention to gender. A number of the report's conclusions on gender seem unsupported by the data presented in the report, or by the record.
• Workshops have regularly been done with co-sponsorship. For example, the NCSU project had Aquaculture without Frontiers as sponsors; most of the larger workshops and meetings have enjoyed significant co-sponsorship from a number of organizations, local governments and institutions (e.g., WAFICOS, Gov Ghana, Kenya Min of Fisheries, IIFET, etc).
• Misleading statements about the composition of CRSP PIs. Many PIs have advanced training in the area of "socio-economic analysis". Two thirds of US PIs are trained (have PhDs) as social scientists (½ econ, ½ other social sciences) and the remaining 1/3 are life sciences.

Page xi
• The suggestion provided on page xi does not reflect later findings of this same report, especially regarding comments that relate to use of "modern and fast-evolving information and communication technologies."

Page 8
• Note that "Overall, USAID encourages the AquaFish CRSP to have a biotechnology component in some of its activities" (from [CRSP-condensed] USAID Goals and Guidelines), but that biotechnology in itself is not one of AquaFish's 4 research themes or 10 topic areas. It is addressed across several themes and TAs.

Page 11
• Misleading statement in report: Note that women comprise 48% of all graduate students, and 49% of undergraduate students.
• Needs clarification and specificity. As stated, it is unclear how the traditions of this new CRSP present barriers to the participation of women. No evidence is presented to support this statement.

• The second sentence is untrue as explained previously. The current composition of PIs have training in the social sciences and extension. One third of US PIs are trained as social scientists (other than economics). 2/3rds are social scientists, including economists.

Page 13

• Responsibility for the absence of an impact assessment baseline component built into the program from inception (2006) also lies with the granting agency for not providing that level of guidance when the Leader Award proposal was reviewed and approved.

Page 20

• Unclear whether the reviewers took into account the nature of each event in determining its effectiveness for a large number of people.

Page 21

• The implication that this CRSP operates within an exclusive network is incorrect and unsupported by the data. Six of the eight Lead US PIs had not been involved with the CRSP in a leadership capacity prior to the inception of AquaFish CRSP in 2006. Likewise, 6 of the 8 lead US institutions are new to their current role. An RFP was broadly distributed for this CRSP, with ample lead-time to encourage proposal submissions from any eligible institution. RFPs are competitively bid and externally reviewed, eliminating institutional bias. AquaFish strives to include new partners and to expand the reach of the program through new participants. The top institutions in the fields of fisheries and aquaculture tend to be involved in the program over long periods of time, however the personnel and roles change as research objectives are updated and priorities evolve.

Page 23

• Publish or Perish is based on Google Scholar and provides the most accurate citation counts for the following disciplines in:

- o Business, Administration, Finance & Economics;
- o Engineering, Computer Science & Mathematics;
- o Social Sciences, Arts & Humanities.

The developers of PoP do not encourage heavy reliance on Google Scholar for individual academics working in areas other than those listed above without verifying results with either Scopus or WoS. (see Harzing.com).

• Most if not all CRSP peer-reviewed papers are available as links on the CRSP website.

Page 26

• This network of 300+ includes students, farmers, scientists, development specialists, etc. who have been involved with the program in a number of capacities. At the time of the review, the subset of participants that were contacted were those who would be both willing and able to provide the necessary level of feedback given that some projects ended/winded down over this unfunded 6th year.

Page 29

• Need some recognition that these collaborations have been strongly encouraged in the past.

Page 31

• Context was added here to improve accuracy. EPAC was highly involved in the second phase

-- IP09-11. In fact, it was only in 2011 – in the final year and into the 6th unfunded year -- that EPAC and other groups winded down following USAIDs indecision on future extensions. EPAC still nominally exists and can be re-invigorated going forward. (The EPAC chair is involved in this review for example.)
• Poor data collection; no record supports the reviewers claim about DTAP. DTAP functioned well, and continues to function well providing input on proposals, new directions, etc. The challenge was that the DTAP members' workload became heavier and overall focus shifted more to USAIDs indicators. That DTAP could shift could be viewed positively (rather than how it was in this report) in its ability to adapt to a changed environment at USAID.
• The mislaid comment about PIs lack of knowledge about the EIP is to be expected since the EIP at OSU was designed to interact directly with the Director at OSU, and not with PIs.
• Inaccurate statement about EIP. Members of the EIP were involved throughout the 5+ years in proposal reviews, serving on CRSP-funded graduate student committees, advising the Director on emerging topics, on engaging with external organizations, and in networking for CRSP.

Page 32
• Decisions made regarding the cost share requirement are highly nuanced and balance many factors. In response to changes in the economic climate at Land Grant and other universities since 2006, the ME is looking to lower the cost share requirement. The ME brought this matter to the attention of the Review Team and sought their understanding of why the ME will be changing the rate in future. That the Team felt it important to place blame is unfortunate.

Page 33
• The comment about lack of visibility may reflect reviewer perception of the US "marketplace". AquaFish CRSP has broad international exposure and dissemination of achievements through a variety of electronic outlets, including listservs hosted by SARNISSA and IIFET, ACDI/VOCA, and others; podcasts; and social media linkages through Facebook. Both international and domestic electronic distribution of material occurs independently though partner institution outlets or other nodes (such as links through ISTA's website, SARNISSA's website, and podcast links through NCSU). The AquaFish website serves as an effective outreach and exposure tool. Over 100 non-CRSP websites link to it. Also of note is the presence of several AquaFish videos publically available on YouTube and Vimeo. No objection to the recommendation to continue broadening the CRSPs reach both internationally and domestically, but the review does not adequately show the current reach, which is considerable.

Page 34
• AquaFish CRSP does indeed have US industry partners, including: Fish Farmacy LLC, Goosepoint Oysters Inc., Shrimp Improvement Systems LLC. (AquaFish also has many HC industry partners.)

Page 58
• This is not correct. The Philippines HCPI does not think that SANTEH has commercialized the feed formulation developed by NCSU.
• This is a well-known factor in deciding to use any byproduct. This comment may refer to one PI, or be the reviewer's conjecture, and should be deleted as it is not representative of the CRSP. The CRSP is aware of trade-offs involved in using chicken litter, compost, scraps, etc, as there are competing uses that vary in space and time, and through cultural and other

preferences. Input availability, cost and other factors are assessed at a local level, and protocols are developed collaboratively with those constraints in mind. This misleading sentence implies the CRSP is not aware of this concept. Not only is CRSP aware, but CRSP has undertaken years of research on local v imported inputs, byproducts and feedstuffs, on cultural practices and norms, and on trade-offs thereof.

Page 60

• Regarding the promise for the entry of women in the post harvest sector, this is already happening probably at a smaller scale. There are towns in the province of Nueva where a livelihood project was developed for women in the area to do post-harvest of tilapia. The same is true in the processing of milkfish -- women traditionally are involved in this activity.
• The CRSP podcasts are free for download anywhere in the world. The NCSU project cannot be responsible for data charges on phone plans.

Page 65

• The statement about no longer needing additional investments in pond digging is a misconception by some people who are not actively involved in CRSP themselves. AquaFish did not invest at all in pond digging. Construction of many small ponds at Sagana and a few at Moi happened through funding for short courses on pond construction and management. Construction/digging was by trainees, as part of the training.

APPENDIX 7:
REPORTING REQUIREMENTS

ATTACHMENT III (REVISED DECEMBER 31, 2009)

a. REPORTING REQUIREMENTS FOR THE AQUACULTURE & FISHERIES CRSP

"AQUAFISH CRSP" IS THE ACCEPTED PROGRAM NAME FOR "AQUACULTURE & FISHERIES CRSP"

Upon notification and acceptance of an initial project award, via Subcontract, each PI will receive a copy of the AquaFish CRSP Cooperative Agreement. The procedures and policies for reporting are primarily those that follow from the requirements set forth by USAID in the CRSP Cooperative Agreement. Applicants may consult that document under the RFP linkages on this website.

1. Financial Reporting for projects is in accordance with the terms of the sub-award from OSU. In general, the following information will be required: quarterly invoices will contain data on cost-share "earned" so that expenditures and cost-share can be monitored. Data will also be required quarterly on country-level expenditures and training (short-term and long-term) expenditures. Other allocations and expenditures will also be monitored, and Principal Investigators will cooperate with the Management Entity in supplying requested data.

Schedule for quarterly reports: October 1, January 1, April 1, and July 1 for each quarter that the Subcontract is active. For prompt payment by UNIVERSITY, CONTRACTOR must provide the following information quarterly: invoice, cost-share statement, expenditures by country, expenditures related to training, and quarterly performance reports.

2. Allocation of Funds. Incremental funds will be awarded provided that:

a. Memoranda of Understanding (MOUs) are in place with all Host Country entities (see RFP website for example MOUs: http://aquafishcrsp.oregonstate.edu/rfp.php).

Upon initial award selection, the Lead Partner Institution will be required to enter into Memoranda of Understanding (MOUs) with institutions at Host Country sites. For continuing projects: Additional MOUs must be put in place with new HC institutions. Subcontracting US institutions may also enter into MOUs with HC partners to strengthen institutional relationships and streamline administrative processes. MOUs between Host Country institutions are not discouraged but will not take the place of MOUs between US and Host Country institutions. MOUs must provide the opportunity for other CRSP projects to function under the authority of the agreement and must provide for joint authorship of reports and site visits at the discretion of the CRSP Management Entity. Draft MOUs must be submitted to the ME for review *prior to execution*. The ME will not approve or deny another institutions' MOU.

Send signed MOUs to the ME within 14 days of execution.

b. Comprehensive Host Country Research Site Descriptions are on file.

Each Lead Project PI is required to prepare and submit full characterizations of Host Country research locations during project start-up. Send full site characterizations to: aquafish@oregonstate.edu. At the end of Attachment III are instructions for preparing the site descriptions. For continuing projects: Submit full site characterizations for new HC research sites.

c. Conditional funding for Implementation Plan 2009-2011.

Conditional funding applies to subcontracts receiving partial (year one) funding for Implementation Plan 2009-2011. All deliverables from Implementation Plan 2007-2009 must be submitted and approved by the ME prior to the release of further funding under this amendment.

3. <u>Performance Reporting</u> is in accordance with (a) the terms of each project's work plan as it appears in the Subcontract, and (b) the requirements specified by USAID for impact reporting (for example, training data must be disaggregated by gender). The following reports will be required at the very *minimum*:

- Quarterly performance reports (January 1, April 1, and July 1);
- Annual performance reports (due October 1, 2010 and September 29, 2011);
- Final technical reports for each investigation within 30 days following the stated date of completion or on September 29, 2011, whichever date is earlier;
- Trip reports following each trip taken, to be submitted along with the quarterly performance report on January 1, April 1, and July 1;
- At least one outreach document (or the amount of deliverables specified in Attachment I, whichever is greater), refer also to the Outreach and Dissemination Plan in Attachment I;
- At least one lessons learned document;
- At least one success story or policy brief;
- At least one program newsletter article;
- Stated project deliverables due on the approved timeframe;
- A brief statement describing the quantifiable economic impacts of the research (including identification of the primary beneficiaries of the information, technologies, or management practices developed by the project);
- Progress and synthesis reports toward program component *benchmarks* and *indicators* (including DTAP indicators), USAID results framework *indicators*, IEHA, and other *indicators* (as applicable).

Indicators will be used to complete reports for USAID, and evaluate project performance, progress in meeting stated objectives, and guide resource allocation decisions. The CONTRACTOR will be responsible for collecting and reporting data as specified in the indicators. If the CONTRACTOR wishes to amend the indicators a letter should be written to the CRSP Director stating the reasons for the change; any substituted measurements may require approval of other CRSP advisory bodies. Final approval for changes in stated indicators rests with UNIVERSITY.

In addition, projects are expected to publish in a number of established outlets including but not limited to the peer-reviewed literature, conference proceedings, trade journals, etc. The ME's Policy and Operating Procedures (POP) Manual provides guidance on acknowledgements and disclaimers; CRSP accession numbers for tracking outputs; internal review if needed; policies for USAID compliance with branding and marking; and other details.

All CRSP publications must follow USAID Standard Provisions, USAID Branding and Marking Rules for the CRSP, USAID Partner Co-Branding Guide, AquaFish CRSP Publications Policy, and other rules and schedules as specified in Subcontracts and USAID Standard Provisions.

AquaFish CRSP Reporting Requirements; Roles and Responsibilities

Additional information may be obtained from the AquaFish CRSP Cooperative Agreement Program Description (2006-2011) and the Aquaculture CRSP Annual Administrative and Technical Reports, which are available through the AquaFish CRSP website http://aquafishcrsp.oregonstate.edu.

b. Roles, Responsibilities, and Rules of Conduct for the AquaFish CRSP

The goal of the AquaFish CRSP is to conduct research that contributes significantly to the removal of major constraints to sustainable aquaculture development and responsible small-scale fisheries management, thereby promoting economic growth, enhancing food security, and conserving natural resources in developing countries. CRSPs are funded by USAID under authority of the International Development and Food Assistance Act of 1975 (PL 94-161), and by participating institutions.

The CRSP will be managed in a manner that achieves maximum program impacts, particularly for small-scale farmers and fishers, in Host Countries and more broadly. CRSP overall program objectives address the need for world-class research, capacity building, and information dissemination. Specifically, the AquaFish CRSP will strive to:

• Develop sustainable end-user level aquaculture and fisheries systems to increase productivity, enhance international trade opportunities, and contribute to responsible aquatic resource management;
• Enhance local capacity in aquaculture and aquatic resource management to ensure long-term program impacts at the community and national level;
• Foster wide dissemination of research results and technologies to local stakeholders at all levels, including end users, researchers, and government officials; and
• Increase Host Country capacity and productivity to contribute to national food security, income generation, and market access.

The AquaFish CRSP is a new CRSP awarded competitively under USAID/EGAT. On 29 September 2006, Oregon State University was awarded the Leader with Associates Cooperative Agreement (No. EPP-A-00-06-00012-00) for the "Aquaculture & Fisheries CRSP", which will run until 2011. In 2010, the program will be evaluated for a possible 5-year extension. Three major implementation plans (2006-2007; 2007-2009; 2009-2011) will describe the specific research to be carried out under the CRSP's framework of general research priorities. The first RFP was released in Nov 2006. The second RFP was released in Nov 2008, and the new project from that RFP began 1 August 2009. The third RFP was released in June 2009 to current 2007-09 projects that have shown adequate performance.

CRSP researchers with incomplete Second Implementation Plan (2007-09) investigations will not be eligible to receive full funding until all previous obligations and deliverables are satisfactorily met. This includes fulfilling reporting specified by this attachment, providing investigation deliverables, meeting cost share commitments, and submitting final investigation reports. [* directed RFP pertains to current project continuations.]

All projects, regardless of start date, have an end date of 29 September 2011, which is the termination date for this CRSP, unless another 5-year award is made by USAID.

Fostering Respectful Partnerships: Proposals that foster linkages with organizations including US minority-serving institutions, non-governmental organizations (NGOs), national agricultural research institutions, other CRSPs, international centers, private businesses, and others are desired. Proposals that link Host Country researchers from one CRSP site to another CRSP site are encouraged. US and Host Country PIs will share in budgetary decisions and overall priority setting for the project, as well as in other collaborative activities related to the CRSP. Proposals, work plans, and project budgets must be developed collaboratively between HC and US

researchers. US PIs must actively establish an effective working relationship with the ME and other CRSP US and Host Country PIs and program participants. At least 50% of funds must be expended in or on behalf of the Host Country or region.

Expected Advisory Group Participation: US and HC PIs will be responsible for interactions with CRSP internal technical advisory groups. Each project lead US and HC PI has been assigned to one *Regional Center of Excellence* and one *Development Theme Advisory Panel*. These advisory groups will perform critical analysis and synthesis work for meeting USAIDs goals, producing lessons learned materials, attracting and managing associate awards, identifying gaps in the research portfolio, among other responsibilities (see Cooperative Agreement).

Additional Guidelines for Involvement:
Collaborative efforts that involve undergraduate students, graduate students, and post-doctoral fellows are encouraged. CRSP funds will not be used to support US expatriate personnel or consultants, as the CRSP model is intended to build institutional networks and capacities.

Projects must demonstrate return benefits to the US in furtherance of the program's responsibility to provide mutual benefits and discoveries that can apply to the HC region and US and that will support future development of sustainable aquaculture.

