



AQUACULTURE CRSP 21ST ANNUAL TECHNICAL REPORT

AQUACULTURE TRAINING FOR KENYAN FISHERIES OFFICERS AND UNIVERSITY STUDENTS

Ninth Work Plan, Adoption/Diffusion Research 3 (9ADR3)
Final Report

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ABSTRACT

Lack of technical training has been cited as a major reason for the low output of fish ponds in Kenya. The lack was observed at all levels, from the lowest level extension agent through university levels. This training program, undertaken under the Ninth Work Plan by the Aquaculture CRSP Kenya Project, has sought to improve training and to provide a cadre of trainers who have extensive practical fish production experience.

Full scholarship support was provided for two M.S. students under this activity, one at Moi University's Chepkoilel Campus, Eldoret, Kenya, and the other at Auburn University, Alabama. Stipends were provided to allow graduate and undergraduate university students to work at Sagana Fish Farm to conduct thesis research and gain valuable field experience, and a small research project program has allowed the station staff to further their professional development and carry out their own research, which is expected to have a positive impact on station management.

A series of five short courses for personnel of the Kenya Fisheries Department (FD) was begun in 1999 and concluded in 2000. In the first four sessions of the series, more than 80 FD staff received two weeks of training in pond construction methods and pond management techniques, and in the final session an additional 26 persons (24 fisheries officers and two outside-funded participants) received three weeks of advanced training in pond construction, pond management, and business planning.

Following requests from farmers, a program of farmer education days was developed to complement the short-course training undertaken in this activity. During the first half of 1999, five farmer education days were held in which 107 farmers and 40 extensionists participated. All districts in the Central Province were covered, and one district each from the Eastern and Rift Valley Provinces was included. The farmer education days were continually improved, following feedback from farmers. A one-day farmers' field day, sponsored by the World Bank (Lake Victoria Management Project), was held in April 2002 in which 20 fish farmers from Kisumu District were trained in pond construction and management techniques. Four additional farmer field days for 31 farmers, including fisheries extension workers, were conducted at Moi University and at Sagana Fish Farm in August 2002.

INTRODUCTION

Lack of technical training has been cited as a major reason for the low output of fish ponds in Kenya. This lack has been observed at all levels, from the lowest-level extension agent through university levels. The Kenya Project's training program in Kenya has sought to improve training and to provide a cadre of trainers who have extensive practical fish production experience. This activity was originally planned to include

training only for university students and fisheries officers, but was subsequently expanded to include farmer and extension agent training as well.

Objectives:

1. To increase the pond management skills of fisheries personnel currently involved in aquaculture extension activities in Kenya.
2. To enhance the research and extension capabilities of

Table 1. Graduate students supported by the CRSP Kenya Project during the Ninth Work Plan.

Name	University / Department	Project	Date Started	Date Completed	Thesis Title
Daniel Oenga Nyanchiri	Moi University Fisheries	Largemouth bass introductions and fingerling production	July 1998	Not yet completed	No draft submitted to date.
Bernard Meso	University of Nairobi Soil Sciences	MS research on irrigation of horticulture crops with pond water effluents.	Sept 1998	October 2000	<i>Fish pond effluent effects on yield of French beans and kale in central Kenya</i>
Paul Bilal Izaru	University of Nairobi Zoology	Phytoplankton dynamics at different nitrogen and phosphorus input levels	October 1998	Not completed	Note: Student passed away before finishing his work
Robert Olendi	Moi University Zoology	Effects of suspended silt on primary production and fish growth	October 1999	Not yet completed	No draft submitted to date
Enos MacWere	Moi University Fisheries	Commercial tilapia and <i>Clarias</i> production systems	October 1999	Defended 14 th March 2002	<i>Comparison of tilapia and Clarias polyculture yields and economic benefits resulting from rice bran, pig finisher pellet, and a pelleted test diet in fertilized ponds</i>
Bethuel Omolo	Auburn University	Feed conversion efficiencies in channel catfish	January 2000	Fall 2001	<i>Feed conversion efficiency as a function of fish size in channel catfish</i>
Robinson Mugo	Moi University Fisheries	Comparative growth of tilapia in ponds	July 2000	Thesis submitted 15 Jan 2002	<i>A comparative study on the growth and economic performance of Nile tilapia (<i>Oreochromis niloticus</i>) fed on maize bran, wheat bran and rice bran in fertilized ponds</i>

Kenyan university students likely to be employed in the aquaculture sector.

