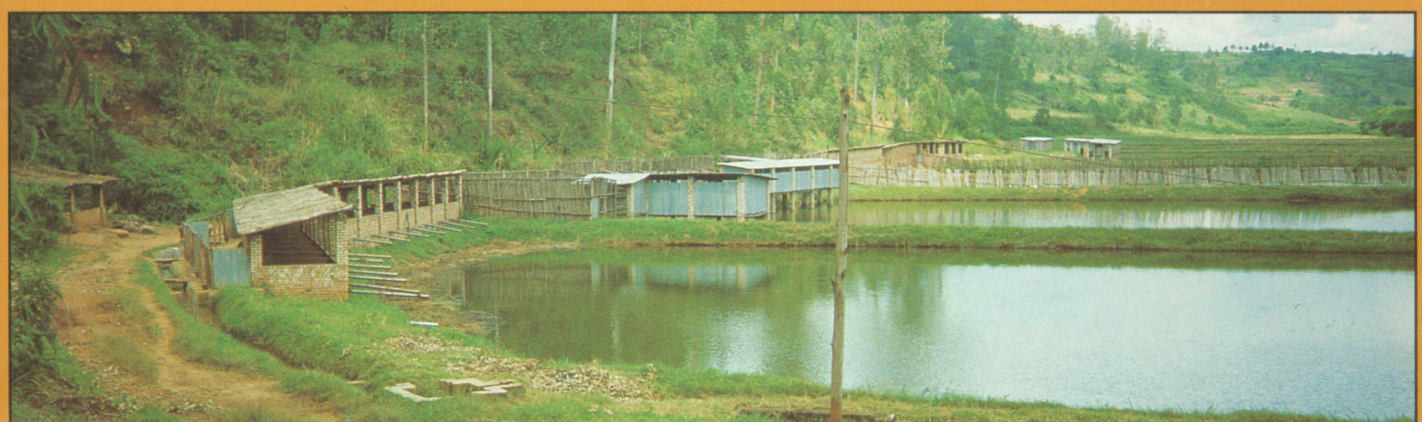
Socioeconomic Factors Affecting the Transfer and Sustainability of Aquacultural Technology in Rwanda

International Center for Aquaculture and Aquatic Environments **Research and Development Series No. 38**
Alabama Agricultural Experiment Station **Auburn University**
Lowell T. Frobish, Director **Auburn University, Alabama** March 1994



Contents

ACKNOWLEDGEMENTS

Research supported by a USAID Program Support Grant to Auburn University; data collection supported by the USAID Collaborative Research Support Program in Pond Dynamics/Aquaculture led by Oregon State University (Pub. no. 1086); and travel supported by the USAID Rwanda Natural Resources Management Project-Aquaculture Component led by Auburn University. We thank: the Rwasave Research Station for typing, transport, and the counsel of Eugene Rurangwa and Lieven Verheurst; the College of Agriculture, National University of Rwanda, Butare for duplication and computer services; the Department of Research Data Analysis, Alabama Agricultural Experiment Station for data entry services; and Nathanael Hishamunda and Paul Mpawenimana for translation and interpretation assistance.

SUMMARY

Beginning in 1983, the Rwanda National Fish Culture Project helped farmers improve their ponds and pond management. It also identified and provided a species of tilapia better-suited to the high-elevation, cool-water environment. The report focuses on the experiences of three specific categories of farmers, about which little systematic information exists.

Interviews were conducted with 115 active farmers including 56 women who were pond group members or individual operators. Interviews were conducted with 21 dropouts about their reasons for quitting fish culture. Similarly, 16 emulators were interviewed about their lack of contact with extension personnel.

The results suggest that aquaculture has become an integral part of the diversification strategy of Rwandan farmers. Despite a lessening in the intensity of extension assistance, farmers continue to grow repeated crops of fish. They express positive sentiments about the activity, its benefits, and the technical support they receive.

The segment of farmers that has stopped growing fish seems to have done so for reasons other than dissatisfaction with the enterprise per se. Dropouts were slightly more involved in other farm enterprises, but the problems they identified were more related to circumstances in their household or in the milieu of neighboring landowners than with fish culture itself. A narrow segment quit because the water was too cold or otherwise was not conducive to growing fish. Dropout farmers perceived more time and effort conflicts with other farm enterprises and household work. They were more interested in the cash proceeds of fish culture than the other sample segments and less likely to feel that the pond was the best use of the land it occupied.

Women in groups seemed the most satisfied and productive segment of the study respondents. They had larger harvests, they experienced fewer marketing problems, and they were more attentive to the general practice of fish culture. They also seemed to get better prices. Women in groups seemed better able to exploit pond bank sales as a marketing channel for tilapia. Friends, relatives, and neighbors are an immediate network of fish consumers that are readily alerted and mobilized to purchase fish at harvest. Women in pond groups were characterized by an overlay of multiple social networks, and seem better positioned to distribute fish among rural households.

Women in pond groups seem to have most effectively realized the promise of fish culture to yield benefits for families, particularly children. The access to land, sociability, and perhaps gender solidarity in a male-oriented society, are major advantages of fish culture for women.

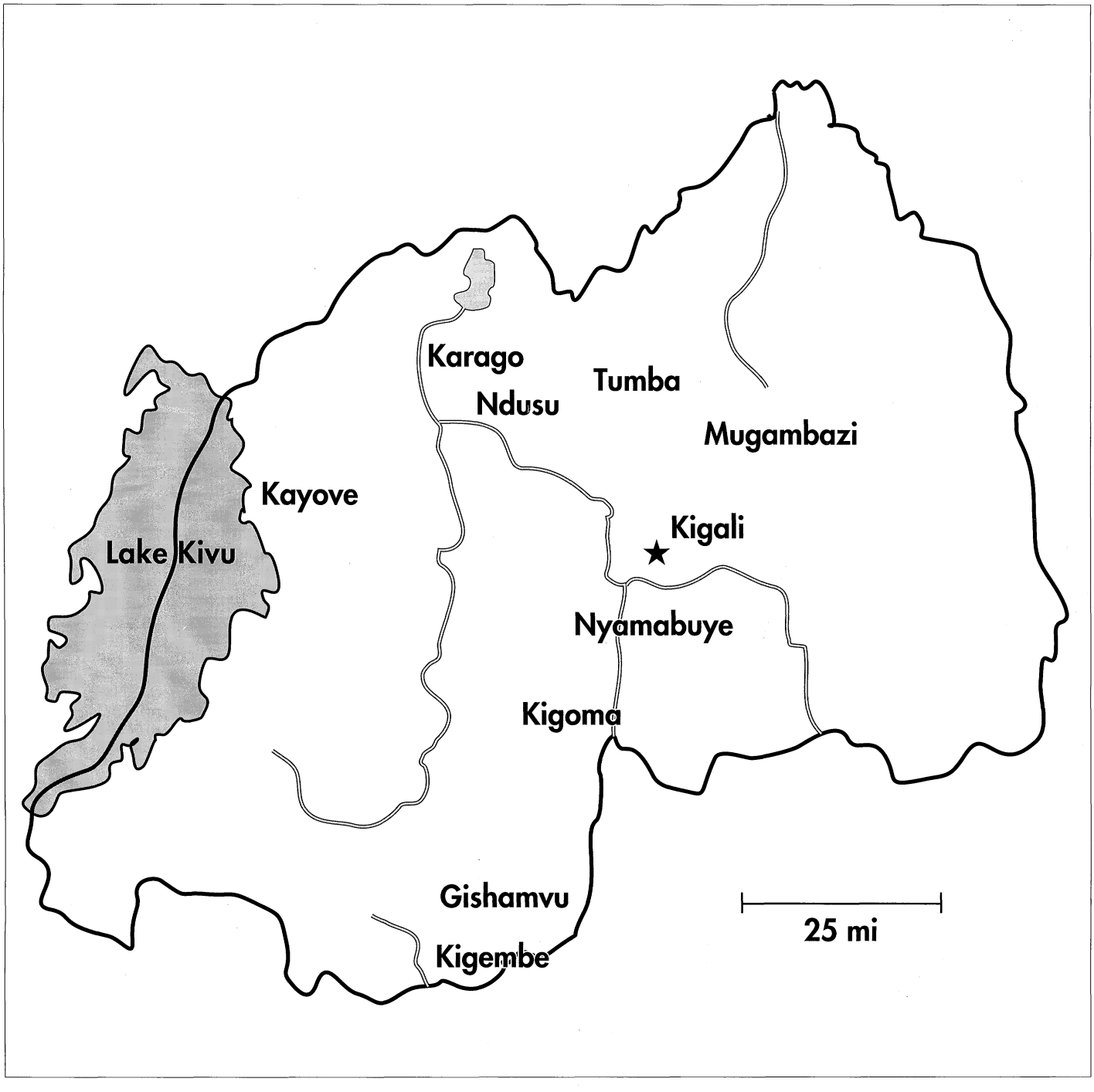


Figure 1. Map of Rwanda showing sample communes and major river basins, 1992.

