FISH CULTURE IN THE PERUVIAN AMAZON: PRODUCER PERCEPTIONS AND PRACTICES IN THREE RIVER SYSTEMS

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ABSTRACT

The Instituto de Investigaciones de la Amazonia Peruana (IIAP) is the leading governmental organization working in aquaculture and fisheries research in the Peruvian Amazon region. In addition, IIAP produces fingerlings, offers training courses, and works with nongovernmental organizations (NGOs) endeavoring to promote fish culture. This report summarizes fieldwork and survey results from rural communities in the Iquitos area of the Amazon served by NGOs assisted by IIAP. The researchers visited rural communities and interviewed fish farmers, community residents, and public and private agency officials to discover the strategies and approaches to small-scale, community-based aquaculture employed in the Peruvian Amazon. Subsequently, data were collected from a sample of 146 practicing fish farmers in the Napo, Tamishiyacu, and Tahuayo river systems areas north and south of Iquitos, as well as in the Iquitos-Nauta Road area directly south of the city. Fish farmers were identified in selected communities provided technical assistance in aquaculture by CARE/Peru and several other nongovernmental organizations. Results portray the species cultured, marketing strategies employed, and the perceived impact of fish culture on families and farming systems. The data show that fish farmers are in an advantageous situation for fish culture. They encounter few barriers to building ponds, obtaining fingerlings, feeding their fish, or marketing the product. Fruits and other forest-based fish foods are widely available to support extensive production systems. A number of NGOs are providing regular farm visits and advice on fish culture. The natural cycle of the Amazonian river systems ensures a market period of relatively high prices for farm-reared fish. Additional attention is needed on identifying and communicating production practices that will reduce risk and enhance the benefits of aquaculture.

INTRODUCTION

Loreto, Peru's largest department, is entirely forested except for water bodies and urban areas. Iquitos is a city of more than 300,000 people accessible only by boat or airplane. No roads connect the city in northeast Peru to Lima on the western coast. Founded during an earlier period of rubber boom (Barnham and Coomes, 1996), Iquitos is now a regional trade center that serves the many small communities that line the Amazon and its tributaries (Chibnik, 1994). Many humanitarian and environmental nongovernmental organizations (NGOs) operate in the Loreto area and are based in Iquitos (Rainforest Conservation Fund, 1999). The Peruvian Amazon has been subjected to large-scale commercial exploitation for the last two centuries. As Nauta, Tamishiyacu, and then Iquitos grew during the late 1800s, they became centers of urban consumption and international export. While fine rubber—*jebe fino* (*Hevea brasiliensis*)—was recognized worldwide, Peru produced large amounts of weak rubber—*jebe debil*—from upland varieties of *Hevea* sp. Coomes (1992b) provides an analysis of the rubber trade and the difficulties involved in the business. Over 3,000 metric tons was exported annually from the Peruvian Amazon between 1902 and 1917 (Villarejo, 1988). This export economy crashed after the Second World War, but the tire industry in Lima rejuvenated the rubber trade during the 1960s and early 1970s. Petroleum-based tires have effectively ended the rubber trade in the northeastern Peruvian Amazon.

The Amazon River fishery plays a fundamental role in the livelihoods and survival of rural populations in this region (McDaniel, 1997). Fishing is by far the most important source of animal protein in the Amazon Basin and the main generator of cash for people living along the river. Araujo-Lima and Goulding (1997) argue that fishing is the most promising means for increasing animal protein within the Amazon Basin with a minimum of environmental degradation. Aquaculture plays a unique and dynamic role in the forest-and-river-based farming system of the Peruvian Amazon or Selva (Tomich et al., 1995; Pinedo-Vasquez et al., 1992).

The number of fish species in the Amazon hydrographic basin has been estimated at 2,000. Only 1,400 of these have been described scientifically. These represent approximately 10% of the planet's ichthyofauna (Rainforest Conservation Fund, 1999). The percentile distribution of the species in the main fish families is as follows: Sirulydeous 44%, Characoids 42%, Cichlidae 6%, and other species comprising 8%. Araujo-Lima and Goulding (1997) maintain that while *Colossoma macropomum* (called gamitana in Peru) is not the only Amazon fish species deserving of special attention, it is the first species about which enough is known to both manage wild stocks and develop aquaculture.

Fishing Strategies

Successful fishing depends on the fisherman's knowledge of fish biology and physiology, of the peculiarities of the river or lake, and of water level variations. This knowledge and the necessary tools, which vary according to the species to be caught, have been largely developed by the Indians and inherited by the *ribereños*—the multi-ethnic river community dwellers. These native fishing techniques, which are carried out with bow and arrow, harpoon, spear, hooks, nets, traps, or even by poisoning parts of the floodplains with a plant poison (of the *Lonchocarpus*, *Phyllanthus*, and *Tephrosia* genera, which paralyzes the fish gill, forcing them to come up to breathe) do not damage the fishing stock significantly (Rainforest Conservation Fund, 1999; Hiraoka, 1986, 1989).