Activities undertaken as part of this activity have included: providing full-scholarship sponsorship for two M.S. students, conducting a series of five short courses in pond construction and management for Fisheries Department (FD) extensionists, supporting undergraduate and graduate students conducting research at Sagana Fish Farm by providing stipends for some students along with guidance and mentorship by the US Research Coordinator stationed at Sagana, and conducting a series of farmer field days for farmers and extension agents interested in learning about fish culture basics. Progress reports on these activities have been provided in previous CRSP Annual Reports (Veverica et al., 2000, 2001). This is the final report for the activity.

Training of University Students

Two M.S. students received full scholarship support from the CRSP Kenya Project under this activity. Robinson Mugo began receiving CRSP support for his graduate program in the Department of Fisheries at Moi University (MU, Eldoret, Kenya) in October 1999. Mugo finished his work and submitted his thesis, entitled "A Comparative Study on the Growth and Economic Performance of Nile Tilapia (*Oreochromis niloticus*) Fed on Maize Bran, Wheat Bran and Rice Bran in Fertilized Ponds." He submitted the thesis to the school of Graduate Studies in January 2002 for examination. Bethuel Omolo, selected by the Kenya FD in 1999 to receive training for the Department's new Research/Extension Liaison position, began an M.S. program in the Department of Fisheries and Allied Aquacultures at Auburn University, Alabama, in January 2000. Omolo's studies have focused on extension methods and programming and general aquaculture; he completed his work and defended his thesis, "Feed Conversion Efficiency as a Function of Fish Size in Channel Catfish," in the fall of 2001.

Other students from MU and the University of Nairobi also received support for their graduate work in the form of stipends as shown in Table 1. Most of them conducted research

or completed senior projects at Sagana Fish Farm with on-site supervision by the resident CRSP research coordinator, Karen Veverica.

University of Nairobi students (Departments of Zoology and Soil Science) that were supported included Wilson Gichuri, Paul Bilal Izaru, Patricia Mwau, and Bernard Meso. Gichuri was awarded the M.S. degree for his thesis, entitled "Relative Contribution of Rice Bran and Inorganic Fertilizers in Semi-Intensive Tilapia (*Oreochromis niloticus*) and Catfish (*Clarias gariepinus*) Polyculture in Kenya" in 1999. Patricia Mwau completed her thesis, entitled "Nutrient Dynamics, with Special Reference to Nitrogen and Phosphorus in Tilapia (*Oreochromis niloticus*) / Catfish (*Clarias gariepinus*) Polyculture Ponds at Sagana Fish Farm, Central Kenya" in November 2000, and was awarded the M.S. degree. Izaru did his M.S. work at Sagana and submitted a thesis for consideration by University of Nairobi (Department of Zoology) in late 1998. However, in early 2001, we received word that Paul had passed away. Paul's degree work remained incomplete at the time of his passing. Meso's stipend was provided by another CRSP project, but much of his work was overseen by the CRSP resident researcher Karen Veverica. He completed his thesis "Fish Pond Effluent Effects on Yield of French Beans and Kale in Central Kenya" and was awarded the M.S. degree in 2000.