Socioeconomic Factors Affecting the Transfer and Sustainability of Aquacultural Technology in Rwanda

Joseph J. Molnar, Christopher L. Cox, Pelagie Nyirahabimana, Alphonse Rubagumya[1]

INTRODUCTION

Beginning in 1983, the Rwanda National Fish Culture Project helped farmers improve their ponds and pond managment *(15,18)*. It also identified and provided a species of tilapia better-suited to the high-elevation, cool-water environment through an extension service of approximately 40 agents *(19)*. Important questions pertain to the amount and quality of technical assistance farmers received, the degree to which farmers adopted the technical package extended to them, and the existence of various signs and conditions that signaled the incorporation of fish culture into the cycle and mosaic of farm activity *(7,8,9)*.

Previous research obtained data from a sample of 186 active Rwandan fish farmers taken from project rolls throughout the nation *(20)*. Several significant questions were not addressed in the survey of active farmers. Specifically, the economic aspects of fish culture were not specified in detail nor was the marketing process examined in sufficient depth to identify intervention points for extension assistance.

Another shortcoming pertained to gender representation *(1,6,28)*. Only five women were interviewed in the 1991 study, a nearly representative number at the time. Recent reports suggest that fish culture is expanding rapidly among women. Women now represent about 25% of the fish farmers in Rwanda *(14)*. Given the conflicts reported by women, the primary role played by women in food production for household consumption, and the emphasis placed on gender sensitivity and equity in USAID policy, it is important to address their experience in aquaculture *(13,17)*.

A third shortcoming in this previous research pertains to the factors that cause farmers to abandon aquaculture as a farm enterprise. Previous research has pointed to the problems associated with group farming and the division of rewards that are insufficient for the size of a pond group *(21)*. Young farmers may quit fish farming for more advantageous endeavors. Some farmers may drain their ponds to grow other crops. Loss of fish crops to theft, disease, or poor management may discourage others from starting a new crop of fish. The reasons underlying dropout decisions among project participants are not well-understood *(20)*.

Finally, little is known about a fourth category of farmers termed "emulators." These individuals built and stocked ponds on their own initiative, relying on hearsay and informal advice for assistance. Many of these individuals lie outside the normal circuit of extension workers. Others simply have not developed relationships with extension workers who make regular calls in nearby areas. Little is known about the adequacy of the technical approach used by these individuals, the influence they have on their neighbors, their relative levels of success, or why they eschew extension assistance.

This report focuses on selected categories of fish farmers, particularly women, dropouts and emulators. It summarizes the data in terms of a typology encompassing the key segments of the target population *(25)*. Understanding the circumstances and motivations that shape decision processes will be a significant step toward designing and maintaining a technology transfer effort that will be sustainable and effective *(4,16)*.

Sustainable Aquaculture

Sustainability can be defined in different ways and sought through different means. The term is usually used in the context of yield from a renewable resource, such as a fishery, that is maintainable over time without depleting the resource. The concept also implies a broader concern for the overall fit, congruity, and lasting incorporation of an intervention in a socioeconomic system *(3,20)*.

Sustainable farm activities contribute to a general pattern of durability or harmony in the relationship between a population and its resource base. When considered in the context of Rwanda's rapid population growth and limited land area, sustainability must be regarded as a dynamic objective for both policy makers and farmers. Although broader perspectives emphasize the long-term viability of whole agricultural systems, the focus here is on the perceived fit of a specific activity in a complex cycle and array of enterprises *(22)*.

This report documents the ways fish culture is implemented by different segments of the target population. It diagnoses the ways fish culture does or does not fit in the lives of Rwandan farm families. It also profiles the special problems facing women and other key segments of the clientele population.

Objectives

1. To establish baseline quantitative information about women and men who operate fish ponds individually or in groups in Rwanda.

2. To profile the circumstances and motivations underlying decisions to discontinue the practice of fish culture in Rwanda.

3. To describe the practices and technical proficiency of independently established fish farmers who have no regular contact with extension personnel.

[1]Alumni Professor and Research Aide of Agricultural Economics and Rural Sociology; Director of Fish Culture, Aquaculture, and Apiculture, Rwanda Ministry of Agriculture, Livestock, and Environment; and Postdoctoral Fellow in Sociology, Louisiana State University.

RESEARCH METHODS

Sample and Data Collection

Active Farmers. Data were obtained from a sample of active Rwandan fish farmers randomly selected from National Fish Culture Service (SPN) rolls in eight local administrative districts *(communes)* during the winter and early spring of 1992. Several districts were chosen to represent agroclimatic diversity in the nation's regions; others were selected randomly. Interviews were conducted with 115 active fish farmers, 45 % of whom were women. Figure 1 shows the location of the sample communes.

To contact respondents, aquaculture *monitors* (extension representatives) were asked to arrange with the farmers to meet the interviewer at specified locations and times. The Rwandan interviewer conducted individual interviews in the native *Kinyarwanda* language using a standardized set of questions and response frameworks. Approximately 60 minutes were spent with each farmer.

Emulators. Interviews were conducted with 16 individuals who had independently adopted fish culture as a farm enterprise. Several techniques were employed to contact farmers who have built ponds and were growing fish without the benefit of extension services. Extension staff were asked to identify individuals who had been growing fish, but with whom they had not had contact, or who had refused or otherwise discouraged extension assistance. Similarly, active farmers were asked to identify neighbors who independently built and stocked ponds. Information specifying the name and location of these individuals were used by the interviewer to locate emulators of fish culture.

Fish farmers in areas not receiving extension assistance were identified through network sampling procedures and local informants *(2)*. General agricultural extension agents provided information about individuals who had constructed fish ponds. Local residents made referrals to farmers who had ponds. Neighbors also provided information about the owners of ponds visible from the roadside.

Dropouts. Interviews were conducted with 21 farmers who had discontinued fish culture. Several techniques were employed to contact this segment. Extension staff were asked to identify individuals who had discontinued fish culture in the past three years. Similarly, active farmers were asked to identify neighbors who drained ponds or did not restock after the last harvest. Information specifying the name and location of these individuals was used by the interviewer to try to locate the discontinuing farmers. The interviewer met the farmer at the household or in fields, sometimes organizing a meeting through a neighbor or other intermediary.

Separate interview schedules were developed for active and dropout farmers. The active farmer interview schedule was segmented to allow separate lines of questions for individual pond owners and group pond members. Additional production and economic information was obtained. Each survey instrument was developed, translated into *Kinyarwanda*, pretested with members of each category, and accordingly adjusted. The schedules were developed collaboratively with SPN staff members Pelagie Nyirahabimana, Nathanael Hishamunda, and Paul Mpawenimana.

Analysis

The data were edited then directly entered according to precoded numerical response categories on the printed questionnaire that did not require translation. The data were tabulated in this report according to gender, type of pond ownership, and participation status. This approach reveals the pattern of responses for each of the major segments of fish farmers and former fish farmers targeted in the study.

