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Tilapia Producer Perceptions and Practices in Five PD/A CRSP Countries

Eighth Work Plan, Adoption and Diffusion Research 1A (ADR1A)
Progress Report

Joseph J. Molnar and Malkia Lockhart
Department of Agricultural Economics and Rural Sociology
International Center for Aquaculture and Aquatic Environments
Auburn University, Alabama, USA

Judith Amadiva and Bethuel Omolo
Fisheries Department
Sagana Fish Culture Farm
Sagana, Kenya

Abstract

The PD/A CRSP site in Sagana, Kenya, is situated in the highlands of Central Province, which provide excellent growing conditions for many types of farm enterprises. This is mainly due to the great abundance of fertile volcanic soil in the lands around Mount Kenya. The area is well watered and cool temperatures make the area very productive in food crops, but other factors affect the potential for fish culture. Central Province had about 2,230 fishponds in 1995. In contrast, the Lake Basin area (Western and Nyanza Provinces) has about 5,000 to 10,000 active ponds, although there were as many as 25,000 in the area during the mid sixties and mid seventies. This article summarizes the results of a five-year program of farm-level surveys conducted in five PD/A CRSP countries, updating previous reporting with new data from tilapia producers in Central Province. Kenya is the new PD/A CRSP site in Africa, and data were collected from practicing fish farmers in 1998.

Introduction

The Pond Dynamics/Aquaculture Collaborative Research Support Program (PD/A CRSP) is a global research network organized to generate basic scientific data that may be used to advance aquacultural development. One of a family of research programs funded by the United States Agency for International Development, this CRSP focuses on improving the efficiency of aquaculture systems—in many projects working with the culture of Nile tilapia (*Oreochromis niloticus*). Much of the work of the PD/A CRSP has been directed to specifying optimum ways that farmers can feed and fertilize their ponds to increase fish yields. The PD/A CRSP has identified many of the needed parameters that apply across diverse environments.

The PD/A CRSP began work in 1982 in Thailand, and subsequently in the Philippines, Honduras, Rwanda, Indonesia, and Panama. Research continues today in Thailand, the Philippines, Honduras, the US, and, until recently, Rwanda. At each site, the goal is the same: to identify constraints to aquaculture production and to design responses that are environmentally and culturally appropriate. The Kenya effort continues the effort in the context of the unique constraints and food security needs of East Africa.

The highlands in Kenya's Central Province provide excellent growing conditions for many types of farm enterprises. This is mainly due to the abundance of fertile volcanic soil that originated from Mount Kenya. The area is well watered and cool temperatures make the area very productive in food crops, but other factors affect the potential for fish culture. In contrast with Western and Nyanza Provinces, the populace of Central Province has not traditionally consumed fish, nor has the area received concentrated fish culture extension assistance over the years. However, fish culture is intended to provide some of the needed protein and to serve as an alternative source of income. Central Province had approximately 2,230 fishponds in 1995. The species produced were tilapia, carp, and trout. In contrast, the Lake Basin area (Western and Nyanza Provinces) had approximately 5,000 to 10,000 active ponds, although there were as many as 25,000 in the area during the mid sixties and mid seventies.

Kenya is the new PD/A CRSP site in Africa; data were collected from practicing fish farmers in 1998. Research at Sagana Fish Farm focuses on tilapia culture, an enterprise with high potential to augment the array of alternatives available to local farmers.

This paper summarizes the results of a five-year program of farm-level surveys that begin to specify the extent to which research processes are serving farmers in five of the seven PD/A CRSP countries.

Materials and Methods

Sample Size and Data Collection

Data were collected from tilapia farmers in five PD/A CRSP countries: Kenya, Rwanda, Honduras, Thailand, and the Philippines. The following sections detail the procedures employed in each country and the approach used to analyze the data. Table 1 summarizes the number of respondents interviewed from each country.

Kenya
Data were obtained from interviews with 43 active Kenyan fish farmers from the five districts in Central Province during winter 1998. The survey was revised and adapted in English and then translated into Kiswahili. Interviews were conducted in Kiswahili.

Table 1. Number of respondents by region of tilapia farmers in PD/A CRSP countries, 1992-98.

Country	Respondents	
	Number	*Percent*
KENYA DISTRICTS – 1998		
Kiambu	4	9
Kirinyaga	7	17
Muranga	11	25
Nyandarua	5	12
Nyeri	16	37
(Total)	(43)	(100)
RWANDA COMMUNES – 1992		
Gishamvu	10	7
Karago	19	14
Kayove	16	12
Kigembe	20	15
Mugambazi	26	19
Ndusu	10	7
Nyamabuye	19	14
Tumba	16	12
(Total)	(136)	(100)
HONDURAS DEPARTMENTS – 1993		
Atlantida	5	10
Colon	4	7
Comayagua	9	18
Copan	9	18
Cortes	9	18
El Paraiso	5	10
Francisco Morazon	1	2
Olancho	4	7
Santa Barbara	3	6
Yoro	2	4
(Total)	(51)	(100)
PHILIPPINE PROVINCES – 1995		
Bulacan	14	28
Nueva Ecija	9	18
Pampanga	11	22
Tarlac	16	32
(Total)	(50)	(100)
THAILAND PROVINCES – 1995		
Ayutthaya	22	39
Nakhon Pathom	14	25
Pathum Thani	20	36
(Total)	(56)	(100)

Tilapia farmers were identified through referrals from Fisheries Department personnel, knowledgeable local individuals, and fish farmers who knew of neighbors raising tilapia. Central Province is distinguished by the presence of Nairobi in its southernmost district. Although Central Province is not a major tilapia producing area, because of Nairobi's large population and the positive geographic and climatic conditions of the area, there exists a clear need and high potential for increased production. Thus, Central Province represents the primary target population for PD/A CRSP research in Kenya.

Rwanda

Data were obtained from interviews with 136 active Rwandan fish farmers in eight local administrative districts (communes) during the winter and early spring of 1992. Interviews were conducted with 120 active fish farmers randomly selected from National Fish Culture Service (SPN) extension rolls. An additional 16 active farmers who had not received extension assistance were interviewed. See Molnar et al. (1993) for details.