Each Subcontracting US institution must ensure 35% US non-federal cost sharing as required in the USAID Cooperative Agreement. Projects should overall target a 50% matching contribution, with at least 35% of the match provided as non-federal cost share from the participating US entities and 15% or more from HC institutions.

Salary support for US PIs is limited. US PIs charging any portion of salary to the CRSP award must also be serving in the capacity of major advisor to a graduate student working under an approved CRSP investigation. In that case alone, a PI may charge up to two months of annual salary to the award, to be approved in advance by the UNIVERSITY's Principal Investigator, Dr. Hillary Egna (also called CRSP Director).

Successful projects will embrace the following USAID *environmental restrictions*:
• Biotechnical investigations will be conducted primarily on research stations in Host Countries;
• Research protocols, policies and practices will be established prior to implementation to ensure that potential environmental impacts are strictly controlled;
• All training programs and outreach materials intended to promote the adoption of CRSP-generated research findings will incorporate the appropriate environmental recommendations;
• All sub-awards must comply with environmental standards;
• CRSP Projects will not procure, use or recommend the use pesticides of any kind. This includes but is not limited to algicides, herbicides, fungicides, piscicides, parasiticides, and protozoacides.
• CRSP Projects will not use or procure genetically modified organisms (GMO); and
• CRSP Projects will not use or recommend for use any species that are non-endemic to a country or not already well established in its local waters, or that is non-endemic and well established but is the subject of an invasive species control effort.

Funding is typically allocated on an annual basis. All allocations are contingent on the annual funding level obtained from USAID and on performance under Subcontract provisions.

c. HOST COUNTRY RESEARCH SITE CHARACTERIZATIONS

Site Selection Criteria

1. The crop, livestock, fishery, or other resources to be investigated are major sources of food and income, or the other factor(s) to be researched relate importantly to agricultural or fishery production in the primary country;

2. The primary country site is representative of the ecological zone, or geographic region of the commodity, fisheries, or other resources; the primary country site could serve as the activating nucleus of a scientific network for technology transfer and exchange, depending on the commodity or condition to be investigated; the zone or region may include a number of countries less advantageously equipped to support viable research programs;

3. The country government is interested in participating in the CRSP and is willing to make adequate commitments to support the research and assist the neighboring network countries;

4. There exists in the country the basic institutional research capacity needed to make collaborative research viable; this capacity would be found in the ministry, or other government agency responsible for research, and in the national research stations and research system for agriculture, fisheries, or other resources which the agency or ministry supervises; the institutional research capacity might also exist at an agricultural university where it has responsibility for research in areas related to the CRSP activities;

5. Government policies are supportive of research, extension, and production; and

6. There is reasonable assurance of political and economic stability and ability to sustain a viable research program.

Specific Criteria

1. Existing physical infrastructure – including ponds (or land with suitable soils for ponds), laboratory facilities, communications, housing, transportation, roads, and access.
2. Institutional collaboration – the existence of a Host Country university or agency willing to serve as Host Country collaborator and to provide the necessary personnel (Host Country PI). In addition, the specific site operators must be willing to collaborate and have a mechanism for collaboration.
3. USAID Mission support – the USAID Mission or local office goals and objectives must be compatible with Aquaculture & Fisheries CRSP operations and objectives.
4. Country political stability.
5. Safety, health considerations – adequate working conditions for the HC and US participants are a consideration.
6. Species available for research – Each potential research species should be permitted for use.
7. Economic considerations – operational costs, travel, and other costs should be considered.
8. Rural aquaculture development – evaluate presence of rural fish farms and Host Country extension apparatus and operations.
9. Language – official and rural languages.
10. National strategies for aquaculture development – Host Country policies and strategies may affect research conduct and extension of results.
11. USAID eligibility status – Host Country should have USAID program eligibility without a planned termination in the near future.
12. Possibilities for leveraging funds and attracting buy-ins.
13. Environmental/ecological significance – site represents an important environment and is useful within the CRSP global perspective.
14. Shipping/customs/clearance obstacles – evaluate potential constraints for shipping project supplies, or soil samples.
15. Potential for establishing a stable, long-term presence – prefer situations where the CRSP can enter as a significant part of a site operation rather than a peripheral position with low priority to site operators.
16. Potential for improving food security and the environment in targeted areas.

REQUIRED: Full Characterization of Each AquaFish Research Site

Assuming the aforementioned criteria (under "A" and "B" above) have been minimally met for approval of a proposal, PI's were then asked to further characterize each of their AquaFish research sites. The general outline for site characterization for all sites within a country is as follows. For multiple countries, submit individual characterizations for each country. For multiple sites within a country, submit one characterization "Introduction" and any number of "Content" sections to describe specific detail for each site within that country.

Introduction (1 to 2 pages):

1. One paragraph summary of Site Selection criteria, describing salient points under Section A above.
2. Two to three paragraph summary of Specific Criteria, focusing on points #4, 5, 6, 8, 9, 10, and 13.

Content (4 to 20 pages):

Please refer to the website for the report on Site Descriptions and use the report as a model for your characterizations. http://pdacrsp.oregonstate.edu/pubs/featured_titles/

3. Country Map locating the Site(s)
4. Site Status
5. General Location: Geographical information: location, other general informative information.
6. Description of Area/Region:

Climate; Temperatures; Precipitation; Humidity; Seasonality; Topography; Geology and Soils

7. Soil and Water data. Secondary data are acceptable for meeting the "second allocation funding condition", but these data must be updated with project-specific data by May 31, 2008.
8. Layout map of the site(s)
9. Site Description: Map Coordinates; Elevation; General background on each site describing facilities, and history of past uses (if known); water supply; Soils; Support facilities
10. Affiliations: addresses
11. Current Contacts at the site(s): addresses

HSE 5/09

APPENDIX 8: AQUACULTURE & FISHERIES COLLABORATIVE RESEARCH SUPPORT PROGRAM REQUEST FOR PROPOSALS - 2006

Aquaculture & Fisheries Collaborative Research Support Program

Request for Proposals:
Global Research, Capacity Building, and Institutional Development in Aquaculture and Aquatic Resources Management

Important Dates Date of Release: 23 November 2006
Proposals are Due (10 weeks): 31 January 2007
Announcement of Selections: 31 March 2007

This Request for Proposals is issued by the Management Entity of the Aquaculture & Fisheries CRSP, Snell Hall 418, Oregon State University, Corvallis, Oregon, 97331 USA. Website: http://pdacrsp.oregonstate.edu/afcrsp Email: acrsp@oregonstate.edu

The Aquaculture & Fisheries CRSP (CRSP) Management Entity (ME) is inviting proposals for solving critical problems facing global aquaculture development and aquatic resources management in lower-income countries. The Aquaculture & Fisheries CRSP is managed by Oregon State University under a five-year award from the US Agency for International Development (USAID). This RFP is designed to attract proposals that will develop linkages between the United States and selected Host Countries for Global Research, Capacity Building, and Institutional Development. Proposals must target regions and themes in furtherance of USAID's goals, as described in this RFP.

A single US institution will be the Lead Partner Institution for each proposal. Eligible lead institutions include US universities, colleges, and minority-serving institutions (see shaded box for details). Lead Partners are expected to assume strong administrative and technical leadership for projects, be involved in advisory groups serving the overall program, and form collaborative partnerships through sub-awards to developing country institutions, NGOs, IARCs, private sector firms, and other US universities or colleges.

The total award period under this RFP will be 2.5 years, from April 1, 2007 to September 30, 2009. Proposals will ideally include the participation of other US institutions to be funded by the Lead Partner Institution by means of secondary subcontracts. Host Country (HC) institution involvement is mandatory and will be funded via the Lead Partner Institution's award.

The average funding level available for 30-month multi-institutional and multi-disciplinary proposals is $400,000. The program's flexibility in the number of proposals that will be funded depends on the overall funding received from USAID. Under current funding projections, up to eight Lead Partner awards are anticipated to be made to eight different institutions. Funding is typically allocated on an annual basis. All allocations are contingent on the annual funding level obtained from USAID and on performance under subcontract provisions.

A successful proposal will focus on one theme (p. 2) in one or more geographic regions (p. 5). Each proposal will likely include multiple investigations that each target one of the identified research topics (p. 3 to 4). Investigations are discussed in this RFP in more detail under Technical Considerations (p. 6). Proposals must address how they will align with overall Program goals.

The goal of the new Aquaculture & Fisheries CRSP as stated by USAID is to "develop more comprehensive, sustainable, ecological and socially compatible, and economically viable aquaculture systems and innovative fisheries management systems in developing countries that contribute to poverty alleviation and food security." (USAID, May 2006)

Eligibility for Lead Partner Institution

Based on Section 269(d) of Title XII of the Foreign Assistance Act of 1961, as amended, an eligible university or college is defined as: "... those colleges or universities in each State, territory, or possession of the United States, or the District of Columbia, now receiving, or which may hereafter receive, benefits under the Act of July 2, 1862 (known as the First Morrill Act) or the Act of August 30, 1890 (known as the Second Morrill Act), which are commonly known as 'land-grant' universities; institutions now designated or which may hereafter be designated as sea-grant colleges under the Act of October 5, 1966 (known as the National Sea Grant College and Program Act), which are commonly known as sea-grant colleges; Native American land-grant colleges as authorized under the Equity in Educational Land-Grant Status Act of 1994 (7 U.S.C. 301 note); and other United States colleges and universities which – (1) have demonstrable capacity in teaching, research, and extension (including outreach) activities in the agricultural sciences; and (2) can contribute effectively to the attainment of the objectives of this title."

Eligibility for Additional Partners under the Lead: Public and private entities such as other universities, colleges, minority-serving institutions, companies, international non-government organizations (NGOs), and others with resources and relevant experience for conducting research, training and outreach activities, and implementing research projects, are eligible to apply. For-profit firms may participate as sub-awardees but, pursuant to 22 CFR 226.81, it is USAID policy not to award profit under assistance instruments such as cooperative agreements. All reasonable, allocable, and allowable expenses, both direct and indirect, which are related to the program and are in accordance with applicable cost standards (22 CFR 226, OMB Circular A-122 for non-profit organization, OMB Circular A-21 for universities, and the Federal Acquisition Regulation (FAR) Part 31 for-profit organizations), may be paid under the CRSP. US Minority-Serving Institutions include those mandated as Historically Black Colleges and Universities (HBCU), Tribal Colleges and Universities, Asian American and Pacific Islander (AAPI) Serving Institutions, and Hispanic Serving Institutions.

This Request for Proposals is issued by the Management Entity of the Aquaculture & Fisheries Collaborative Research Support Program, Oregon State University, Corvallis, Oregon, USA, under Leader with Associates Cooperative Agreement No. EPP-A-00-06-00012-00. The ME will notify Lead Principal Investigators (PIs) of rankings on or around 31 March 2007. Lead PIs will be notified if the selection decision will be delayed. The ME reserves the right to modify this schedule as necessary to ensure that standards of fairness and accuracy are met. Actual awards are contingent on funding received by the ME. Assuming timely funding by USAID, projects are anticipated to begin 1 April 2007. As this RFP solicits 30-month projects, all investigations should be completed and all final reports submitted by 30 September 2009. All eligible institutions are encouraged to apply. Proponents with a demonstrable commitment to promoting and enhancing diversity are encouraged to apply.

Disclaimer: *Issuance of this RFA does not constitute an award commitment on the part of Oregon State University, nor does it commit the University to pay for costs incurred in the preparation or submission of an application. In addition, final award of any resultant sub-awards cannot be made until funds have been fully appropriated, allocated, and committed through internal OSU procedures. While it is anticipated that these procedures will be successfully completed, potential applicants are hereby notified of these requirements and conditions for award. Applications are submitted at the risk of the applicant. Should circumstances prevent award of a project, all preparation and submission costs are at the applicant's expense.*

Global Themes

The four global themes of the CRSP are cross-cutting and address several specific USAID policy documents and guidelines, including the *Policy Framework for Bilateral Foreign Aid*, *Agriculture Strategy*, EGAT Offices of Agriculture and Natural Resource Management Strategic Objectives, and IEHA (Initiative to End Hunger in Africa). To see how these themes relate to USAID's focal areas and for additional information on these USAID documents, please refer to the CRSP RFP website: *USAID Goals and Guidelines*. The overall research context for this RFP is poverty alleviation and food security improvement through sustainable aquaculture development and aquatic resources management. **Proponents will identify one primary theme (goal) for their overall proposal.** Proposals must address all four themes in an integrated systems approach, but will primarily focus on one theme as it relates to producing positive development outcomes:

Global Aquaculture & Fisheries CRSP Themes (Goals)

A. Improved Health and Nutrition, Food Quality, and Food Safety
B. Income Generation for Small-Scale Fish Farmers
C. Environmental Management for Sustainable Aquatic Resources Use
D. Enhanced Trade Opportunities for Global Fishery Markets

The CRSP will be managed in a manner that achieves maximum program impacts, particularly for small-scale farmers and fishers, in Host Countries and more broadly. CRSP overall program objectives address the need for world-class research, capacity building, and information dissemination. Specifically, the Aquaculture & Fisheries CRSP will strive to:

- Develop sustainable end-user level aquaculture and fisheries systems to increase productivity, enhance international trade opportunities, and contribute to responsible aquatic resource management;
- Enhance local capacity in aquaculture and aquatic resource management to ensure long-term program impacts at the community and national level;
- Foster wide dissemination of research results and technologies to local stakeholders at all levels, including end users, researchers, and government officials; and
- Increase Host Country capacity and productivity to contribute to national food security, income generation, and market access.

Aquaculture & Fisheries CRSP Topic Areas for Research, Outreach and Capacity Building

Thematic proposals will contain implementation plans (investigations) organized around a number of specific areas of inquiry (called Topic Areas). **Proponents will identify one topic area for each investigation in the proposal.** Proposals may contain between one and ten investigations (see p. 9). Thus, proposals may focus on more than one topic area in describing aquaculture research that will improve diets, generate income for small-holders, manage environments for future generations, and enhance trade opportunities. Proposals should be formed around *core program components*, as identified by USAID:

- a systems approach
- social, economic, and environmental sustainability
- capacity building and institution strengthening
- outreach, dissemination, and adoption;
- gender integration

A systems approach requires that each CRSP project integrate topic areas from both *Integrated Production Systems*, and *People, Livelihoods and Ecosystem Interrelationships* (see below).* USAID also encourages the CRSP portfolio (the sum of all funded projects) to address biodiversity conservation and non-GMO biotechnology solutions to critical issues in aquaculture. While not every investigation will individually address each element recommended by USAID, **overall the proposal must describe a comprehensive development approach to a problem.**

Topic Areas pertain to aquaculture AND the nexus between aquaculture and fisheries. Some of the following topic areas overlap and are interconnected. Select each topic area so that it best describes each individual investigation. Select a range of topic areas so that together they address the broader theme (goal). The text under each topic area is provided for illustrative purposes and is not prescriptive.

Research and Outreach Topic Areas: Integrated Production Systems

• Production System Design and Best Management Alternatives
Aquaculture is an agricultural activity with specific input demands. Systems should be designed to improve efficiency and/or integrate aquaculture inputs and outputs with other agricultural and non-agricultural production systems. Systems should be designed so as to limit negative environmental impacts. CRSP research should benefit small-holder or low- to semi-intensive producers, and focus on low-trophic species for aquaculture development. Research on soil-water dynamics and natural productivity to lessen feed needs were fundamental to the Aquaculture CRSP; critical new areas of research may be continued. Interventions for disease and predation prevention must adopt an integrated pest management (IPM) approach and be careful to consider consumer acceptance and environmental risk of selected treatments.

• Sustainable Feed Technology
Methods of increasing the range of available ingredients and improving the technology available to manufacture and deliver feeds is an important research theme. Better information about fish nutrition can lead to the development of less expensive and more efficient feeds. Investigations on successful adoption, extension, and best practices for efficient feed strategies that reduce the "ecological footprint" of a species under cultivation is encouraged. Feed research that lessens reliance on fish meals/proteins/oils and lowers feed conversion ratios is desired, as is research on feeds (ingredients, sources, regimes, formulations) that result in high quality and safe aquaculture products with healthy nutrition profiles.

• Indigenous Species Development
Domestication of indigenous species may contribute positively to the development of local communities as well as protect ecosystems. At the same time, the development of new native species for aquaculture must be approached in a responsible manner that diminishes the chance for negative environmental, technical, and social impacts. Research that investigates relevant policies and practices is encouraged while exotic species development and transfer of non-native fishes are not encouraged. A focus on biodiversity conservation, and biodiversity hotspots, as related to the development of new native species for aquaculture is of great interest. Aquaculture can be a means to enhance and restock small-scale capture and wild fisheries resources (Aquaculture-Fisheries Nexus Topic Area). Augmentation of bait fisheries through aquaculture to support capture fisheries is an area of interest, provided there are no net negative environmental effects.

