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Economic Analysis of the Inland Fisheries Project in El Salvador

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SUMMARY AND CONCLUSIONS

During the 2-year period Dr. David R. Bayne served as Fisheries Advisor to the Ministry of Agriculture, the fisheries program of El Salvador recorded substantial progress. Specific advances were as follows:

- The Fisheries Station at Santa Cruz Porrillo was essentially completed, a survey of lakes and ponds was instituted, and a farm pond culture survey was completed.
- Research directed towards increasing harvests from the national waters of El Salvador was conducted.
- The Fisheries Service expanded and began an active program of disseminating fisheries information to prospective fish farmers.
- A program of community ponds was developed to further increase awareness of fish farming as a production alternative.
- Arrangements were completed for professional training of fisheries personnel.

Lack of funds for construction severely limited developments at the Fisheries Station and construction did not proceed on schedule. At the time Dr. Bayne completed his tour, however, the program had reached a stage where significant benefits could accrue to the country. The next stage in the fisheries program should be a melding of research and extension. Economically feasible production techniques that have been developed must be accepted by producers before success of the program can be assured. A strong commitment on the part of the Fisheries Service and the Ministry of Agriculture is essential for strengthening the extension program in fisheries.

A new fisheries advisor should have been present in El Salvador during the final period of Dr. Bayne's tour so that programs in progress could have undergone an orderly transition. Presently, there are two individuals with training in fish culture working with Fisheries Service in El Salvador: David Dunseth, Peace Corps Volunteer working at the Fisheries Station, and Ralph Parkman, Peace Corps Volunteer working on a fish marketing study. Both are masters candidates. One Salvadorean is presently training for a B.S. degree in fisheries at Auburn University, and the Head of the Fisheries Service, Jose E. Cabrero, will enroll as a Ph.D. candidate at Auburn University in March 1974. In June 1974, Cecilio Garcia Ramirios will begin study towards a M.S. degree at Auburn University. The return of trainees will provide the nucleus of trained people necessary to carry out an effective fisheries program. While the training programs are imperative, the interim period must be utilized effectively. A fisheries service without a trained technical advisor and with its head out of the country could easily be diverted into nonproductive bypaths.

Farm fish culture in El Salvador is clearly in a pre-emergence stage. Consumption of fish per capita is less than one-fifth of consumption in Panama. Research has only begun to examine the various production possibilities for different areas of the country. In the United States, production of over 20,000 kilograms per hectare can be attained under certain commercial production systems. In El Salvador, with its favorable climatic conditions, production levels should far exceed those attainable in the United States, once producers obtain an assured water supply, a polyculture system utilizing supplementary feeding, and management knowledge regarding production and harvesting. Envision a chicken producing unit with waste material moved directly into a pond. Rafted on the pond is a hydroponic crop that is fed to the chickens or fish, or sold for human consumption. Within the pond are several species of fish, each utilizing a different level of the food chain. Should research indicate that fresh water crabs or clams would fit within the system, then production would become three dimensional. Under such a system, 1 hectare of water surface would represent 2 or 3 hectares of production simultaneously. Applied research must be continued to attain the highest levels of productivity possible. While some research results are transferable, the situation in each country requires different production systems. Thus, research must be carried out in El Salvador. It will be at least 2 years, however, before experienced and trained Salvadorean aquaculturists will be available to carry the research programs forward.

The externalities of expanded fish production are difficult to perceive, but the possibilities are constructive. Producers with multiple ponds can ensure a stable water supply by drilling wells, with the resultant benefit of a domestic water supply. Full time on-farm labor for the producer and his family, coupled with a higher protein diet, may improve the educational level of part of the population. Each of these factors is difficult to quantify. For a country with a high population density and limited land resources, however, intensive fish culture represents one means to supply maximum return. In terms of protein equivalents per unit of input, fish production far exceeds cattle or hog production. Before any of the returns postulated in this analysis can occur, however, the research results must be transmitted to and accepted by the production sector.

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COVER PHOTO. The "ensarta" of fish shown is the typical volume sold daily by small retailers.

Economic Analysis of the Inland Fisheries Project in El Salvador

E. W. McCOY*

INTRODUCTION

THE INLAND FISHERIES PROJECT in El Salvador has a comparatively brief history. In February 1971, Dr. D. D. Moss, of the International Center for Aquaculture at Auburn University, conducted a survey of the inland fisheries of El Salvador *(5)*. Dr. David R. Bayne was employed as a fisheries advisor to the government of El Salvador and arrived on post January 28, 1972. In September 1972, the El Salvador cooperative fisheries project was formalized. In February 1973, Drs. Moss and Bayne completed a review of the El Salvador fisheries project *(6)*. Dr. Bayne completed his service as fisheries advisor to the El Salvador Government in November 1973, and submitted an end of tour report *(1)*. At that time USAID/El Salvador requested an economic evaluation of the freshwater fisheries of El Salvador. Dr. E. W. McCoy, agricultural economics researcher with the Agricultural Experiment Station, Auburn University, arrived in San Salvador, El Salvador, November 18, 1973, to conduct the study. During the period November 18-28, 1973, Dr. Bayne remained in-country and provided information regarding all phases of the inland fisheries project. In addition, he arranged access to other sources of information necessary for the economic evaluation.

The reports cited *(1,5,6)* indicate the physical status of the fisheries program in 1971 and 1973 and will not be repeated in detail in this report. In 1970, the fisheries program was stagnant. A single biologist of the fisheries section was carrying out the entire fisheries program. The program's operating budget was approximately ¢22,000[1] and there was no capital budget. In 1973, the operating budget was over ¢227,000 and there was more than ¢130,000 in the capital budget for the construction of 100 community ponds throughout the country. Substantial contributions made by the government of El Salvador indicate the priority placed on the fisheries program by the host country.

STATUS OF EL SALVADOR FISHERIES

Efforts of the resident fisheries advisor were concentrated in four areas during his tour of duty. Two of the four areas pertained to developments at the Fisheries Station, Santa Cruz Porrillo, and are covered in depth in the end of tour report. Additional work was directed at an evaluation of the inland fishery resources of the country, including ponds, lakes, and streams.

Lake Study

In a study of the fisheries of the major lakes in El Salvador, Johnson and Hidalgo *(3)* found that total annual production was 1,109,934 kilograms. Lake Olomega contributed almost half of the total production. Trials were conducted to demonstrate more efficient methods of harvesting lake fish. In addition, *Tilapia aurea* were stocked in Lake Olomega and Laguna de Jocotal since studies indicated a significant quantity of nutrients was available but not utilized by existing fish populations in the lakes. The lake studies are still underway and will continue through 1974.

