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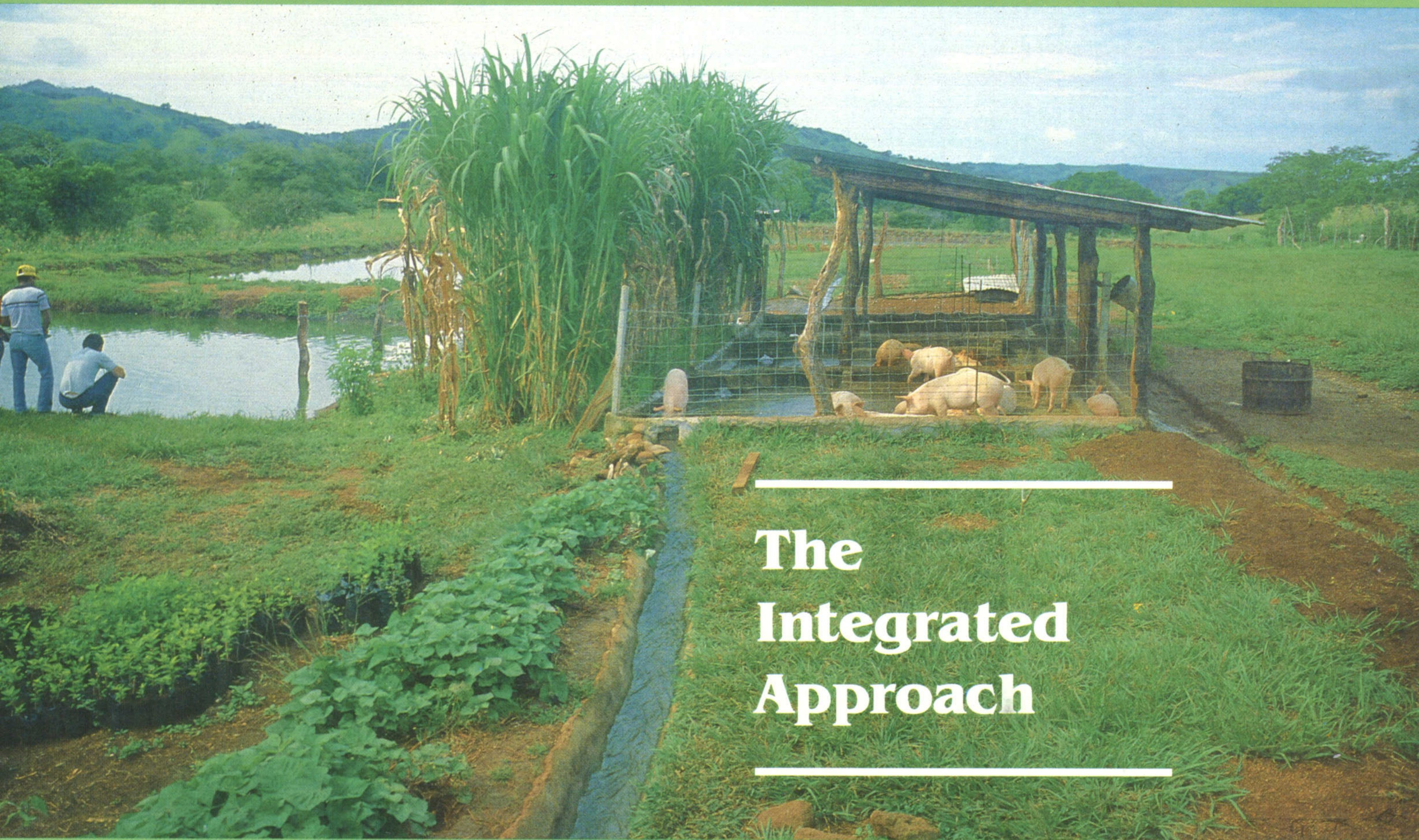
Cooperatively Managed Panamanian Rural Fish Ponds



The Integrated Approach

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Cooperatively Managed Rural Panamanian Fish Ponds: The Integrated Approach

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INTRODUCTION

AN EMERGING VIEW of development is that the governments of developing nations must satisfy basic human needs as well as foster economic growth. Improved nutrition is prominent among these needs, particularly since average annual increases in food production world-wide (1.6 percent from 1970 to 1979) have not always kept up with demographic growth. Even when food production and demography are in balance, food supplies may be unevenly distributed, the tendency being to favor urban populations over rural ones. Thus, many planners are especially concerned with the food needs of rural groups in developing nations, and in this context there is increasing interest in the application of rural freshwater fish culture technology as one of several ways to help meet the needs of these groups.

In Latin America, interest in rural freshwater fish culture has grown rapidly. Governments actively promote construction of family, community, and commercial fish ponds to improve nutritional and economic well-being among rural groups. In many places, disillusionment replaced early enthusiasm when initial research and pilot study successes were not duplicated on a larger scale. Reasons for the lack of success range from technical to political and are varied and complex. There are no simple explanations for failure, but in many cases a principal cause has been inadequate numbers of seed fish to stock grow-out ponds.

People in countries with no history of fish culture need government assistance to make their ponds technically and economically viable. Thus, hatcheries are built and research and pilot studies carried out, often with the financial and technical assistance of donor nations. Initial results are usually quite promising, and policy makers promote the construction of grow-out ponds through private bank loans or government subsidies. Government institutions produce the seed and transport them to grow-out ponds where they are sold or donated to growers. This approach works well at first. As word of the nutritional and economic benefits of the program spreads, more ponds are constructed, but the early momentum may be difficult to sustain as the amount of seed needed to stock increasing numbers of widely dispersed ponds increases. Eventually, the government is unable to meet the seed needs of growers, and then expansion ceases or the program slowly fails.

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A government may be unable to supply sufficient seed stock to producers for several reasons.

1. Frequent changes in government policy and/or administrators, and political instability which make rural areas unsafe.
2. Economic constraints which prevent hatchery installation, expansion, and/or acquisition of additional staff and vehicles for transporting fish seed.
3. Inadequately trained and poorly paid hatchery personnel who lack the knowledge and dedication needed to intensify seed production.

In the private sector, commercial seed producers are often slow to respond to the need for more seed for the following reasons.

1. The technology required to reproduce the species selected for small-scale rural fish ponds is too demanding for inexperienced culturists. Only the government or large, well-financed growers with trained biologists and adequate spawning facilities can reproduce the fish.
2. Even when the species selected for culture is easily reproduced, planning which fails to anticipate economic and political constraints results in a limited capacity to produce adequate numbers of seed stock.

The project under discussion was designed to cope with these and related problems.

PROJECT BACKGROUND

The rural fish culture program in Panama was initiated in 1976. At that time, the political philosophy of the country supported a communal approach to nutritional problems. Grow-out ponds were constructed with government financial and technical assistance. Tilapias were selected as the principal culture species, and all-male hybrids of *Tilapia nilotica* x *T. hornorum* and *T. mossambica* x *T. hornorum* were produced in a government hatchery and transported to the grow-out ponds. Common carp (*Cyprinus carpio*), bighead carp (*Aristichthys nobilis*), and silver carp (*Hypopthalmichthys molitrix*) were also stocked to increase fish production. Initial efforts to culture fish with a commercial ration proved unsatisfactory. The high cost of the ration required that the fish be sold at a price beyond the means of rural consumers. Since the major goal was to improve nutrition, a way to lower the cost of the cultured fish had to be found. Thus, the Panamanian government began to focus on an integrated strategy: combining fish ponds with gardens and livestock production. The use of locally produced animal manures to fertilize grow-out ponds proved successful in terms of fish harvests. Early success stimulated program expansion and soon about 200 family and community ponds of 100-10,000 square meters were in operation in a tri-province area. The need for hybrid tilapia fingerlings grew rapidly, and a shortage of seed developed. The complex technology and pond installations needed to produce the hybrid seed barred the inexperienced rural grower from producing his own seed.

Then, in 1980, the United States Agency for International Development (USAID) granted the Government of Panama (GOP) $1,142,000 to carry out a 4-year, pilot fish culture program. The main goals of the program were:

1. To teach organized groups of poor rural people to manage the integrated systems by themselves. Within 24 months, they would have to learn to produce their own seed fish, fatten, harvest, and either consume or market their products, and meet recurrent costs with no more than modest government extension support. The goal was self-sufficiency.

2. To focus on *integrated* production activities. The ponds are a nucleus around which other enterprises—livestock production, gardening, silviculture—develop. Each operation should enhance the efficiency and value of the others. None stand alone.

3. To have multiple benefits for the rural poor. The program should improve their nutrition, provide them with some additional income, and inhibit some of them from migrating to urban areas for economic reasons.

4. To design a simple, practical technology that is compatible with microenvironmental and local community conditions. If anything, the technology is intended to upgrade microecologies by improving soils and by fomenting reforestation.

Twenty-two communities in a five-province area were selected for the pilot study. Prerequisites for inclusion were:

1. A source of good quality, gravity-flow water of sufficient quantity to permit year-round maintenance of pond water levels.

2. Soils that permit no more than minimum water loss to infiltration.

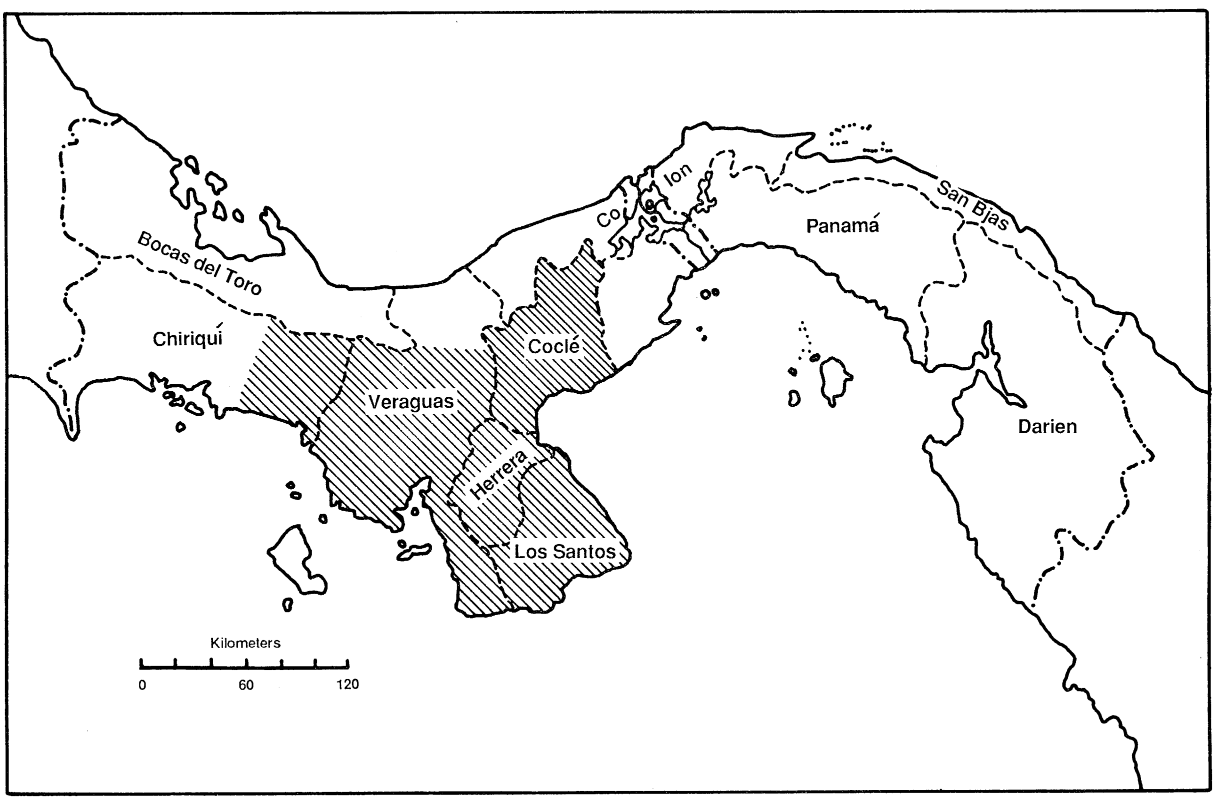
3. Sites with topographical features that permit pond construction at reasonable cost.

4. All-weather road access to pond sites (with one exception).

5. Community interest in the project which was determined at organizational meetings with community groups and also by willingness of these groups to cooperate with project personnel.

In addition to the "pilot" communities, 10 "control" communities (i.e., settlements without ponds) and 10 "traditional" communities (i.e., settlements with pre-project ponds that usually lack animal and garden components) were selected for purposes of nutritional and sociological study.

The project was administered by the National Directorate of Aquaculture (DINAAC) of the Ministry of Agriculture and Livestock Production (MIDA). Technical, economic, nutritional, and sociological studies, to be carried out over a 2.5-year period, were to measure project impact on the pilot communities. The major empirical results of these studies are reported in the following chapters. For the most part, pilot study recommendations, final analytic conclusions, and synthesis of technical, economic, nutritional, and sociological studies are *not* reported here. The emphasis is on empirical findings, and these other matters are left for subsequent discussion, [(4) Chapter 3].



Map of Panama with shaded areas defining project borders.

Chapter I
Technical Evaluation

L. L. Lovshin

STRATEGY

Fish Species

Tilapia nilotica was chosen as the principal species because of ease of seed production and handling, resistance to diseases and low levels of dissolved oxygen, and response to manures to increase yields. Chinese carp were also stocked to improve pond production through polyculture. Common carp, bighead carp, silver carp, bighead x silver carp hybrids, and grass carp (*Ctenopharyngodon idella*) were reproduced in the government hatchery. Communities that restock any of the carps must buy seed from the government. Guapote tigre (*Cichlasoma managuense*), a predator fish native to Central America, was stocked together with mixed sex *T. nilotica* in some grow-out ponds to control excess tilapia seed.

