



# AQUACULTURE CRSP 21<sup>ST</sup> ANNUAL TECHNICAL REPORT

## AQUACULTURE TRAINING FOR KENYAN FISHERIES OFFICERS AND UNIVERSITY STUDENTS

*Tenth Work Plan, Adoption/Diffusion Research 1 (10PDR3)  
Final Report*

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### ABSTRACT

Food security is an issue for many developing countries, and maintaining an adequate and sustainable supply of fish and other aquatic products is an important part of this issue. There is no doubt that in Kenya fish can contribute to food security directly by making high quality food available to communities and indirectly by providing incomes and livelihoods to the producers and fish farmers. Over the next 25 years, one of the challenges in fisheries management will be to increase aquaculture production sustainably to meet the country's demand for fish and other aquatic products.

Increasing aquaculture production in a sustainable way requires trained manpower. Officers serving in the Kenya Fisheries Department (FD) need to be equipped with an understanding of pond dynamics and modern technologies for small-scale commercial aquaculture in order to cope with the emerging challenges in aquaculture development. Initial plans to provide training of this type were made at a 1997 CRSP-sponsored workshop at Sagana Fish Farm and later incorporated into the CRSP's Ninth Work Plan. Because of very positive feedback received from the training offered under that Work Plan, the FD requested that this type of training be continued into the subsequent phase of CRSP work, the Tenth Work Plan.

In this activity three three-week short courses in fish pond construction and management were conducted for Fisheries Officers of the FD. Emphasis was placed on the practical skills needed for pond management, and on viewing fish ponds and fish farms as commercial enterprises rather than as subsistence activities. Participants were assigned written projects in which they had to describe the planning and development of an aquaculture enterprise, including establishing the existence of a market for a product, specifying the site where the farm would be located and the species and size of fish to be produced. Plans included the number and sizes of ponds or other culture units to be constructed, their use and purpose, and stocking, feeding, harvesting, and draining schedules. Enterprise and cash flow budgets were developed by each participant for their chosen aquaculture enterprise. At the end of the course each participant gave a 10- to 15-minute presentation on his or her enterprise. Each course included twenty participants, for a total of sixty trainees.

Scholarship support was also provided for students in the Moi University Department of Fisheries. Support for five undergraduates was provided in the form of stipends to support "attachments" at Moi University's Chepkoilel Fish Farm to conduct senior research projects. Full scholarship support, including tuition and stipends, was provided for four FD Fisheries Officers to undertake master's-level graduate work at Moi University. As a result of this support, five undergraduates will have completed their bachelor's degrees and four Fisheries Officers will receive M.Sc. degrees.

### INTRODUCTION

Food security is an issue for many developing countries, and maintaining an adequate and sustainable supply of fish and other aquatic products is an important part of this issue. High quality products should be accessible to the consumer in sufficient quantity to provide adequate nutrition.

Since we are near a state of crisis with respect to food supplies in Kenya, the future contribution of fish to food security is in

question and now is an appropriate time to examine fish production issues. Past experience shows that fisheries resources in Kenya have been degraded and overexploited due to a lack of qualified managers and uninformed stakeholders. The end results are drastic reductions in fish catches and huge post-harvest losses, leading to poor quality fish being supplied to the markets or even no fish at all. Over the next 25 years, the challenges in fisheries management will be to maintain fish harvests at present or near-present levels while sustainably increasing aquaculture production to meet demand for fish and

Table 1. Names, study topics, and support period for undergraduate students receiving CRSP stipend support at Moi University under the CRSP Tenth Work Plan.

Name of Student	Study Topic	Stipend Support Period
Emmy Amwayi	Effect of fertilizer application on zooplankton abundance in static ponds at Chepkoilel Fish Farm, Moi University, Eldoret	1.5 months
Geoffrey Mwangi	Influence of pond fertilization on primary productivity, with special reference to phytoplankton in fish ponds	3.0 months
Joseph Onyango	Microbiological analysis of fish samples from ponds at Chepkoilel Fish Farm, Moi University, Eldoret	1.0 month
James Mugo Bundi	Effect of organic fertilizer applications on water quality and fish production in ponds at Chepkoilel Fish Farm	3.0 months
Daniel Otieno	Soil and water interaction and pond dynamics influenced by inorganic fertilizer applications in a high altitude environment	3.0 months

Table 2. Names, thesis topics, and supervisors of graduate students receiving M.Sc. program support (tuition and stipends) at Moi University under the CRSP Tenth Work Plan. All students began their course of work on 1 May 2002 and are expected to complete their programs by the end of April 2004.