Students from the MU Department of Fisheries, who received stipend support, included Daniel Oenga Nyanchiri, Robert Olendi, and Enos Mac'Were. Oenga began his work in July 1998. He has submitted a draft thesis, but some revisions are still needed. He remains employed by Kenya Marine Fisheries Research Institute (KMFRI), so the going is slow with regard to completion of his thesis. His research working title is "The introduction, history and induced spawning of largemouth bass, *Micropterus salmoides* (Lacepede) in Kenya." Mac'Were and Olendi began M.S. research at Sagana Fish Farm in 1999. Mac'Were received CRSP stipend assistance and did his thesis research on commercial tilapia and *Clarias* production systems. He defended his thesis, entitled "Comparison of Tilapia and *Clarias* Polyculture Yields and Economic Benefits Resulting from a Locally Available Animal Feed (Pig Finisher Pellet), Agricultural By-Product (Rice Bran) and a Pelleted Test Diet

Table 2. Undergraduate students supported by the CRSP Kenya Project during the Ninth Work Plan, 1999 to 2000. All undergraduate students were finished by May 2000.

Name	University / Department	Project	Dates
<i>Undergraduates</i>			
Paul Wamwea Wabitah	Kenyatta University Zoology	Attachment. Senior project in comparison of tanks and hapas for sex reversal of tilapia	May 1998-May 2000
David Mirera	Moi University Fisheries	Attachment. Senior project on primary productivity indicators	May 1999-May 2000
William Nyaga	Moi University Fisheries	Attachment. Senior project on treatments to enhance survival of goldfish larvae.	May 1999-May 2000
Cosmas Munga	Moi University Fisheries	Attachment. Senior project on <i>Clarias</i> larvae feeding strategies.	May 1999-May 2000

in Fertilized Ponds," in March, 2002. Mac'Were's work was supervised by Charles Ngugi of MU, and Karen Veverica of the Aquaculture CRSP. Olendi did his research on the effects of suspended silt on primary production and fish growth. He finished his research in 2001 but has not yet submitted a thesis draft. He was already employed as chief technician of the MU Department of Fisheries before entering graduate school and has returned to that position.

Undergraduates at Kenyan universities are required to do six-week "attachments," in which they learn the practical aspects of station work and often take on a special subject for their Attachment Report. If the student can stay longer, they can often conduct their Senior Project research, for which a report is due at the end of their senior year. Student stipends from the CRSP have made it possible for some students to remain at Sagana for the whole break between their junior and senior years, thus allowing them to complete a senior project.

Three undergraduates from MU and one from Kenyatta University finished their junior/senior year attachment in September 1999 and returned to Sagana for December break. They graduated with bachelor's degrees in May 2000. Two other recently graduated MU students (Arthur Tuda and Charles Achuodo) worked at Sagana under the CRSP for one to four months and left to take jobs that they obtained as a result of their Sagana experience. Each had already finished a senior project prior to arriving at Sagana. Undergraduates who received stipend support from the CRSP under this activity are shown in Table 2.

Training for Fisheries Department Personnel

A series of five two-week short courses in pond construction and pond management was begun in 1999 and completed in November 2000. Each course was designed to accommodate 20 participants. These courses were typically a collaborative effort between the Sagana CRSP and FD group and the faculty of the MU Department of Fisheries. Some courses were held at the MU Chepkoilel Campus in Eldoret (home of the MU Department of Fisheries), whereas others were held at Sagana Fish Farm. Primary MU participants included Ngugi, professor in the Department of Fisheries, Mucai Muchiri, Head of the MU

Department of Fisheries, and David Liti, of the MU Department of Zoology.

The first course focused on pond construction and was held at the Chepkoilel Campus from 29 November through 14 December 1999. Fifteen extension workers, four private pond contractors, and one farmer participated. As part of their training, participants constructed two small ponds at the MU Department of Fisheries site near Eldoret. In February 2000, this group received an additional four days of training at Sagana, where they joined the second session to study pond management.

The second two-week course was held at Sagana from 14 to 25 February 2000. This group included one Fisheries Officer, 19 Fisheries Assistants and Fisheries Scouts, and three workers from the crew of a private contractor. Oversight for this training session was provided by Judith Amadiva, Social Development Officer assigned to Sagana by the Kenya FD. Both the first and second sessions (Eldoret and Sagana) were co-taught by Veverica and Ngugi of MU. Mac'Were, a graduate student working with the Aquaculture CRSP, provided assistance.