Ponds

The government assisted and subsidized the construction of a series of earthen ponds or pond modules in the selected communities, figure 1. The earthen pond modules consist of a large grow-out pond, small tilapia spawning pond, and one or two intermediate-sized nursery ponds, depending on the technology being tested. The modules are designed to use common pond dikes to lower construction costs. Each pond has an independent PVC drain with an elbow standpipe to control water levels. Depending on topography and costs, water inlets are independent or water passes from one pond to another. Water entering the ponds is strictly controlled so that the water level is maintained, but excess source water and rain run-off are diverted around the ponds. Of the 22 pilot pond projects, 18 were new and four were built on the site of an existing grow-out pond. Old sites were improved by enlarging and repairing the grow-out pond and adding spawning and nursery ponds. The 22 projects consisted of 5 two-pond modules, 11 three-pond modules, and 5 four-pond modules. An approximate area ratio of 1:2.5:2.5:25 was used for spawning pond:nursery pond:prestocking pond:grow-out pond.

In projects using a commercial livestock ration, a simple storehouse with a galvanized roof and cement floor was built. Project members also used the shed to store equipment and as an overnight shelter.

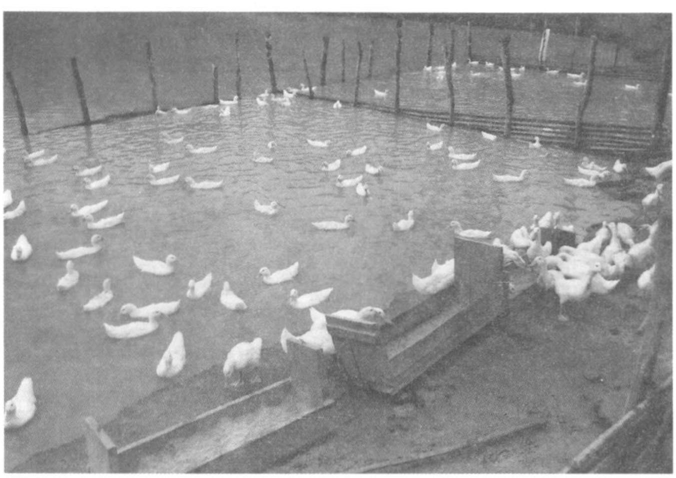


FIG. 1. Cooperatively managed 2,700 m² four-pond module located in Cascajal, Cocle. This duck-fish-vegetable project provides food to 11 families.

Pond Management

Two-Pond Module

This consists of a spawning-nursery pond and a grow-out pond. The spawning-nursery pond is stocked with *T. nilotica* adults, and large fingerlings are produced as outlined in figure 2. Mixed-sex *T. nilotica* seed are transferred into the grow-out pond at the average number of 11,463 per hectare (range 8,333 to 14,290 per hectare). The predator *C. managuense* is stocked to control excessive tilapia seed. The *C. managuense* is tolerant of poor water quality and reproduces at 6 months of age in the grow-out pond, providing a source of fingerlings. The initial stocking ratio of predator to tilapia for complete control of tilapia offspring is 1:5. When the tilapia reach harvestable size, part of the crop is removed.

Large fingerlings, not subject to predation, are seined from the spawning-nursery pond and stocked into the grow-out pond to replace the harvested tilapias. The functioning of a two-pond module is depicted in figure 2. The spawning-nursery pond also serves as a holding pond for carp seed that can be transported from the government hatchery in large quantities and restocked as required. Common carp were initially stocked into the grow-out pond at an average of 450 per hectare (range 200 to 1,333 per hectare). Silver carp, bighead carp, or their hybrids were stocked into the grow-out pond at an average rate of 1,450 per hectare (range 588 to 6,667 per hectare).

Three-Pond Module

This module consists of spawning, nursery, and grow-out ponds. The spawning pond is stocked with adult *T. nilotica* as demonstrated in figure 3. The spawning pond is totally or partially harvested after 2 to 3 months and the small fingerlings are transferred to the manured nursery pond for further growth. The stocking density is 10 small fingerlings per square meter. The nursery pond is partially or totally harvested 3 to 4 months after stocking, when the fingerlings weigh 30 to 60 grams. The large tilapia fingerlings are separated by sex using a dye on the genital papilla to help distinguish the sexes. The male and female tilapia are separated and held in net bags (hapas) located in the nursery or spawning pond.

The females are used as broodstock or consumed by the com-

SPAWNING-NURSERY POND	GROW-OUT POND
T. nilotica males and female adults. ⇨	*T. nilotica* males and females of 6 cm to 10 cm + a predator *C. managuense*
Stocking rate: Females = 1/3 m² Males = 1/9 m²	Initial stocking rate: Tilapia = 1 to 2/m² Predator = 1 to 2/5 m²
Ratio of males to females: 1 male for each 3 females	Ratio of tilapias to predator: 5 tilapias for each predator
Harvest: Time - after 4 months Type - partial Size of fingerling - 6 to 10 cm	Harvest: Time - after 4 to 6 months Type - partial or total Restocking: Partial harvest - stock 5 tilapias of 6-10 cm for each 4 tilapias harvested, *C. managuense* will reproduce in the pond and does not require restocking. Total harvest - equal to the initial stocking rate

FIG. 2. Two-pond module.

SPAWNING POND	NURSERY POND	GROW-OUT POND
T. nilotica male and female adults.	*T. nilotica* mixed sex fingerlings of 3 cm to 6 cm.	*T. nilotica* males
Stocking rate: Females = 1/3 m^2 Males = 1/9 m^2 Ratio of males to females: 1 male for each 3 females Harvest: Time - 2 to 3 months Type - total Size of fingerling - 3 to 6 cm Restocking: All fingerlings and fry remaining in the pond must be eliminated before restocking with adults.	Stocking rate: Tilapias = 10/m^2 Harvest: Time - 3 to 4 months Type - total Size of fingerling - 8 to 12 cm Restocking: All fingerlings remaining in the pond must be eliminated before restocking.	Stocking rate: Tilapias = 1 to 2/ m^2 Harvest: Time - 4 to 6 months Type - partial or total Size - 17 to 22 cm Restocking: Partial harvest - 5 male tilapias for each 4 male tilapias harvested Total harvest - equal to the initial stocking rate.

FIG. 3. Three-pond module.

munity while the males are retained for further growth. After all the nursery pond fingerlings have been sexed, the pond is dried, prepared, and restocked with small fingerlings from the spawning pond. Well managed spawning and nursery ponds will permit three cycles (harvests) per year.

The grow-out pond is initially stocked with male tilapias and carps at the rate described for the two-pond module. The grow-out pond is partially harvested 4 to 6 months after stocking and restocked with male *T. nilotica* taken from the nursery pond. The nursery pond is also used to hold Chinese carp seed produced in the government fish hatchery for restocking the grow-out pond. The management steps carried out in a 3-pond module are shown in figure 3.

Four-Pond Module

This module consists of spawning, nursery, prestocking, and grow-out ponds, figure 4. The procedure used to produce small and large tilapia fingerlings in the spawning and nursery ponds is similar to that of the three-pond module. Male tilapia fingerlings can be stocked directly into the grow-out pond or held in the prestocking pond until needed. Holding the male tilapias in a prestocking pond permits a second manual sexing to reduce the number of females inadvertently included with the males. The prestocking pond also serves as a Chinese carp holding pond. Stocking rates, partial harvests, and restocking of the grow-out pond are performed as in the other modules. Figure 4 depicts the steps used by a community to produce male *T. nilotica* seed, stock, and harvest a four-pond, grow-out system.

LIVESTOCK

All pond modules were associated with animal husbandry activities. The organic wastes were washed daily into all ponds to increase water fertility. Projects with pigs, chickens, ducks, and cattle were tested to determine the effects of the manure on fish production.

Materials such as cement, galvanized zinc sheets, wire, and cement blocks to build the animal enclosures and storehouses were subsidized by the government and were included in pond construction costs. Each community provided local building materials, such as sand, gravel, and wood poles, and the labor to build the facilities. Animal shelters were located to permit water to flow through the enclosures and transport wastes to the ponds. Most grow-out ponds received either a prestocking application of chicken manure, 2,000 kilograms per hectare, or 12-24-12 (N,P_20_5, K_20), 60 kilograms per hectare, in addition to the livestock manure.

Pigs

Ten pond projects were associated with hogs. The pig sties enclosed 30 square meters with cement floors, wire enclosures, and

SPAWNING POND	NURSERY POND	PRESTOCKING POND	GROW-OUT POND
T. nilotica male and female adults	*T. nilotica* mixed sex fingerlings of 3 to 6 cm	*T. nilotica* males (storage)	*T. nilotica* males
Stocking rate: Females = 1/3 m^2 Males = 1/9 m^2 Ratio of males to females: 1 male for each 3 females Harvest: Time - 2 to 3 months Type - total Size of fingerling - 3 to 6 cm Restocking: All fingerlings and fry remaining in the pond must be eliminated before restocking with adults.	Stocking rate: Tilapia = 10/m^2 Harvest: Time - 3 to 4 months Type - partial or total Size of fingerling-8 to 12 cm Restocking: All fingerlings remaining in the pond must be eliminated before restocking with adults.	Stocking rate: Tilapia = 5/m^2 Harvest: Time - when males are needed in the grow-out pond Type - partial or total Restocking: Partial-5 male tilapias for every 4 harvested Total - same as initial stocking rate	Stocking rate: Tilapia = 1 to 2/m^2 Harvest: Time - 4 to 6 months Type - partial or total Size - 17 to 22 cm Restocking: Partial harvest - 5 male tilapias for each 4 male tilapias harvested. Total harvest - equal to the initial stocking rate.

FIG. 4. Four-pond module.

galvanized zinc sheet roofs. The sties were divided so that two lots of pigs could be raised simultaneously. Lots were introduced about 2 months apart so that the sty always contained pigs. The staggered fattening cycle facilitates marketing and the fish pond never lacks manure. The sties were built to hold 30 pigs, but were initially stocked with 20 pigs. This stocking rate was the equivalent of 64-101 pigs per hectare of water, table 1. The piglets, Yorkshire x Landrace hybrids, were purchased from private producers and fattened on commercial rations bought in large cities. The pigs were fed a growers ration daily for the first 1½ months and then a fattening ration to slaughter size at approximately 5 percent of their body weight. The community was encouraged to plant forage crops, manioc, corn, bananas, or other crops to supplement the commercial ration and lower feed costs. Pigs were fattened over a 100- to 120-day period and marketed locally or transported to a slaughter house. Transportation of piglets, ration, and fattened pigs is by public, private, and government transportation. Project members provide daily maintenance and simple prophylatic health care. The government provides veterinarian service.

Chickens

Three communities with existing chicken fattening projects were selected. They contain between 5,000 and 10,000 birds and the manure produced was greater than required for the fish ponds and gardens. Chicken manure, mixed with litter, was bagged and stored after each fattening cycle. The manure was then applied weekly to the fish ponds at rates from 500 to 1,000 kilograms per hectare. Chicks were bought from government and private producers. Commercial chicken feed was purchased from a private supplier who delivered the ration to the growers for a modest transportation fee. The 60-day-old chickens were sold alive, on-the-farm to a private processer who cleaned, froze, and marketed them.

Ducks

Two communities raised Peking ducks. The ducks were placed on the grow-out ponds at a rate equivalent to one duck every 10.4 square meters and 12.5 square meters of pond surface. Two-week-old ducklings were purchased from a commercial producer. The ducks were fed a commercial chicken ration placed in feeders located on floating pond rafts. The ducks were restricted within a fence, allowing them access to specific pond areas. The duck corral was divided in half so that two lots of ducks could be raised. When one lot was ready for market, a second lot remained, providing manure to the ponds. The ducks were ready for harvest in approximately 11 weeks of fattening, processed by project members, and transported to freezing facilities. The government provided transport of ration and also ducks to markets.

Cattle

Four communities with existing extensive cattle or dairy cow projects and fenced pastures used liquid cattle manure to fertilize their fish ponds. A cement-floored cattle corral was built near the pond modules. The corral was positioned so that the water used to fill the ponds passed through the corral before reaching the ponds. Cattle or dairy cows were corraled in the evening, 3 to 7 days per week. Each morning the cattle were released to pasture. The wastes deposited during the night were washed into the fish ponds in a liquid form. Although the correct number of adult animals per hectare of water is unknown, community groups were advised to use one cow per 100-200 square meters of pond area. One project was able to supplement its cattle manure production by collecting and transporting manure from a nearby dairy farm. The experienced Panamanian cattle rancher needs little help in reproducing, fattening, and marketing his animals. The grass-fed cattle do not receive a commercial ration.

Cattle and Chicken Manure

Three projects started with cattle but, because of technical or social problems, were unable to continue solely with cattle. The communities started supplementing the periodic applications of cattle manure with chicken manure at the rate of 200-500 kilograms per hectare per week. Chicken manure was purchased locally or donated by the government. Irregular doses of liquid cattle manure were applied as detailed for cattle only ponds.

TABLE 1. RELATIONSHIP OF LIVESTOCK TO TOTAL FISH PRODUCTION

Livestock	Module, no. of ponds	Grow-out pond area	Prestocking fertilization	Culture period	Type of harvest	Animals per hectare	Fish yield hectare/day	Fish yield hectare/yr.	Average yield hectare/yr.
		m^2		*Days*		*No.*	*kg*	*kg*	*kg*
Pigs									
Chumical	3	1,980	C.M.[1]	552	Total	101	3.5	1,288	
Guayabito	4	2,072	C.M.	642	Total	96	7.7	2,821	
Mata Palo	2	2,450	C.M.	629	Total	82	7.4	2,693	2,197
Montana	4	3,219	—	688	Total	64	5.9	2,161	
La Penita	2	2,260	C.M.	587	Total	88	5.5	2,022	
Ducks									
La Arena	2	1,845	—	249	Total	962	9.9	3,613	3,460
Cascajal	4	2,500	C.M.	484	Total	800	9.1	3,306	
Chickens									
Los Higos	3	3,823	C.M.	781	Partial	—	5.6	2,027	
Majarilla	4	3,010	C.M.	482	Total	—	8.3	3,031	2,329
San Jose	3	12,400	C.M.	652	Total	—	5.3	1,928	
Cattle									
Espavecito	3	4,051	N-P-K[2]	538	Total	—	3.3	1,205	
La Miel	3	2,534	N-P-K	755	Total	59	5.2	1,893	1,727
Remedios	3	4,118	N-P-K	581	Partial	—	5.7	2,084	
Cattle + Chickens									
Bayano	4	3,966	N-P-K	727	Partial	—	2.6	960	
Pedregoso	2	1,805	C.M.	536	Total	—	5.4	1,955	1,171
Las Trancas	2	3,029	—	551	Total	—	1.6	597	

1. Chicken manure.
2. 12-24-12 (N, P_2O_5, K_2O).

Horticulture

Thirteen of 22 integrated projects have vegetable and/or traditional gardens. Ideally, the gardens are located in lowland areas next to the fish ponds. Enriched pond water is taken by gravity through the drainpipe or by siphon to irrigate the gardens. Gardens also are fertilized with excess manures or chemical fertilizers. In the future, enriched pond bottom mud will be transferred to gardens to reduce the need for chemical fertilizers. Gardens range in size from 400 to 2,000 square meters. Vegetables were consumed and sold by the community.