Name of Student	Supervisors	Thesis Topic (tentative titles)
John G. Rauni	BCC Wangila, James R. Bowman	A comparative study of survival rates of African catfish ( <i>Clarias gariepinus</i> Burchell, 1822) fry reared under different shading levels in ponds
Rachel Kamau	BCC Wangila, Karen Veverica	The effect of different stocking densities on the growth rate and production of African catfish, <i>Clarias gariepinus</i> (Burchell, 1822) fry in ponds
Julius Nzeve	Charles C. Ngugi, James R. Bowman	Influence of three different live feeds (rotifers, copepods, and <i>Artemia</i> ) on survival and growth of juveniles of the African catfish ( <i>Clarias gariepinus</i> ) reared in tanks
Daniel Omwansa	Charles C. Ngugi, Karen Veverica	Effects of stocking density and shelter on growth and survival rates of African catfish ( <i>Clarias gariepinus</i> ) fry in the nursery

other aquatic resources. The Government of Kenya's National Development Plan (1996) called for an increase in aquaculture production to compensate for the shortfall in production from capture fisheries.

Increasing aquaculture production in a sustainable way requires trained manpower. Training opportunities in the past have been limited, and sustained funding and well-thought-out training strategies have been lacking. In the last decade, Fisheries Extension Officers serving in the Government have had no formal training program because the only training institution, the Naivasha Wildlife and Fisheries Training Institute, reverted to training Wildlife Officers only. This has had far reaching repercussions for the fisheries sector, because serving Fisheries Officers, who are charged with the responsibility of managing the country's fisheries resources and helping fish farmers manage their ponds and farms effectively, have received neither initial basic training nor periodic in-service training.

Given this scenario, we recognized the need for capacity development through assistance from reputable international institutions. Serving Fisheries Officers who are unable to participate in longer-term degree courses needed to be equipped with an understanding of pond dynamics and modern technologies for small-scale commercial aquaculture in order to cope with the emerging challenges in aquaculture development. Training by experienced personnel would enable the Fisheries Department (FD) to transfer appropriate knowledge and skills to fish farmers, which would be necessary for the continued develop-

ment of aquaculture in Kenya. Wangila (1996) stated that more technical certificate, diploma, and higher level training should be included in the aquaculture sector's future training plans. This need was recognized in the CRSP's Regional Plan for Africa (PD/A CRSP, 1997). Hence, Provincial Fisheries Officers, officers of the Kenya Marine Fisheries Research Institute (KMFRI), and faculty from Moi University's Department of Fisheries identified training as a primary need in a planning workshop held at Sagana Fish Farm during the first year of CRSP involvement in Kenya (CRSP Workshop, 1997). Initial plans for such training were made at that workshop and later incorporated into the CRSP's Ninth Work Plan (WP9). Feedback from the five training sessions conducted under WP9 indicated that they were extremely valuable to the participants, giving them the ability to construct fish ponds properly and to give sound pond management advice to farmers. Because of this very positive feedback, the FD requested that this type of training be continued into the subsequent (current) phase of CRSP work, the Tenth Work Plan.

The objectives of this activity were to:

- Support graduate and undergraduate aquaculture training for university students in Kenya.
- Provide in-service training for Kenyan Fisheries Officers to enable them to disseminate appropriate current aquaculture information to fish farmers.