A third course, involving 20 FD officers and another three private contractor crew members was held at the Chepkoilel Campus of MU from 14 to 27 May 2000. This course also focused on pond construction and management. Ngugi had the major responsibility for teaching this course.

The fourth course of this type was held from 13 to 26 August at the Chepkoilel Campus. Geraldine Matolla helped teach the course. KMFRI requested three spots in this training program. Their officers began constructing two new ponds themselves immediately following the training. A total of 104 individuals received hands-on training in these two-week short-courses (Table 3).

The full MU report on this five-session sequence of short courses is not included in this report because of space constraints but is available upon request to the Program Management Office. That report also includes, as attachments, course evaluations provided by the Training Assessor of the Kenya FD.

A benefit of these training courses has been the construction

Table 3. Summary of Fisheries Department (FD) staff and non-FD participants who completed two-week training programs in pond construction and management. A total of four programs were held between November 1999 and August 2000. Trainees came from all provinces except the Northeastern Province.

Designation	Male	Female	Total	Remarks
<i>Kenya Fisheries Department (FD)</i>				
Fishery Officer	2	1	3	Four additional FOs sat in on the course
Assistant Fishery Officer	4	1	5	Three did not complete the pond management section
Fisheries Assistant	52	9	61	
Fish Scout	9	1	10	
Subordinate Staff		1	1	
Total FD staff	67	13	80	
<i>Non-FD participants</i>				
KMFRI staff*	3		3	One Research Officer, two technicians
private farmers	14		14	Includes 13 from African Bulldozers
university students	6	1	7	Three were undergraduates; four were graduate students
Total others	23	1	24	
OVERALL TOTAL	90	14	104	

Group A: Held at Chepkoilel campus from 29 November to 14 December 1999, 28 November to 3 December 1999 at Moi University (MU), and 22 to 25 February, 2000 at Sagana.

Group B: 14 to 25 February 2000 at Sagana Fish Farm.

Group C: 14 to 27 May 2000 at MU.

Group D: 13 to 26 August 2000 at MU.

* Kenya Marine Fisheries Research Institute

Group A reported at Sagana with Group B to finish the management section that they had not covered at Moi University. They stayed in Sagana for one week

of a considerable number of small research ponds at the facilities of both Sagana Fish Farm and MU. By the end of the fifth training session, eight ponds had been constructed by trainees at the MU site near Chepkoilel and a similar number had been constructed at Sagana; these new ponds will be invaluable for use in student research projects and future training programs.

In addition to the formal short courses offered, the Aquaculture CRSP supported James Karuri in a three-year diploma program in Applied Biology at the Murang'a College of Technology. He began his first year in January 1999 and finished at the end of 2001.

Farmer and Extension Agent Training

With reduced government spending, the extension service cannot be expected to disseminate information to all farmers. Farmer education days were, therefore, developed by Omolo, Veverica, and Judith Amadiva, the FD Social Development Officer at Sagana Fish Farm. The intent was to bring basic fish culture information to as many farmers as possible. A planning meeting for District Fisheries Officers was conducted dur-

ing which the latest Aquaculture CRSP research results were presented and farmer and extension agent training sessions were planned. Short (one-day) training sessions were planned because it is difficult for farmers (especially women) to leave their homes for long periods. A series of five farmer education days involving 107 farmers and 40 extension workers was held during the first half of 1999, and are summarized in Table 4. All districts in the Central Province were covered, and one district each from the Eastern and Rift Valley Provinces was included.

The first farmers' education day was requested by the newly formed Mt. Kenya Fish Farmers' Association. Education day packages consisting of binders containing fact sheets were prepared for the trainees at each education day; subjects covered in these packages are described in Table 5. As field days continued, new subjects were added and new handouts were developed. Feedback from farmers was very positive and encouraging. A few basic ideas such as water inflow control and pond fertilization were totally new to the majority of farmers. Most meetings were held at Sagana, which is an ideal place because farmers accept information on pond management

Table 4. Farmer/Extension Agent training programs in 1999. The term "Fisheries Officer" is used loosely; it indicates Fisheries Department staff—mostly Fisheries Officers, Assistant Fisheries Officers, or Fisheries Assistants. Except as noted, education days were held at Sagana Fish Farm.