Forestry

Upland areas adjacent to the pond modules with a topography unsuitable for gardens were reforested with fruit, pine, and fast-growing firewood trees. Trees planted were leucaena (*Leucaena leucocephala*), eucalyptus (*Eucalyptus camaldulensis* and *tereticornis*), Caribbean pine (*Pinus caribea*), and guasimo (*Guszuma ulmifolia*). Fruit trees include orange, lemon, guava, banana, plantain, and cashew. The seedlings were donated or produced by the project members. Community labor was used to plant trees.

Harvesting

Fish were harvested with gill nets and seines at approximately monthly intervals, figure 5. Partial harvest was the preferred method, but total harvest by pond draining also was employed. Fish were counted and weighed by species. Silver and bighead carps and their hybrids were combined because of the difficulty involved in separating them when stocked together in the same pond. Weights were recorded in pounds and ounces and later converted to the metric system.

Credit

Communities were provided bank loans to finance the purchase of young animals, ration, transport, and medicines. A special credit fund of $20,000 was established with the Agricultural Development Bank (BDA) to offer low interest loans (9 percent annually) to needy communities. Fifty percent of the credit fund was provided by USAID and the other 50 percent by the bank. Loans were repaid through animal sales. Extension agents encouraged project groups to reinvest profits from sales in the purchase of replacement animals and feeds.

FIG. 5. A partial harvest of tilapia and carps is evenly distributed amongst the 14 families participating in the agroaquaculture project located in Mata Palo, Veraguas.

Technology Transfer

Extension

Each fish pond project was supervised by one or two aquaculture extensionists. They worked out of MIDA regional offices and were located by province as follows: Eastern Chiriqui—1, Cocle—2, Herrera—4, Los Santos—2, and Veraguas—6. Nine of the extensionists were recent graduates of a 2.5-year university "Technician in Aquaculture" program. These extensionists were well-trained and adjusted rapidly to their jobs. The remaining five were already working in fish culture extension and had varying abilities.

Each region had a 4-wheel drive Jeep plus occasional use of an additional vehicle. The extensionist assisted project members in organization, pond site selection, construction of ponds and animal enclosures, and production and harvest of tilapia seed, fish, livestock, and vegetables. Most of the economic and fish production data presented in this document were collected by the extensionists. DINAAC supervisors and the authors held monthly meetings with the extensionists to exchange ideas, discuss advances and constraints, and provide further training.

Training

A "Department of Technology Transfer" was initiated. Printed and audiovisual materials were produced to assist trainers and extensionists. Battery-operated slide projectors and flannel boards were distributed to each region. Extensionists were encouraged to give slide shows and seminars in project communities. Two 3-day training programs were given in the Divisa training center to two or three members of each pond project. The training program consisted of classroom lectures and practical exercises performed in the Divisa fish hatchery ponds. Skills learned in Divisa were reinforced by the extensionists in the communities.

Data Analysis

It was not possible to statistically analyze fish production data due to variations in water quality and quantity, amount of manure applied, quantity and quality of extension assistance, and fish stocking rates and survival, as well as unreported harvests. However, data were summarized, reported, and comparisons made, tables 1, 3, and 4.

RESULTS AND DISCUSSION

Sixteen of 22 projects had a production cycle of sufficient length to generate adequate data for non-statistical analysis. The length of the production period for each project analyzed can be found in table 1.

TABLE 2. AVERAGE MONTHLY RAINFALL, IN DIVISA, PANAMA, 1977-81, 1982, AND 1983

Period	Rainfall, by months												Total
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
	mm	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*
1977-81	1	0	36	115	279	228	162	205	180	246	212	79	1,743
1982	92	0	0	25	59	76	162	95	244	537	110	0	1,400
1983	0	0	1	8	56	215	159	85	236	248	—	—	1,008[1]

[1]Ten months.

TABLE 3. PRODUCTION, AVERAGE WEIGHT, AND PERCENT OF TOTAL FISH YIELD FOR SPECIES CULTURED IN EACH LIVESTOCK GROUP

Performance measure by species	Pigs	Ducks	Livestock-chickens	Cattle	Cattle + chicken	Average
Tilapia						
Average yield	(790-2,550)[1]	(1,461-2,107)[1]	(1,203-1,715)[1]	(929-1,120)[1]	(311-1,019)[1]	
Kg/ha/yr.	1,584	1,784	1,400	1,023	682	1,295
	(79-185)	(141-146)	(147-250)	(90-209)	(81-240)	
Average weight, g	133	144	191	168	147	154
Avg. percent of total	(59.0-91.0)	(49.0-66.0)	(57.0-63.0)	(47.0-77.0)	(52.0-74.0)	
Yield	71.0	53.7	59.7	61.0	60.3	61.1
Common carp						
Average yield	(86-134)	(266-399)	(36-172)	(9-69)	(33-221)	
Kg/ha/yr.	150	333	93	32	104	142
	(244-1, 165)	(556-624)	(391-488)	(303-1,733)	(393-815)	
Average weight, g	582	590	448	852	545	601
Avg. percent of total	(3.0-16.0)	(6.0-12.0)	(2.0-8.0)	(1.0-3.0)	(6.0-12.0)	
Yield	7.4	10.0	4.0	1.7	8.7	6.4
Silver and bighead carps						
Average yield	(103-814)	(710-917)	(672-1,216)	(269-1,074)	(21-597)	
Kg/ha/yr.	442	814	866	698	346	712
	(381-793)	(363-750)	(318-797)	(325-418)	(369-439)	
Average weight, g	598	557	613	384	408	520
Avg. percent of total	(4.0-30.0)	(22.0-45.0)	(33.0-41.0)	(22.0-50.0)	(22.0-38.0)	
Yield	21.6	36.3	36.3	37.3	31.0	32.5

[1]Range of values.

TABLE 4. FISH YIELD COMPARISON BETWEEN TWO-POND AND THREE- AND FOUR-POND MODULES

Performance measure	Two-pond module mixed sex tilapia with a predator	Three and four-pond modules all-male tilapia
Average tilapia yield, kg/ha/yr.	1,052	1,371
Average tilapia weight, g	136	163
Total fish yield, kg/ha/yr.	1,864	2,064

WEATHER

Average monthly rainfall data were collected in Divisa, Panama, for a 5-year period, 1977-81, and the drought years of 1982 and 1983 are presented in table 2. One millimeter of rainfall was recorded over a 165-day period from November 11, 1982, to April 28, 1983. The 6-month period from November 1, 1982, to April 30, 1983, was the driest in the last 75 years. As a result, 8 of 16 projects analyzed in this chapter were seriously affected by a lack of water. Two projects dried completely and six had their spawning and nursery ponds dry up.

Two conclusions may be drawn from this situation:

1. Despite technical problems, people maintained an interest in their ponds.
2. The technology can withstand severe environmental pressures.

WATER QUALITY

Pond water quality was measured in each community with a Hach kit. Readings for pH values ranged from 6.5 to 7.5, with an average reading of 7.2. Total alkalinity ranged between 10 and 150 milligrams per liter, an average of 68, and hardness ranged between 0 and 103 milligrams per liter, an average of 51. Water quality was not considered a constraint on fish production except in Chumical, table 1, where the pH was 7.0, total alkalinity was 10 milligrams per liter, and hardness was 0. Pond water and soil in Chumical were recently limed to improve water quality. Lime was not applied in any other projects.

No fish mortalities due to low dissolved oxygen caused by excess manure were recorded.

FISH PRODUCTION

Average fish production for all projects was equivalent to 2,177 kilograms per hectare per year, table 2. Integration with ducks resulted in the largest average fish production, followed by fish production with chickens, pigs, cattle, and cattle plus chickens, table 2.

Highest average tilapia production also was obtained with ducks, followed by pigs and chickens. Reduced tilapia production occurred with cattle and cattle plus chickens. Average tilapia production for all livestock treatments was 1,295 kilograms per hectare per year, table 3. Average tilapia harvest weight for all livestock treatments was 154 grams. The size of tilapia harvested depended on community desire and net mesh size used. Some project members were satisfied with fish of 50 to 100 grams, while others wanted fish of 200 grams, table 3. An average of 61 percent of the total fish production from all livestock treatments was comprised of tilapia.

Average common carp and silver and bighead carp production for all livestock treatments was 142 and 712 kilograms per hectare per year, respectively. Common carp had an average harvest weight of 601 grams, while silver and bighead carps averaged 520 grams. Common carp and silver and bighead carps averaged 6 percent and 32 percent, respectively, of the average total weight harvested. A summary of fish production results are presented in tables 2 and 3.

The guapote tigre effectively controlled tilapia density and consisted of 0.6-2.8 percent of the total catch by weight (17 kilograms per hectare per year). Many small guapote were confused with and reported as tilapia.

The average fish production obtained from the two-pond modules using mixed-sex *T. nilotica* with a predator and three- and four-pond modules stocked with male tilapia is given in table 4. A small difference was observed in average tilapia and total fish production in the two systems.

Survival of stocked fish was hard to determine because partial harvests left an undetermined number of fish in some ponds. However, eight totally drained grow-out ponds allowed an estimate of fish survival. An average of 72 percent of the stocked tilapias were harvested, while an average of 57 percent and 53 percent of the stocked common carp and silver and bighead carps were recovered. Low survival appears to be related to the small size of stocked fish, 1 to 3 grams, and unregistered harvesting by project participants and non-participants. Demand for Divisa hatchery fish seed is high. Thus, fish seed are stocked below ideal size, resulting in high mortality due to handling during transport and insect predation after stocking.

Unregistered harvesting by hook and line is hard to control. Thus, the quantity of fish lost to poaching cannot be determined. The nutritional survey demonstrated that 11 percent of non-participants in pilot communities harvested tilapia and carp for their own consumption. Where nutritional need is high, the only way to eliminate unregistered harvest is good group cooperation and strict vigilance. Nevertheless, normal rainfall, improved pond fertility, fish survival, and pond management will all contribute to increased fish production and harvest.

Seed Production

Project members are producing their own tilapia seed to restock grow-out ponds. The two-pond module is the easiest system to manage because no manual sexing is needed. Project members simply count and stock the required number of mixed-sex *T. nilotica* seed into the grow-out pond. Tilapia recruitment is not a problem in the grow-out pond when guapote tigre are properly stocked. Grow-out ponds normally need draining only when pond maintenance is required. The three-pond module also works well, although its seed production system is more difficult. Manual sexing of the tilapia fingerlings requires dedication and care. It is difficult to select 100 percent male fish manually, and some females are introduced into the grow-out ponds resulting in tilapia reproduction. Elimination of unwanted tilapia seed requires grow-out pond draining every 12 to 18 months. However, a large number of small tilapia males can be collected upon draining and held in the nursery pond for restocking. The four-pond module is similar to the three-pond module and results are about the same. The only difference is underutilization of the prestocking pond. The prestocking pond was used only to hold carp seed for restocking the grow-out pond. To better utilize prestocking ponds, they are also used as grow-out ponds.

The strategy behind the use of pond modules is not only to establish self-sufficiency in tilapia seed production but to sell excess seed to nearby growers. There are many small family ponds located near the modular units. The community project should also stimulate the construction of more family ponds. Some spawning and nursery pond areas are intentionally larger than required to permit the potential for excess tilapia fingerling production. In essence, the modular pond projects can become rural mini-hatcheries to supply tilapia seed as required for local demand and, thus, reduce dependency on the governmental hatchery.

The short time available for data collection and the unusual dry weather made it impossible to determine if pond project members were able to maintain adequate stocking levels in grow-out ponds.

Communities were producing tilapia fingerlings but numbers were not available for inclusion in this report. More time will be needed to determine if fish production increases, remains stable due to adequate stocking levels, or declines due to inadequate stocking rates.

Harvests

Given participants' desires and resources, partial harvest (removal of small quantities of fish that can be consumed or sold fresh) is preferred to total harvest. A high percentage of harvested fish were consumed by project members and few fish were marketed. Since project members showed little size or species preferences, all were consumed.

Initially, partial harvests were carried out with seines; however, seines are expensive, not readily available in Panama, and are not effective in harvesting tilapia in a large grow-out pond. Tilapia readily pass under a seine in deep water. Gillnets with 3- and 4-inch stretch mesh are now successfully used. Gillnets are much cheaper and easier to handle than an equivalent length of seine and are available in most regions of Panama. Tilapia of 150-250 grams are caught in a 3-inch stretch mesh net. However, gillnets with stretch mesh less than 2 3/4 inches are not available in Panama. Communities harvesting tilapia weighing less than 130 grams cannot use gillnets because mesh size is too large to hold the fish. Also, gillnets effectively remove carps at 200 grams, before their superior growth rate can be exploited. Once caught, the damaged carp cannot be returned to the pond. Seines must be used for partial harvest of small tilapia from spawning, nursery, and grow-out ponds.

Hook-and-line can be a cheap and effective method of partial harvesting tilapia and common carp. Silver and bighead carps do not take a baited hook and are left to reach a large size. Unfortunately, use of hook-and-line often leads to unregistered harvest, which makes data collection difficult.

Total harvest is often used when grow-out ponds become overpopulated with tilapia recruitment or large harvest nets are not available. Total harvest by netting and draining results in a large quantity of fish that is often difficult to preserve and sell in isolated rural communities. Also, fertilized pond water is lost by draining.

Livestock

Studies demonstrate that manure from livestock associated with grow-out operations increases fish production, figure 6. If healthy, economical livestock operations can be maintained, then good fish production will follow.

