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9. ABSTRACT

The objectives of this fisheries program in El Salvador were to reduce the dietary deficiency in animal protein, to increase farm income, and to create employment within the target population of low and medium-income commercial farmers. It is known that fish is a practical source of protein, with about 80% protein on a moisture free basis, versus 40-50% for red meats and 77% for rice. Fish are more efficient converters of feed than animals or poultry. Too, whereas feeds used for meat production also can be used for human consumption, fish can feed on items otherwise not used or wasted. With an increased supply of fish on a year-around basis, a fish-processing industry could develop. It was found that farm fish culture in El Salvador is in a pre-emergence stage, with consumption still very low. Research on various production possibilities for different areas of the country has only begun. But in a country with a high population density and limited land resources, intensive fish culture represents one means of supplying maximum return. Full time labor for the producer and his family coupled with a higher protein diet may increase the educational level of this population segment. But for any of these benefits to occur, the research results detailed in this report must be transmitted to and accepted by the production sector, and in addition, both short and long-term capital will be necessary for production and processing.

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ECONOMIC ANALYSIS OF THE INLAND FISHERIES PROJECT IN EL SALVADOR

by

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Project A.I.D./ la-688

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1.0 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 U.S.A.I.D. Mission to discuss study and arrange for work schedule. Initial visit to Fisheries Station Santa Cruz Porrillo. Tour of Lakes Olemega and Ilapango.
November 21	Initial meeting with U.S.A.I.D. 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. Discussion with U.S.A.I.D. officials to report progress.
November 29	Visit super markets in San 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 from November 28 - December 6. Numerous meetings with David Zimet, University of Florida were held during the period November 28 - December 6.

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 U.S.A.I.D. 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 U.S.A.I.D. Mission El Salvador.
December 6	Depart San Salvador, Republic of El Salvador.

2.0 SUMMARY AND CONCLUSIONS

During the two year period Dr. David R. Bayne served as Fisheries Advisor to the Ministry of Agriculture, substantial progress was recorded. The Fisheries Station at Santa Cruz Porrillo was essentially completed, a survey of the lakes and ponds was instituted and a survey of farm pond culture was completed. Research directed towards increasing harvests from the national waters of El Salvador was conducted. The Fisheries Service expanded and has begun an active program of disseminating fisheries information to prospective fish farmers. A program of community ponds has been developed to further increase awareness of fish farming as a production alternative. Arrangements have been 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 the program 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. The economically feasible production techniques 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 necessary to insure strengthening of the extension program in Fisheries.

Ideally, a new fisheries advisor should have been present in El Salvador during the final period of Dr. Bayne's tour. The programs in progress then 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, P.C.V. working at the Fisheries Station and Ralph Parkman, P.C.V. 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. With the return of trainees, the fisheries program will have 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 the Head out-of-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 favorable climatic conditions, an insured water supply, a polyculture system utilizing supplementary feeding, and management knowledge regarding production and harvesting, the production levels should far exceed any levels attainable in the United States. 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,

fish, or sold for human consumption. Within the pond are several species of fish, each utilizing a different level of the food chain. If research indicated fresh water crabs or clams would fit within the system then production would become three dimensional. A hectare of water surface would represent two or three 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. It will be at least two years before experienced trained Salvadorean aquaculturists will be available to carry the research programs forward.

The externalities of expanded fish production are difficult to perceive. Producers with multiple ponds will drill wells to insure a stable water supply 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 a proportion of the population. Each of these factors is difficult to quantify. In a country with a high population density and limited land resources, 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. However, before any of the returns postulated in this analysis can occur, the research results must be transmitted to and accepted by the production sector.

3.0 ECONOMIC ANALYSIS OF THE INLAND FISHERIES PROJECT IN EL SALVADOR

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3.01 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, Auburn University, conducted a survey of the inland fisheries of El Salvador (1). In September, 1972 the El Salvador cooperative fisheries project was formalized. Dr. David R. Bayne was employed as a fisheries advisor to the government of El Salvador and arrived on post January 28, 1972. In February 1973, Dr's D.D. Moss and D.R. Bayne completed a review of the El Salvador fisheries project (2). In November 1973, Dr. D.R. Bayne completed his service as fisheries advisor to El Salvador government and submitted an end of tour report (3). In November 1973, USAID/El Salvador requested an economic evaluation of the fresh water fisheries of El Salvador. Dr. E.W. McCoy, agricultural economist with the School of Agriculture, Auburn University, arrived in San Salvador, El Salvador November 18, 1973 to conduct the study. During the period November 18 - 28, 1973, Dr. D.R. Bayne remained in-country and provided information regarding all phases of the inland fisheries project. In addition, Dr. Bayne provided access to other sources of information necessary for the evaluation.