Honduras

Data were obtained from interviews with 51 active Honduran fish farmers in 10 of 15 Honduran departments during the fall of 1993. The survey instrument was translated into Spanish and all interviews were conducted in Spanish. Tilapia farmers were identified through referrals made by Peace Corps volunteers working in fish culture, Honduran extension personnel, and farmers who identified neighbors raising tilapia. The departments were chosen to represent the major tilapia production regions in the country.

Philippines

Data were obtained from interviews with 50 Philippine fish farmers in 4 of 15 provinces on the main island of Luzon during winter 1994. Tilapia farm operators in Bulacan, Nueva Ecija, Pampanga, and Tarlac provinces were interviewed. The survey was revised and adapted and then translated into and conducted in Tagalog.

Names of tilapia farmers were obtained from lists of farmers who had purchased fingerlings at the Freshwater Aquaculture Center at Central Luzon State University in Muñoz. Farmers were interviewed and asked to identify neighbors who raised tilapia who also were approached for interviews. Interviews were conducted with 50 active fish farmers in provinces north of Manila and the City of Angeles in Central Luzon, the major tilapia production region in the country.

Thailand

Data were obtained from a sample of 56 active Thai fish farmers in 3 of Thailand's 75 provinces—Ayutthaya, Pathum Thani, and Nakhon Pathom—in central Thailand during winter 1994. The survey was revised, adapted, and translated into the Thai language. All interviews were conducted in Thai.

Tilapia farmers were identified through referrals made by Department of Fisheries extension personnel, knowledgeable local individuals, and fish farmers identifying neighbors raising tilapia. The provinces chosen represented major tilapia production regions in southcentral Thailand, the major aquaculture region in the country, located directly north of Bangkok.

Representativeness

There are limits to the ability of these data to extrapolate to wider populations of fish farmers and other regions of the selected nations (Casley, 1988). The 1998 Kenya sample is the smallest of the five. Some of the study procedures were compromised due to security problems in two northern districts of Kenya that made travel unsafe and costly for the interviewer. The 1992 Rwanda sample is more representative than the samples drawn in the other countries. It is nationwide, a larger number of interviews were obtained, and the range of variability in the population of fish farmers is smaller in Rwanda. Molnar et al. (1994) previously examined the Rwanda data in detail, but the aggregate findings presented here allow comparative analysis across five PD/A CRSP sites. Similarly, Molnar et al. (1996) previously examined survey data from four sites, but the Kenyan data are presented here for the first time. The number of farmers in each sample—save Rwanda—are inadequate for statistical estimation of population

parameters; they do, however, provide information about practicing fish farmers where none is otherwise available.

RESULTS

Respondent Characteristics

Table 2 describes the individual and household characteristics of study respondents. Women comprised approximately one-third of the Kenyan sample, one-fourth of the respondents in Rwanda and Thailand, but only approximately one-tenth of the Honduran and Philippine tilapia farmers we contacted.

Most Kenyan farmers were in the middle age categories, between the ages of 25 and 64. The Rwandan farmers were younger and the Philippine farmers tended to be older than farmers in the other countries. Most farmers were married. A somewhat higher proportion of the Philippine farmers was over age 65.

Nearly all the Kenyan, Rwandan, Honduran, and Philippine households had children under age ten, but only approximately half the Thai families had young children. Philippine families had the fewest children between the ages of 10 and 18 and the most children over age 18.

Kenyans and Rwandans had the largest households; 64 and 65%, respectively, reported having six or more members. Approximately one-half the respondent households in each of the other countries were that large.

Land Holding

Table 3 profiles the land holdings of study respondents. Honduran farms were much more fragmented than the others, as all respondents reported nine or more parcels in their farms. In Kenya, Thailand, Rwanda, and the Philippines, most farmers had relatively consolidated holdings of one to three pieces of land.

Approximately 5% of the Rwandan respondents did not own any land, primarily young people farming in groups formed to use communal lands for aquaculture. In the face of burgeoning numbers of young people seeking farm land, local authorities prefer to grant land use rights to groups rather than individuals. In Thailand, 19% said they did not own land. Young Thai farmers in the study area face rising land prices associated with the growth of the greater Bangkok region. Nearly all respondents in Kenya, Honduras, and the Philippines owned some land. These data also reflect on the relative standing of fish farmers in the social structure of each nation and the level of development in each context.

Kenyan and Honduran farmers did not rent much land from others, but in Rwanda two-thirds said they rented land. About 44% of Thai farmers rented land from others; they also were more likely to rent land out. Only 8% of the Rwandan farmers said they rented land to others.

As in Honduras, about 41% of the Kenyan farmers thought they had more land than their neighbors. In contrast, three-quarters of the Rwandan fish farmers felt that they had less land than their neighbors did; one-third of the Thai farmers felt they had less land, compared to 15% of the farmers from the other countries. About half the Philippine respondents said they had "about the same [amount of land] as people around here." Hondurans were about equally split between those who felt they had more land and those who felt they owned the same amount of land.

Farm Enterprises

The farm enterprises maintained by tilapia farmers are portrayed in Table 4. Three-quarters of the Kenyan farmers

Table 2. Respondent characteristics of tilapia farmers in five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	Rwanda N = 136 (%)	Honduras N = 51 (%)	Philippines N = 50 (%)	Thailand N = 56 (%)
GENDER OF RESPONDENT					
Male	70	71	86	91	76
Female	30	29	14	9	24
AGE OF RESPONDENT					
Less than 25	0	12	8	4	4
25 to 34	19	25	24	20	13
35 to 44	23	33	25	23	32
45 to 54	28	13	27	21	25
55 to 64	28	12	12	14	19
65 or Older	2	5	4	18	7
AGE OF CHILDREN					
Under Age 10	72	81	98	98	47
Age 10 to 18	61	71	51	38	45
Over Age 18	100	41	41	57	43
NUMBER IN HOUSEHOLD					
Two or Less	2	1	8	15	6
Three to Five	12	34	38	40	47
Six or More	64	65	54	45	47

Table 3. Land ownership of tilapia farmers in five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	Rwanda N = 136 (%)	Honduras N = 51 (%)	Philippines N = 50 (%)	Thailand N = 56 (%)
NUMBER OF PIECES OF LAND					
1-3 Parcels	100	18	0	93	94
3-9 Parcels	0	63	0	7	4
9 or More	0	19	100	0	2
LAND OWNED					
None	2	5	0	2	19
Some or All	98	95	100	98	81
LAND RENTED					
None	98	43	98	89	56
Some	2	69	2	11	44
LAND RENTED TO OTHERS					
None	93	92	100	95	85
Some	7	8	0	5	5
COMPARED TO OTHERS, HOW MUCH LAND DO YOU HAVE?					
More	42	10	43	33	26
About Same	34	15	43	51	42
Less	24	75	14	16	32