• Quality Seedstock Development
Procuring reliable supplies of high quality seed for stocking local and remote sites is critical to continued development of the industry, and especially of small-holder private farms. A better understanding of the factors that contribute to stable seedstock quality, availability, and quantity for aquaculture enterprises is essential. Genetic improvement (e.g., selective breeding) that does not involve GMOs may be needed for certain species that are internationally traded. All genetic improvement strategies need to be cognizant of marketplace pressures and trends, including consumer acceptance and environmental impacts.

* USAID requires scientists to adopt a systems approach for understanding how their research relates to three elements: Livelihoods, Production Landscapes, and Market Forces. The correspondence of these three USAID elements to the Topic Areas above is: Livelihoods and Market Forces = *People, Livelihoods and Ecosystem Interrelationships*; Production Landscapes = *Integrated Production Systems.*

Research and Outreach Topic Areas: People, Livelihoods, and Ecosystem Interrelationships

• Human Health Impacts of Aquaculture
Aquaculture can be a crucial source of proteins and micronutrients for improved human health, growth, and development. Research on the intrinsic food quality of various farmed fish for human consumption is needed – this might include science-based studies of positive and negative effects of consuming certain farmed fishes. Patterns of fish consumption are not well understood for many subpopulations. Human health can be negatively impacted by aquaculture if it serves as a direct or indirect vector for human diseases. There is interest in better understanding the interconnectedness of aquaculture production and water/vector-borne illnesses such as malaria, schistosomiasis, and Buruli ulcer and human health crises such as HIV/AIDS and avian flu.

• Food Safety and Value-Added Product Development
(Aquaculture-Fisheries Nexus Topic Area)
Ensuring high quality, safe, and nutritious fish products for local consumers and the competitive international marketplace is a primary research goal. Efforts that focus on reducing microbial contamination, HACCP controls and hazards associated with seafood processing, value-added processing, post-processing, and byproduct/waste development are of interest. Consumers and producers alike will benefit from research that contributes to the development of standards and practices that protect fish products from spoilage, adulteration, mishandling, and off-flavors. Certification, traceability, product integrity and other efforts to improve fish products for consumer acceptance and international markets are desired. Gender integration is important to consider as women are strongly represented in the processing and marketing sectors.

• Technology Adoption and Policy Development
Developing appropriate technology and providing technology-related information to end-users is a high priority. The program encourages research that results in a better understanding of factors and practices that set the stage for near-term technology implementation and that contribute to the development of successful extension tools and methods. Areas of inquiry can include institutional efforts to improve extension related to aquaculture and aquatic resources management; science-based policy recommendations targeting poor subpopulations within a project area, or more broadly (for example, national aquaculture strategies); methods of improving access to fish of vulnerable populations including children (e.g., school-based aquaculture programs); science-based strategies for integrating aquaculture with other water uses to improve wellbeing, such as linkages with clean drinking water and improved sanitation. Policy initiatives that link aquaculture to various water uses to improve human health are needed. Additionally, social and cultural analyses regarding the impacts of fish farming may yield critical information for informing policy development.

• Marketing, Economic Risk Assessment, and Trade
(Aquaculture-Fisheries Nexus Topic Area)
Aquaculture is a rapidly growing industry and its risks and impacts on livelihoods need to be assessed. Significant researchable issues in this arena include cost, price, and risk relationships; domestic market and distribution needs and trends; the relationships between aquaculture and women/underrepresented groups; the availability of financial resources for small farms; and the effects of subsidies, taxes, and other regulations. Understanding constraints across value chains in local, regional, and international markets is of interest, especially as constraints affect competitiveness, market demand, and how to link producers to specific markets.

• Watershed and Integrated Coastal Zone Management
(Aquaculture-Fisheries Nexus Topic Area)
Aquaculture development that makes wise use of natural resources is at the core of the CRSP. Research that yields a better understanding of aquaculture as one competing part of an integrated water use system is of great interest. The range of research possibilities is broad—from investigations that quantify water availability and quality to those that look into the social context of water and aquaculture, including land and water rights, national and regional policies (or the lack thereof), traditional versus industrial uses, and the like. Water quality issues are of increasing concern as multiple resource use conflicts increase under trends toward scarcity or uneven supply and access, especially for freshwater. Ecoregional analysis is also of interest to explore spatial differences in the capacities and potentials of ecosystems in response to disturbances. Innovative research on maximizing water and soil quality and productivity of overall watersheds is of interest. Pollution is a huge concern, as over 50% of people in developing countries are exposed to polluted water sources. Additionally, aquatic organisms cannot adequately grow and reproduce in polluted waters, and aquaculture may not only be receiving polluted waters, but adding to the burden. Rapid urbanization has further harmed coastal ecosystems, and with small-scale fisheries and aquaculture operations in the nearshore, integrated management strategies for coastal areas are also important.

• Mitigating Negative Environmental Impacts
(Aquaculture-Fisheries Nexus Topic Area)
With the rapid growth in aquaculture production, environmental externalities are of increasing concern. Determining the scope and mitigating or eliminating negative environmental impacts of aquaculture—such as poor management practices and the effects of industrial aquaculture—is a primary research goal of this program. A focus on biodiversity conservation, especially in biodiversity "hotspot" areas, as related to emerging or existing fish farms is of great interest. Therefore, research on the impacts of farmed fish on wild fish populations, and research on other potential negative impacts of farmed fish or aquaculture operations is needed, along with scenarios and options for mitigation.

Please note that specific fisheries issues will be addressed through subsequent Associate Awards involving USAID Missions, and not in the current RFP.

Program Regions

Proposals that focus on established Aquaculture CRSP Host Countries and overlap with emerging interest areas of the CRSP are encouraged. Strengthening existing countries' infrastructure builds on previous USAID investments. However, new host country linkages may be proposed (RFP website: *New HC Research Location Considerations*). Proposals will be evaluated based on the strength of linkages to host countries, among other criteria. **Your proposal must focus on one USAID-eligible country within a region, but activities are encouraged in nearby countries within the same region or across regions**. Please refer to the RFP webite for current countries included in USAID's *Country-Level Foreign Assistance Framework* and USAID's *Policy Framework for Bilateral Foreign Aid.* USAID requires that one-quarter of the overall Aquaculture & Fisheries CRSP portfolio focuses on countries included in the *Initiative to End Hunger in Africa* (RFP website: *USAID Links*). CRSP will focus primarily, although not exclusively, on Rebuilding Countries, Developing Countries, and Transforming Countries in the following regions:

- Central America
- South America
- Caribbean
- Africa
- South and East Asia
- Eastern Europe
- Central Asia

Current IEHA countries: Mali, Ghana, Zambia, Mozambique, Uganda, Kenya.
Additional IEHA countries under consideration: Malawi, Nigeria, and Tanzania.

Continuing relationships may be built on foundation work laid by the Aquaculture CRSP in the following countries. For established institutional partners under the Aquaculture CRSP, please see weblink: http://pdacrsp.oregonstate.edu/

AMERICAS

- Bolivia
- Brazil
- Colombia
- Ecuador
- El Salvador
- Guatemala
- Honduras
- Mexico
- Nicaragua
- Panama
- Peru
- Domican Republic

AFRICA

- Egypt
- Ghana
- Kenya
- Malawi
- Rwanda
- Tanzania
- South Africa

ASIA

- Bangladesh
- Cambodia
- China
- Indonesia
- Laos
- Nepal
- Philippines
- Thailand
- Vietnam

OTHER SITE CONSIDERATIONS

USAID-Eligible Countries: Several countries listed above are not identified in the USAID Country-Level Foreign Assistance Framework currently under development. It is unknown whether these unidentified countries are ineligible. If you are interested in a country not mentioned in the Framework, please contact the CRSP ME for additional information. Cautionary note: Proposed activities will require USAID country-level concurrence prior to award. Non-concurrence can mean that a project or investigation is not approved for funding. For a list of USAID-presence countries, please go to the USAID links from the RFP website.

Memoranda of Understanding: Upon award selection, the Lead Partner Institution will be required to enter into Memoranda of Understanding (MOUs) with institutions at Host Country sites. Subcontracting US institutions may also enter into MOUs with HC partners to strengthen institutional relationships and streamline administrative processes. MOUs between Host Country institutions are not discouraged but will not take the place of MOUs between US and Host Country institutions. MOUs must provide the opportunity for other CRSP projects to function under the authority of the agreement and must provide for joint authorship of reports and site visits at the discretion of the CRSP Management Entity. Draft MOUs must be submitted to the ME for review prior to execution (RFP website: *MOUs*).

New Host Country Collaborating Institutions: Proposals that add a new Host Country research location must include a response to the New Host Country Research Location Considerations (RFP website: *New HC Research Location Considerations*). Successful proponents may be required to prepare and submit full characterizations of new Host Country research locations during project negotiation. Descriptions of previous and current ACRSP research sites are available: http://pdacrsp.oregonstate.edu/pubs/featured_titles/

Fostering Respectful Partnerships: Proposals that foster linkages with organizations including US minority-serving institutions, non-governmental organizations (NGOs), national agricultural research institutions, other CRSPs, international centers, private businesses, and others are desired. Proposals that link Host Country researchers from one CRSP site to another CRSP site are encouraged. US and Host Country PIs will share in budgetary decisions and overall priority setting for the project, as well as in other collaborative activities related to the CRSP. Proposals, work plans, and project budgets must be developed collaboratively between HC and US researchers.

US PIs must actively establish an effective working relationship with the ME and other CRSP US and Host Country PIs and program participants.

Technical Considerations for Award of a CRSP Project

Research that generates new information should form the core of proposals. Proposals must also include institutional strengthening, outreach, and capacity building activities such as training, formal education, workshops, extension, and conference organizing to support the scientific research being proposed.

1. Proposals must be innovative, feasible, and demonstrate technical merit as assessed via peer review.

2. Investigations that generate new information should form the core of proposals. Each investigation must be clearly identified as an experiment, study, or activity, based on the following definitions:

   Experiment A scientifically sound investigation that addresses a testable hypothesis. An experiment implies collection of new data by controlled manipulation and observation.

   Study A study may or may not be less technical or rigorous than an experiment and may state a hypothesis if appropriate. Studies include surveys, focus groups, database examinations, most modeling work, and collection of technical data that do not involve controlled manipulation (e.g., collection and analysis of soil samples from sites without having experiments of hypothesized effect before collection).

   Activity An activity requires staff time and possibly materials but does not generate new information like an experiment or a study. Conference organization, training sessions, workshops, outreach, and transformation and dissemination of information are examples of activities.

   Investigations provide a transparent means for evaluating different types of work under the CRSP, be it quantitative, empirical, biologically-based, qualitative, policy-based, or informal.

3. Proposals must include at least one *experiment* or *study*. Proposals must also include outreach *activities* such as training, formal education, extension, and conference organizing to supplement the scientific research being proposed.

4. Proposals must identify intended beneficiaries, stakeholders, and end-users. To this end, each investigation must include a section on the *quantifiable benefits* that are anticipated (RFP website: *Quantifiable Benefits, and Outreach and Dissemination Plan*).

5. Proposals must provide a gender inclusivity strategy (RFP website: *Gender Inclusivity Strategy*).

6. Proposals that add a new Host Country research location to one of the CRSP regions must include a response to *New Host Country Research Location Considerations* and a plan for characterizing the new location (RFP website: *New HC Research Location Considerations*). Proponents may be required to prepare and submit full characterizations (*Site Descriptions*) of new Host Country research locations.

7. PI(s) will be responsible for fulfilling all ME and USAID reporting requirements (RFP website: *Reporting Requirements*).

8. Proposals must contain a plan for outreach and dissemination (RFP website: *Outreach and Dissemination Plan*). The CRSP seeks to build capacity of HC researchers, farmers, and other stakeholders through improved understanding of aquacultural technologies, including soft technologies such as best practices and knowledge-based systems, as well as hard technologies. Proposals must also briefly describe future plans for additional work in critical need areas, whether funded by CRSP or a different agency.

9. Successful proposals will address the following general *research priorities*:

   Priority Ecosystems
   Freshwater and brackishwater ecosystems for aquaculture and aquaculture-fishery nexus topic areas; marine ecosystems are also included for the aquaculture-fishery nexus topic areas.

   Priority Species
   Low-trophic level fishes; domesticated freshwater fishes; non-finfishes (e.g., bivalves, seaweeds); aquatic organisms used in polycultures and integrated systems; native species. Food fishes are a priority but species used for non-food purposes (e.g., ornamental, pharmaceutical) may also be included as a priority if they are a vital part of an integrated approach towards food security and poverty alleviation.

   Target Groups
   Aquaculture farms (small- to medium-scale, subsistence and commercial) and aquaculture intermediaries, policy makers, and others in host countries.

   Key Partners
   University, government, non-government, and private sector.

10. Successful proposals will consider the following USAID *environmental restrictions*:
    - Biotechnical investigations will be conducted primarily on research stations in Host Countries;
    - Research protocols, policies and practices will be established prior to implementation to ensure that potential environmental impacts are strictly controlled;
    - All training programs and outreach materials intended to promote the adoption of CRSP-generated research findings will incorporate the appropriate environmental recommendations;
    - All sub-awards must comply with environmental standards;
    - CRSP Projects will not procure, use or recommend the use pesticides of any kind. This includes but is not limited to algicides, herbicides, fungicides, piscicides, parasiticides, and protozoacides.
    - CRSP Projects will not use or procure genetically modified organisms (GMO); and
    - CRSP Projects will not use or recommend for use any species that are non-endemic to a country or not already well established in its local waters, or that are non-endemic and well established but are the subject of an invasive species control effort.

11. Successful proponents will be responsible for interactions with CRSP internal technical advisory groups. Each project will be assigned to one *Regional Center of Excellence* and one *Development Theme Advisory Panel*. These advisory groups will perform critical analysis and synthesis work for meeting USAIDs goals, and producing lessons learned materials.

12. Overall program goals will address USAID needs for meeting biodiversity conservation and biotechnology earmarks. Not every project will need to address these earmarks, but overall CRSP portfolio selection will be based on meeting USAID needs, as well as the needs of host countries and others.

13. Projects will be expected to participate in a global pre-synthesis workshop early in the project start-up phase – most likely in Spring 2007. During this workshop, indicators, benchmarks and targets will be developed for synthesizing information across the broad global portfolio.

14. Applicants must provide a statement of project vision. (RFP website: *Project Vision*)

Programmatic Considerations for Award of a CRSP Project

1. Proposals will ideally present a multi-disciplinary and multi-institutional approach to aquaculture research, development, and outreach in eligible Host Countries. Lead Partner Institutions and Lead PIs may submit more than one proposal, but award selection is likely to be limited to one proposal per Lead Partner Institution.
2. At least 50% of funds must be expended in or on behalf of the Host Country or region. (RFP website: *Budget Information*)
3. Proposals must be consistent with USAIDs strategic objectives, goals, and requirements. (RFP website: *USAID Goals and Guidelines*)
4. Applicants are asked to select a USAID-eligible country for their base operations and are encouraged to involve satellite countries to broaden the potential impact of their results. Information regarding USAID-eligible countries can be accessed via the RFP website under USAID links.
5. At least 25% of the overall program portfolio will be devoted to proposals targeting IEHA countries. Current IEHA countries are: Mali, Ghana, Zambia, Mozambique, Uganda, and Kenya. (RFP website: *USAID links*). It is anticipated that funds awarded under this RFP will be allocated as follows: 32% to Africa; 32% to Asia; 32% to Latin America and the Caribbean; and 4% to other regions.
6. Each applying US institution must provide US non-federal cost sharing as required by USAID. Proponents should target a 50% matching contribution for this project, with at least 35% of the match provided as non-federal cost share from the participating US entities (RFP website: *Budget Information*).
7. A key consideration for award of CRSP funding is that each applying US institution provide strong institutional support through cost-sharing PI effort. Salary support for US PIs will be limited (RFP website: *Budget Information*). US PIs charging <u>any</u> portion of salary to the CRSP award must also be serving in the capacity of major advisor to a graduate student working under an approved CRSP investigation.
8. Collaborative efforts that involve undergraduate students, graduate students, and post-doctoral fellows are encouraged. CRSP funds will not be used to support US expatriate personnel or consultants, as the CRSP model is intended to build institutional networks and capacities.
9. Proposals that leverage support from other sources in furthering the broad goals of the CRSP are desired. Leveraged support is support in addition to US non-federal cost sharing funds required for award of a CRSP project and in addition to the HC institutional match.
10. Familiarity with institutions in the proposed HC and region as indicated by past relationships is desirable, as is a successful institutional track record of work in the proposed country. A short statement describing institutional capacity and track record in the proposed host country or countries is required.
11. Proponents from diverse backgrounds are encouraged to apply. US minority-serving institutions are encouraged to apply.
12. Proposals must demonstrate return benefits to the US in furtherance of the program's responsibility to provide mutual benefits and discoveries that can apply to the HC region and US and that will support future development of sustainable aquaculture.
13. Funding is typically allocated on an annual basis. All allocations are contingent on the annual funding level obtained from USAID and on performance under subcontract provisions.
14. USAID concurrence for projects in host countries will be required prior to award. The ME will obtain concurrence on behalf of highly ranked applicants via USAID/Washington. Applicants may include letters of support from USAID Missions in their proposals, but these will not take the place of USAID concurrence to the ME.