The reports cited above 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. The entire fisheries program was essentially carried out by a single biologist of the fisheries section. The operating budget of the fisheries program was approximately ¢22,000[1] and there was no capital budget. In 1973, the operating budget was over ¢227,000 and the capital budget was in excess of ¢130,000 for the construction of 100 community ponds throughout the country. The substantial contributions by the GOES indicate the priority placed upon the fisheries program by the host country.

3.02 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 conducted on an evaluation of the inland fishery resources of the country; including ponds, lakes, and streams.

3.021 Lake study

A study of the fisheries of the major lakes in El Salvador was conducted by Johnson and Hidalgo (4). Total annual production from the lakes studied was 1,109,934 kg. 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

[1] $1.00 is equivalent to 2.5 colones

Figure 1. Stocking *Tilapia aurea* in Lake Olomega

quantity of nutrients were available but not utilized by the existing fish populations in the lakes. The lake studies are still underway and will continue through 1974.

Significant production increases by stocking in natural waters are probably quite limited. Some of the lakes in El Salvador 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 kg/ha/yr 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 fresh water fish in El Salvador.

Concurrent with the lakes study, a cooperative study conducted by personnel from the Department of Fisheries, USAID, and Peace Corps was carried out to evaluate the fish pond culture in El Salvador. The results of the study were reported by Jensen (5).

3.022 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 the time of the survey. The average production from all ponds was approximately 136 kg/ha/yr with a total production of about 7,000 kg from all harvested ponds. The evaluation

Figure 2. Dr. Edwin A. Anderson, Director, U.S.A.I.D. Mission; Mr. Jack R. Morris, Assistant Food and Agricultural Office, U.S.A.I.D.; Mr. Geronimo Chavez, Extension Advisor, U.S.A.I.D.; and pond owner inspecting 100 m^2 fish pond in Osicala, El Salvador.

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 an amount in excess of 150,000 kilograms per year.

3.023 Fish consumption

In 1971 the FAO conducted a study of fish production and consumption in San Salvador (6). The majority of fish sold in San Salvador was from marine waters. Perhaps more importantly, most of the fish for local consumption were an incidental increment to a primary harvest. The shrimp fishing industry which exported most of the shrimp catch sold the fish caught to channels for local consumptions. Many non-shrimp fishermen operated out of port areas, however, the total catch of all these fishermen did not equal the incidental catch of the shrimp fishermen. The quality of the fish was generally poor.

Per capita consumption of fish in El Salvador was estimated at 2.2 kg, with urban consumption at 4.4 kg and rural consumption at 1.1 kg. The rural area includes coastal areas where per capita consumption of fish was very high. In general, the rural area, excluding the coast, received very little fresh fish. 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 fresh or dried fish.

3.03 Fish marketing

In 1973 a marketing study was undertaken under the auspices of the Fisheries Service, USAID, and the Peace Corps. The study was designed to determine 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 survey has been completed and certain general comments can be made regarding market structure and marketing margins.

3.031 Existing marketing systems

The El Salvador marketing system has evolved over time and rigidities due to tradition and custom have become incorporated within the system. The function of any marketing system is to move the product from producer to consumer and make the product available at the time and in the form required. In a competitive economy, the price system insures availability of the product. Normally the price is transmitted from the consumer to the producer calling forth additional production or signaling a cutback in existing production. In the system existing in El Salvador, fisheries production is largely based on the shrimp fishery, the majority of fish are 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 the fish caught by shrimpers. Fresh water fish sell for a higher price than salt water fish. Two factors may be in operation in determining the price structure. First, fresh water fish may be preferred to salt water fish.

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

Second, fresh water fish may have a higher quality than salt water fish. The first factor would require consumer testing, however, the second factor is almost universally valid in El Salvador. The fish caught by fishermen have a higher quality than the fish caught by shrimpers and the fish harvested from fresh water reaches the market in better condition than fish from salt water.