In Amazonia, the introduction of dip nets and their use in the flooded parts of the forest, the use of ice to store the fish, and the improvements in refrigeration and transport systems all led to increased exploitation of river fisheries. In turn, these technical innovations were a response to the increasing demand from foreign markets and facilitated exports. Boats with large-scale gear operated by urban interests are often a threat to stocks in local rivers and oxbow lakes. Moreover, fish with skin—traditionally not consumed by Indians and *ribereños*—began to be included in the number of edible fish. Consequently, predatory practices tended to replace traditional fishing techniques (Rainforest Conservation Fund, 1999).

The Amazon's fishing potential, previously regarded as inexhaustible, was overestimated. Though most waters in the Iquitos area are brown, black and clear water rivers are poor in fish. The fishing output of the Amazonian basin in 1980 was estimated at 150,000 t yr^{-1}, but the fishing potential could be approximately twice this figure, that is, 300,000 t. This estimate encompasses all species and sizes, not only those with commercial value (Rainforest Conservation Fund, 1999).

Under these circumstances, it is foreseeable that fish supplies for the rapidly growing Amazonian population cannot be guaranteed for long. Management of fish for subsistence use or local consumption is done by the inhabitants of the areas around the lakes, whose interests in preservation conflict with those of the professional fishermen. The river people supplement fishing with subsistence agricultural activities, jute plantations, and extraction of wood and other products. Now aquaculture is widely perceived as a farm-based activity that complements traditional sources of food and livelihood.

Aquaculture in the Selva

There is no fish-breeding tradition in Amazonia. The aboriginal populations kept fish, manatees, and turtles in large corrals for periodic consumption, but no techniques for reproduction in captivity were developed. Previous efforts by government agencies, NGOs, missionaries, and others, however, have led to a certain level of indigenous knowledge and interest in aquaculture.

There is a unique relationship between aquaculture and fisheries in many parts of the Selva (Hall, 1997). The abundance of large, rapidly growing fish species supports an extensive capture fishery in the Amazon, its tributaries, and a large number of oxbow lakes. The fishery, however, is cyclic, as fishing is more difficult during the high water period of December through March. At this time, fish prices for some species are as much as twice the low water period price. This cyclical deficit in the supply of fish coupled with a widespread perception that river and lake fish stocks have declined and will continue to do so are the primary motivations for fish culture in the Selva. Commercial-scale fishers using large-scale fishing gear have depleted fish stocks in many oxbow lakes, further encouraging pond-based fish production.

Abundant supplies of warm water, generally available pond inputs, and easily obtainable grow-out stock are some of the favorable conditions for fish culture in the Amazon river system. Fingerlings can be obtained through individual effort in rivers or oxbow lakes or through purchase from fishermen. Longstanding efforts by the Department of Fisheries and other agencies that provided technical assistance in aquaculture has stimulated interest in fishponds. Current NGO efforts build on previous government efforts in some communities. In others, NGOs are introducing pond aquaculture as a new activity.

For example, the upper Tahuayo is mainly *várzea* forest with abundant and productive aquatic habitat. Nonetheless, many farmers on this other river systems construct the regionally popular *piscigranjas* (small dams on creeks or wetlands). While fish are scarce during some parts of the year and often difficult to catch in others, the flooding of the forest limits where farmers can build ponds.

An environmental NGO (Rainforest Conservation Fund) reported building a small pond project with some of its staff and members of the Chino Lakes ranger (vigilante) group. The environmental group's conclusions emphasized the risks involved in fish farming (theft, dike breakage, predators, etc.) and the high labor costs. It concluded that the construction of *piscigranjas* (fishponds) was unproductive on the Tahuayo. Nonetheless, CARE/Peru and other agencies are undertaking a program of pond construction in this and similar locales. Our fieldwork suggests that ponds are popular among farmers and do contribute to income and food security in these communities.

Fishing is not an important activity on the Tamishiyacu due to the lack of lakes and natural habitat for fish. While fish are abundant there, little commercial fishing occurs due to the lack of an accessible market. On the upper Tahuayo River, however, fishing is a very important economic and subsistence activity (Rainforest Conservation Fund, 1998).

On the upper Tahuayo, scores of ponds and swampy areas as well as large lakes and the river itself make fishing a primary economic activity. In this part of the buffer zone, seven lakes are presently, and have historically been, of utmost importance to the people here. These lakes, as well as the Tahuayo River, are blackish in color and support species considered to be "blackwater fish," but the pH and nutrient content of the water is similar to "white water" (see Coomes, 1992a, 1992b).

Rainforest Conservation Fund (1998) identifies a number of uses for the oxbow lakes. Charo *Cocha* (*cocha* is the word for "lake" in the local Quechua dialect) is over 500 ha in size, and supplies residents of Esperanza and the village of Charo with fish and income. Cunshicu *Cocha*, lying within the jurisdiction of Buena Vista, has an area of 65 ha, and provides subsistence and income to Buena Vista and the village of Cunshicu. The NGO reports that some 100 families use these two lakes, with often-considerable pressure from non-locals who come from as far as the Amazon River and Iquitos.