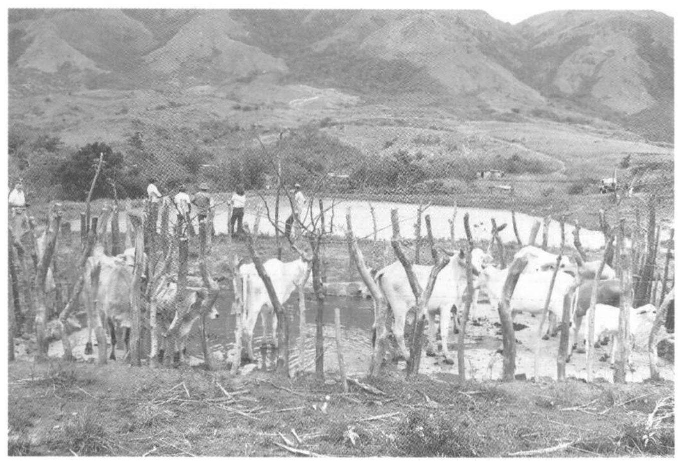


FIG. 6. Pastured cattle are herded into a corral each afternoon in El Pedregoso, Veraguas. Manure deposited at night is washed into the pond to increase pond fertility and fish yield.

Pigs

Few problems were encountered with pig rearing, figure 7. Survival among the initial 122 piglets was 97 percent. Disease was not a serious problem, but feed cost and quality are problems.

The biggest problem was transport of piglets, ration, and fattened pigs. Many communities have no private transportation and precarious public transportation. If the government is unable to provide this service for economic or political reasons, integrated projects with pigs will fail. Thus, the government must provide transportation.

Also, improved efficiency is needed in pig production. Only one or two cycles of pigs per year were obtained due to drought, delays in obtaining loans, and the inexperience of extensionists and project members in raising and marketing pigs. Increasing the number of pigs raised per year should increase profits as well as fish production.

FIG. 7. Typical pigsty constructed of cement, wire, wood poles, and zinc sheets located on the bank of a pond module in Mata Palo, Veraguas. Unemployed boys and women commonly provide daily care to the pigs and fish.

Ducks

Ducks proved to be an excellent culture animal, figure 8. There are transportation difficulties with ducks, but the greatest problem is marketing. Duck, considered a luxury, is not commonly eaten by Panamanians. Oriental families and Chinese restaurants are the principal consumers. Thus, market constraints caused the elimination of one duck project and threatened the continuation of a second. There is little potential for expansion of the duck component without developing reliable markets.

Chickens

Chicken projects were not controlled by the DINAAC but by another directorate within the MIDA. The projects were large, permitting a feed company to deliver the ration in bulk to the community. A chicken processor purchased the birds live, directly from the community. Thus, government transportation was not involved. Fish ponds with chickens never lacked manure and the amount applied depended only on dissolved oxygen levels. Chicken projects presented the largest fish production with the fewest problems.

Cattle

Cattle are widely raised and are the most important livestock operation in Panama. The infrastructure for transporting and marketing animals is well established. The cattle are grass fed so there is no need to buy and transport costly feed. Fish ponds fertilized with cattle manure were located in cattle pastures. Cattle offer the best alternative for isolated communities where road access and transport are limited.

The cattle enterprise does have several limitations, including the following:

1. Compared with ponds fertilized with manure from ration-fed animals, total fish production with the lower-nutrient cattle manure appears to be reduced.
2. Rainy season grass is plentiful and cattle can be maintained near the corral and ponds, but in the dry season pasture is poor and the animals must be dispersed to obtain adequate grazing. Thus, the number of animals retained in the corral was less than optimum for best fish production.
3. In some projects, members did not place an adequate number of animals in the corrals. This was the result of poor coordination and/or conflicts among membership. Conflicts were prevalent when members placed cattle from their herds in the corral on alternating days. Conversely, successful projects used one member's herd or collectively owned cattle.

Cattle and Chickens

Two of the three projects intended to be cattle and chickens were in reality cattle-only projects that failed. The third project was located in an isolated, impoverished community with a limited number of cattle and pasture. Available cattle were not sufficient to provide an adequate quantity of manure to properly fertilize this pond. Nevertheless, social and technical problems remained and low fish production resulted, table 3.

Forestry

Exact numbers of trees planted and production data are not available at this time. However, 7 of the reported 16 projects planted trees. The principal restriction is obtaining sufficient land to plant a large number of trees. Competition with cattle for grazing land limits space for tree planting.

Horticulture

Production data from gardens are not yet available. Two gardens had good harvests of cucumbers, tomatoes, green peppers, green beans, and traditional crops. Considerably more attention should be devoted to this component. The remaining gardens gave mixed results due to community inexperience and/or low soil fertility.

Credit

Credit is an area in need of improvement. Over $20,000 in loans were distributed by BDA in 1.5 years, and only $200 in loans went unpaid. Once the loan agreement between the bank and the project members was signed, disbursement of funds flowed smoothly, however, processing of loan agreements was slow and burdensome.

Initially, aquaculture extensionists and project representatives joined together in processing loan requests, but the ultimate goal was to teach project members how to obtain loans by themselves. Unfortunately, when project members tried to do so, the bank was not prepared for, nor sympathetic to, the assistance needed by inexperienced small farmers.

Extensionists must become more familiar with the BDA procedure and policy and accept the fact that loan approval is a lengthy process requiring long-range planning. Loan applications should be initiated months before they are needed. At the same time, BDA must become more sensitive to the needs of small farmers.

FIG. 8. Up to 800 ducks per hectare can be intensively raised to yield fish harvests of 3,500 kg/ha/yr. as is seen in this view of a grow-out pond in Cascajal, Cocle.

Technology Transfer

Extension

An attempt was made to determine the average number of days extensionists spent in each project. During the time that participant groups were being organized and construction completed, extension activities were intense. Thereafter, extension assistance was slowly reduced as project members became more experienced and as new projects demanded attention. After the first year of operation, extension effort was reduced to three visits per month, about 12 hours, and involved routine pond checks, harvesting, attending group meetings, transporting feed and animals, processing loan applications, and giving seminars.

An average of about 261 hours was spent by extensionists in project communities during the first year. Over two-thirds of this time was spent in group organization and construction of pond and animal facilities. The quantity and quality of extension assistance varied greatly, depending on the number of projects each extensionist serviced and the distance and accessibility of each project from headquarters. For example, the extensionist in charge of Eastern Chiriqui attends only 3 projects, four extensionists assist 17 projects in Herrera, two attend 81 ponds in Cocle, two oversee 11 projects in Los Santos, and six assist 182 ponds in Veraguas. While extension efforts were mainly directed toward the AID financed projects, exclusive attention was not possible because other pond operators needed assistance. Technical capacity of extension workers was adequate. Dedication and interest were excellent. The number of extensionists was not a major limiting factor except in Veraguas Province.

Transportation of extensionists to the field was the principal constraint on effectiveness of the extension program. Nevertheless, the authors feel that technical aspects of the extension effort during the 2.5-year pilot phase were adequate. As demand for fish projects increased, the extensionists' work load became greater and less time could be spent with each project. Transportation limitations placed additional strains on them. Interest in rural, integrated aquaculture was growing, but the technical transfer support base remained stable. The necessity of an adequate extension program cannot be over emphasized. Working with the most needy and inexperienced segment of the rural population requires time and patience. Expansion of rural agroaquaculture must coincide with the growth of the technical support services (extension).

Training

Initially, the AID supported project groups selected members to be trained at Divisa. Demand for training increased rapidly and the program was expanded to non-AID supported communities. Members of 70 communities participated in fish culture training programs. Courses also were offered to personnel, including extensionists, from other government agencies interested in promoting agroaquaculture. The training component was highly effective and should be continued and even strengthened.

Constraints on Self-Sufficiency

There are many factors that affect the ability of a community to attain self-sufficiency. Two principal constraints, transportation and credit, have been discussed. A third constraint, group size, warrants mention. Many projects have too many participants to provide each an adequate amount of fish per harvest. Approximately 2 kilograms per week, about 104 kilograms per year, would allow a family of five to eat fish twice a week. Based on the average fish production obtained to date, 2,177 kilograms per hectare per year, approximately 484 square meters of pond space would be needed to provide each participant with 104 kilograms per year. If fish production is increased to 3,000 kilograms per hectare per year through improved management, then 350 square meters of pond area would suffice. Thus, at least 350 square meters of grow-out area should be allotted per participant. At this time, most projects have only 100-200 square meters of pond per participant. Where topography does not permit at least 350 square meters of grow-out pond per participant, the number of project members should be limited to conform to the pond area available. Too many members for the amount of fish harvested can produce social pressures that cause the project to fail.

CONCLUSIONS

In summary, projects have been well-received by participants. Groups have organized and generally followed instructions of the extensionists. In general, the participants have learned to manage their agroaquaculture projects. However, several more years are needed to determine if agroaquaculture projects can generate enough social, economic, and nutritional benefits to become self-sustaining operations in rural Panama. Project groups also need more time to improve their operational efficiency. Finally, more time is needed to determine if these groups can operate with minimal Government of Panama logistical support.

Chapter II
Nutritional Monitoring and Evaluation

V.G. deCastillo

The impact of integrated rural development programs on the diets and nutritional status of low-income rural families is of great interest to governments and international funding agencies. Changes in family diet and/or nutrition may result from increasing home production of nutritional foods and/or by increasing the purchasing power of the family. The latter may result from greater sales of agricultural surplus or from improved local employment opportunities.

An agroaquaculture program focused on low-income communities in rural areas can improve family diets and nutrition through:

1. The availability of fish to participating families can be increased.
2. Family income formerly used to buy fish or other animal products can be used to purchase greater quantities of regularly consumed foods and/or to acquire new foods and thus, increase calories, vitamins, proteins, and minerals consumed.
3. The generation of additional income derived from the sale of agricultural-aquacultural products (fish, poultry, swine, and vegetables) may lead to the acquisition of greater quantities of other foods.

The nutritional impact of rural programs is also evaluated in terms of whether the changes (or improvements) in the domestic diet are of equal, smaller, or greater magnitude than the energetic and nutrient needs of family members.

The following sections summarize nutritional problems in Panama and the objectives, methodology, and results of a study conducted to evaluate the nutritional impact of the "Freshwater Fish Culture Project" in Panama. The nutritional study was carried out in the provinces of Veraguas, Cocle, Herrera, and Los Santos by means of anthropometric, dietetic, and household budget surveys. Information was gathered between December 1981 and October 1983.

THE NUTRITIONAL PROBLEM IN PANAMA

Thirty percent of the children under 5 years of age in Panama suffer from malnutrition according to weight and age data (3). Recent studies (4) reveal that, on the average, the Panamanian population consumes 95 percent of their daily recommended caloric requirements. In the Provinces of Cocle and Veraguas, the average caloric adequacy is 91 percent of the recommended levels; for Herrera and Los Santos 100 and 108 percent, respectively. In 1980, however, 28 percent of the families did not reach 75 percent of caloric adequacy. This percentage was greater in Cocle and Veraguas, 36 and 41 percent, respectively. The study revealed that average protein adequacy for the country was 153 percent of required levels. None of the provinces had an average lower than 100 percent, but the allocation of proteins is far from satisfactory. Thus, about 9.3 percent of the families did not reach 75 percent of the daily recommended levels of protein consumption. In the provinces of Cocle, Veraguas, Herrera, and Los Santos, the percentage of families that did not consume 75 percent of recommended protein levels was 16, 10, 9, and 6 percent, respectively, figure 1.

Data on the frequency of food consumption show that, in general, breakfast in Panama is based on coffee or tea and sugar or honey. In addition to the above-mentioned foods, dairy products are consumed in Los Santos and bread in Cocle. Meats are normally part of lunch, along with rice and fats in all Panamanian provinces except Veraguas. Meat does not appear as part of the common dietary pattern at dinner in Veraguas and Chiriqui provinces (5). Less than half of the studied families consumed meat the day before the survey was conducted. It should be emphasized that only in the region of San Blas is fish a part of the basic dietary pattern. The food pattern found in Panama reflects a monotonous diet, deficient in vegetables and fruits and, in some provinces, a diet insufficient in products of animal origin.

FIG. 1. A typical member household in the mountains of impoverished El Pedregoso, Veraguas.

OBJECTIVES

The general objective of the study was to evaluate the nutritional impact of the "Freshwater Fish Culture" project on rural families. More specifically, the objectives were:

1. To determine if freshwater fish culture projects improve the intake of calories, protein, vitamin A, iron, and riboflavin by the participating families and their children; the proportion of children included in adequate weight/age, height/age, and weight/height categories; and the total income of the family and the structure of family budgets.
2. To determine the relationship between the observed changes in the above, and the size of the project, production attained, and the number of participating families.
3. To identify and quantify the channels and destination of the fish production.
4. To identify and describe the nutritional and socioeconomic differences between participating and non-participating families in integrated aquaculture projects and between experimental and control communities.

METHODOLOGY

Evaluation Model

The evaluation model or sample consisted of three kinds of communities.

Traditional

Ten communities selected at random from a total of 77 that had aquacultural ponds built under traditional schemes from 1976 to 1980. All the communities were located in the province of Veraguas and all had communal ponds.

Pilot

Ten communities in the pilot integrated aquaculture scheme initiated in 1981 (the first 10 projects implemented) were selected. Three are in the province of Veraguas, three in Herrera, three in Los Santos, and one in Cocle.

Control

Ten control communities which do not have or will not have fish pond programs in the next 3 years were selected. The selected communities had approximately the same socio-political and population structures as the pilot communities and are located in the same provinces, i.e. three are in Veraguas, and so on.

From each of the three groups, an attempt was made to survey a maximum of 40 randomly selected families, and at least 50 percent of the participant and non-participant populations in the fish pond project communities. It was not possible to achieve this goal in all the communities. Information on domestic diet, anthropometry, and household budgets was gathered in 30 communities, from the provinces of Veraguas, Cocle, Herrera, and Los Santos. Data were collected using a package of seven questionnaires. The 24-hour recall method combined with food weight and measurement was utilized for the dietetic survey. Equipment used consisted of measuring cups, 500-gram balances (Hanson brand, with 2-grams sensitivity), waxed paper, and aluminum wrap. For the anthropometric survey, infant meters (*'infantometros'*), meter sticks, and scales were utilized.

The surveying team consisted of seven DINAAC staff members. All of them received survey and measurement training and three pilot tests were run in order to standardize anthropometric measurement techniques. The study sample consisted of 839 families with a total of 3,667 members.