Evaluation Criteria and Proposal Review

Prior to undergoing review, proposals will be checked for eligibility, completeness, and receipt date. Eligible proposals will undergo external technical peer review, which will be followed by programmatic review. Technical review will focus on scientific and intellectual merit, collaboration, and broader impact. Programmatic review will focus on overall portfolio balance among regions and themes; adherence to the RFP including the programmatic and budget sections; and adherence to the goals of USAID and needs of the host countries. (RFP website: *Proposal Review Criteria*)

EVALUATION GUIDELINES (excerpted). Please refer to the RFP Website for the complete review criteria.

INITIAL SCREENING

- Eligibility (institutional; RFP theme and topic area; country)
- Completeness
- Submission deadline

Eligible proposals will proceed to the review phase. Ineligible or late proposals will not qualify for review and/or funding consideration.

I. TECHNICAL PEER-REVIEW

INTELLECTUAL MERIT (50%)
1. Soundness
2. Innovation
3. Qualification of Researchers
4. Application of Research

COLLABORATION, CAPACITY BUILDING, AND BROADER IMPACTS (50%)
1. Education and Training
2. Inclusiveness
3. Human Health and Welfare
4. Networking and Institutional Development

II. PROGRAMMATIC REVIEW

Part 1. RFP Adherence

- Adherence to all Programmatic Criteria listed in the RFP
- Adherence to Budget Criteria
- Adherence to Requested information for compliance and institutional support

Part 2. Portfolio Balance

- Regional Balance Assessment
- Thematic Balance Assessment
- Area of Inquiry (Topic Area) Representation
- Technical Ranking within Region and Theme

Part 3. USAID Compliance

USAID Eligibility
- Does the proposal have Mission concurrence?
- Is work proposed for a USAID-eligible country?
- Does the proposal address key USAID goals and interests as defined in the RFP materials?

Initial Environmental Examination Screening (problems may delay projects, or decline projects)

- Assessment of whether there are any obvious environmental issues not raised by the technical review
- Screening process and findings
- Examination and review as necessary

Proposal Organization and Format

Format: • Paper Size: Standard (8.5″ x ll″)
• Line Spacing: Single space
• Minimum Page Margin: 1 inch on all sides
• Minimum Font Size: 10 point (9 point for header or footer)
• Each page of the proposal subsequent to the cover page must identify the Lead PI and proposal title (abbreviated if necessary) and the page number.

Checklist for Proposals

A checklist is provided for assembling the proposal packet (RFP website: *Checklist for Proposals*). The research proposal narrative, item 3 below, **must not exceed 30 pages**.

Proposals must contain the following elements:

- ☐ 1. Cover Sheet Form with Institutional signature
- ☐ 2. Summary Page Form
- ☐ 3. Research Proposal Narrative (30 pages maximum)
  - ☐ a. Executive Summary; Introduction and Vision Statement (2-page limit)
  - ☐ b. Investigations (5-pg limit for each investigation; up to 10 investigations total; 26 pp total)
  - ☐ c. Outreach and Dissemination Plan (1-page limit)
  - ☐ d. Gender Inclusivity Strategy (1-page limit)
- ☐ 4. New HC Research Location Considerations (2-page limit)
- ☐ 5. Budget (with Institutional signature)
  - ☐ (3) single-year budgets for Lead. Include budgets for subcontractors and HC institutions (up to 9 single-year budgets)
  - ☐ (1) combined-year budget for Lead. Include the combined-year budget for subcontractors and HC institutions (up to 3 combined-year budgets)
- ☐ 6. Budget Justification for Lead, Subcontractors, and HC for each year (up to 9 forms)
- ☐ 7. Pending Funds Form
- ☐ 8. Conflict-of-Interest Form for each (Lead, US, and HC) PI
- ☐ 9. List of names of 5 reviewers (names, address and email, areas of expertise)
- ☐ 10. Letters of Commitment from HC PIs and from US and HC partners
- ☐ 11. Statement of institutional track record and experience in the proposed HC (2-page limit)
- ☐ 12. Lead Institution supporting information:
  - ☐ Animal Use Approval (or written waivers)
  - ☐ Human Subjects Approval (or written waivers)
  - ☐ NICRA for Lead Institution (Negotiated indirect cost rate agreement)
  - ☐ Institutional & Agency Certifications and Assurances (5 forms)
- ☐ 13. CVs of Lead PI and all US and HC Co-PIs (2-page limit per CV)

Instructions for Completing the Descriptions of Investigations ~ see Checklist: 3b ~

1. Individual investigation descriptions must not exceed five pages. All investigation descriptions within one proposal must not exceed 26 pages. Proposals may contain up to 10 investigations.
2. Each investigation must be described separately and include the following elements:
   a. Title: below the title include the topic area (p. 3-4) to which the proposed investigation applies and specify whether the investigation is an experiment, study or activity (p. 6, item 2).
   b. Lead PI and institutional affiliation; subcontracting co-PIs and institutional affiliations; HC PIs and institutional affiliation
   c. Objective(s) [and null hypotheses for experiments]
   d. Significance: Provide justification for conducting the proposed work, review similar and related work reported in the literature (include citations below under h.), and describe how the work relates to the priorities described in this RFP.
   e. Quantified Anticipated Benefits: Identify target groups and direct and indirect benefits accruing from the research and outreach work. Benefits must be quantifiable (RFP website: *Quantifiable Benefits*).
   f. Research Design or Activity Plan
      (1) Location of work
      (2) Methods
   g. Schedule, indicating the start date (not earlier than 1 April 2007) and completion date (not later than 30 September 2009) of the proposed work.
   h. Literature Cited

Proposal Submission

1. Submit your full proposal via email to acrsp@oregonstate.edu by 5pm Pacific Time on Wednesday, January 31, 2007. Also ten (10) printed copies and one (1) electronic copy on CD of each proposal must be received by Friday, February 2, 2007. The ME will acknowledge timely receipt of proposals via email to the Lead PI.
2. Do not exceed the proposal narrative 30-page limit. Proposals exceeding the proposal narrative page limit will not be considered.
3. Proposal packets must have the formal signed approval of the Lead Partner Institution.
4. Individual proposal parts (investigations) that will be carried out under subcontract from the Lead Partner Institution to another US institution must be affirmed by the formal signed approval of the subcontracting US institution. (*Attach a separate letter*)
5. Mail paper and CD submissions to:
   Dr. Hillary S. Egna
   CRSP Director
   Oregon State University
   Snell Hall 418
   Corvallis, OR 97331-1643 USA

Program objectives and future work

The goal of the Aquaculture & Fisheries CRSP is to conduct research that contributes significantly to the removal of major constraints to sustainable aquaculture development and responsible small-scale fisheries management, thereby promoting economic growth, enhancing food security, and conserving natural resources in developing countries. CRSPs are funded by USAID under authority of the International Development and Food Assistance Act of 1975 (PL 94-161), and by participating institutions.

The Aquaculture & Fisheries CRSP is a new CRSP under USAID/EGAT's Office of Natural Resources Management. Oregon State University was awarded the Leader with Associates Cooperative Agreement (No. EPP-A-00-06-00012-00) for the Aquaculture & Fisheries CRSP, which will run until 2011. In 2010, the program will be evaluated for a possible 5-year extension. Two major work plans (each with defined annual implementation plans) will describe the specific research to be carried out under the CRSP's framework of general research priorities. This RFP is a call for the First Work Plan. A second directed RFP is planned for late Spring 2007, about 4 months prior to the end of work commissioned by this first RFP. The second RFP will focus on gaps and emergent areas of research. It will run for two years, from October 1, 2009 through September 30, 2011. For the second directed RFP, CRSP researchers with incomplete First Work Plan investigations will not be eligible to receive funding until all previous obligations are satisfactorily met.

Additional information may be obtained from the Aquaculture & Fisheries CRSP 5-year plan and the Aquaculture CRSP Annual Administrative and Technical Reports, which are available on the CRSP RFP website. http://pdacrsp.oregonstate.edu/afcrsp/rfp

~ AQUACULTURE & FISHERIES CRSP RFP ~

http://pdacrsp.oregonstate.edu/afcrsp/rfp

QUESTIONS ABOUT THE CRSP RFP ?

Consult the CRSP RFP website <pdacrsp.oregonstate.edu/afcrsp/rfp> for answers to **Frequently Asked Questions**, a feature that will be added to over time.
Send an email to <acrsp@oregonstate.edu> or call ~ 541.737.6426

APPENDIX 9: AQUACULTURE & FISHERIES COLLABORATIVE RESEARCH SUPPORT PROGRAM REQUEST FOR PROPOSALS - 2008

AquaFish Collaborative Research Support Program

Request for Proposals:
Global Research, Capacity Building, and Institutional Development in Aquaculture and Aquatic Resources Management

Important Dates Date of Release: 14 November 2008
Proposals are Due (~12 weeks): 5 February 2009
Announcement of Selections: 1 May 2009

This Request for Proposals is issued by the Management Entity of the AquaFish CRSP, Snell Hall 418, Oregon State University, Corvallis, Oregon, 97331 USA. Website: http://aquafishcrsp.oregonstate.edu Email: aquafish@oregonstate.edu

The AquaFish CRSP (CRSP) Management Entity (ME) is inviting proposals for solving critical problems facing global aquaculture development and aquatic resources management in lower-income countries in Africa. The AquaFish CRSP is managed by Oregon State University under a five-year award from the US Agency for International Development (USAID). This RFP is designed to attract proposals that will develop linkages between the United States and selected Host Countries in Africa for Global Research, Capacity Building, and Institutional Development. Proposals must target countries and themes in furtherance of USAID's goals, as described in this RFP.

A single US institution will be the Lead Partner Institution for each proposal. Eligible lead institutions include US universities, colleges, and minority-serving institutions (see shaded box for details). New US Lead Partners are encouraged to apply. Lead Partners are expected to assume strong administrative and technical leadership for projects, be involved in advisory groups serving the overall program, and form collaborative partnerships through sub-awards to developing country institutions, NGOs, IARCs, private sector firms, and other US universities or colleges.

The award period under this RFP will be up to 26 months, from 1 August 2009 to 30 September 2011. Proposals will ideally include the participation of other US institutions to be funded by the Lead Partner Institution by means of secondary subcontracts. Host Country (HC) institution involvement is mandatory and will be funded via the Lead Partner Institution's award.

The maximum funding available for 26-month multi-institutional and multi-disciplinary proposals is $400,000. The program's flexibility in the number of proposals that will be funded depends on the overall funding received from USAID. Under current funding projections, one or two new Lead Partner awards are anticipated to result from this RFP. Funding is typically allocated on an annual basis. All allocations are contingent on the annual funding level obtained from USAID and on performance under subcontract provisions.

A successful proposal will focus on one theme (p. 2) in an IEHA-country (p. 5). Each proposal will likely include multiple investigations that each target one of the identified research topics (p. 3 to 4). Investigations are discussed in this RFP in more detail under Technical Considerations (p. 6). Proposals must address how they will align with overall Program goals.

The goal of the Aquaculture & Fisheries (AquaFish) CRSP as stated by USAID is to "develop more comprehensive, sustainable, ecological and socially compatible, and economically viable aquaculture systems and innovative fisheries management systems in developing countries that contribute to poverty alleviation and food security." (USAID, May 2006)

Eligibility for Lead Partner Institution

Based on Section 269(d) of Title XII of the Foreign Assistance Act of 1961, as amended, an eligible university or college is defined as: "... those colleges or universities in each State, territory, or possession of the United States, or the District of Columbia, now receiving, or which may hereafter receive, benefits under the Act of July 2, 1862 (known as the First Morrill Act) or the Act of August 30, 1890 (known as the Second Morrill Act), which are commonly known as 'land-grant' universities; institutions now designated or which may hereafter be designated as sea-grant colleges under the Act of October 5, 1966 (known as the National Sea Grant College and Program Act), which are commonly known as sea-grant colleges; Native American land-grant colleges as authorized under the Equity in Educational Land-Grant Status Act of 1994 (7 U.S.C. 301 note); and other United States colleges and universities which – (1) have demonstrable capacity in teaching, research, and extension (including outreach) activities in the agricultural sciences; and (2) can contribute effectively to the attainment of the objectives of this title."

Eligibility for Additional Partners under the Lead: Public and private entities such as other universities, colleges, minority-serving institutions, companies, international non-government organizations (NGOs), and others with resources and relevant experience for conducting research, training and outreach activities, and implementing research projects, are eligible to apply. For-profit firms may participate as sub-awardees but, pursuant to 22 CFR 226.81, it is USAID policy not to award profit under assistance instruments such as cooperative agreements. All reasonable, allocable, and allowable expenses, both direct and indirect, which are related to the program and are in accordance with applicable cost standards (22 CFR 226, OMB Circular A-122 for non-profit organization, OMB Circular A-21 for universities, and the Federal Acquisition Regulation (FAR) Part 31 for-profit organizations), may be paid under the CRSP. US Minority-Serving Institutions include those mandated as Historically Black Colleges and Universities (HBCU), Tribal Colleges and Universities, Asian American and Pacific Islander (AAPI) Serving Institutions, and Hispanic Serving Institutions.

This Request for Proposals is issued by the Management Entity of the AquaFish CRSP, Oregon State University, Corvallis, Oregon, USA, under Leader with Associates Cooperative Agreement No. EPP-A-00-06-00012-00. The ME will notify Lead Principal Investigators (PIs) of rankings on or around 1 May 2009. Lead PIs will be notified if the selection decision will be delayed. The ME reserves the right to modify this schedule as necessary to ensure that standards of fairness and accuracy are met. Actual awards are contingent on funding received by the ME. Assuming timely funding by USAID, projects are anticipated to begin 1 August 2009. As this RFP solicits 26-month projects, all investigations should be completed and all final reports submitted by 30 September 2011. Proponents with a demonstrable commitment to promoting and enhancing diversity are encouraged to apply.

Disclaimer: *Issuance of this RFA does not constitute an award commitment on the part of Oregon State University, nor does it commit the University to pay for costs incurred in the preparation or submission of an application. In addition, final award of any resultant sub-awards cannot be made until funds have been fully appropriated, allocated, and committed through internal OSU procedures. While it is anticipated that these procedures will be successfully completed, potential applicants are hereby notified of these requirements and conditions for award. Applications are submitted at the risk of the applicant. Should circumstances prevent award of a project, all preparation and submission costs are at the applicant's expense.*

Global Themes

The four global themes of the CRSP are cross-cutting and address several specific USAID policy documents and guidelines, including the *Policy Framework for Bilateral Foreign Aid*, *Agriculture Strategy*, EGAT Offices of Agriculture and Natural Resource Management Strategic Objectives, and IEHA (Initiative to End Hunger in Africa). To see how these themes relate to USAID's focal areas and for additional information on these USAID documents, please refer to the CRSP RFP website: *USAID Goals and Guidelines*. The overall research context for this RFP is poverty alleviation and food security improvement through sustainable aquaculture development and aquatic resources management. **Proponents will identify one primary theme (goal) - either A or B - for their overall proposal.** Proposals ideally will address all four themes in an integrated systems approach, but must focus on one theme as it relates to producing positive development outcomes:

Global AquaFish CRSP Themes (Goals) for this RFP are A and B

A. Improved Health and Nutrition, Food Quality, and Food Safety
B. Income Generation for Small-Scale Fish Farmers

(Two other themes in addition to A and B above are represented by other projects in the current AquaFish CRSP: C. Environmental Management for Sustainable Aquatic Resources Use; and D. Enhanced Trade Opportunities for Global Fishery Markets

The CRSP will be managed in a manner that achieves maximum program impacts, particularly for small-scale farmers and fishers, in Host Countries and more broadly. CRSP overall program objectives address the need for world-class research, capacity building, and information dissemination. Specifically, the AquaFish CRSP will strive to:

- Develop sustainable end-user level aquaculture and fisheries systems to increase productivity, enhance international trade opportunities, and contribute to responsible aquatic resource management;
- Enhance local capacity in aquaculture and aquatic resource management to ensure long-term program impacts at the community and national level;
- Foster wide dissemination of research results and technologies to local stakeholders at all levels, including end users, researchers, and government officials; and
- Increase Host Country capacity and productivity to contribute to national food security, income generation, and market access.