The local people have long contested the use of freezer boats, illegal nets, traps, poisons, and explosives. Just upriver, five small lakes, ranging from 1 to 10 ha in size, are of vital importance to the village of Chino (population 310). Besides being subjected to the same problems as Charo and Cunshicu *Cocha*, their small size makes them extremely sensitive to environmental conditions (water levels, temperature, predators, etc.). The strong drop in the Tahuayo River's water levels during July to November nearly eliminates fish from these lakes. Consequently, the community of Chino has implemented an effective vigilance and management system since 1986 (Penn and Alvarez, 1990). These conditions underscore the importance of fishponds as a means for countering the cycles of the river.

The reciprocal relationship between fisheries and aquaculture in the Peruvian Amazon is further enhanced by the well-established patterns of fish marketing present in the region. Fish are a central part of the *ribereños'* diet, many species are accepted for consumption, and fish sales seem to be readily accomplished locally or at market centers. Tello's (1998) study of fish landings in Iquitos illustrates the diversity of fish in the markets and the centrality of *Prochilodus nigricans* (boquichico) as the most heavily harvested fish. *Colossoma macropomum* (gamitana) has had a steady, albeit slightly declining level of reported fish landings over the extended period of data that were available (see also Alcántara, 1994).

METHODS AND MATERIALS

Sample and Data Collection

Fish farmers were identified in selected communities that were provided technical assistance in aquaculture by CARE/Peru and several other NGOs in the Napo, Tamishiyacu, and Tahuayo river systems that combine to form the Amazon, as well as in the Iquitos–Nauta Road area south of Iquitos (Figure 1). Structured interviews were conducted with a sample of 146 fish farmers having accomplished at least one harvest in the past two years (Casley, 1988; Townsley, 1996). The sample was drawn from NGO program participants in selected communities provided technical assistance in aquaculture by CARE-Peru and other selected NGOs.

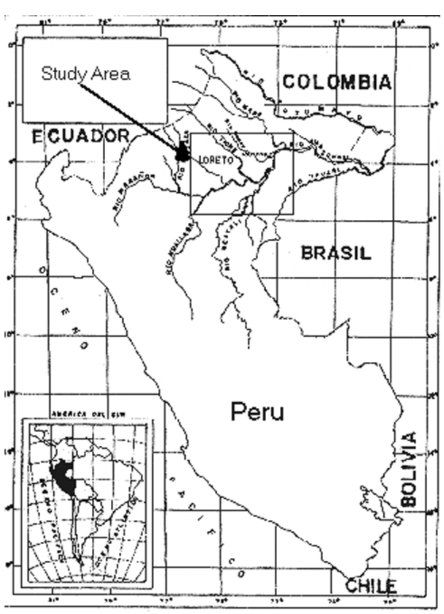

Figure 1. Study area near Iquitos, in the Department of Loreto in the Peruvian Amazon.

The survey instrument was adapted from previous research conducted by Molnar et al. (1996) in five PD/A CRSP countries—Honduras, Thailand, the Philippines, Rwanda, and Kenya. The Peru survey, however, reflects the unique conditions and context of Amazonian fish culture, the diversity of species, and the singular relationship of aquaculture to the river fishery in the region. Ponds were identified in communities on three river systems north and south of Iquitos as well as the Nauta Road area south of Iquitos. Data collection took place in early 1999 and was conducted by graduate students from the Department of Fisheries at the Universidad Nacional de la Amazonia Peruana.

Analysis

The analysis tabulates the survey responses across the three locations—north, south, and central to Iquitos—where data were collected for the study. From this information, central patterns of comparison and difference in practice and approach to fish production and technology utilization can be discerned.

RESULTS

Respondent Characteristics

Table 1 describes the individual and household characteristics of study respondents. Women comprised about 45% of the respondents in Nauta Road, but only about one-tenth of the Napo River and Tamishiyacu fish farmers who we contacted. The Napo River farmers were somewhat older and the Tamishiyacu farmers slightly younger than those in the other locations.

Women and children are central beneficiaries of enhanced protein availability, income, and food security associated with fish ponds in the Selva. While pond construction labor seems primarily to be the province of men, it was sometimes reported that women provided pond inputs and participated in fish harvest.

Over 75% of the study households had children under age ten. Tamishiyacu families had the most children under age 10 and the smallest proportion with children over age 18. Tamishiyacu farmers also had the largest households, as 72% reported six or more members. About two-thirds of the respondent households in the other locations were that large.

Most respondents in the study were associated with individual family ponds. In some communities, NGO technicians worked with groups of families that shared pond construction labor and pond management responsibilities. About 14% of the study respondents were associated with such group ponds.

Few group or collective ponds were reported or encountered during our field visits, but the survey data show that group

Table 1. Respondent characteristics, fish farmers in the Peruvian Amazon, 1999.