Date	Farmers		Fisheries Officers		Origin	Subjects
	Women	Men	Women	Men		
11 March	5	13	1	1	Kiambu	Introduction to fish farming
18 May	5	25	1	9	Nyeri, 7 divisions	Farmers education package
24-25 June			0	5	Central province	Research results CRSP On-farm trials Training programming
11 June*	7	28	0	0	Kerugoya	Fish harvesting and processing
8 July	0	10	0	5	Kirinyaga District	Farmers education package
	0	5	0	0	Muranga DST	
20-21 July	2	13	1	3	Thika and Kiambu Districts	Farmers education package
	1	5	0	6	Nyandarua District	
29 July	2	9	2	6	Nyeri District	
	2	6	1	1	Nyanyuki District	
	0	6	1	1	Embu District	
	0	0	0	1	Muranga District	

* Held at a reservoir site in Kerugoya.

Table 5. Subjects covered in the farmers education day package. Fact sheets were printed for each of the subjects and presented to farmers in a binder. Two fact sheets have not yet been prepared: fish harvesting methods and fish preservation. Translation into Kiswahili is being considered, but the fact sheets still need some editing. Students on assignment at Sagana accompany the trainees and help with translations into Kikuyu.

Subject	Instructor
Pond management- especially water flow control, and weed control	Veverica
Feeds and feeding	Lagat or Gichuri
Fertilizing options and rates	Lagat
Predator control	Oenga or Veverica
Parasites and their prevention	Njau
Requirements and biology of tilapia, catfish and carp	Omolo
Stocking rates as they relate to carrying capacity and desired size	Mbaluka
Tips on pond construction and pond maintenance	Veverica
Integration of farm practices with fish ponds	Meso or Njau
Fish drying and smoking	Wasane
Fish harvesting techniques	Kibe or Makau

Table 6. Fisheries Officers assigned to Sagana that worked on their own research projects in 1999 and 2000, with advice and materials provided by the Aquaculture CRSP.

Name	Project title	Status
Francis Mwonjoria	Cage culture of tilapias: trials using low volume/high density cages based on work done in China.	Began Nov. 1999; Officer lost interest as of Feb 2000. Coordinator examined data with him and made suggestions on reporting.
Raphael Mbaluka	<i>Clarias</i> fingerling production technologies: simultaneous fry growout with tilapia fry	Second experiment began Aug. 1999. Worked up data and discussed with CRSP coordinator.

more readily when they actually see a pond with static water in which fish are actively feeding. One on-site demonstration on fish harvesting and preservation was held at a large, seven-acre dam in Kerugoya. These programs seem to be a very good way to get out basic information because they are easily attended by women and they allow for additional involvement of on-lookers, including school teachers.

Observations on Farmer and Extension Agent Training

Extensionists were selected by their superiors based on the likelihood that they would use their new information to the benefit of the farmers. The selection process seems to have worked fairly well. Most extensionists were very eager to learn more and complained about never having received training before. Only a few showed little interest in the subjects.

Farmers who participated in the first round of field days in 1999 were asked what kinds of new things they learned at the education days. The following is a list of their answers with the more frequent appearing first:

- Flowing cool water through the pond is not a good thing for tilapia and *Clarias* production.
- Inputs do not have to be purchased, but many things available on the farm can be used as feeds or fertilizers.
- Chemical fertilizers can be used in ponds.
- *Clarias* catfish is a good second species to grow with tilapia, and it consumes those tadpoles and frogs that are such a bother.
- Just about anybody can smoke and dry fish for their own use; it is not so difficult.
- Some of the algae growing on the pond surface, like *Euglena*, are not a problem for tilapia and are consumed by them.
- It is better to capture a spring and divert its water to the pond when needed instead of growing fish right in the cool, flowing spring.