Processing

The Latin American Food Composition Table, *Tabla de Composicion de Alimentos Latinoamericana*, was utilized to evaluate the diet (*1*) and the standards recommended by the OPS were used to evaluate weight and height as related to age. The data were processed in the Computing Center of the INCAP located in Guatemala.

Analysis

Analysis was done at the family and community levels to determine the magnitude and statistical significance of differences observed between participant and non-participant families, and between pilot and control communities. Traditional communities will be compared only to pilot and control communities in the Province of Veraguas because of socioeconomic, nutritional, and geographic differences among provinces and because there are few traditional ponds outside Veraguas. Garden data were insufficient between 1981 and 1983 for analysis and are not included here. The analysis presented here represents a baseline for future evaluations.

RESULTS

ANTHROPOMETRY

Table 1 presents the nutritional condition of children under 5 years of age, according to weight and height measurements. There are no significant differences between participant and non-participant families, nor between children in pilot and control communities.

Diet

Dietary information at the family level and for most nutritionally vulnerable groups (mothers and pre-school children) appears in tables 2 and 3, respectively.

No significant observable differences in average protein adequacy between the groups studied were found. There were differences in caloric adequacy between pilot and control communities. Table 3 shows significant differences in the percentage of families with adequacies below 75 percent. In pilot communities, a greater proportion of non-participating families have caloric and protein adequacy levels below 75 percent (45.0 percent and 20.8 percent, respectively) than participating families, 35.1 percent and 13.2 percent, respectively. Also, a greater proportion of pilot community families have caloric adequacy levels below 75 percent (40.7 percent) than control communities (32.6 percent).

TABLE 1. RESULTS OF THE ANTHROPOMETRIC SURVEY—JULY/AUGUST 1985, PILOT AND CONTROL COMMUNITIES

	Pilot		
	Participating	Non-participating	Average
Number	73	91	
% < -2 S.D. H/A[1]	17.8	14.3	15.9
% < -2 S.D. W/A[2]	8.2	4.4	6.1
% < -2 S.D. W/H[3]	2.7	1.1	1.8
	Pilot	Control	Average
Number	164	137	
% < -2 S.D. H/A[1]	15.9	22.6	18.9
% < -2 S.D. W/A[2]	6.1	10.9	8.3
% < -2 S.D. W/H[3]	1.8	2.9	2.3

[1]Percent of children under 5 years of age with height below two times the standard deviation for their age.
[2]Percent of children under 5 years of age with weight below two times the standard deviation for their age.
[3]Percent of children under 5 years of age with weight below two times the standard deviation for their height.

TABLE 2. RESULTS OF THE DIETETIC SURVEY—JULY/AUGUST 1983, PILOT COMMUNITIES

Diet	Participating	Non-participating	Average
		Families	
Number	114	149	
% < 75% caloric adequacy	35.1	45.0*	40.7
% < 75% protein adequacy	13.2	20.8*	17.5
X ± S.D. caloric adequacy	89.2 ± 27.7	84.6 ± 31.8	86.8 ± 30.2
X ± S.D. protein adequacy	121.0 ± 42.4	115.7 ± 49.7	118.0 ± 46.6
X ± S.D. iron adequacy	88.2 ± 47.5	77.1 ± 42.7*	81.9 ± 45.1
X ± S.D. retinol adequacy	14.1 ± 16.7	13.7 ± 14.8	13.8 ± 15.6
X ± S.D. riboflavin adequacy	59.3 ± 33.5	59.7 ± 39.9	59.5 ± 37.2
		Mothers	
Number	42	56	
% < 75% caloric adequacy	35.7	42.9	39.8
% < 75% protein adequacy	23.8	26.8	25.5
X ± S.D. caloric adequacy	90.2 ± 33.2	82.4 ± 28.9	85.7 ± 30.9
X ± S.D. protein adequacy	112.8 ± 49.0	103.3 ± 42.0	107.4 ±45.2
X ± S.D. iron adequacy	45.2 ± 21.6	40.7 ± 16.0	42.6 ± 18.6
X ± S.D. retinol adequacy	16.2 ± 26.3	10.4 ± 13.9	12.9 ± 20.2
X ± S.D. riboflavin adequacy	59.1 ± 50.2	46.8 ± 26.4	52.1 ± 38.7
		Children	
Number	54	75	
% < 75% caloric adequacy	63.0	50.7*	55.8
% < 75% protein adequacy	9.3	26.7**	19.4
X ± S.D. caloric adequacy	76.0 ± 32.9	80.0 ± 30.6	78.3 ± 31.5
X ± S.D. protein adequacy	121.3 ± 51.8	121.2 ± 56.2	121.2 ± 56.2
X ± S.D. iron adequacy	64.1 ± 28.3	69.8 ± 39.3	67.4 ± 35.4
X ± S.D. retinol adequacy	37.2 ± 45.8	53.5 ± 77.0	46.7 ± 66.0
X ± S.D. riboflavin adequacy	78.7 ± 83.2	84.9 ± 83.8	82.3 ± 83.2

*P < 0.05
**P < 0.01

All groups surveyed had higher protein intake adequacy values than caloric adequacy values, figure 2. Furthermore, even though mean protein intake values are adequate, 15 to 17 percent of the fam-

TABLE 3. RESULTS OF THE DIETETIC SURVEY—JULY/AUGUST 1983, PILOT AND CONTROL COMMUNITIES

Diet	Pilot	Control	Average
		Families	
Number	263	242	
% < 75% caloric adequacy	40.7	32.6**	36.8
% < 75% protein adequacy	17.5	15.3	16.4
X ± S.D. caloric adequacy	86.8 ± 30.2	92.7 ± 34.3*	89.6 ± 32.3
X ± S.D. protein adequacy	118.0 ± 46.7	124.2 ± 47.7	121.0 ± 47.2
X ± S.D. iron adequacy	81.9 ± 45.1	83.9 ± 44.3	82.9 ± 44.7
X ± S.D. retinol adequacy	13.8 ± 15.6	17.0 ± 17.4	15.4 ± 16.6
X ± S.D. riboflavin adequacy	59.5 ± 37.2	64.0 ± 37.2	61.7 ± 37.2
		Mothers	
Numbers	98	76	
% < 75% caloric adequacy	39.8	48.7	43.7
% < 75% protein adequacy	25.5	28.9	27.0
X ± S.D. caloric adequacy	85.7 ± 30.9	79.1 ± 30.0	82.8 ± 30.6
X ± S.D. protein adequacy	107.4 ± 45.2	103.9 ± 42.5	105.8 ± 43.9
X ± S.D. iron adequacy	42.6 ± 18.6	42.2 ± 19.2	42.4 ± 18.8
X ± S.D. retinol adequacy	12.9 ± 20.2	13.3 ± 18.8	13.1 ± 19.6
X ± S.D. riboflavin adequacy	52.1 ± 38.7	53.0 ± 37.0	52.5 ± 37.6
		Children	
Number	129	101	
% < 75% caloric adequacy	55.8	57.4	56.5
% < 75% protein adequacy	19.4	21.8	20.4
X ± S.D. caloric adequacy	78.3 ± 31.5	76.8 ± 32.6	77.6 ± 31.9
X ± S.D. protein adequacy	121.2 ± 54.2	120.3 ± 53.2	120.8 ± 53.6
X ± S.D. iron adequacy	67.4 ± 35.4	62.0 ± 33.0	65.1 ± 34.4
X ± S.D. retinol adequacy	46.6 ± 66.1	40.7 ± 49.9	44.0 ± 59.4
X ± S.D. riboflavin adequacy	82.3 ± 83.3	84.7± 81.8	83.4 ± 82.5

*P < 0.05
**P < 0.01

FIG. 2. About 70 men, women, and children are obtaining additional protein from their communally managed pig-fish project in Mata Palo, Veraguas. Happy participants display their harvest of tilapia and carp.

ilies in both pilot and control communities do not reach 75 percent of recommended protein intake. No differences were detected in mean iron, retinol, and riboflavin adequacy values, though they are extremely low in all groups.

CONSUMPTION OF PROTEINACEOUS FOODS

Monthly fish consumption is higher in participating families than in the non-participating families. Meat consumption is significantly higher in control communities even though price of meat is higher in control communities than in pilot communities, table 4. Families in pilot communities tend to consume more fish than those in control communities, though this difference is not significant (P > 0.079).

Acceptability of fish was 100 percent among participating families, while 96.9 percent of the non-participating families liked fish. At the community level, 98 percent of the families in pilot communities and 92 percent in control communities accepted fish. Most families preferred eating fresh fish fried and preserving fish by salting and drying. Sixty days prior to the survey, 89.8 percent of the participating families and 68.9 percent of the non-participating families ate fish. About 78 percent of pilot community families and 57 percent of control community families were able to obtain fish sometime during a 60-day period before sampling.

Almost all participating families got their fish from the ponds. The most remarkable fact is that a fairly high percentage of non-participants also obtained pond-raised fish. Most of the latter got their fish as gifts or purchased their fish from neighbors or community stores, tables 5 and 6.

SOCIOECONOMIC ASPECTS

The only significant differences between participating and non-participating families were educational level and family size. Heads of participating families (i.e. households) had significantly more years of study and larger families than heads of non-participating families. More pilot community families are involved in complementary food programs than those in control communities. Control communities, on the other hand, enjoy better environmental, sanitary, and housing conditions. Further differences in socioeconomic indicators are given in tables 7 and 8.

No differences in total yearly per capita spending between participating and non-participating families or pilot and control communities were found. Food expenses were 55 to 60 percent of total income for all families. There were no differences between pilot and

TABLE 4. FREQUENCY OF CONSUMPTION OF PROTEIN FOODS[1], JULY/AUGUST 1983, PILOT AND CONTROL COMMUNITIES

Food item	Participating	Non-participating	Average
Number	128	161	
Dairy products	21.2 ± 16.3	19.4 ± 15.4	20.2 ± 15.8
Beans	15.3 ± 9.0	13.2 ± 8.6	14.1 ± 8.8
Eggs	11.0 ± 8.7	9.8 ± 8.4	10.3 ± 8.5
Meats (red)	7.1 ± 6.8	7.5 ± 7.1	7.4 ± 6.9
Poultry	5.6 ± 4.7	5.9 ± 5.7	5.8 ± 5.3
Fish and seafood	4.6 ± 5.0	3.3 ± 4.1*	3.8 ± 4.6
Food item	Pilot	Control	Average
Number	289	265	
Dairy products	20.2 ± 15.8	22.6 ± 16.8	21.3 ± 16.3
Beans	14.1 ± 8.8	14.2 ± 9.0	14.1 ± 8.9
Eggs	10.3 ± 8.5	11.3 ± 8.4	10.8 ± 8.5
Meats (red)	7.4 ± 6.9	9.9 ± 8.5**	8.6 ± 7.8
Poultry	5.8 ± 5.3	5.6 ± 4.4	5.7 ± 4.9
Fish and seafood	3.8 ± 4.6	3.2 ± 4.3	3.5 ± 4.4

[1]Number of times per month families consumed the above mentioned food.
*P < 0.05
**P < 0.005

TABLE 5. KINDS OF FISH CONSUMED AND SOURCES[1], JUNE/AUGUST 1983, PILOT COMMUNITIES

Kind of fish	Participating N = 117		Sources of fish[3] 1		4		5		6		Non-participating N = 117		Sources of fish[3] 1		2		3		4		5		6	
	No.[1]	%[2]	No.	%	No.	%	No.	%	No.	%	No.[1]	%[2]	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Tilapia	96	82.1	96	82.1							47	40.2	11	9.4	19	16.2	8	6.8			9	7.7		
Carp	87	75.0	87	75.0							34	29.1	9	7.7	17	14.5	5	4.3			3	2.6		
Snapper	20	17.1			10	8.5	2	1.7	8	6.8	29	24.8			1	.9	3	2.6	17	14.5			8	5.8
Corvina	17	14.5			12	10.3	1	.9	4	3.4	20	17.1											6	5.1
Spanish mackerel	15	12.8			9	7.7	1	.9	5	4.3	18	15.4					1	.9	10	8.5			7	5.0
Cojinua	9	7.7			5	4.3			4	3.4	5	4.3							5	4.3				
Revoltura	5	4.3	2	1.7	2	1.7			1	.9	8	7.0	1	0.9	1	.9			6	5.2			1	.9
Yellowtail	3	2.6			2	1.7			1	.9	5	4.3							3	2.6			2	1.7
Mullet	7	6.0	2	1.7	4	3.4	1	.9			2	1.7							2	1.7				
Snook	3	2.6	3	2.6							2	1.7	1	.9	1	.9								

[1,2]Number and % of participating or non-participating families that reported obtention of each kind of fish in the 60 days prior to the survey.
[3]1: Own crop; 2: Gift; 3: Purchased from neighbor; 4: Ambulant truck; 5: Community store; 6: Store in another place.

TABLE 6. KINDS OF FISH CONSUMED AND SOURCES, JULY/AUGUST 1983, PILOT AND CONTROL COMMUNITIES

Kind of fish	Pilot N = 117		Sources of fish[3] 1		2		3		4		5		6		Control N = 117		Sources of fish[3] 1		3		4		5		6	
	No.[1]	%[2]	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.[1]	%[2]	No.	%	No.	%	No.	%	No.	%	No.	%
Tilapia	143	61.1	107	45.7	19	8.1	8	3.4			9	3.8														
Carp	121	51.9	96	41.2	17	7.3	5	2.1			3	1.3														
Snapper	49	20.9			1	.4	3	1.3	27	11.5	2	.9	16	6.8	54	35.3			1	0.7	44	28.8			9	5.9
Corvina	37	15.8							26	11.1	1	.4	10	4.3	43	28.3					35	23.0			8	5.3
Spanish mackerel	33	14.1					1	.4	19	8.1	1	.4	12	5.1	49	32.2					35	23.0	1	.7	13	8.6
Cojinua	14	6.0							10	4.3			4	1.7	15	9.8			3	2.0	8	5.2	1	.7	3	2.0
Revoltura	13	5.6	3	1.3					8	3.4			2	.9	9	5.9			2	1.3	7	4.6				
Yellowtail	8	4.4							5	2.1			3	1.3	14	9.2					8	5.3	1	.7	5	3.3
Mullet	9	3.8	2	.9					6	2.6	1	.4			7	4.6					6	3.9	1	.7		
Snook	5	2.1	4	1.7	1	.4									1	.7	1	0.7								

[1,2]Number and % of participating or non-participating families that reported obtention of each kind of fish in the 60 days prior to the survey.
[3]1: Own crop; 2: Gift; 3: Purchased from neighbor; 4: Ambulant truck; 5: Community store; 6: Store in another place.