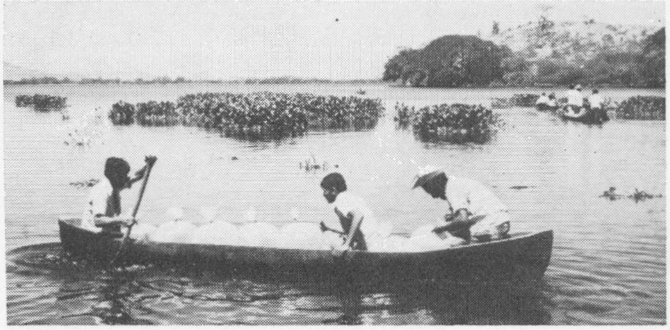

FIG. 1. Stocking *Tilapia aurea* in Lake Olomega.

Significant production increases by stocking in natural waters are probably quite limited. Some of the nation's lakes with limited watershed and relatively low fertility exhibit low productivity per hectare of water surface. All of the lakes except Olomega yielded less than 100 kilograms per hectare per year, and it is doubtful that a sustained yield above this level could be attained. Lake fisheries do not lend themselves readily to intensive management techniques. Fertilization normally is not feasible. Determining the optimum time, size of fish, and number of fish to harvest is also difficult. The lakes study has shown gaps in production and improved the efficiency of harvest; however, other means must be utilized to significantly increase the supply of freshwater fish in El Salvador.

Concurrent with the lakes study, personnel from the Department of Fisheries, USAID, and Peace Corps carried out a cooperative study to evaluate the fish pond culture in El Salvador. Results of the study were reported by Jensen *(2)*.

Fish Pond Culture Study

The fish pond study disclosed that an insignificant amount of fish was harvested from the 53 hectares of fish ponds existing in the country. Many of the ponds were not in production at time of the survey. Average production from all ponds was approximately 136 kilograms per hectare per year

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[1] $1.00 is equivalent to 2.5 colones (¢).

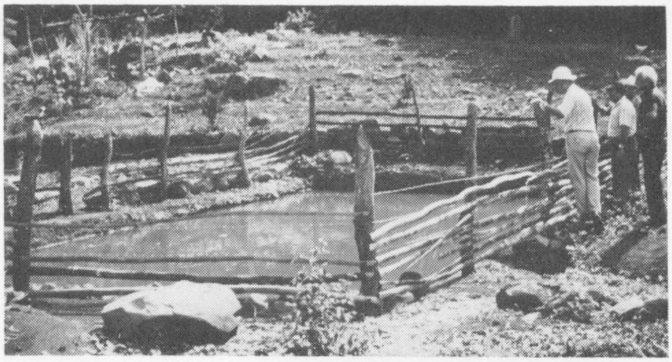

FIG. 2. Inspecting 100-square-meter fish pond in Osicala, El Salvador, are Dr. Edwin A. Anderson, Director, USAID Mission; Mr. Jack R. Morris, Assistant Food and Agricultural Office, USAID; Mr. Geronimo Chavez, Extension Advisor, USAID; and pond owner.

with a total production of about 7,000 kilograms from all harvested ponds. The evaluation team assisted with management of production and supervised harvest of fish for several pond owners. Of the harvests analyzed, about half were for ponds managed by the survey team. Average production from managed ponds was about four times as great as production from unmanaged ponds. Even the unmanaged ponds, however, yielded 10 times the amount of fish per hectare as the lakes. With no improvement in culture techniques and no additional pond construction, the annual yield from farm ponds could be increased to more than 150,000 kilograms yer year.

Fish Consumption

Results of a 1971 FAO study of fish production and consumption in San Salvador *(8)* show that the majority of fish sold there was from marine waters. Perhaps more importantly, most of the fish for local consumption were an incidental increment to a primary harvest of the shrimp fishing industry. While exporting most of the shrimp catch, the shrimp fishermen sold what fish they caught to channels for local consumption. Many non-shrimp fishermen operated out of port areas, but their total catch did not equal the incidental catch of the shrimp fishermen. Quality of the fish was generally poor.

Per capita consumption of fish in El Salvador was estimated at 2.2 kilograms, with urban consumption 4.4 kilograms and rural consumption 1.1 kilograms. The rural area includes coastal areas where per capita consumption of fish was high. Except for coastal regions, the rural areas received little fresh fish, which accounts for the extremely low per capita consumption average. The majority of the dried fish was sold in rural areas; however, less than 10 per cent of the total harvest was dried. Price did not seem to be a significant factor in determining demand for either fresh or dried fish.

Fish Marketing

In 1973 a marketing study was undertaken under the auspices of the Fisheries Service, USAID, and the Peace Corps. Designed to identify the sources and quantity of fish marketed within El Salvador, the study will cover all seasons of the year to determine if seasonality of supply and demand occurs *(7)*. The initial season's survey has been completed and certain general comments can be made regarding market structure and marketing margins.

Existing Marketing Systems

The function of any marketing system is to move the product from producer to consumer, delivering the product at the time and in the form required by the consumer. In a competitive economy, the price system ensures availability of the product. Normally the consumer transmits a price to the producer, a signal calling for an addition or a cutback in production.

The El Salvador marketing system has evolved over time, with rigidities due to tradition and custom incorporated within the system. Among the limitations of this marketing system are that fisheries production in El Salvador is largely based on the shrimp fishery, the majority of fish are of low quality, and the expression of consumer preference is difficult to measure.

Fresh fish caught by fishermen at the ports sell for a higher price than fish caught by shrimpers and freshwater fish command a higher price than salt water fish. Two factors may be in operation in determining the price structure. First, freshwater fish may be preferred to salt water fish, and second, freshwater fish may be of higher quality than salt water fish. The first factor would require consumer testing for verification, but the second one is almost universally valid in El Salvador. The fish caught by fishermen not only have a higher quality than fish caught by shrimpers, but those harvested from fresh water reach the market in better condition than fish from salt water.

A preliminary finding of the market study was the discovery of an inflow of dried fish from Guatemala and Nicaragua. Before this source was established, and still to a certain extent, the only dried fish available were small ones unsold in the fresh market. The quantity of dried fish in El Salvador is presently insufficient to meet the demand because

FIG. 3. Fish wholesalers and retailers loading fish on train at Olomega.

of such factors as (1) less of the fresh fish are unsold, and (2) the quantity of smaller fish caught has declined due to pesticide problems in the rivers and estuaries. The pesticide problem will be discussed in greater detail in the section on production.

