

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

AQUAFISH EIGHTH ANNUAL REPORT
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AQUAFISH
INNOVATION LAB



AQUAFISH INNOVATION LAB EIGHTH ANNUAL REPORT

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Front cover center: A fish farmer feeds fish in her pond in Tanzania. Photo by Kat Goetting.

Front cover left: A woman fish cleaner prepares small fish for processing in the Tonle Sap, Cambodia. Photo by Peg Herring.

Front cover right: An AquaFish researcher conducts a feed demonstration in Ghana. Photo courtesy of AquaFish Innovation Lab.

Back cover: Women and children after pond harvest in Nepal. Photo by Hare Ram Devkota.

Bottom silhouette: Fishermen returning from a trip in Mali. Photo courtesy of Jim Bowman.

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Inside Cover Photo

An earthen fish pond near Morogoro, Tanzania. Photo by Caleb Price.

Photos

All photographs included in this publication are provided courtesy of the AquaFish Innovation Lab.

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MANAGEMENT ENTITY INFORMATION

The Management Entity (ME) for the AquaFish Innovation Lab is headquartered at Oregon State University (OSU) in Corvallis, Oregon. AquaFish ME staff are listed below.

MANAGEMENT ENTITY STAFF

Patricia Hawk	Director, Office of Sponsored Programs
Hillary Egna	Director and Lead Principal Investigator, AquaFish Innovation Lab
Ford Evans	Administrative Officer, AquaFish Innovation Lab
Jenna Borberg	Research & Communication Manager, AquaFish Innovation Lab
Kathryn Goetting	Outreach & Communication Manager, AquaFish Innovation Lab

TECHNICAL AND ADVISORY COMMITTEE INFORMATION

The AquaFish Innovation Lab assembled knowledgeable people to serve on advisory groups during the Aquaculture Collaborative Research Support Program (ACRSP), and carried this successful structure forward into AquaFish Phase I. In Phase II, AquaFish streamlined advisory groups in response to USAID and BIFAD reviews suggesting a slimmer structure. Three advisory groups (two technical, one external) were retained and one (Emerging Issues Panel) was dissolved. These advisory groups provide linkages to the broad community engaged in global aquaculture and fisheries development issues.

DEVELOPMENT THEMES ADVISORY PANEL (DTAP)

DTAP provide technical advice on emerging issues and gaps in the portfolio from a thematic perspective. Lead coordinators of the thematic panels assist the Management Team (MT) in integrating cross-cutting needs identified by USAID and adding additional emphases, such as conserving biodiversity and using biotechnology approaches cautiously. The lead coordinators are also responsible for reviewing annual reports and project adjustments in cases where research is curtailed for various reasons (e.g., laboratory equipment malfunction, poaching, etc.) and worked together to provide quality information for thematic synthesis and lessons learned reporting.

The DTAP Coordinators for the four themes for FY14 were as follows:

DTAP A: Improved Human Health and Nutrition, Food Quality, and Food Safety

Lead Coordinator: Kwamena Quagrainie (Purdue University)

DTAP B: Income Generation for Small-Scale Fish Farmers and Fishers

Lead Coordinator: Joe Molnar (Auburn University)

DTAP C: Environmental Management for Sustainable Aquatic Resources Use

Lead Coordinator: Jim Diana (University of Michigan)

DTAP D: Enhanced Trade Opportunities for Global Fishery Markets

Lead Coordinator: Bob Pomeroy (University of Connecticut – Avery Point)

REGIONAL CENTERS OF EXCELLENCE (RCE)

The RCEs were established to synthesize findings across regions and from leveraged activities such as Associates Awards. They provide technical advice on emerging issues and identify gaps in the portfolio from a regional perspective. Centers develop useful materials for Missions, other regional stakeholders and end-users, and gauge opportunities for collaboration based on regional or national needs. Two centers are established in three regions. Additional RCEs may be added depending on the portfolio of projects funded through Associate Awards. RCE Coordinators assist in integrating Associate Award partners into the portfolio. Coordinators also assist the Director in cases where a screening process is required in advance of an Initial Environmental Examination. The RCE Coordinators for FY14 included:

RCE – Africa: *Charles Ngugi (Kenya) & Héry Coulibaly (Mali)*

RCE – Asia: *Remedios Bolivar (Philippines) & Yuan Derun (Thailand)*

RCE – Latin America & Caribbean: *Wilfrido Contreras (Mexico) & Maria Célia Portella (Brazil)*

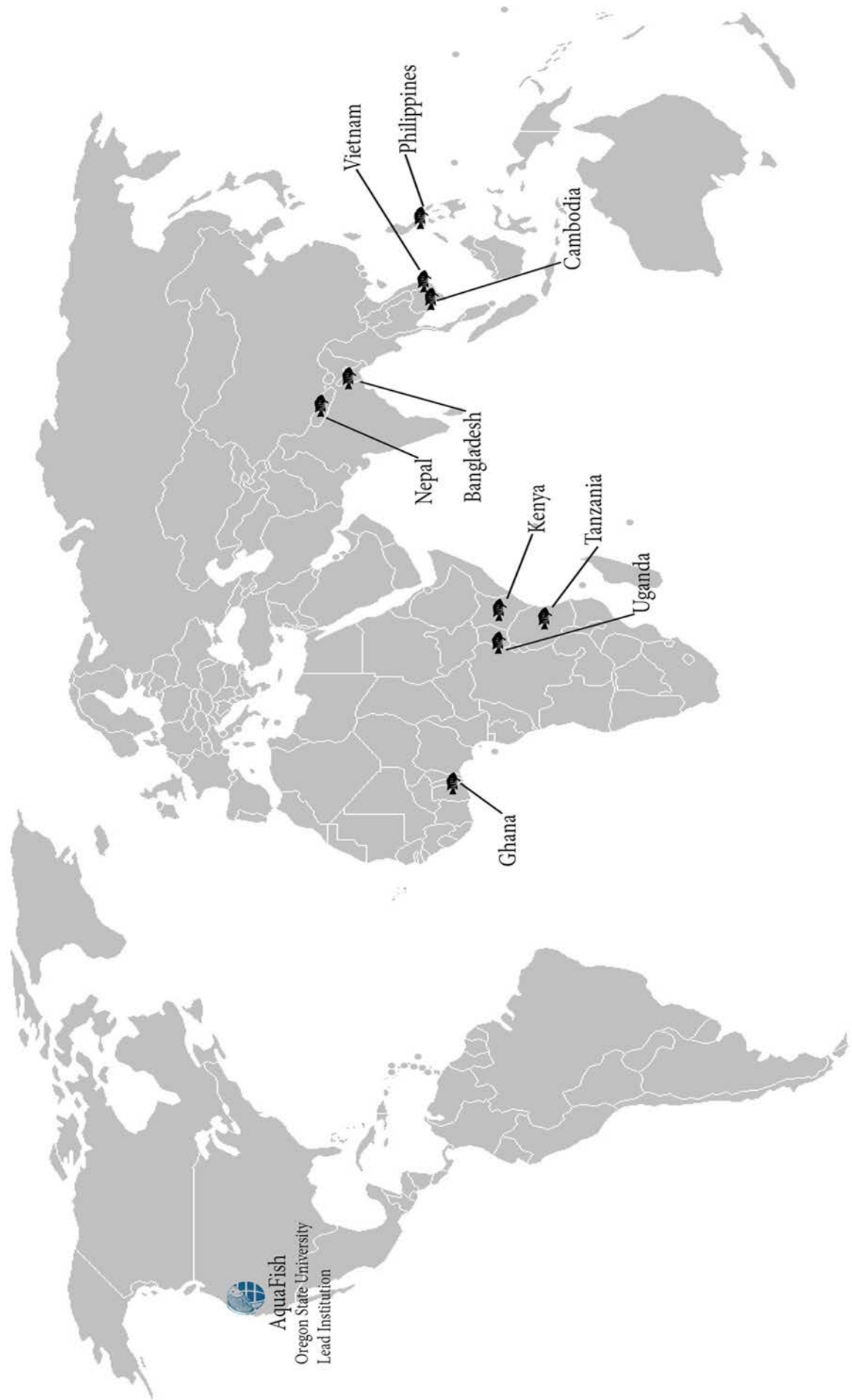
EXTERNAL PROGRAM ADVISORY COUNCIL (EPAC)

The EPAC is a policy and programmatic advisory panel composed of specialists who are external to the program. Panel members are drawn from the international aquatic resources community with expertise in various aspects of AquaFish research, including socioeconomic, environmental, and ecological factors that can influence research and adoption of technology generated from research. EPAC members for FY14 included:

Africa: *Nancy Gitonga*

Asia: *Liping Liu*

AquaFish Project Countries in FY14



PROGRAM PARTNERS

The AquaFish Innovation Lab partners and collaborates with institutions and individuals around the world to maximize the benefits of aquaculture and fisheries research, technology development, and capacity building. AquaFish US and Host Country (HC) participants accomplish this by sharing expertise, conducting collaborative research, engaging and educating stakeholders, and leveraging opportunities through a strong and growing aquaculture network.

Since inception in 2006, AquaFish has fostered linkages with more than 250 institutions globally. AquaFish builds and maintains its network through formal funded partnerships as well as through non-funded collaborations.

Funded Partners in FY14

(The list below includes all partners who received AquaFish funding during FY14).

Bangladesh

Bangladesh Agricultural University
Hajee Mohammad Danesh Science & Technology University
Khulna University
Patuakhali Science and Technology University
Shushilan NGO
University of Dhaka

Brazil

Sao Paulo State University

Cambodia

Inland Fisheries Research and Development Institute

China

Shanghai Ocean University

Ghana

FarmerLine
Kwame Nkrumah University of Science and Technology
University for Development Studies

Kenya

FishAfrica
Kenya Ministry of Fisheries Development
University of Eldoret

Mexico

Universidad Juarez Autonoma de Tabasco

Nepal

Agriculture and Forestry University
Directorate of Fisheries Development
Nepal Agricultural Research Council

Philippines

Central Luzon State University
Southeast Asian Fisheries Development Center - Aquaculture Division

Tanzania

Institute of Marine Sciences, University of Dar es Salaam
Sokoine University of Agriculture
Western Indian Ocean Marine Science Association

Thailand

Network of Aquaculture Centers in Asia

Uganda

Gulu University
Makerere University
National Fisheries Resources Research Institute- Aquaculture Research and Development Center

US

Alabama A&M University
Auburn University
North Carolina State University
Oregon State University
Purdue University
University of Arizona
University of Arkansas at Pine Bluff
University of Connecticut at Avery Point
University of Hawaii at Hilo
University of Michigan
University of Rhode Island
Virginia Polytechnic Institute and State University

Vietnam

Can Tho University

Non-Funded Collaborators in FY14

(The list below includes collaborators who did not receive funding from AquaFish during FY14).

Argentina

Universidad Nacional del Comahue

Australia

Australian Center for International Agricultural Research
Monash University (Melbourne)
University of Tasmania

Bangladesh

Bangladesh Department of Fisheries
CGIAR-WorldFish, South Asia & Bangladesh
Chanchal Hatchery (World Fish Supported)
Institution of Nutrition and Food Science
(University of Dhaka)
WorldFish Aquaculture Income & Nutrition
WorldFish Farmer's Group

Cambodia

Cambodia Department of Conservation
Cambodia HARVEST Project, USAID
Department of Aquaculture Development
Freshwater Aquaculture Research & Development Center
Hun Sen Aquaculture Institute
Kampong Cham National School of Agriculture
Kandal Fisheries Administration
Marine Aquaculture Research and Development Center
Mekong River Commission
Ministry of Agriculture, Forestry, and Fisheries
Phnom Penh Fisheries Administration
Prek Leap National School of Agriculture
Royal University of Agriculture
Royal University of Law and Economics
WorldFish Center, Cambodia

Ethiopia

Ethiopian Institute of Agricultural Research

Kenya

Kenyatta University
Ministry of Agriculture, Livestock, and Fisheries
Moi University
Mwea Fish Farm
University of Nairobi

Nepal

Rural Integrated Development Society
Winrock International

Tanzania

University of Dar es Salaam

Uganda

Bidii Fish Farmers
Grameen Foundation
Walimi Fish Cooperative Society Ltd

US

Cultural Practice LLC
Michigan State University
Nutrition Innovation Lab, Tufts University
University of Georgia
World Aquaculture Society

Vietnam

An Giang Department of Agriculture and Rural Development

Current and Former AquaFish Linkages (FY06-FY14)

(This is a comprehensive list of funded and non-funded AquaFish linkages from inception in 2006 through FY14).

Australia

Monash University (Melbourne)

Bangladesh

Bangladesh Agricultural University
Bangladesh Department of Fisheries
CGIAR-WorldFish, South Asia & Bangladesh

Chanchal Hatchery (World Fish Supported)

Hajee Mohammad Danesh Science & Technology University
Institution of Nutrition and Food Science
(University of Dhaka)
Khulna University
Patuakhali Science and Technology University

Shushilan NGO
University of Dhaka
WorldFish Aquaculture Income & Nutrition
WorldFish Farmer's Group

Brazil

Embrapa Meio Ambiente
Sao Paulo State University
Universidad Estadual Paulista, Centro de
Acüicultura, Jaboticabal
Universidad Federal do Amazonas

Cambodia

Cambodia Department of Conservation
Cambodia HARVEST Project, USAID
Cambodia Molecular Genetic Group, Health
Scientific Research Centre University Health
Sciences
Department of Aquaculture Development
Department of Fisheries, Post-Harvest
Technologies & Quality Control of Fisheries
Administration
Fisheries Administration in Cambodia
Freshwater Aquaculture Research &
Development Center
Hun Sen Aquaculture Institute
Inland Aquaculture Extension & Productivity
Improvement Project
Inland Fisheries Research and Development
Institute
Institution for Research in Food and
Development
Kampong Cham National School of Agriculture
Kandal Fisheries Administration
Marine Aquaculture Research and Development
Center
Mekong River Commission
Ministry of Agriculture, Forestry, and Fisheries
Phnom Penh Fisheries Administration
Prek Leap National School of Agriculture
Royal University of Agriculture
Royal University of Law and Economics
WorldFish Center, Cambodia

Canada

International Development Research Centre

Chile

Foundation Chile

China

China Aquatic Products Processing & Marketing
Association
Guizhou Normal University
Hainan University
Haoshideng Shrimp Farm
Huazhong University
Huiting Reservoir Fisheries Management
Company
Shanghai Ocean University
Sichuan Aquacultural Engineering Research
Center
Southwest University
Tongwei Co. Ltd
Wuhan University
Xiamen University
Zhanghe Reservoir Fisheries Management
Company
Zhejiang University

Colombia

Centro Internacional de Agricultura Tropical

Costa Rica

University of Costa Rica

Ecuador

Ecostas

Egypt

Academy of Scientific Research & Egyptian
Universities
Central Laboratory for Aquaculture Research
Egyptian Society of Agribusiness
Ministry of Agriculture & Land Reclamation

Ethiopia

Ethiopian Institute of Agricultural Research

Ghana

FAO-Ghana (not FAO Regional Office)
FarmerLine
Fisheries Department, Ministry of Food &
Agriculture
Kwame Nkrumah University of Science and
Technology
Ministry of Agriculture Fisheries Directorate
University for Development Studies
Water & Sewage Company
Water Research Institute's Aquaculture Research
Development Center

Guatemala

San Carlos University

Guyana

Anna Regina Fish Culture Station
Guyana Department of Fisheries
Guyana School of Agriculture
Maharaja Oil Mill
Mon Repos Aquaculture Center, Department of Fisheries
National Aquaculture Association of Guyana
Trafalgar Union Women's Cooperative
University of Guyana
USAID Farmer-to-Farmer Program
USAID/GTIS Programme
Von Better Aquaculture

Honduras

Centro Nacional de Investigación Piscícola El Carao
Escuela Agrícola Panamericana
Laboratorio de Calidad de Agua La Lujosas
Secretaría de Agricultura y Ganadería
Zamorano University

Indonesia

Indonesian Department of Fisheries
Ladong Fisheries College
Ujung Batee Aquaculture Center

International

Heifer International
International Water Management Institute of the Consultative Group on International Agriculture Development (CGIAR)

Italy

United Nations Food & Agriculture Organization

Kenya

Kenya Business Development Services
Kenya Marine & Fisheries Research Institute
Ministry of Agriculture, Livestock, and Fisheries
Moi University
Mwea Fish Farm
National Investment Center
Nyanchwa College of Science and Technology
Sagana Aquaculture Center
University of Nairobi

Women in Fishing Industry Project
Kenyatta University

Kenya, Tanzania, Uganda

Lake Victoria Fisheries Organization (Kenya, Tanzania, Uganda)

Kenya, Tanzania, Uganda, Rwanda, Burundi

Lake Victoria Environmental Management Project (Kenya, Tanzania, Uganda, Rwanda, Burundi)
FishAfrica
Kenya Ministry of Fisheries Development†
University of Eldoret

Lebanon

American University of Beirut

Malawi

Bunda College, Lilongwe

Malaysia

WorldFish Center

Mali

Assemblée Permanente des Chambres d'Agriculture du Mali
Direction Nationale de la Pêche
Ministère de L'Élevage et de la Pêche
Rural Polytechnic Institute for Training & Applied Research
The Permanent Assembly of Chambers of Agriculture
USAID Mali

Mexico

Centro de Investigación de Alimentación y Desarrollo (Research Center for Food & Development)
Centro de Transferencia Tecnológica Para La Acuicultura
Comité Estatal de Sanidad Acuicóla de Sinaloa
Cooperativa Pesquera San Ramon
Federation of Shrimp Cooperatives
Instituto Nacional de Investigaciones Forestales y Agropecuarias
Instituto Nacional de Investigaciones Forestales y Agropecuarias
Instituto Sinaloense de Acuicultura
Instituto Tecnológico del Mar
Mariano Matamoros Hatchery

Regional Center of Education and Qualification
for Sustainable Development
Research Center for Food & Development
Secretariat of Agricultural Development for the
State of Tabasco
Sinaloa State Fisheries Department
The Autonomous University of Sinaloa-
Culiacan
The Autonomous University of Sinaloa-
Mazatlan
Universidad Autónoma de Sinaloa–Culiacán
Universidad Autónoma de Sinaloa–Mazatlán
Universidad Autónoma de Tamaulipas
Wetlands Conservation Program
Universidad Juárez Autónoma de Tabasco
Women's Oyster Culture Cooperatives of
Nayarit
Women's Oyster Culture Cooperatives of Puerto
Penasco

Nepal

Agriculture and Forestry University
Directorate of Fisheries Development
Institute of Agriculture and Animal Science
Nepal Agricultural Research Council
Rural Integrated Development Society
Rural Integrated Development Society-Nepal
Winrock International

Nicaragua

Center for Research for Aquatic Ecosystems and
Aquaculture/Central American University
Nicaraguan Ministry of the Environment

Peru

Fondo Nacional del Desarrollo Pesquero
Instituto de Investigaciones de la Amazonia
Peruana
Universidad Nacional Mayor de San Marcos

Philippines

Bureau of Fisheries and Aquatic Resources
Central Luzon State University
Department of Agriculture
Genetically Improved Farmed Tilapia
Foundation International, Inc.
Mindanao State University
Southeast Asian Fisheries Development Center -
Aquaculture Division
University of the Philippines at the Visayas
(Institute of Fish Processing Technology)

West Visayas State University

Puerto Rico

University of Puerto Rico

South Africa

Department of Water Affairs & Forestry
Stellenbosch University
Water Research Commission

Tanzania

Institute of Marine Sciences, University of Dar
es Salaam
Kingorwila National Fish Center
Mbegan 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
Western Indian Ocean Marine Science
Association

Thailand

CNN Aquaculture and Supply Company
Department of Fisheries
FAO in Asia-Pacific
Kasetsart University
Network of Aquaculture Centers in Asia

The Netherlands

Intervet-Schering Plough Animal Health
Tilapia International Foundation

Uganda

Bidii Fish Farmers
Blessed Investment Fish Farm
Grameen Foundation
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

US

American Soybean Association
AmeriSci International
Aquaculture without Frontiers
Bemidji State University
Brooklyn College
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
Goldman Sachs
Goosepoint Oyster Inc.
Institute for Agriculture and Trade Policy, Minnesota
International Institute for Fisheries Economics and Trade, OSU
Louisiana State University
Michigan State University
Montana State University
National Oceanic and Atmospheric Administration—International Sea Grant
National Sea Grant Program Extension Office
Nutrition Innovation Lab, Tufts University
Ohio State University
Oxfam America
Pacific Shellfish Growers Association
Partners of the Americas
Peanut CRSP
Shrimp Improvement Systems

Southern Illinois University at Carbondale
Sustainable Management of Watershed CRSP
Texas A&M University
Texas Parks & Wildlife Department
Texas Sea Grant
Texas Tech University
U.S. Food & Drug Administration
University of California, Davis
University of Delaware
University of Georgia
University of Hawaii at Manoa
University of Oklahoma
University of Tennessee
University of Texas
University of the Virgin Islands
US Department of Commerce-NOAA
US-Mexico Aquaculture TIES Program
USAID Sustainable Coastal Communities & Ecosystems Program (SUCCESS)
USAID-Micro, Small & Medium Enterprises-Aquaculture-DAI
World Aquaculture Society
World Wildlife Fund

Venezuela

BIOTECMAR C.A.