Table 4. Enterprises on tilapia farms of five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	Rwanda N = 136 (%)	Honduras N = 51 (%)	Philippines N = 50 (%)	Thailand N = 56 (%)
WHAT ANIMALS RAISED?					
Cattle	84	83	62	32	15
Goats	51	78	5	32	0
Pigs	7	41	45	43	31
Chickens	77	23	69	80	51
Ducks	16	14	19	32	36
Rabbits	26	11	5	0	0
Sheep	28	--	--	--	--
Other	14	19	12	50	8
RAISE ANIMALS WITH FISH?					
No	90	100	72	60	31
Yes	10	0	28	40	69
WHAT GIVES MOST CASH?					
Vegetables	33	0	49		9
Rice	2	0	2	36	36
Bananas	16	19	2	56	31
Fruit Crops	9	0	2	13	53
Fish	7	0	30	27	93
Sugar Cane	2	0	4	86	0
Livestock	19	0	34	4	62
Corn/Maize	21	10	15	25	0
Other	63	36	49	9	0
Sorghum	0	29	0	9	0
Cabbage	0	10	0	0	0
Sweet Potatoes	0	83	0	0	0
Beans	0	10	0	0	0
Taro	0	16	0	0	0
Cassava	0	63	0	0	0
Irish Potatoes	0	12	0	0	0
Sweet Peas	0	9	0	0	0

reported having chickens and one-half said they had goats. Chickens were the most commonly reported animal enterprise, except in Rwanda. In Rwanda, 83% said they had cattle, nearly as many had goats, and about 41% had pigs. Cattle were nearly as popular in Honduras, followed by pigs. In the Philippines, the second most common animal enterprise was "other," reflecting the widespread husbandry of water buffalo. About a third reported owning cattle, goats, pigs, and ducks.

No single animal enterprise dominated the farming system in the Thailand sample. Approximately one-third of the farmers had ducks and pigs. The Thai farmers also were more likely to integrate animal production with aquaculture, as more than two-thirds of the Thai farmers sampled reported integrating tilapia culture with some type of animal enterprise. At present, integrated fish-animal production systems are only in the demonstration phase in Rwanda and are not widely adopted in the Philippines.

Fish was the main source of cash income for about 90% of the Philippine and Thai farmers. Coffee and maize are important sources of cash for Kenyan farmers. Sweet potatoes, followed by cassava, were identified as providing the most cash income by more than 80% of the Rwandan farmers. In Honduras, vegetables and other crops (mainly coffee) provided the most farm income.

Pond Location and Water Source

More than 80% of the Rwandan farmers had a single pond, as shown in Table 5. In contrast, more than half the Kenyan farmers and 70% of the Philippine and Honduran farmers had more than one pond. About three-quarters of the Honduran farmers had less than a quarter hectare of ponds; one-half the Thai farmers had ponds a quarter hectare in size, but only one-third of the Philippine farmers did. Nearly all Kenyan ponds were small, i.e., less than a quarter hectare in size.

Most Kenyans obtained water for their ponds from streams or springs. Honduran farmers supplied their ponds from a variety of sources, most frequently identifying lakes or reservoir sources. Thai farmers depended most on irrigation canals, while Philippine farms indicated the least dependence on any single source. Nearly all Kenyan and Rwandan ponds used gravity flow, but most Thai farmers had pumps.

More than half the Thai farmers, one-third of the Philippine farmers, and one-quarter of the Rwandan farmers reported problems getting enough water to keep ponds full.

The location of the fish pond relative to the household is significant. Ponds near households are easier to monitor.

Table 5. Pond location and water source for tilapia farms in five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	Rwanda N = 136 (%)	Honduras N = 51 (%)	Philippines N = 50 (%)	Thailand N = 56 (%)
NUMBER OF PONDS OWNED					
One	45	84	16	9	39
Two	33	11	12	20	26
Three or More	22	5	72	71	35
AREA OF PONDS					
< .25 Hectare	96	--	76	48	34
0.25 to 1 Hectare	2	--	20	48	58
> 1 Hectare	2	--	4	4	8
PROBLEMS WITH WATER SUPPLY					
No	89	76	82	66	45
Yes	2	24	18	34	55
WHERE ARE PONDS?					
Next to House	12	--	66	36	79
< 1 km	83	--	12	35	6
1 to 3 km	5	--	2	22	9
More than 3 km	0	--	20	7	6
WATER SOURCE					
Well	5	--	2	9	0
Spring	40	--	8	7	0
River or Stream	43	--	18	14	2
Lake or Reservoir	0	--	48	0	2
Irrigation Canal	2	--	14	13	64
Collected Runoff	5	--	0	16	0
Combination	5	--	10	41	32
WATER SUPPLY TO POND					
Pumped	0	0	16	42	96
Gravity Flow	98	100	82	38	2
Combination	2	0	2	20	2

Family members can attend to the pond as well as give regular surveillance to deter theft. About 79% of the Thai fish ponds were located next to the house, as were two-thirds of the Honduran ponds and one-third of the Philippine ponds. Only 5% of the Kenya ponds were more than a kilometer from the house, but only 12% were next to the house.

In Rwanda, fish ponds are always located in the marshy valley bottoms (marais). These lands are communally owned and individual farmers are given relatively secure use concessions, but no houses are permitted. Consequently, ponds usually are some distance from homesteads built on the hillsides of this mountainous nation. In some areas, group or family members take turns guarding harvestable fish at night. Some farmers hire watchmen to protect the ponds and other crops. In general, ponds that were not under regular household surveillance were most vulnerable to theft.

Fish Feeding

Farmers in the five countries fed their tilapia a variety of items, reflecting differences in the intensity of aquaculture practiced in each nation (Table 6). Feeding and fertilization often represent overlapping activities for the subsistence-level tilapia farmer. In Rwanda, respondents primarily understood questions about feeding in terms of the amount and kind of organic materials they put in their ponds. At the other sites, farmers primarily understood feeding as the use of commercial, purchased feeds.