Much of the marketing is conducted by women who have been in business for many years. No generalization can suffice to characterize all markets; however, an example may assist in illuminating the complexities of moving one type of fish from one port city to consumers. Bagre or salt water catfish, a common fish sold both fresh and dried in El Salvador markets, will serve as the example. The movement of this type fish from the port at Acajutla has been traced for one season. The quantity has not been determined since origins intersect in all of the major markets.

A Market Channel Example

Fishing boats arrive at the pier in Acajutla in the afternoon, and most of the fish are immediately sold. Figure 4 is a graphic representation of the market channels used. At the pier, catfish sell for approximately ¢0.35 per pound. A portion of this is bought by consumers in 4- to 10-pound strings. The wives of fishermen also retain some fish which they sell in the Acajutla market the following day at an average of ¢0.55 per pound. The markup is possible since the price per unit increases as the quantity purchased decreases. The investment for the retailer is minimal on a daily basis. Market space costs ¢0.10 per day and the other assets consist of fish baskets and banana leaves. No transportation or storage charges are involved at this level.

Wholesalers buy most of the fish at the dock, for shipment to Sonsonate, Santa Ana, and San Salvador. The fishermen normally gut the fish prior to sale, the wholesaler provides the function of collecting, storing, and transporting. The fish are usually iced down in metal containers before being moved overnight by bus, truck, or train, depending on the wholesaler and the volume transported. When the fish reach the market they are immediately in direct competition with freshwater fish and fish from other ports, as well as the volume of "Pescado del Barco" from the shrimp fleets. The small size of the country allows ease of shipment from the ports and lakes to all of the major markets.

Establishing Market Price

Several levels of wholesalers exist, and the line between wholesaler and retailer narrows as the fish reach central markets. In some instances, a large wholesaler-retailer may sell to the public and to smaller retailers. The market study will determine if differential pricing allows the phenomena, or if the cause may be informal arrangements whereby larger retailers do not sell fish in small lots while the smaller retailers subdivide larger lots and sell on a per unit basis. The markets are organized in a manner to nearly meet theoretical supply and demand conditions. Fifteen or 20 sellers of similar products normally would result in a price which just covers the seller's cost of operation plus a sufficient return to stay in business. The El Salvador markets do not appear to meet model conditions with regard to price. The total investment for all levels of the market except the large volume wholesaler of "Pescado del Barco" at El Triunfo would

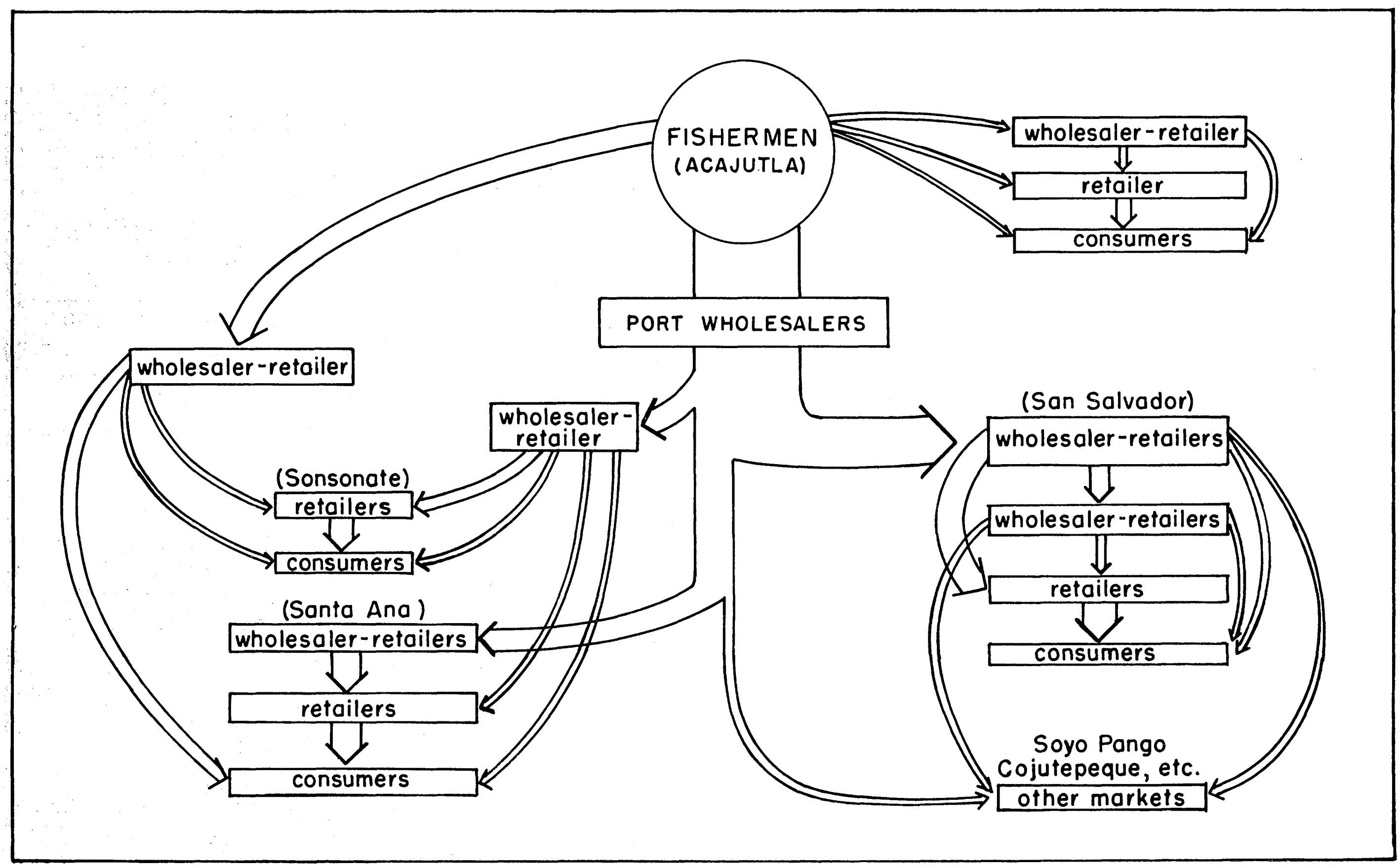

FIG. 4. Movement of salt water fish from the port of Acajutla to principal areas of consumption, November 1973.

be less than ¢3 per day or ¢0.03 per 100 pounds of fish marketed. The smallest mark-up of bagre during the time period covered was ¢0.11 between Acajutla and the La Campana market in El Salvador. Since the marketing margin has been maintained, certain supply and demand features can be postulated. First, demand has been sufficient to move the product at the prevailing price. Three factors indicate the validity of the assumption: (1) "Pescado del Barco" with extremely low quality sells in the market as fresh fish; (2) dried fish are imported to meet the demand for the product in that form; and (3) some wholesalers or retailers show no tendency to cut price to move the product.