One of the preliminary findings of the market study was the discovery of an inflow of dried fish from Guatemala and Nicaragua. Formerly and still to a certain extent, the dried fish were represented by small fish and fish unsold in the fresh market. The quantity of dried fish in El Salvador is presently insufficient to meet the demand due to one of several factors. First, less of the fresh fish are unsold and second, 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 contained in the movements of one type of fish from one port city to consumers. Bagre or salt water catfish is a common fish sold, both fresh and dried, in El Salvador markets. The movement of this type of fish from the port at Acajutla has been traced for one season. The quantity of fish has not been determined since origins intersect in all of the major markets.

3.032 A market channel example

Fishing boats arrive at the pier in Acajutla in the afternoon

and the majority 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 the fish is bought by consumers in 4 to 10 pounds 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.

The majority of the fish is sold at the dock to wholesalers who ship the fish to Sonsonate, Santa Ana, and San Salvador. The fishermen normally have gutted the fish prior to sale thus the wholesaler provides the function of collecting, storing and transporting. The fish are moved overnight by bus, truck, and train depending upon the wholesaler and the volume transported. In most instances the fish are iced down in metal containers. When the fish reach the market they are immediately in direct competition with fresh water 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.

3.033 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

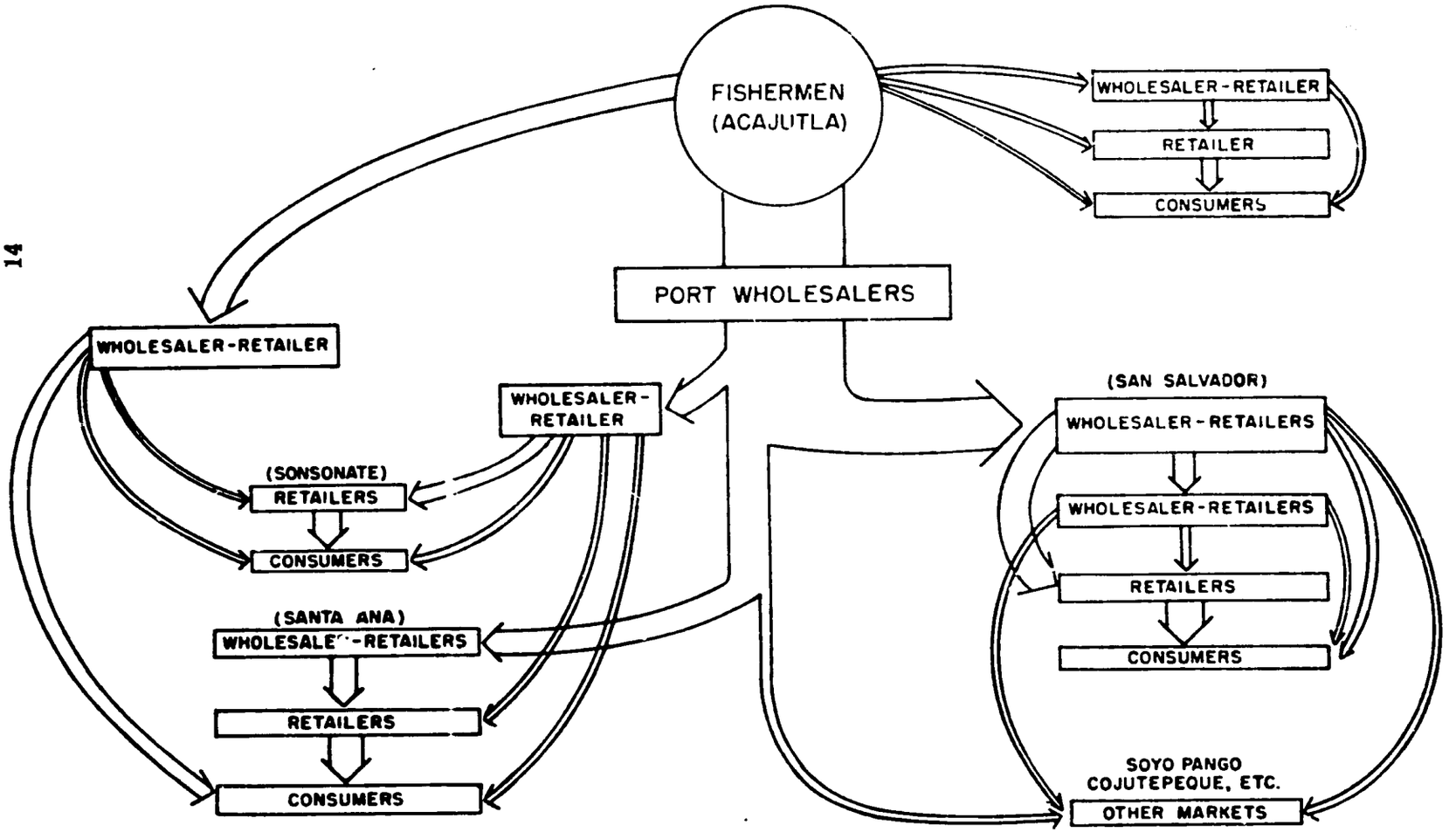

Figure 4. Movement of Salt Water Fish from the Port of Acajutla to Principal Areas of Consumption, November 1973.