Vietnam

An Giang Department of Agriculture and Rural Development
Can Tho University
Dong Nai Fisheries Company
Nong Lam University (University of Agriculture and Forestry)
Research Institution for Aquaculture No. 1
University of Agriculture and Forestry (Nong Lam University)
World Wildlife Fund in Asia

ACRONYMS

ABF	Air-Breathing Fishes
ACRSP	Aquaculture Collaborative Research Support Program
AFU	Agriculture and Forestry University
AquaFish	The Feed the Future Innovation Lab for Collaborative Research on Aquaculture & Fisheries (Formerly Aquaculture & Fisheries CRSP)
ASEAN	Association of Southeast Asian Nations
AU	Auburn University
BAU	Bangladesh Agricultural University
BFS	Bureau for Food Security
BMA	Production System Design and Best Management Alternatives
BMP	Best Management Practice
CGIAR	Consultative Group on International Agricultural Research
CRSP	Collaborative Research Support Program
DAI	Development Alternatives Incorporated
DTAP	Development Theme Advisory Panel
EdOpNet	Educational Opportunities Network
EPAC	External Program Advisory Council
FAO	Food and Agriculture Organization of the United Nations
FARDeC	Freshwater Aquaculture Research and Development Center
FCR	Feed Conversion Ratio
FFA	Future Farmers of America
FSV	Food Safety, Post Harvest, and Value-Added Product Development
FTF	Feed the Future
FTFMS	Feed the Future Monitoring System
FY14	Fiscal Year 2014 (01 October 2013 – 30 September 2014)
GIS	Geographic Information System
GMO	Genetically Modified Organism
GTIS	Guyana Trade and Investment Support
HACCP	Hazard Analysis and Critical Control Point
HARVEST	Helping Address Rural Vulnerabilities and Ecosystem Stability
HC	Host Country
HHI	Human Nutrition and Human Health Impacts of Aquaculture
HICD	Human and Institutional Capacity Development
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
IA	Impact Assessment
iAGRI	Innovative Agriculture Research Initiative
IFReDI	Inland Fisheries Research and Development Institute
IIFET	International Institute of Fisheries Economics & Trade
IMS	Institute of Marine Sciences
IND	Climate Change Adaptation: Indigenous Species Development
IPM	Integrated Pest Management
ISTA	International Symposium on Tilapia in Aquaculture
KMFD	Kenya Ministry of Fisheries Development
KMT	Kenya Marketing Trust
KNUST	Kwame Nkrumah University of Science and Technology
LLC	Limited Liability Company
LWA	Leader-with-Award
M&E	Monitoring and Evaluation
MER	Marketing, Economic Risk Assessment, and Trade

ME	Management Entity
MNE	Mitigating Negative Environmental Impacts
MOU	Memorandum of Understanding
MT	Management Team
NaFIRRI	National Fisheries Resources Research Institute
NCE	No Cost Extension
NCSU	North Carolina State University
NOAA	National Oceanic and Atmospheric Administration
NGO	Non-Governmental Organization
OSU	Oregon State University
PD/A	Pond Dynamics/Aquaculture
PDV	Policy Development
PI	Principal Investigator
PoC	Point of Contact
QSD	Quality Seedstock Development
RCE	Regional Center of Excellence
RFP	Request for Proposals
SARNISSA	Sustainable Aquaculture Research Networks in Sub-Saharan Africa
SIS	Small Indigenous Species (of fish)
SFT	Sustainable Feed Technology and Nutrient Input Systems
SIRTD	Strategic Investment in Rapid Technology Dissemination
SMIS	Seafood Market Information System
SOU	Shanghai Ocean University
SUCCESS	Sustainable Coastal Communities and Ecosystems Program
TIES	Training, Internships, Education and Scholarships Program
UK	United Kingdom
UN	United Nations
US	United States
USAID	United States Agency for International Development
USG	United States Government
VCA	Value Chain Assessment
WAS	World Aquaculture Society
WIOMSA	Western Indian Ocean Marine Science Association
WIZ	Watershed and Integrated Coastal Zone Management

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I. EXECUTIVE SUMMARY

The mission of the *Feed the Future Innovation Lab for Collaborative Research on Aquaculture & Fisheries (AquaFish Innovation Lab)* is to enrich livelihoods and promote health by cultivating international multidisciplinary partnerships that advance science, research, education, and outreach in aquatic resources. The United States Agency for International Development (USAID) looks to AquaFish 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.” Headquartered at Oregon State University (OSU), AquaFish began in 2006 and was extended on 31 March 2013 for an additional five-years (Phase II) through 29 March 2018.

The AquaFish Eighth Annual Report describes activities and accomplishments of the AquaFish Innovation Lab from 1 October 2013 to 30 September 2014 (FY14). During this reporting period, activities involving 24 Host Country (HC) institutions and 12 US universities in 10 countries focused on improving the health and livelihoods of the poor and building human and institutional capacity through research, technology development, and training students and stakeholders at all levels. Five research projects under [*Implementation Plan 2013-2015*](#) are integrated across four interrelated themes:

- A. Improved Human 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

Building on successes of AquaFish Phase I (2006-2013), Phase II efforts are strengthening longstanding collaborative partnerships while establishing new connections, and maintaining alignment with the US Feed the Future (FTF) Initiative. Phase II research focuses on improving the sustainability of aquaculture through the development of innovative technologies that enhance the well-being of the poor.

As part of the USAID/Bureau for Food Security (BFS) *Feed the Future Food Security Innovation Center*, AquaFish operates under the *Program for Research on Nutritious and Safe Foods*, which “addresses undernutrition, especially in women and children, by increasing the availability and access to nutrient dense foods through research on horticulture crop, livestock, fish and dairy, food safety threats such as mycotoxins and other contaminants, and on household nutrition and food utilization” (R. Bertram, 7 December 2012). AquaFish has adapted its research portfolio to include the impacts of aquaculture on human nutrition while still focusing on food security and safety.

The new human nutrition focus has allowed for a more deliberate emphasis on connecting AquaFish research to broader nutrition goals. AquaFish promotes the cultivation of fish species that help meet the cross-cutting goals of increasing quantity, accessibility, availability, and quality of aquaculture products to address food security and food safety issues that have long-lasting impacts on human health. During FY14, several investigations focused on increasing access to nutrient-dense fish species. In Bangladesh, improved cultivation of fish species and better access to seed is increasing availability of vitamin and mineral-rich fish for undernourished populations. Survey data collected from Cambodian households is improving understanding of consumption behaviors related to popular fish, while research in Tanzania and Ghana focuses on measuring and improving household food security in fish farming communities.

AquaFish is dedicated to improving gender equity in the aquaculture and fisheries sectors. Efforts to increase women's involvement in and access to aquaculture technologies and resources during FY14 included a workshop in Kenya that addressed the roles of women in aquaculture. This workshop focused on women's participation in aquaculture and emphasized product development and marketing, roles often undertaken by women in aquaculture businesses. Support of women in long-term degree trainings is another way that AquaFish increases women's participation in the aquaculture industry. Sustained involvement during formal degree training helps create connections and build networks that can be accessed far into the future.

In FY14, AquaFish researchers continued to examine cultivation methods for indigenous fish species in an effort to provide sustainable, local food sources. In Nepal, wild sahar (*Tor putitora*) populations are declining, yet no commercial production is established. AquaFish researchers have begun breeding and rearing sahar in order to develop appropriate and effective techniques so that sahar culture can extend from experimental farms to larger systems. Work has also begun in Uganda to develop low-cost captive breeding and hatching technologies for endangered native lungfish species. As air breathers, lungfish may offer a high-value alternative to the cultivation of other species impacted by climate change.

Human and institutional capacity development are cornerstones of the AquaFish mission. These are achieved through short- and long-term trainings and institutional strengthening, as well as collaboration and partnerships with governmental research institutions, the commercial sector, and non-governmental organizations (NGOs). Eleven short-term training events were held in FY14, with a total of 380 participants. AquaFish supported 108 students in long-term formal degree programs. AquaFish has also supported curriculum development at several HC institutions in FY14, made possible through sustained relationships and extensive networks that have carried over from Phase I and earlier AquaFish CRSP efforts. Institutional strengthening also arises from successful partnerships that allow institutions in developing nations to gain valuable experience in managing international grants and research projects.

In this final year of the Strategic Investment in Rapid Technology Dissemination (SIRTD) Associate Award, four workshops were held in Tanzania and Kenya, along with a closeout meeting for the project. These events brought together personnel from the three project countries – Ghana, Kenya, and Tanzania – to discuss strategies for successfully disseminating research results and developing final outreach products.

In FY14, the AquaFish Management Team (MT) at OSU organized programmatic meetings, including the SIRTD Associate Award closeout meeting, the Asia Regional Meeting, and the AquaFish Annual Meeting. These meetings provide opportunities for project personnel to discuss progress and to strengthen collaboration across institutions. In addition, the MT participated in national and international meetings and conferences, serving as a member of the organizing committee and a gold sponsor at the 10th International Symposium on Tilapia in Aquaculture (ISTA10), and organized and chaired two sessions at the 2014 Aquaculture America conference. Attending and presenting research results at conferences and meetings supports a dual-purpose goal of disseminating reliable research results while forming connections and staying informed on the latest innovations and technologies in aquaculture and fisheries.



II. PROGRAM ACTIVITIES AND HIGHLIGHTS

Oregon State University (OSU) serves as the Lead Institution for the AquaFish Innovation Lab Leader Award and the SIRTHD Associate Award. The AquaFish mission is built around sound science, education, and outreach that improve the health and well-being of vulnerable communities through aquatic science research. In FY14, AquaFish worked towards these accomplishments by building and strengthening international multidisciplinary partnerships to collectively produce and disseminate reliable research regarding aquaculture and fisheries innovations around the world.

Five US universities (Auburn University, North Carolina State University, Purdue University, University of Connecticut at Avery Point, and University of Michigan) were selected through an external peer-review RFP process to subcontract with OSU in nine countries in Africa and Asia. These universities had funded partnerships with six other US universities and 24 organizations in Africa and Asia to conduct 33 research investigations using a systems approach focusing on *Integrated Production Systems*, and *People, Livelihoods, and Ecosystem Interrelationships*.

AquaFish strives to strengthen the capacities of its partnering 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 **development of feeds and feeding strategies** that reduce costs and improve growth and production, while also mitigating negative environmental impacts that result from over-feeding, is one major focus of AquaFish research. In FY14, eight research activities examined feed technologies and alternative protein sources for feed ingredients. In Bangladesh, growout trials evaluated the effectiveness of different feeding regimes, as well as feed efficiency. A farmer's workshop in Kenya included a session on feed administration and formulation. In addition to field research, AquaFish shared results among program researchers and to the broader research community to advance feed science and technologies through activities such as chairing two sessions at Aquaculture America 2014 in Seattle, WA, and producing two peer-reviewed articles for scientific journals and three publications for trade magazines and journals.

AquaFish research examines ways to **mitigate negative environmental impacts** through the culture of air-breathing fishes to provide a sustainable and nutrient-rich food source in the wake of environmental degradation. In Uganda, over 250 African lungfish samples were collected to develop appropriate and cost-effective breeding and hatching technologies. In the lower Mekong River Basin in Vietnam and Cambodia, researchers bred both wild and domesticated snakehead in preparation to measure the growout performance of each under different culture practices.

Gender and nutrition are cornerstones of the AquaFish mission and researchers are examining methods to improve gender equity and human health in all projects. In Ghana, 164 household nutrition surveys were completed that focused on dietary patterns. The results of the surveys will be analyzed in the coming year to assess the nutritional impacts of the national aquaculture policy. Interviews and focus groups were conducted in Cambodia to gather nutritional information on children less than five years old. Work is underway in Nepal to establish fish ponds to improve the health and nutrition of women and children. These efforts address the importance of the role of women in household well-being and assess the impact fish has on human health and nutrition, especially for women and children.

Strengthening human and institutional capacity is a primary objective for AquaFish and is accomplished through support of degree-seeking students, curriculum development, short-term training

courses, and recognition of outstanding achievements at international aquatic resources conferences.

AquaFish HICD achievements in FY14 included:

- 108 long-term degree students at 22 universities in nine countries.
- Eleven short-term trainings reaching 380 people.
- Development of new long-term degree programs created at universities in Kenya and Nepal.
- Sponsorship of the 4th *Shanghai Ocean University (SOU)-AquaFish Yang Yi Young Scientist Travel Award*.
- Gold sponsorship and participation on the organizing committee for the Tenth International Symposium on Tilapia in Aquaculture (ISTA10).
- Sponsorship of three awards for best aquaculture economics papers at the International Institute of Fisheries Economics & Trade (IIFET) 2014 Australia conference.

Programmatic meetings offer opportunities for regular communication and face-to-face interactions with US and HC partners to discuss research progress and solutions to issues, and ensure that project objectives and benchmarks are being met. In FY14, AquaFish held the following meetings with project partners:

- Asia Regional Meeting at the Inland Fisheries and Research and Development Institute (IFReDI) in Phnom Penh, Cambodia (December 2013)
- AquaFish Annual Meeting and associated program meetings in Seattle, Washington, US (February 2014)
- SIRTID Associate Award closeout meeting in Tanzania (August 2014)

The AquaFish Management Team at OSU produced programmatic reports and outreach materials to disseminate program achievements and opportunities to a broad audience. In addition, AquaFish researchers are often called to collaborate or assist in the development of related activities and projects. Examples of these collaborative efforts in FY14 include:

- Evaluation and consultation on two USAID nutrition projects in Bangladesh and Cambodia.
- Development of the vision and strategy for a possible new USAID project in Burma.
- Assistance with the content development for the upcoming FAO Inland Fisheries Conference.



III. KEY ACCOMPLISHMENTS

AquaFish outputs and achievements in research, capacity building, information dissemination, and gender integration are measured relative to qualitative and quantitative targets identified in the USAID approved Monitoring and Evaluation (M&E) Plan and Feed the Future Monitoring System (FTFMS). Key FY14 accomplishments from the AquaFish Leader and Associate Awards are highlighted below.

Research and Technology Development

Nineteen innovative aquaculture technologies were at varying stages of development in Africa and Asia in FY14. In developing these technologies, AquaFish projects involved 65 food security enterprises, producer organizations, women's groups, trade and business associations, and community-based organizations. Research in Bangladesh made progress toward diversifying the small-scale aquaculture industry by incorporating mola, a small indigenous species dense in vitamin A, calcium, and other important nutrients. In Nepal, AquaFish researchers began expanding the production of the high-value native species, sahar (*Tor putitora*), for potential commercial production and stock enhancement. Steps were taken to improve the aquaculture industries of Uganda and Ghana through the development of cell phone-based marketing tools compatible with markets in each region. The Associate Award project closeout meeting was held in Tanzania, where key personnel discussed achievements and lessons learned in Ghana, Kenya, and Tanzania, and agreed on final actions to ensure successful completion of the project. AquaFish also engaged with USAID and other Innovation Labs on topics related to human nutrition—including the development of concept notes for collaborative work in Bangladesh and Cambodia.

Human and Institutional Capacity Building

Since program inception in 2006, AquaFish has fostered linkages with over 250 institutions globally. In FY14, AquaFish had a total of 80 active linkages, including formal (funded) institutional or individual partnerships with 41 organizations in 14 countries, and an additional 39 informal (non-funded) collaborators. AquaFish supported 108 students enrolled in long-term degree programs at US and HC institutions this fiscal year. Eleven short-term training events were held, with a total of 380 participants, and included workshops, on-farm trainings, and train-the-trainer events to target a range of audiences. A South-South exchange took place at Can Tho University in Vietnam, where Vietnamese AquaFish researchers transferred information and technologies on snakehead cultivation to Cambodian researchers. AquaFish continued supporting Regional Centers of Excellence (RCEs), with two coordinators each in Africa, Asia, and Latin America and the Caribbean. They assisted with regional meetings, assessing regional strengths and challenges, and building linkages for sharing information and technology.

Information Dissemination

AquaFish has disseminated programmatic findings to stakeholders through multiple avenues including the AquaFish website (aquafish.oregonstate.edu), social media sites, newsletters, conference presentations, and publishing in trade magazines. Additionally, 12 issues of *EdOpNet* (education opportunities in aquaculture and fisheries-related fields) reached over 1,500 recipients in FY14. AquaFish encourages researchers to publish findings in peer-reviewed journals in order to reach the broader research community, and to advance aquaculture science. AquaFish's scientific strengths and accomplishments are evidenced by over 160 peer-reviewed publications on AquaFish-supported research and data since program inception in 2006, 15 of which were published in FY14.

Gender Integration

AquaFish continues to collect and analyze gender-disaggregated data in order to gauge gender inclusiveness and success. Strategies for engaging women are adapted, as needed, as AquaFish works towards the 50% benchmark for training women in formal and informal education, and for retaining women scientists and administrators in all facets of AquaFish operations.



Workshop participants examine phytoplankton under a microscope in a laboratory at Sokoine University of Agriculture in Morogoro, Tanzania.



IV. RESEARCH PROGRAM OVERVIEW AND STRUCTURE

AquaFish is managed to achieve maximum program impacts, particularly for small-scale farmers and fishers, in Host Countries and more broadly. AquaFish program objectives address the need for world-class research, capacity building, and information dissemination. Specifically, AquaFish 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 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.

The overall research context for the projects described in this Annual Report is poverty alleviation and food security improvement through sustainable aquaculture development and aquatic resources management. Discovery through research and technology development forms the core of projects. Projects also integrate institutional strengthening, gender, outreach, and capacity building through activities such as training, formal education, workshops, extension, and conferences to support the scientific research being conducted.

Projects focus on one or two USAID-eligible countries within a region, and may include activities in nearby countries within the same region. All projects received USAID country-level concurrence prior to award. They were formed around the following *core program components*, as identified by USAID: a systems approach; social, economic, and environmental sustainability; capacity building and institution strengthening; outreach, dissemination, and adoption; and gender integration. USAID also encourages AquaFish to address biodiversity conservation and non-GMO biotechnology solutions in aquaculture. Each overall project describes a comprehensive development approach to a problem.

GLOBAL AQUAFISH PROJECT THEMES (GOALS)

- A. Improved Human 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 focuses on one primary AquaFish theme, yet integrates all four themes to achieve a systems approach. The global themes of AquaFish are cross-cutting and address several specific USAID policy documents and guidelines.

AQUAFISH SYSTEMS APPROACH

All projects are organized around ten specific areas of inquiry called Topic Areas. Current projects contain between six and eight investigations. Project investigations focus on more than one topic area in describing aquaculture research that will improve diets, generate income for smallholders, manage environments for future generations, and enhance trade opportunities.

A systems approach requires that each AquaFish project integrate topic areas (listed below and described later in this Section) from the following two categories:

Integrated Production Systems

- Production System Design & Best Management Alternatives (BMA)
- Sustainable Feed Technology (SFT)
- Climate Change Adaptation: Indigenous Species Development (IND)
- Quality Seedstock Development (QSD)

People, Livelihoods, and Ecosystem Interrelationships

- Human Nutrition and Human Health Impacts of Aquaculture (HHI)
- Food Safety, Post Harvest, and Value-Added Product Development (FSV)
- Policy Development (PDV)
- Marketing, Economic Risk Assessment, and Trade (MER)
- Watershed and Integrated Coastal Zone Management (WIZ)
- Mitigating Negative Environmental Impacts (MNE)

RESEARCH PROJECT STATISTICS

Fifty-one percent of investigations were categorized as *Integrated Production Systems* and 49% as *People, Livelihoods, and Ecosystem Interrelationships* for Phase I and II research projects (Table IV-1).