	Napo River (N = 87)	Nauta Road (N = 20)	Tamishiyacu-Tahuayo River (N = 39)	All (N = 146)
	(%)			
GENDER OF RESPONDENT				
Male	92	55	87	86
Female	8	45	13	14
AGE OF RESPONDENT (YR)				
Less than 25	3	5	8	5
25 to 34	17	15	15	16
35 to 44	30	35	44	34
45 to 54	23	25	18	22
55 to 64	22	5	13	17
65 or Older	5	15	3	6
RESPONDENTS WITH CHILDREN				
Under Age 10	76	70	82	77
Age 10 to 18	70	70	72	71
Over Age 18	94	100	87	93
NUMBER OF PEOPLE IN HOUSEHOLD				
Two or Less	5	0	8	3
Three to Five	31	45	20	30
Six or More	64	65	72	67
INDIVIDUAL OR GROUP POND				
One or Two Families	84	95	85	86
Three to Seven Families	5	5	15	7
Eight or More Families	11	0	0	7

Table 2. Land ownership of fish farmers in the Peruvian Amazon, 1999.

	Napo River (N = 87)	Nauta Road (N = 20)	Tamishiyacu-Tahuayo River (N = 39)	All (N = 146)
	(%)			
NUMBER OF PIECES OF LAND IN FARM				
One to Two Parcels	96	100	90	95
Three to Nine Parcels	0	0	8	2
Ten or More Parcels	4	0	2	3
AMOUNT OF LAND OWNED				
< 1 ha	0	25	3	5
1 to 10 ha	50	15	27	36
> 10 ha	50	60	70	59
LAND OWNED IN COMPARISON WITH OTHER FARMERS				
More	17	15	10	15
About the Same	15	20	24	18
Less	68	65	66	67

ponds are an important mechanism for introducing aquaculture into poor rural communities. CARE/Peru officials indicated that they used community groups to construct an initial demonstration pond in some locales, but that family-based ponds were the preferred strategy. In some communities, groups of families cooperate in a *minga*—a labor exchange arrangement—to jointly construct a fishpond on one family's land. *Minga* is a Quechua word for the collaboration of communities on specific tasks (e.g., harvesting, sowing, and house building). The completion of the pond is typically followed by a small celebration hosted by the beneficiary family. Subsequent group efforts may build additional fish ponds on other farms.

Landholding

Table 2 profiles the landholding of study respondents. Nearly all owned one or two parcels of land. Napo River holdings tended to be divided between the two larger categories, but 70% of the Tamishiyacu farmers reported holding more than 10 ha. Holders of multiple parcels were primarily pond groups organized for constructing and maintaining a fishpond.

Nauta Road farmers were most diverse in size as one-fourth reported holdings less than 1 ha in size. About two-thirds of the farmers in each location indicated that they owned less land than other farmers did.

Farm Enterprises

The farm enterprises maintained by fish farmers are portrayed in Table 3. Chickens were the most commonly reported animal enterprise, followed by pigs, ducks, and cattle. In terms of cash income, 60% of the Nauta Road farmers cited fish as their primary source. Furthermore, Nauta Road farmers were more likely to integrate animal production with fish culture. Fish was identified as the primary source of cash income by about 20% of the farmers in the other locales. Chickens were the primary source of cash income for most farmers in the study.

More Nauta Road farmers raised animals near or with their fishponds than farmers from other areas. Such integrated operations recycle the undigested feed and other nutrients from penned animals.

Pond Location and Water Source

More than 85% of the fish farmers had but a single pond, as shown in Table 4. In contrast, about 45% of the Nauta Road farmers had more than one pond. None of the Napo ponds were located near the farm residence, but one-third of the Nauta Road ponds were. The location of the fishpond relative to the household is significant; ponds near households are easier to monitor. Family members can attend to the pond as well as give regular surveillance to deter theft. About 19% of the fishponds were located near the house. Farmers primarily filled their ponds from springs using gravity flow methods. No farmers experienced problems obtaining water for their fishponds.

Species Cultured

Table 5 shows that *Prochilodus nigricans* (boquichico) was the most frequently cultured fish in the Peruvian Amazon, grown by about 75% of the farmers. *Colossoma macropomum* (gamitana) was the next most frequently culture fish. *Piaractus brachypomus* (pacu) was grown by more group operations (71%) than on individual farms (58%), the largest difference in the comparison. Similar proportions grew *Brycon* sp. (sabalo) and *Leporinus* sp. (Lisa), but 9% more individual farmers favored *Semaprochilodus insignis* (yaraqui) and 11% more individual farmers reported growing *Astronotus ocellatus* (Oscar or acarahuazú). Alcántara (1994) presents a detailed analysis of

Table 3. Farm enterprises of fish farmers in the Peruvian Amazon, 1999.