retailers. The market study will determine if differential pricing allows the phenomena. The situation may exist due to 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 product normally would result in a price which just covers the seller's cost of operation including 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 be less than ¢30 per day or ¢0.03 per 100 lbs of fish marketed. The smallest mark-up of bagre during the time period covered was ¢0.11 between Acajutla and 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. First, "Pescado del Barco" with extremely low quality sells in the market as fresh fish. Second, dried fish are imported to meet the demand for the product in that form. Third, no tendency by some wholesaler or retailers to cut price in order to move the product has been observed.

3.034 Price response to supply increase

In analyzing the market for fish, one factor is paramount: fresh water fish sell for approximately twice as much as most salt water fish and sell competively with the most preferred species of salt water fish. Two

events would occur with a substantial increase in the number of fresh water fish reaching the market. Demands which are presently not met could be satisfied at the same price for the producer. 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 very substantial production increases, the fresh water fish would drive the lower quality salt water fish into the dried fish sector. Fresh water 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 production from 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 an increase in population would result in an increase in per capita consumption by approximately 0.5 kilogram per year.

4.0 PROJECTED IMPACT OF FISHERIES PROJECT

The USAID/El Salvador objectives and strategy paper for 1972 identified a target group and two critical problem areas for primary emphasis (8). The target group was identified as low and medium-income commercial farmers. More specifically the group of farmers with land holdings between 1 and 49.9 hectares; a group which lacks credit availability, market access, knowledge of new technology, and other factors which limit their ability to fully utilize land and labor resources. Unemployment and under-employment of labor are fundamental problems in El Salvador.

Fish production will attack three basic problems of the rural sector according to the strategy paper; (a) dietary deficiency in animal protein, (b) low farm income, and (c) rate of unemployment. Fish are about 80 per cent protein on a moisture free basis in comparison to 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 as shown below. In addition, fish are more efficient converters than red meat animals. Poultry production has improved to the point that two pounds of supplemental feed produces a pound of gain. Beef

Product	Price per kg of moisture free flesh	Protein per kg of moisture free flesh	Price per kg of protein
	Colones	Gr	Colones
Pork	3.90	450	8.66
Beef	5.25	450	11.66
Poultry	4.60	450	10 22
Fish	3.75	800	4.68
Rice	0.25	70	3.57

Figure 5. Hand harvest and threshing of rice

require six to seven pounds of feed for a pound of gain. Often, feeds used for red meat production could be utilized for human consumption. The species of fish grown in El Salvador feed on decayed organic matter, bottom organisms, plankton, algae, and can utilize by-products from other industries such as chicken manure and coffee pulp.

Research at the Fisheries Station, Santa Cruz Porrillo has been undertaken to determine feasible production systems for fish culture. Research is underway to determine optimum stocking rates and cultural systems in order to maximize returns to land, labor, and capital investment. At the present time, a production system for farmers within the target group has been developed. The micro impact on the individual producer is illustrated below.

4.01 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. Construction of a one-hectare pond requires a capital investment of approximately ¢5,000 including the dam and drainage system, as shown below. Construction costs do not change proportionately with surface area, thus a one-half hectare pond might require an investment of ¢3,500 and a two hectare pond require 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 reducing the initial investment per operator by ¢231.

The construction cost of ¢5,000 assumes a bulldozer was used. If ponds were constructed using hand labor and bullocks with scrapers, the cost of construction would be reduced to some extent.