Price Response to Supply Increase

In analyzing the market for fish, one factor is paramount: Freshwater fish sell for approximately twice as much as most salt water fish and sell competitively with the most preferred species of salt water fish. If the number of freshwater fish reaching the market were to increase, two events would occur: (1) demands which are presently not met could be satisfied at the same price for the producer; and (2) if production increased by a large enough factor, a portion of the marketing margin would be passed on to consumers in order to move the product. With substantial production increases, the freshwater fish would drive the lower quality salt water fish into the dried fish sector. Freshwater fish could enter the markets at rates up to 36,000 kilograms per week before any significant price effects would occur at the pond level. The production of 36,000 kilograms per week under existing conditions would require 600 hectares of surface water. Both increasing income and increasing population would increase the amount of acreage feasible without significant price changes. Increased production without population growth would result in an increase in per capita consumption by approximately 0.5 kilogram per year.

PROJECTED IMPACT OF FISHERIES PROJECT

The USAID/El Salvador objectives and strategy paper for 1972 *(8)* identified for primary emphasis two critical problem areas, unemployment and underemployment, and a target group of low and medium income farmers. More specifically, the target group is composed of farmers with land holdings between 1 and 49.9 hectares. This group lacks credit, market access, knowledge of new technology, and other assets which limit their ability to fully utilize land and labor resources. According to the strategy paper, fish production will attack three basic problems of this rural sector: (1) dietary deficiency in animal protein, (2) low farm income, and (3) high rate of unemployment.

As shown by nutritional data, fish are about 80 per cent protein on a moisture-free basis, in comparison with 40-50 per cent for red meats and 7 per cent for rice *(9)*. On a per pound protein basis, red meat generally costs about twice as much as fish. The fact that fish production enjoys a more efficient conversion factor than red meat production is of primary importance. While poultry production has improved to the point that 2 pounds of supplemental feed produces a pound of gain, beef production requires 6 to 7 pounds of feed per pound of gain. Of particular significance, feed used for red meat production often can be used for human consumption. In contrast, the feed used for the species of fish grown in El Salvador does not compete for human consumption. These species feed on decayed matter, bottom organisms, plankton, and algae, and can utilize such by-products as chicken manure and coffee pulp.

FIG. 5. Threshing of hand harvested rice.

Research at the Fisheries Station, Santa Cruz Porrillo, has been undertaken to determine feasible production systems for fish culture. Objectives are to determine optimum stocking rates and cultural systems that will maximize returns to land, labor, and capital investment. Already a production system for farmers within the target group has been developed. The micro impact on the individual producer is illustrated in the next section.

Capital Requirement

Two major requirements for fish culture are a stable water supply and soil suitable for pond construction. With completion of the geological survey in El Salvador, the estimated acreage feasible for pond construction will be known. As shown below, construction of a 1-hectare pond, including dam and drainage system, requires a capital investment of approximately ¢5,000:

Item	*Life, years*	*Total cost for 1-hectare pond*
Pond construction	---	¢4,970
Seine net	5	198
Containers	5	33
TOTAL INVESTMENT		¢5,511

Construction costs do not change proportionately with surface area. Thus a ½-hectare pond might require an investment of ¢3,500 and a 2-hectare pond only ¢7,000. If a sufficient number of ponds were constructed in close proximity, a cooperative arrangement to purchase seines and containers could be made, thereby reducing the initial investment per operator by ¢231. The construction cost of ¢5,000 assumes the use of a bulldozer. If ponds are constructed using hand labor and bullocks with scrapers, the cost of construction would be reduced to some extent.

Labor Requirement

The climate in El Salvador is so warm that fish production can be carried out year-round. If the water supply is not sufficient to maintain the pond level during the dry season, still one crop of fish can be raised per year. Labor requirements per hectare given in Table 1 are for two pro-

TABLE 1. MONTHLY LABOR REQUIREMENTS PER HECTARE FOR *Tilapia*-GUAPOTE TIGRE PRODUCTION IN EARTHEN PONDS IN EL SALVADOR

Activity	Labor required by month[1]												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
	Hr.	*Hr.*	*Hr.*	*Hr.*	*Hr.*	*Hr.*	*Hr.*	*Hr.*	*Hr.*	*Hr.*	*Hr.*	*Hr.*	*Hr.*
Apply inorganic fertilizer	4.3		2.2	2.2			4.3		2.2	2.2			17.4
Stock fingerlings	4.65						4.65						9.3
Apply chicken manure	4.0	4.0	4.0	4.0	4.0	3.3	4.0	4.0	4.0	4.0	4.0	3.3	46.6
Harvest fish			24.0			143.3			24.0			143.3	334.6
Maintain pond	8.0	8.0	8.0	8.0	8.0	40.0	8.0	8.0	8.0	8.0	8.0	40.0	160.0
Total labor	20.95	12.0	38.2	14.2	12.0	189.6	20.95	12.0	38.2	14.2	12.0	186.6	567.9

[1] Starting month is arbitrary.

duction periods of 6 months each. The starting point for the system is arbitrary unless water supply serves as a constraint. The labor requirements peak twice yearly as portrayed in the table; however, the peaks could be smoothed over a 3-month period. Following initial stocking of the fish, only feeding and pond maintenance are required until the first partial harvest at 3 months. The remainder of the fish are harvested at 6 months; then the pond is cleaned, restocked, and production begins for the second batch. Harvesting could continue from the third month through the sixth month, with partial harvests of the larger fish each month. Then the cash flow to the producer would stabilize and the flow of fish to market would be more orderly. With two ½-hectare ponds 3 months out of sequence, the producer could harvest each month and have cash income on a monthly basis. Each of the alternatives are economically and biologically feasible and each represents slightly different cost and return situations.