AquaFish CRSP Topic Areas for Research, Outreach, and Capacity Building Investigations

Thematic proposals will contain implementation plans (investigations) organized around a number of specific areas of inquiry (called Topic Areas). **Proponents will identify one topic area for each investigation in the proposal.** Proposals may contain between one and ten investigations (see p. 9). Thus, proposals may focus on more than one topic area in describing aquaculture research that will improve diets, generate income for small-holders, manage environments for future generations, and enhance trade opportunities. Proposals should be formed around *core program components*, as identified by USAID:

- a systems approach
- social, economic, and environmental sustainability
- capacity building and institution strengthening
- outreach, dissemination, and adoption;
- gender integration

A systems approach requires that each CRSP project integrate topic areas from both *Integrated Production Systems*, and *People, Livelihoods and Ecosystem Interrelationships* (see below).* USAID also encourages the CRSP portfolio (the sum of all funded projects) to address biodiversity conservation and non-GMO biotechnology solutions to critical issues in aquaculture. While not every investigation will individually address each element recommended by USAID, **overall the proposal must describe a comprehensive development approach to a problem.**

Topic Areas pertain to aquaculture AND the nexus between aquaculture and fisheries. Some of the following topic areas overlap and are interconnected. Select each topic area so that it best describes each individual investigation. Select a range of topic areas so that together they address the broader theme (goal). The text under each topic area is provided for illustrative purposes and is not prescriptive.

Research and Outreach Topic Areas: Integrated Production Systems

• Production System Design and Best Management Alternatives
Aquaculture is an agricultural activity with specific input demands. Systems should be designed to improve efficiency and/or integrate aquaculture inputs and outputs with other agricultural and non-agricultural production systems. Systems should be designed so as to limit negative environmental impacts. CRSP research should benefit small-holder or low- to semi-intensive producers, and focus on low-trophic species for aquaculture development. Research on soil-water dynamics and natural productivity to lessen feed needs were fundamental to the Aquaculture CRSP; critical new areas of research may be continued. Interventions for disease and predation prevention must adopt an integrated pest management (IPM) approach and be careful to consider consumer acceptance and environmental risk of selected treatments.

• Sustainable Feed Technology
Methods of increasing the range of available ingredients and improving the technology available to manufacture and deliver feeds is an important research theme. Better information about fish nutrition can lead to the development of less expensive and more efficient feeds. Investigations on successful adoption, extension, and best practices for efficient feed strategies that reduce the "ecological footprint" of a species under cultivation is encouraged. Feed research that lessens reliance on fish meals/proteins/oils and lowers feed conversion ratios is desired, as is research on feeds (ingredients, sources, regimes, formulations) that result in high quality and safe aquaculture products with healthy nutrition profiles.

• Indigenous Species Development
Domestication of indigenous species may contribute positively to the development of local communities as well as protect ecosystems. At the same time, the development of new native species for aquaculture must be approached in a responsible manner that diminishes the chance for negative environmental, technical, and social impacts. Research that investigates relevant policies and practices is encouraged while exotic species development and transfer of non-native fishes are not encouraged. A focus on biodiversity conservation, and biodiversity hotspots, as related to the development of new native species for aquaculture is of great interest. Aquaculture can be a means to enhance and restock small-scale capture and wild fisheries resources (Aquaculture-Fisheries Nexus Topic Area). Augmentation of bait fisheries through aquaculture to support capture fisheries is an area of interest, provided there are no net negative environmental effects.

• Quality Seedstock Development
Procuring reliable supplies of high quality seed for stocking local and remote sites is critical to continued development of the industry, and especially of small-holder private farms. A better understanding of the factors that contribute to stable seedstock quality, availability, and quantity for aquaculture enterprises is essential. Genetic improvement (e.g., selective breeding) that does not involve GMOs may be needed for certain species that are internationally traded. All genetic improvement strategies need to be cognizant of marketplace pressures and trends, including consumer acceptance and environmental impacts.

* USAID requires scientists to adopt a systems approach for understanding how their research relates to three elements: Livelihoods, Production Landscapes, and Market Forces. The correspondence of these three USAID elements to the Topic Areas above is: Livelihoods and Market Forces = *People, Livelihoods and Ecosystem Interrelationships*; Production Landscapes = *Integrated Production Systems.*

Research and Outreach Topic Areas: People, Livelihoods, and Ecosystem Interrelationships

• Human Health Impacts of Aquaculture
Aquaculture can be a crucial source of proteins and micronutrients for improved human health, growth, and development. Research on the intrinsic food quality of various farmed fish for human consumption is needed – this might include science-based studies of positive and negative effects of consuming certain farmed fishes. Patterns of fish consumption are not well understood for many subpopulations. Human health can be negatively impacted by aquaculture if it serves as a direct or indirect vector for human diseases. There is interest in better understanding the interconnectedness of aquaculture production and water/vector-borne illnesses such as malaria, schistosomiasis, and Buruli ulcer and human health crises such as HIV/AIDS and avian flu.

• Food Safety and Value-Added Product Development
(Aquaculture-Fisheries Nexus Topic Area)
Ensuring high quality, safe, and nutritious fish products for local consumers and the competitive international marketplace is a primary research goal. Efforts that focus on reducing microbial contamination, HACCP controls and hazards associated with seafood processing, value-added processing, post-processing, and byproduct/waste development are of interest. Consumers and producers alike will benefit from research that contributes to the development of standards and practices that protect fish products from spoilage, adulteration, mishandling, and off-flavors. Certification, traceability, product integrity and other efforts to improve fish products for consumer acceptance and international markets are desired. Gender integration is important to consider as women are strongly represented in the processing and marketing sectors.

• Technology Adoption and Policy Development
Developing appropriate technology and providing technology-related information to end-users is a high priority. The program encourages research that results in a better understanding of factors and practices that set the stage for near-term technology implementation and that contribute to the development of successful extension tools and methods. Areas of inquiry can include institutional efforts to improve extension related to aquaculture and aquatic resources management; science-based policy recommendations targeting poor subpopulations within a project area, or more broadly (for example, national aquaculture strategies); methods of improving access to fish of vulnerable populations including children (e.g., school-based aquaculture programs); science-based strategies for integrating aquaculture with other water uses to improve wellbeing, such as linkages with clean drinking water and improved sanitation. Policy initiatives that link aquaculture to various water uses to improve human health are needed. Additionally, social and cultural analyses regarding the impacts of fish farming may yield critical information for informing policy development.

• Marketing, Economic Risk Assessment, and Trade
(Aquaculture-Fisheries Nexus Topic Area)
Aquaculture is a rapidly growing industry and its risks and impacts on livelihoods need to be assessed. Significant researchable issues in this arena include cost, price, and risk relationships; domestic market and distribution needs and trends; the relationships between aquaculture and women/underrepresented groups; the availability of financial resources for small farms; and the effects of subsidies, taxes, and other regulations. Understanding constraints across value chains in local, regional, and international markets is of interest, especially as constraints affect competitiveness, market demand, and how to link producers to specific markets.

• Watershed and Integrated Coastal Zone Management
(Aquaculture-Fisheries Nexus Topic Area)
Aquaculture development that makes wise use of natural resources is at the core of the CRSP. Research that yields a better understanding of aquaculture as one competing part of an integrated water use system is of great interest. The range of research possibilities is broad—from investigations that quantify water availability and quality to those that look into the social context of water and aquaculture, including land and water rights, national and regional policies (or the lack thereof), traditional versus industrial uses, and the like. Water quality issues are of increasing concern as multiple resource use conflicts increase under trends toward scarcity or uneven supply and access, especially for freshwater. Ecoregional analysis is also of interest to explore spatial differences in the capacities and potentials of ecosystems in response to disturbances. Innovative research on maximizing water and soil quality and productivity of overall watersheds is of interest. Pollution is a huge concern, as over 50% of people in developing countries are exposed to polluted water sources. Additionally, aquatic organisms cannot adequately grow and reproduce in polluted waters, and aquaculture may not only be receiving polluted waters, but adding to the burden. Rapid urbanization has further harmed coastal ecosystems, and with small-scale fisheries and aquaculture operations in the nearshore, integrated management strategies for coastal areas are also important.

• Mitigating Negative Environmental Impacts
(Aquaculture-Fisheries Nexus Topic Area)
With the rapid growth in aquaculture production, environmental externalities are of increasing concern. Determining the scope and mitigating or eliminating negative environmental impacts of aquaculture—such as poor management practices and the effects of industrial aquaculture—is a primary research goal of this program. A focus on biodiversity conservation, especially in biodiversity "hotspot" areas, as related to emerging or existing fish farms is of great interest. Therefore, research on the impacts of farmed fish on wild fish populations, and research on other potential negative impacts of farmed fish or aquaculture operations is needed, along with scenarios and options for mitigation.

Please note that specific fisheries issues will be addressed through subsequent Associate Awards involving USAID Missions, and not in the current RFP.

Program Regions

Proposals must focus on IEHA Host Countries. Supportive activities in non-IEHA countries, or in regions outside Africa are allowed, but IEHA-countries will be the focus of the funded work. IEHA countries represented in the current CRSP portfolio include Kenya and Ghana, plus Mali through an Associate Award. New host country linkages may be proposed (RFP website: *New HC Research Location Considerations*). Proposals will be evaluated based on the strength of linkages to host countries, among other criteria. **Your proposal must focus on one USAID-eligible IEHA country, but activities are encouraged in nearby countries within the same region or across regions**. Please refer to the RFP webite for current countries included in USAID's *Country-Level Foreign Assistance Framework* and USAID's *Policy Framework for Bilateral Foreign Aid.* USAID requires that one-quarter of the overall AquaFish CRSP portfolio focuses on countries included in the *Initiative to End Hunger in Africa* (RFP website: *USAID Links*). CRSP will focus primarily, although not exclusively, on Rebuilding Countries, Developing Countries, and Transforming Countries in the following regions:

- Central America
- South America
- Caribbean
- Africa
- South and East Asia
- Eastern Europe
- Central Asia

FY08 IEHA countries: Mali, Ghana, Zambia, Mozambique, Uganda, Kenya, Nigeria, Malawi, plus East, West, South Regional Offices

Continuing relationships may be built on foundation work laid by the AquaFish CRSP in the following countries. For established institutional partners under the Aquaculture CRSP, please see weblink: http://pdacrsp.oregonstate.edu/

AMERICAS
- Guyana
- Mexico
- Nicaragua

AFRICA
- Egypt
- Ghana
- Kenya
- Mali
- Tanzania
- South Africa

ASIA
- Cambodia
- China
- Indonesia
- Nepal
- Philippines
- Thailand
- Vietnam

OTHER SITE CONSIDERATIONS

USAID-Eligible Countries: If you are interested in a country not mentioned in the Framework, please consult USAID's website for guidance, and read the FAQ on this RFP website. Cautionary note: Proposed activities will require USAID country-level concurrence prior to award. Non-concurrence can mean that a project or investigation is not approved for funding. For a list of USAID-presence countries, please go to the USAID links from the RFP website.

Memoranda of Understanding: Upon award selection, the Lead Partner Institution will be required to enter into Memoranda of Understanding (MOUs) with institutions at Host Country sites. Subcontracting US institutions may also enter into MOUs with HC partners to strengthen institutional relationships and streamline administrative processes. MOUs between Host Country institutions are not discouraged but will not take the place of MOUs between US and Host Country institutions. MOUs must provide the opportunity for other CRSP projects to function under the authority of the agreement and must provide for joint authorship of reports and site visits at the discretion of the CRSP Management Entity. Draft MOUs must be submitted to the ME for review prior to execution (RFP website: *MOUs*).

New Host Country Collaborating Institutions: Proposals must include a response to the New Host Country Research Location Considerations (RFP website: *New HC Research Location Considerations*). Successful proponents will be required to prepare and submit full characterizations of all Host Country research locations shortly after award. Descriptions of previous and current CRSP research sites are available: http://pdacrsp.oregonstate.edu/pubs/featured_titles/, and from the Links part of the RFP website.

Fostering Respectful Partnerships: Proposals that foster linkages with organizations including US minority-serving institutions, non-governmental organizations (NGOs), national agricultural research institutions, other CRSPs, international centers, private businesses, and others are desired. Proposals that link Host Country researchers from one CRSP site to another CRSP site are encouraged. US and Host Country PIs will share in budgetary decisions and overall priority setting for the project, as well as in other collaborative activities related to the CRSP. Proposals, work plans, and project budgets must be developed collaboratively between HC and US researchers.

US PIs must actively establish an effective working relationship with the ME and other CRSP US and Host Country PIs and program participants.

Technical Considerations for Award of a CRSP Project

Research that generates new information should form the core of proposals. Proposals must also include institutional strengthening, outreach, and capacity building activities such as training, formal education, workshops, extension, and conference organizing to support the scientific research being proposed.

1. Proposals must be innovative, feasible, and demonstrate technical merit as assessed via peer review.

2. Investigations that generate new information should form the core of proposals. Each investigation must be clearly identified as an experiment, study, or activity, based on the following definitions:

   Experiment A scientifically sound investigation that addresses a testable hypothesis. An experiment implies collection of new data by controlled manipulation and observation.

   Study A study may or may not be less technical or rigorous than an experiment and may state a hypothesis if appropriate. Studies include surveys, focus groups, database examinations, most modeling work, and collection of technical data that do not involve controlled manipulation (e.g., collection and analysis of soil samples from sites without having experiments of hypothesized effect before collection).

   Activity An activity requires staff time and possibly materials but does not generate new information like an experiment or a study. Conference organization, training sessions, workshops, outreach, and transformation and dissemination of information are examples of activities.

   Investigations provide a transparent means for evaluating different types of work under the CRSP, be it quantitative, empirical, biologically-based, qualitative, policy-based, or informal.

3. Proposals must include at least one *experiment* or *study*. Proposals must also include outreach *activities* such as training, formal education, extension, and conference organizing to supplement the scientific research being proposed.

4. Proposals must identify intended beneficiaries, stakeholders, and end-users. To this end, each investigation must include a section on the *quantifiable benefits* that are anticipated (RFP website: *Quantifiable Benefits, and Outreach and Dissemination Plan*).

5. Proposals must provide a gender inclusiveness strategy (RFP website: *Gender Inclusiveness Strategy*).

6. Proposals must include a response to *New Host Country Research Location Considerations* and a plan for characterizing the new location (RFP website: *New HC Research Location Considerations*). Proponents will be required to prepare and submit full characterizations (*Site Descriptions*) of all Host Country research locations.

7. PI(s) will be responsible for fulfilling all ME and USAID reporting requirements (RFP website: *Reporting Requirements*).

8. Proposals must contain a plan for outreach and dissemination (RFP website: *Outreach and Dissemination Plan*). The CRSP seeks to build capacity of HC researchers, farmers, and other stakeholders through improved understanding of aquacultural technologies, including soft technologies such as best practices and knowledge-based systems, as well as hard technologies. Proposals must also briefly describe future plans for additional work in critical need areas, whether funded by CRSP or a different agency.

9. Successful proposals will address the following general *research priorities*:

   Priority Ecosystems
   Freshwater and brackishwater ecosystems for aquaculture and aquaculture-fishery nexus topic areas; marine ecosystems are also included for the aquaculture-fishery nexus topic areas.

   Priority Species
   Low-trophic level fishes; domesticated freshwater fishes; non-finfishes (e.g., bivalves, seaweeds); aquatic organisms used in polycultures and integrated systems; native species. Food fishes are a priority but species used for non-food purposes (e.g., ornamental, pharmaceutical) may also be included as a priority if they are a vital part of an integrated approach towards food security and poverty alleviation.