Investment cost for one hectare pond

Item	Life	Total cost
	years	¢
Pond construction	--	4,970
Seine net	5	198
Containers	5	33
Total investment		5,511

4.02 Labor requirement

The climate in El Salvador is sufficiently warm so 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. The labor requirements per hectare are shown in Table 1. Two production periods of six months are shown. 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 three-month period. Following initial stocking of the fish, only feeding and pond maintenance are required until the first partial harvest at three months. The remainder of the fish are harvested at six months; the pond is cleaned and 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. The cash flow to the producer

Table 1

Monthly Labor Requirements Per Hectare for *Tilapia* - Guapote Tigre Production in Earthen Ponds in El Salvador

Activity	Month [1]												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
	hours												
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
Pond maintenance	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	186.6	20.95	12.0	38.2	14.2	12.0	186.6	567.9

[1] Starting month is arbitrary

would be stabilized and the flow of fish to market would be more orderly. With two one-half hectare ponds three 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.

4.03 Production cost

The production cost budget presented assumes two partial harvests and two principal harvests per year, Table 2. While a labor cost of ¢122 is budgeted, most of the cost is imputed to accrue to the pond owner. Except for additional labor at harvest, the pond owner and family members should be able to supply the labor needs. 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. 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 occurs 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 represented in the budget represent transportation costs of moving 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

Table 2

Costs and Return Per Hectare for Production of Tilapia - Guapote Tigre Polyculture Using Chicken Manure.
(Stocking rate of 2 male Tilapia to 1 guapote tigre)

Item	Unit	Cost/unit colones [1]	No. units	Cost	Total cost
		¢		¢	
LABOR	man/hrs.	.30	408		122.40
Apply organic fert.	applications	0.65	8	5.20	
Stock fingerlings	stockings	1.40	2	2.80	
Apply chicken manure	application	.04	350	14.00	
Partial harvest	harvests	7.20	2	14.40	
Final harvest	harvests	43.00	2	86.00	
SUPPLIES					708.76
Ammonium sulfate	lbs	.08	175	14.00	
Fingerlings	no	.018	19,466	350.39	
Chicken manure	lbs	.03	11,479	344.37	
TOTAL OPERATING EXPENSES					831.16
TOTAL OPERATING EXPENSES AND INTEREST					863.06
Interest on operating capital at 9 per cent [2]				31.90	
OTHER EXPENSES					94.00
Pond maintenance	hrs	.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 RETURNS TO LAND, CAPITAL AND MANAGEMENT					1,249.94
Capital at 8 per cent (pond construction)				397.60	
NET RETURN TO LAND AND MANAGEMENT [3]					952.34
Land charge of ¢215 per hectare				215.00	

Table 2 (continued)

Item	Unit	Cost/unit colones [1]	No. units	Cost	Total
		¢		¢	
RETURN TO MANAGEMENT [3]					737.34
Percentage 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 changes 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.

in conjunction. Presently, a major turkey producer is examining the possibility of fish production 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.

4.04 Returns

Gross returns are based on sales of 2,345 kilograms of fish larger than 14 centimeters in length and 307 kilograms of fish less than 14 centimeters in length. 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 a charge of eight 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.

4.05 Micro impact of production

Since the budget includes a return of ¢0.30 per hour for labor, no inputed 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 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

	Amount	Recipient
	14.00	importer
	350.39	farm level fingerling producer
	344.39	transportation sector
	31.90	credit sector
Total	740.68	

and consumption multipliers especially if bullock carts are used to haul chicken manure to the pond. Each colon 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, four per cent is returned to the credit sector where a portion will become available for new loans. In addition, approximately two per cent goes to the import sector and leaves the system. As the pond ages less ammonium nitrate may be required and the amount going to the import sector will be reduced.

Reduction of gross returns by the amount of cash expenses leaves ¢1,466 for the producer to utilize for capital investment, amortization and to meet living expenses. Amortization of land and pond costs over a 20-year period requires approximately ¢250 per year principal payment and on a decreasing basis, ¢398 interest the first year and approximately ¢20 less each year until the debt is retired. The land charge would be ¢215 to cover both principal and interest over the same time period. 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.