The tables show responses for: all respondents -- data for all sample segments; active farmers -- excluding dropout farmers; group members -- active farmers who are members of pond groups; individual farmers -- operators of ponds on land under their personal control; and emulators -- active farmers in areas not receiving extension services. In all cases where active group farmers are considered, separate tabulations for men and women are reported. Due to small numbers of cases, individual and dropout farmers were not tabulated by gender.

RESULTS

Farm and Household Characteristics

Gender and Participation. Table 1 shows the distribution of sample respondents by gender and pond ownership. This tabulation is the base for establishing the typology of Rwanda farmers that will be used for the remainder of the report. Figure 2 shows the relative size of the target population segments in the sample.

The number of farmers in each sample segment is roughly proportional to the corresponding population. The 62 group farmers in the sample represent 3.2% of the 1,950 group ponds in the country in 1990. The 53 individual pond operators represent 4.6% of the 1,152 individual ponds. Women are 24% of the fish farmers in Rwanda and 43% of the sample *(12)*. Women were oversampled to provide sufficient numbers for analysis.

Group pond operators were nearly equally divided between males and females, but most individual pond operators were men. As women typically have more difficulty gaining access to land, participation in one or more pond groups provides a means for increasing food production and income opportunities for them. This pattern reflects the traditional Rwandan land tenure system that inhibits women's access to land.

Table 1. Typology of Study Respondents, Rwanda, 1992

	Active		Dropout	
Gender	Group	Individual	Group	Individual
	Pct.	Pct.	Pct.	Pct.
Male	55	91	81	80
Female	45	91	92	0
(Number)	(62)	(53)	(16)	(5)

The dropout farmers were 80% male. Women did not seem to withdraw from pond groups to the extent that men did. Due to the small number of dropouts of either gender, dropouts will be profiled as a single category in subsequent tables.

Although it is not shown in the table, emulator farmers were nearly all men. They are aggregated with all active farmers due to their small number, but are examined separately in one section of the analysis. Similarly, results for individual fish farmers of both genders will be combined, as less than 10% of these respondents were female. This simplified typology of participation status and gender is the independent variable used to tabulate the data. It consists of four categories: active group men; active group women; active individuals; and dropouts.

Location of Respondents. Table 2 shows the distribution of study communes by participation status. The 141 communes (or counties) are the basic units of administration in Rwanda. The map displays the location of the nine sample communes where respondents were contacted (Figure 1).

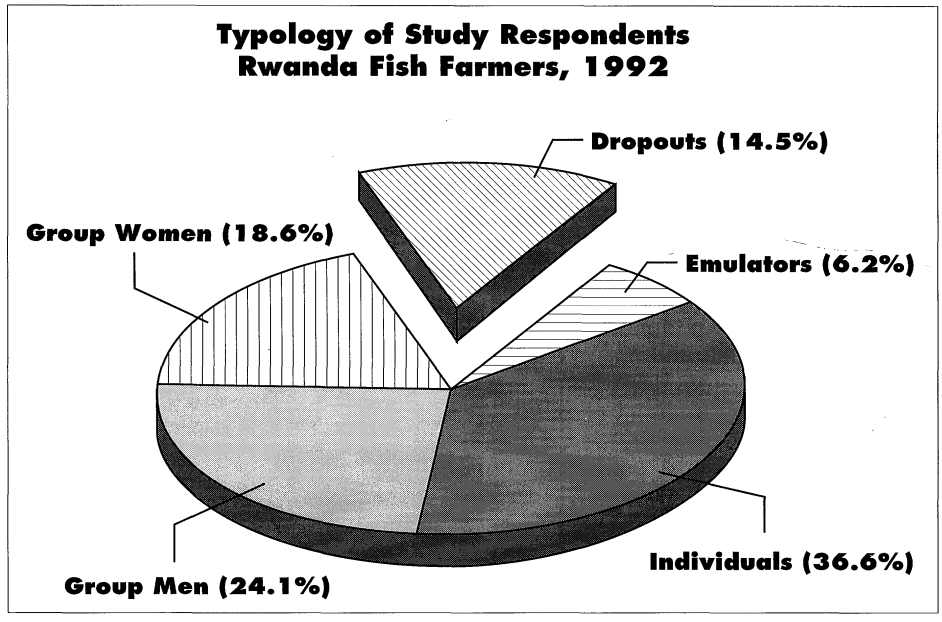


Figure 2. Typology of study respondents, Rwanda, 1992.

Table 2 details their participation status. About 65% of the dropouts were interviewed in three of the study communes (Gishamvu, Kayove, and Kigoma). Two communes, Mugambazi and Tumba, did not have formally assigned extension monitors. Gishamvu was only recently assigned a half-time monitor; in an earlier period an extension monitor had operated for two years, but he had not been replaced when he left.

The second item in the table suggests that dropouts tended to live closer to administrative centers than active farmers. Larger proportions of the active farmers lived more than one hour's walk from the commune office. This finding suggests that farmers are not participating in fish culture because of perceived political or administrative benefits; rather, the enterprise seems to be proceeding on its own merits.

Table 2. Location of Study Respondents, Rwanda, 1992

	Active Fish Farmers			Dropout
	Group		Individual	
	Male	Female		
	Pct.	Pct.	Pct.	Pct.
Name of commune				
Gishamvu	9	7	6	31
Karago	9	7	9	4
Kayove	9	21	26	22
Kigembe	20	11	40	13
Kigoma	15	46	13	22
Ndusu	17	4	2	4
Nyamabuye	15	0	2	4
Tumba[1]	0	4	2	0
Mugambazi[1]	6	0	0	0
(Number)	(34)	(28)	(53)	(23)
Walking distance to commune office				
1 to 60 min.	29	40	40	52
61 to 100 min.	20	18	18	
101 to 150 min.	32	32	36	26
More than 150	18	8	6	4
(Number)	(34)	(25)	(50)	(23)

[1]Not served by an extension monitor.

Family Structure. Only 15% of the women group farmers were household heads (Table 3). In contrast, more than 85% of the other categories headed households. This is a major difference in the composition of the sample.

Young children were present in most other sample households, as shown in Table 3, although 46% of the active group women did not have children under age 10. Active individual farmers were more likely to have young children in their households.

Table 3. Household Characteristics of Study Respondents, Rwanda, 1992

	Active Fish Farmers			Dropout
	Group		Individual	
	Male	Female		
	Pct.	Pct.	Pct.	Pct.
Respondent is the household head				
No	3	85	9	14
Yes	97	15	91	86
Children under age 10				
None	33	46	19	44
1 to 3 children	55	42	63	30
More than 4	12	12	18	26
Children age 10 to 18				
None	27	54	37	44
1 to 3 children	64	42	49	52
4 to 6 children	9	4	14	4
Children over age 18				
None	64	77	55	57
1 to 3 children	15	15	21	26
More than 4	21	8	24	17
Household size				
1 to 5 persons	34	46	31	35
More than 6	66	54	69	65
(Number)	(33)	(28)	(51)	(23)

Active group women farmers were less likely to have children aged 10 to 18, while men group farmers were most likely to have children that age. Similarly, group women farmers were least likely to have older children. Most households were large, with six or more people present in the home. Group women farmers tended to have smaller households because most were young women with no or few children.

Age and Marital Status. Most respondents were between 35 and 44 years of age, although more than a third of the active female group fish farmers were less than 25 (Table 4). Group ponds may be a more accessible avenue to land and economic activity for young women. More than half the active female group farmers were not married. About 75% or more of the other respondents were married.