Table IV-1. AquaFish research project investigations by Systems Approach and Topic Areas for Phase I (includes work conducted under Implementation Plan 2007-2009, 2009-2011, and additional work that occurred prior to Phase II) and for Phase II (Implementation Plan 2013-2015).

occurred prior to Phase II) and for Phase II (implementation April 2013-2015).					
Systems Approach	Topic Area	Number of Investigations			Percent of Total
		Phase I (2007-2013)	Phase II (2013-2015)	Total	
Integrated Production Systems					
	Production System Design & Best Management Alternatives (BMA)	17	6	23	17%
	Sustainable Feed Technology (SFT)	13	8	21	15%
	Climate Change Adaptation: Indigenous Species Development (IND)	14	4	18	13%
	Quality Seedstock Development (QSD)	7	2	9	6%
	Subtotal	51	20	71	51%
People, Livelihoods, and Ecosystem Interrelationships					
	Human Nutrition and Human Health Impacts of Aquaculture (HHI)	7	4	11	8%
	Food Safety, Post Harvest, and Value-Added Product Development (FSV)	4	0	4	3%

Systems Approach	Topic Area	Number of Investigations			Percent of Total
		Phase I (2007-2013)	Phase II (2013-2015)	Total	
	Policy Development (PDV)	11	1	12	9%
	Marketing, Economic Risk Assessment, and Trade (MER)	14	6	20	14%
	Watershed and Integrated Coastal Zone Management (WIZ)	5	1	6	4%
	Mitigating Negative Environmental Impacts (MNE)	14	1	15	11%
	Subtotal	55	13	68	49%
	Total	106	33	139	

Thirty-three investigations were underway in FY14 and will continue into FY15 as part of Implementation Plan 2013-2015, with 20 addressing *Integrated Production Systems* and 13 addressing *People, Livelihoods, and Ecosystem Interrelationships*. A total of 10 countries, 12 US Universities, and 24 HC institutions are involved in formal funded partnerships as part of these investigations, and an additional five HC partners are involved through AquaFish advisory panels.

AQUAFISH TOPIC AREAS

Topic areas pertain to aquaculture and the nexus between aquaculture and fisheries. Some of the following topic areas overlap and are interconnected. Each investigation identifies a single topic area that best describes it. The text under each topic area is provided for illustrative purposes and is not prescriptive.

Integrated Production Systems

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

Aquaculture is an agricultural activity with specific input demands. Systems need to be designed to improve efficiency and/or integrate aquaculture inputs and outputs with other agricultural and non-agricultural production systems. AquaFish research must benefit smallholder or low- to semi-intensive producers, and should focus on low-trophic species for aquaculture development. Design systems to limit negative environmental impacts, to improve overall fish health, and optimize carrying capacity. 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. Innovative research is encouraged on: recirculating and aquaponics systems for supplying aquatic products to denser marketplaces in urban and peri-urban areas; integrated systems using shellfish, seaweeds, or other plants and animals; and new solutions for aeration, cold storage, and pond operations involving solar or other novel energy sources.

- ***Sustainable Feed Technology and Nutrient Input Systems (SFT)***

Methods of increasing the range of available ingredients and improving the technology available to manufacture and deliver feeds are critical research themes. 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. Research on soil-water dynamics and natural productivity to lessen feed needs were fundamental to the Pond Dynamics/Aquaculture (PD/A) and Aquaculture Collaborative Research Support Program (ACRSP); critical new areas of research may be continued, along with outreach to poor farmers using low-cost, no/low-feed technologies. 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. Complex pond dynamics technologies need to be simplified for use by new farmers; improved applications of pond dynamics technologies for driving non-fed plankton-driven systems are applicable where access to feeds is expensive or unreliable.

- ***Climate Change Adaptation: Indigenous Species Development (IND)***

Aquaculture, like agriculture and other human activities, will feel the effects of long-term climate change. Among the myriad challenges, ocean acidification and sea level rise will affect the world's coastal aquaculture operations, much of which occur in poorer countries. Temperature changes will test the resiliency of domesticated varieties. Research challenges involve understanding the adaptive range of these species, and developing cultivation techniques for new species, such as air-breathing fishes. The shifting distribution of global freshwater supplies will pose challenges for the aquaculture industry, small farmers, and the marketplace. Genomics tools may be used to characterize candidate air-breathing species already being evaluated through previous CRSP research. 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, economic, 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 native species for aquaculture, is of great interest. Aquaculture, done sensitively, can be a means to enhance and restock small-scale capture and wild fisheries resources. (Aquaculture-Fisheries Nexus Topic Area)

- ***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 for 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 genetically-modified organisms (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. Augmentation of bait fisheries through aquaculture to support capture fisheries is an area of interest, provided there are no net negative environmental effects.

People, Livelihoods, and Ecosystem Interrelationships

- ***Human Nutrition and 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. Focus on vulnerable populations, women and children, and underserved populations, and assess how any given technology will affect or improve the welfare of these groups. Research or field-testing with schools and nutrition centers is encouraged. (Aquaculture-Fisheries Nexus Topic Area)

- ***Food Safety, Post Harvest, and 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, hazard analysis and critical control point (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. Processing waste can claim up to 70% by weight of finfish depending on the species and manner processed, and post harvest losses can claim around 30%. Partnering with other groups and co-developing outreach techniques to reduce post harvest losses can significantly contribute to the amount of fish available for consumption, thus, contributing to the nutrition goals of USAID's Feed the Future Initiative. 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, and throughout much of the value chains. (Aquaculture-Fisheries Nexus Topic Area)
- ***Policy Development (PDV)***

Policy initiatives that link aquaculture to various water uses to improve human health are needed. 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 (e.g., 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 well-being, such as linkages with clean drinking water and improved sanitation. 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 (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 and Integrated Coastal Zone Management (WIZ)***

Aquaculture development that makes wise use of natural resources is at the core of the AquaFish program. 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 are needed, along with scenarios and options for mitigation. (Aquaculture-Fisheries Nexus Topic Area)

ENVIRONMENTAL COMPLIANCE

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

- 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 AquaFish-generated research findings will incorporate the appropriate environmental recommendations.
- All sub-awards must comply with environmental standards.
- AquaFish Projects will not procure, use, or recommend the use of pesticides of any kind. This includes but is not limited to algaecides, herbicides, fungicides, piscicides, parasiticides, and protozoacides.
- AquaFish Projects will not use or procure genetically modified organisms (GMO).
- AquaFish 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.

TERMINOLOGY FOR INVESTIGATIONS

Investigations that generate new information form the core of projects. Each investigation is 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.
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Investigations provide a transparent means for evaluating different types of work under AquaFish, be they quantitative, empirical, biologically-based, qualitative, policy-based, or informal. Each project is required to include at least one experiment or study, and at least one outreach activity that focus on women and/or girls.

GENERAL RESEARCH PRIORITIES

All projects address the following general research priorities:

- Priority Ecosystems
Inland and coastal ecosystems for aquaculture and aquaculture-fishery nexus topic areas.
- Priority Species
Low-trophic level fishes, domesticated freshwater fishes, non-fishfishes (e.g., bivalves, seaweeds), aquatic organisms used in polyculture and integrated systems, and 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
Universities, HC and US government, non-government organizations, private sector, Consultative Group on International Agricultural Research (CGIAR), and the USAID Food Security Innovation Center.



V. RESEARCH PROJECT REPORTS

Annual reports submitted by AquaFish Lead Project PIs cover the period from 1 October 2013 to 30 September 2014. Reports represent project progress during the first full year of the 2013-2015 Implementation Plan. The five lead projects address four global themes in an integrated systems approach, but focus primarily on one theme as it relates to producing positive development outcomes.

Theme A – *Improved Human Health and Nutrition, Food Quality, and Food Safety*
Africa Project: Ghana & Tanzania

Theme B – *Income Generation for Small-Scale Fish Farmers and Fishers*
Africa Project: Kenya & Uganda

Theme C – *Environmental Management for Sustainable Aquatic Resources Use*
Asia Project: Bangladesh
Asia Project: Nepal

Theme D – *Enhanced Trade Opportunities for Global Fishery Markets*
Asia Project: Cambodia & Vietnam

THEME A: IMPROVED HUMAN HEALTH AND NUTRITION, FOOD QUALITY, AND FOOD SAFETY

Africa Project: Ghana & Tanzania

Aquaculture Development and the Impact on Food Supply, Nutrition, and Health in Ghana and Tanzania

Project Description

Investigations

1. Assessing the Nutritional Impact of Aquaculture Policy in Fish Farming Districts in Tanzania and Ghana (13HHI01PU)
2. Development of a Cell-Phone Based Seafood Market Information System (SMIS) in Ghana: Application to Tilapia (13MER01PU)
3. Value Chain Analysis of Farmed Nile Tilapia (*Oreochromis niloticus*) and African Catfish (*Clarias gariepinus*) in Tanzania (13MER02PU)
4. Spat Collection and Nursery Methods for Shellfish Culture by Women (13QSD01PU)
5. Coastal Women's Shellfish Aquaculture Development Workshop (13BMA01PU)
6. Identifying Local Strains of Nile Tilapia (*Oreochromis niloticus*) that are Adapted to Future Climate Conditions (13IND01PU)
7. Evaluation of Invertebrates as Protein Sources in Nile Tilapia (*Oreochromis niloticus*) Diets (13SFT01PU)
8. Enhancing the Nutritional Value of Tilapia for Human Health (13SFT02PU)

Project Summary

This project builds on Phase I work to enhance the profitability of the aquaculture industry in Ghana and Tanzania through physical and human capacity development; enhancing market information sharing and trading; improving nutritional qualities of fish and consequently human nutrition; growing a whole chain

of activities from farm to consumer; and better management of native fish and shellfish species. Results from the investigations listed above are helping achieve the goals of improving human nutrition and efficiency in the value chain, increasing incomes for aquaculture producers and traders, diversifying production systems, and helping reduce post harvest losses through efficient market information sharing mechanisms.

Principal Project Personnel

Purdue University, US (Lead US University)
Kwamena Quagrainie – US Lead Project PI

University of Arkansas at Pine Bluff, US
Rebecca Lochmann – US Co-PI

Kwame Nkrumah University of Science & Technology, Ghana (Lead HC Institution)

Stephen Amisah – HC Lead Project PI
Gifty Anane-Taabeah – HC Investigator
Regina Edziyie – HC Investigator
Nelson Agbo – HC Investigator
Reginald Annan – HC Investigator

Virginia Polytechnic Institute & State University, US
Emmanuel Frimpong – US Co-PI

Sokoine University of Agriculture, Tanzania
Sebastian Chenyambuga – HC Co-PI & Tanzania PoC
Elibariki Emmanuel Msuya – HC Investigator
Nazael Madalla – HC Investigator

Institute of Marine Sciences (IMS), University of Dar es Salaam, Zanzibar, Tanzania
Narriman Jiddawi – HC Co-PI

FarmerLine, Ghana
Alloysius Attah – HC Co-PI

University of Hawaii-Hilo, US
Maria Haws – US Co-PI

Western Indian Ocean Marine Science Association (WIOMSA), Zanzibar, Tanzania
Julius Francis – HC Co-PI

University for Development Studies, Ghana
Akwasi Ampofo-Yeboah – HC Co-PI

Achievements

Field data on nutrition and household health was collected from 164 households in five districts in Ghana, targeting farmers who have participated in past AquaFish trainings. Four sites have been established along the Volta River for monitoring in order to identify local strains of climate change-resilient Nile tilapia in Ghana, and historical data have been acquired and compiled into a geodatabase and ArcGIS for mapping and modeling tilapia distribution along the Volta River. Efforts to use maggots and earthworms as sources of protein in tilapia diets are underway, representing potential low-cost and efficient alternatives for small-scale farmers. Data collection has been initiated relating to potential feed ingredients to enhance the nutritional value of tilapia for human health.

Capacity Building

During FY14, progress was made toward short-term trainings that will take place during FY15. One future training will focus on spat collection and nursery rearing for coastal women in Tanzania. Work is underway with FarmerLine to develop a cell phone-based seafood market information system in Ghana, and trainings on this technology will target fish farmers, artisanal fishers, and women in processing, marketing, and trading. Six long-term students were supported in Ghana, Tanzania, and the US in FY14: Four Master's students and two PhD students – 50% were women. These students studied at Kwame Nkrumah University of Science and Technology in Ghana, Sokoine University of Agriculture in Tanzania, and Virginia Tech University and Purdue University, both in the US.

Lessons Learned

Lessons learned from the first full year of operations under Phase II are integrated and compiled at the end of this section.

Presentations and Publications

- Adjei-Boateng, D., C.D. Prah, and R.E. Edziyie. 2014. *Effects of fertilization and feeding level on the productivity of tilapia pond culture in Ghana*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.
- Agbo, N.W., S. Amisah, E. Tettey, and E.A. Frimpong. 2014. Effects of dietary protein levels on growth performance of claroteid catfish, *Chrysichthys nigrodigitatus*, fingerlings. *Annals of Biological Research* 5(4): 17-22.
- Ansah, Y.B., E.A. Frimpong, and E.M. Hallerman. 2014. Genetically-Improved tilapia strains in Africa: potential benefits and negative impacts. *Sustainability* 6: 3697-3721.
- Frimpong, E.A., Y.B. Ansah, S. Amisah, and D. Adjei-Boateng. 2014. *Using on-farm experiments to untangle the causes of low productivity of tilapia Oreochromis niloticus grown in ponds in Ghana*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.
- Fynn, I. and E.A. Frimpong. 2014. *Estimating the actual and potential production capacity of aquaculture ponds in Ghana*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.
- Githukia, C.M., K.O. Obiero, J.O. Manyala, C.C. Ngugi, and K.K. Quagrainie. 2014. Consumer perceptions and preferences of wild and farmed Nile tilapia (*Oreochromis niloticus* L.) and African catfish (*Clarias gariepinus* Burchell 1822) in urban centres in Kenya. *International Journal of Advanced Research* 2(7): 694-705.
- Madalla, N.A., O.D. Kitojo, and S. Chenyambuga. 2014. *Effect of feeding level and frequency on performance of Nile tilapia Oreochromis niloticus fed diets containing Moringa leaf meal and sunflower seed cake*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.
- Ndanga, L.Z.B., K.K. Quagrainie, and J.H. Dennis. 2013. Economically feasible options for increased women participation in Kenyan aquaculture value chain. *Aquaculture* 414-415: 183-190.
- Quagrainie, K., C. Ngugi, J. Amadiva, and S.K. Macaria. 2014. *Aquaculture product development and marketing innovations for sustainable small-scale aquaculture in Kenya*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.

THEME B: INCOME GENERATION FOR SMALL-SCALE FISH FARMERS AND FISHERS

Africa Project: Kenya & Uganda

Aquaculture Development in Kenya and Uganda: Advancing Cost-Effective Technology, Market Assessment, and End-User Engagement

Project Description

Investigations

1. Development of Low-Cost Captive Breeding and Hatching Technologies for the African Lungfish (*Protopterus aethiopicus* and *P. amphibius*) to Improve Livelihoods, Nutrition, and Income for Vulnerable Communities in Uganda (13IND03AU)
2. New Approaches to Inform, Motivate, and Advance Small and Medium-Scale Fish Farmers: Building Industry Capacity through Cell Phone Networks, Training, and Market Participation (13BMA04AU)
3. Assessment of Market Opportunities for Small-Scale Fishers and Farmers in Central Uganda (13MER05AU)
4. Assessment of Growth Performance of Monosex Nile Tilapia (*Oreochromis niloticus*) in Cages Using Low-Cost, Locally Produced Supplemental Feeds and Training Fish Farmers on Best Management Practices in Kenya (13SFT06AU)
5. Formulation and Manufacture of Practical Feeds for Western Kenya (13SFT07AU)
6. Development of Low-Cost Aquaponics Systems for Kenya (13BMA05AU)

Project Summary

This project is working to solve or clarify bottlenecks that limit the advancement of fish culture in Uganda and Kenya to improve livelihoods, nutrition, and income for fishers, farmers, and vulnerable communities. Investigations are underway to improve breeding and hatching technologies for African lungfish species in Uganda; assess feed formulations and growth performance of Nile tilapia in Kenya; develop low-cost aquaponics systems; and build capacity through activities such as trainings, cell phone networks, and assessing market opportunities.

Principal Project Personnel

Auburn University, US (Lead US University)

Joseph Molnar – US Lead Project PI

Claude Boyd – US Investigator

Makerere University, Uganda (Lead HC Institution)

Theodora Hyuha – HC Lead Project PI

Monica Beharo – HC Investigator

University of Arizona, US

Kevin Fitzsimmons – US Co-PI

Kenya Ministry of Agriculture, Kenya

Charles Ngugi – HC Co-PI & Kenya PoC

Julius Nyoro Ndogoni – HC Investigator

Judith Amadiva - HC Investigator

Mwangi Mbugua - HC Investigator

Alabama A&M University, US

James Bukenya – US Co-PI

National Fisheries Resources Research Institute (NaFIRRI), Uganda

John Walakira – HC Co-PI

Gertrude Atukunda – HC Investigator

University of Eldoret, Kenya

Julius Manyala – HC Co-PI

Non-Funded Collaborating Institutions

University of Georgia, US

Achievements

In Uganda, a total of 251 African lungfish samples were collected from four sources to begin breeding trials. Focus groups were held with 48 Ugandan fish farmers in five districts to learn how mobile phones are used to acquire fish farming information; findings will inform the design and improvement of fish farming content being created by the Grameen Foundation. Data on catfish prices were collected to examine the role of price as a mechanism for characterizing the linkages between farm-raised and wild-harvest African catfish markets, and survey instruments were developed to assess market opportunities for wholesalers, retail buyers, and institutional buyers in central Uganda. In Kenya, research was initiated to design and implement a low-cost, medium-scale aquaponics demonstration facility at the University of Eldoret, where students and fish farmers gain exposure to the basics of growing plants with nutrient-rich effluent water from aquaculture ponds.

Capacity Building

During FY14, a Farmers' Day workshop was held in Kenya with 88 farmers (26 women and 62 men) from five districts in attendance. Lectures covered topics such as feed formulation, fish reproduction, pond management strategies, challenges and solutions in farming, and propagation of catfish. Curricula for new long-term degree programs at the University of Eldoret were developed and seven long-term students under this project were supported in FY14: Three Master's students, and four PhD students; 43% were women. They studied at Eldoret University and Kenyatta University in Kenya, Makerere University in Uganda, and Auburn University and University of Arizona in the US.

Lessons Learned

Lessons learned from the first full year of operations under Phase II are integrated and compiled at the end of this section.

Presentations and Publications

Bukenya, J.O., M. Ssebisubi, and J. Molnar. 2014. *A test for price integration in the Uganda aquaculture market*. [Oral presentation] Southern Rural Sociological Association's Annual Meeting, Dallas, Texas, US. 1-4 February 2014.

Fitzsimmons, K. 2014. *FFA program and competition in aquaculture*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.

Fitzsimmons, K. 2014. *Global tilapia production and market situation in 2014*. [Oral presentation] World Aquaculture Society -- World Aquaculture 2014, Adelaide, Australia. 7-11 June 2014.

Githukia, C.M., K.O. Obiero, J.O. Manyala, C.C. Ngugi, and K.K. Quagrainie. 2014. Consumer perceptions and preferences of wild and farmed Nile tilapia (*Oreochromis niloticus* L.) and African catfish (*Clarias gariepinus* Burchell 1822) in urban centres in Kenya. *International Journal of Advanced Research* 2(7): 694-705.

Hyuha, T.S., J. Molnar, J. Bukenya, and W. Cornelius. 2014. *Gender perspectives in processing and handling of aquaculture products in Uganda*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.

Manyala, J.O., K. Fitzsimmons, C. Ngugi, J. Ani, and H. Lubanga. 2014. *Enhancement of pond productivity by organic manure fertilization and supplementary feeding in Kenya* [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.

- Molnar, J.J. 2014. *Using cell phones to advance aquaculture development in Uganda*. [Oral presentation] New Technologies & Industries Conference, Shenzhen, China. 2-5 September 2014.
- Opiyo, M.A., C.C. Ngugi, and J. Rasowo. 2014. Combined effects of stocking density and background colour on growth performance and survival of Nile tilapia (*Oreochromis niloticus*, L.) fry reared in aquaria. *Journal of Fisheries Sciences* 8(3): 228-237.
- Tran, L., K. Fitzsimmons, and D.V. Lightner. 2013. *Effects of tilapia in controlling Acute Hepatopancreatic Necrosis Disease (AHPND)*. [Oral presentation] World Aquaculture Society – Asian-Pacific Aquaculture, Ho Chi Minh City, Vietnam. 10-13 December 2013.
- Walakira, J., J. Molnar, and E. Nankya. 2014. *Sustainable strategy for controlling fish disease conditions using banana (Musa sp.) leaf extracts in Uganda*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.



Catfish gulp air from the surface of a eutrophic fish pond.