   Target Groups
   Aquaculture farms (small- to medium-scale, subsistence and commercial) and aquaculture intermediaries, policy makers, and others in host countries.

   Key Partners
   University, government, non-government, and private sector.

10. Successful proposals will consider the following USAID *environmental restrictions*:
    - Biotechnical investigations will be conducted primarily on research stations in Host Countries;
    - Research protocols, policies and practices will be established prior to implementation to ensure that potential environmental impacts are strictly controlled;
    - All training programs and outreach materials intended to promote the adoption of CRSP-generated research findings will incorporate the appropriate environmental recommendations;
    - All sub-awards must comply with environmental standards;
    - CRSP Projects will not procure, use or recommend the use pesticides of any kind. This includes but is not limited to algicides, herbicides, fungicides, piscicides, parasiticides, and protozoacides.
    - CRSP Projects will not use or procure genetically modified organisms (GMO); and
    - CRSP Projects will not use or recommend for use any species that are non-endemic to a country or not already

well established in its local waters, or that are non-endemic and well established but are the subject of an invasive species control effort.

11. Successful proponents will be responsible for interactions with CRSP internal technical advisory groups. Each project will be assigned to one *Regional Center of Excellence* and one *Development Theme Advisory Panel*. These advisory groups will perform critical analysis and synthesis work for meeting USAIDs goals, and producing lessons learned materials.

12. Overall program goals will address USAID needs for meeting biodiversity conservation and biotechnology earmarks. Not every project will need to address these earmarks, but overall CRSP portfolio selection will be based on meeting USAID needs, as well as the needs of host countries and others.

13. Projects will be expected to participate in CRSP Annual Meetings.

14. Applicants must provide a statement of project vision. (RFP website: *Project Vision*)

Programmatic Considerations for Award of a CRSP Project

1. Proposals will ideally present a multi-disciplinary and multi-institutional approach to aquaculture research, development, and outreach in eligible Host Countries. Lead Partner Institutions and Lead PIs may submit more than one proposal, but award selection is likely to be limited to one proposal per Lead Partner Institution.

2. At least 50% of funds must be expended in or on behalf of the Host Country or region. (RFP website: *Budget Information*)

3. Proposals must be consistent with USAIDs strategic objectives, goals, and requirements. (RFP website: *USAID Goals and Guidelines*)

4. Applicants are asked to select a USAID-eligible country for their base operations and are encouraged to involve satellite countries to broaden the potential impact of their results. Information regarding USAID-eligible countries can be accessed via the RFP website under USAID links.

5. At least 25% of the overall program portfolio will be devoted to proposals targeting IEHA countries. Current IEHA countries are: Mali, Ghana, Zambia, Mozambique, Uganda, and Kenya. (RFP website: *USAID links*). Funds awarded under this RFP will be allocated primarily to IEHA countries.

6. Each applying US institution must provide US non-federal cost sharing as required by USAID. Proponents should target a 50% matching contribution for this project, with at least 35% of the match provided as non-federal cost share from the participating US entities (RFP website: *Budget Information*).

7. A key consideration for award of CRSP funding is that each applying US institution provide strong institutional support through cost-sharing PI effort. Salary support for US PIs will be limited (RFP website: *Budget Information*). US PIs charging <u>any</u> portion of salary to the CRSP award must also be serving in the capacity of major advisor to a graduate student working under an approved CRSP investigation.

8. Collaborative efforts that involve undergraduate students, graduate students, and post-doctoral fellows are encouraged. CRSP funds will not be used to support US expatriate personnel or consultants, as the CRSP model is intended to build institutional networks and capacities.

9. Proposals that leverage support from other sources in furthering the broad goals of the CRSP are desired. Leveraged support is support in addition to US non-federal cost sharing funds required for award of a CRSP project and in addition to the HC institutional match.

10. Familiarity with institutions in the proposed HC and region as indicated by past relationships is desirable, as is a successful institutional track record of work in the proposed country. A short statement describing institutional capacity and track record in the proposed host country or countries is required.

11. Proponents from diverse backgrounds are encouraged to apply. US minority-serving institutions are encouraged to apply.

12. Proposals must demonstrate return benefits to the US in furtherance of the program's responsibility to provide mutual benefits and discoveries that can apply to the HC region and US and that will support future development of sustainable aquaculture.

13. Funding is typically allocated on an annual basis. All allocations are contingent on the annual funding level obtained from USAID and on performance under subcontract provisions.

14. USAID concurrence for projects in host countries will be required prior to award. The ME will obtain concurrence on behalf of highly ranked applicants via USAID/Washington. Applicants may include letters of support from USAID Missions in their proposals, but these will not take the place of USAID concurrence to the ME.

Evaluation Criteria and Proposal Review

Prior to undergoing review, proposals will be checked for eligibility, completeness, and receipt date. Eligible proposals will undergo external technical peer review, which will be followed by programmatic review. Technical review will focus on scientific and intellectual merit, collaboration, and broader impact. Programmatic review will focus on overall portfolio balance among regions and themes; adherence to the RFP including the programmatic and budget sections; and adherence to the goals of USAID and needs of the host countries. (RFP website: *Proposal Review Criteria*)

EVALUATION GUIDELINES (excerpted). Please refer to the RFP Website for the complete review criteria.

INITIAL SCREENING

- Eligibility (institutional; RFP theme and topic area; country)
- Completeness
- Submission deadline

Eligible proposals will proceed to the review phase. Ineligible or late proposals will not qualify for review and/or funding consideration.

I. TECHNICAL PEER-REVIEW

INTELLECTUAL MERIT (50%)
1. Soundness
2. Innovation
3. Qualification of Researchers
4. Application of Research

COLLABORATION, CAPACITY BUILDING, AND BROADER IMPACTS (50%)
1. Education and Training
2. Inclusiveness
3. Human Health and Welfare
4. Networking and Institutional Development

II. PROGRAMMATIC REVIEW

Part 1. RFP Adherence

- Adherence to all Programmatic Criteria listed in the RFP
- Adherence to Budget Criteria
- Adherence to Requested information for compliance and institutional support

Part 2. Portfolio Balance

- Regional Balance Assessment
- Thematic Balance Assessment
- Area of Inquiry (Topic Area) Representation
- Technical Ranking within Region and Theme
- New US Lead Partner University

Part 3. USAID Compliance

USAID Eligibility:
- Does the proposal have Mission concurrence?
- Is work proposed for a USAID-eligible country?
- Does the proposal address key USAID goals and interests as defined in the RFP materials?

Initial Environmental Examination Screening (problems may delay projects, or decline projects):
- Assessment of whether there are any obvious environmental issues not raised by the technical review
- Screening process and findings
- Examination and review as necessary

Proposal Organization and Format

Format: • Paper Size: Standard (8.5″ x ll″)
• Line Spacing: Single space
• Minimum Page Margin: 1 inch on all sides
• Minimum Font Size: 10 point (9 point for header or footer)
• Each page of the proposal subsequent to the cover page must identify the Lead PI and proposal title (abbreviated if necessary) and the page number.

Checklist for Proposals

A checklist is provided for assembling the proposal packet (RFP website: *Checklist for Proposals*). The research proposal narrative, item 3 below, **must not exceed 30 pages**.

Proposals must contain the following elements:

- ☐ 1. Cover Sheet Form with Institutional signature
- ☐ 2. Summary Page Form
- ☐ 3. Research Proposal Narrative (30 pages maximum)
  - ☐ a. Executive Summary; Introduction and Vision Statement (2-page limit)
  - ☐ b. Investigations (5-pg limit for each investigation; up to 10 investigations total; 26 pp total)
  - ☐ c. Outreach and Dissemination Plan (1-page limit)
  - ☐ d. Gender Inclusiveness Strategy (1-page limit)
- ☐ 4. New HC Research Location Considerations (2-page limit)
- ☐ 5. Budget (with Institutional signature)
  - ☐ (3) single-year budgets for Lead. Include budgets for subcontractors and HC institutions (up to 9 single-year budgets)
  - ☐ (1) combined-year budget for Lead. Include the combined-year budget for subcontractors and HC institutions (up to 3 combined-year budgets)
- ☐ 6. Budget Justification for Lead, Subcontractors, and HC for each year (up to 9 forms)
- ☐ 7. Pending Funds Form
- ☐ 8. Conflict-of-Interest Form for each (Lead, US, and HC) PI
- ☐ 9. List of names of 5 reviewers (names, address and email, areas of expertise)
- ☐ 10. Letters of Commitment from HC PIs and from US and HC partners
- ☐ 11. Statement of institutional track record and experience in the proposed HC (2-page limit)
- ☐ 12. Lead Institution supporting information:
  - ☐ Animal Use Approval (or written waivers)
  - ☐ Human Subjects Approval (or written waivers)
  - ☐ NICRA for Lead Institution (Negotiated indirect cost rate agreement)
  - ☐ Institutional & Agency Certifications and Assurances (5 forms)
- ☐ 13. CVs of Lead PI and all US and HC Co-PIs (2-page limit per CV)

Instructions for Completing the Descriptions of Investigations ~ see above Checklist: 3b ~

1. Individual investigation descriptions must not exceed five pages. All investigation descriptions within one proposal must not exceed 26 pages. Proposals may contain up to 10 investigations.
2. Each investigation must be described separately and include the following elements:
   a. Title: below the title include the topic area (p. 3-4) to which the proposed investigation applies and specify whether the investigation is an experiment, study or activity (p. 6, item 2).
   b. Lead PI and institutional affiliation; subcontracting co-PIs and institutional affiliations; HC PIs and institutional affiliation
   c. Objective(s) [and null hypotheses for experiments]
   d. Significance: Provide justification for conducting the proposed work, review similar and related work reported in the literature (include citations below under h.), and describe how the work relates to the priorities described in this RFP.
   e. Quantified Anticipated Benefits: Identify target groups and direct and indirect benefits accruing from the research and outreach work. Benefits must be quantifiable metrics (RFP website: *Quantifiable Benefits*).
   f. Research Design or Activity Plan
      (1) Location of work
      (2) Methods
   g. Schedule, indicating the start date (not earlier than 1 April 2007) and completion date (not later than 30 September 2009) of the proposed work.
   h. Literature Cited

Proposal Submission

1. Submit your full proposal via email to aquafish@oregonstate.edu by 5pm Pacific Time on Thursday 5 February 2009.

2. Mail ten (10) printed copies and one (1) electronic copy on CD/DVD of each proposal must be received by Friday 6 February 2009. The ME will acknowledge timely receipt of proposals via email to the Lead PI from the US Lead Partner Institution.

2. Do not exceed the proposal narrative 30-page limit. Proposals exceeding the proposal narrative page limit will not be considered.

3. Proposal packets must have the formal signed approval of the Lead Partner Institution.

4. Individual investigations that will be carried out under subcontract from the Lead Partner Institution to another US institution must be affirmed by the formal signed approval of the subcontracting US institution. (*Attach a separate letter*)

5. Mail paper and CD/DVD submissions to:
   Dr. Hillary S. Egna, CRSP Director
   Oregon State University
   Snell Hall 418
   Corvallis, OR 97331-1643 USA

Program objectives and future work

The goal of the AquaFish CRSP is to conduct research that contributes significantly to the removal of major constraints to sustainable aquaculture development and responsible small-scale fisheries management, thereby promoting economic growth, enhancing food security, and conserving natural resources in developing countries. CRSPs are funded by USAID under authority of the International Development and Food Assistance Act of 1975 (PL 94-161), and by participating institutions.

The AquaFish CRSP is a newer CRSP under USAID/EGAT's Office of Natural Resources Management. Oregon State University was awarded a 5-year Leader with Associates Cooperative Agreement (No. EPP-A-00-06-00012-00) for the Aquaculture & Fisheries CRSP (AquaFish CRSP) on 29 September 2006. In 2010, the program will be evaluated for a possible 5-year extension. Two major work plans (each with defined annual implementation plans) will describe the specific research to be carried out under the CRSP's framework of general research priorities. This RFP is a call for the Second Work Plan. For the second directed RFP, CRSP researchers with incomplete First Work Plan investigations will not be eligible to receive funding until all previous obligations are satisfactorily met. The Implementation Plan resulting from the first RFP is available from the AquaFish CRSP website. Please refer to the RFP website and the CRSP website for additional information.

~ AQUAFISH CRSP RFP ~

http://aquafish.oregonstate.edu

QUESTIONS ABOUT THE CRSP RFP ?

Consult the CRSP RFP website <aquafish.oregonstate.edu> for answers to **Frequently Asked Questions**, a feature that will be added to over time.
Send an email to <aquafish@oregonstate.edu> or call ~ 541.737.6426

APPENDIX 10: AQUACULTURE & FISHERIES COLLABORATIVE RESEARCH SUPPORT PROGRAM REQUEST FOR PROPOSALS - 2009

AquaFish Collaborative Research Support Program

Request for Proposals 2009-2011:
Global Research, Capacity Building, and Institutional Development in Aquaculture and Aquatic Resources Management

Important Dates Date of Initial Notification: 15 February 2009
Proposals Due: 3 August 2009
Announcement of Selections: 1 November 2009

This Request for Proposals is issued by the Management Entity of the AquaFish CRSP, Snell Hall 418, Oregon State University, Corvallis, Oregon, 97331 USA. Website: http://aquafishcrsp.oregonstate.edu Email: aquafish@oregonstate.edu

The AquaFish CRSP (CRSP) Management Entity (ME) is inviting proposals from current US Lead Partner Institutions (LPIs) for solving critical problems facing global aquaculture development and aquatic resources management in lower-income countries. The AquaFish CRSP is managed by Oregon State University under a five-year award from the US Agency for International Development (USAID). This streamlined RFP is designed for continuation proposals from current Lead CRSP projects at UM, NCSU, UConn, UArizona, UHH, and Purdue. The continuing goal is to attract proposals that will develop linkages between the United States and selected Host Countries for Global Research, Capacity Building, and Institutional Development. Proposals must target regions and themes in furtherance of USAID's goals, as described in this RFP.

For this streamlined RFP, existing LPIs will be the Lead Partner Institution submitting the proposal. Special exceptions can be requested to change a Lead, but will likely require review and analysis beyond this RFP's timeframe. Eligible lead institutions include US universities, colleges, and minority-serving institutions (see shaded box for details). Lead Partners are expected to assume strong administrative and technical leadership for projects, be involved in advisory groups serving the overall program, and form collaborative partnerships through sub-awards to developing country institutions, NGOs, IARCs, private sector firms, and other US universities or colleges.

The total award period under this RFP will be approximately 2 years, ending on September 29, 2011 when the current CA/LWA expires. Proposals will ideally include the participation of other US institutions to be funded by the LPI by means of secondary subcontracts. The LPI may elect to change or add new partners or subcontractors to their existing project. Host Country (HC) institution involvement is mandatory and will be funded via the Lead Partner Institution's award from Oregon State University.

The funding level available for these multi-institutional and multi-disciplinary proposals is $450,000. The start date is the date that current work has been successfully completed: 9/30/09, 12/31/09, or 3/31/10. All allocations are contingent on the annual funding level obtained from USAID and on performance under subcontract provisions.

A successful proposal will focus on the same theme (p. 2) in the same region as the existing project. Topic areas can be changed in this new proposal. Themes can not. Each proposal will likely include multiple investigations that each target one of the identified topic areas (p. 3 to 4). Investigations are discussed in this RFP in detail under Technical Considerations (p. 6). Proposals must address how they will align with overall Program goals, and how they build on and add value to currently funded CRSP work.

The goal of the new Aquaculture & Fisheries CRSP as stated by USAID is to "develop more comprehensive, sustainable, ecological and socially compatible, and economically viable aquaculture systems and innovative fisheries management systems in developing countries that contribute to poverty alleviation and food security." (USAID, May 2006)

Eligibility for Lead Partner Institution

Based on Section 269(d) of Title XII of the Foreign Assistance Act of 1961, as amended, an eligible university or college is defined as: "... those colleges or universities in each State, territory, or possession of the United States, or the District of Columbia, now receiving, or which may hereafter receive, benefits under the Act of July 2, 1862 (known as the First Morrill Act) or the Act of August 30, 1890 (known as the Second Morrill Act), which are commonly known as 'land-grant' universities; institutions now designated or which may hereafter be designated as sea-grant colleges under the Act of October 5, 1966 (known as the National Sea Grant College and Program Act), which are commonly known as sea-grant colleges; Native American land-grant colleges as authorized under the Equity in Educational Land-Grant Status Act of 1994 (7 U.S.C. 301 note); and other United States colleges and universities which – (1) have demonstrable capacity in teaching, research, and extension (including outreach) activities in the agricultural sciences; and (2) can contribute effectively to the attainment of the objectives of this title."