Kitchen waste and vegetation were the most commonly used items in Kenya, but leaves and manure were most frequent in Rwanda. Chicken litter and commercial feed were most often mentioned in Honduras. In Thailand, farmers most often utilized rice bran, commercial feed, and chicken litter. A similar pattern to Thailand was noted in the Philippines, although rice bran was used more often.

Commercial feed was not used in Rwanda, and three-quarters of the Kenyan farmers and two-thirds of the Honduran and Philippine farmers did not use commercial feeds. Thai farmers were most dependent on commercial inputs to raise their tilapia crops. They also used the most diverse variety of purchased feeds, reflecting the high level of availability of different feed types and a greater willingness to use feeds for other animals for the fish as well.

Honduran and Rwandan farmers were most likely to report inadequacies in feed availability on their farms. About 7% of the Rwandan farmers said that they never had enough inputs for their ponds.

Table 6. Feeding practices used by tilapia farmers in five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	**Rwanda N = 136** (%)	**Honduras N = 51** (%)	**Philippines N = 50** (%)	**Thailand N = 56** (%)
THINGS MOST OFTEN FED					
Termites	0	6	0	0	0
Bees Wax/Larvae	0	2	0	0	0
Leaves	0	87	0	0	0
Manure	0	67	0	0	0
Beer Waste	0	32	0	0	0
Kitchen Waste	72	0	14	2	12
Fresh Vegetation	74	0	16	6	34
Rice Bran	12	0	14	61	34
Dead Animals	0	0	0	0	8
Slaughter Waste	12	15	4	0	2
Purchased Feed	16	0	41	32	42
Chicken Litter	7	0	0	37	45
Other	14	8	57	0	2
Grass Cuttings	0	28	0	0	0
Compost	0	28	0	0	0
Inorganic N	0	0	8	48	61
Chicken Feed	0	0	0	2	0
Fish Feed	0	0	0	0	0
USE OF COMMERCIAL FEED					
Only	2	--	21	10	7
Mainly	0	--	10	24	20
Both Equally	5	--	6	2	0
Use No Feed	78	100*	63	64	73
TYPE OF FEED PURCHASED					
None Purchased	72	100*	43	25	0
Rice Bran	8	0	14	35	36
Rabbit Pellets	0	0	8	0	0
Chicken Feed	7	0	2	3	2
Fish Feed	5	0	21	33	28
Other	2	0	12	0	34

*Imputed data

Fertilization

Table 7 shows the use of lime and fertilizer in the five samples. Farmers apply lime to their ponds to increase the alkalinity (and pH) of the pond and foster primary productivity. At the time of this survey, Kenyan farmers had not limed their ponds in the past year, nor had 95% of the Philippine farmers. Three-quarters of the Thai farmers used lime, as did almost half of the Honduran farmers.

In Rwanda, commercial fertilizer represents a cash outlay that subsistence farmers prefer to avoid and is generally not applied to fish ponds. Because commercial fertilizer is not used or recommended for fish ponds, questions about liming and fertilization were not asked in Rwanda.

Honduran farmers typically use cattle and chicken manure as fertilizer for their ponds. Chicken manure is the most frequent pond fertilizer in Thailand and the Philippines. Given the pervasive use of integrated systems in Thailand, ponds are most frequently fertilized with poultry manure in that country.

About 73% of the Thai farmers fed their fish several times a day. The multiple daily feedings that are required with integrated poultry and duck production literally spill over into the tilapia crop. Poultry houses are typically located directly over the fish pond, so feed and litter are nearly continuously deposited into the pond.

Honduran farmers reported a high level of attentiveness to their ponds. About one-quarter of the Rwandans fed their fish several times a week or less. Feeding in the Rwanda case refers primarily to the provision of manure and other inputs, some of which are directly consumed. These items mainly serve as nutrients to foster primary productivity in the ponds.

About 85% of the Kenyan farmers said they visited their ponds once or more daily. Rwandan farmers indicated the least attentive approach to fish farming, as only one-half said the ponds were visited every day. Philippine farmers spent the most time at their ponds when they visited them, while Thai farmers spent the least amount of time.

Fingerlings

Rwandan farmers were dependent on government hatcheries for fingerlings. No commercial fingerling production has developed yet in Rwanda or Kenya, although fingerling sales

Table 7. Fertilization practices of tilapia farmers in five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	Rwanda N = 136 (%)	Honduras N = 51 (%)	Philippines N = 50 (%)	Thailand N = 56 (%)
POND FERTILIZER USED *					
Urea	2	--	0	14	0
0-46-0	0	--	0	0	9
18-46-0 (DAP)	5	--	10	2	0
Other N-P-K	--	--	24	79	49
Chicken Manure	9	--	29	70	53
Cattle Manure	81	--	37	4	6
Compost	0	--	0	2	25
HOW OFTEN FERTILIZE?					
Several Weekly	2	--	27	0	69
Weekly	8	--	18	11	10
Several Monthly	8	--	14	19	2
Monthly	28	--	10	21	0
Less Often	43	--	21	43	4
Never	13	--	10	6	15
LIMED PONDS LAST YEAR?					
No	100	--	57	95	26
Yes	0	--	43	5	74
HOW OFTEN VISIT PONDS?					
Several Daily	22	0	39	34	73
Every Day	65	53	37	36	19
Almost Daily	7	2	14	25	0
Several Weekly	2	32	2	5	6
Once a Week	2	13	6	0	0
Several Monthly	2	0	2	0	2
TIME USUALLY SPENT					
Less than an Hour	85	34	18	4	79
About an Hour	12	48	30	5	11
Two or Three Hours	0	14	20	16	4
More than Three Hours	2	5	32	75	6

*Multiple responses possible

are reported between neighboring farmers. Mixed-sex fingerlings from local ponds constitute a primary source of most fish crops in Rwanda and Kenya. Table 8 profiles the fingerling sources used by fish farmers in the other countries. Few private farm dealers exist in Honduras. The private sector provided fingerlings to more than 80% of the Thai farmers and about 37% of the Philippine operators. In each country, most farmers were using Nile tilapia (*Oreochromis niloticus*).

Thai and Philippine farmers tend to densely stock the smallest fingerlings available. Honduran farmers tended to stock somewhat larger fingerlings. All-male tilapia were stocked in each country, although mixed-sex production was the normal mode of production in Rwanda and Kenya. Even though farmers would seek all-male fingerlings, they often received mixed sexes.