Table 4. Age and Marital Status of Study Respondents, 1992

	Active Fish Farmers			Dropout
	Group		Individual	
	Male	Female		
	Pct.	Pct.	Pct.	Pct.
Age in years				
Less than 25 years	3	37	6	6
25 to 34	18	26	30	18
35 to 44	40	22	30	36
45 to 54	15	8	16	32
55 to 64 15	7	12	9	
65 or older	9	0	6	5
Marital status				
Married	97	46	85	73
Single	3	29	4	14
Widow	0	7	2	13
Separated or divorced	0	18	4	0
More than one spouse	0	0	5	0
(Number)	(34)	(28)	(53)	(22)

Hill Land Tenure. Table 5 shows that most farmers owned some land on the hillsides. Hill land comprises the core holdings of the Rwandan farmstead. Hill land holdings give some indication of the socioeconomic standing of the household. Hill land is privately owned and passed on through family inheritance.

Men in groups and dropouts tended to report ownership of more parcels. More dropouts felt that they owned more hill land than their neighbors. Women in groups tended to feel they owned less land than other farmers. They tended to rent more land into their farmstead and to rent almost none to others.

Marais Land Tenure. Marais lands are largely held by the government *(26).* Use rights are allocated to individuals and groups by the chief communal administrative officer, the bourgmestre *(23,24).* Fish ponds are constructed on marais land. Active women group farmers tended to control fewer parcels in the marais and to feel they had less marais land than others (Table 6). More than 75% of the women and individual farmers said they did not rent any marais plots to others. Nor did active women group farmers rent any marais plots from others. It should be noted that the renting of marais plots is an illegal activity, although the exchange of plots for labor and other considerations is not uncommon.

Table 5. Hill Land Holdings of Study Respondents, Rwanda, 1992

	Active Fish Farmers			Dropout
	Group		Individual	
	Male	Female		
	Pct.	Pct.	Pct.	Pct.
Hill land parcels owned				
None	3	0	0	0
1 to 5 parcels	82	100	96	87
More than 6 parcels	15	0	4	13
Hill land more or less than other farmers				
More	9	4	16	30
Less	59	81	54	48
About the same	32	15	30	22
Hill land rented from others				
None	35	32	45	36
1 to 3 parcels	59	68	49	59
4 to 6 parcels	6	0	6	5
More than 6 parcels	0	0	0	0
Hill land rented to others				
None	94	96	86	77
1 to 3 parcels	6	4	12	23
4 to 6 parcels	0	0	0	0
More than 6 parcels	0	0	2	0
(Number)	(34)	(25)	(49)	(22)

Table 6. Marais Land Holdings of Study Respondents, Rwanda, 1992

	Active Fish Farmers			Dropout
	Group		Individual	
	Male	Female		
	Pct.	Pct.	Pct.	Pct.
Number of marais parcels you control				
None	12	29	2	4
1 to 5 parcels	73	67	82	74
6 to 10 parcels	9	4	8	9
More than 10 parcels	6	0	8	13
Land in the marais more or less than other farmers				
More	10	5	10	45
Less	71	90	71	55
About the same	19	5	19	0
Marais rented from others				
None	61	76	76	61
1 to 3 parcels	36	24	20	35
4 to 6 parcels	3	0	4	4
Marais land rented to others				
None	91	100	90	96
1 to 3 parcels	6	0	8	4
4 to 6 parcels	3	0	2	0
(Number)	(34)	(25)	(49)	(23)

Food and Income Enterprises. Table 7 shows the farm enterprises reported as providing most of the respondent's cash income and most of the food for the family. These data reflect multiple responses from each respondent. Consequently, the percentages do not sum to 100. Significantly, no respondent reported fish as a primary source of cash income.

More than a fourth of male group farmers indicated that bananas, cassava, livestock, and sweet potatoes produced the bulk of their cash income. A fourth of the group women also reported

Table 7. Food and Income Enterprises of Study Respondents, Rwanda, 1992

	Active Fish Farmers			Dropout
	Group		Individual	
	Male	Female		
Provides cash income:				
Cabbage	0	0	2	13
Sweet potatoes	27	31	18	27
Bananas	39	19	47	47
Sorghum	6	19	6	13
Beans	21	27	18	20
Livestock	27	12	14	20
Taro	3	8	0	0
Maize	3	4	2	0
Cassava	30	27	18	20
White potatoes	24	0	39	47
Sweet peas	6	8	4	0
Provides most food:				
Cabbage	6	0	17	6
Sweet potatoes	85	89	79	94
Bananas	75	25	25	19
Sorghum	30	37	26	38
Beans	82	74	62	94
Taro	6	19	21	19
Maize	9	15	9	6
Cassava	64	67	62	69
White potatoes	9	16	9	0
Sweet peas	6	7	9	6

Table 8. Animal Enterprises of Study Respondents, 1992

	Active Fish Farmers			Dropout
	Group		Individual	
	Male	Female		
	Pct.	Pct.	Pct.	Pct.
Types of animals raised				
Goats	74	74	57	69
Chicken	65	78	61	50
Cows	56	39	61	69
Sheep	32	17	24	31
Rabbits	29	13	31	44
Pigs	27	22	24	19
Ducks	3	0	6	0
Other	9	0	14	13
(Number of responses)	(100)	(56)	(141)	(47)
Previous experience raising animals in pens or cages?				
No	0	21	2	0
Yes	100	79	98	100
(Number)	(34)	(24)	(51)	(23)

cash income from sweet potatoes and cassava. Beans were more frequently reported as a cash source for the group women.

Women much less frequently reported bananas as a cash source, reflecting traditional patterns of enterprise responsibility. Individual and dropout farmers were more dependent on bananas for cash income (47%). They also relied more heavily on white potatoes, a cash income source reported by none of the active women group farmers.

Respondents were asked to profile the main food sources for their family. None of the respondents reported fish as a main food source. More than half the sample reported sweet potatoes, beans, and cassava as main food sources. Bananas were important for 75% of the active male group farmers, but were important for only a quarter or less in the other segments. No respondent mentioned fish or cattle as main food sources for his or her family.

Animal Enterprises. Table 8 profiles animal enterprises maintained by the study respondents. Although nearly all the male, individual, and dropout farmers reported experience growing animals in pens or cages, 21% of active group women farmers did not. This is a major difference among the sample segments.

Women farmers were less likely to raise three types of animals: cattle, rabbits, and sheep. Women more often reported chickens as an enterprise.

Production and Marketing

Pond Visits. More than half the active farmers visited their ponds on a daily basis (Table 9). Another third visited several times a week. When fish farmers visited their ponds, they tended to spend less than two hours each time. More women in groups reported stays of an hour or more, but men in groups spent the most time at their ponds.

Fish Feeding. Tilapia directly ingest some organic materials introduced into fish ponds; they also feed on the plankton bloom induced by these substances. This line of questioning understands feeding to include the provision of inputs and the stirring of compost. Both efforts directly or indirectly provide nutrients for the fish.

Table 9. Pond Visit Frequency and Duration, Active Farmers, Rwanda, 1992

	Group		Individual
	Male	Female	
	Pct.	Pct.	Pct.
How often do you visit your pond(s)?			
Every day	51	55	58
Almost every day	3	0	9
Several times a week	32	31	23
Once a week	14	14	8
Several times a month	0	0	2
How much time do you spend when visiting your pond(s)			
Less than an hour	33	41	52
An hour or more	43	52	34
Two or three hours	16	7	10
More than three hours	8	0	4
(Number)	(37)	(29)	(52)

Women reported having sufficient inputs for their fish ponds most of the time (Table 10). Direct access to slaughter, garden, and kitchen waste may facilitate feeding practices. Women also seemed to be more committed to supplying these inputs to their ponds. Compared to women in groups, more men in groups and individual pond operators reported problems obtaining sufficient inputs.

Almost half the active farmers furnished inputs, stirred compost, or otherwise tended to their fish every or nearly every day. Of the women in groups, 90% fed their fish several times a week or more often. Because women are more attentive to their ponds, they may be more sensitive to inadequacies in the amount or kind of inputs available for their fish crop.