	Napo River (N = 87)	**Nauta Road** (N = 20)	**Tamishiyacu-Tahuayo River** (N = 39)	**All** (N = 146)
	(%)			
ANIMALS RAISED				
Cows	33	5	13	24
Pigs	66	30	62	60
Chickens	91	90	90	90
Ducks	63	55	49	58
ENTERPRISES THAT PROVIDE MOST OF CASH INCOME				
Rice	17	25	23	17
Bananas	24	30	31	27
Fruits	18	60	38	29
Fish	23	60	18	27
Sugar Cane	3	20	0	5
Cows	20	5	5	14
Corn	14	25	13	15
Chickens	63	10	31	47
RAISE ANIMALS WITH FISHPOND				
No	74	40	59	65
Yes	26	60	41	35

Table 4. Pond location and water source reported by fish farmers in the Peruvian Amazon, 1999.

	Napo River (N = 87)	Nauta Road (N = 20)	Tamishiyacu-Tahuayo River (N = 39)	All (N = 146)
	(%)			
NUMBER OF PONDS OWNED				
One	91	55	95	86
Two	7	25	5	9
Three or More	2	20	5	5
DISTANCE TO THE MAIN ROAD OR RIVER				
Next to House	0	33	27	19
< 1 km	63	33	33	42
2 to 3 km	24	34	33	31
> 3 km	13	0	7	8
PROBLEMS GETTING ENOUGH WATER				
No	100	100	100	100
Yes	0	0	0	0
WATER SOURCE FOR PONDS				
Well	0	0	3	1
Spring	71	100	77	77
River or Stream	1	0	5	2
Lake or Reservoir	0	0	5	1
Irrigation Canal	25	0	10	17
Collected Runoff	3	0	0	2
WATER SUPPLY TO POND				
Pumped	0	0	0	0
Gravity Flow	100	100	100	100
Combination	0	0	0	0

Table 5. Species cultured by fish farmers in the Peruvian Amazon, 1999. See also Alcántara (1994).

Type of Fish Raised	Napo River (N = 87)	Nauta Road (N = 20)	Tamishiyacu-Tahuayo River (N = 39)	All (N = 146)
	(%)			
Colossoma macropomum (gamitana)	66	63	61	64
Piaractus brachypomus (paco)	61	53	63	60
Prochilodus nigricans (boquichico)	76	63	82	76
Brycon sp. (sábalo)	54	74	26	49
Leporinus sp. (lisa)	38	37	13	31
Astronotus ocellatus (acarahuazú)	17	21	24	19
*Cichla monoculus (*tucunaré)	14	11	5	11
Cichlasoma amazonarum (bufurqui)	39	42	37	39
Semaprochilodus insignis (yaraqui)	45	16	47	42

Table 6. Feeding practices of fish farmers in the Peruvian Amazon, 1999.

	Napo River (N = 87)	Nauta Road (N = 20)	Tamishiyacu-Tahuayo River (N = 39)	All (N = 146)
	(%)			
THINGS MOST OFTEN FED*				
Kitchen Waste	42	95	74	58
Fresh Vegetation	10	65	62	31
Rice Bran	6	15	3	7
Dead Animals	1	5	6	3
Slaughter Waste	8	60	21	19
Fruits	92	50	59	77
VISITS TO PONDS				
Several Times a Day	10	70	37	25
Daily	37	15	42	36
Almost Daily	25	10	13	20
Several Times Weekly	23	5	3	15
Once a Week	3	0	5	3
Several Times a Month	2	0	0	1
NUMBER OF FEEDINGS				
Several Times a Day	4	45	22	14
Weekly	29	20	22	26
Several Times Monthly	35	25	22	30
Monthly	20	10	19	18
Less Often	6	0	6	5
Never	6	0	8	6
TIME USUALLY SPENT AT PONDS				
Less than an Hour	76	55	35	62
About an Hour	21	15	16	19
Two or Three Hours	3	15	19	9
More than Three Hours	1	15	30	10

* Multiple responses possible.

Table 7. Pond management practices of fish farmers in the Peruvian Amazon, 1999.

	Napo River (N = 87)	Nauta Road (N = 20)	Tamishiyacu-Tahuayo River (N = 39)	All (N = 146)
	(%)			
POND FERTILIZER USED*				
None	40	84	13	38
Other	0	0	10	3
Chicken Manure	1	16	21	8
Cattle Manure	58	0	54	48
Compost	1	0	10	3
PONDS LIMED LAST YEAR				
No	99	85	97	96
Yes	1	15	3	4

* Multiple responses possible.

fish landings at Iquitos ports and the species that are brought to market.

Fish Feeding

Farmers in the four locations fed their fish a variety of different items reflecting differences in the species cultured and items available (Table 6).

About 73% of the Napo farmers fed their fish several times a day. The greater incidence of integration with poultry and duck production that requires multiple daily feedings literally spills over to the fish crop. Poultry houses are typically located directly over the fishpond, so feed and litter are nearly continuously deposited into the pond.

Nauta Road resident farmers reported a high level of attentiveness to their ponds, but more Tamishiyacu farmers spent long periods at their ponds when they visited them. All the Nauta Road farmers fed their fish several times a week or more often. Three-quarters of the Nauta Road farmers spent less than an hour on each visit as they were making more visits to attend to their fish. Feeding refers primarily to the provision of fruits, household scraps, and other items directly consumed by the fish. Patterns of fish feeding parallel patterns of pond visitation.