Chemically induced sex reversal was the most commonly employed method of producing all-male tilapia fingerlings by government stations and large-scale commercial operators at all the sites. It is notable that 84% of the Thai farmers did not know the method by which all-male tilapia fingerlings were produced.

Stocking and Grow-Out Practices

Table 9 suggests that nearly all farmers grew a single crop of tilapia each year. Most Kenyan farmers grew one or two crops. In Honduras, almost one-half reported two or more crops, and in the Philippines two-thirds obtained two crops per year. Although most of these questions were not asked in Rwanda, cooler water may slow fish growth and lengthen the crop cycle to eight months or more, thus decreasing the potential number of crops per year. Warmer water, the stocking of larger fingerlings, or the harvest of a smaller fish may have accounted for why more than a quarter of the Honduran farmers reported growing tilapia in less than 180 days.

Nearly all the Thai farmers in the study practiced polyculture, raising other species of fish in the same pond. One-third of the Kenyan and Honduran farmers reported stocking other species, but only 11% of the Philippine farmers did so. Although the question was not asked, polyculture is generally not practiced in Rwanda. In Honduras and Thailand, the additional stocked species tended to be a predator fish such as Guapote tigre or snakehead, respectively.

Philippine farmers were least likely to stock a predator fish. Although not reflected in the survey data, the practice of stocking a predator fish was not yet used in Rwanda. The presence of a predator eliminates small fish and reduces the impact of unwanted tilapia reproduction. The predator species generally is not viewed as another crop or enterprise, given the relatively small number that are stocked. Small tilapia are undesirable because they compete for feed with the market-

Table 8. Fingerling sources for tilapia farmers in five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	**Rwanda N = 136** (%)	**Honduras N = 51** (%)	**Philippines N = 50** (%)	**Thailand N = 56** (%)
WHERE OBTAIN FINGERLINGS?					
Government Hatchery	29	--	57	40	4
Research Station	0	--	18	0	0
Hatchery Station	0	--	6	0	0
Private Dealer	7	--	2	37	82
Neighbor	21	--	2	7	9
Own Ponds	33	--	16	9	9
Other	10				
TYPE OF FINGERLINGS USED					
Natural-Colored	--	--	63	7	100
Red-Colored	--	--	6	0	0
Other (Black & Red)	--	--	31	93	0
TILAPIA SPECIES USED					
Oreochromis niloticus	--	--	100	96	100
O. mossambicus	--	--	0	0	0
O. aureus	--	--	0	2	0
Hybrids	--	--	0	2	0
KIND STOCKED					
Mixed-Sex	90	100	4	0	0
All-Male	0	0	88	93	100
Both	5	0	8	7	0
Both (Separate Ponds)	5	--	--	--	--
ALL-MALE FINGERLING METHOD					
Hybridization	0	--	2	11	2
Sex Reversal	0	--	76	78	10
Hand-Sexing	0	--	20	11	2
Combination	0	--	2	0	2
Don't Know	100	--	0	0	84

Table 9. Stocking and grow-out practices used by tilapia farmers in five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	Rwanda N = 136 (%)	Honduras N = 51 (%)	Philippines N = 50 (%)	Thailand N = 56 (%)
CROPS PER POND					
One	64	--	54	25	95
Two	28	--	40	66	5
Three or More	5	--	6	9	0
None Recently	3	--	--	--	--
CROP CYCLE LENGTH					
< 180 Days	55	--	50	94	10
180 to 240 Days	10	--	14	6	6
More than 240 Days	35	--	36	0	84
OTHER FISH WITH TILAPIA					
No	63	--	64	89	2
Yes	37	--	36	11	98
STOCK PREDATOR SPECIES					
No	68	--	6	71	2
Yes	32	--	94	29	98
PROBLEMS RESTOCKING					
No	--	76	78	70	96
Yes	--	24	22	30	4
USUAL STOCKING DENSITY					
Less than 1 m^{-2}	--	--	13	13	9
1 m^{-2} or More	--	--	87	87	91
SIZE OF FINGERLINGS STOCKED					
Less than 3 cm	25	--	46	70	86
3 to 5 cm	64	--	40	16	14
5 to 10 cm	8	--	12	5	0
More than 10 cm	0	--	2	0	0
Mixed Sizes	3	--	0	9	0

size fish. Fingerling availability was a problem for 30% of the respondents in the Philippines, 24% in Rwanda, 22% in Honduras, and only 4% in Thailand.

Water Management

Table 10 shows how fish farmers use and move water. To maintain the quality of water in farm ponds, farmers often add additional water or use an aerator to provide additional oxygen to the fish. The most immediate symptoms that cause farmers to intervene are piping fish (fish that surface to draw oxygen rich water into their mouths) and, in extreme cases, dead fish. Some ponds with large populations of intensively managed large fish also may require additional water to dilute excessive amounts of fish waste.

Water exchange was the most frequently used strategy to maintain water quality by all the Thai farmers, more than half the Philippine farmers, and approximately one-quarter of the Honduran farmers. Approximately 80% of the Honduran farmers said they never exchanged water, suggesting that they understood the procedure but were rarely required to use it (or did not have enough water to do it). About 37% of the Philippine respondents said they never exchanged water.

Farmers were asked to report the presence or absence of various types of equipment on their farms. Kenyan farmers were most likely to have a wheelbarrow. Honduran farmers were most likely to have a vehicle. Philippine farmers were most likely to have a net, and more Thai farmers had a water quality test kit and a scale.

Harvest Practices

All Philippine farmers relied on their own or family labor to harvest their fish and did not hire any (Table 11). Most labor for harvesting fish was usually supplied by family members in Kenya. Honduran farmers were most likely to pay laborers for harvest of their ponds. Approximately 15% of the Kenyan farmers reported labor problems in the harvest process.