The three categories of active farmers each provided a similar profile of substances to their fish. Leaves and manure were the most commonly applied pond inputs. Women in groups tended to supply sorghum beer waste and slaughter waste more often than other

farmers. Individual farmers tended to use less compost, but rather employed a more diverse set of substances as pond inputs.

Table 10. Fish Feeding Practices, Active Farmers, Rwanda, 1992

	Group		Individual
	Male	Female	
	Pct.	Pct.	Pct.
Do you have enough inputs for your pond?			
Always	27	59	41
Sometimes	51	38	35
Never	22	3	24
How often do you provide inputs for your fish?			
Every day	46	52	44
Almost every day	6	3	2
Several times a week	32	35	40
Once a week	16	10	12
Several times a month	0	0	2
(Number)	(37)	(29)	(52)
What types of inputs do you use?			
Grass cuttings	27	29	28
Compost	47	50	28
Manure	65	64	68
Sorghum	27	50	32
Rice bran	6	0	0
Slaughter waste	18	46	5
Kitchen remainders	3	0	0
Leaves	77	82	87
Beeswax	0	0	2
Termites or other	0	0	14
(Number of responses)	(91)	(90)	(145)

Table 11. Production Problems, Active Farmers, Rwanda, 1992

	Group		Individual
	Male	Female	
	Pct.	Pct.	Pct.
Problems getting enough water to keep pond full?			
Yes	21	14	31
Problems finding fingerlings for restock?			
Yes	28	18	25
Do you sell fingerlings to other farmers?			
Yes	56	45	49
Did you have any trouble selling fingerlings to other farmers?			
Yes	37	17	31
(Number)	(33)	(29)	(51)

Production Problems. Table 11 reports the problems experienced by active farmers while growing fish. About a fourth had trouble finding fingerlings. Group women were somewhat less likely to encounter this problem.

Water supply problems were not frequently encountered by respondents. Individual farmers did experience more difficulties keeping their pond full (31%). About half the active farmers sold fingerlings to other farmers. Of these farmers, about a third reported problems selling their fingerlings to other farmers. Group women reported the least problems in this area (17%).

Harvesting Practices. Table 12 shows that 71% of active women group farmers tended to use one complete harvest. In contrast, male groups and individual farmers more frequently employed multiple partial harvests. This seems to suggest that men use the pond more often for meals or limited cash sales than women.

Male group farmers had the largest harvested pond area, but women reported harvesting more fish by weight. Individual farmers tended to harvest fewer ares of ponds than group farmers (an are is one-tenth of a hectare of surface area and one hectare equals 2.47 acres). It should be noted that harvesting is more difficult for women to accomplish. Seining typically requires actually entering the pond waters, an activity not traditionally acceptable for women.

For women, harvests may be more of an organized event involving the recruitment of male labor (sons, brothers, or husbands) to drain the pond and collect the fish. In some cases, laborers may be paid or otherwise compensated for their assistance.

Table 12. Fish Harvesting Practices, Active Farmers Rwanda, 1992

	Group		Individual
	Male	Female	
	Pct.	Pct.	Pct.
How many areas of ponds did you harvest?			
1 to 5 acres	74	85	92
6 to 10 acres	23	15	6
More than 10 acres	3	0	2
How much fish did you harvest last time?			
1 to 10 kilograms	22	14	36
11 to 30 kilograms	47	38	38
31 to 90 kilograms	22	31	22
91 kilograms or more	9	17	4
Do you usually perform partial harvests or one large harvest?			
Usually partial	41	29	44
Usually one large	59	71	56
Why partial harvest?			
Never partial harvest	52	71	52
Take fish home	3	11	13
Marketing is easier	23	4	2
Both reasons	19	14	29
Other	3	0	4
(Number)	(34)	(28)	(48)

Marketing Practices. Table 13 profiles the marketing practices of active farmers. More men than women group farmers sold fish.

Group women farmers tended to get the best price for their fish. None reported receiving less than 100 FRW per kilogram. Almost a third of the men said they obtained more than 140 FRW per kilogram. A quarter of the individual farmers received less than 100 FRW per kilogram. (For comparison purposes, the price of beans, a food staple, is approximately 70 FRW per kilogram.)

Marketing Outlets. Table 14 describes to whom respondents actually sold their fish. Few sold any of their production to middlemen. Only a few more said they sold some to owners of restaurants or bars. No women reported any sales to either outlet.

Organized markets for food and merchandise take place on a regular day or days of the week in most communities. More than a third of the men in groups sold fish in the public market, but fewer women and individual farmers took their fish to the marketplace

Table 13. Marketing Practices, Active Farmers, Rwanda, 1992

	Group		Individual
	Male	Female	
	Pct.	Pct.	Pct.
Did you sell your fish after your last harvest?			
No	9	17	23
Yes	91	83	77
How much of your fish did you sell last time?			
Did not sell any	3	11	18
Less than half	37	27	44
Half	13	12	10
More than half	47	50	28
What price did you get?			
100 FRW/kg or less	22	0	25
101 to 140 FRS/kg	46	71	51
141 to FRW/kg or more	32	29	
(Number)	(32)	(26)	(51)

for sale. Home consumption and pond bank sales seemed to exhaust their supply. Public markets are disadvantageous for fish sales because they require transport. Without ice or refrigeration, the seller is then under pressure to dispose of a perishable commodity.

Nearly everyone (85%) sold fish to other people. From extension reports it is known that most fish sales take place on the pond bank to friends and neighbors. Word-of-mouth precedes an impending harvest. Willing buyers then purchase the fish at understood prices soon after they are seined. Organizing buyers to purchase the fish at harvest eliminates price risk and transport problems for farmers.

Table 14. Marketing Outlets, Active Farmers Rwanda, 1992

	Group		Individual
	Male	Female	
	Pct.	Pct.	Pct.
Did a middleman buy any of your fish?			
No	97	100	98
Yes, some of it	3	0	2
Yes, all of it	0	0	0
Did you sell any fish to owners of restaurants or bars?			
No	94	100	96
Yes, some of it	6	0	4
Yes, all of it	0	0	0
Did you sell any fish at the market?			
No	63	82	89
Yes, some of it	34	18	11
Yes, all of it	3	0	0
Is there anyone else you sold fish to?			
No	16	14	17
Yes	84	86	83
(Number)	(32)	(28)	(47)

Marketing Problems. Almost half (48%) of the male group farmers reported problems selling their fish (Table 15). Men in groups tended to expect and receive the highest price for their fish, explaining some part of their slow sales. A third of the women and individual farmers reported problems selling fish. In contrast, about 55% of the group men reported difficulty selling at the desired price.

Table 15. Marketing Problems, Active Farmers, Rwanda, 1992

	Group		Individual
	Male	Female	
	Pct.	Pct.	Pct.
Did you have any problems selling your fish?			
Yes	48	32	37
Are you satisfied with the price you sell your fish?			
Yes	35	57	47
Did you have problems selling fish at price desired?			
Yes	55	35	45
If can't get price desired, can you sell fish for less?			
Yes	77	89	63
Are there many people who don't like to eat fish?			
Yes	44	36	27
Would a larger type of fish be easier to sell?			
Yes	75	78	70
(Number)	(32)	(27)	(53)

Women were more satisfied with the price they received for their fish, but only a third of the male group members were satisfied. Men reported the most problems selling fish at a desired price, women reported the least.

The major set of problems farmers associated with fish culture related to the marketing of the product. Most male group farmers said they could sell their fish for a lower price if they had to (77%). Only 63% of individual farmers felt this way, compared to 89% of the women growing fish in a group.

More men in pond groups thought that there were many people who did not like to eat fish (44%). A third of the women felt this way, but only about a quarter of the individual farmers agreed. Overall, around 74% thought that a larger type of fish would be easier to sell.

Extension Assistance

Visit Frequency and Helpfulness. Most respondents saw their extension monitor twice a month (Table 16). Individual farmers saw the extensionist slightly more often.