THEME C: ENVIRONMENTAL MANAGEMENT FOR SUSTAINABLE AQUATIC RESOURCES USE**Asia Project: Bangladesh*****Enhancing Aquaculture Production Efficiency, Sustainability, and Adaptive Measures to Climate Change Impacts in Bangladesh******Project Description******Investigations***

1. Economic and Environmental Benefits of Reduced Feed Inputs in the Polyculture of Tilapia and Major Indian Carps (13SFT04NC)
2. Pulsed Feeding Strategies to Improve Growth Performance, Gastrointestinal Nutrient Absorption Efficiency, and Establishment of Beneficial Gut Flora in Tilapia Pond Culture (13SFT05NC)
3. Novel Approach for the Semi-Intensive Polyculture of Indigenous Air-Breathing Fish with Carp for Increasing Income and Dietary Nutrition while Reducing Negative Environmental Impacts (13MNE01NC)
4. The Culture Potential of Pangasius Catfish in Brackish (Hyposaline) Waters of the Greater Barisal Regions in Southern Bangladesh (13BMA02NC)
5. Integrated Mola Fish and Gher/Freshwater Prawn Farming with Dyke Cropping to Increase Household Nutrition and Earnings for Rural Farmers in Southwest Bangladesh (13HHI03NC)
6. Production for Nutrient-rich Small Fish Mola and Freshwater Prawn Using Integrated Cage-Pond Carp Polyculture for Northwest Bangladesh (13BMA03NC)
7. Improving Nutritional Status and Livelihoods for Marginalized Women Households in Southwest Bangladesh through Aquaculture and Value Chain Analysis (13MER04NC)

Project Summary

This project is enhancing aquaculture production efficiency and sustainability, and developing adaptive measures to climate change impacts in Bangladesh through improved management of aquatic resources. Researchers are developing improved aquaculture production practices through a series of investigations. This research is providing additional yields of nutritious seafood, improving income earnings for impoverished households and in communities impacted by global climate change, and reducing degradation of water quality (nutrient loading). These project goals align well with Bangladesh's national health and food security policies and USAID's Feed the Future priorities for Bangladesh.

Principal Project Personnel**North Carolina State University, US (Lead US University)**

Russell Borski – US Lead Project PI

Upton Hatch – US Investigator

Harry Daniels – US Investigator

Bangladesh Agricultural University, Bangladesh (Lead HC Institution)

Md. Abdul Wahab – HC Lead Project PI

Sharoz Mahean Haque – HC Investigator

Sadika Haque – HC Investigator

Md. Ashraful Islam – HC Investigator

Central Luzon State University, Philippines

Wilfred Jamandre – HC Co-PI & Philippines PoC

Southeast Asian Fisheries Development Center, Philippines

Emilia Qunitio – HC Co-PI

University of Dhaka, Bangladesh

Abu Torab M.A. Rahim – HC Co-PI

Nazma Shaheen – HC Investigator

Hajee Mohammad Danesh Science Technology University, Bangladesh

Rezoanul Haque – HC Investigator

Patuakhali Science and Technology University, Bangladesh

Md. Lokman Ali – HC Co-PI

Khulna University, Bangladesh

Md. Bazlur Rahaman – HC Co-PI

Shak Md. Anisul Huq – HC Investigator

Shushilan NGO, Bangladesh

Satchidananda “Sattu” Biswas – HC Co-PI

Non-Funded Collaborating Institutions

WorldFish, Bangladesh

Monash University, Australia

Achievements

Tilapia in Bangladesh are predominantly grown in monoculture with high feed inputs. New research found that the gross and net production performances of tilapia when grown in polyculture with Chinese (silver) carp were considerably higher in fertilized ponds fed on a rationed diet set at half of the current industry standard, or when grown in ponds on fertilization alone. Research on carp/prawn/mola polyculture techniques and the integration of cage/pond aquaculture and dyke-crop farming with pond effluent fertilizers are successfully underway and are projected to have positive impacts on household nutrition and income. Surveys are also under way to help determine nutritional impact, particularly for women and children. Men and women in the Barisal region, a climate-impacted region experiencing saltwater inundation, are working with researchers to introduce pangasius catfish farming to saline ponds. Current research will influence management practices with positive impact on the production and profit potential for small-scale farmers.

Capacity Building

Three trainings reaching 149 people (72 women and 77 men) took place in Bangladesh during FY14. They focused on improved management practices for integrated tilapia/mud crab culture, mola polyculture, and water quality. The tilapia/mud crab culture workshop featured a presentation on previous AquaFish work conducted in the Philippines and provided recommendations for application in Bangladesh. Eighteen long-term students were supported under the NCSU project: Two Bachelor's students, 12 Master's students, three PhD students, and one Post-doc student – six were women and 12 were men. These students studied at NCSU in the US, and at three universities in Bangladesh: Bangladesh Agricultural University, Khulna University, and Patuakhali Science and Technology University.

Lessons Learned

Lessons learned from the first full year of operations under Phase II are integrated and compiled at the end of this section.

Presentations and Publications

Baltzegar, D.A., B.J. Reading, J.D. Douros, and R.J. Borski. 2014. Role for leptin in promoting glucose mobilization during acute hyperosmotic stress in teleost fishes. *Journal of Endocrinology* 220(1): 61-72.

Borski, R.J. 2013. *Current status on the biology of leptin in tilapia: Implications for energy homeostasis*. [Oral presentation] Perspectives in Endocrinology of Cichlids, Ihud, Israel, 2-6 October 2013.

Borski, R.J. 2014. *Characterization of novel actions for glucocorticoids and leptin in controlling osmotic stress responses and growth in the euryhaline tilapia*. [Oral presentation] Seminar – Toxicology, North Carolina State University, April 2014.

Borski, R.J. and E.G.T. de Jesus-Ayson. 2014. *Alternate day feeding is more cost effective than daily feeding for culture of milkfish in brackishwater ponds and sea cages*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.

- Douros, J.D., D.A. Baltzegar, J.P. Breves, D.T. Lerner, A.P. Seale, E.G. Grau, and R.J. Borski. 2014. Prolactin is a major inhibitor of hepatic Leptin A synthesis and secretion: studies utilizing a homologous Leptin A ELISA in the tilapia. *General and Comparative Biology* 207: 86-93.
- Hinshaw, J., R.J. Borski, H. Daniels, D. Green, and B. Reading. 2014. *North Carolina State University aquaculture – research update*. [Oral presentation] Aquaculture Development Conference, New Bern, North Carolina, US. 20-22 February 2014.
- Picha, M.E., P.R. Biga, N. Galt, A.S. McGinty, K. Gross, V.S. Hedgpeth, T.D. Siopes, and R.J. Borski. 2014. Overcompensation of circulating and local insulin-like growth factor-1 during catch-up growth in hybrid striped bass (*Morone chrysops* x *Morone saxatilis*) following temperature and feeding manipulations. *Aquaculture* 428-429: 174-183.
- Wahab, Md.A., M.N. Sakib, and R.J. Borski. 2014. *Effect of different feeding regimes on growth and production performance of air-breathing stinging catfish, shing Heteropneustes fossilis and major carps in pond polyculture*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.



Tilapia juveniles in a hatchery rearing tank.

THEME C: ENVIRONMENTAL MANAGEMENT FOR SUSTAINABLE AQUATIC RESOURCES USE**Asia Project: Nepal*****Development of More Efficient and Environmentally Sustainable Aquaculture Systems for Nepal******Project Description******Investigations***

1. Reproduction and Seed Production of Sahar (*Tor putitora*) in Chitwan, Nepal (13QSD02UM)
2. Production of Periphyton to Enhance Yield in Polyculture Ponds with Carps and Small Indigenous Species (13SFT08UM)
3. Household Fish Ponds in Nepal: Their Impact on Fish Consumption and Health of Women and Children and their Constraints Determined by Value Chain Analysis (13MER06UM)
4. Two Small Indigenous Species to Improve Sustainability in Typical Polyculture Systems in Nepal (13IND04UM)
5. Demonstrating the Value of Tilapia and Sahar Production in Polyculture Ponds Using Government Farm and On-Farm Trials (13BMA06UM)
6. Establishing School Ponds for Fish Farming and Education to Improve Health and Nutrition of Women and Children in Rural Nepal (13HHI04UM)

Project Summary

The Nepal project focuses on small-holder farms and producing more sustainable aquaculture systems through environmental management, in both production systems and in managing wastes from aquaculture. Addressing nutrition is also a key project priority. To address these priorities, investigations are examining polyculture systems that incorporate small indigenous species (SIS) to determine if they offer a viable means to increase food production for poorer households; enhancing production of native species, particularly sahar, a cool water species that is valued by locals and important as a target of restoration; and evaluating the impact of household and school fish ponds on nutritional education and fish consumption.

Principal Project Personnel

University of Michigan, US (Lead US University)

James Diana – US Lead Project PI

Directorate of Fisheries Development, Nepal

Rama Nanda Mishra – HC Co-PI

Agriculture and Forestry University, Nepal (Lead HC Institution)

Madhav Shrestha – HC Lead Project PI

Dilip Kumar Jha – HC Investigator

Narayan Pandit – HC Investigator

Sunila Rai – HC Investigator

Fisheries Research Center, Nepal

Jay Dev Bista – HC Co-PI

Achievements

During FY14, researchers in Nepal collected sahar broodstock and have started to rear the fry at a reference site in Pokhara. Polyculture SIS trials began with fry collection and stocking in research ponds in Chitwan. SIS samples are also being collected for the development of periphyton production techniques to enhance yield in carp-SIS polyculture. All preparations for a trial at a government fish farm in Bhairahawa have been completed. Ponds were stocked with fingerlings to demonstrate the value of growing tilapia with sahar in a polyculture system.

Capacity Building

During FY14, preparations were made for short-term trainings to be conducted in the second half of the implementation plan. Research conducted in FY14 will inform workshops that will introduce farmers to SIS cultivation and demonstrate methods for improving yield using polyculture systems. AquaFish partners in Nepal helped develop curricula for new long-term degree programs at the Agriculture and Forestry University (AFU). Twenty-four long-term students were supported at the AFU in Nepal and the University of Michigan in the US in FY14: Fourteen Bachelor's students, nine Master's students, and one PhD student, including nine women and 15 men.

Lessons Learned

Lessons learned from the first full year of operations under Phase II are integrated and compiled at the end of this section.

Presentations and Publications

- Bista, J.D. 2014. *Environmentally friendly cage culture: a successful model of small-scale aquaculture for livelihood of fishing communities in Nepal*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, US. 9-12 February 2014.
- Bista, J.D. 2014. *Spawning response of sahar (Tor putitora) in different seasons under pond reared condition in Pokhara, Nepal*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, US. 9-12 February 2014.
- Gurung, S., M.K. Shrestha, and N.P. Pandit. 2013. Nitrogen and phosphorus budget analysis of carp based polyculture ponds in Chitwan, Nepal. *Our Nature* 11(2): 116-125.
- Keeler, B. 2014. *Optimal stocking density for small indigenous species within a large carp polyculture system in rural Nepal*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, US. 9-12 February 2014.
- Liu, L., Z. Hu, X. Dai, and Y. Avnimelech. 2014. Effects of addition of maize starch on the yield, water quality and formation of bioflocs in an integrated shrimp culture system. *Aquaculture* 418-419: 79-86.
- Pandit, N.P. 2014. *Effect of different fertilization and feeding systems on water quality and growth performance in Nile tilapia Oreochromis niloticus*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.
- Pandit, N.P. 2014. *Growth performance and gonadal development of heat-induced sterile Nile tilapia, Oreochromis niloticus*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.
- Pandit, N.P. 2014. *Identification of immunological response analysis of tnfr13 (April) gene in grass carp, Ctenopharyngodon idella*. [Poster] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.
- Rai, S. 2014. *Production performance of dedhuwa Esomus danricus in monoculture and polyculture with carp in Chitwan, Nepal*. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.

THEME D: ENHANCED TRADE OPPORTUNITIES FOR GLOBAL FISHERY MARKETS**Asia Project: Cambodia & Vietnam*****Improving Food Security, Household Nutrition, and Trade through Sustainable Aquaculture and Aquatic Resource Management in Cambodia and Vietnam******Project Description******Investigations***

1. Impacts of Climate Change on Fish Value Chains in the Lower Mekong Basin of Cambodia and Vietnam (13MER03UC)
2. Alternative Feeds and Processing for Freshwater Aquaculture Species (13SFT03UC)
3. Sustainable Snakehead Aquaculture Development in the Lower Mekong River Basin of Cambodia (13IND02UC)
4. Estimating Carrying Capacity for Aquaculture in Cambodia (13WIZ01UC)
5. Enhancing Food Security and Household Nutrition of Women and Children with a Focus on Nutrient Dense Commonly Consumed Fish from Capture Fisheries and Aquaculture in Cambodia (13HHI02UC)
6. Policy Recommendations to Improve Food Security and Household Nutrition through Sustainable Aquaculture and Aquatic Resource Management in Cambodia and Vietnam (13PDV01UC)

Project Summary

The goals of this project are improved nutrition, poverty alleviation, and food security through sustainable aquaculture development and aquatic resources management in Cambodia and Vietnam, especially in the context of links between trade and markets and climate change. In alignment with the Feed the Future Initiative, these goals takes into account the need to address malnutrition, especially in women and children, by increasing the availability and access to nutrient dense foods through research on fish. Project goals are being accomplished through six separate but complementary investigation on fish value chains, development of feeds and feeding strategies and processed products, sustainable snakehead aquaculture systems, estimating carrying capacity for aquaculture, food and nutrition security vulnerability of women, and policy and outreach.

Principal Project Personnel**University of Connecticut, US (Lead US University)**

Robert Pomeroy – US Lead Project PI
Sylvain DeGuise – US Investigator

Inland Fisheries Research and Development Institute (IFReDI), Cambodia (Lead HC Institution)

So Nam – HC Lead Project PI
Hap Navy – HC Investigator
Prum Somany – HC Investigator
Touch Bungthang – HC Investigator
Chheng Phen – HC Investigator
Phanara Thach – HC Investigator
Setha Im – HC Investigator

University of Rhode Island, US

David Bengtson – US Co-PI

Can Tho University, Vietnam

Tran Thi Thanh Hien – HC Co-PI & Vietnam PoC
Tran Ngoc Hai – HC Investigator
Truong Hoang Minh – HC Investigator
Thi Nhu Ha Nguyen – HC Investigator
Pham Minh Duc – HC Investigator

Freshwater Aquaculture Research and Development Center (FARDeC), Cambodia

Nen Phanna – HC Co-PI

Non-Funded Collaborating Institutions

Department of Agriculture, Vietnam
Royal University of Agriculture, Cambodia

Achievements

Researchers have successfully transferred technology between partners in Vietnam and Cambodia regarding snakehead breeding and domestication. Feeding trials are being conducted using varying concentrations of soy-protein and fishmeal to determine the best level of soy-protein in snakehead diets for eventual use in small-scale snakehead aquaculture. Techniques have been developed for processing value-added snakehead, including salty, fermented snakehead and preserved, dried snakehead. Surveys and data collection on existing processing practices for snakehead products are being conducted and analyzed to effectively administer trainings. Models for determining aquaculture carrying capacity for water quality management and regulation are under development. Project participants have coordinated training for local regulators and managers as consultants and future users of these models. The results of this work will help influence the sustainability of the growing aquaculture industry in Cambodia, Vietnam, and the Mekong Delta region.

Capacity Building

A total of 40 short-term trainees were reached through three trainings in FY14, including 12 women and 28 men. All of these workshops were conducted in Cambodia and focused on training scientists, regulators, and fisheries officers to estimate carrying capacity through the use of models. There were 38 long-term students supported in Cambodia and Vietnam in FY14: Twenty-six Bachelor's students, 10 Master's students, and two PhD students – 14 women and 24 men. These students studied at Can Tho University in Vietnam and three universities in Cambodia: Royal University of Agriculture, Royal University of Law and Economics, and Kampong Cham National School of Agriculture.

Lessons Learned

Lessons learned from the first full year of operations under Phase II are integrated and compiled at the end of this section.

Presentations and Publications

- Bùi, P.Đ., T.M.T. Truong, and T.T.H. Tran. 2014. Investigations of types of products from snakehead fish (*Channa striata*) and their production process in An Giang province. Can Tho University Journal of Science 1: 36-41.
- Le, X.S., H. Navy, and R. Pomeroy. 2014. Value chain of snakehead fish in the lower Mekong basin of Cambodia and Vietnam. Aquaculture Economics & Management 18(1): 76-96.
- Somany, P. 2014. *Enhancing climate resilience for fisheries sector in Cambodia*. [Oral presentation] Executive Forum on ASEAN Leaders in Agriculture and Development, SEARCA, Laguna, Philippines. 16-20 June 2014.
- Trần, H.T., T.L. Nguyễn, V.H. Huỳnh, H.M. Truong, N.H. Trần, and R.S. Pomeroy. 2014. Assessment on production efficiency and weather change impacts on snakehead pond culture in An Giang and Tra Vinh provinces [13MER03UC]. Can Tho University Journal of Science 2: 141-149 [in Vietnamese].
- Trần, H.T., T.L. Nguyễn, V.H. Huỳnh, H.M. Truong, N.H. Trần, and R.S. Pomeroy. 2014. *Assessment on production efficiency and weather change impacts on snakehead pond culture in An Giang and Tra Vinh provinces*. [Poster] Can Tho University, Can Tho, Vietnam. 15 August 2014[in Vietnamese].
- Trần, T.T.H., L.C.T. Trần, V.T. Nguyễn, B.T. Nguyễn, M.P. Trần, M.D. Phạm, and D. Bengtson. 2014. Replacing fishmeal by some of soy protein sources in feed for snakehead (*Channa striata*). Can Tho University Journal of Science 1: 310-318 [in Vietnamese].

LESSONS LEARNED

Lessons learned from the first year of operations under Phase II are integrated and compiled below.

1. In AquaFish field projects, weather often causes disruptions. Weather can make or break a season of research experiments. Stronger and more resilient projects survive disruptions, from weather events to natural and human-caused hazards, better than weaker projects. Resilience is improved when projects have sufficient resources banked and readily available for use. The slow trickle of funds to projects on start up can cause a temporary state of instability, when an unanticipated weather event or hazard can result in greater losses. The lesson learned is to allow the program and projects to hold substantial reserves to mitigate the effects of risk. USAID pipeline exercises are not helpful in this regard and need to be reviewed given the greater risks and need for ready capital flows among projects that operate in risky environments. A recommendation is to regard AquaFish's authorized core annual funding of \$4M as the minimum amount to be allocated each year through 2017, on time, without reductions. This would not only lower transaction costs when dealing with budget reductions, but increase resilience of projects and improve performance overall. USAID can be commended in this first full year of Phase II for its on-time allocation of annual funds.

2. USAID, and the USG overall, has recently become increasingly interested in the effects of and responses to climate change impacts. In Phase II, AquaFish has been able to continue its longer-term research on adapting for climate change, primarily through work on air breathing fishes. Not too long ago, USAID requested that climate change research terminology be removed from our portfolio. In an effort to de-politicize our research portfolio, the actual work remained as *Indigenous Species Development* and *Mitigating Negative Environmental Impacts* research topics. The importance of our indigenous fish research extends not only to climate change, but to environmental sustainability (e.g., using native species and not introducing species) and addresses local community values, especially dietary preferences. The lesson learned is that in the face of ever-changing politics, the importance of retaining long-term and well-considered research foci is heightened.

3. Reporting under USAID FTFMS and associated year-end reporting has occasionally presented problems due to insufficient guidance for producing indicator metrics; overly general definitions of terminology for which greater specificity would be helpful; rushed requests for information that interrupt tight scheduling for year-end reporting; and no opportunity to modify targets. The lesson learned is the importance of clear and consistent guidance from USAID, which affects what the Management Team provides to project participants. Looking ahead, the new FTFMS guidance released in October 2014 may help to streamline FY15 reporting. However, the inability to modify targets as initially expected will continue to pose problems. At the same time, an easing of program-derived DTAP reporting metrics, beginning with Phase II, improved streamlining by removing duplicative reporting burdens. The Phase I DTAP reporting framework was dropped in favor of reporting only under FTFMS.

4. AquaFish programs at KNUST, Ghana, have left a visible mark both on the university's aquaculture and fisheries programs, especially student enrollment and engagement in research, and on the development of faculty research skills and output. These benefits are not captured in the current metrics being used in project impact assessment by USAID. While curriculum development was not a research objective of AquaFish, it was an unintended benefit that has only recently drawn the interest of USAID. Often, the most important benefits turn out to be those that were unplanned.



VI. ASSOCIATE AWARD RESEARCH PROJECT REPORTS

Project Title

Enhancing the Profitability of Small Aquaculture Operations in Ghana, Kenya, and Tanzania

Associate Award Number

AID-OAA-LA-10-00006 under

Leader with Associates Award

EPP-A-00-06-00012-00

Project Description

The AquaFish Strategic Investment in Rapid Technology Dissemination (SIRTD) Associate Award is framed around USAID and the Feed the Future (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 United Nations' (UN) Millennium Campaign and works 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 SIRTD Associate Award conducted work in three FTF focus countries: Ghana, Kenya, and Tanzania. The project focused on the adoption and dissemination of best management practices that would help increase productivity and profitability while decreasing environmental impacts. Project participants worked with private sector partners to expand commercially sustainable agro-input industries and dealer networks, including small enterprises. Increased access to inputs was coupled with strategies to help ensure their safe and sustainable use. AquaFish technologies were refined and tailored to local conditions by supporting national research institutes and building local research capacities, including training local researchers, technicians, and farmer-trainers. Gender inequalities inhibiting women's access to information, inputs, or technology were anticipated and addressed. The aim is to provide women with equal access to affordable inputs and improved technologies.