Some farmers partially harvested to sell only larger fish, fill an order, provide a certain amount of cash, harvest only a quantity of fish that could be marketed with certainty, or avoid

Table 10. Water management strategies used by tilapia farmers in five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	Rwanda N = 136 (%)	Honduras N = 51 (%)	Philippines N = 50 (%)	Thailand N = 56 (%)
AERATE OR EXCHANGE					
Exchange Water	--	--	24	59	100
Use an Aerator	--	--	0	0	0
Use Both	--	--	0	0	0
Use Neither	100	--	76	41	0
HOW OFTEN EXCHANGE WATER?					
Never Exchange	100	--	80	38	2
Every Day	--	--	8	7	2
Almost Daily	--	--	2	2	2
Several Times a Week	--	--	4	2	4
Once a Week	--	--	2	4	16
As Needed	--	--	4	47	74
WHAT EQUIPMENT ON FARM?					
Truck	0	--	71	16	
Harvest Net	23	--	71	84	38
Water Test Kit	0	--	4	0	6
Water Pump	7	--	18	75	98
Aerator	5	--	2	2	0
Oxygen Meter	0	--	2	2	0
Scale	12	--	90	26	100
Wheelbarrow	80	--	0	0	22

Table 11. Harvest practices used by tilapia farmers in five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	Rwanda N = 136 (%)	Honduras N = 51 (%)	Philippines N = 50 (%)	Thailand N = 56 (%)
HIRE HARVEST LABOR?					
No, Self	56	-	6	9	0
No, Family	13	-	29	91	8
Yes, Laborers	10	-	65	0	28
Buyer Harvested	3	-	0	0	64
HAD HARVEST PROBLEMS ?					
No Labor Used	56	--	26	66	9
No Problems	28	--	66	28	89
Yes, Difficulty	15	--	8	6	2
USUALLY PARTIAL HARVEST?					
Usually Partial	78	36	37	69	6
Partial and Large	3	0	22	21	17
A Single Harvest	19	64	41	10	77
MEAN SIZE HARVESTED					
Less than 120 g	12	--	4	13	6
120 to 249 g	27	--	18	49	26
250 to 499 g	58	--	35	27	33
500 to 749 g	0	--	29	11	27
Greater than 750 g	3	--	14	0	8

Table 12. Marketing practices of tilapia farmers in five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	Rwanda N = 136 (%)	Honduras N = 51 (%)	Philippines N = 50 (%)	Thailand N = 56 (%)
ANY CASH LAST HARVEST?					
No	54	60	13	2	0
Yes	46	40	87	98	100
HOW MUCH SOLD?					
None for Cash	55	7	6	4	0
Less than Half	8	33	92	20	0
Half for Cash	8	12	2	76	4
More than Half	28	48	0	0	96
DID MIDDLEMAN BUY?					
No	97	98	51	21	0
Yes, Some of it	0	2	47	23	31
Yes, All of it	3	0	2	56	69
SELL ANY TO RESTAURANTS?					
No	97	98	71	92	98
Yes, Some of it	3	2	29	8	2
Yes, All of it	0	0	0	0	0
SOLD ANY IN THE MARKET?					
No	92	86	92	70	93
Yes, Some of it	5	13	8	19	5
Yes, All of it	3	1	0	11	2
ANYONE ELSE?					
No	95	58	18	26	41
Pond Bank Sales	5	42	82	74	59

cash outlays for the labor that might otherwise be required for a complete harvest. Partial harvesting was most common in Kenya and the Philippines. Farmers in Thailand and Rwanda tended to do a single large harvest, while Honduran farmers used a combination of harvest practices.

Thai farmers tended to harvest all the fish at one time and were most likely to have the buyer's labor crew harvest the fish. Buyers harvest the fish they purchase from farmers as part of the marketing transaction. In Honduras and Thailand, harvest labor was typically accomplished by paid workers engaged either by the farmer or the buyer. Family labor did the work in about one-quarter of the Honduran situations.

In Rwanda, approximately one-half of the ponds are group ponds. Previous work (Molnar et al., 1994) shows that members of the group or their family members supply the labor at harvest time. Some private farmers hire laborers or organize neighbors to work for a share of the harvest when it is time to drain the pond. About two-thirds of the Rwandans reported one large harvest, for which cooperative labor arrangements usually are made. Kenyan farmers tended to have smaller ponds and single harvests.

In Rwanda, we estimated that about 80% of the farmers harvest an average fish less than 120 g. Lack of feeds, cool waters due to high elevations in most locales, but primarily lack of nutrient inputs all tend to lengthen the time necessary to grow larger fish.

Farmers tended to harvest larger fish in Honduras, as more than two-thirds reported harvesting fish larger than 200 g. The Philippine operators had a similar harvest size preference, though a few more harvest smaller fish. In Thailand, however, more than half the sample harvested fish less than 200 g in size. Most of the fish harvested in Kenya were between 250 and 499 g.

Marketing

Only a small proportion of each sample reported fish harvested solely for home consumption or barter, i.e., not sold for cash (Table 12). Most sold some of their fish for cash, though one-third of the Rwandans said that they sold less than half the harvest for cash. Only 46% of the Kenyan and 40% of the Rwanda respondents sold fish for cash. Previous research suggests that much of the fish in Rwanda was used for home consumption or bartered for harvest labor. In Honduras, 87% said they sold more than half of their fish for cash. Nearly 100% did so in both the Philippines and Thailand.

Middlemen purchased fish from all the Philippine farmers, three-fourths of the Thailand farmers, almost half the Hondurans, but nearly none of the Rwandans. Farmers that sold tilapia to restaurants were more common in Honduras. Direct marketing was more common in the Philippines, where 30% reported selling fish in the market. The most common marketing method for farmers in all countries was pond bank sales to neighbors and others who came to the ponds at harvest. The surrounding populace's word-of-mouth

Table 13. Marketing problems experienced by tilapia farmers in five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	Rwanda N = 136 (%)	Honduras N = 51 (%)	Philippines N = 50 (%)	Thailand N = 56 (%)
TROUBLE SELLING TILAPIA					
No	92	79	82	100	69
Yes	8	21	18	0	31
PROBLEMS WITH PRICE					
No	88	77	90	100	44
Yes	12	23	10	0	56
CAN SELL AT LOWER PRICE					
No	64	27	36	76	50
Yes	36	13	64	24	50
SOME DON'T LIKE TILAPIA					
No	80	66	84	100	85
Yes	20	34	16	0	15
LARGER EASIER TO SELL					
No	10	28	58	15	4
Yes	90	72	42	85	96
SOLD FINGERLINGS					
No	56	49	84	74	94
Yes	44	51	16	26	6
TROUBLE SELLING FINGERLINGS					
No, Did Not Sell	50	42	84	70	94
No Problems	44	31	16	30	4
Yes, Problems	6	27	0	0	2

knowledge about prospective harvests or understanding of the farmer's willingness to partial harvest for immediate sale remained the primary means for marketing tilapia for most small- and medium-scale farmers.