The water flow question appeared to be the single most important issue in improving fish growth and production. Most extensionists were previously taught to continually flow water through ponds. Unfortunately, most surface waters in the Central Province are very cold and have very low total alkalinity and hardness. This is a recipe for disaster in low-input warmwater fish culture ponds. But simply telling farmers that static water is better had not been enough—they needed to see ponds in which no new water had been added during the previous five months, except for topping off to replace water lost due to evaporation. At Sagana Fish Farm the farmers saw

such ponds and the fish produced in them. They also saw evidence that Sagana's leakiest ponds are consistently the poorest producers.

Only informal farmer training was conducted in 2000, through individual contacts when farmers visited Sagana or during farm visits. However, a considerable benefit from training farmers and the Fisheries Officers and extension agents who work with them was seen as a result of the on-farm trials that were conducted in Central Province. That activity is reported on separately (see "On-farm trials: Evaluation of alternative aquaculture technologies by local farmers in Kenya," 9ATR1; pp.5 of this report).

In 2002, two additional sets of farmer field days were conducted in western Kenya. In April, a field day was held for 20 farmers from the Kisumu District. Sponsorship came in part from the World Bank (Lake Victoria Project) in recognition of the need to involve Lake Victoria riparian farmers in fish farming. Their training included visits to fish farmers who had been involved in the CRSP-sponsored on-farm trials in western Kenya. They learned new techniques for spawning of catfish (*Clarias gariepinus*), for pond construction, and how to feed their fish.

In August 2002, 31 farmers from western Kenya were invited to attend a four-day farmers' field day. The activity started at Bungoma Farmers Training Centre, where farmers met with extension officers, staff from Sagana that had been working on the western region on-farm trials, and faculty of the MU Department of Fisheries. Activities included visits to the MU fish farm, Sagana Fish Farm, and Kiganjo trout farm. A questionnaire was used to assess the impact of the field days. This activity is reported on separately in the report "Fish Farmers Field Days at Bungoma, Moi University, Sagana and Kiganjo 4th–7th August 2002" (Matolla et al, 2002).

Additional Training Activities

During the first year of this activity, the CRSP resident research coordinator continued to provide guidance for Fisheries Officers assigned to Sagana Fish Farm in conducting small research projects, advice on experimental design, and some material assistance. These projects furthered the professional development of the officers and provided background information and experience for writing proposals for more detailed research. Some of the projects, such as those looking at *Clarias* fingerling production techniques, have immediate impact on station management. Two such projects were undertaken during the year, as shown in Table 6.

Two graduate courses in aquaculture were given at Sagana Fish Farm. One was for MU graduate students, given in February 2000 by David Liti. The second course was given for hydrobiology students of the University of Nairobi Department of Zoology; it was organized by Liti and included short talks given by a variety of Sagana station staff and students.

Anticipated Benefits

The Pond Construction and Management Training program has been included in the MU training curriculum and has been accepted as an official course by the FD. This means that those who have completed the program are eligible for promotion or they have an advantage over their untrained colleagues when it comes time for downsizing of staff. This is why the FD elected to send mostly Fisheries Assistants to the training. The FD is phasing out its use of Fish Scouts, so both the FD and the CRSP were hesitant to include many of these in the training. In fact, hundreds of Fish Scouts were retrenched in September 2000. So far, none of the staff who received a certificate from these short courses has been retrenched.

This activity is providing university students, FD personnel (including those involved in extension efforts), and farmers with knowledge about proper pond construction and skills for improved fish handling and pond management. Senior Fisheries Officers who participated in the final course in November to December 2000 received more intensive training than previous groups, including experience in enterprise budget

development and farm operation planning. Short training courses are improving technical confidence and morale among fisheries personnel involved in extension work. Linkages between research and extension activities in Kenya are being strengthened. Support and hands-on guidance of undergraduate and graduate aquaculture students will strengthen their degree programs and help promote productive and sustainable aquaculture growth in Kenya and in the region by providing a cadre of trained staff for commercial aquaculture. Ultimately, better pond management by farmers will lead to increases in fish production, farm income, amounts of fish available to communities and markets, and employment opportunities.

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