## METHODS AND MATERIALS

Financial support to provide stipends for undergraduates and

Table 3. List of Fisheries Officers who participated in the first training session held under the CRSP Tenth Work Plan. This session was held at the Chepkoilel Campus of Moi University, in Eldoret, Kenya, from 11–31 August, 2002

Name	Gender	Home District
James I. Nduthu	M	Nyandarua
Andrew M. Ndamburi	M	Meru
Hilda Njoroge	F	Kiambu
N. Kamunde	F	Tharakanithi
Geoffrey M. Kamakya	M	Malindi
Stephen Njau	M	Kirinyaga
J.N. Njue	M	Nyeri
Anne Kimotho	F	Embu
M. Kiongora	M	Marsabit
Vincent I. Kinyua	M	Kiganjo
Daniel Gisore	M	Bomet
Timothy M. Ngumi	M	Kiambu
Christine Adhiambo	F	Uasu Gisu
Roy Aseka	M	Meru
P. Wekesa	M	Turkana
C.C. Oriewo	M	Kericho
Samoie Kipkosgei	M	Uasu Gisu
Filix Muthomi	F	Meru
Daniel K. Wambua	M	Baringo
Ali Mohasin	M	Kwale

scholarships and stipends for graduate (M.Sc.) students was included in the budget for this activity. Principal Investigators Charles Ngugi, (Moi University) and James Bowman (Oregon State University), Professor Barasa Wangila (Moi University), and Karen Veverica (Auburn University) served on the advisory committees of the graduate students. The programs from previous CRSP-sponsored Fisheries Officer short courses were modified for three new sessions, based on feedback from trainees, evaluators, and reviewers of CRSP proposals. Three three-week training sessions were planned and carried out during 2002 and 2003.

## RESULTS

### *Undergraduate Stipends*

Five undergraduate students from Moi University received stipend support for work on short-term “attachment” research carried out at Moi University’s Chepkoilel Fish Farm under this activity. Research topics covered areas such as pond fertilization, water quality management, fish disease control, predator control, or other topics important to the development of aquaculture in the region. Moi University faculty members supervised these students. One student (Joseph Onyango) worked under the direction of Professor Patel, a visiting professor of microbiology from Memorial University of Newfoundland, St. John, Canada. The names, study or project topics, and other pertinent information are shown for these students in Table 1. These students have finished their field attachments and are now working on their senior projects.

### *M.Sc. Program Support for Government of Kenya Fisheries Officers*

Four masters students received tuition and stipend support for their graduate work. The four students supported under this effort are listed, together with pertinent information about their research topics, in Table 2. Two of these students are conducting research on critical aspects of *Clarias* fingerling

Table 4. List of Fisheries Officers who participated in the second training session held under the CRSP Tenth Work Plan. This session was held at the Chepkoilel Campus of Moi University, in Eldoret, Kenya, from 12 January to 1 February, 2003.

Name	Gender	Home District
David K. Kemboi	M	Baringo
John G.E. Bore	M	Mbeere
Beatrice G. Akunga	F	Nairobi
Peter N. Mwanzia	M	Nyambene
Cesar M. Kaiga	M	Machakos
Zachary O. Kinaro	M	Migori
Sammy K. Macharia	M	Kisumu
Patrick M. Kiara	M	Embu
Henry M. Nzinga	M	Tana River
Erastus S. Micheni	M	Nyeri
Josephat M. Kirima	M	Meru
Rufus K. M’rewa	M	Isiolo
David K. Bett	M	Kajiado
Stephen W. Ndegwa	M	Laikipia
Peter G. Njenga	M	Kerugoya
Peter K. Ibuuri	M	Bungoma
Daniel M. Mutie	M	Makueni
Kariuki J. Kingori	M	Lamu
Josephine A. Imbamba	F	Nairobi
Joseck J. Mwaniki	M	Naivasha

production, as described in our other WP10 activity entitled “Techniques for the production of *Clarias gariepinus* as bait-fish for the Lake Victoria Nile perch longline fishery,” and the topics chosen by the other two are also directly related to this line of *Clarias* research. The four students have finished their coursework and had their thesis proposals approved and are now conducting their research at the Chepkoilel Campus of Moi University. Some supporting work (e.g., spawning to produce larvae for the experiments) is also being done at Sagana Fish Farm and at Chwele Fish Farm, near Bungoma (operated by the Government of Kenya Fisheries Department). These students’ programs are being directed by Dr. Ngugi, Dr. Bowman, Professor Wangila, and Karen Veverica.