Brief synopses of the target technologies that were examined for this project are provided below.

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.

Nutrient Management Practices

Better nutrient management practices include fertilizing and feeding regimes that reduce waste and prevent water quality degradation that threaten fish health. Avoiding excessive feeding saves on input costs and translates directly into farm profitability. Uneaten feed often functions like an expensive fertilizer and can lead to highly eutrophic water conditions that both reduce yields and escalate the cost of operations.

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.

A no-cost extension (NCE) was approved on 29 September 2014 to extend the award end date from 30 September 2014 to 30 December 2014. This extension allows project participants to complete reports, and develop translations for project outputs in Kenya, Tanzania, and Ghana.

Principal Project Personnel

AquaFish, Oregon State University, US (Lead University)

Hillary Egna – Lead PI

Kwame Nkrumah University of Science and Technology, Ghana

Steve Amisah – HC Co-PI

Purdue University, US

Kwamena Quagrainie – US Co-PI

Ministry of Fisheries Development, Kenya

Charles Ngugi – HC Co-PI

Virginia Polytechnic Institute and State University, US

Emmanuel Frimpong – US Co-PI

Sokoine University of Agriculture, Tanzania

Sebastian Chenyambuga – HC Co-PI

Achievements

This Associate Award has the broad objectives of scaling up innovations from previous Collaborative Research Support Program and AquaFish successes, and accelerating BMP adoption rates in Ghana, Kenya, and Tanzania. The project was divided into two separate but complementary investigations based upon countries. Progress made and results achieved for the two investigations for the two subcontracting US Lead Institutions (Purdue University and Virginia Polytechnic Institute and State University) are presented separately below.

Enhancing the Profitability of Small Aquaculture Operations in Kenya and Tanzania (10BMA01PU)

Four workshops were held under this investigation in FY14, two in Tanzania and two in Kenya. The workshops in Tanzania targeted emerging and experienced small-scale fish farmers who could benefit from learning and adopting BMPs. The first of the two workshops in Kenya served as an end-of-cycle training on BMPs for fish farmers in the region. The second targeted women specifically, and successfully brought together female fish farmers and producers from the area.

In preparation of the project closeout, final outreach materials are being prepared. Calendars and kangas (printed cotton fabrics) with BMP adoption messages will be produced in Kiswahili for distribution in Tanzania. Kangas will also be produced with BMP messages in Kenya. These materials will help further disseminate information about effective pond management strategies.

Enhancing the Profitability of Small Aquaculture Operations in Ghana (10BMA02VT)

Project work for the investigation in Ghana focused on data entry and analysis in FY14, since all short-term trainings were completed in previous years. Approximately 400 surveys, as well as other field data, are being analyzed to calculate BMP adoption rates in the country.

In addition to posters with infographics, BMP messages will be broadcast on radio stations in Ghana in local languages to reach farmers on a national level.

Publications and Presentations

Ansah, Y.B. and E.A. Frimpong. 2014. Profitability and adoption of two pond aquaculture best management practices in Ghana. [Oral presentation] World Aquaculture Society -- Aquaculture America, Seattle, Washington, US. 9-12 February 2014.

- Frimpong, E.A., Y.B. Ansah, S. Amisah, D. Adjei-Boateng, N.W. Agbo, and H. Egna. 2014. Effects of two environmental best management practices on pond water and effluent quality of growth of Nile Tilapia, *Oreochromis niloticus*. *Sustainability* 6: 652-675.
- Frimpong, E.A. and I.E.M. Fynn. Tilapia aquaculture in Ghana: ponds can contribute more to overall production, food security. *Global Aquaculture Advocate* 17(4): 18-21.
- Goetting, K., C. Price, M. Chow, S. Ichien, and H. Egna. 2014. *Identifying and implementing best management practices for small-scale aquaculture in sub-Saharan Africa*. [Poster] World Aquaculture Society – Aquaculture America, Seattle, Washington, USA. 9-12 February 2014.
- Price, C. and H. Egna. 2014. Strategies for reducing feed costs in small-scale aquaculture. *Global Aquaculture Advocate* 17(3): 24-26.
- Price, C., S. Ichien, and H. Egna. 2014. *Strategies for reducing feed costs in smallholder tilapia aquaculture*. [Poster] World Aquaculture Society – Aquaculture America, Seattle, Washington, USA. 9-12 February 2014.

Capacity Building

AquaFish human capacity building efforts were accomplished through short-term (non-degree) and long-term (degree) programs. These efforts help develop professional-level skills and abilities for trainees in fisheries science, aquaculture, aquatic resource management, and other fields of study. Short-term trainings took the form of seminars, workshops, field demonstrations, and short-courses scheduled for periods of one day to several weeks. Short-term training sessions focus on specific topics, often linked to innovative methodologies and technologies developed by AquaFish researchers in response to perceived needs in host countries. Long-term training encompasses academic programs leading to BS, MS, or PhD degrees at accredited institutions either in the Host Country, the US, or a third country, as well as other programs leading to certificates of completion or high school diplomas.

During FY14 a total of four trainings took place in Kenya and Tanzania, reaching 103 trainees (69 men and 34 women), 33% of whom were women. The project supported 16 long-term trainees, including 10 women and six men, at seven institutions in three countries, including Kwame Nkrumah University of Science and Technology in Ghana; Eldoret University, Kenyatta University, Moi University and the University of Nairobi in Kenya; and Purdue University and Virginia Tech University in the US (Table VI-1). There were three students seeking Bachelor's degrees, eight students seeking Master's degrees, and five students seeking PhD's (Figures VI-1 and VI-2).

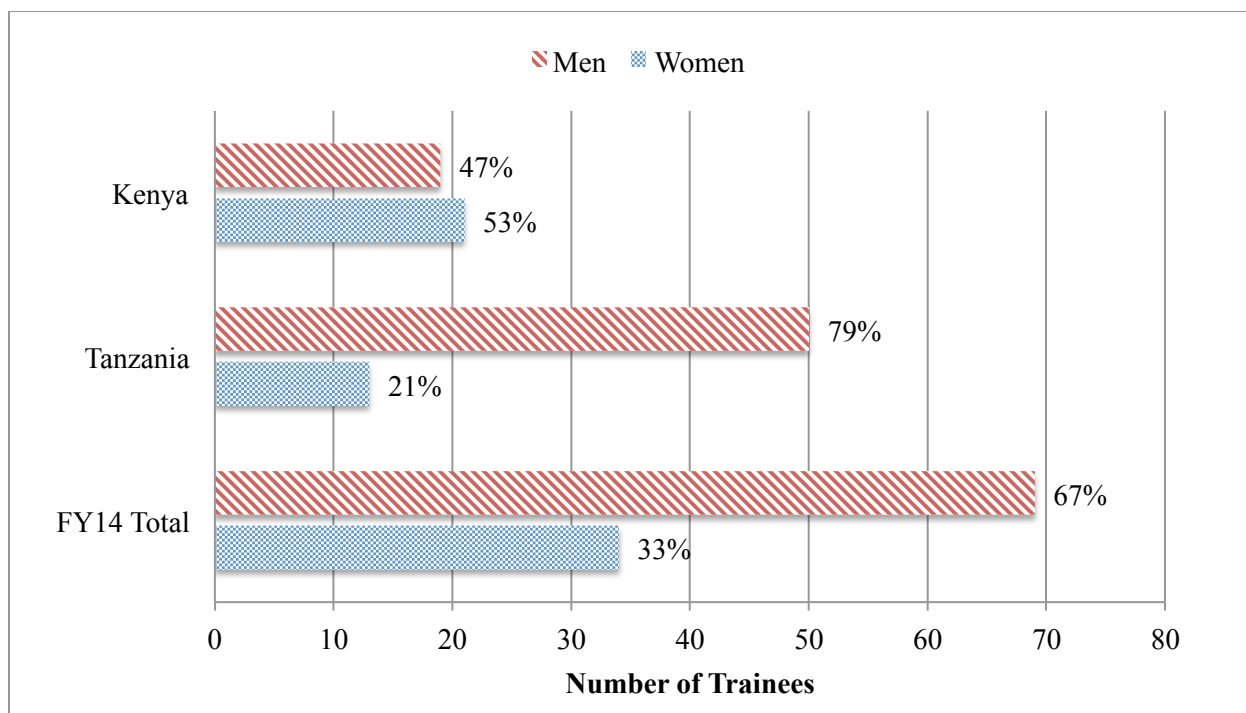


Figure VI-1. Number and percent of SIRTH short-term trainees by country and gender in FY14.

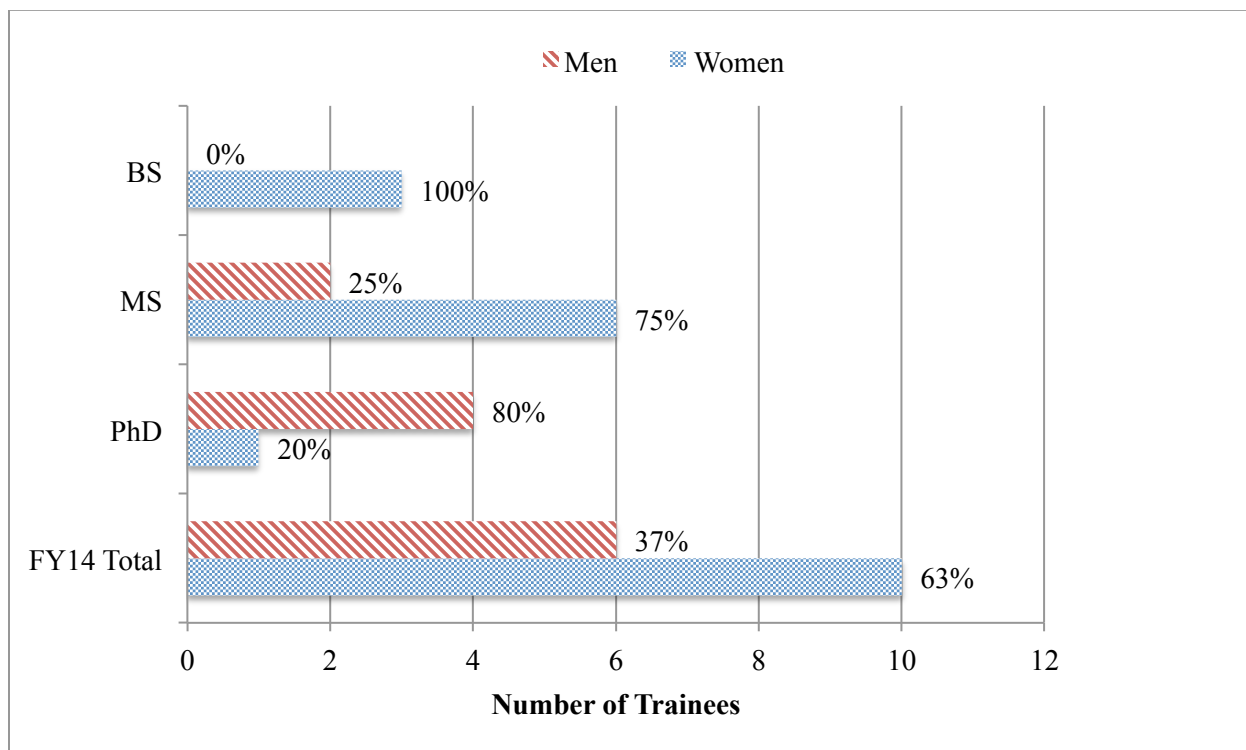


Figure VI-2. Number and percent of SIRTH long-term trainees by degree and gender in FY14.

Table VI-1. Long-term students in FY14 under the SIRTD award by degree, gender and training location.

Degree	BS	MS	PhD	Grand Total
Female	3	6	1	10
Ghana				
Kwame Nkrumah University of Science & Technology		2		2
Kenya				
Eldoret University	3			3
Kenyatta University		1		1
Moi University		1		1
University of Nairobi		1		1
USA				
Purdue University			1	1
Virginia Tech University		1		1
Male	0	2	4	6
Kenya				
Eldoret University			1	1
Kenyatta University		1	1	2
Moi University		1		1
USA				
Purdue University			1	1
Virginia Tech University			1	1
FY14 Total	3	8	5	16

Lessons Learned

1. Outreach and training tools, such as on-farm trials, demonstrations, and workshops, are highly effective for sharing critical information and providing hands-on, practical experiences for trainees. In the SIRTD Associate Award, participants involved in these trainings were enthusiastic, actively engaged, and excited about the material at the end of each activity. Lessons learned from previous work led us to conduct follow up trainings with subsets of outreach participants. We observed that information had been assimilated and utilized, and that participants were often able to help other farmers and producers who were not initially reached by the SIRTD (BMP) sponsored events.

2. Coordinating a collaborative effort involving partners from three African countries and three US universities requires considerable effort. Although at times administratively burdensome, the Associate Award provided AquaFish with an opportunity to contribute to aquaculture development through a greater presence in Africa. Many project tasks, although similar to those necessary to run the core AquaFish program, had to be handled independently and thus require extra resources and effort. Additional time was thus factored in for reaching consensus on important decisions and for compiling information for reporting. However, when all partners are already involved in high-level programs of their own and one or more of them are unavailable at any particular time, it becomes even more difficult to make timely decisions and keep the collective activities moving ahead on schedule. This lesson became even more apparent this past year when over half of the Associate Awards' Principal Investigators were unable to attend meetings or contribute as anticipated due to illnesses, injuries, or employment changes. The lesson learned is to create and involve a deeper and broader cadre of researchers and managers, which will require additional funding and time, and to downscale anticipated outputs to better factor in risks.

3. Synchronizing Associate Award projects into AquaFish requires considerable coordination, and stresses both parties as there are independent demands on timeframes, deliverables, reporting, and networks. These alignment issues can be reduced only if the Associate Awards do not have independent technical or performance reporting requirements, if adequate funding is given for management and administration, if time is allotted up front for coordination among partners, and if the awarding unit at USAID understands that the project will be fitting into an organization that operates under a University system that has its own sets of rules and cultural norms. In this Associate Award, independent reporting was required for FTFMS and performance reports; even though the SIRTH project overlapped with core country locations, there were substantial additional reporting burdens to core projects and to management. Fortunately, previous lessons learned anticipated extra costs and planning time associated with these reporting burdens, and thus the core award and core projects were not parasitized or negatively affected.

4. Third-country training can provide exceptionally good benefits for stakeholders. In-person observations of successes and failures in other countries, complemented with face-to-face discussions with practitioners in those countries, often provides a richer educational experience than reading reports or listening to conference presentations from afar. This truth has been demonstrated in several AquaFish projects, including this Associate Award.

5. Aquaculture trainings disproportionately reached men, as was predicted yet unfortunately not easily prevented. The Lead PI understood this possibility and intentionally organized workshops with a focus on including women. However, a breakdown in reaching equal numbers of men and women occurred for a number of reasons. The effort to recruit and retain underrepresented groups was far greater than anticipated. Even forearmed with knowledge regarding barriers to participation, a lesson learned is that more time was needed to effectively reach these groups. Additionally, inherent bias and lack of comprehension regarding gender inclusiveness by many of the researchers themselves resulted in less effective planning and interventions. This indicates that training on gender and diversity should be provided at all levels of the enterprise, including researchers and graduate students who do the trainings in the field.

6. More timely information and feedback from USAID regarding project extensions is required. The organizations involved are large and complex and require substantial lead time for closedown. Management discussed the need for extension with USAID managers in Winter 2014 and submitted paperwork in Spring 2014. Until late September, the project was planning to closedown on 30 September. The lead institution and its partner subagreements were ending and contract offices were beginning layoffs and closedown procedures. While we appreciate the no-cost extension that was eventually granted, it came only one day before the contract was to expire.

7. The Associate Award project has benefitted substantially from the cumulative effect of previous AquaFish-sponsored activities in Ghana and Kenya, and to some extent Tanzania. AquaFish's well-patronized training programs play a vital role in extension and in farmer-to-farmer networking. Overall, extension services for fish farming are weak to non-existent in many parts of the world, with Africa being no exception. Adoption of aquaculture, a knowledge-driven activity, depends on reliable information being distributed among many stakeholders, including farmers, marketers, processors, extension agents, government specialists and feed mills. Lead SIRTH project principal investigators understood this research-extension-implementation bottleneck at the outset and designed outreach and training activities accordingly. The project was highly successful in providing access to good quality information on a consistent basis. At the end of the project, those trained are responsible for knowing how to seek out reliable information, and can build upon basic good practices. There is unfortunately much technical misinformation on aquaculture provided by the government and private sector. Examples of unreliable advice were found in all three countries. A government-financed hatchery recommended buying fry and stocking at 20 fish/m³ for a new small-scale grower when the actual recommendation is 3-4 fish/m³; the

fish farmer in this case would lose money. Another example occurred when feed distributors recommended feeding at unnecessarily high levels to sell more product. There is an opportunity for our partners (i.e., KNUST in Ghana, Mwea Farms in Kenya, and SUA in Tanzania) to continue to help develop extension services and information, whether they end up in public or private hands, or both. Follow up activities after the project ends could involve HC partners working with private groups, such as FarmerLine in Ghana, Kenya government, and feed mills such as Ranaan, to help accredit them so as to improve the reliability of information being disseminated, and reduce implications of conflicts of interest.



AquaFish researchers discuss pond aquaculture with participants during a workshop in Morogoro, Tanzania.



VII. HUMAN AND INSTITUTIONAL CAPACITY DEVELOPMENT

HUMAN CAPACITY DEVELOPMENT

The capacity building efforts of AquaFish help benefit stakeholders in Host Countries and the US, and regionally through the transfer of knowledge and technology in aquaculture and aquatic resource management. AquaFish supports trainees in both short- and long-term trainings, and provides opportunities for young scientists and farmers to make connections and strengthen networks. AquaFish understands that women's participation is essential to successful growth and development of the aquaculture and fisheries sectors. To ensure that women are included in the development agenda in meaningful and equitable ways, AquaFish has set benchmarks to track the inclusion of women and men in projects funded by AquaFish. Some key capacity building strategies include: collecting and analyzing disaggregated gender data from individual research and outreach projects, tailoring specific extension and technical services to women producers, engaging extension specialists who are sensitive to diversity issues and access to resources of underrepresented groups, and setting a 50% benchmark for women in short- and long-term trainings.

Each core project conducted by an AquaFish Lead Partner Institution is designed to address country-specific development gaps. Research findings and technologies that apply on a broader scale are transferred regionally through AquaFish's Regional Centers of Excellence in Africa, Asia, and Latin America and the Caribbean. The overall capacity building effort is one of the cross-cutting elements of the program as a whole, and is a fundamental component towards addressing the AquaFish mission.

Project-Wide Short-Term Summary

During FY14, a total of 11 short-term trainings, reaching 380 trainees, took place in AquaFish Host Countries in Africa and Asia. Women comprised 38% of these trainees, including 144 women and 236 men (Figure VII-1). Seven of the short-term trainings were carried out under the AquaFish Leader Award, reaching 277 trainees (110 women and 167 men); and four took place as part of the SIRTD Associate Award in Kenya and Tanzania, reaching 103 trainees (34 women and 69 men). Lower-than-anticipated percentages of women participants in short-term trainings in FY14 may indicate that the types of aquaculture and fisheries trainings were skewed towards male-dominated activities.

Project-Wide Long-Term Training Summary

During FY14, the AquaFish Innovation Lab, under the Leader Award and the SIRTD Associate Award, supported 108 long-term trainees at 22 institutions in nine different countries (Figure VII-2), including 47 women and 61 men. There were 46 students seeking Bachelor's degrees (25 women and 21 men), 45 students seeking Master's degrees (18 women and 27 men), 16 students seeking PhD's (4 women and 12 men) (Figure VII-3), and one male Post-doc. Overarching cultural barriers can pose challenges for involving women in long-term trainings and AquaFish is taking action to improve educational opportunities for women.



Figure VII-1. Number and percent of short-term trainees by country and gender in FY14 under the AquaFish Leader and Associate Awards.