Production Cost

The production cost budget presented in Table 2 assumes two partial harvests and two principal harvests per year. Most of the budgeted labor cost of ¢122 is imputed to accrue to the pond owner since the pond owner and family members should be able to supply all labor needs except for additional help at harvest. The cost of supplies is ¢709 per year, or ¢354 per crop of fish. Short term operating capital would be required at a cost of approximately ¢16 per growing period or ¢32 for two batches of fish per year. The total production cost of ¢957 includes pond maintenance and depreciation on the seines and fish containers. The major cash expense items included in the total are cost of chicken manure and cost of fingerlings. If sufficient production begins in an area, one producer may specialize in fingerling production. In the interim, fingerlings are provided by the Government Fisheries Service. Chicken manure presently represents a cost item both to the chicken producer and the fish producer. The costs listed in the budget represent those for transporting the manure from the chicken producer to fish producer. In production schemes where waste material from one product represents a primary input for another product, the two are normally produced in conjunction. Presently, a major turkey producer in El Salvador is examining the possibility of producing fish to utilize turkey wastes. Production of the two products in common or in close proximity is indicated by research at the Fisheries Station. The budget presented does not include any reduced costs for chicken or turkey production.

TABLE 2. COSTS AND RETURN PER HECTARE FOR PRODUCTION OF *Tilapia*-GUAPOTE TIGRE POLYCULTURE USING CHICKEN MANURE (STOCKING RATE, 2 MALE *Tilapia* TO 1 GUAPOTE TIGRE)

Item and unit	Costs and returns[1]			
	Per unit	No. units	Unit total	Total
	¢	*No.*	¢	¢
Labor, total man-hours	0.30	408		122.40
Apply organic fertilizer	.65	8	5.20	
Stock fingerlings	1.40	2	2.80	
Apply chicken manure	.04	350	14.00	
Partial harvest	7.20	2	14.40	
Final harvest	43.00	2	86.00	
Supplies				708.76
Ammonium sulfate, lb.	.08	175	14.00	
Fingerlings, no.	.018	19,466	350.39	
Chicken manure, lb.	.03	11,479	344.37	
TOTAL OPERATING EXPENSES				831.16
Interest on operating expenses at 9%[2]			31.90	31.90
Other expenses				94.00
Pond maintenance, hr.	.30	160	48.00	
Depreciation on nets and containers (5-yr. life)			46.00	
TOTAL PRODUCTION COST				957.06
Returns				2,207.00
Large fish > 14 cm., kg.	.88	2,354	2,071.80	
Small fish < 14 cm., kg.	.44	307	135.20	
Net to land, capital, and management				1,249.94
Capital at 8%, pond construction			397.60	
Net to land and management[3]				952.34
Land charge @ ¢215/ha			215.00	
Return to management[3]				737.34
Return on capital investment			22%	

[1] U.S. $ is equivalent to 2.5 colones.

[2] Family labor is used in production. Interest increases by ¢5.50 if hired labor is required.

[3] The budget includes charges for all items included in production and contains a net return of ¢952.36 after payments of wages, purchase of supplies, interest on operating capital, and interest on fixed capital. If pond construction is financed, the ¢952.36 would be available to repay the loan. The amount could repay capital investment in slightly more than 5 years. If both land and pond construction are financed, then ¢737.36 would be available to repay both loans.

Returns

Gross returns are based on sales of 2,345 kilograms of fish larger than 14 centimeters in length and 307 kilograms of fish smaller than 14 centimeters. Based on market studies and empirical evidence from Fisheries Station sales, larger fish sell for ¢0.88 per kilo and the smaller fish bring ¢0.44 per kilo at the pond bank. Gross returns of ¢2,207 per hectare result from sales at these levels. The net return is ¢1,250 per hectare on a capital investment of approximately ¢5,000. With an interest rate of 8 per cent on fixed capital, the net return to land and management is ¢952. Assuming a land charge of ¢215 per hectare, the return to management is ¢737. The percentage return on capital is approximately 22 per cent.

Micro Impact of Production

Since the budget includes a return of ¢0.30 per hour for labor, no imputed charge for family labor was deducted from gross returns. If family labor is used to raise and harvest the fish, then the producer will have gross returns of ¢2,207 which will re-enter the income stream. Of the total expenses for supplies and interest, 47 per cent is returned directly to the farm sector for purchase of fingerlings. An additional 47 per cent goes to the transportation sector for handling chicken manure. Both of these sectors have high employment and consumption multipliers, especially if bullock carts are used to haul chicken manure to the pond. Each colone spent in these sectors will create approximately ¢9.5 of additional income in the economy after the expenditure rounds are completed. Of the remaining expenditure, 4 per cent is returned to the credit sector where a portion will become available for new loans. In addition, approximately 2 per cent goes to the import sector and leaves the system. The amount going to the import sector will be reduced as the pond ages, since less ammonium nitrate will be required.

Distribution of cash expenses given below indicates impact of production on different segments of the economy:

Amount	*Recipient*
¢ 14.00	importer
350.39	farm level fingerling producer
344.39	transportation sector
31.90	credit sector
¢740.68	total

Reduction of gross returns by the amount of cash expenses leaves ¢1,466 for the producer to utilize for capital investment, amortization, and living expenses. Amortization of pond costs over a 20-year period requires a principal payment of approximately $250 per year plus an interest payment of ¢398 the first year, decreasing approximately ¢20 each year until the debt is retired. The land charge would be ¢215 to cover both principal and interest over the 20 years. Total payment to the long term credit sector the first year would be ¢862, much of which would re-enter the economy as loanable funds.

After total payment of expenses, principal, and interest, the producer received ¢604 return for labor and risk bearing. Of the ¢604 return, ¢46 must be set aside for replacement of depreciable assets, leaving ¢568 direct disposable income for the fish producer. For producers who presently have pond and/or land, the amount of disposable income would be increased accordingly.

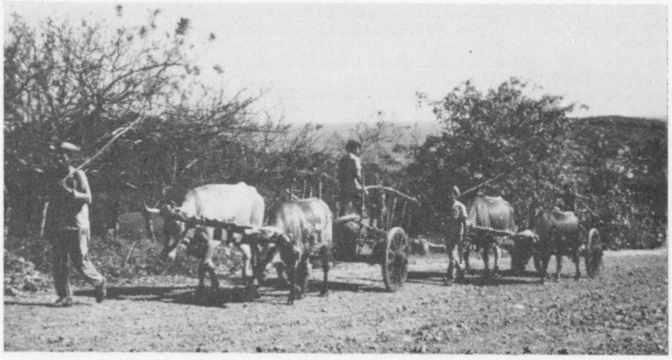

FIG. 6. Bullock carts used to transport goods to market.