Although the original work plan and budget allowed for only a single year of support for these students, the nature of graduate work at the master’s level requires students to spend, on average, approximately two years on master’s programs. Savings realized during the course of previous CRSP activities in Kenya (WP8, WP9) were therefore applied to this activity, allowing us to provide an additional year of support (tuition and stipends) for these students.

Since it was agreed that Fisheries Officers from the Government of Kenya Fisheries Department would receive this graduate support, a formal process was developed and used to select candidates. The selection procedure used is outlined in the attached document “Student Selection Process for Masters Study.”

### *Training for Fisheries Officers*

Three training sessions were conducted under this activity, each one spanning a three-week period and involving 20 participants. The first course was held at the Chepkoilel Campus of Moi University, Eldoret, from 11–31 August 2002, the second was held at Sagana Fish Farm, Sagana, from 12 January through 1 February 2003, and the third and final session was

Table 5. List of Fisheries Officers who participated in the third training session held under the CRSP Tenth Work Plan. This session was held at the Chepkoilel Campus of Moi University, in Eldoret, Kenya, from 12–30 May, 2003.

Name	Gender	Home District
J.B.K. Ngeno	M	Baringo
Emman J.K. Otieno	M	Busia
Cosmas M. Wekesa	M	Siaya
Willy K. Mututa	M	Tana River
Robert K. Nyathore	M	Kiambu
S.M. Njuguna	M	Nakuru
P.W. Gathongo	M	Laikipia
J.M. Gachuru	M	Nyeri
D.J. Oketch	M	Vihiga
Tom Jienda	M	Migori
S.T. Kipkorir	M	Kuria
S.C. Gichunge	M	Tharakanithi
Timothy Odede	M	Busia
Paddington Odari	M	T/Nzoia
Edward Gakui	M	Taita Taveta
Joyce Lugonza	F	Naivasha
Antony Gatundu	M	Meru Central
Christine Amuguni	F	Siaya
T.M. Ojuok	M	Nakuru
Justine N. Ireri	M	Embu

held at Chepkoilel from 12–30 May 2003. The names and duty stations of the participants in each training session are shown in Tables 3, 4, and 5.

Course content included pond construction, soil characteristics and management, fry and fingerling production of various species under culture in the region, and general principles of pond management. Fish handling, pond fertilization, integrated systems, water quality management, fish nutrition and disease control, predators and fish marketing were also covered, and pond systems were compared with other, more-intensive types of culture systems. All courses emphasized practical work in pond design and construction and managing aquaculture ponds and farms as commercial enterprises.

However, emphasis was placed on treating small-scale fish farming as a business enterprise, rather than as a subsistence activity. Trainees were assigned written projects in which they described the planning and development of an aquaculture enterprise, including establishing the existence of a market for a product, then specifying the site where the farm would be located and the species and size of fish to be produced. Plans included the number and sizes of ponds (or other culture units) to be constructed, the use and purpose of each, and stocking, feeding, harvesting, and draining schedules for each. Enterprise and cash flow budgets were also developed by each participant for their chosen aquaculture enterprise. At the end

of each training session each participant gave a 10- to 15-minute presentation on his or her enterprise.

Moi University and US Principal investigators ensured that course content was up to date. The majority of the training was done by resource persons from Moi University, under the leadership of Dr. Charles Ngugi. Resource persons from the US included the US PI Jim Bowman and former resident researcher Karen Veverica, who was invited to participate in the first course to provide continuity from previous courses. Additional input was provided for the first course (August 2002) by Auburn University graduate student Michael Mahoney, who filled in when PI Jim Bowman was unable to attend. Approximately two-thirds of the time in each session was spent doing field work and the remaining third was spent in a classroom setting. Although there was provision for up to five additional trainees to be allowed into each session, no outside funding support for additional trainees was received, so no session included more than 20 participants. The USAID/ Uganda mission had expressed interest in sending up to five trainees, but it turned out that they required a different sort of training than that which was being offered.