Pond Management

Table 7 profiles some of the pond management practices used in the Peruvian Amazon. Nauta Road farmers tended to not fertilize their ponds, whereas half the farmers at the other sites used cattle manure. Curiously, 15% of the Nauta Road farmers limed their ponds, a fundamental fish culture management practice not followed by many farmers in the other areas. These farms had truck delivery access to Iquitos port facilities where lime and other bulk agricultural chemicals are more readily available. Lime increases the alkalinity (pH) of the pond and fosters primary productivity. Tamishiyacu farmers spent the most time with their ponds when they visited them, Napo farmers the least.

Stocking Practices

Table 8 suggests that fingerlings are typically acquired from local fisherman, and few farmers are using farm-produced fingerlings from private or government sources. About two-thirds of the farmers experienced some problems finding fingerlings when they wanted to restock their ponds. Most were stocking fingerlings between 3 and 10 cm in size.

Table 8. Stocking practices of fish farmers in the Peruvian Amazon, 1999.

	Napo River (N = 87)	Nauta Road (N = 20)	Tamishiyacu-Tahuayo River (N = 39)	All (N = 146)
	(%)			
SOURCE OF FINGERLINGS				
Research Station	0	10	3	2
Private Dealer	7	50	11	14
From a Neighbor	1	5	3	2
Other (Collected from River)	92	35	83	82
PROBLEMS FINDING FINGERLINGS FOR RESTOCKING				
No	34	55	27	35
Yes	66	45	73	65
SIZE OF FINGERLINGS STOCKED				
< 3 cm	4	10	14	7
3 to 5 cm	34	55	57	43
5 to 10 cm	57	35	29	48
> 10 cm	5	0	0	2

Table 9. Farm equipment owned by fish farmers in the Peruvian Amazon, 1999.

Equipment on Farm	Napo River (N = 87)	Nauta Road (N = 20)	Tamishiyacu-Tahuayo River (N = 39)	All (N = 146)
	(%)			
Fish Net	15	29	48	26
Water Quality Test Kit	1	0	0	1
Scale	17	86	24	27
Wheelbarrow	99	64	70	87

Table 10. Harvest practices of fish farmers in the Peruvian Amazon, 1999.

	Napo River (N = 87)	Nauta Road (N = 20)	Tamishiyacu-Tahuayo River (N = 39)	All (N = 146)
	(%)			
LABOR HIRED TO HARVEST FISH				
No, Self	37	0	33	28
No, Family	59	85	63	65
No, Laborers	2	10	4	4
Buyer Harvested Pond	2	5	0	3
TROUBLE GETTING ENOUGH HELP TO HARVEST				
No, Labor Used	77	80	72	77
No Problems	21	20	23	21
Yes, Difficulty	2	0	5	2
AVERAGE SIZE HARVESTED				
< 20 cm	0	5	10	3
20 to 45 cm	84	90	85	86
> 45 cm	16	5	5	11
AVERAGE WEIGHT HARVESTED				
< 120 g	0	0	14	3
120 to 249 g	2	0	5	2
250 to 499 g	41	0	18	27
500 to 749 g	20	6	18	17
> 750 g	37	94	45	51

Farm Equipment

Table 9 shows the farm equipment reported by the surveyed farmers. Wheelbarrows were owned by about 87% of the sample. About one-quarter had a scale and a similar proportion a fish net.

Harvest Practices

Farm labor for harvesting fish was usually supplied by family members, particularly in the Tamishiyacu-Tahuayo communities, as shown in Table 10. Few operators employed laborers or used the services of a buyer to harvest their ponds. Few reported difficulties obtaining labor. Farmers harvested large fish, most favoring sizes 20 to 45 cm in length and greater than 750 g. Thus, most operators achieved only one cycle of production each year.

Marketing

Only a small proportion of each sample reported fish harvested solely for home consumption or barter, i.e., not sold for cash (Table 11). Most sold some fish for cash and only a few said that they sold less than half the harvest for cash. About 80% of the Napo River respondents sold all their harvest for cash, but only 21% of the Tamishiyacu did. In Nauta River, 80% said they sold more than half the harvest for cash. Nearly 100% did so in Tamishiyacu-Tahuayo Rivers.

Middlemen purchased fish from about 41% of the farmers overall. In the Napo River 56% used a middleman. Only 18% of Tamishiyacu farmers sold to middlemen. Few farmers sold fish to restaurants.

Tamishiyacu farmers were less likely to sell fish in a community marketplace than farmers from the Napo River and Nauta Road regions. Direct marketing by way of pond bank sales was most common for farmers of Tamishiyacu-Tahuayo Rivers. The most common marketing method for farmers from all regions was pond bank sales to neighbors and others coming to the ponds at harvest. Word-of-mouth knowledge about prospective harvests or the willingness to partial-harvest for immediate sale remain primary means for marketing fish for most small- and medium-size farmers.