Marketing Problems

Table 13 shows that Kenyan farmers had few problems marketing the fish they produced. Philippine farmers indicated the least trouble marketing their fish. Marketing difficulties of some kind were reported by about one-third of the Thai respondents and 20% of the Honduran and Rwandan respondents. Over one-half of the Thai farmers reported difficulties securing the price they wanted for their tilapia. Honduran farmers were the most confident about being able to sell their tilapia at some price, even if it was not what they originally offered.

About 20% of the Kenya sample and one-third of the Rwanda sample said that many people in their area did not like tilapia. Around 15% of the Honduran and Thai respondents felt this way, but no Philippine respondent said this. Of the five countries, the Philippines seemed to have the highest consumer acceptance of tilapia. With the exception of Honduras, most respondents felt that larger fish are easier to sell. This was particularly true in Thailand and Kenya.

Fingerling sales to other farmers were most common in Kenya and Rwanda, where more than one-half the respondents reported such transactions. Private fingerling sales among farmers is an important indicator of sustainability, especially where government services are unreliable or unavailable in much of the country.

Fingerling sales between farmers were least common in Thailand (6%), largely because a network of private dealers is well developed there. Dealers are less common in Honduras, but a small segment reported fingerling sales (16%), as did a few more in the Philippines (26%). Rwandan farmers and, to a lesser extent, Kenyan farmers apparently were most actively seeking to sell fingerlings—largely because the mixed-sex production strategy that they employed yields many small fish. About one-half sold fingerlings, but about one-half of the fingerling sellers reported problems in making the sales they wanted. Few of the respondents in other countries reported problems selling fingerlings.

Impacts on Households

Table 14 shows a series of questions profiling the impacts of fish culture on households. About 78% of the Philippine farmers thought that there were points in the annual farm cycle when the pond was too much work. This figure was 37% in Thailand, and only 7% in Kenya. Previous work suggests that Rwandan women are much more likely to report these difficulties (Molnar et al., 1994).

Table 14. Pond impacts on households of tilapia farmers in five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	Rwanda N = 136 (%)	Honduras N = 51 (%)	Philippines N = 50 (%)	Thailand N = 56 (%)
POND IS SOMETIMES TOO MUCH WORK					
No	93	--	78	22	63
Yes	7	--	22	78	37
TILAPIA FITS WELL WITH OTHER ACTIVITIES OF HOUSEHOLD					
No	10	17	36	9	21
Yes	90	83	64	91	79
POND MAKES IT HARDER TO CARE FOR OTHER CROPS					
No	93	94	92	100	94
Yes	7	6	8	0	6
POND MAKES IT HARDER TO TAKE CARE OF FAMILY					
No	100	95	94	100	91
Yes	0	5	6	0	9
POND MAKES OTHER HOUSEHOLD WORK HARDER					
No	98	94	90	98	92
Yes	2	6	10	2	8
TILAPIA CASH EASIER TO BUY THINGS FOR FAMILY					
No	70	95	27	14	8
Yes	30	5	73	86	92

About 90% of the Kenya and Philippine respondents felt that tilapia fit well with other farm activities, but only 64% of the Honduran and 79% of Thai farmers thought so. The latter respondents were slightly more likely to report problems completing household work or taking care of their family. Few respondents noted problems associated with the tilapia enterprise in taking care of other crops, taking care of the family, or completing other household work.

Kenyan and Rwandan farmers were much less likely to indicate that tilapia cash made it easier to buy things for their families, given the relatively small amount of cash produced by tilapia in each locale. In Kenya, only 30% felt this way, and 5% of the Rwandans agreed with this statement. In contrast, three-quarters or more of the respondents in the Philippines, Honduras, and Thailand noted the benefits of additional cash for their households as something associated with the tilapia crop.

Pond Conflicts

Table 15 shows respondents' experiences with a series of problems sometimes encountered by tilapia farmers. Thai farmers were most likely to note problems over water resources emanating from the tilapia crop (57%), an issue noted by only a few of the other respondents. Philippine operators had few problems with predators eating their fish, but this was an issue for farmers in each of the other countries.

Theft was a concern for 44% of the Honduran farmers and 29% of the Kenyan farmers. In contrast, only 20% or so of the Rwandan and Thai respondents noted this as an issue, and only 11% did so in the Philippines. Thai farmers were most likely to agree that tilapia were easier to steal, though one-third of the Honduras respondents thought so as well.

Prospects for the Pond

Kenyan farmers were least likely to think that their fish pond produced enough to be worth the work they put into it. In comparison, twice as many Rwandans thought it was (Table 16). Nearly 90% thought that the tilapia pond was the best use of the land it occupied, though the Thai sample was somewhat less positive.

Most respondents thought tilapia culture was the best use of the land it occupied. Nearly all the Philippine respondents were planning more ponds, as were 74% of the Kenyans. In contrast, only 39% of the Honduran respondents and 29% of the Thai respondents were contemplating expansion. Only 11% of the Rwandan farmers expected to add ponds to their farming system.

Only 54% of the Rwandan farmers and 72% of the Kenyan farmers were happy with tilapia as a type of fish to grow; they desired a larger, faster-growing fish. Nonetheless, more than 90% of respondents in the other nations were happy with tilapia as a type of fish to grow.

Only 3% of the Kenyan farmers felt that tilapia was more profitable than other crops, and 85% thought it was less

Table 15. Pond conflicts experienced by tilapia farmers in five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	Rwanda N = 136 (%)	Honduras N = 51 (%)	Philippines N = 50 (%)	Thailand N = 56 (%)
CONFLICTS OVER WATER					
No	88	--	94	100	43
Yes	12	--	6	0	57
BIRDS OR OTHER ANIMALS EATING TILAPIA FROM PONDS					
No	40	31	24	95	4
Yes	60	69	76	5	96
PEOPLE STEALING TILAPIA					
No	71	78	56	89	81
Yes	29	22	44	11	19
TILAPIA ARE EASIER TO STEAL					
No	88	97	62	80	55
Yes	12	3	38	20	45

Table 16. Prospects for the fish pond according to tilapia farmers in five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	Rwanda N = 136 (%)	Honduras N = 51 (%)	Philippines N = 50 (%)	Thailand N = 56 (%)
TILAPIA PRODUCE ENOUGH TO BE WORTH THE WORK					
No	65	28	8	7	10
Yes	35	72	92	93	90
TILAPIA POND BEST USE OF LAND IT USES ON THE FARM					
No	12	11	12	0	24
Yes	88	89	88	100	76
PLANNING MORE PONDS					
No	26	89	61	2	71
Yes	74	11	39	98	29
GENERALLY HAPPY WITH TILAPIA AS A FISH TO RAISE					
No	28	46	6	2	6
Yes	72	54	94	98	94
TILAPIA COMPARED TO OTHER ACTIVITIES					
More Profitable	3	--	23	90	78
About the Same	1	--	17	8	8
Less Profitable	85	--	60	2	14

profitable. The perceived profitability of tilapia relative to other farm activities was highest in the Philippines, where 90% thought it was more profitable than other crops. About 78% thought so in Thailand. In Honduras, 23% thought it was more profitable. About 60% of the Honduran respondents thought that tilapia was less profitable than their other activities.