## DISCUSSION AND CONCLUSIONS

As with the previous training course for Fisheries Officers (i.e., that conducted under WP9), this training was generally favorably received by the trainees. Of course not all officers are as interested in aquaculture as others, and not all come from areas where fish farming has a high potential, so some officers typically arrive for training with a somewhat negative attitude about the benefit of attending. However, even those who began these three-week sessions with skepticism seemed to take on a more positive attitude by about the second week or so, and most seemed to return to their posts with an improved understanding of what fish farming is all about, with a good idea of how to go about constructing fish ponds properly, with at least a basic understanding of what constitutes good pond management, and with an idea of how to go about preparing enterprise and cash-flow budgets for this type of enterprise.

For these three training sessions we administered pre- and post-training “mini-tests” in an attempt to evaluate the immediate impact of the training on the knowledge and skills of the trainees themselves (in contrast to any impacts on aquacultural production in the field, which could only be measured months or perhaps even years after the training; evaluation of such impacts can therefore only come long after the time-frame of this activity). For all sessions we found that a majority of the participants did show improvement in scores from the pre-test to the post-test, as shown in Table 6. For the first session (August 2002), 17 of the 20 participants improved their test scores

Table 6. Impacts of training on aquaculture skills and knowledge of Kenyan Fisheries Officers, as indicated by pre- and post-training tests, for the three training sessions held in 2002 and 2003 under the CRSP Tenth Work Plan.

Training Session	Number of Participants	Improved Test Scores	Unchanged Test Scores	Decreased Test Scores
August 2002	20	17	1	2
January 2003	16*	14	0	2
May 2003	20	20	0	0

\*There were 20 participants in each of the sessions; however, four of the participants in the January 2003 session arrived at the site too late to take the pre-test. Results shown here are therefore only for the 16 participants who took both the pre-test and the post-test.

after the three week training, one participant scored exactly the same on the pre- and post-tests, and the scores of two participants were actually lower on the post-test than they had been on the pre-test. For the second session (January 2003), four participants did not arrive at the training site until after the pre-test had been administered; of the 16 who took the pre-test, post-test scores were higher for 14 of them but had decreased for the other two. For the final session, held in May 2003, all participants improved their scores on the post test as compared with the pre-test. We were surprised (and dismayed), however, to find that some participants actually scored more poorly on the post-test than they had on the pre-test. This was particularly surprising in some cases because some of those scoring poorly on the post-test were, we thought, among those who had shown a better understanding of the subject matter over the three-week training period; we can only speculate that by the end of these intense training sessions some trainees were so weary that they simply did not care how well they did on the post-test and did not give it the effort that we expected. In spite of the few decreased test scores, though, our impression from working with these officers during these three training sessions is that most of them benefited immensely from this exposure and training, and that this effort will prove to have been beneficial towards boosting the development of aquaculture in Kenya.

As with all short courses offered previously, each training session was evaluated by a Training Assessor from the Kenya Fisheries Department. The Assessor's reports for these sessions provide further, independent evaluation of the training, and they are attached to this report.

#### ANTICIPATED BENEFITS

Sixty Fisheries Officers who had not received training during WP9 received short-term training, and it is expected that the information and expertise gained will ultimately be disseminated to a considerably wider audience of extension workers and fish farmers. Fisheries Officers learned how to construct fish ponds, how to handle fish, and how to manage ponds and fish stocks properly. Receiving this training has increased the

skills of Fisheries Officers, and will hopefully also improve their morale and increase their confidence when advising extensionists and fish farmers. Better-trained officers will improve the fisheries extension services by providing better information to fish farmers. Properly informed farmers will increase production of farmed fish through better fish husbandry. Linkages between researchers and extension workers will be improved and the linkage between the Kenya Fisheries Department and the Moi University Department of Fisheries will be strengthened. The expertise of Moi University faculty and students involved in the training has also been strengthened, both in aquacultural and educational techniques.

Graduate and undergraduate students supported by this activity benefited from longer-term and more in-depth studies in aquaculture. They gained the knowledge and ability to move into managerial and/or supervisory positions that contribute to future development in the aquaculture sector. Their research topics will address information gaps and contribute to the development of better management packages for dissemination to farmers. Four graduate and five undergraduate students benefited from this activity. They have learned much about searching the literature for relevant material and about how to conduct scientific research and they have benefited from information exchange and interaction with aquaculture experts, especially PIs from outside institutions. And finally, when they finish their programs these students will hold degrees in aquaculture or fisheries science.

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