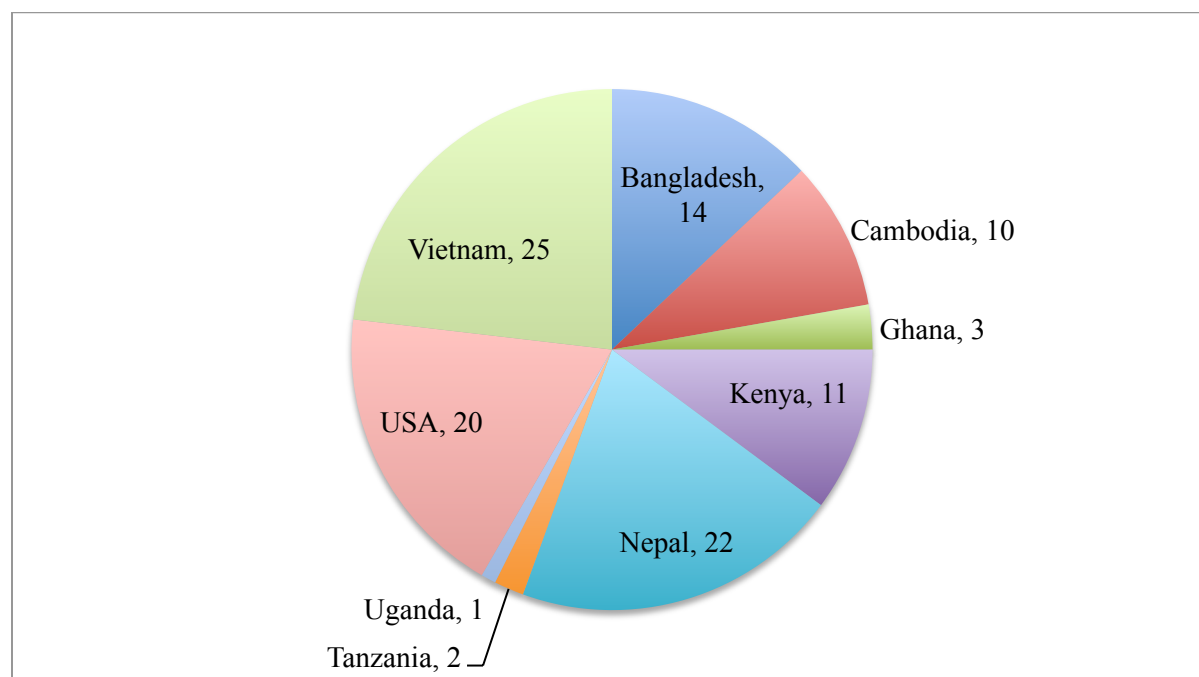


Figure VII-2. Number of long-term trainees by training country in FY14.

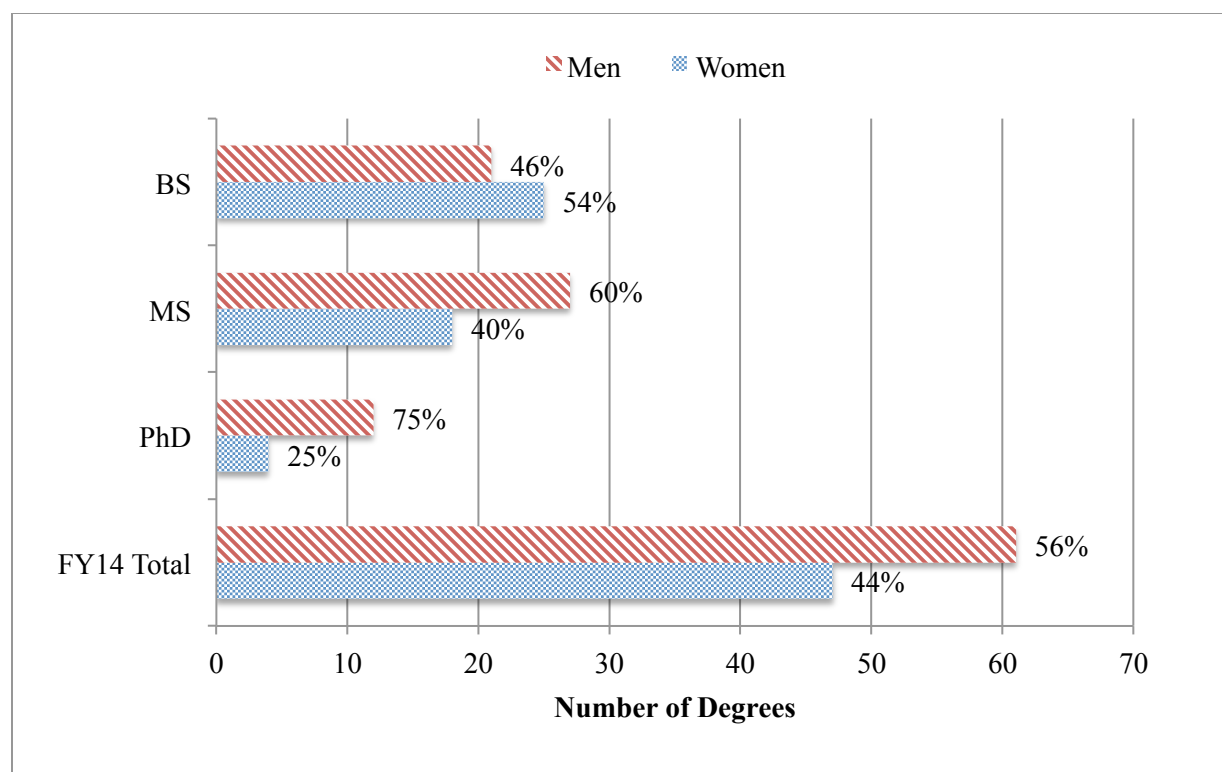


Figure VII-3. Number and percent of long-term trainees by degree and gender in FY14.

TRAINING BY COUNTRY

Bangladesh

Trainings

AquaFish in Bangladesh hosted three short-term trainings in FY14, with 77 men and 72 women participating, for a total of 149 participants. Nearly half of all short-term trainees in Bangladesh were women (48%). Participants learned about best management practices for integrated tilapia/mud crab culture and mola polyculture. AquaFish supported fourteen long-term students in Bangladesh: One Bachelor's student, twelve Master's students, and one PhD student, including four women and ten men. These students studied at Bangladesh Agricultural University, Khulna University, and Patuakhali Science and Technology University in the following three disciplines: 1) Aquaculture, 2) Aquaculture Physiology, and 3) Fisheries Management (Table VII-1).

Table VII-1. Long-term trainings in Bangladesh in FY14.

Degree Sought	BS	MS	PhD	Grand Total
Female		4		4
Bangladesh Agricultural University		3		3
Patuakhali Science and Technology University		1		1
Male	1	8	1	10
Bangladesh Agricultural University		6	1	7
Khulna University	1	1		2
Patuakhali Science and Technology University		1		1
Grand Total	1	12	1	14

Cambodia***Trainings***

In FY14 in Cambodia, 40 trainees, including 28 men and 12 women, participated in three short-term trainings. The workshops focused on modeling aquaculture carrying capacity. Ten long-term students were supported by AquaFish in Cambodia in FY14: Six Bachelor's students and four Master's students, including one woman and nine men. These students studied at the Royal University of Agriculture, Royal University of Law and Economics, and Kampong Cham National School of Agriculture in the following three disciplines: 1) Aquaculture, 2) Economics, and 3) Nutrition (Table VII-2).

Table VII-2. Long-term trainings in Cambodia in FY14.

Degree Sought	BS	MS	Grand Total
Female	1		1
Royal University of Law and Economics	1		1
Male	5	4	9
Kampong Cham National School of Agriculture	1	1	2
Royal University of Agriculture	4	3	7
Grand Total	6	4	10

Ghana***Trainings***

No short-term trainings were scheduled in Ghana during FY14 as technologies were being developed and tested. Two workshops are scheduled in FY15 to train fish farmers, artisanal fishermen, and women fish processors, marketers, and traders in the use of the newly developed Seafood Market Information System (SMIS). Two long-term students were supported in Ghana under the Leader Award and the Associate Award in FY14. Both were women Master's students at Kwame Nkrumah University of Science and Technology under the Fisheries and Watershed Management program (Table VII-3).

Table VII-3. Long-term trainings in Ghana in FY14.

Degree Sought	MS	Grand Total
Female	2	2
Kwame Nkrumah University of Science and Technology	2	2
Grand Total	2	2

Kenya***Trainings***

In FY14, three trainings were conducted in Kenya, reaching a total of 128 trainees (81 men and 47 women). One training was carried out as part of the Leader Award, with 88 trainees (62 men and 26 women); and two were part of the Associate Award, with 40 trainees (19 men and 21 women). These workshops taught trainees about catfish propagation, best management practices, and aquaculture commercialization. AquaFish supported ten long-term students in Kenya under the Leader Award and the Associate Award in FY14: Three Bachelor's students, five Master's students, and two PhD students, including six women and four men. These students studied at Eldoret University, Kenyatta University, Moi University, and the University of Nairobi in the following three disciplines: 1) Agricultural Resource Management, 2) Fisheries Science, and 3) Journalism and Mass Communication (Table VII-4).

Table VII-4. Long-term trainings in Kenya in FY14.

Degree Sought	BS	MS	PhD	Grand Total
Female	3	3		6
Eldoret University	3			3
Kenyatta University		1		1
Moi University		1		1
University of Nairobi		1		1
Male		2	2	4
Eldoret University			1	1
Kenyatta University		1	1	2
Moi University		1		1
Grand Total	3	5	2	10

Nepal***Trainings***

No short-term trainings were conducted in Nepal in FY14 as the work focused on collecting baseline data and conducting experiments. This information will be transferred during the latter part of the 2013-2015 Implementation Plan, with six scheduled trainings. There were 22 long-term students supported under in Nepal in FY14: Fourteen Bachelor's students, seven Master's students, and one PhD student, including eight women and fourteen men. These students trained at the Agriculture and Forestry University in two separate disciplines, Aquaculture and Fisheries Science (Table VII-5).

Table VII-5. Long-term trainings in Nepal in FY14

Degree Sought	BS	MS	PhD	Grand Total
Female	7	1		8
Agriculture and Forestry University	7	1		8
Male	7	6	1	14
Agriculture and Forestry University	7	6	1	14
Grand Total	14	7	1	22

Tanzania***Trainings***

Two trainings reaching 63 trainees (including 50 men and 13 women) were conducted in Tanzania at Sokoine University of Agriculture during FY14 under the Associate Award. Both workshops focused on disseminating BMP guidelines and facilitating adoption of BMPs in Tanzania. Two long-term Master's students were supported in Tanzania under the Leader Award in FY14. These students trained at Sokoine University of Agriculture in Animal Science and Production and Agriculture (Table VII-6).

Table VII-6. Long-term trainings in Tanzania in FY14.

Degree Sought	MS	Grand Total
Female	1	1
Sokoine University of Agriculture	1	1
Male	1	1
Sokoine University of Agriculture	1	1
Grand Total	2	2

Uganda***Trainings***

No short-term trainings were scheduled to take place in Uganda during FY14, as initial work focused on conducting experiments, assessing needs, and developing technologies. Five workshops are scheduled for FY15 to transfer information and technologies. One male PhD student was supported in Uganda in FY14 at Makerere University in the discipline of Agricultural Economics (Table VII-7).

Table VII-7. Long-term trainings in Uganda in FY14.

Degree Sought	PhD	Grand Total
Male	1	1
Makerere University	1	1
Grand Total	1	1

US***Trainings***

There were no short-term trainings scheduled in the US during FY14, or for any part of the AquaFish 2013-2015 Implementation Plan. All short-term training events will take place in Host Countries. Twenty long-term students were supported in the US under both the Leader Award and the Associate Award in FY14: Three Bachelor's students, eight Master's students, eight PhD students, and one Post-doc, including twelve women and eight men. These students studied at Auburn University, North Carolina State University, Oregon State University, Purdue University, University of Arizona, University of Michigan, and Virginia Tech University in 16 disciplines, including Agricultural Economics, Fisheries and Wildlife, Fisheries and Allied Aquaculture, Aquaculture Physiology, Natural Resources, and Soil, Water, & Environmental Sciences (Table VII-8).

Table VII-8. Long-term trainings in the US in FY14.

Degree Sought	BS	MS	PhD	Post-doc	Grand Total
Female	3	6	3		12
Auburn University		2			2
North Carolina State University	1		1		2
Oregon State University	2	2	1		5
Purdue University			1		1
University of Michigan		1			1
Virginia Tech University		1			1
Male		2	5	1	8
Auburn University			1		1
North Carolina State University			1	1	2
Oregon State University		1			1
Purdue University			1		1
University of Arizona			1		1
University of Michigan		1			1
Virginia Tech University			1		1
Grand Total	3	8	8	1	20

Vietnam**Trainings**

No formal short-term trainings were scheduled in Vietnam during FY14; however, a South-South exchange took place at Can Tho University in Vietnam between Cambodian and Vietnamese project personnel regarding snakehead cultivation. Seven short-term trainings are scheduled to take place during FY15. There were 24 long-term AquaFish-supported students in Vietnam in FY14: Eighteen Bachelor's students, four Master's students, and two PhD students, including twelve women and twelve men. All students in Vietnam studied at Can Tho University in five different disciplines: 1) Aquatic Nutrition and Products Processing, 2) Fisheries Management and Economics, 3) Freshwater Aquaculture, 4) Coastal Aquaculture, and 5) Aquatic Biology and Pathology (Table VII-9).

Table VII-9. Long-term trainings in Vietnam in FY14.

Degree Sought	BS	MS	PhD	Grand Total
Female	10	1	1	12
Can Tho University	10	1	1	12
Male	8	3	1	12
Can Tho University	8	3	1	12
Grand Total	18	4	2	24

INSTITUTIONAL DEVELOPMENT

Description

Building human and institutional capacity in partner countries is a hallmark of the AquaFish collaborative research program. AquaFish provides financial support, research mentoring, and academic guidance for students in undergraduate and graduate programs in aquaculture, fisheries, aquatic ecology, economics, engineering, and many other degree programs. Long-term (degree) trainees constitute a pipeline of educated professionals who move on to careers in government, academia, and private enterprise upon graduation, building human capacity for aquaculture research and development.

Since 2006, AquaFish has helped HC institutions develop specialized curricula and institutional infrastructure for building local capacity. In FY14, curricula were developed for new degree programs at universities in Kenya and Nepal. These accomplishments, aided by AquaFish support and collaboration, increase the capacity for institutions to admit more students and improve facilities, and help establish these institutions as leaders in higher education and research.

In addition to curriculum development, Host Country colleagues and their associated institutions build institutional capacity through the management of international grants. Universities in developing nations often require external guidance and training to facilitate intake and administration of international research awards. The capacity to process awards from US Universities tends to be underdeveloped and basic research structures are seldom in place. AquaFish's collaboration with HC institutions allows these universities to build the administrative infrastructure necessary to be competitive for future international awards.



Workshop participants pose for a group photo during an AquaFish training event in Tanzania.

Partners

Fostering connections with institutions around the world is a primary component of AquaFish human and institutional capacity development (HICD) efforts. These networks help create long-lasting collaborations and provide both trainees and the institutions with resources that they can access and build upon throughout their lives. Below is a list of universities where AquaFish supported long-term trainees were enrolled in FY14 (for a complete list of our institutional affiliations see *List of Program Partners*).

Bangladesh Bangladesh Agricultural University Khulna University Patuakhali Science and Technology University Cambodia Kampong Cham National School of Agriculture Royal University of Agriculture Royal University of Law and Economics Ghana Kwame Nkrumah University of Science and Technology Kenya Kenyatta University Moi University University of Eldoret University of Nairobi	Nepal Agriculture and Forestry University Tanzania Sokoine University of Agriculture Uganda Makerere University US Auburn University North Carolina State University Oregon State University Purdue University University of Arizona University of Michigan Virginia Polytechnic Institute and State University Vietnam Can Tho University
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VIII. TECHNOLOGY TRANSFER AND SCALING PARTNERSHIPS

In FY14, AquaFish continued building on previous successes to make significant global and regional technological advances in Asia and Africa. Collaborative research remained focused on improving sustainable aquaculture productivity through the development and transfer of innovative technologies and management practices that address health and nutrition, enhance food security, consider environmental impacts, and advance market development.

An underlying theme of the AquaFish research agenda has been the development of responsible aquaculture technologies and systems. As a result, AquaFish has received praise for its forward-thinking approach to sustainable aquaculture and for simplifying complex innovations into practical, accessible technologies.

AquaFish focuses on research that creates a multiplier effect for farm-level income and works with partners to scale up technologies to have broader impacts. AquaFish technologies are tailored to local conditions and on-the-ground needs by supporting and partnering with Host Country (HC) research institutions as part of this effort to create sustained impacts and effective technology transfer. These linkages play a critical role in the scaling process by increasing local buy-in, forging connections with other projects, and growing the local institutional infrastructure. Additionally, the AquaFish training efforts focus on local researchers, technicians, and students as a way to develop and build human capacity for increasing the longevity of the work. AquaFish efforts target small-scale producers and prioritize the development and transfer of high quality seed, low-cost sustainable feeds, and best management practices. Increasing access to inputs is coupled with training on innovative strategies to help ensure safe and sustainable use. AquaFish investments aim to give women equal access to affordable inputs and improved technologies through training opportunities and by emphasizing equitable participation in aquaculture development in project goals.

Efforts have been made to streamline successful technology development at key sites, and highlight human nutrition and systems research. AquaFish researchers use a variety of methods, including the on-farm and on-station trials, baseline surveys, and stakeholder engagement to fine-tune appropriate technologies for transfer, to identify and verify parameters for scaling up, and for capacity building efforts that aim to create successful and sustained diffusion into local communities. The tables below list the AquaFish-supported, scalable technologies and associated partnerships as a result of efforts in FY14.

Asia Project: Bangladesh**Project Partners**

North Carolina State University (Lead US University); Bangladesh Agricultural University (Lead HC Institution); Hajee Mohammed Danesh Science and Technology University; Khulna University; University of Dhaka; Shushilan NGO; Central Luzon State University; South East Asian Fisheries Development Center; Patuakhali Science and Technology University; WorldFish; and WorldFish Aquaculture Income & Nutrition Project.

Technology	Description	Key Impact
Pangasius culture in hyposaline water	This technology will help farmers adapt to saline water encroachment and make use of large areas of abandoned or underused land by developing Pangasius catfish culture in brackish waters.	Farmers may be able to make more productive use of encroached hyposaline waters in the coastal Southern region of Bangladesh.
Mola-carp-prawn cage-pond culture	Improving yields, profitability, and nutrition in the Bogra district of Northern Bangladesh. Ponds in this region are often too deep for high value prawns, so this system creates a way to add both prawns and mola into carp culture using cage-in-pond techniques, thus allowing for crop diversification and increased income potential.	This technique will help enhance production capacity and income potential, while reducing negative environmental impacts. Greater access to highly nutritious mola fish may help address widespread nutritional deficiencies, and the introduction of prawns in the polyculture system will help diversify the aquaculture operation.
Mola and gher-rice culture of prawns	Improving current practices to increase production yields using polyculture and integrated aquaculture techniques by incorporating mola and vegetables into gher (rice field)/prawn culture.	Improved access to income and highly nutritious mola fish may help address widespread nutritional deficiencies.
Semi-intensive polyculture with ABF species and carp in Bangladesh	Culturing shing or koi with carps represents a novel polyculture technology in Bangladesh. This system involves two indigenous air-breathing fish (ABF) and will increase yield and diversify aquaculture products available for consumption in Bangladesh, currently dominated by carps.	ABFs provide an advantage, as they can be resilient to harsh conditions. The mixed-trophic level nutrient utilization may make semi-intensive culture of shing catfish and koi more feasible for greater adoption among farmers while also mitigating the environmental impacts of nutrient loading.
Reduced feeding strategies for semi-intensive polyculture of shing and carp	Previous CRSP studies have shown that equivalent production yields of tilapia can be achieved with 50% less feed, significantly improving feed conversion and reducing costs. This study will evaluate these techniques in shing/carp production.	Successful implementation of feed-reduced strategies will decrease feed costs by as much as 50%, thereby increasing profits and making fish farming more accessible to low-income farmers.

Asia Project: Cambodia & Vietnam**Project Partners**

University of Connecticut-Avery Point (Lead US University); University of Rhode Island; Inland Fisheries Research and Development Institute (Lead HC Institution); Can Tho University; and Cambodia HARVEST Project.