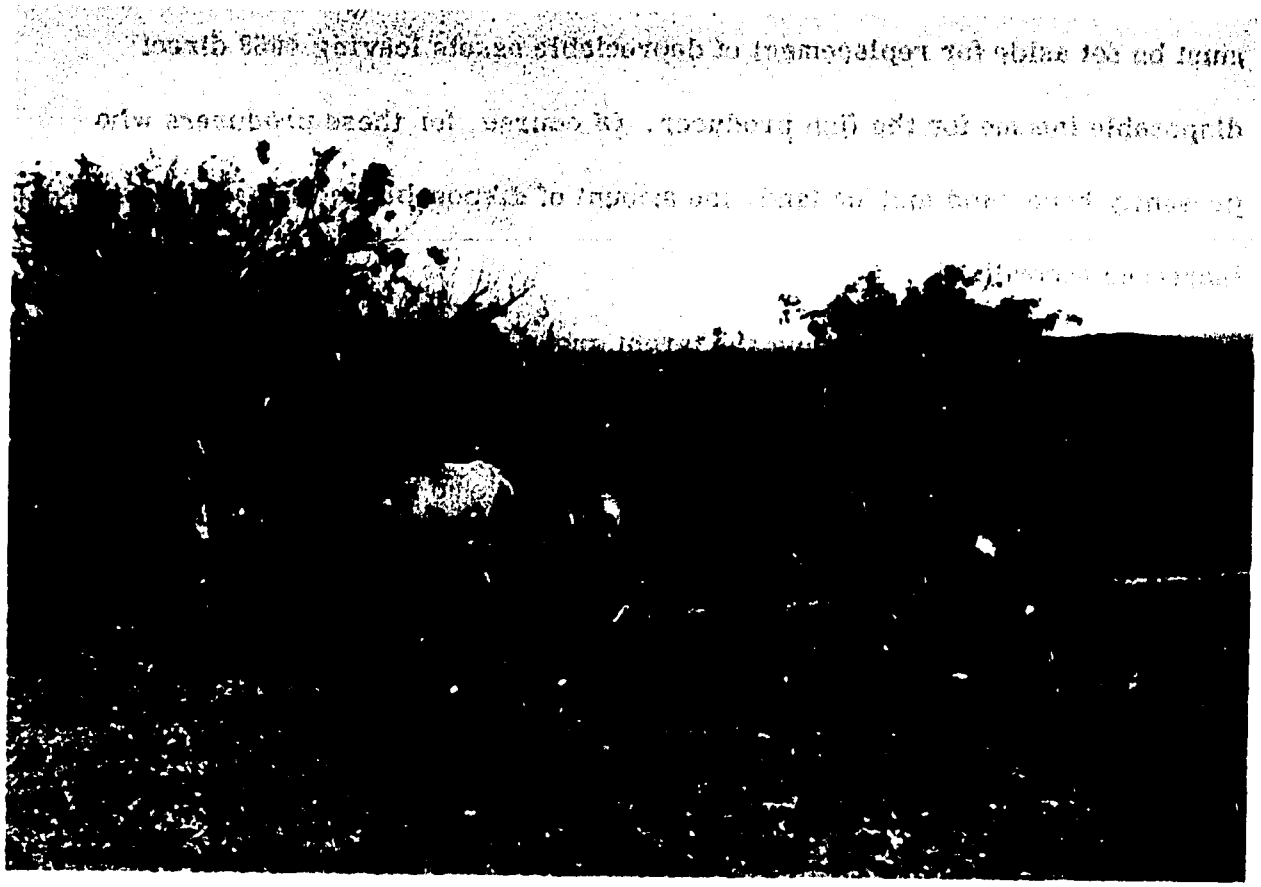

Figure 6. Bullock carts used to transport goods to market

With total payment of expenses, principal and interest, the producer receives ¢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. Of course, for these producers who presently have pond and/or land, the amount of disposable income would be increased accordingly.

In the farm sector, among the target group, the consumption function has approximately the same slope as the income function. A certain amount of saving will arise as the farmer perceives the income shift as permanent. The savings will be necessary to offset risk over the life of the loan. Assuming an initial five per cent savings, the producer will return approximately ¢520 to the income stream in the form of purchase for 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.

4.06 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 producers. The first two systems are Tilapia monoculture with 10,000 and 15,000 fingerlings per hectare. With the wide

Table 3

Costs and Returns Per Hectare From Four Fish Production Systems in El Salvador

Item	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	84.50	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
Large fish [3]	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		1,580.60	1,872.00	2,207.00	3,251.60
Production cost		957.06	1,047.96	957.06	1,467.90
Net return to land, capital, and management		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 kilograms pondside

System A — Tilapia monoculture for commercial production (10,000 fingerlings per ha)

System B — Tilapia monoculture for commercial production (15,000 fingerlings per ha)

System C — Tilapia - guapote tigre culture without supplementary feeding (6,666 male Tilapia plus 3,334 guapote tigre per ha)