Marketing Problems

Table 12 shows that very few farmers experienced trouble marketing their fish. Few reported price problems, though one-fourth of the Nauta Road farmers did so. Most felt they could move their product at a lower price. Most respondents felt that larger fish are easier to sell.

Fingerling sales to other farmers were most common in Napo River, where more than half the respondents reported such transactions. Private fingerling sales among farmers are an important indicator of sustainability, especially where government services are unreliable or unavailable in much of the locale. The respondents did not frequently report fingerling sales. Most were growing species that do not naturally reproduce in ponds, so fingerlings would not be an expected by-product of their ponds.

Impacts on Households

Table 13 shows a series of questions profiling the impacts of fish culture on households. Almost none of the farmers thought that there were points in the annual farm cycle when the pond was too much work. Few respondents noted problems associated with the fish enterprise in taking care of other crops, taking care of the family, or completing other household work. Most thought the pond fit well with other activities of the household. Previous work suggests that women are much more likely to report these difficulties (Molnar et al., 1996). About 84% of the respondents noted the benefits of additional cash for their families as something associated with the fish crop.

Pond Conflicts

Table 14 shows respondent experiences with a series of problems sometimes encountered by fish farmers. No farmers noted problems concerning conflict with others about water resource available for fish crops. Tamishiyacu operators had the most problems with predators eating their fish, but this was also an issue for many farmers in each of the other locations.

Theft was a concern for about two-thirds of the Napo River and Nauta Road farmers, but much less so on the Tamishiyacu-Tahuayo Rivers. Napo farmers were most likely to agree that fish were easier to steal than other crops, though one-third of the other respondents thought so as well.

In our field visits, farmers reported few specific production problems. Nutria was most frequently mentioned as a source of production losses, with some occasional mentions of alligators and birds. In general, farmers seemed happy with the fish enterprise, several were in the process of planning or constructing additional ponds, and we encountered only a few unused or abandoned ponds. These were typically small ponds with water supply problems. Ponds that fail to keep water during the dry season thwart the counter-cyclical possibilities of fish culture.

Prospects for the Pond

Nearly all respondents thought their fish pond produced enough to be worth the work they put into it, though a few Nauta Road respondents were skeptical (Table 15). Nearly all respondents thought fish was the best use of the land it occupied. Nauta Road and Tamishiyacu residents were most likely to report themselves as planning to build new ponds (over 90%). In Napo River, only 72% thought so. Nearly all were happy with fish as a crop to raise, but less so on the Tamishiyacu River (84%). Overall, 86% of the farmers surveyed felt that fish was more profitable than other farm activities, but 92% of the Napo River farmers felt this way.

Table 11. Marketing practices of fish farmers in the Peruvian Amazon, 1999.

	Napo River (N = 87)	**Nauta Road** (N = 20)	**Tamishiyacu-Tahuayo River** (N = 39)	**All** (N = 146)
		(%)		
CASH LAST HARVEST				
Yes	90	70	67	80
No	10	30	33	20
AMOUNT OF FISH SOLD				
None for Cash	9	7	36	16
Less than Half	2	7	11	5
Half for Cash	2	7	11	5
More than Half	7	47	21	18
All for Cash	80	32	21	56
MIDDLEMAN PURCHASED FISH				
No	44	72	82	59
Yes, Some of it	19	17	12	17
Yes, All of it	37	11	6	24
FISH SOLD TO RESTAURANTS				
No	94	95	100	96
Yes, Some of it	6	5	0	4
Yes, All of it	0	0	0	0
FISH SOLD IN THE MARKET				
No	48	55	70	55
Yes, Some of it	30	25	25	27
Yes, All of it	22	20	5	17
FISH SOLD TO OTHER BUYERS				
No	44	45	39	43
Pond Bank Sales	56	55	61	57

Table 12. Marketing problems of fish farmers in the Peruvian Amazon, 1999.

	Napo River (N = 87)	Nauta Road (N = 20)	Tamishiyacu-Tahuayo River (N = 39)	All (N = 146)
	(%)			
TROUBLE SELLING FISH				
No	98	93	87	94
Yes	2	7	13	6
PROBLEMS SELLING AT DESIRED PRICE				
No	85	73	79	81
Yes	15	27	21	19
FISH SOLD AT A LOWER PRICE (IF DESIRED PRICE NOT OBTAINED)				
No	67	33	31	53
Yes	33	67	69	47
LARGER FISH EASIER TO SELL				
No	7	12	3	7
Yes	93	88	97	93
FINGERLINGS SOLD TO OTHER FARMERS				
No	100	90	100	98
Yes	0	10	0	2
TROUBLE SELLING FINGERLINGS				
No, Did Not Sell	100	90	100	98
No Problems	0	0	0	0
Yes, Problems	0	10	0	2

Technical Assistance

Aquacultural extension services were making frequent contacts with farmers on the Napo and Tamishiyacu Rivers, but less so on the Nauta Road. In each location, NGO technicians were working in aquaculture in one way or another. Most farmers reported some kind of extension contact in the past year. Most farmers received regular visits if they wanted them. Nearly all respondents indicated that they wanted extension help in the future.