Technology	Description	Key Impact
Culture techniques for snakehead (<i>Channa striata</i>) in Cambodia	As a way to make the aquaculture of snakehead more sustainable, this research optimizes snakehead breeding, domestication, and weaning, as well as improving growout through the development of cost-effective formulated feed.	Development of successful domestication and breeding, weaning, and rearing (growout) of snakehead are in development to help lift the 2010 ban with more sustainable practices and increased opportunities for local fish farmers.
Value-added processing of farmed snakehead	Snakeheads can yield many value-added processed products that improve the shelf life of the fish. This work improves the use of two major value-added products: dried and fermented snakehead.	The successful implementation of these technologies will lead to broader scale improvements in the snakehead value chain.
Feed formulation and processing with soy protein concentrate for snakehead diets	Continues the development of cost-effective alternative feeds for small-scale farming of snakehead, replacing fishmeal with plant-based protein (soy protein concentrate).	Success of this technology should overcome the use of small-size fish for fishmeal, improving the sustainability of snakehead aquaculture and reducing pressures on wild caught small-size fish.
Development of an aquaculture carrying capacity estimate for a Cambodian water way	This study develops a planning tool for sustainable aquaculture in Cambodia by training Cambodian scientists, regulators/managers, and officers in the use of models to estimate the amount of aquaculture waste that an ecosystem can assimilate.	This work has initiated the development of carrying capacity estimates for Cambodian waterways as part of a regional planning effort for a more sustainable aquaculture industry.

Asia Project: Nepal**Project Partners**

University of Michigan (Lead US University); Agricultural and Forestry University (Lead HC Institution); Nepal Agricultural Research Center; and Directorate of Fisheries Development.

Technology	Description	Key Impact
Sahar reproduction in warm water—Chitwan, Nepal.	Large-scale production of sahar fry and more accessible nursing and rearing techniques in warm water—developed in Pokhara, ready for transfer to Chitwan.	The promotion of Sahar, indigenous to Nepal, increases pond production, harvest, and income for local fish farmers. It also provides fry for restocking natural waterways to reverse population declines in Chitwan.
Controlled introduction of small indigenous species (SIS) of fish to household ponds in Nepal	The inclusion of 'SIS' in carp polyculture systems introduces a new source of protein for household consumption without changing sales generated from carp production. This work specifically investigates the most effective stocking density of SIS for establishing a breeding population.	It is anticipated that the successful introduction of 'SIS' will increase yield by at least 20% in the Terai region of Nepal without reducing carp production. The addition of 'SIS' to household diets is also expected to enhance the nutritional options for farmers and their families.
Sahar-tilapia polyculture	Sahar (<i>Tor putitora</i>) is cultured with Nile tilapia (<i>Oreochromis niloticus</i>) to control in-pond tilapia recruitment. The proper ratio may provide multiple harvests of tilapia with new recruits for continuous seeding along with sahar production.	Cultured sahar is now available for human consumption. Tilapia production has improved by 15%. This is a positive impact on smallholder farmers in Nepal and region.

Africa Project: Ghana & Tanzania***Project Partners***

Purdue University (Lead HC University); University of Arkansas at Pine Bluff; Virginia Polytechnic Institute and State University; University of Hawaii Hilo; FarmerLine; University of Development Studies, Tamale; Kwame Nkrumah University of Science and Technology (Lead HC Institution); Ministry of Agriculture, Livestock, and Fisheries; Sokoine University of Agriculture; Western Indian Ocean Marine Sciences Association (WIOMSA); and University of Dar es Salaam.

Technology	Description	Key Impact
Earthworm and maggot meal for Nile tilapia aquaculture in Tanzania	Evaluate the suitability of selected invertebrates (earthworms and maggots) as protein sources for Nile tilapia diets. Through this investigation, feeding packages based on the selected invertebrates will be developed and promoted for adoption by small-scale fish-farmers.	Through the use of these diets, farmers can improve tilapia production and reduce the cost of feeds, thereby increasing the profitability of fish farming in Tanzania. Income increases may improve the purchasing power of rural farmers, reducing the risks of food insecurity at the household level.
Cell phone marketing tool in Ghana	A cell phone-based information exchange technology platform for fish producers, fishers, seafood marketers, and consumers involved in the tilapia market is being developed.	Development and scaling of this technology will enhance the trade and profitability of tilapia in Ghana. It will provide a transparent and fair fish trading system.

Africa Project: Kenya & Uganda***Project Partners***

Auburn University (Lead US University); Alabama A&M University; University of Arizona; University of Eldoret; Kenya Ministry of Fisheries Development (KMFD); Makerere University (Lead HC Institution); National Fisheries Resources Research Institute (NaFIRRI); Grameen Foundation; and the Bidii Fish Farmers Cooperative.

Technology	Description	Key Impact
Cell phone marketing tool in Uganda	This study develops baseline information about the needs and interest of fish farmers in order to encourage public agencies, NGOs, and cellular providers to facilitate the use of cell phones as a means to guide, coordinate, and instruct fish farmers.	This technology may improve livelihoods by networking and informing previously unconnected portions of the population.
Formulation and manufacture of practical feeds for Western Kenya	This work involves increasing the stability of pelleted feeds in water, testing newly formulated feeds with more readily available ingredients, and reducing the overall cost of feeds.	Feed represents more than 50% of the production costs in Western Kenya. Often commercial feed quality can vary, which can have negative impacts on fish growout. This technology may increase fish production by at least 10% and improve FCR by 50%.



IX. GOVERNANCE AND MANAGEMENT ENTITY ACTIVITY

In FY14, Oregon State University (OSU) continued to serve as the Management Entity (ME) of AquaFish, responsible for the programmatic, technical, and fiscal performance of the program. The AquaFish Management Team (MT) managed, participated in, and contributed to research, education and outreach, capacity building, and program development related to sustainable aquaculture strategies that enhance food security and improve livelihoods. The AquaFish MT also supports researchers, students, and young scientists in building and maintaining professional networks and advancing innovative aquaculture technologies throughout the world.

Support of students is a cornerstone of the AquaFish mission. In addition to short-term training workshops and prolonged, continuous support of students in long-term degree programs, AquaFish sponsors outstanding students and young scientists to present papers at academic and scientific conferences. Furthermore, AquaFish assists in chairing and organizing conferences. The following activities are examples of AquaFish engagement in capacity building in FY14.

- 10th International Symposium on Tilapia in Aquaculture (ISTA10) in Israel (October 2013) – gold sponsor, member of organizing committee, and chaired session
- 4th *Shanghai Ocean University (SOU)-AquaFish Yang Yi Young Scientist Travel Award* – Mr. Kang Li from SOU and Mr. Md. Shariful Islam from Bangladesh Agricultural University
- IIFET Conference in Australia (July 2014) – sponsored three awards for best aquaculture economics papers

AquaFish recognizes the importance of sharing information with the development community, including research results and innovative industry technologies as well as opportunities for future development collaborations. AquaFish engaged with the development community and the donor agency in FY14 by participating in the following:

- World Food Prize and Innovation Lab Council Meeting in Des Moines, IA, US (October 2013)
- FTF Innovation Lab Council Meeting in Nepal (March 2014) – Dr. Madhav Shrestha of AFU attended and presented on behalf of AquaFish
- FTF Global Forum in Washington, DC, US (May 2014)
- FTF Innovation Lab Council Meeting in Washington, DC, US (September 2014)

AquaFish engages in technical and professional development by attending and presenting at aquaculture conferences and meetings, as well as reaching out to broader communities to share AquaFish findings and achievements. Examples of AquaFish's efforts in this arena in FY14 included:

- Asian-Pacific Aquaculture 2013 Conference in Vietnam (December 2013) – organized AquaFish partners' event
- Two sessions at Aquaculture America 2014 in Seattle, WA, US (February 2014), entitled: "Low-Cost Feeds and Input Solutions for Sustainable Small-Scale Aquaculture in Developing Countries" and "Low-Cost Solutions for Sustainable Small-Scale Aquaculture in Developing Countries" – organized and chaired
- Peace Corps/FTF Sustainability and Food Security Campus Tour in Corvallis, OR, US (February 2014)
- OSU Earth Day Fair in Corvallis, OR, US (April 2014) – exhibitor on sustainable aquaculture and fisheries practices
- OSU University Day in Corvallis, OR, US (September 2014) – exhibitor

In order to effectively manage a large, international program with colleagues throughout the world, AquaFish organizes regular meetings with project personnel to discuss progress and challenges. The FY14 AquaFish programmatic meetings included:

- AquaFish Asia Regional Meeting in Cambodia (December 2013) – organized and chaired
- AquaFish Annual Meeting in Seattle, WA, US (February 2014) – organized and chaired
- AquaFish Global Experiment, Impact Assessment, and SIRTID Associate Award meetings in Seattle, WA, US (February 2014) – organized and chaired
- AquaFish SIRTID Associate Award Closeout Meeting in Tanzania (August 2014) – organized and chaired

The overall AquaFish mission is to enrich livelihoods and enhance health for vulnerable populations through the cultivation of international, multidisciplinary partnerships that advance science, research, education, and outreach in aquatic resources. The AquaFish MT engages in site visits, data synthesis and analysis, publication of programmatic reports, and consistent communication with project partners and the development community to measure progress and achieve these goals. Furthermore, AquaFish looks for potential new and related projects that can strengthen collaboration. Management activities in FY14 included:

- Quarterly conference calls between the AquaFish Director, Management Office staff, and Project PIs to discuss progress of AquaFish work related to reporting, funding, upcoming opportunities, and challenges.
- Visited research field sites and partnering institutions in Cambodia, Vietnam, and Tanzania.
- Met with USAID/Cambodia Mission staff from the Office of Food Security and Environment (FSE), Phnom Penh, Cambodia.
- Publication of AquaFish 7th Annual Report, Implementation Plan 2013-2105, Technical Report 2011-2013, two issues of the newsletter *Aquanews*, and 12 monthly employment opportunity newsletters (*EdOpNet*).
- Met with President of Nong Lam University (Vietnam) to discuss potential areas of collaboration with OSU.
- Continuation of the AquaFish Library Donation Project, which involves donating science-related books, journals, and other publications to institutions in Africa and Asia.
- AquaFish reviewed and contributed to two concept notes for proposed USAID projects in Bangladesh and Cambodia, linking horticulture, aquaculture, and nutrition.
- Regular conference calls with the AquaFish AOR, Shivaun Leonard, to discuss ongoing research progress, funding timelines, and other programmatic concerns.
- Consulted with advisory groups (e.g., RCE, EPAC) to strengthen linkages and promote networking opportunities.
- Provided input in response to questions from the Social Impact contracting agency as part of a USAID-sponsored review of research projects that are being funded through Feed the Future - Food Security Innovation Centers (FtF-FSIC).
- Maintained open communication with other Innovation Labs.
- AquaFish Director participated in the organization of the upcoming FAO Global Conference on Inland Fisheries in Italy (January 2015) and will serve on the writing team to prepare a high-level paper on the outcomes.
- Met with the Director of the Innovative Agricultural Research Initiative (iAGRI), Sokoine University of Agriculture, Morogoro, Tanzania.
- Worked closely with the Asian Fisheries Society to further develop the Yang Yi Young Scientist Fellowship.

The AquaFish MT continued to reach out to various stakeholder groups during FY14 in the form of posters, publications, and presentations, which included:

- Borberg, J., S. Ichien, and H. Egna. 2014. *Building human and institutional capacity in developing countries to enhance sustainable aquaculture*. [Poster] World Aquaculture Society – Aquaculture America, Seattle, Washington, USA. 9-12 February 2014.
- Edwards, P., C. Price, S. Ichien, and H. Egna. 2013. *Building capacity and developing technology to alleviate poverty through sustainable aquaculture development: AquaFish research in Asia*. [Poster] World Aquaculture Society – Asian-Pacific Aquaculture, Ho Chi Minh City, Vietnam. 10-13 December 2013.
- Edwards, P., C. Price, S. Ichien, and H. Egna. 2013. *Building capacity in developing countries to provide opportunities for enhancing sustainable aquaculture*. [Poster] 10th International Symposium on Tilapia in Aquaculture (ISTA10), Jerusalem, Israel. 6-10 October 2013.
- Edwards, P., H. Egna, S. Ichien, and J. Borberg. 2014. Value chain analysis helps overcome gender barriers in aquaculture. *Global Aquaculture Advocate* 17(5): 70-72.
- Edwards, P., J. Borberg, and H. Egna. 2014. *Gender equity in aquaculture: Women in the aquaculture value chain*. [Poster] World Aquaculture Society – Aquaculture America, Seattle, Washington, USA. 9-12 February 2014.
- Frimpong, E.A., Y.B. Ansah, S. Amisah, D. Adjei-Boateng, N.W. Agbo, and H. Egna. 2014. Effects of two environmental best management practices on pond water and effluent quality of growth of Nile tilapia, *Oreochromis niloticus*. *Sustainability* 6: 652-675.
- Goetting, K., C. Price, F. Evans, and H. Egna. 2013. *Improving human health and nutrition through shellfish aquaculture*. [Poster] World Aquaculture Society – Asian-Pacific Aquaculture, Ho Chi Minh City, Vietnam. 10-13 December 2013.
- Goetting, K., C. Price, S. Ichien, and H. Egna. 2013. *Developing human and institutional capacity in the aquaculture, fisheries, and aquatic resources sectors*. [Poster] Board of International Food and Agricultural Development (BIFAD) World Food Prize, Des Moines, Iowa, USA. October 2013.
- Goetting, K. 2014. *AquaFish: Feeding the future through sustainable aquaculture and fisheries research*. [Invited presentation] OSU, Peace Corps and USAID: How Beavers are Feeding the Future, Oregon State University, Corvallis, Oregon, USA. 27 February 2014.
- Goetting, K., C. Price, M. Chow, S. Ichien, and H. Egna. 2014. *Identifying and implementing best management practices for small-scale aquaculture in sub-Saharan Africa*. [Poster] World Aquaculture Society – Aquaculture America, Seattle, Washington, USA. 9-12 February 2014.
- AquaFish Innovation Lab. 2014. *Empowering women through innovative aquaculture technologies*. [Poster] Feed the Future Global Forum Innovation Marketplace, Washington, DC, USA. May 2014.
- Price, C. 2013. *Aquaculture in the modern world*. [Invited speaker] Marine Resource Management Graduate Seminar, Oregon State University, Corvallis, Oregon. 25 November 2013.
- Price, C., S. Ichien, and H. Egna. 2013. *Optimizing small-scale tilapia culture for improved health and income generation in developing countries*. [Poster] 10th International Symposium on Tilapia in Aquaculture (ISTA10), Jerusalem, Israel. 6-10 October 2013.
- Price, C. and H. Egna. 2014. Strategies for reducing feed costs in small-scale aquaculture. *Global Aquaculture Advocate* 17(3): 24-26.
- Price, C., H. Egna, and K. Goetting. 2014. *You already have what it takes to get a good job*. [Invited presentation] World Aquaculture Society – Aquaculture America, Seattle, Washington, USA. 9-12 February 2014.
- Price, C., S. Ichien, and H. Egna. 2014. *Strategies for reducing feed costs in smallholder tilapia aquaculture*. [Poster] World Aquaculture Society – Aquaculture America, Seattle, Washington, USA. 9-12 February 2014.



X. OTHER TOPICS

GENDER INITIATIVES AND ACCOMPLISHMENTS

Gender equality and female empowerment are core development objectives of the USAID research agenda and are fundamental to accomplishing effective and sustainable development outcomes. Gender integration involves identifying and addressing differences and inequalities due to gender. These differences are addressed during the project design process and throughout the implementation, monitoring, and evaluation processes. AquaFish takes a systems approach to integrating women into aquaculture research and outcome goals. Gender integration, a strategy used to improve equity, cross-cuts efforts like capacity building, economic development, agricultural development, food security, and poverty alleviation—key issues targeted by USAID’s Feed the Future initiative.

AquaFish takes a holistic approach for integrating women into all programmatic activities, with a goal of extending gender equity beyond the life of any given project and of the AquaFish program itself. Each AquaFish project includes a Gender Inclusiveness Strategy and at least one outreach activity that focuses specifically on women or girls. A compilation of these efforts is collected and synthesized in a Programmatic Gender Integration Plan. Gender equity is a major focus of AquaFish capacity building efforts, with a goal of involving equal numbers of men and women in training activities such as formal education, workshops, and conferences; as well as in institutional strengthening efforts and as project investigators. Gender disaggregated data have been historically collected, and AquaFish has continued to collect and analyze gender data to inform project management and future capacity building needs.

Gender disaggregated data show that women make up large numbers of short and long-term trainees, earning specialized skills, adopting best management practices and new technologies, and earning professional degrees. Results have shown that these experiences help to strengthen their ability to earn income, improve household nutrition, contribute to aquaculture development in their respective communities, and help strengthen educational institutions. Improving gender equity at the institutional level and ensuring that women are included in leadership is central to the long-term benefits of gender integration. During FY14, AquaFish made significant progress toward including women as beneficiaries in the processes and outcomes of aquaculture research. Social and cultural barriers can pose challenges to meeting the 50% gender benchmark, and AquaFish works with US and Host Country researchers, extension agents, and others to overcome these obstacles.

Gender Integration Initiatives

AquaFish’s Gender Integration Initiatives (highlighted with the green background) on Phase II progress are presented in the table below. These gender initiatives are a component of AquaFish’s USAID-approved Monitoring & Evaluation Plan.

Year 1 Initiatives:
Require that all funded projects address gender inclusiveness within their planned scope-of-work.
In the 2013 AquaFish Request for Proposals (RFP), guidance was provided to applicants to form projects around the core program components, which include gender integration. In a more directed effort, the RFP also required the inclusion of at least one outreach activity focusing on women and/or girls. Further, each project was required to submit a Gender Inclusiveness Strategy as a component of their overall research proposal. The AquaFish Management Team and USAID subsequently reviewed these plans prior to implementation. Projects were not implemented until these gender inclusiveness

requirements were met in final project work plans.
In FY14, AquaFish published its 2013-2015 Gender Integration Plan which includes the USAID approved strategy and metrics for tracking accomplishments, as well as the Gender Inclusiveness Strategies and gender focused investigations for each of the five projects.
Seek out USAID review of projects' gender inclusiveness plans and respond by improving plans prior to project implementation.
Guidance and reviews on project gender inclusiveness plans sought and obtained from USAID in September 2013. PIs revised their plans accordingly.
Years 2-5 Initiatives:
Collect disaggregated gender data from individual research and outreach projects funded by AquaFish.
Data collected for short-term and long-term training activities have been disaggregated by gender and will continue to be for the life of the project.
Analyze disaggregated data on an annual basis to gauge gender inclusiveness success and take appropriate action as indicated through data analysis.
Since program inception in 2006, gender disaggregated data have been analyzed annually to gauge gender inclusiveness and success (see detailed HICD data in section 7 of this report). To help facilitate success, women's participation is integrated at the planning stage for all sponsored projects, utilizing context-based circumstances and information to anticipate and overcome obstacles on the ground.
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.
Gender is a cross-cutting issue for all AquaFish projects. Gender Inclusiveness Strategies identify specific project approaches. Each investigation focusing on women includes forethought, including a tailored approach that considers conditions on the ground to help ensure success. PIs and researchers are involved in monitoring and evaluation.
Focus one component of a lessons learned and synthesis assessment specifically on the social context and impact of AquaFish research and outreach activities on the lives of women.
AquaFish communicates gender activities and accomplishments through conference presentations, posters, Aquanews articles, and other media. In FY14, AquaFish published a synthesis article in the September/October 2014 issue of the Global Aquaculture Advocate called "Value Chain Analysis Helps Overcome Gender Barriers in Aquaculture," highlighting AquaFish research on fish value chains and gender integration. The article addresses the importance of recognizing women's part in these fish value chains in a systems approach to improving the wellbeing of entire communities.
Tailor specific extension and technical services related to sustainable aquaculture and aquatic resource management to women producers.
AquaFish tailors specific interventions to empower women through information and access to networks and resources. For example, in a study assessing the viability of growing Pangasius catfish in hyposaline waters in Bangladesh, ten of the 13 pond owners selected for trials are women. These efforts expose women pond owners directly to innovative aquaculture techniques, and involves them in the process of refining the techniques.
Engage extension specialists who are 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 AquaFish training opportunities.
Each AquaFish project makes an effort to include more women in key positions with roles such as investigators, research collaborators, and workshop leaders. In FY14, approximately 30% of the key personnel involved in AquaFish projects were women.

Promote the participation of women in formal and informal education and training opportunities provided through AquaFish. AquaFish 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 AquaFish activities, as project researchers, advisory group members, and managers.

AquaFish continues to set a 50% benchmark for the involvement of women in all programmatic activities. During FY14, AquaFish supported 144 women in short-term trainings and 47 women in long-term training degree programs. Women are well represented as key personnel on AquaFish projects, Advisory Groups, and in program management. Yet work remains in attracting and retaining women in lead research positions and in better involving women stakeholders in short-term trainings.

Gender-Focused Research and Outreach

Highlights of FY14 gender-focused investigations for the five AquaFish projects are included below.