System D — Tilapia - guapote tigre culture with supplementary feeding (12,000 Tilapia plus 3,000 guapote tigre per ha). Coffee pulp ration cost ¢0.10 per kg

variance in income within the country, a mixture of large and small fish might optimize distribution of output in some areas. The smaller fish could be sold at variable rates depending on the size of the fish 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. In system A, a profitable level of return is generated but with additional stocking, a higher level of return can be reached as in system B. By introducing a biological control agent, the level of returns can be increased even further. With the biological control agent, the stocking rate can be increased and supplementary feeding introduced. 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. For every 60 kilo bag of bean coffee, about 300 kilos of cherry coffee is required. Approximately 240 kilos per bag or 480 million kilos of waste material on a wet basis are available. A prepared ration containing 30% coffee pulp was tested as supplementary feed and increased net returns from ¢1,250 to ¢1,784 per hectare. Trials to determine the optimum feeding and stocking levels are continuing. As indicated below, the optimum economic level has not been approached. The marginal cost shown in the table includes both the cost of the additional feed and the cost of additional fingerlings. With extremely low cost supplementary feed in relationship to high value output, feeding could continue until a conversion rate of approximately seven is reached.

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-ha pond
[2] Includes additional cost of fingerlings

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

4.07 Extension activities

Research in the long run has a high multiplier for each dollar invested, however, research results must be transmitted to the clientele of the researchers. One of the gaps in the fish culture program in El Salvador 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 has been the commitment by the Fisheries Service to build 100 community ponds throughout the country. Production from these ponds will substantially increase the amount of fresh water fish available. More importantly, research can be directly transmitted to producers by demonstration projects within 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 indicated catfish production in farm ponds was economically feasible. The Soil Conservation Service and Agricultural Stabilization and Conservation Service promoted the development of catfish ponds on a cost sharing basis; fingerling producers initially made profit then developed processing facilities to continue sales. During a limited period a catfish industry with seven processing plants in Alabama and 21 plants in the Southeast U.S. developed. The dissemination of information through bulletins, magazine articles and Sunday supplements was very rapid. Catfish production began on land which could not be utilized for other type of production. With the level of profits realized, 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.

El Salvador has mountainous terrain throughout much of the country and in many areas, 20 or 30 hectare ponds are not feasible. 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. In addition, fish production could be carried out in association with chicken, turkey, and possibly swine production. 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 research results are generally disseminated. The community ponds represent field stations in miniature. Fish production should first increase in the areas of community ponds then spread to other areas as the profitability becomes apparent.

One of the most promising areas for fish production with respect to terrain and water resources is the coastal plains 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 the major fish production occur conjointly within the same area. An additional impetus in El Salvador is the location of the Fisheries Station at Santa Cruz Porrillo within the cotton production area. All of the factors which contribute to increase production in the coastal area are negated by the present 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 fresh and brackish water within the area. In the

event a fish kill following pesticide contamination does not occur, the growth cycle of the fish is halted for a period with resultant increases in cost of production. Other application methods which would lower costs and increase plant protection would be more compatible with fish production. Until the problems associated with pesticide residues are alleviated, fish production in the coastal zone would entail high risk in the cotton producing areas. Ample production possibilities remain, however, in both the central and northern zones. The northern zone is especially applicable since the scarcity of fresh fish is highest in that region.

5.0 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 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. With an increased supply of fish on a year-round basis, a fish processing industry could develop. Under existing conditions, fish reach the market in essentially the same form as harvested. Scaling, cleaning, and packaging the fish as well as fileting, smoking, and freezing would arise with sufficient production.

5.01 Macro effect of production increase

A budget indicating the impact on employment and income with increased production has been developed, Table 4. 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 per hectare of pond of 3,000 kilograms was assumed to be feasible. Thus, to increase average consumption by one-half kilogram or approximately one 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

Table 4

Impact of Employment and Income with a Projected Increase in Fresh Water Fish Production in El Salvador

SECTOR		FUNCTION PERFORMED		TOTAL	
	Hrs/Hectare		Hectares	Hrs (000)	¢ (000)
FARM					
	600	Production	600	360	108
	1,150	Transporation to Farm	600	690	207
	500	Fingerling Producer	600	300	90
Total	2,250		600	1,350	405
Monthly Average			50	112	34
	Hrs/Metric Ton		Metric Tons	Hrs (000)	¢ (000)
PROCESSING					
	162	Transportation [1]	1,620	262	79
	162	Processing A [2]	1,296	210	63
	324	Processing B [3]	324	105	32
	324	Transportation [2]	1,620	525	157
Total A	648		1,296	840	252
Total B	810		324	262	79
Total Processing			1,620	1,102	331
Monthly Average			135	92	28

[1] 10 per cent of the production is assumed to remain at the farm level for family consumption and pond sales.