For the small and medium farmer making up the target group, the consumption function has approximately the same slope as the income function. A certain amount of saving will arise when the farmer perceives his income shift is permanent. The savings will be necessary to offset risk over the life of the loan. Assuming an initial 5 per cent savings, the producer will return approximately ¢520 to the income stream in the purchase of food, clothing, and other items. With an assumed multiplier of 9.5 in the farm sector, the producer expenditures will generate additional income of ¢4,940. The income generated by production expenditure was assumed to approximate ¢6,593 per year; thus, the direct income effect would approach ¢11,500 per hectare of production per year.

Additional Production Systems

The combination of *Tilapia aurea* and guapote tigre, stocked at 9:1 ratio with 10,000 fingerlings per hectare and fertilization with chicken manure, is only one of the possibilities for commercial production. In Table 3, simplified budgets for four production systems are presented. Each system may be relevant for different problems. Systems A and B are *Tilapia* monoculture with 10,000 and 15,000 fingerlings per hectare. With the wide variance in income within the country, the mixture of large and small fish produced by these systems might optimize distribution of output in some areas. The smaller fish could be sold at variable rates depending on size, while larger fish could be sold on a kilogram basis for sale through supermarkets.

System D represents an example of the payoff from research techniques. While system A generates a profitable level of return, additional stocking can result in a higher level as in system B. By introducing a biological control agent, the producer can increase the level of returns even further, as in System C. With the biological control agent, the stocking rate can be increased and supplementary feeding introduced as in system D. The supplemental feed adds weight to existing fish in the pond rather than increasing the number of fish in the pond. The supplementary feed, however, must be a by-product and not a competitor with the human diet.

The number one crop in El Salvador is coffee. Output exceeds 2 million 60-kilo bags per year. To produce a 60-kilo bag of bean coffee requires about 300 kilos of cherry coffee. Approximately 240 kilos per bag (480 million kilos total) of waste material on a wet basis are available. A prepared ration containing 30 per cent coffee pulp was tested as supplementary feed and increased net returns from ¢1,250 to ¢1,784 per hectare. Trials to determine the optimum feed-

TABLE 3. STOCKING RATE, PRODUCTION, COSTS, AND RETURNS PER HECTARE FROM FOUR FISH PRODUCTION SYSTEMS IN EL SALVADOR

Item and unit	System A	System B	System C	System D[1]
Stocking rate, no.	10,000.00	15,000.00	10,000.00	15,000.00
Total production,[2] kg.	1,942.70	3,249.90	2,661.00	3,864.00
Large fish, pct.	84.90	30.90	88.05	91.00
Large fish,[3] kg.	1,649.60	1,004.60	2,354.00	3,256.00
Small fish, kg.	293.10	2,245.40	307.00	338.00
Returns				
Large fish,[4] colones	1,451.60	884.00	2,071.80	3,102.90
Small fish,[5] colones	129.00	987.90	135.20	148.70
Total returns, colones	1,580.60	1,872.00	2,207.00	3,251.60
Production cost, colones	957.06	1,047.96	957.06	1,467.90
Net return to land, capital, and management, colones	623.54	824.04	1,249.94	1,783.70

[1] Based on one trial (replication in process).
[2] Based on market survey. A demand exists for smaller fish, thus the entire pond production can be sold.
[3] Larger than 14 centimeters.
[4] ¢0.88 per kilogram pondside.
[5] ¢0.44 per kilogram pondside.
System A—Tilapia monoculture for commercial production (10,000 fingerlings per hectare).
System B—Tilapia monoculture for commercial production (15,000 fingerlings per hectare).
System C—Tilapia-guapote tigre culture without supplementary feeding (6,666 male *Tilapia* plus 3,334 guapote tigre per hectare).
System D—Tilapia-guapote tigre culture with supplementary feeding (12,000 *Tilapia* plus 3,000 guapote tigre per hectare). Coffee pulp ration cost ¢0.10 per kilogram.

ing and stocking levels are continuing. As indicated in the table below, the optimum economic level has not been approached:

The marginal cost shown includes the cost of both additional feed and additional fingerlings. With extremely low cost supplementary feed in relationship to high value output, feeding could continue until the fish reach a conversion rate of approximately seven.

Stocking rate per hectare	*Production, kg./ha./yr.*	*Marginal product, kg./ha./yr.*	*Value of marginal production*	*Marginal cost*
3,000	4,025	1,235[1]	¢ 950.95	¢ 456.95
4,000	9,982	5,957	¢4,586.89	¢1,371.61[2]
6,000	12,504	1,261	¢ 970.97	¢ 360.88[2]

[1] Change based on *Tilapia*-guapote tigre without supplementary feeding stocked at 300 per 0.1-hectare pond.
[2] Includes additional cost of fingerlings.

With high pond densities and high supplementary feeding rates, controlling reproduction in the ponds becomes crucial. Biological control by using guapote tigre is one method, but in addition researchers have developed a method of obtaining *Tilapia* hybrids which are all male. Stocking only male fish, which grow faster and have more efficient conversion ratios, increases the value of each harvest.

Extension Activities

Research generally has a high multiplier for each dollar invested, but results must be transmitted to the clientele of the researchers for its value to be realized. One of the gaps in the El Salvador fish culture program has been a vehicle to disseminate research results to the target group. Efforts have begun to remedy the situation. Short courses and demonstrations have been conducted for extension agents throughout the country. A demonstration pond has been constructed and managed on a model farm in the northeastern part of the country. The Ministry of Agriculture has established fish culture specialists and now allows the Fisheries Service to conduct extension activities. One of the most hopeful developments was the commitment by the Fisheries Service to build 100 community ponds throughout the country. Production from these ponds will substantially increase the amount of freshwater fish available, but more importantly, researchers can transmit information directly to producers by demonstration projects in the ponds.

Even though the situations differ in the extreme, certain sequences in production of catfish in the United States and *Tilapia* in El Salvador might be comparable. Also the effects of research at field stations on production in the surrounding area could have some application. Research at Auburn University Agricultural Experiment Station indicated catfish production in farm ponds was economically feasible. Then Soil Conservation Service and Agricultural Stabilization and Conservation Service promoted the development of catfish ponds on a cost sharing basis. Finally fingerling producers initially made profit and then developed processing facilities to continue sales. During a limited period there was developed a catfish industry with 7 processing plants in Alabama and 21 plants in the Southeast. The dissemination of information through bulletins, magazine articles, and Sunday supplements was rapid. Catfish production began on land which could not be utilized for other types of production. With reasonable profits realized, however, fish production replaced corn, soybeans, cotton, and rice on some acreage. In some instances in the Mississippi Delta, entire farms of 500 to 1,500 acres were converted to fish production.