Africa Project: Ghana & Tanzania

Assessing the Nutritional Impact of Aquaculture Policy in Fish Farming Districts in Tanzania and Ghana (13HHI01PU)

- A nutritional survey was developed through a nutritionist at KNUST and data were collected from 164 households in five districts in Ghana on their dietary patterns. The survey focused on household health, mother's education, breastfeeding, and portion sizes per meal for mother and child. Data are being analyzed to assess the nutritional impacts of the national aquaculture policy.

Africa Project: Kenya & Uganda

New Approaches to Inform, Motivate, and Advance Small and Medium-scale Fish Farmers: Building Industry Capacity through Cell Phone Networks, Training, and Market Participation (13BMA04AU)

- Focus group interviews were conducted with fish farmers in six Ugandan districts. As women play a large part in fish marketing in Kenya and Uganda, work is underway to organize a workshop that will be focused on cell phone access, use, and potential with a specific focus on women.

Asia Project: Bangladesh

Improving Nutritional Status and Livelihoods for Marginalized Women Households in Southwest Bangladesh through Aquaculture and Value Chain Analysis (13MER04NC)

- A survey was developed, field-tested, and revised to capture data on household nutrition and current production practices in the context of crab fattening/farming for women in Bangladesh.
- A mud crab stakeholders workshop was held at the Shushilan Conference Hall in Satkhira Bangladesh in June 2014, and included a presentation on potential economic benefits to coastal women involved in crab aquaculture.
- A value chain analysis was carried out by AquaFish researchers to better integrate women mudcrab farmers into the supply chain in Bangladesh.
- A database of over 1,200 crab farmers was collected and women farmers were included in the selection of three on-site mud crab fattening trials.

Asia Project: Cambodia & Vietnam

Enhancing Food Security and Household Nutrition of Women and Children with a Focus on Nutrient Dense Commonly Consumed Fish from Capture Fisheries and Aquaculture in Cambodia (13HHI02UC)

- Interviews and focus groups were conducted to gather information on the nutritional status of children less than five years of age. Women were interviewed regarding their nutritional status. Additionally, several survey questionnaires assessing the nutritional status of women and children have been developed and translated to Khmer.

Asia Project: Nepal

Establishing School Ponds for Fish Farming and Education to Improve Health and Nutrition of Women and Children in Rural Nepal (13HHI04UM)

- The project team agreed upon research methods, and initial steps have been taken to develop a survey aimed to improve health of women and children.



Workshop participants pose for a group photo during an AquaFish training event in Cambodia.

REGIONAL CENTERS OF EXCELLENCE (RCE) ANNUAL REPORTS

The AquaFish Regional Centers of Excellence (RCEs) in Africa, Asia, and Latin America and the Caribbean have continued to build community among AquaFish participants; identify potential additional partners and collaborators; and bridge the knowledge gap from local-regional perspectives to global development outcomes.

RCE – Africa Annual Report

Charles Ngugi (Lead Coordinator, East and Southern Africa) &
Héry Coulibaly (Co-Coordinator, West Africa)

Regional Needs for Aquaculture Development and Gaps in Technology Transfer and Adoption

Fingerling production is still a major challenge in Africa, influenced by quantity and quality of seed produced, cost of seed, and seed distribution. Rural freshwater aquaculture in most African countries is still dependent upon government support for seed; however, an increasing number of small scale farmers have built fish hatcheries that are now producing and selling monosex tilapia to fish farmers. Through training activities, these farmers are learning about record keeping and better pond management through Best Management Practices (BMPs). Lack of reliable supplies of fish feeds also remains a major challenge for development of aquaculture in the region.

Activities that Support Women's Involvement in Aquaculture and Fisheries

The RCE has made efforts to address gender integration within the planned scope of work, aiming to involve equal numbers of men and women in AquaFish training and project implementation. The RCE will continue to extend partnerships with women's groups and youth through deliberate attempts to increase the participation of women in formal and informal education and training opportunities.

Capacity Building and Information Dissemination

The Africa RCE targeted a range of audiences for its dissemination strategy, each requiring different levels of investment and approaches for effective communication. Specific approaches included:

- Developing an Africa RCE Web Page (<http://rceafrica.com/>).
- Collaborating on research and building institutional linkages (e.g., ILRI, WorldFish, CGIAR).
- Networking with global scientists through ISTA, SARNISSA, WAS, and other meetings and conferences. During ISTA 2013 in Israel, discussions were held with feed manufacturers from Israel and Africa, and a visit to Kenya was planned to assess the viability of starting a fish feed factory there.
- Presenting at professional conferences, e.g., Héry Coulibaly gave two presentations that discussed the role of collaboration in aquaculture development in Mali at Aquaculture America (AA) 2014.
- Engaging stakeholders in the region to develop and adopt new aquaculture technologies.

Leveraged Activities

The Africa RCE has actively engaged various organizations and governments to leverage aquaculture development. Key among the organizations and governments are the Food and Agriculture Organization of the United Nations (FAO), the German and Israeli government under a trilateral arrangement, and Kenya Marketing Trust (KMT), among others. FAO has committed funds under a technical cooperation for aquaculture development in Kenya and Uganda. The FAO Country Programming Framework (CPF) for Kenya sets out priority areas to guide FAO's partnership with the Government of Kenya at both national and county levels, bringing together innovative international best practices and global standards with national and regional expertise until 2017.

RCE – Asia Annual Report

Remedios Bolivar (Lead Coordinator) &
Yuan Derun (Co-Coordinator)

Regional Needs for Aquaculture Development and Gaps in Technology Transfer and Adoption

Tilapia farmers in most Asian countries are constrained by the lack of high quality broodstock. As a model to emulate, Bangladesh has tried to resolve the existing situation by establishing five Tilapia Breeding Nuclei (TBNs), and further establishment of a satellite hatcheries are in the pipeline throughout the country. There is also room to more broadly transfer technologies in the region through improved connections to the internet and cell phones, and through development of podcasts and other internet-based outreach materials.

Activities that Support Women's Involvement in Aquaculture and Fisheries

The Philippines Bureau of Fisheries and Aquatic Resources (BFAR), a former AquaFish partner, is the government agency mandated to ensure development, management, and conservation of the country's fisheries and aquatic resources. As part of their commitment to promoting social justice for fishers and to empower women, BFAR developed a set of Gender and Development checklists and the Magna Carta of Women. A joint activity of NACA (Network of Aquaculture Centres in Asia-Pacific) and the USAID MARKETS Project aims to produce a Thematic Aquaculture Gender Report that will contain the current status of gender policies, programs, and participation in aquaculture value chains in southeast Asia. Case studies on selected value chains will also be produced to present good practices and as outreach and training materials. The Fisheries Administration (FIA) in Cambodia and Can Tho University in Vietnam were invited as local partners; and connections were also extended to the Mekong River Commission Network for the Promotion of Gender in Fisheries and the AFS Gender Network.

Capacity Building and Information Dissemination

The Asia RCE coordinators were involved in the following outreach and dissemination activities in FY14:

- Trainings on small-scale hatchery management, rice-fish culture, and community-based resource management in Cambodia; and a course on aquaculture broodstock management with support from United Nations University Fisheries Training Program.
- Facilitation of exchange of young aquaculture professionals between Africa and Asia to learn principles and practices of aquaculture developed by AquaFish projects.
- Meeting and conference participation with local, regional, and international foci on policy issues, good aquaculture practices, food safety, aquatic animal diseases and health management, and mitigation of impacts of climate change. For example, Yuan Derun was a plenary speaker at the Malaysian International Seafood Exposition and Conference in Malaysia in June 2014.

Leveraged Activities

An ACIAR (Australian Centre for International Agricultural Research) funded project on Culture Based Fisheries (CBF) development in southeast Asia built upon previous ACIAR projects in the region. The goal was to optimize CBF benefits in rural areas, watersheds, and among community organizations. In Cambodia, suitability of water bodies, species, and stocking density for CBF were tested, and dissemination packages were developed. Capacity building among researchers, government officers, and farmers in optimizing and adopting BMPs of CBF was a major output of both project components.

RCE–LAC Annual Report

Wilfrido Contreras (Lead Coordinator) &
Maria Célia Portella (Co-Coordinator)

In Phase II, USAID requested that AquaFish focus on Africa and Asia. As a result, there are currently no funded projects in LAC, but AquaFish hopes to continue assisting in the region informally through an established network and previous relations. The LAC RCE, thus, plays an important role in maintaining communication with past and present AquaFish collaborators, building capacity, and leveraging resources.

Regional Needs for Aquaculture Development and Gaps in Technology Transfer and Adoption

To inform this regional assessment, many collaborators and colleagues representing a wide range of stakeholders were consulted by the LAC RCE to best capture regional gaps. There are roughly half a million aquaculture producers in LAC, and there is a growing demand for qualified technical assistance in the aquaculture sector. This demand has pushed governments to increase resources allocated to aquaculture extension; however, countries in the region still lack adequate organization and trained personnel to support fish farmers in sustainably growing aquatic organisms, marketing their products advantageously, managing their businesses efficiently and competitively, and improving the standard of living of their families and communities.

Activities that Support Women's Involvement in Aquaculture and Fisheries

A survey on women's participation in aquaculture was conducted among authorities and researchers involved in aquaculture activities in seven LAC countries. In general, the participation of women remains infrequent, and when occurs, is primarily in fish processing. Some countries have initiatives that provide incentives for women aquaculture producers, but there is room for improvement as most of the support is used in the broader agriculture sector rather than being focused on aquaculture and fisheries. The FAO funded the Aquaculture Network for the Americas, an intergovernmental organization with representation from 14 LAC countries, to contribute to the fight against hunger and poverty. The network delivers information on sustainable and equitable development of aquaculture, and encourages the incorporation of women, indigenous people, and the poor.

Capacity Building and Information Transfer

The LAC RCE has been involved in the following capacity building and dissemination efforts:

- Training support to researchers and extension agents in the region on tropical gar culture and designing nurseries.
- Partnership building for collaborative research in areas such as the culture of tilapia, native cichlids, and aquaponics with related workshops.
- Participate in regional and international conferences, e.g., Dr. Portella organized sessions at LACQUA 14 in Mexico, bringing together several CRSP and AquaFish colleagues. Coordinators are also actively involved in AA 2015 to be held in New Orleans, LA, where they requested a special session on snook; helped secure participation by the International Network of Garfish researchers; and presentations will be given by the Universidad Juárez Autónoma de Tabasco, Mexico, as well as from other LAC institutions.
- Mentor long-term students - during the last two years five graduate students and four undergraduate students participated in research projects, fish production, and training activities.

Leveraged Activities and Associate Awards

Due to a strong emphasis on snook aquaculture, funding was received from two Mexican organizations that support conservation and production of native species. The National Commission for Biodiversity (CONABIO) provided funding for a new laboratory on snook culture, with a goal of successfully

releasing three species of juvenile snook in the Usumacinta River systems. In this project, RCE coordinators are providing information on snook conservation and aquaculture, the importance of native fishes in riverine environments, and native fish aquaculture. The second project, funded by the Coordinadora Nacional de las Fundaciones Produce, A.C. (COFUPRO), aims to build a laboratory for genome cryopreservation of native species of fish. The third project, also funded by CONABIO, was recently accepted and aims to reintroduce and monitor four native species in three lagoons to determine the impact of re-introduction.



Workshop participants and AquaFish trainers test water quality parameters of a fish culture pond in Tanzania.



XI. ISSUES AND CHALLENGES

- Oregon State University is currently undergoing a period of rapid growth, both in terms of student enrollment and in capital investment in buildings. While growth is generally considered positive, the University must, during periods of construction and remodeling, relocate displaced staff and, often, entire departments or colleges. In a continuing effort to find adequate space in or around the OSU campus, AquaFish has been forced to relocate in its entirety two times in the last three years and an additional near-future move is planned. The challenges faced by the moves themselves and, importantly, the looming uncertainty of future space, can not be overstated. Planning and conducting these large-scale moves has a high impact on the Management Office, especially during times of heavy reporting. Despite these disruptions the AquaFish Management Office has been able to operate effectively in achieving program goals through forward-thinking management decisions.
- Increasing Management Office staffing to administer Associate Awards 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 management and advisory groups at the 2009 Annual Meeting was that future Associate Awards must be treated more similarly to core research projects, adhering to technical peer-review, organizational, and reporting requirements. With this SIRTID Associate Award, we heeded this lesson by requiring all tasks to be written as “investigations” that undergo peer-review; to add to the overall AquaFish metrics/indicators; and to conform with core program guidelines and policies. Integration and alignment require extra planning time. Quick turnaround task-order USAID RFAs do not typically allow for this. Another method for promoting integration of Associate Award personnel is for them to provide service on core AquaFish advisory groups. The East and West Africa RCE Leaders on the core program were involved in the Associate Award from the beginning; however, due to changes in their work responsibilities they were unable to devote the necessary time for integrating project activities across East and West Africa. A re-evaluation of the role of RCEs on Associate Awards will be taken up at a future advisory meeting.
- Timely information from USAID regarding project extensions is required for the AquaFish Management Office to make effective programmatic and funding decisions as awards close down. The AquaFish Management Office requested a 3-month no-cost extension (NCE) to its SIRTID Associate Award in June 2014, to avoid simultaneously closing down the prime Associate Award from USAID and subawards to project partners on the same date. This untenable situation would not have provided the Management Office adequate time to synthesize data and information across the two projects and three countries in a meaningful way. The NCE was fully executed on 29 September 2014 – one day before the Associate Award was slated to close down. We appreciate receiving the NCE, however it came at the 11th hour and thus presented program management challenges due to the uncertainty of whether or not an NCE would ultimately be granted.
- AquaFish experienced a hiatus in AOR leadership from USAID BFS in FY13-14, during which a transition from AquaFish’s longtime AOR (Harry Rea) occurred. The transition involved a lengthy regrouping period when institutional memory was unfortunately lost. As of the very end of FY14, the transitional period appears to be coming to a close -- the new Activity Manager recently received clearance and a USAID email address and phone number, along with some administrative and operational training, although AOR training still awaits. Looking back, the transition in AORs was probably made more challenging due to changes occurring in tandem at BFS. The learning curve for

anyone coming into such a situation can be very steep. While AquaFish has made mentoring its new USAID AORs a priority, the additional information sharing burden has at times been high. Although USAID tried to overlap AORs, ensuring success during the transition depended heavily on having an experienced Director and management team in place. Had both sides (USAID and the Management Team) been in a period of transition, serious problems could easily have ensued.

- The cost of doing business has increased considerably over the past few years. New and more regulations, increased risk aversion, and heightened security issues mean more effort must be put into management, compliance, and oversight. These factors, along with rising personnel and health care costs, have increased management costs at US universities even in the short period since the start of Phase II. Overseas, many of these same costs are causing budgets to go less far. Our field projects have encountered steep price increases for feed, labor, and other research inputs. The cost sharing and leveraging AquaFish has raised in the past is very meaningful for success of its collaborative research projects, however, these streams are harder to come by. The ability to manage Associate Awards will become increasingly difficult as core funds are worth less and less. USAID correctly recognized these challenges when it increased the core annual budget of the most recent Lab to the highest of any Lab fashioned in the CRSP vein (i.e., Sustainable Intensification at Kansas State, core funding of \$25M over 5 years, with a \$25M additional ceiling to \$50M total). The AquaFish ceiling and, thus, its ability to take on Associate Awards without infringing on its core performance and funding, is very low at \$1M. Without a higher ceiling, any Associate Award would need to absorb the heavier management costs so as not to jeopardize core research and field projects. A recommendation would be to increase the ceiling of AquaFish in the next modification.



XII. FUTURE DIRECTIONS

Oregon State University (OSU) received a five-year extension from USAID beginning 30 March 2013 and ending 29 March 2018, under the new USAID-approved name *Feed the Future Innovation Lab for Collaborative Research on Aquaculture & Fisheries* (or AquaFish Innovation Lab). AquaFish prioritizes research to improve sustainable aquaculture practices and transfer technologies to individuals and institutions through capacity building efforts, such as training events, long-term educational support, and curriculum development. Moving forward, AquaFish will continue to monitor project progress through various mechanisms, including Feed the Future Monitoring System (FTFMS) metrics, disaggregated short- and long-term training data, and benchmarks. The Strategic Investment in Rapid Technology Dissemination (SIRTD) Associate Award is scheduled to close down; project activities are complete and final reporting is in progress.

AquaFish 2013-2015 Implementation Plan

Current AquaFish projects were funded over a two-year Implementation Plan from 2013-2015 (<http://aquafishcrsp.oregonstate.edu/page/implementation-plans>), and are taking place in the following countries in Asia and Africa: Bangladesh, Nepal, Cambodia, Vietnam, Ghana, Tanzania, Uganda, and Kenya, with additional key project personnel in the Philippines. The AquaFish Program is managed at OSU, and individual projects are led by investigators at the following five US Universities: Auburn University, North Carolina State University, Purdue University, University of Connecticut, and University of Michigan. Projects have been underway for nearly a year, and moving forward into FY15, work will continue according to the 2013-2015 Implementation Plan. Through long-term training efforts, AquaFish intends to continue funding over 100 students seeking degrees on a range of subjects in the aquaculture sector.

Work in Bangladesh is well under way and the following activities will continue in FY15: Data collection towards refining the application and benefits associated with reduced feeding protocols, trials to develop innovative polyculture systems, and surveys to inform a value chain assessment (VCA) of the aquaculture industry in southwest Bangladesh. The VCA is intended to help identify ways of improving the nutritional status and livelihoods of marginalized women and households. This investigation employs a similar methodology used in previous Collaborative Research Support Program (CRSP) work for the Philippines, and is led by researchers who were involved in that work.

In Nepal, AquaFish researchers will continue working to diversify the small-scale aquaculture industry by expanding the availability of native fishes and by adding small indigenous fish species to typical carp polyculture systems for household consumption. Work on establishing school ponds for fish farming and education will get underway to improve health and nutrition within local communities.

Building on work carried out by AquaFish prior to the 2013-2018 extension, work in Cambodia and Vietnam will continue with surveys, analyses, and stakeholder meetings aimed at identifying the impacts of climate change on aquaculture and making related policy recommendations for improving livelihoods in the region. Additional work on improving the sustainability of snakehead aquaculture in Cambodia continues with collaborations between Vietnamese and Cambodian researchers.

In Ghana and Tanzania, researchers will continue to test and develop methods that enhance the nutritional value of farmed tilapia. AquaFish will be conducting a VCA in Tanzania and developing a cell phone-based seafood market information system. In Zanzibar, work is underway for developing and improving

shellfish aquaculture enterprises in collaboration with the Western Indian Ocean Marine Science Association (WIOMSA).

In Uganda, AquaFish will continue to assess market opportunities for small-scale fish farmers and to build industry networks using cell phone-based information exchanges. Work continues in the development of breeding and hatching technologies for the African lungfish. Under the same project, the AquaFish team in Kenya is beginning work on alternative feeds and the development of low-cost aquaponics systems.

2016-2018 Continuing Projects

AquaFish will develop a request for proposals (RFP) for a second two-year funding cycle. Existing projects will be reviewed and those in good standing will be invited to submit continuation proposals. The purpose of this mid-term process is to reinforce the portfolio in knowledge or geographical gap areas, respond to changes within USAID, terminate projects, and introduce modifications to otherwise successful projects.

Expanding Work to New Countries

In FY13, AquaFish Management released an RFP to expand work within the Asia region to Burma. Although several proposals were received, none were funded as they were determined to be deficient in terms of research and capacity building. In addition, a lack of established institutional partners in Burma, which are necessary preconditions for aquaculture research, as well as funding delays from USAID to AquaFish led to a decision to postpone the project. As Burma remains an area of interest for USAID, AquaFish is considering the possibility of funding a pilot project.

Assessing Programmatic Impacts

AquaFish plans to initiate a program-wide Impact Assessment (IA) project during the Phase II (2013–2018) period. Early discussions on IA began at AquaFish regional and programmatic meetings in FY13 and FY14 and IA project leads have been established. The IA work will focus on evaluating the long-term training impacts of the AquaFish program.

Regional and Global Work

The Management Team will stay informed of emerging development and technical issues through open dialogue with three established external and internal advisory groups: Development Theme Advisory Panel (DTAP), Regional Centers of Excellence (RCE), and the External Program Advisory Council (EPAC).

AquaFish is also in the early stages of initiating a Global Experiment (GE) that builds on work led by the Pond Dynamics/Aquaculture (PD/A) CRSP from the 1980s and early 1990s. The goal of the initial GE was to quantitatively describe the physical, chemical, and biological principles of pond culture systems, considering site specificity and other factors. Through this research and other related work, good, standardized aquaculture practices were developed. AquaFish is now interested in taking the next step to disseminate these “best practices” to a range of end-users on a global scale.



APPENDICES

AQUAFISH LIST OF PUBLICATIONS

The following publications and peer-reviewed articles by AquaFish Innovation Lab (formerly CRSP) investigators on their AquaFish-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 also operational on a no-cost extension.

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