Respondents gave yes or no answers to a series of questions about "How is the monitor helpful?" Most thought the monitor was helpful in learning how to properly feed fish, providing nets for harvesting fish, and reminding farmers of the importance of regularly stirring up compost.

Almost a third of the women said the monitor was helpful in marketing. Only six percent of the other respondents mentioned the monitors assistance in this regard. This reflects a major difference in opinion between men and women.

Perceived Utility of Services. About half the male group farmers thought that the monitor gave good advice about garden crops (Table 17). Less than a quarter of the women felt this way, compared to three-quarters of the individual farmers. This is a notable difference in perception between men and women.

Nearly all said that the monitor: provides needed technical information; is able to help solve problems; is available when needed; comes when expected; gives good answers to farmer questions; and is able to bring the net when it is needed. These

aspects of extension assistance seemed to be uniformly well-received, but women were somewhat more critical.

Women were less satisfied with monitor performance on almost every dimension. Women also were more likely to say that the monitor did not come when expected. Women were not necessarily dissatisfied with extension assistance; they simply were less uniformly positive about the nature of the help they were getting than were men.

Table 16. Visit Frequency and Monitor Helpfulness, Active Farmers, Rwanda, 1992

	Group		Individual
	Male	Female	
	Pct.	Pct.	Pct.
How many times per month do you see the fish monitor?			
Never	0	7	2
Once	10	11	5
Twice	76	61	60
Three times	0	14	14
Four times	14	7	19
(Number)	(29)	(28)	(43)
How is the monitor most helpful?			
Feeding fish	93	96	85
Stirring up compost	80	48	77
Harvesting	83	88	59
Getting fingerlings	13	20	5
Disease problems	3	0	8
Clean fish before cooking	3	0	5
Marketing	7	32	5
Preserving	0	0	5
Building ponds	7	4	15
Other	17	8	23
(Number of responses)	(92)	(73)	(112)

Table 17. Perceptions of Fish Monitor Assistance, Active Farmers, Rwanda, 1992

	Group		Individual
	Male	Female	
	Pct.	Pct.	Pct.
Does your monitor give good advice about managing garden crops?			
Yes	52	23	76
Does the monitor provide the technical information you need?			
Yes	100	92	94
Is the monitor usually able to help solve your prblems?			
Yes	100	93	97
Is your monitor available when you need him/her?			
Yes	90	93	93
Does the monitor give good answers to your questions?			
Yes	100	93	98
Does the monitor bring the net when needed?			
Yes	90	89	95
(Number)	(29)	(28)	(42)

Other Extension Contacts. Table 18 suggests that pond groups had most of their contact with any type of government-sponsored extension services through the fish culture monitor. Five-eighths of the group men and three-quarters of the group women reported no other extension contacts. For about half the individual and dropout farmers, the fish culture monitor was the only contact.

Table 18. Visits by Other Extensionists to Study Respondents, Rwanda, 1992

	Group		Individual	Dropout
	Male	Female		
	Pct.	Pct.	Pct.	Pct.
Do other types of monitors visit you?				
No	63	75	51	52
Yes	37	25	49	48
(Number)	(30)	(28)	(37)	(21)

Prospects for Fish Culture

Enterprise Viability. Table 19 shows responses to a series of items related to the maintenance and expansion of fish culture as a farm activity. Tilapia is not the only type of fish that could be raised by Rwandan farmers, but this was the species selected by the SPN for culture and propagation. Most male and individual farmers had heard of species other than tilapia. Only about a third of the women had heard of other species. Overall, about half the sample were satisfied with tilapia as a species.

Rwandans can operate their own ponds or participate in group ponds. Women who wanted additional ponds did not want to be individual pond owners, but would much rather join another pond group. Apparently, the sociability and mutual support associated with group membership, the possibility of independent cash income, and the shared burden of fish farming tasks were advantages particularly valued by women.

Membership in a pond group was not perceived as a particularly useful avenue for receiving credit or marais land. About 18% of the male group members thought it was easier to obtain credit for fish culture, but lesser proportions of the other farmers saw the enterprise as conferring any particular advantages in this regard.

Individual pond operators were more interested in additional individual ponds than membership in a group. About 7% of the group farmers thought group membership made it easier to get land in the marais. Yet no group members thought it was easier to get land to grow fish than for other crops.

Table 19. Prospects for Fish Culture, Active Farmers, Rwanda, 1992

	Group		Individual
	Male	Female	
	Pct.	Pct.	Pct.
Are you satisfied growing the tilapia species?			
Yes	49	58	56
Have you heard of other fish species?			
Yes	71	32	88
Do you want other fish ponds?			
No	17	26	24
Yes, my own	35	6	41
Yes, with a group	37	53	29
Yes, my own and group	11	15	6
Is it easier to get credit if in a group pond?			
Yes	8	6	0
Is it easier to get land for fish for than for other crops?			
Yes	0	0	4
(Number)	(32	(28)	(49)

Production Constraints. Respondents were asked questions about the factors limiting their ability to grow bigger fish. (They gave nearly identical answers to a question about growing more fish.) Table 20 summarizes the multiple responses given to this question.

Farmers felt that the main obstacle to growing bigger fish and obtaining larger harvests is a shortage of inputs. About two-thirds saw insufficient manure and other nutrients as limiting their efforts in fish culture. Almost half blamed the species chosen. Around 10% identified cool water as a limit to fish growth and reproduction.

Farmers recognized the material constraints on the outcomes of fish culture enterprise. They were not necessarily motivated to abandon fish culture by these limits; they seemed only to have a realistic appraisal of the possibilities of the activity at present levels of effort.

Table 20. Production Constraints Limiting Fish Size, Active Farmers, Rwanda, 1992

	Group		Individual
	Male	Female	
	Pct.	Pct.	Pct.
Main things that keep you from growing bigger fish and obtaining larger harvests:			
The species	47	47	47
Not enough inputs	66	59	57
Water too cold	9	7	10
My understanding	0	0	4
Other	0	4	0
(Number)	(32)	(27)	(60)

Problems with Fish Farming. Table 21 reports the affirmative responses to a series of questions about problems respondents experienced growing fish in Rwanda. The items were intended to show the relative position of fish culture in comparison to other farm activities. Given the dichotomous response framework, only "yes" responses are shown.

Most farmers did not think that fish farming made it harder to care for other crops, although active group women were more likely to feel this way (15%). Active group farmers reported some conflict with neighbors over marais property boundaries (12%).

Table 21. Problems with Fish Farming, Active Farmers, Rwanda, 1992

	Group		Individual
	Male	Female	
	Pct.	Pct.	Pct.
Does fish farming make it harder to care for other crops?			
Yes	3	15	4
Do you have conflicts with other farmers over marais boundaries?			
Yes	12	4	4
Do you have problems with people stealing fish?			
Yes	21	11	30
Are fish easier to steal than other crops?			
Yes	0	0	6
Do you have problems with animals eating fish?			
Yes	69	57	76
(Number)	(32)	(28)	(51)

Compatibility of Fish Farming. The major difference between dropout farmers and the active respondents pertained to the amount of work required by the pond (Table 22). Almost 17% of the dropouts said there were times when the fish pond was too much work, versus four percent or less for the others. Apparently the dropouts experienced more conflicts during peak workload periods over the labor and time required by the fish crop.

Theft of the fish was a problem for 30% of the individual farmers, a higher level than other categories. Active male group farmers were also somewhat more likely than group women to report this problem (21% versus 11%). Only a few thought fish were easier to steal than other crops. Three-quarters of the individual pond owners reported problems with predators, primarily birds. Birds remove a significant amount of fish from ponds in Rwanda.

More than 60% of the respondents felt that the fish pond was worth the work. The individual farmers were most likely to think so (77%). Even 61% of the dropouts agreed, suggesting that other extenuating factors resulted in their withdrawal from fish culture, and not the activity itself.