Since El Salvador has mountainous terrain throughout much of the country, 20- or 30-hectare ponds are not feasible in many areas. Initial production efforts might be directed towards natural pond areas where dams could be constructed in the watershed. Construction costs would be minimized in this fashion, and fish production would represent an additional enterprise rather than a replacement for existing enterprises. Carrying out fish production in association with chicken, turkey, and possibly swine production offers additional flexibility. For swine production, the major benefits would accrue when hogs are raised in confinement.

Innovators in close proximity to field stations have typically assimilated new production methods and varieties before the general dissemination of research results. The community ponds represent field stations in miniature. Fish production should first increase in the areas of community ponds, and then when profitability becomes apparent, spread to other areas.

One of the most promising areas for fish production with respect to terrain and water resources is the coastal plains, which is presently used for cotton production. Much of the area is low, marshy, or innundated by brackish water. Fish culture is competitive with cotton on the micro level and could be expected to replace cotton on marginal land. In the United States, the major cotton production and fish production occur in juxtaposition. An additional impetus in El Salvador is the location of the Fisheries Station at Santa Cruz Porrillo within the cotton production area. A limiting factor in the Coastal Area is that all of the factors which contribute to increased production are negated by current methods of insect control on cotton. The relatively indiscriminate spraying of the area has caused numerous fish kills at the station, as well as in the area's fresh and brackish water. Even if pesticide contamination does not result in a fish kill, the growth cycle of the fish is halted for a period with resultant increases in cost of production. Other application methods could be used to lower costs and increase plant protection, and some of these would be more compatible with fish production. Until the problems associated with pesticide residues are alleviated, fish production in the cotton producing area of the coastal zone would entail high risk. Ample production possibilities remain, however, in both the central and northern zones. The northern zone is especially promising because the scarcity of fresh fish is highest in that region.

EFFECTS OF INCREASED FISH PRODUCTION IN EL SALVADOR

Three objectives were set forth in the fisheries program: (1) reduce the dietary deficiency in animal protein, (2) increase farm income, and (3) create employment within the target population. The preceding section on production dealt briefly with the dietary benefits, and then indicated the degree of income and employment enhancement at the producer level for each hectare of production. Brief mention also was made of level of payments to the transportation and farm sectors. An increased supply of fish on a year-round basis could make possible development of a fish processing industry. Under existing conditions, fish reach the market in essentially the same form as harvested. The demand for such fish processing functions as scaling, cleaning, and packaging, as well as fileting, smoking, and freezing, would arise with sufficient production.

Macro Effect of Production Increase

In Table 4 is a budget indicating the impact of increased production on employment and income. Since many assumptions are incorporated within the data, each will be clearly stated. First, the population of El Salvador was assumed to be approximately 3,600,000 in 1973. Second, net annual production of 3,000 kilograms per hectare of pond was assumed to be feasible. Thus, to increase average consumption by ½ kilogram, or approximately 1 pound, per person would require 600 hectares or 1,800 metric tons of production. Based on the *Tilapia*-guapote tigre budget, 600 hectares of production would require 1,350,000 man-hours of labor at a cost of ¢405,000 per year. On a monthly basis, 112,500 man-hours at ¢33,750 would be required. Assuming labor is employed 60 hours per week or 240 hours per month, the farm sector would provide full time employment for approximately 470 persons. As indicated in the production budget previously, the fish enterprise would provide part time employment to some multiple of 470 during the harvest periods.

TABLE 4. IMPACT OF EMPLOYMENT AND INCOME WITH A PROJECTED INCREASE IN FRESHWATER FISH PRODUCTION IN EL SALVADOR

Function performed	Employment and income			
	Labor per unit		Totals	
	Hours/ha.	*Ha.*	*Hours*	*¢*
Farm sector				
Production	600	600	360,000	108,000
Transporting to farm	1,150	600	690,000	207,000
Producing fingerlings	500	600	300,000	90,000
TOTAL	2,250	600	1,350,000	405,000
Monthly average	----	50	112,000	34,000
Processing sector	*Hours per metric ton*	*Metric tons*		
Transportation[1]	162	1,620	262,000	79,000
Processing A[2]	162	1,296	210,000	63,000
Processing B[3]	324	324	105,000	32,000
Transportation[2]	324	1,620	525,000	157,000
Total A	648	1,296	840,000	252,000
Total B	810	324	262,000	79,000
TOTAL	----	1,620	1,102,000	331,000
Monthly average	----	135	92,000	28,000

[1] Ten per cent of the production is assumed to remain at the farm level for family consumption and pond sales.
[2] Processing A includes gutting fish and packing in ice.
[3] Processing B includes gutting, packaging, and freezing fish. Fileting occurs in this sector.
Assumptions: A—600 hectares of production; B—1,800 metric tons of production; and C—0.5 kilogram per person consumption.

Macro Effect of Inclusion of a Processing Sector

The processing sector as postulated does not exist in El Salvador at present; however, the fish market cooperative at La Libertad is used as a model. The fish cooperative presently markets about 25 to 30 metric tons of fish per year, and provides marketing services for about 35 fishermen. It has two freezers and space for other processing facilities. The organization has 12 full time employees and hires up to 18 part time workers to transport fish. The fish are gutted and occasionally degilled by the fisherman; thus, only storage is undertaken by the cooperative. The wage rate for the processing sector is assumed to be ¢0.30 per hour. Labor necessary for construction is not included since the expenditures are one time and dissipate quickly.

The processing sector is assumed to replace the present marketing system for freshwater fish. Since the present freshwater sector is relatively insignificant, any losses caused by this replacement have not been incorporated in the analysis. A processing sector would dislocate some wholesalers from the market, and bus revenues would decline slightly if fish were transported in volume by other means.

The projected marketing system includes two levels of processing. About 90 per cent of total production is transported to processing plants, and farmers retain approximately 10 per cent for home consumption and sales to individuals at the pond bank. The fish going into processing are subdivided into two groups.

Eighty per cent are gutted, packed in ice, and transported to market. If marketing flow is not stable, some of the fish may be held by the processor at low temperatures for several days to equalize the daily marketing. The fish are sold at retail in essentially the same form as presently marketed, but quality will be improved. Most of the fish marketed in this manner will be sold through the public markets.