TABLE 7. SOCIOECONOMIC CHARACTERISTICS, JULY/AUGUST 1983, PILOT COMMUNITIES

Socioeconomic characteristics	Participating N = 128	Non-participating N = 161
Age of the family/household head	47.6 ± 12.3	49.2 ± 14.1
Years of education of head	3.3 ± 3.3	2.4 ± 2.2**
Years of living in the community	37.3 ± 16.7	37.2 ± 19.6
Family composition	5.2 ± 2.6	4.6 ± 2.6*
Hectares per capita	5.6 ± 20.6	4.2 ± 24.4
Total income per year per capita (Balboas)	370.6 ± 741.0	266.4 ± 823.0
Total expenditures per year per capita (Balboas)	413.2 ± 402.6	423.6 ± 665.6
Number of bedrooms per capita	0.5 ± 0.4	0.5 ± 0.4
Percent of families involved in complementary nourishment programs	52.3	43.5
Drinking water consumption	54.7	64.4
Adequate sewage disposal, percent	76.6	74.5
Inadequate roofs, percent	19.5	16.8
Inadequate walls, percent	26.4	23.9

*P < 0.05
**P < 0.01

TABLE 8. SOCIOECONOMIC CHARACTERISTICS, JULY/AUGUST 1983, PILOT AND CONTROL COMMUNITIES

Socioeconomic characteristics	Pilot N = 128	Control N = 161
Age of the family/household head	48.5 ± 13.4	48.2 ± 14.7
Years of education of head	2.8 ± 2.8	2.8 ± 2.6
Years living in the community	37.2 ± 18.3	38.8 ± 19.2
Family composition	4.8 ± 2.6	4.5 ± 2.3
Hectares per capita	4.8 ± 22.7	3.2 ± 8.0
Total income per year per capita (Balboas)	312.6 ± 788.1	390.5 ± 682.1
Total expenditures per year per capita (Balboas)	419.0 ± 563.6	427.8 ± 376.6
Number of bedrooms per capita	0.5 ± 0.4	0.5 ± 0.4
Percent of families involved in complementary nourishment programs	47.4	32.8***
Drinking water consumption	60.1	84.2***
Adequate sewage disposal, percent	75.4	86.4***
Inadequate roofs, percent	17.9	9.8*
Inadequate walls, percent	25.0	15.0**

*P < 0.05
**P < 0.01
***P < 0.005

control communities or participating and non-participating families.

However, two differences did occur: (1) participating families spent a significantly larger sum on electricity, medical attention, soap, transportation, and parties than the non-participating families; and (2) families in control communities spent a significantly larger sum on electricity and medical attention than families in pilot communities, tables 7 and 8.

FOOD PRICES

No differences between participating and non-participating families were found in the prices paid for regular staple foods. Apparently both groups buy their food at the same stores. People in control communities pay more for fresh meat and milk and less for rice than people in pilot communities. These differences, however, are small (less than 3 percent). The statistically significant difference found was due to low variation rather than a great difference in actual cost.

Participating families pay significantly less than non-participating families for fish, and the expenditure for fish per family is also smaller. Consistent with this, the price of fish and the domestic expenditure for them in pilot communities are significantly lower than in control communities, table 9.

TABLE 9. AVERAGE COST (BALBOAS) PER KILOGRAM OF FISH AND EXPENDITURE PER FAMILY, JULY/AUGUST 1983, PILOT AND CONTROL COMMUNITIES

	Participating N = 100	Non-participating N = 103	Pilot N = 213	Control N = 130
Per kg of fish	0.33 ± 0.46	0.84 ± 0.64***	0.57 ± 0.62	1.41 ± 0.44***
Expenditure per family	0.88 ± 1.28	1.23 ± 1.10*	1.03 ± 1.21	1.98 ± 1.17***

*P < 0.05
***P < 0.005

TRADITIONAL COMMUNITIES

The differences found between pilot and traditional communities in Veraguas were similar to those found between pilot and control communities in the global study. The only detected differences occurred in the frequency of selected food consumption, i.e., traditional communities consume more red meats and fish than control and pilot communities. However, it was noted that only 5 percent of families from traditional communities get fish from ponds. In addition, socioeconomic comparisons between control and traditional communities in Veraguas demonstrated that traditional communities enjoy better sanitation and a greater involvement in complementary food programs.

DISCUSSION

No differences were detected in the nutritional condition, measured anthropometrically, of children under 5 years of age, table 10. These results were expected since nutritional problems are affected by diverse factors such as environmental and sanitary conditions, nutrition and health habits, and morbidity. Research under controlled conditions also shows that it takes a long time for anthropometry (as a nutritional indicator) to be affected by intervention. None of the projects in this study had been in operation long enough to affect anthropometry. Moreover, there was an appreciable amount of pond group membership change during the course of the study, i.e., some original members dropped out, non-members became members, etc., table 11.

Nevertheless, it is interesting to note that the pilot project is reaching the neediest communities. As shown in table 12, the intake of calories and protein in pilot communities is below that reported for the whole country, and less than in the control communities. When the same analysis is done at the level of children under 5 years of age, the situation is even worse.

Diet is better in participating than in non-participating families. It may be that participating families were better off before the project began, or that project benefits are manifesting themselves. Although the educational level of family heads and family composition differ, no other significant socioeconomic differences were detected between participating and non-participating families. Apparently, there were no significant socioeconomic differences other than the two noted between participating and non-participating families before the beginning of the project. We cannot yet assert that the difference in diet between participating and non-participating families was an effect of the aquaculture project, but the absence of differences in most of the socioeconomic variables supports this possibility.

Families in pilot communities had a caloric intake inferior to that of families in control communities. Because of the parallel link between calories and protein, it was expected that protein intake would also be inferior. However, there was no difference in protein consumption between pilot and control communities, perhaps demonstrating an effect of the freshwater fish culture project. An additional positive impact of the program may occur as pond-linked gardens contribute to participating family diets.

The monthly frequency of fish consumption is significantly higher in participating families than in non-participating ones. Moreover, a fairly high percentage of the families from pilot communities get their fish from the ponds. This suggests that the pilot program benefits all the families in the communities in which they have been constructed and not only those labeled as participating.

Participating families are spending more than others for goods

TABLE 10. NUTRITIONAL CHARACTERISTICS OF PILOT AND CONTROL COMMUNITIES, SECOND SURVEY, JULY/AUGUST 1983

Communities	No. of families	Malnutrition in children under 5				$\bar{X}$ Adequacy/type of diet					
		No.	Percent of children under 2 times S.D.			Families		Mothers		Children	
			Height/ age	Weight/ height	Weight/ age	Calories	Protein	Calories	Protein	Calories	Protein
Los Santos Province											
Las Trancas (P)[1]	24	12	—	—	—	104.1	143.2	99.7	127.9	91.2	167.6
Rio Hondo (C)	25	9	—	—	—	108.7	150.0	82.7	126.3	74.6	150.2
La Miel (P)	33	28	14.8	—	—	87.5	126.5	90.6	119.0	91.6	135.6
El Munoz (C)	41	9	—	12.5	—	87.2	121.9	90.4	123.6	83.6	140.8
Bayano (P)	28	11	9.1	—	—	102.6	148.6	86.1	127.3	76.2	129.4
Valle Rico (C)	24	5	—	—	20.0	108.2	145.5	120.5	147.5	76.8	144.0
Herrera Province											
Los Higos (P)	37	17	11.8	—	5.9	91.3	108.2	98.0	108.7	73.5	121.8
Pedernal (C)	39	13	—	—	—	92.5	126.4	74.8	115.4	59.4	99.7
Guayabito (P)	36	24	8.3	—	4.2	85.8	110.4	89.6	108.1	75.7	115.3
Las Guabas (C)	34	25	29.1	—	12.5	87.2	116.5	70.5	95.6	79.9	132.4
La Arena (P)	32	18	31.3	—	31.3	89.8	112.9	83.7	97.6	79.7	110.4
Calabacito (C)	26	14	14.3	14.3	14.3	97.0	128.0	74.2	91.4	86.3	131.4
Cocle Province											
Chumical (P)	21	21	9.5	—	—	70.1	103.8	66.5	88.4	69.8	103.8
Salado (C)	14	15	25.0	—	8.3	67.2	101.5	44.6	49.2	58.8	86.8
Veraguas Province											
La Montana (P)	32	17	25.0	12.5	16.3	61.6	90.0	82.5	111.0	71.7	115.8
Llano Grande (C)	22	27	57.7	—	23.1	84.3	110.0	82.8	103.7	62.1	92.6
Espavacito (P)	26	18	33.3	—	5.6	85.8	116.7	81.2	95.0	75.4	109.0
La Arena (C)	19	20	10.5	5.6	5.6	92.6	111.4	78.4	89.0	87.6	120.2
Mata Palo (P)	17	2	—	100.0	100.0	96.0	122.1	49.0	61.4	66.1	106.0
Pereque (C)	21	7	28.6	—	14.3	96.5	116.6	90.3	125.4	104.8	151.8
TOTAL	555	312	18.9	2.3	8.3	89.6	120.9	82.8	105.8	77.6	120.8

[1](P) = pilot; (C) control.

TABLE 11. SOCIOECONOMIC CHARACTERISTICS OF PILOT AND CONTROL COMMUNITIES, SECOND SURVEY, JULY/AUGUST 1983

Communities	Family data			Family head		Projects		
	Hectares	Income per year (Balboas)	Family composition	Age	Years of education	Months fish harvested	Lb./mo./ family	Participating families
Los Santos Province								
Las Trancas (P)[1]	10.7	1,287	3.9	50.6	4.4	4	9	15
Rio Hondo (C)	18.9	1,665	3.8	53.6	3.8			
La Miel (P)	34.2	1,221	4.9	49.0	3.2	11	6	29
El Munoz (C)	5.1	1,165	4.3	50.3	2.5			
Bayano (P)	20.4	1,777	4.1	46.1	3.8	10	6	20
Valle Rico (C)	33.1	2,326	3.9	48.1	4.3			
Herrera Province								
Los Higos (P)	1.3	1,080	4.4	48.2	2.1	11	12	19
Pedernal (C)	4.8	968	3.6	47.7	2.5			
Guayabito (P)	8.3	617	4.9	48.5	1.9	4	12	21
Las Guabas (C)	7.5	711	4.9	48.4	1.4			
La Arena (P)	10.6	1,034	5.1	46.6	2.9	6	9	19
Calabacito (C)	10.6	1,366	4.3	45.3				
Cocle Province								
Chumical (P)	5.3	1,056	6.4	49.2	4.4	5	4	16
Salado (C)	7.2	1,074	5.6	49.3	3.3			
Veraguas Province								
La Montana (P)	6.0	365	5.5	51.9	1.8	9	10	21
Llano Grande (C)	16.9	525	6.0	43.3	2.7			
Espavacito (P)	4.5	783	5.5	42.9	2.5	5	4	32
La Arena (C)	3.6	1,202	4.9	45.7	3.2			
Mata Palo (P)	21.6	201	3.8	54.4	2.1	6	10	10
Pereque (C)	15.0	1,019	4.8	48.8	3.0			
TOTALS	12.8	1,343	4.7	48.4	2.8			

[1](P) = pilot; (C) = control.

TABLE 12. AVERAGE ADEQUACY LEVELS AND PERCENT FAMILIES BELOW 75 PERCENT ADEQUACY IN CALORIES AND PROTEINS

Families	Calories		Protein	
	$\overline{X}$ adequacy	Percent families below 75 percent adequacy	$\overline{X}$ adequacy	Percent families below 75 percent adequacy
Participating	89.7	35.1	121.0	13.2
Non-participating	84.6	45.0	115.7	20.8
Pilot	86.8	40.7	118.0	17.5
Control	92.7	32.6	124.2	15.3
National (1980)[1]	95.0	28.0	153.0	9.3

[1]Results from the National Nutritional Survey conducted in July 1980 *(4)*.

and services (e.g., soap and medical attention) which do not belong in the category of highest priority needs. This suggests that they have a more flexible budget than non-participating families. Further research is necessary to find out if this is a consequence of the integrated aquaculture project.

The impact of traditional ponds in the Province of Veraguas is difficult to evaluate, especially because of the high percentage of families that have been favored with complementary food programs. However, a low percentage of families obtain fish from ponds. This suggests that the few differences found between community types may be due to causes other than the integrated fish pond programs. This may reflect the low fish yields per family within traditional communities. Thus, it may be useful to upgrade traditional ponds, i.e., add animal-garden components to them, train participants at Divisa, etc., (see Chapter I) to improve fish production.

CONCLUSIONS

1. The freshwater fish culture program has led to increased fish consumption. People in communities with pilot projects eat more fish and spend less money for this food item than people in communities where there are no ponds. Thus, this program reduces the cost of animal protein and increases its availability for the rural poor. This is quite important given the inadequate dietary and income levels of many rural inhabitants of Central Panama.

2. The program positively affects the diets of all families living in communities where it functions, not only those of participating families.

3. The program has benefited some of the neediest communities in which caloric and protein intakes were below the national average.

4. In addition to affecting caloric and protein intake, the program may have a positive effect on family budgets. Further evaluations are necessary to confirm this.

5. Fish is well accepted and in great demand in the different communities.

6. The impact of the program on the growth of children under 5 years of age could not be determined within the time frame of the study. The ponds will have to be in operation at least several more years before impact on growth can be measured.

7. The methodology developed for this evaluation permitted an adequate collection, tabulation, and analysis of data. These data represent a base-line for future evaluations. This study also helped develop a simplified low-cost methodology for conducting future evaluations.

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Chapter III
Socioeconomic Considerations

N.B. Schwartz

Goals of the socioeconomic study were to identify community socioeconomic factors which promote or retard project success and project group technical proficiency, and to identify the distinguishing social features of people who join project groups (PGs), and if possible to discover their reasons for doing so.

Data were collected through two household and community surveys, from National Aquaculture Directorate (DINAAC) archives, and by ethnographic techniques. To better understand project (pilot) communities, several communities with non-modular ponds (traditional) and several without ponds (control) also were examined, although space prohibits discussion of the two latter types of community *(4)*.