Eligibility for Additional Partners under the Lead: Public and private entities such as other universities, colleges, minority-serving institutions, companies, international non-government organizations (NGOs), and others with resources and relevant experience for conducting research, training and outreach activities, and implementing research projects, are eligible to apply. For-profit firms may participate as sub-awardees but, pursuant to 22 CFR 226.81, it is USAID policy not to award profit under assistance instruments such as cooperative agreements. All reasonable, allocable, and allowable expenses, both direct and indirect, which are related to the program and are in accordance with applicable cost standards (22 CFR 226, OMB Circular A-122 for non-profit organization, OMB Circular A-21 for universities, and the Federal Acquisition Regulation (FAR) Part 31 for-profit organizations), may be paid under the CRSP. US Minority-Serving Institutions include those mandated as Historically Black Colleges and Universities (HBCU), Tribal Colleges and Universities, Asian American and Pacific Islander (AAPI) Serving Institutions, and Hispanic Serving Institutions.

This Request for Proposals is issued by the Management Entity of the *Aquaculture & Fisheries Collaborative Research Support Program*, Oregon State University, Corvallis, Oregon, USA, under Leader with Associates Cooperative Agreement No. EPP-A-00-06-00012-00. The ME will contact Lead Principal Investigators (PIs) on or before 1 November 2009, requesting revisions. Lead PIs will be notified if the selection decision will be delayed. The ME reserves the right to modify this schedule as necessary to ensure that standards of fairness and accuracy are met. Actual awards are contingent on funding received by the ME. All existing and prior funded work must be satisfactorily completed and all final reports and deliverables received by the ME before any new funding is awarded. All existing LPIs encouraged to apply. Proponents must demonstrate a commitment to promoting and enhancing diversity.

Disclaimer: *Issuance of this RFA does not constitute an award commitment on the part of Oregon State University, nor does it commit the University to pay for costs incurred in the preparation or submission of an application. In addition, final award of any resultant sub-awards cannot be made until funds have been fully appropriated, allocated, and committed through internal OSU procedures. While it is anticipated that these procedures will be successfully completed, potential applicants are hereby notified of these requirements and conditions for award. Applications are submitted at the risk of the applicant. Should circumstances prevent award of a project, all preparation and submission costs are at the applicant's expense.*

Global Themes

The four global themes of the CRSP are cross-cutting and address several specific USAID policy documents and guidelines, including the *Policy Framework for Bilateral Foreign Aid*, *Agriculture Strategy*, EGAT Offices of Agriculture and Natural Resource Management Strategic Objectives, and IEHA (Initiative to End Hunger in Africa). To see how these themes relate to USAID's focal areas and for additional information on these USAID documents, please refer to the CRSP RFP website: *USAID Goals and Guidelines*. The overall research context for this RFP is poverty alleviation and food security improvement through sustainable aquaculture development and aquatic resources management. ***Proponents will continue work in their existing primary theme*** (goal) for their overall proposal. Proposals must address all four themes in an integrated systems approach, but will primarily focus on one theme as it relates to producing positive development outcomes:

Global AquaFish CRSP Themes (Goals)

A. Improved Health and Nutrition, Food Quality, and Food Safety
B. Income Generation for Small-Scale Fish Farmers
C. Environmental Management for Sustainable Aquatic Resources Use
D. Enhanced Trade Opportunities for Global Fishery Markets

The CRSP will be managed in a manner that achieves maximum program impacts, particularly for small-scale farmers and fishers, in Host Countries and more broadly. CRSP overall program objectives address the need for world-class research, capacity building, and information dissemination. Specifically, the AquaFish CRSP strives to:

- Develop sustainable end-user level aquaculture and fisheries systems to increase productivity, enhance international trade opportunities, and contribute to responsible aquatic resource management;
- Enhance local capacity in aquaculture and aquatic resource management to ensure long-term program impacts at the community and national level;
- Foster wide dissemination of research results and technologies to local stakeholders at all levels, including end users, researchers, and government officials; and
- Increase Host Country capacity and productivity to contribute to national food security, income generation, and market access.

AquaFish CRSP Topic Areas for Research, Outreach and Capacity Building Investigations

Thematic proposals will contain implementation plans (investigations) organized around a number of specific areas of inquiry (called Topic Areas). **Proponents will identify one topic area for each investigation in the proposal. Proposals ideally will contain six investigations (see p. 9), with most investigations being experiments or studies, and at least one of the six being an activity that focuses on outreach to women (see CA/LWA p. 20)**. The maximum number of investigations is ten. Proposals will focus on more than one topic area in describing aquaculture research that will improve diets, generate income for small-holders, manage environments for future generations, and enhance trade opportunities. Proposals should be formed around *core program components*, as identified by USAID:

- a systems approach
- outreach, dissemination, and adoption;
- gender integration
- social, economic, and environmental sustainability
- capacity building and institution strengthening

A systems approach requires that each CRSP project integrate topic areas from both *Integrated Production Systems*, and *People, Livelihoods and Ecosystem Interrelationships* (see below).* USAID also encourages the CRSP portfolio (the sum of all funded projects) to address biodiversity conservation and non-GMO biotechnology solutions to critical issues in aquaculture. While not every investigation will individually address each element recommended by USAID, overall the proposal must describe a comprehensive development approach to a problem. **Investigations that address biodiversity and biotechnology, as described above, are encouraged as those areas were underrepresented in the 2007-09 Implementation Plan.**

Topic Areas pertain to aquaculture AND the nexus between aquaculture and fisheries. Some of the following topic areas overlap and are interconnected. Select each topic area so that it best describes each individual investigation. Select a range of topic areas so that together they address the broader theme (goal). The text under each topic area is provided for illustrative

Research and Outreach Topic Areas: Integrated Production Systems

• Production System Design and Best Management Alternatives
Aquaculture is an agricultural activity with specific input demands. Systems should be designed to improve efficiency and/or integrate aquaculture inputs and outputs with other agricultural and non-agricultural production systems. Systems should be designed so as to limit negative environmental impacts. CRSP research should benefit small-holder or low- to semi-intensive producers, and focus on low-trophic species for aquaculture development. Research on soil-water dynamics and natural productivity to lessen feed needs were fundamental to the Aquaculture CRSP; critical new areas of research may be continued. Interventions for disease and predation prevention must adopt an integrated pest management (IPM) approach and be careful to consider consumer acceptance and environmental risk of selected treatments.

• Sustainable Feed Technology
Methods of increasing the range of available ingredients and improving the technology available to manufacture and deliver feeds is an important research theme. Better information about fish nutrition can lead to the development of less expensive and more efficient feeds. Investigations on successful adoption, extension, and best practices for efficient feed strategies that reduce the "ecological footprint" of a species under cultivation is encouraged. Feed research that lessens reliance on fish meals/proteins/oils and lowers feed conversion ratios is desired, as is research on feeds (ingredients, sources, regimes, formulations) that result in high quality and safe aquaculture products with healthy nutrition profiles.

• Indigenous Species Development
Domestication of indigenous species may contribute positively to the development of local communities as well as protect ecosystems. At the same time, the development of new native species for aquaculture must be approached in a responsible manner that diminishes the chance for negative environmental, technical, and social impacts. Research that investigates relevant policies and practices is encouraged while exotic species development and transfer of non-native fishes are not encouraged. A focus on biodiversity conservation, and biodiversity hotspots, as related to the development of new native species for aquaculture is of great interest. Aquaculture can be a means to enhance and restock small-scale capture and wild fisheries resources (Aquaculture-Fisheries Nexus Topic Area). Augmentation of bait fisheries through aquaculture to support capture fisheries is an area of interest, provided there are no net negative environmental effects.

• Quality Seedstock Development
Procuring reliable supplies of high quality seed for stocking local and remote sites is critical to continued development of the industry, and especially of small-holder private farms. A better understanding of the factors that contribute to stable seedstock quality, availability, and quantity for aquaculture enterprises is essential. Genetic improvement (e.g., selective breeding) that does not involve GMOs may be needed for certain species that are internationally traded. All genetic improvement strategies need to be cognizant of marketplace pressures and trends, including consumer acceptance and environmental impacts.

* USAID requires scientists to adopt a systems approach for understanding how their research relates to three elements: Livelihoods, Production Landscapes, and Market Forces. The correspondence of these three USAID elements to the Topic Areas above is: Livelihoods and Market Forces = *People, Livelihoods and Ecosystem Interrelationships*; Production Landscapes = *Integrated Production Systems.*

Research and Outreach Topic Areas: People, Livelihoods, and Ecosystem Interrelationships

• Human Health Impacts of Aquaculture
Aquaculture can be a crucial source of proteins and micronutrients for improved human health, growth, and development. Research on the intrinsic food quality of various farmed fish for human consumption is needed – this might include science-based studies of positive and negative effects of consuming certain farmed fishes. Patterns of fish consumption are not well understood for many subpopulations. Human health can be negatively impacted by aquaculture if it serves as a direct or indirect vector for human diseases. There is interest in better understanding the interconnectedness of aquaculture production and water/vector-borne illnesses such as malaria, schistosomiasis, and Buruli ulcer and human health crises such as HIV/AIDS and avian flu.

• Food Safety and Value-Added Product Development
(Aquaculture-Fisheries Nexus Topic Area)
Ensuring high quality, safe, and nutritious fish products for local consumers and the competitive international marketplace is a primary research goal. Efforts that focus on reducing microbial contamination, HACCP controls and hazards associated with seafood processing, value-added processing, post-processing, and byproduct/waste development are of interest. Consumers and producers alike will benefit from research that contributes to the development of standards and practices that protect fish products from spoilage, adulteration, mishandling, and off-flavors. Certification, traceability, product integrity and other efforts to improve fish products for consumer acceptance and international markets are desired. Gender integration is important to consider as women are strongly represented in the processing and marketing sectors.

• Technology Adoption and Policy Development
Developing appropriate technology and providing technology-related information to end-users is a high priority. The program encourages research that results in a better understanding of factors and practices that set the stage for near-term technology implementation and that contribute to the development of successful extension tools and methods. Areas of inquiry can include institutional efforts to improve extension related to aquaculture and aquatic resources management; science-based policy recommendations targeting poor subpopulations within a project area, or more broadly (for example, national aquaculture strategies); methods of improving access to fish of vulnerable populations including children (e.g., school-based aquaculture programs); science-based strategies for integrating aquaculture with other water uses to improve wellbeing, such as linkages with clean drinking water and improved sanitation. Policy initiatives that link aquaculture to various water uses to improve human health are needed. Additionally, social and cultural analyses regarding the impacts of fish farming may yield critical information for informing policy development.

• Marketing, Economic Risk Assessment, and Trade
(Aquaculture-Fisheries Nexus Topic Area)
Aquaculture is a rapidly growing industry and its risks and impacts on livelihoods need to be assessed. Significant researchable issues in this arena include cost, price, and risk relationships; domestic market and distribution needs and trends; the relationships between aquaculture and women/underrepresented groups; the availability of financial resources for small farms; and the effects of subsidies, taxes, and other regulations. Understanding constraints across value chains in local, regional, and international markets is of interest, especially as constraints affect competitiveness, market demand, and how to link producers to specific markets.

• Watershed and Integrated Coastal Zone Management
(Aquaculture-Fisheries Nexus Topic Area)
Aquaculture development that makes wise use of natural resources is at the core of the CRSP. Research that yields a better understanding of aquaculture as one competing part of an integrated water use system is of great interest. The range of research possibilities is broad—from investigations that quantify water availability and quality to those that look into the social context of water and aquaculture, including land and water rights, national and regional policies (or the lack thereof), traditional versus industrial uses, and the like. Water quality issues are of increasing concern as multiple resource use conflicts increase under trends toward scarcity or uneven supply and access, especially for freshwater. Ecoregional analysis is also of interest to explore spatial differences in the capacities and potentials of ecosystems in response to disturbances. Innovative research on maximizing water and soil quality and productivity of overall watersheds is of interest. Pollution is a huge concern, as over 50% of people in developing countries are exposed to polluted water sources. Additionally, aquatic organisms cannot adequately grow and reproduce in polluted waters, and aquaculture may not only be receiving polluted waters, but adding to the burden. Rapid urbanization has further harmed coastal ecosystems, and with small-scale fisheries and aquaculture operations in the nearshore, integrated management strategies for coastal areas are also important.

• Mitigating Negative Environmental Impacts
(Aquaculture-Fisheries Nexus Topic Area)
With the rapid growth in aquaculture production, environmental externalities are of increasing concern. Determining the scope and mitigating or eliminating negative environmental impacts of aquaculture—such as poor management practices and the effects of industrial aquaculture—is a primary research goal of this program. A focus on biodiversity conservation, especially in biodiversity "hotspot" areas, as related to emerging or existing fish farms is of great interest. Therefore, research on the impacts of farmed fish on wild fish populations, and research on other potential negative impacts of farmed fish or aquaculture operations is needed, along with scenarios and options for mitigation.

Please note that specific fisheries issues will be addressed through subsequent Associate Awards involving USAID Missions, and not in the current RFP.

Program Regions

Proposals that focus on established AquaFish CRSP Host Countries and overlap with emerging interest areas of the CRSP are encouraged. Strengthening existing countries' infrastructure builds on previous USAID investments. However, new host country linkages may be proposed (RFP website: *New HC Research Location Considerations*). Proposals will be evaluated based on the strength of linkages to host countries, among other criteria. **Your proposal must focus on one USAID-eligible country within your existing region, but activities are encouraged in nearby countries within the same region, and as appropriate, across regions**. Continuing existing AquaFish CRSP relationships are encouraged. Additional work can be built on foundation work laid by the Aquaculture CRSP, or by proposing new countries. Adding new countries may require additional USAID review of your proposal, and will require a full site description to be on file prior to award.

Please refer to the RFP webite for current countries included in USAID's *Country-Level Foreign Assistance Framework* and USAID's *Policy Framework for Bilateral Foreign Aid.* USAID requires that one-quarter of the overall Aquaculture & Fisheries CRSP portfolio focuses on countries included in the *Initiative to End Hunger in Africa* (RFP website: *USAID Links*). CRSP will focus primarily, although not exclusively, on Rebuilding Countries, Developing Countries, and Transforming Countries in the following regions:

- Central America
- South America
- Caribbean
- Africa
- South and East Asia
- Eastern Europe
- Central Asia

OTHER SITE CONSIDERATIONS

USAID-Eligible Countries: If you are interested in a country not in the existing AquaFish CRSP, please contact the CRSP ME for additional information. Cautionary note: Proposed activities will require USAID country-level concurrence prior to award. Non-concurrence can mean that a project or investigation is not approved for funding. For a list of USAID-presence countries, please go to the USAID links from the RFP website.

Memoranda of Understanding: Within 3 months of award notification, the Lead Partner Institution will be required to enter into Memoranda of Understanding (MOUs) with new institutions at Host Country sites. **MOUs with existing institutions will need to be renewed and filed with the ME prior to award**. Subcontracting US institutions may also enter into MOUs with HC partners to strengthen institutional relationships and streamline administrative processes. MOUs between Host Country institutions are not discouraged but will not take the place of MOUs between US and Host Country institutions. MOUs must provide the opportunity for other CRSP projects to function under the authority of the agreement and must provide for joint authorship of reports and site visits at the discretion of the CRSP Management Entity. **Draft MOUs with new institutions must be submitted to the ME for review prior to execution** (RFP website: *MOUs*).

New Host Country Collaborating Institutions: Proposals that add a new Host Country research location must include a response to the New Host Country Research Location Considerations (RFP website: *New HC Research Location Considerations*). Successful proponents will be required to prepare and submit full characterizations of new Host Country research locations during project negotiation. Descriptions of previous and current AquaFish CRSP research sites are available from the AquaFish CRSP website.

Fostering Respectful Partnerships: Proposals that foster linkages with organizations including US minority-serving institutions, non-governmental organizations (NGOs), national agricultural research institutions, other CRSPs, international centers, private businesses, and others are desired. Proposals that link Host Country researchers from one CRSP site to another CRSP site are encouraged. US and Host Country PIs will share in budgetary decisions and overall priority setting for the project, as well as in other collaborative activities related to the CRSP. Proposals, work plans, and project budgets must be developed collaboratively between HC and US researchers.