More than 80% of the active farmers thought that fish culture fit well with other activities. Surprisingly, most of the dropouts thought so too (77%). More than 85% of the active farmers felt the fish ponds made the best use of land. Many dropouts also agreed (61%). This pattern of findings further suggests that other circumstances were causing dropout farmers to abandon the practice of fish culture. Although dropouts more readily recognized each disadvantage, no one single shortcoming of the activity seemed to cause farmers to quit.

Table 22. Compatability of Fish Farming with Other Activities, Active Farmers, Rwanda, 1992

	Active Fish Farmers			
	Group		Individual	Dropout
	Male	Female		
	Pct.	Pct.	Pct.	Pct.
Is there ever a time when your fishpond is too much work?				
Yes	3	4	0	17
Is your fish pond worth the work?				
Yes	63	71	77	61
Does fish farming fit well with your other farm activities?				
Yes	81	86	83	77
Is your fish pond the best use of the land it occupies?				
Yes	93	89	88	61
(Number)	(30)	(26)	(50)	(18)

Family Impacts of Fish Farming. Women were consistently more likely to cite role conflicts or hardships associatedwith fish culture as an additional enterprise in their repertoire of activities (Table 23). About 11% of the women felt that fish farming made it harder to take care of the family and to complete household work.

About 16% of the dropouts thought that the cash from fish farming made it easier to buy things for their children. Less than 10% of the active farmers felt that way. The small cash flow from fish culture seemed a salient advantage of the enterprise remembered by farmers no longer actively growing fish. About 44% of the individual operators said that there were times when the fish pond

kept them from going hungry. Only 18% of the active group women farmers reported this.

Table 23. Family Impacts of Fish Farming, Active Farmers Rwanda, 1992

	Group			
	Male	Female	Individual	Dropout
	Pct.	Pct.	Pct.	Pct.
Does fish farming make it harder to care for your family?				
Yes	6	11	2	10
Does fish farming make it harder to complete household work?				
Yes	9	11	2	10
Does the cash you make from fish farming make it easier to buy things for your children?				
Yes	9	4	4	16
Was there ever a time when fish kept your family from going hungry?				
Yes	28	18	44	28
(Number)	(32)	(28)	(52)	(18)

Table 24. Pond Ownership Characteristics, Active Individual Farmers, Rwanda, 1992

Item	Active Farmers Individual Ponds
	Pct.
Also a group pond member?	
No	78
Yes	22
Number of ponds you own	
One pond	84
Two ponds	11
Three ponds	5
Size of individual ponds	
1 to 3 ares	75
3.1 to 6 ares	23
More than 6 ares	2
(Number)	(51)

Table 25. Reasons for Independence from Extension, Active Emulator Farmers, Rwanda, 1992

Item	Emulator Farmers Individual Ponds
	Pct.
Have you had contact with fish culture extension in past?	
No	8
Yes	92
Would you like to work with a monitor in the future?	
No	25
Yes	75
(Number)	(16)
Why did you stop seeing the monitor?	
Never have had contact	14
Know enough to be autonomous	14
Monitor is not helpful	43
Monitor stopped coming	14
We have no monitor in this area	29
I can get information from other extensionists	0
I can get information from other farmers	14
Other	0
(Number of responses)	(9)

Emulator Farmers. All emulator ponds were operated by individual farmers. More than 90% of the emulator pond owners had some contact with a fish culture monitor in the past (Table 25). About three-fourths would like extension assistance to continue. Many had no contact because they lived in a commune not served by an extension monitor. Still, 43% said that the monitor was not helpful to them.

Why Farmers Become Dropouts. Table 26 suggests that only a few of the pond groups broke up because of inability to collaborate. When asked to identify reasons why their group ceased operating the pond, they mentioned several different types of problems. A third of the problems related to group processes of conflict or leadership. Not enough harvest was cited by 27% as providing insufficient incentive to continue participation.

Table 26. Factors Affecting Leaving Fish Farming, Dropout Group Farmers, Rwanda, 1992

Item	Dropout farmers Group ponds
	Pct.
Did you quit because your group could not work together?	
No	83
Yes	17
What were the problems?	
Conflicts between members	13
Lack of leadership	20
Not enough harvest	27
Theft of fish	20
Other	67
(Number of responses)	(22)

Table 27. Factors Affecting Possible Return to Fish Farming, Dropout Farmers, Rwanda, 1992

Item	Dropout farmers Group	Dropout farmers Individual
	Pct.	Pct.
Does your pond still contain water?		
No	56	25
Yes, some do	25	25
Yes, all/it do(es)	19	50
Do you plan to start growing fish again?		
No	27	17
Yes	73	83
When was your last contact with the monitor?		
Never had contact	7	0
In past 6 months	40	100
6 months to a year	0	0
More than a year	53	0
Is another group or individual operating your pond now?		
No	100	
Yes	0	
Would you join another group pond if you had the chance?		
No	18	
Yes	82	
(Number)	(16)	

Why Dropouts Might Return. Most of the group dropout ponds did not contain water any longer (Table 27). Most group and individual farmers planned to start growing fish again. About

half the group farmers had not seen the monitor for more than a year, but all the individual farmers had seen an extension monitor in the past six months. The last two questions in the table were asked of group dropouts only. None of the ponds they abandoned were being operated by other parties. Most (82%) would join a pond group again if given the opportunity.

CONCLUSIONS

Fish ponds make a significant contribution to the well-being of Rwandan households. Most respondents were married with children, although many women fish farmers were unmarried and living in their father's house. Most fish ponds were linked to households comprising more than six people. The income, diet variety, nutritional improvement, and food security associated with the output from the fish pond seemed a valued component of the array of pursuits that meet family needs.

The results suggest that aquaculture has become an integral part of the diversification strategy of Rwandan farmers. Despite a lessening in the intensity of extension assistance, farmers continue to grow repeated crops of fish. They express positive sentiments about the activity, its benefits, and the technical support they receive. Fish culture seems to fit the mosaic of activities that produces food and cash with minimal risk for farm operators.

The segment of farmers that stopped growing fish seemed to have done so for reasons other than dissatisfaction with the enterprise per se. Dropouts were slightly more involved in other farm enterprises, but the problems they identified were more related to circumstances in their household or in the milieu of neighboring landowners than with fish culture itself. A narrow segment quit because the water was too cold or otherwise was not conducive to growing fish.

Group farming remains a popular organizational strategy for fish culture in Rwanda. More than half the active farmers in the study grew fish in a group. Most women are engaged in fish culture through a group, particularly young women. Groups provide sociability, solidarity, and access to land and farm activity for a gender that has traditionally experienced many limits to independent action. Groups also seem to be a significant step toward life and participation outside the household for some young women.

Women in groups seemed the most satisfied and productive segment of the study respondents. They had larger harvests, they experienced fewer marketing problems, and they were more attentive to the general practice of fish culture. They also seemed to get better prices. Women in groups seemed better able to exploit pond bank sales as a marketing channel for tilapia. Friends, relatives, and neighbors are an immediate network of fish consumers that are readily alerted and mobilized to purchase fish at harvest. Women in groups represent an overlay of multiple social networks. Women seem best positioned to distribute fish among rural households.

Individual pond owners were mainly men, although a few widows operated ponds. Individual operators had smaller ponds, smaller harvests, more marketing problems, and were less satisfied with the size of the fish they obtained.

Dropout farmers perceived more time and effort conflicts with other farm enterprises and household work. They were more interested in the cash proceeds of fish culture than the other sample segments and less likely to feel that the pond was the best use of the land it occupied.

Emulators built and stocked ponds on their own initiative. The small number of emulator farmers included in this study were from communes that did not have an extension worker. Nearly all emulators did, however, have some kind of past contact with extension. Only a small number had actually implemented fish culture without any contact with extension.

The fish pond was not cited as a major source of food or income by the respondents in this study. Fish sales yield cash for school fees and the purchase of manufactured goods. Fish help meet emergencies, augment diet variety, and improve nutrition availability in a protein-short nation. Fish ponds also represent food security in the early part of the year when harvests from primary rainy season crops are not yet available.