PROJECT BACKGROUND

Panama and other developing nations are interested in freshwater fish farming as a complement to agriculture to improve nutrition and raise income in the countryside. Relevant to this concern in Panama are land tenancy, economic and nutritional conditions among poor farmers have been deteriorating over the last two decades. And, the central government is also unable to afford permanent subsidies for the rural poor, and must rely on some form of local self-help to improve conditions in the countryside, although initial capital investment for projects usually must be donated by government or international agencies. Self-help without genuine access to social, political, and economic power is a stop-gap measure, but many Panamanians have no other alternatives at this time.

Central Panama has several advantages for the type of project described in Chapter I (Technical Evaluation). Among these are the countrymen's "felt needs" for additional sources of food and their long history of consuming freshwater and ocean fish. Moreover, participation in a PG is compatible with peak demands for on- and off-farm labor, in part because women and children can carry out many modular tasks. Project work routines are homologous with central Panamanian horticultural practices, and the same vocabulary can describe both, an important point for technology transfer (*4*). There also are many underemployed young men in the countryside who find the project appealing. By offering them a way to contribute to the family larder, the project seems to boost their self-esteem, and often they are among the most dedicated PG members. In addition, the Catholic Church since the 1940s and the central government since about 1968 have promoted local cooperatives and given them legitimacy. One result is that many local leaders have had experience, even if as often negative as positive, with different types of development programs.

In addition to these broad favorable conditions, several specific features of the project are also compatible with the situation. First, the technology is compatible with local ecological conditions and is energy conserving. Second, it is a labor intensive, low cost venture for participants as long as they do not pay for initial modular construction (or, in some cases, for transportation). Third, the project can attract poor people without threatening elite interests. This is a salient characteristic of successful local level projects (9). The project draws upon a resource poor Panamanian countrymen have—labor time—and the need for project benefits is greater among them than among the affluent. Furthermore, while dividends (food, income) are divisible, the modules are not, and well-organized PGs can set and enforce membership standards. None of these factors guarantees the absence of elite capture or free-riders, but taken together they do favor "rural development for the poor" (9).

Although government initiated the project, it is not entirely a "top down" operation. PG members contribute labor, time, and some local materials to modular construction; government and donor agencies supply initial capital outlays and machinery for building the ponds and associated structures. PGs elect their own officers, decide for themselves how to arrange work routines and how to distribute project benefits, maintain records, and so on. Members also have the right of exit should the project not live up to their expectations, just as PGs can expel those who do not meet their obligations to the group. Thus, although the project does not satisfy all the standards for "rural development participation" set forth by, for example, Gow and Vansant (5), its success does depend on the cohesion and commitment of project group members. There are also several factors which may hinder success in this project. Until 1968, central government neglected rural settlements, and even today most countrymen mistrust officials and politicians, e.g., about 90 percent of survey respondents felt that the latter will not fulfill promises (at the same time, a nearly equal number believed that only government could resolve their economic problems). In addition, Panama's rural settlements are not closed and consistently cohesive units, government sponsored development projects have often failed, commonly for reasons unclear to and costly for participants. The interest officials show in a community can evoke initial enthusiasm for almost any project because people do respond to attention. If nothing else, it is an opportunity to establish ties with potential patrons and/or take advantage of low cost inputs. But once the participants have to sustain the project by themselves and take some risks, many will abandon all but the best projects. Consistent with this, many development projects in rural Panama have failed within a year or two after the departure of technical advisors. These and other factors comprise a formidable array of obstacles to collective adoption of a new technology, particularly one involving cooperation in production, figure 1.

PROJECT EVALUATION

Since most PGs are learning to handle the technical aspects of modular operations, extensionists must be given credit for their site selections and training programs. Most PGs can meet their operating costs, produce extra food for themselves, and earn some additional income. Given their annual incomes, most countrymen regard even an extra $25-50 per year as significant. Moreover, by regularly substituting fish for meat, which is twice as expensive, families can save money, and the modules do offer some work to the underemployed.

Although the project is socially and ecologically sound, two problems remain unsolved:

1. Some PGs, particularly those using pigs to fertilize the ponds, need bank loans to purchase young animals and commercial food rations for them. A revolving credit fund has been set up with a government bank to offer PGs low interest loans, and they have been

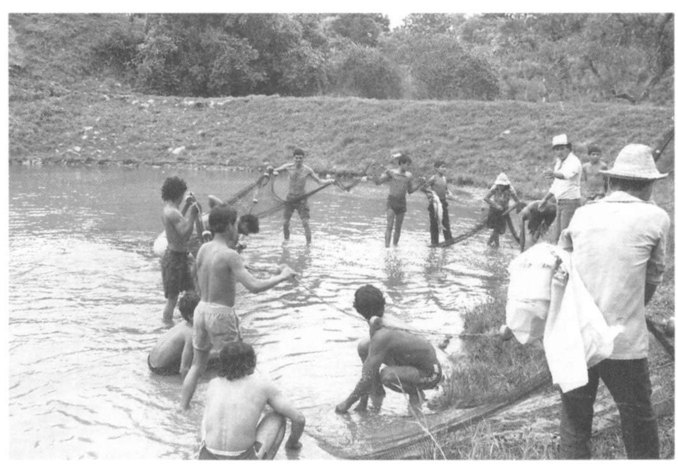

FIG. 1. Men, women, and children are assisted by DINAAC extensionists in partial harvesting their grow-out pond in Mata Palo, Veraguas.

repaid on time. Although PGs were to become as self-sufficient in securing loans as in technical management of modules 2 years after the project began, some still depend on extension to deal with the bank. This shortcoming is related to banking procedures, timidity on the part of the poor farmers unfamiliar with banks (see Chapter I), and the readiness of some extensionists to accept client dependency. Panamanian social relationships are often cast into paternalistic and patron-client molds, and both countrymen and extensionists alike readily accept the situation.

2. Several PGs lack access to inexpensive reliable public or private transportation, and continue to depend on extension help to bring in animal feed, take animals to market, and so on. So far, these PGs have not earned enough to defray the cost of transport, and the government cannot afford permanent transportation subsidies. One of the frustrating ironies of this problem is that it exists only with the use of pigs and fowl fed commercial ration, both of which do a good job fertilizing ponds in an association that is economically sound (see reference 4 and Chapter IV). On the other hand, transport is no problem at all with grass-fed cattle which do not require commercial feed to be trucked in, and for which buyers travel to the community. But cattle graze on poor pasture, and so do not fertilize the ponds as well as pigs or fowl. Moreover, during the dry season, ranchers must pasture their cattle further and further from pond sites, which in turn creates coordination and social problems with respect to the association between cattle and ponds.

Community Characteristics

Although community as such is but one element in an explanation of differences in collective adoption and proficient use of a new technology (a wide range of extra-local factors, technical, administrative, economic, and political are also important), community characteristics, the center of attention here, remain critical, tables 1 and 2.

TABLE 1. COMMUNITY CHARACTERISTICS, 1983-84[1]

Column	Code
A -	Approximate number of households in community: direct code
B -	Administrative level 1 - Hamlet 2 - Subcounty seat 3 - County seat
C -	Province 1 - Coclé 2 - Herrera 3 - Los Santos 4 - Veraguas 5 - Chiriquí
D -	Potable water system: 1 - Yes 2 - No
E -	Electricity: 1 - Yes 2 - No
F -	Primary school: 1 - Yes 2 - No
G -	Secondary school: 1 - Yes 2 - No
H -	Health post: 1 - Yes 2 - No
I -	Number of churches: direct code
J -	Dance halls and/or saloons: 1 - Yes 2 - No
K -	Number of stores: direct code
L -	Large general merchandise store(s): 1 - Yes 2 - No
M -	Hon. Representative (HR) resident in community: 1 - Yes 2 - No
N -	Collective farm *(asentamiento)* in community: 1 - Yes 2 - No 3 - Other form of collective
O -	Primary sources of employment for adult males: 1 - Agriculture and sugar cane field work 2 - Agriculture and other 3 - Ranching and agriculture 4 - Wage labor, office employment, and agriculture

Community	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1. Guayabito	37	1	2	2	2	1	2	2	0	2	1	2	2	2	1
2. Peñitas	29	1	1	1	2	2	2	2	0	2	2	2	2	2	2
3. Mata Palo	24	1	4	1	2	1	2	2	0	2	0	2	2	2	1
4. Montañita	45	1	4	2	2	1	2	2	0	2	1	2	2	2	1
5. Chumical	23	1	1	2	2	2	2	2	0	2	1	2	1	2	1
6. Pedregoso	13	1	4	1	2	1	2	2	0	2	1	2	2	3	1
7. Remedios	600	3	5	1	1	1	1	1	2	1	9	1	1	1	2
8. San José	37	1	4	1	2	1	1	1	1	2	2	2	2	1	1
9. La Miel	52	2	3	2	2	1	2	2	0	2	3	1	1	2	3
10. Los Higos	84	1	2	1	1	1	2	1	0	1	2	2	2	1	2
11. La Arena	40	2	2	2	2	1	2	2	1	1	1	2	1	2	3
12. Espavacito	33	1	4	2	2	1	2	2	0	2	1	2	2	1	1
13. Bayano	42	2	3	1	1	1	2	2	1	1	7	1	1	2	3
14. Trancas	59	2	3	1	1	1	2	1	1	1	4	1	1	2	3

[1]Communities listed in terms of overall PG technical performance, from best to worst, as of June 1984. Initial work on supplying San José with electricity was not completed by June 1984. Note that because of the number of private and public vehicles in Los Santos and access to paved roads, the functional distance between many communities and, e.g., health posts, is not great. Communities 1-14 are pilot study settlements.

Certainly no two rural places in central Panama are identical, but they do share some common features. Thus, none are "closed corporate communities" and people look outside the community for employment, patronage and secondary sources of support. Furthermore, even in the smallest hamlet there is considerable variation in socioeconomic status as measured by annual family income, land distribution, and cattle ownership, table 3. Voluntary organizations and collective efforts tend to be short-lived. Countrymen more commonly participate in intermittent group activities (e.g., labor exchanges at critical moments in the agricultural cycle, sports teams, and so on) rather than in those calling for continuous commitments of time and labor, such as PG work. This is countered by the fact that in Panama, as in much of Central America, community remains an important principle of social organization (*12*) and commonly a reference group for its members (*13*). In addition, the government channels services and projects through the community, typically as an administrative-territorial unit as well as a social one. Countrymen identify with their community, see its welfare linked to their own and, if conditions are right, will unite for the common good.

Most of the communities under review are small and composed of interrelated families and ritual kinsmen (*6*). People live in independent, patripotestal households. Individual legal ownership of or usufruct right to land is an important economic and cultural value. Most men, aided by wives and children, operate small farms, but many are landless and destitute. The major, sometimes the sole, source of cash income is sugarcane cutting. Generally, ranching settlements are wealthier than farming ones, and the degree of socioeconomic inequality within them is much greater, table 3.

In Veraguas, Cocle, and Herrera, the most common type of off-farm labor is in the sugarcane fields. In Los Santos and eastern Chiriqui, countrymen work off-farm for large-scale commercial agriculturalists and ranchers. Rural employment opportunities are particularly scarce in Los Santos, a province with ever increasing latifundia-minifundia dichotomies and outmigration (*7*). In fact, the complexity of individual household strategies to juggle on- and off-farm labor appears to be a major reason why countrymen often find it difficult to sustain continuous collective activities.

Countrymen distinguish social esteem, wealth, and political power or office as bases for deference and local leadership. In some places power, wealth, and esteem are congruent, and in as many others they are not. The poor both defer to and mistrust their rich and/or politically powerful neighbors, which is perhaps an acknowledgment of divergent interests. The mistrust is only partially offset by patron-client relations.

Provincial histories differ in important ways, the sharpest contrasts being between Los Santos and Veraguas. Until about the middle of this century, Los Santos was characterized by medium-sized land holdings, Hispanic cultural traditions, an egalitarian ideology, and active opposition to central government. In contrast, Veraguas has a history of latifundia and minifundia associated with ethnic (Hispanic and Indian) differences. Although many Indians are now almost indistinguishable from Hispanic countrymen, outward servility is a common social pose among them in certain situations, for example in dealing with urban officials. Veraguas, neglected by central government until 1968, is also one of the poorest provinces in Panama.

With reference to this project, Santenos are quick to impose their own ideas on extensionists and not at all ready to go along with proj-

TABLE 2. COMMUNITY AND PILOT PROJECT GROUP CHARACTERISTICS

Column	Code
A -	Ability to meet transport needs 1 - Very good 2 - Good 3 - Fair 4 - Poor 5 - Very poor
B -	Road access 1 - Year round, with 2-wheel drive vehicle 2 - Year round, with 4-wheel drive vehicle 3 - Year round, 4-wheel drive vehicle, but wet season problems 4 - Year round, 4-wheel drive vehicle, but severe wet season problems 5 - No year round access, road often impassable in wet season
C -	Animal component 1 - Cattle 2 - Chickens 3- Pigs 4 - Ducks and pigs 5 - None
D -	Project group leadership and/or presidency of PG based primarily on: 0 - President not regarded as a community leader 1 - Social esteem 2 - Political power and/or political office 3 - Wealth (which usually implies some measure of political power) 4 - Derived from presidency of collective farm
E -	Project Group membership, June 1984: direct code
F -	Change in PG membership from June 1983 - June 1984 1 - Decrease 2 - No change 3 - Increase 4 - Ponds abandoned

Community		Columns					
1.	Guayabito	4	2	3	1	15	1
2.	Peñitas	4	2	3	1	14	1
3.	Mata Palo	5	2	3	1	12	1
4.	Montañito	2	3	3	1	21	2
5.	Chumical	5	3	3	1	8	1
6.	Pedregoso	3	5	1	1	14	2
7.	Remedios	2	1	1	4	8	1
8.	San José	1	1	2	4	23	2
9.	La Miel	1	1	1	3	17	1
10.	Los Higos	1	2	2	4	14	2
11.	La Arena	3	2	4	2	15	1
12.	Espavacito	1	3	1	4	33	3
13.	Bayano	1	1	1	3	14	1
14.	Las Trancas	1	1	1	0	3	1

ects they perceive as "imposed" from above. Many countrymen in Veraguas, on the other hand, view extension personnel as potential patrons and will agree to plans which subsequent experience shows they did not fully understand. Yet, to judge from interviews, beneath the overt deference there is much greater mistrust, even fear, of superordinates here than in Los Santos. Negative experience with prior development programs reinforces these attitudes, but at the same time, countrymen (especially in Veraguas, Cocle, Chiriqui, and Herrera) say that they must have government assistance to cope with their most pressing economic needs for more food, more work, and feeder roads.