US PIs must actively establish an effective working relationship with the ME and other CRSP US and Host Country PIs and program participants.

Technical Considerations for Award of a CRSP Project

Research that generates new information will form the core of proposals. Proposals must also include institutional strengthening, outreach, and capacity building activities such as training, formal education, workshops, extension, and conference organizing to support the scientific research being proposed.

1. Proposals must be innovative, feasible, and demonstrate technical merit as assessed via peer review.

2. **Investigations that generate new information will form the core of proposals.** Each investigation must be clearly identified as an experiment, study, or activity, based on the following definitions:

   Experiment A scientifically sound investigation that addresses a testable hypothesis. An experiment implies collection of new data by controlled manipulation and observation.

   Study A study may or may not be less technical or rigorous than an experiment and may state a hypothesis if appropriate. Studies include surveys, focus groups, database examinations, most modeling work, and collection of technical data that do not involve controlled manipulation (e.g., collection and analysis of soil samples from sites without having experiments of hypothesized effect before collection).

   Activity An activity requires staff time and possibly materials but does not generate new information like an experiment or a study. Conference organization, training sessions, workshops, outreach, and transformation and dissemination of information are examples of activities.

   Investigations provide a transparent means for evaluating different types of work under the CRSP, be it quantitative, empirical, biologically-based, qualitative, policy-based, or informal.

3. Proposals must include at least one *experiment* or *study*. Proposals must also include at least one outreach *activity* that focuses on women (see AquaFish M&E plan).

4. Investigations must identify intended beneficiaries, stakeholders, and end-users. To this end, each investigation must include a section on the *quantifiable benefits* that are anticipated (RFP website: *Quantifiable Benefits; Outreach & Dissemination Plan*).

5. Investigations must integrate gender to the extent possible to meet program targets. Overall, proposals will include a gender inclusiveness strategy (RFP website: *Gender Inclusivity Strategy*). **The existing strategy can be revised or resubmitted if it is still applicable to the work proposed. If resubmitting the gender strategy from 2007-09, additional details incorporating gender will need to be apparent in the new investigations.**

6. Proposals that add a new Host Country research location to one of the CRSP regions must include a response to *New Host Country Research Location Considerations* and a plan for characterizing the new location (RFP website: *New HC Research Location Considerations*). Proponents will be required to prepare and submit full characterizations (*Site Descriptions*) of new Host Country research locations before award.

7. PI(s) will be responsible for fulfilling all ME and USAID reporting requirements (AquaFish website: *Reporting Requirements 2009*).

8. Proposals must contain a plan for outreach and dissemination (RFP website: *Outreach and Dissemination Plan*). The CRSP seeks to build capacity of HC researchers, farmers, and other stakeholders through improved understanding of aquacultural technologies, including soft technologies such as best practices and knowledge-based systems, as well as hard technologies.

9. Proposals must briefly describe future plans for additional work in critical need areas, whether funded by CRSP or a different source, and exit strategies within the Introduction..

10. Successful proposals will address the following general *research priorities*:

    Priority Ecosystems
    Freshwater and brackishwater ecosystems for aquaculture and aquaculture-fishery nexus topic areas; marine ecosystems are also included for the aquaculture-fishery nexus topic areas.

    Priority Species
    Low-trophic level fishes; domesticated freshwater fishes; non-finfishes (e.g., bivalves, seaweeds); aquatic organisms used in polycultures and integrated systems; native species. Food fishes are a priority but species used for non-food purposes (e.g., ornamental, pharmaceutical) may also be included as a priority if they are a vital part of an integrated approach towards food security and poverty alleviation.

    Target Groups
    Aquaculture farms (small- to medium-scale, subsistence and commercial) and aquaculture intermediaries, policy makers, and others in host countries.

    Key Partners
    University, government, non-government, and private sector.

11. Successful proposals will consider the following USAID *environmental restrictions*:
    - Biotechnical investigations will be conducted primarily on research stations in Host Countries;
    - Research protocols, policies and practices will be established prior to implementation to ensure that potential environmental impacts are strictly controlled;
    - All training programs and outreach materials intended to promote the adoption of CRSP-generated research findings will incorporate the appropriate environmental recommendations;
    - All sub-awards must comply with environmental standards;
    - CRSP Projects will not procure, use or recommend the use pesticides of any kind. This includes but is not limited to algicides, herbicides, fungicides, piscicides, parasiticides, and protozoacides.
    - CRSP Projects will not use or procure genetically modified

organisms (GMO); and
- CRSP Projects will not use or recommend for use any species that are non-endemic to a country or not already well established in its local waters, or that are non-endemic and well established but are the subject of an invasive species control effort.

12. Successful proponents will be responsible for interactions with CRSP internal technical advisory groups. Each project will continue its service on one *Regional Center of Excellence* and one *Development Theme Advisory Panel*. Upon petition to the Director, a Lead Coordinator may rotate off during this next cycle, provided that a replacement can be found. CRSP advisory groups perform critical analysis and synthesis work for meeting USAIDs goals, and producing lessons learned materials.

13. Overall program goals will address USAID needs for meeting biodiversity conservation and biotechnology earmarks. Not every project will need to address these earmarks, but overall CRSP portfolio selection will be based on meeting USAID needs, as well as the needs of host countries and others.

14. Proposals must describe how the proposed new work builds on current work. Include this information in the *Introduction* and more specifically within each Investigation, under *Significance*.

Programmatic Considerations for Award of a CRSP Project

1. Proposals will ideally present a multi-disciplinary and multi-institutional approach to aquaculture research, development, and outreach in eligible Host Countries. Lead Partner Institutions and Lead PIs may submit only one proposal.
2. At least 50% of funds must be expended in or on behalf of the Host Country or region. (RFP website: *Budget Information*)
3. Proposals must be consistent with USAIDs strategic objectives, goals, and requirements. (RFP website: *USAID Goals and Guidelines*)
4. Applicants will retain their existing region and select a USAID-eligible country for their base operations. They are encouraged to involve satellite countries to broaden the potential impact of their results. Information regarding USAID-eligible countries can be accessed via the RFP website under USAID links.
5. At least 25% of the overall program portfolio will be devoted to proposals targeting IEHA countries.
6. Each applying US institution must provide US non-federal cost sharing as required by USAID. Proponents should target a 50% matching contribution for this $450,000 project, with at least 35% of the match ($157,500) provided as US non-federal cost share from the participating US entities (RFP website: *Budget Information*), and 15% ($67,500) from particpating HC institutions. (For Lead US Universities that provided less than the 35% from 2007-09, the matching requirement will be slightly greater.)
7. A key consideration for award of CRSP funding is that each applying US institution provide strong institutional support through cost-sharing PI effort. Salary support for US PIs will be limited (RFP website: *Budget Information*). US PIs charging any portion of salary to the CRSP award must also be serving in the capacity of major advisor to a graduate student working under an approved CRSP investigation.
8. Collaborative efforts that involve undergraduate students, graduate students, and post-doctoral fellows are encouraged. CRSP funds will not be used to support US expatriate personnel or consultants, as the CRSP model is intended to build institutional networks and capacities.
9. Proposals that leverage support from other sources in furthering the broad goals of the CRSP are desired. Leveraged support is support in addition to US non-federal cost sharing funds required for award of a CRSP project and in addition to the HC institutional match. Provide a statement indicating the support your existing project has leveraged to date, and expects to leverage in the future. **The leveraging statement is part of the pending funds form.**
10. Familiarity with institutions in the proposed HC and region as indicated by past relationships is desirable, as is a successful institutional track record of work in a host country. A short statement describing institutional capacity and track record in any **new** proposed host country or countries must be included in the Introduction. Not required if new countries are not added.
11. Proponents from diverse backgrounds are encouraged to apply. US minority-serving institutions are encouraged to apply.
12. Proposals must demonstrate return benefits to the US in furtherance of the program's responsibility to provide mutual benefits and discoveries that can apply to the HC region and US and that will support future development of sustainable aquaculture. **Within the investigations, include outputs and anticipated benefits that meet this goal.**
13. Funding is typically allocated on an annual basis. All allocations are contingent on the annual funding level obtained from USAID and on performance under subcontract provisions.
14. USAID concurrence in new AquaFish CRSP host countries will be required prior to award. The ME will obtain concurrence on behalf of highly ranked applicants via USAID/Washington. Applicants may include letters of support from USAID Missions in their proposals, but these will not take the place of USAID concurrence to the ME.
15. USAID certifications and assurances are not required unless LPIs have made changes since their last filing with OSU in 2007.

Evaluation Criteria and Proposal Review

Prior to undergoing review, proposals will be checked for eligibility, completeness, and receipt date. Eligible proposals will undergo external technical peer review, which will be followed by programmatic review. Technical review will focus on scientific and intellectual merit, collaboration, and broader impact. Programmatic review will focus on overall portfolio balance among regions and themes; adherence to the RFP including the programmatic and budget sections; and adherence to the goals of USAID and needs of the host countries. (RFP website: *Proposal Review Criteria*)

EVALUATION GUIDELINES (excerpted). Please refer to the RFP Website for the complete review criteria.

INITIAL SCREENING

- Eligibility (institutional; RFP theme and topic area; country)
- Completeness
- Submission deadline

Eligible proposals will proceed to the review phase. Ineligible or late proposals may not qualify for review and/or funding consideration.

I. TECHNICAL PEER-REVIEW

INTELLECTUAL MERIT (50%)
1. Soundness
2. Innovation
3. Qualification of Researchers
4. Application of Research

COLLABORATION, CAPACITY BUILDING, AND BROADER IMPACTS (50%)
1. Education and Training
2. Inclusiveness
3. Human Health and Welfare
4. Networking and Institutional Development

II. PROGRAMMATIC REVIEW

Part 1. RFP Adherence

- Adherence to all Programmatic Criteria listed in the RFP
- Adherence to Budget Criteria
- Adherence to Requested information for compliance and institutional support

Part 2. Portfolio Balance

- Regional Balance Assessment
- Thematic Balance Assessment
- Area of Inquiry (Topic Area) Representation
- Technical Ranking within Region and Theme

Part 3. USAID Compliance

USAID Eligibility for new countries
- Does the proposal have Mission concurrence?
- Is work proposed for a USAID-eligible country?
- Does the proposal address key USAID goals and interests as defined in the RFP materials?

Initial Environmental Examination Screening (problems may delay projects, or decline projects)

- Assessment of whether there are any obvious environmental issues not raised by the technical review
- Screening process and findings
- Examination and review as necessary

Proposal Organization and Format

Format: • Paper Size: Standard (8.5″ x ll″)
• Line Spacing: Single space
• Minimum Page Margin: 1 inch on all sides
• Minimum Font Size: 10 point (9 point for header or footer)
• Each page of the proposal subsequent to the cover page must identify the Lead PI and proposal title (abbreviated if necessary) and the page number.

Checklist for Proposals

A checklist is provided for assembling the proposal packet (RFP website: *Checklist for Proposals*). The research proposal narrative, item 3 below, **must not exceed 30 pages**.

Proposals must contain the following elements:

- ☐ 1. Cover Sheet Form (Institutional signatures are required at time of award)
- ☐ 2. Summary Page Form
- ☐ 3. Research Proposal Narrative (30 pages maximum)
  - ☐ a. Executive Summary; Introduction including information on future directions, exit strategy, and previous CRSP work (2-page limit)
  - ☐ b. Investigations (5-pg limit for each investigation; 6 investigations recommended, limit is 10 investigations total; 26 pp maximum for (b) regardless of the number of investigations)
  - ☐ c. Outreach and Dissemination Plan (1-page limit)
  - ☐ d. Gender Inclusiveness Strategy (1-page limit). Can be resubmitted from existing project; but if so, details on gender inclusion must be evident within each investigation.
- ☐ 4. HC Research Location Considerations ONLY for **new** countries not in existing AquaFish CRSP (2-page limit)
- ☐ 5. Budget (with Institutional signature)
  - ☐ (2) single-year budgets for Lead. Include budgets for subcontractors and HC institutions (up to 6 single-year budgets)
  - ☐ (1) combined-year budget for Lead. Include the combined-year budget for subcontractors and HC institutions
- ☐ 6. Budget Justification for Lead, Subcontractors, and HC for each year (up to 6 forms)
- ☐ 7. Leveraging Statement and Pending Funds Form
- ☐ 8. Letters of Commitment from **new** HC PIs and US and HC partners
- ☐ 9. Lead Institution supporting information (required at time of award):
  - ☐ Animal Use Approval (or written waivers)
  - ☐ Human Subjects Approval (or written waivers)
  - ☐ NICRA for Lead Institution (Negotiated indirect cost rate agreement)
  - ☐ Institutional & Agency Certifications and Assurances (5 forms). Required only if LPIs have made changes since 2007.
- ☐ 10. CVs of **new** US and HC participants (2-page limit per CV)

Instructions for Completing the Descriptions of Investigations ~ see Checklist: 3b ~

1. Individual investigation descriptions must not exceed five pages. All investigation descriptions within one proposal must not exceed 26 pages. Proposals may contain up to 10 investigations, but 6 is considered ideal for this RFP.
2. Each investigation must be described separately and include the following elements:
   a. Title: below the title include the topic area (p. 3-4) to which the proposed investigation applies and specify whether the investigation is an experiment, study or activity (p. 6, item 2).
   b. Lead PI and institutional affiliation; subcontracting co-PIs and institutional affiliations; HC PIs and institutional affiliation
   c. Objective(s) [and null hypotheses for experiments]
   d. Significance: Provide justification for conducting the proposed work, review similar and related work funded by CRSP or reported in the literature (include citations below under h.), and describe how the work relates to the priorities described in this RFP.
   e. Quantified Anticipated Benefits: Identify target groups and direct and indirect benefits accruing from the research and outreach work. Benefits must be quantifiable (RFP website: *Quantifiable Benefits*).
   f. Research Design or Activity Plan
      (1) Location of work
      (2) Methods
   g. Schedule, indicating the start date (using current extension enddates) and completion date (not later than 29 September 2011) of the proposed work.
   h. Literature Cited

Proposal Submission

1. Submit your full proposal via email to aquafish@oregonstate.edu by 5pm Pacific Time on Monday, August 3, 2009.
2. Mail ten (10) printed copies and one (1) electronic copy on CD/DVD/thumb drive of each proposal, to be received by the ME by Friday August 7, 2009. The ME will acknowledge timely receipt of proposals via email to the Lead PI from the US Lead Partner Institution.
3. Do not exceed the proposal narrative 30-page limit.
4. Proposal packets for existing LPIs do not need institutional signatures by 3 August, but do require approval prior to award.
5. Individual proposal parts (investigations) that will be carried out under subcontract from the Lead Partner Institution to another US institution must be affirmed by the formal signed approval of the subcontracting US institution prior to award. (*Attach a separate letter*)
6. Mail paper and CD submissions to:
   Dr. Hillary S. Egna
   CRSP Director
   Oregon State University
   Snell Hall 418
   Corvallis, OR 97331-1643 USA

Program objectives and future work

The goal of the AquaFish CRSP is to conduct research that contributes significantly to the removal of major constraints to sustainable aquaculture development and responsible small-scale fisheries management, thereby promoting economic growth, enhancing food security, and conserving natural resources in developing countries. CRSPs are funded by USAID under authority of the International Development and Food Assistance Act of 1975 (PL 94-161), and by participating institutions.

The AquaFish CRSP is a newer CRSP under USAID/EGAT's Office of Natural Resources Management. Oregon State University was awarded a 5-year Leader with Associates Cooperative Agreement (No. EPP-A-00-06-00012-00) for the Aquaculture & Fisheries CRSP (AquaFish CRSP) on 30 September 2006. In 2010, the program will be evaluated for a possible 5-year extension. Two major work plans (each with defined annual implementation plans) will describe the specific research to be carried out under the CRSP's framework of general research priorities. This RFP is a call for the Third (2009-11) Implementation Plan. For the second directed RFP, CRSP researchers with incomplete Second (2007-09) Implementation Plan investigations will not be eligible to receive funding until all previous obligations are satisfactorily met. The Implementation Plan resulting from the first RFP is available from the AquaFish CRSP website. Please refer to the RFP website and the CRSP website for additional information.

~ AQUAFISH CRSP RFP ~

http://aquafish.oregonstate.edu

QUESTIONS ABOUT THE CRSP RFP ?

Consult the CRSP RFP website <aquafish.oregonstate.edu> for answers to **Frequently Asked Questions**. Send an email to <aquafish@oregonstate.edu> or call ~ 541.737.6426.