Overall, Kenyan and Honduran farmers were least happy with the returns from tilapia, although Thai farmers were less convinced that tilapia ponds were the best use of the land. Thai farmers with irrigation in the Bangkok marketing area have many enterprise choices and marketing opportunities.

Technical Assistance

In Kenya, 95% of respondents said they had seen an extensionist in the past year. About 88% had done so in the past month (Table 17). Kenya has an extensive extension system for fisheries and aquaculture, but currently lacks resources for staff training and educational materials.

Aquacultural extension services were making frequent contacts with farmers in Rwanda prior to the civil war. At the time of the study, a well-trained cadre of extension personnel was supported by donor funds. Most farmers received regular visits if they wanted them. The Rwandan respondents also were somewhat more likely to report some type of extension contact in the past.

A highly professional, relatively well-organized extension and research system is in place in Thailand. Nonetheless, about one-third of the Thai respondents indicated that they had never had contact with an extension representative.

The Philippines has no national extension program. Budget problems limited on-farm extension work to a small number of extensionists supported solely by provincial-level governments.

In Honduras, high inflation has degraded salaries, travel budgets, and morale for extension personnel. These conditions, coupled with high levels of personnel turnover, contributed to the low impact of extension in that country. In Honduras, one-third of the respondents indicated that they had had no contact

Table 17. Technical assistance sources used by tilapia farmers in five PD/A CRSP countries, 1992-98.

	Kenya N = 43 (%)	Rwanda N = 136 (%)	Honduras N = 51 (%)	Philippines N = 50 (%)	Thailand N = 56 (%)
LAST EXTENSION CONTACT					
Never Contacted	0	6	35	22	35
In Past Month	88	75	26	46	50
Months to Year	7	6	10	14	4
Over a Year	5	13	29	18	11
LAST STATION CONTACT					
Never Contacted	--	--	4	25	62
In Past Month	--	--	38	43	17
Months to Year	--	--	22	14	6
Over Year	--	--	36	18	15
PEACE CORPS CONTACT					
No	88	--	16	100	100
Yes	12	--	84	0	0
UNIVERSITY CONTACT					
No	--	--	80		
Yes	--	--	20	28	75
				72	25
WANT EXTENSION HELP					
No	0	90	0	2	17
Yes	100	10	100	98	83
MAIN OBSTACLES TO LARGER HARVESTS					
The Species	0	45	11	0	0
No Inputs	0	59	9	0	0
Water too Cold	0	9	2	0	0
Understanding	0	2	36	0	0
Water Quality	2	0	0	95	40
Pond Leaks	10	0	5	0	0
Kind of Inputs	0	0	23	0	0
No Extension	0	0	5	0	0
Other	0	2	9	5	60

with extension. More contacts were noted with Honduran fish stations that supply fingerlings and some technical assistance to farmers.

In Honduras, Peace Corps has been very active in fish culture, as has the staff of Zamorano University and several other institutions. Kenya and Honduras were the only countries where Peace Corps contacts were reported.

About one-third of the Honduran and Thai farmers had no extension contact. Most Kenyan, Thai, and Philippine farmers wanted extension help in the future, but farmers in Rwanda and Honduras were not certain.

Farmers were asked about the main factors preventing larger harvests. Water quality was the biggest issue in Kenya, Thailand, and the Philippines. The matter was referred to simply as "the pond" in Rwanda. Manure and compost availability was the obstacle most frequently cited in Rwanda. Honduran farmers noted "my understanding" as the major obstacle to obtaining larger harvests from their ponds.

CONCLUSIONS

This report has provided a socioeconomic profile of tilapia culture in five PD/A CRSP countries. One of the signal contributions of this study is the cross-national comparative data obtained from fish farmers across the globe. A common interview guide and data matrix provide a framework for contrasting and understanding the practice of tilapia culture. Similarities in technology and approach to aquaculture also can be counterpoised to the great differences in market receptivity, price, and dietary role of tilapia in each country. In particular, the data reported here complement experimental and biological information about how tilapia are grown and used. The findings show how farmers feed their fish, who they sell them to, and what kinds of problems they are experiencing.

Results of this study suggest that tilapia mean different things to different segments of the rural population. Clearly the wealth or income level of the grower enters into the amount of capital investment and risk to be undertaken, but off-farm employment and life cycle considerations also play a role in determining the production strategies employed and the kinds of benefits individuals seek from the fish culture enterprise.

Tilapia growers in each of the countries face vastly different institutional systems supporting tilapia production (Veverica and Molnar, 1996). The impacts of the PD/A CRSP are muffled by the inherent characteristics of the research process, the nature of institutional functioning in developing countries, and the dynamism of the information environment for aquacultural technologies.

ANTICIPATED BENEFITS

The communication process linking experimental pond to farm practice involves several layers of translation and transmission (Cernea, 1991). Many factors interact to affect the nature and extent of impact PD/A CRSP scientists and research programs have on national aquacultural institutions and farm practice (Huisman, 1990). Experimental findings are at base experimental; that is, they reflect controlled conditions and careful measurement of a focused set of factors. Farm conditions reflect variable physical and management situations that often mitigate the impact of effects identified by repeated experimental trials. The data presented here provide empirical specification of the needs and preferences of the actual intended beneficiaries of the PD/A CRSP. As such, they provide a baseline or template for interpreting the cumulative impact of PD/A CRSP activities and a starting point for identifying new directions and emphases that will help realize the promise of aquaculture for farmers and their families in developing countries.

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