Women in pond groups seem to have most effectively realized the promise of fish culture to yield benefits for families, particularly children. The access to land, sociability, and perhaps gender solidarity in a male-oriented society, are major advantages of fish culture for women.

The number, size, and level of effort applied to fish ponds in Rwanda is never likely to make fish a major cash commodity or family staple. Fish have become a fundamental part of the bundle of activities that farmers undertake to feed their families and further their household objectives.

The data in this report profile a farm enterprise that has been widely embraced by the target population. Fish culture is practiced throughout the country. Fish culture is being autonomously emulated by many individuals in communes receiving extension assistance and in neighboring areas. The emulators are seeking to build fish ponds based on observation, experience, and word-of-mouth testimony about the value of fish as a farm activity.

Respondents were largely satisfied with the extension services they have been receiving. Some dissatisfaction with the species and other limits of the technological strategy suggest an openness to more intensive extension assistance. This may involve monosex cultures, improved fingerlings, closer attention to stocking densities, integration with animal enterprises, or polyculture with other species.

The current extension program is not able to refresh the technical competence of extension monitors at a sufficient rate. Farmers are not receiving assistance at a level that might increase fish culture yields using the present technology package. Instead, most farmers seem to undertake the enterprise largely as a diversification strategy. They seem willing to accept smaller, more reliable yields that offer cash and food security with lower levels of risk and effort. Without additional stimulation, the practice of fish culture is likely to continue to spread on its own merits, albeit at a low standard of practice.

The major risk of this strategy is imperfect or partial emulation that yields markedly less than optimal results. Potential adopters are discouraged by witnessing the outcome of degraded practices. The cumulative impact of deviations from standard practice may undermine the reputation of the enterprise.

This report has profiled basic conditions of acceptance and practice of fish culture in the Rwandan farming system. It has

shown the existence of systematic differences associated with gender and the auspices of the fish ponds. Individual farmers seem to approach fish culture with a stronger emphasis on cash flow and farm diversification.

Fish culture is a popular farm enterprise in Rwanda that is spreading on its own merits beyond the targeted extension zones. It is part of the established set of enterprises competing for agricultural land in the marais. The data suggest that fish culture will sustain itself at a low level of practice for some time to come.

Government and donor investment in aquaculture in the coming years must focus on retaining a competent cadre of extensionists. Their assistance is necessary if farmers are to push back the yield frontier given the available inputs and species. Integrated systems will allow farmers to exploit the positive interactions that fish culture can have with other animal enterprises.

The central advantages to fish culture in Rwanda lie in its ability to confer widespread benefits to rural families, particularly women, on basic dimensions of income and food security. Planning to protect and expand these benefits will be a challenge and obligation for Rwandan officials and sponsors in the present period of conflicting priorities and budgetary scarcity.

REFERENCES

(1) Balakrishnan, R., K.L. Veverica, and P. Nyirahabimana. 1993. Rwanda Women in Aquaculture: Context, Contributions, and Constraints. Corvallis: Office of Women in International Development, Oregon State University.

(2) Casley, D.J. 1988. The Collection, Analysis, and Use of Monitoring and Evaluation Data. Baltimore: Johns Hopkins University Press.

(3) Cernea, M. 1991. Putting People First: Sociological Variables in Rural Development. Washington, D.C.: The World Bank.

(4) Clay, D. 1989. Characteristics of Rwandan Farming Systems. Research in Rural Sociology and Rural Development 4:56-72.

(5) Cross, D. 1991. FAO and Aquaculture: Ponds and Politics in Africa. The Ecologist 21:79-76.

(6) Engle, C.R. 1987. Women in Training and Extension Services in Aquaculture. Pages 67-82 in E.E. Nash, C.R. Engle, and D. Crosetti, eds. Women in Aquaculture. ADCP/REP/87/28. Food and Agricultural Organization of the United Nations, Rome.

(7) FAO. 1991a. Pêche et Aquaculture au Rwanda: Revue Sectorielle. Document Technique No 1. FI:TCP/RWA/0052. FAO, Rome.

(8) FAO. 1991b. Contribution au Plan de Developpement des Pêches et de l'Aquaculture. Document Technique No 2. FI:TCP/RWA/0052. FAO, Rome.

(9) FAO. 1991c. Compte Rendu Final du Project Prepare Pour Le Gouvernement du Rwanda. FI:TCP/RWA/0052. FAO, Rome.

(10) Ford, R.E. 1990. The Dynamics of Human-Environment Interactions in the Tropical Montane Agrosystems of Rwanda: Implications for Economic Development and Environmental Stability. Mountain Research and Development 10:43-63.

(11) Green, B.W. 1992. Substitution of Organic Manure for Pelleted Feed in Tilapia Production. Aquaculture 101:213-222.

(12) Gutpa, M.V., M.P. Bimbao, and C. Lightfoot. 1990. Socioeconomic and Farmers' Assessment of Nile Tilapia (Oreochromis niloticus) Culture in Bangladesh. Tech. Rep. 35. ICLARM, Manila.

(13) Harrison, E. 1991. Aquaculture in Africa: Socioeconomic Dimensions. A Review of the Literature. School of African and Asian Studies, University of Sussex, England.

(14) Hishamunda, N. 1989. Project Pisciculture Nationale Rapport Annuel 1988. Republique Rwandaise, Ministere de l'Agriculture, de Elevage et des Forets, Kigali, Rwanda.

(15) Hishamunda, N. and J. Moehl. 1989. Rwanda National Fish Culture Project. International Center for Aquaculture Research and Development Series No. 34. Department of Fisheries and Allied Aquacultures, Auburn University, Auburn, Alabama.

(16) Huisman, E.A. 1990. Aquacultural Research As a Tool in International Assistance. Ambio 19:400-403.

(17) Lado. C. 1992. Female Labour Participation in Agricultural Production and the Implications for Nutrition and Health in Rural Africa. Social Science and Medicine 34:789-807.

(18) Miller, J.W. 1988. Technical Evaluation of the Rwanda/USAID National Fish Culture Project. USAID/Kigali.

(19) Moehl, J.F. 1991. Aquaculture Planning and Extension Assessment in Rwanda, December. International Center for Aquaculture, Auburn University.

(20) Molnar, J.J., V. Adjavon, and A. Rubagumya. 1991. The Sustainability of Aquaculture as a Farm Enterprise in Rwanda. Journal of Applied Aquaculture 2:37-62.

(21) Molnar, J.J., N.B. Schwartz, and L.L. Lovshin. 1985. Integrated Aquacultural Development: Sociological Issues in the Cooperative Management of Community Fishponds. Sociologica Ruralis XXV:61-80.

(22) Molnar, J.J., B. Duncan and U. Hatch. 1987. Fish in the Farming System: The FSR Approach to Aquacultural Development. Research in Rural Sociology and Rural Development 2:169-193.

(23) Molnar, J.J. and B.L. Nerrie. 1987. Rwanda Fish Culture Project: Technical, Social, and Institutional Issues Affecting Delivery of Fish Farming Extension Services. ICA Technical Paper. International Center for Aquaculture, Auburn University, Auburn, Alabama.

(24) Molnar, J.J. and A. Rubagumya. 1988. Aquaculture and the Marais: Patterns of Organization, Allocation, and Use of Valley Land Under Conditions of Resource Scarcity and Ecological Complexity. ICA Technical Paper. International Center for Aquaculture, Auburn University, Auburn, Alabama.

(25) Roling, N. 1988. Extension Science: Information Systems for Agricultural Development. New York and Cambridge: Cambridge University Press.

(26) Sikkens, R.B. and T.S. Steenhuis. 1988. Development and Management of the Small Marais. WMS Report 79. Department of Agricultural Engineering, Cornell University, Ithaca, New York.

(27) Veverica, K. 1988. Rwandan Women in Aquaculture. Women in Natural Resources 10:18.