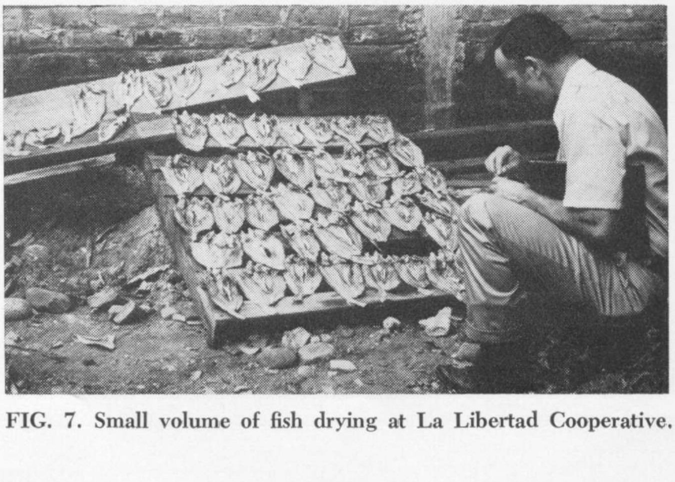

FIG. 7. Small volume of fish drying at La Libertad Cooperative.

The remaining 20 per cent of the fish processed are gutted, weighed, packaged, and packed in ice for sale in supermarkets. Processing for supermarket sales requires twice as much labor per unit volume; however, the eventual sale price is also much higher. The price differential between public markets and supermarkets for various types of fish ranges from 40 to 90 per cent.

All of the fish are packed in ice; thus, transportation from plant to market includes the cost of transporting the ice and packaging materials. Although weight of the fish is reduced in processing, the total weight transported is increased. The transportation activity in Table 4 indicates more time is required per metric ton. In reality the time remains the same while only the tonnage has increased. Equal weight of fish and ice are assumed in the sample.

The processing sector requires 1,102,248 man-hours of labor per year at a cost of ¢330,674, or on a monthly basis, 91,854 man-hours at a cost of ¢27,556. Under the same labor assumptions as the farm sector, approximately 383 employees with an average wage of ¢72 per month would be required for processing purposes.

The combined farm and processing sector would require 853 employees for a volume of 1,800 metric tons of fish from 600 hectares of water source. Little mechanization is assumed at either level. Since the icing occurs at the processor level, the plants should locate near the area of production. Production in a synergistic system would occur in close proximity to processing areas for the primary inputs of chicken, turkey, or hog manure, or coffee pulp. The processing facilities would be centrally located in areas of fish production and the combination of industries would lead to creation of service industries to provide ice, packaging materials, and transportation for production and processing.

Capital Requirements

Provision of both short and long run capital for production and processing would be necesary. No data are available for use in estimating the cost of providing processing facilities or determining the optimum size of any processing facility. The advent of processing requires commitments for production at high enough levels to warrant investment.

During the course of the survey in El Salvador, fish production and estimated returns to investment were discussed with Dr. Antonio Boris, of the International Development Bank. On the basis of experimental results obtained at the Fisheries Station, the Bank expressed an interest in investing in farm fish culture in El Salvador. The Bank will conduct an independent analysis to determine the feasibility of fish culture. Sources such as the International Development Bank may provide a viable alternative in the event that the El Salvador credit sector is unable to finance expansion of fish production.

FIG. 8. Typical roadside market in El Salvador.

Short run production credit will also be necessary for both production and processing. Agencies such as the Associatión de Bienestar Campesina (ABC) a semi-autonomous lending agency for small farmers, presently exist to supply this need. However, the amount of funds available through government agencies is limited. In 1971-72, only ¢12.5 million were available from ABC for supervised credit for agriculture. Financing production from 600 hectares of fish ponds would require a revolving credit amount of approximately ¢0.25 million for operating credit, assuming loans were repaid on a 6-month basis. Larger areas of production would require proportionally more.

From a farm level, fish production represents a viable alternative for producers with the appropriate soil and water supply. For the economy, the impact on employment and income is entirely dependent on the amount of land shifted into fish culture. With no increase in per capita consumption of fish, population increase alone will double demand by 1985 and nearly triple it by the year 2000. Total fisheries production would need to sustain equal increases to maintain the existing level of production per capita.

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David Dunseth, Peace Corps Volunteer, Fisheries Station

Ralph Parkman, Peace Corps Volunteer, Fisheries Service

University of Florida

Dr. Peter Hildebrand, University of Florida/USAID

Mr. David Zimet, University of Florida/USAID

Informal Conference and Interviews

Dr. Antonio Boris, International Development Bank

Program Officer and Program Evaluators, USAID Mission

Manager La Libertad Fish Cooperative

Fishermen at Lake Coatepeque and Olomega and the port of Acajutla

Retailers and wholesalers at numerous locations

ITINERARY[1]

November 18	Arrive San Salvador, Republic of El Salvador.
November 19	Initial meeting with officials of the Fisheries Service and Director General of Natural and Renewable Resources. Tours of Lake Coatepeque and public market at Neuva San Salvador.
November 20	Initial meeting with officials of USAID Mission to discuss study and arrange for work schedule. Initial visit to Fisheries Station Santa Cruz Porrillo. Tour of Lakes Olomega and Ilapango.
November 21	Initial meeting with USAID University of Florida research team to discuss subsector analysis and assist in developing budgeting procedures.
November 22	Initial visit to fish marketing cooperative at La Libertad. Interview with manager regarding scope of operations.
November 23	Initial meeting with Peace Corps Volunteer and counterpart conducting fish marketing study in El Salvador.
November 24	Review of materials and development of data needs.
November 25	Arrange schedule for following week. Review secondary materials available for the Republic of El Salvador.
November 26	Visit public market in Zucatecoluca. Interview fish venders regarding price, availability of supply, and sources of supply. Purchased fish to establish price per unit weight.
November 27	Visit public markets in San Salvador. Interview with official from the Bank for International Development.
November 28	Visit Fisheries Station, Santa Cruz Porrillo, for clarification of budget items. Discuss with USAID officials to report progress.
November 29	Visit supermarkets in San Salvador.
November 30	Visit dried fish markets in San Salvador.
December 1	Establish tentative budgets for fish production in El Salvador.
December 2	Preliminary market analysis for fish in El Salvador.
December 3	Presentation of report outline to USAID officials in El Salvador.
December 4	Visit to port of Acajutla. Visit to model fish pond at Neuva Conception.
December 5	Presentation of draft of final report to USAID Mission El Salvador.
December 6	Depart San Salvador, Republic of El Salvador.

[1] Dr. D. R. Bayne accompanied the author during the period November 18-28. Ralph Parkman, Peace Corps Volunteer, accompanied the author on the visits during November 28-December 6. Numerous meetings with David Zimet, University of Florida, were held during the period November 28-December 6.