[2] Processing A include gutting the fish and packing in ice

[3] Processing B includes gutting, packaging, and freezing the fish. Fileting occurs in this sector.

Assumptions

A. 600 hectares of production

B. 1,800 metric tons of production

C. 0.5 kgm per person consumption

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.

5.02 Macro effect of inclusion of a processing sector

The processing sector as postulated does not exist in El Salvador at present, however, the fish marketing cooperative at La Libertad was used as a model. The fish cooperative presently provides marketing services for about 35 fishermen, has two freezers and space to provide other processing facilities. The organization presently markets about 25 to 30 metric tons of fish per year with 12 full time employees. In addition, the cooperative hires up to 18 part time employees 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 was assumed to be ¢0.30 per hour. The amount of labor necessary for construction was not included since the expenditures are one time and would quickly dissipate.

The processing sector is assumed to replace the present marketing system for freshwater fish. Since the present freshwater sector is relatively insignificant, the losses have not been incorporated within the analysis. Some wholesalers would be dislocated from the market and bus revenues would decline slightly as fish were transported in volume by other means.

The projected marketing system includes two levels of processing. The entire quantity of fish is not transported to processing plants. The

Figure 7. **Small volume of fish drying at La Libertad Cooperative**

farmers retain approximately 10 per cent of the pond production for home consumption and sales to individuals at the pond bank. The remaining fish are subdivided into two groups, 80 per cent of the fish are gutted, packed in ice and transported to market. If marketing flow is not stable, some of the fish may be held at low temperatures for several days to equalize the daily marketing. The fish reach the market in essentially the form presently marketed, however, the quality of the fish will be improved. Most of the fish marketed in this manner will be sold through the public markets. The remaining 20 per cent of the fish processed are gutted, weighed, packaged, and packed in ice for sale in supermarkets. The labor requirements for processing for supermarkets sales are twice as high 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 varied from 40 to 90 per cent.

All of the fish are packed in ice thus transportation from the plant to the market includes the cost of transporting the ice and packaging materials. The weight of the fish is reduced following processing, however, the total weight transported is increased. The transportation activity in Table 4 indicates increase time is required per metric ton, however, the time remains the same while the tonnage has increased. Equal weight of fish and ice were assumed in the example.

The processing sector required 1,102,248 man hours of labor per year at a cost of ¢330,674. Transferred to a monthly basis, 91,854 man hours at a cost of ¢27,556 would be required. Under the same labor assumptions as the

farm sector, approximately 383 employees with an average wage of ¢72 per month would be required.

The combined farm and processing sector would require 853 employees for production and processing of 1.800 metric tons of fish from 600 hectares of water surface. Very little mechanization is assumed at either level. Since the icing occurs at the processor level, the plants would be located close to the area of production. In a synergistic system, the production would occur in close proximity to processing areas for primary inputs; 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, transportation, for production and processing.

5.03 Capital requirements

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

During the course of the survey in El Salvador, fish production and the 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. If the El Salvador credit sector is unable to finance expansion of fish production, then sources such as the International Development Bank may provide a viable alternative.

Short run production credit will also be necessary for both production and processing. Agencies such as the semi-autonomous lending agency for small farmers, Associacion de Bienestar Campesino or ABC presently exist to supply this need. 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 type and water supply. For the economy, the impact on employment and income is entirely dependent upon the amount of land shifted into fish culture. With no increase in the per capita consumption of fish, demand will double by 1985 and nearly triple by the year 2000 due to population increase alone. Total fisheries production would need to sustain equal increases in order to maintain the existing level of production per capita.

Figure 8. Typical roadside market in El Salvador

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Republic of El Salvador Government

Ing. Joaquin Guevara Moran, Director; Direction General of Natural and Renewable Resources, Ministry of Agriculture and Livestock.

Ing. Jose E. Cabrero, Head; Fisheries Service; Direction General of Natural and Renewable Resources, Ministry of Agriculture and Livestock.

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United States Government

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INFORMAL CONFERENCES AND INTERVIEWS

Dr. Antonio Boris, International Development Bank
Program Officer and Program Evaluators, U.S.A.I.D. Mission
Manager La Libertad Fish Cooperative
Fishermen at Lakes Coatepeque and Olemega and the port of Acajutla
Retailers and wholesalers at numerous locations

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