CONCLUSIONS

There are few obstacles to at least limited success with fish culture in Amazonia. We observed a high degree of variability in the quality of pond construction and culture conditions, as well as in the type of species employed and level of management applied. Farmers typically stock a polyculture of three to five different species of wild–caught fry or juveniles for grow-out. Farmers typically reported counts of the number of fish of each species that was stocked.

Peru is in an advantageous situation for fish culture. The data show that farmers encounter few barriers to building ponds, obtaining fingerlings, feeding their fish, or marketing the product. Fish farmers in the Peruvian Amazon are interested in and receptive to technical assistance. Fruits and other forest-based fish foods are widely available to support extensive production systems. A number of NGOs are providing regular farm visits and advice on fish culture. The natural cycle of the Amazonian river systems ensures a market period of relatively high prices for farm-reared fish. The research agenda is appropriately focused on enhancing the availability of hatchery-reared fry. Nonetheless, additional attention is needed on identifying and communicating production practices that will reduce risk and enhance the benefits of aquaculture for the many small- and medium-scale farms in the Selva.

ANTICIPATED BENEFITS

The communication process linking experimental pond practice to farm practice involves several layers of translation and transmission (Cernea, 1991a, 1991b). Many factors interact to affect the nature and extent of impact that 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 trial. The data presented here provide empirical specification of the needs and preferences of the actual intended beneficiaries of PD/A CRSP activities in Peru.

Table 13. Fish pond impacts on households of fish farmers in the Peruvian Amazon, 1999.

	Napo River (N = 87)	Nauta Road (N = 20)	Tamishiyacu-Tahuayo River (N = 39)	All (N = 146)
	(%)			
POND IS SOMETIMES TOO MUCH WORK				
No	97	100	100	98
Yes	3	0	0	2
FISH FIT WELL WITH OTHER FARM ACTIVITIES OF HOUSEHOLD				
No	1	0	3	1
Yes	99	100	97	99
POND MAKES IT HARDER TO CARE FOR OTHER CROPS				
No	98	100	100	99
Yes	2	0	0	1
POND MAKES IT HARDER TO TAKE CARE OF FAMILY				
No	98	95	100	98
Yes	2	5	0	2
POND MAKES IT HARDER TO COMPLETE OTHER HOUSEHOLD WORK				
No	97	100	100	98
Yes	3	0	0	2
CASH FROM FISH MAKES IT EASIER TO BUY THINGS FOR FAMILY				
No	23	6	4	16
Yes	77	94	96	84

Table 14. Pond conflicts experienced by fish farmers in the Peruvian Amazon, 1999.

	Napo River (N = 87)	Nauta Road (N = 20)	Tamishiyacu-Tahuayo River (N = 39)	All (N = 146)
	(%)			
CONFLICTS OVER WATER				
No	100	100	100	100
Yes	0	0	0	0
BIRDS OR OTHER ANIMALS EATING FISH FROM PONDS				
No	38	42	19	34
Yes	62	58	81	66
PEOPLE STEALING FISH				
No	37	32	57	42
Yes	63	68	43	59
FISH EASIER TO STEAL THAN CROPS				
No	38	68	61	61
Yes	62	32	32	39

Table 15. Prospects for the pond reported by fish farmers in the Peruvian Amazon, 1999.

	Napo River (N = 87)	**Nauta Road** (N = 20)	**Tamishiyacu-Tahuayo River** (N = 39)	**All** (N = 146)
	(%)			
FISH PRODUCE ENOUGH TO BE WORTH THE WORK				
No	0	5	3	1
Yes	100	95	97	99
FISHPOND BEST USE OF LAND IT USES ON THE FARM				
No	1	0	8	3
Yes	99	100	92	97
PLANNING TO BUILD MORE PONDS				
No	28	11	8	20
Yes	72	90	92	80
GENERALLY HAPPY WITH FISH AS A CROP TO RAISE				
No	0	0	19	4
Yes	100	100	84	96
FISH PROFITABILITY COMPARED TO OTHER ACTIVITIES				
More Profitable	92	76	76	86
About the Same	8	18	24	13
Less Profitable	0	6	0	1

Table 16. Sources of technical assistance reported by fish farmers in the Peruvian Amazon, 1999.

	Napo River (N = 87)	**Nauta Road** (N = 20)	**Tamishiyacu-Tahuayo River** (N = 39)	**All** (N = 146)
	(%)			
LAST EXTENSION CONTACT				
Never Contacted	5	55	11	13
In Past Month	83	20	76	73
Month to Year	7	5	3	6
More than a Year	5	20	0	8
LAST FISH STATION CONTACT				
Never Contacted	92	80	80	88
In Past Month	7	10	6	7
Month to Year	0	0	6	1
More than a Year	1	10	8	4
WANT EXTENSION HELP				
No	1	15	5	4
Yes	99	85	95	96

As such, they provide a baseline or template for interpreting the cumulative impact of PD/A CRSP and NGO partner activities, as well as 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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