The ambivalence is clearly seen in relations with Hon. Representatives (HRs), elected to represent sub-counties and their subordinate hamlets. HRs have a community development fund at their disposal, the use of which is subject to a great deal of criticism and talk of corruption. Most HRs are not only politically powerful, but also members of local economic elites. The poor are reluctant to challenge them openly, yet they are also skeptical about involvement in their development plans. Because they fear that HRs (and/or wealthy co-residents) will somehow capture project benefits, the poor may avoid participation in a given project which then, by default, is indeed monopolized by HRs or local elites. Galjart (3) points out that "A change agent from the outside is nearly always necessary to start (development) things going" (word in parentheses added), and in Panama this typically involves enlisting HR support. Yet, if the HR is too closely identified with the change agent or the project, this will qualify or dampen popular enthusiasm for "things." Much of what is said of HRs also applies to other officials and wealthy people in a community.

These comments, brief as they are, provide a context within which reasons or differences in PG technical proficiency may be examined.

Differences in PG Proficiency

Three connected community factors in particular appear to exert strong influences on PG proficiency: (1) the HR's role in the project and in the community, (2) the identity of PG leaders, and (3) the degree of intracommunity socioeconomic variation. As mentioned earlier, project technology, internal rates of financial return, access to transportation, extension skill, political climate, and history also affect project success or failure, but the makeup of a community is the influence that is the focus of attention in this chapter. Discussion of the three influencing factors follow:

1. A "plain face" reading of tables 1 and 2 indicates that PGs are more proficient when HRs are not resident in the community. It should be noted that in Chumical and Remedios, the HRs are at odds with the PGs, in Remedios because the *asentamiento* effectively owns the project and the HR regards collectives as communist. In the best traditional PGs, there are no resident HRs *(5)*. Non-resident HRs play different roles in the better PGs, ranging from mild opposition and/or indifference to supportive (in Mata Palo and Montanita). Non-resident HRs mildly opposed to a project unintentionally foster local self-reliance. In contrast, in the less effective PGs, there tends to be a resident HR who is active in the PG. Trancas, the least effective PG, is a major exception. There, the resident HR's negativism is related to the fact that the original (though skeptical) PG sponsor is an ex-HR and the major political opponent of the incumbent.

Wealthy people in a community relate to PGs in a manner nearly identical to that of the HRs. For example, in Bayano several affluent

TABLE 3. HOUSEHOLD INCOME AND LAND AND CATTLE OWNERSHIP IN PILOT COMMUNITIES, 1983

	Community	N[1]	Household income (balboas)[2]				Land ownership (hectares)				Cattle ownership			
			Range	Mean	Median	S.D.	Range	Mean	Median	S.D.	Range	Mean	Median	S.D.
1.	Guayabito . . .	36	100-2,520	617	500	508	0-60	8.3	4.0	12.1	0-15	2.6	0.4	4.9
2.	Peñitas.	29	40-3,120	739	500	800	0-25	3.7	3.0	4.6	0-2	0.1	0.1	0.5
3.	Mata Palo . . .	17	0-864	201	150	203	0-84	21.6	15.0	23.2	0-10	1.6	0.4	3.2
4.	Montañita . . .	32	0-3,600	365	151	644	0-40	6.0	2.0	9.5	0-45	7.0	0.9	13.8
5.	Chumical. . . .	21	40-6,000	1,056	200	1,759	0-20	5.3	3.0	5.8	0-2	0.1	0.1	0.5
6.	Pedregoso . . .	11	120-1,200	378	288	339	0-30	4.6	1.0	8.6	0-7	0.9	0.5	2.5
7.	Remedios . . .	20	374-4,744	1,894	1,621	1,241	0-25	2.7	1.0	6.0	0	0.0	0.0	0.0
8.	San José.	37	100-3,500	832	400	892	0-80	5.3	1.0	14.1	0-21	3.4	1.5	5.8
9.	La Miel	33	0-5,280	1,221	800	1,291	0-300	34.2	2.0	65.7	0-250[3]	21.9	2.8	33.8
10.	Los Higos . . .	37	0-3,992	1,080	1,008	815	0-25	1.3	0.1	4.3	0-40[3]	5.0	0.5	6.0
11.	La Arena	32	100-6,000	1,034	600	1,282	0-70	10.6	5.0	13.9	0-40	6.9	5.0	9.4
12.	Espavacito. . .	26	50-3,456	783	864	641	0-40	4.5	01	8.9	0-35	4.0	0.2	8.8
13.	Bayano.	28	100-9,000	1,777	800	2,324	0-250	20.4	2.0	53.3	0-100	26.2	3.5	38.5
14.	Las Trancas. .	26	250-9,000	1,287	650	1,820	0-110	10.7	2.0	22.9	0-90	17.5	2.0	29.0

[1]Each case represents one household.
[2]Calculated to nearest whole number.
[3]Estimated.

ranchers control the PG, and while they take some pride in having the module in their community, they feel no need to optimize production, treating the entire affair rather as if it were a social club. That may be why poorer residents in Bayano have opted to not participate. PGs work best when HRs and/or the wealthy are indifferent to them or, if supportive, do not live in the community.

Why this is so is relatively complicated. On the one hand, few poor countrymen openly oppose resident HRs and economic elites, but on the other hand, they are reluctant to join them in a common undertaking. If a HR is actively and intensely opposed to a project, few will participate in it. His approval, in contrast, does permit participation, but his direct involvement with a project arouses suspicion and discourages popular cooperation and genuine commitment. Moreover, in such places a Guayabito, HRs and the wealthy constitute a negative reference group for the poor, with the result that (their perception of) mild opposition to something by the elite can help mobilize support for it, although vigorous elite opposition inhibits participation among the poor.

HRs who actively aid a PG pose dependency problems. They can recruit clients for a project, aid participants with transportation and banking problems, and so on, but if the HR leaves the community for any reason, project work is apt to deteriorate. Thus, in La Arena people are enthusiastic about the module, but when the project HR is absent, PG members find it difficult to mobilize labor for the project precisely because they depend on the HR for this. Thus, PG proficiency in La Arena fluctuates a good deal. Again, La Miel initially had an excellent PG led by an energetic, popular HR. When he took up residence elsewhere, PG productivity declined, partly due to an intra-group squabble which his presence had muted. So just as resident HRs who aggressively oppose a project inhibit participation in it, overly helpful resident HRs foster counterproductive dependency among its members.

2. The leaders of the more effective PGs are men of solid reputation for concern with community welfare. Ethnographic open-ended interviews and survey data show that others name them as people to turn to for advice (but they themselves seek out HRs and the rich for political and economic aid). With one exception, all have had prior committee and/or project experience. Most are religious, but are not church lay officials. They are not wealthy, but usually they are in the 3rd quartile of land owners, table 4. Most have the average third grade formal education, but are most interested in and better informed about the wider world than their peers.

When a project is placed on an agricultural cooperative, *asentamiento*, its president normally becomes PG president. The social esteem of the *asentamiento* president varies from place to place for several reasons, e.g., how well the collective is doing, how land tenure disputes with non-members have been handled, and so on. For this reason, the position is not related to PG proficiency in any straightforward way.

TABLE 4. PERCENTAGE OF LAND IN HECTARES HELD BY POPULATION QUARTILES

Community	Quartiles: First	Second	Third	Fourth	Total
1. Guayabito	0	4.7	22.4	72.9	100.0
2. Peñitas	3.8	11.4	26.7	58.1	100.0
3. Mata Palo	1.1	12.8	26.4	59.8	100.1
4. Montañita	0	3.2	14.4	82.4	100.0
5. Chumical	0	8.3	27.5	64.2	100.0
6. Pedregoso	0	5.5	7.3	873	100.1
7. Remedios	2.3	5.8	5.8	86.0	99.9
8. San José	0	4.1	10.7	85.2	100.0
9. La Miel	0	.4	11.4	88.3	100.1
10 Los Higos	0	0	0.0	100.0	100.0
11. La Arena	3.8	9.4	19.8	67.0	100.0
12. Espavacito	0	0	9.2	90.8	100.0
13. Bayano	0	0.7	3.2	96.1	100.0
14. Las Trancas	.4	3.6	13.7	82.4	100.1

No matter how participatory or egalitarian a project group, someone must have or be given authority to move things along (*1*). Someone must organize work crews, make sure group decisions are implemented, cope with free riders (a concern of many PG members), and the like. Poor countrymen are most at ease with and most willing to cooperate voluntarily with each other when led by a respected peer, rather than by an outstandingly wealthy or powerful person. Thus, PG leadership based primarily on social esteem is closely associated with capable group performance, table 2. These leaders are best able to strike a needed balance between authority and equality in collective enterprises.

3. Inequality varies from community to community. Although no single measure may suffice to capture completely the difference, land ownership in many "Third World" countries is "a fairly reliable indicator of social and political power" (*5*) and socioeconomic status within and across settlements. An examination of survey data on land ownership, family income, and cattle ownership leads to the tentative conclusion that in a general way (e.g., La Arena is an exception) less stratified communities have more proficient PGs, tables 3 and 5. This is consistent with some comparative studies of rural development (*8,10*), but contradicts others (*2*).

Apparently, near absolute equality (not an issue here) impedes collective adoption of technology, and too much inequality has the same effect. Unfortunately, there is no consensus about how much is "too much," but in highly stratified communities elite and non-elite interests may diverge so greatly that the former undermine (*9*) or monopolize (*11*) projects designed for the latter. Elites can legitimate and provide managerial expertise for a project, but they have little need to optimize production, and in this sense undercut project goals. Leadership is necessary, but effective leaders must share the need for project benefits, in this case additional food and income.

Tendler (*14*) reports that farmer groups perform better when they are organized around concrete goals which require cooperation for completion and involve a minimum of non-farm skills, conditions generally satisfied in this instance. In addition, the groups should be small, about 10 members, and composed of peers. Peer pressure can sustain group cohesion and assure fulfillment of group obligations. One may infer from this that group leaders must be regarded as peers. In this project, the leaders of the better PGs have resources (some land, social esteem), but they are not markedly wealthier, better educated, or more powerful than the majority. They are the

TABLE 5. PROJECT GROUP TECHNICAL PROFICIENCY AND LAND DISTRIBUTION[1]

Project group proficiency rank order	Coefficient of variation (land)	C-statistic rank order
1	1.46	5
2	1.24	3
3	1.07	1
4	1.58	6
5	1.09	2
6	1.87	7
7	2.22	11
8	2.66	13
9	1.92	8
10	3.31	14
11	1.31	4
12	1.98	9
13	2.61	12
14	2.14	10

[1]The coefficient of variation (C) is the ratio of standard deviation to mean; the closer the ratio to 1.0, the less skewed the distribution of values for a given sample (Koch and Link 1971). When group technical performance and C for land ownership are rank ordered and compared, Spearman's rho = .631 (df 12), t = 2.817, thus $p < .02$. Given the sample size and possible distortions in survey data, the table does no more than suggest that the less skewed land ownership in a settlement, the more proficient its project group.

countrymen's peers and so do not discourage effective popular participation in a collective undertaking.

4. Other differences can also impede a project, e.g., occupational diversity or diverging interests between members and non-members of collective farms. In addition, to judge from what some people in San Jose say, table 1, an abundance of projects can weaken commitments to any one or all of them. There, the collective farm, the government, and the Catholic Church all sponsor cooperative food production activities, and this diffuses the help an individual can give to any one of them. As one countryman put it, "There is so much to help with that I am not a (formal) member of anything."

Esman and Uphoff (2) find that difficult terrain positively correlates with task success in local organizations. The current study supports that conclusion, qualified by the requirement that groups other than those working with cattle had to have year-round access to urban places. Unlike easy access, moderately difficult access appears to be associated with relative PG success, table 2. Access is probably also related to the number and type of services available in a community.

As a general rule, the fewer the public and commercial services in a community, the more technically self-sufficient and proficient its PG, table 6. Settlements which lack electricity, potable water, health posts, churches (which often serve as centers for cooperative projects in rural Panama), saloons, and/or general merchandise stores are better sites for this project than places with these facilities. These are typically hamlets rather than sub-county seats. The service-poor communities also tend to have middling to difficult road access and are not highly stratified, all of which may throw people back on their own resources and set the stage for successful cooperative enterprises. If nothing else, a lack of large stores and other facilities, combined with difficult access to them and an absence of competing programs, means that for want of alternatives people can or must commit themselves to a given project.

TABLE 6. PROJECT GROUP PROFICIENCY AND SERVICES IN PROJECT GROUP COMMUNITY[1]

Community	Technical ranking	Number of services
Guayabito	1	2
Peñitas	2	3
Mata Palo	3	2
Montañita	4	2
Chumical	5	1
Pedregoso	6	3
Barrio[2]	7	3
San José	8	7
La Miel	9	4
Los Higos	10	7
La Arena	11	4
Espavacito	12	2
Bayano	13	12
Las Trancas	14	10

[1]Data derived from table 1.

[2]Refers to the Barrio in Remedios in which the module is located. Remedios as a whole has 17 services.

CONCLUSION

The final test of project strategy, PG self-sufficiency, is still several years off. Although the basic incentive for a household to participate in a PG is a felt need to produce food, social organizational factors and household characteristics affect project success. The project appears to appeal especially to relatively well-informed, somewhat younger than average married men with large households. Although they may not be poorer than others, they are at a stage in the domestic cycle when they have not only the time and strength to risk participation but the need to do so. They also have children who can assist them in modular activities.

Households exist in communities, and several community level factors affect project chances for success. PGs appear to work best in the less complex structured communities. Organizational complexity related to such things as socioeconomic inequality, ranching, and divisions between members and non-members of *asentamientos*, appear to hinder PG performance. Relative socioeconomic homogeneity fosters PG success. Effective PG leaders are socially esteemed people who are neither so rich nor powerful that they cannot be seen as peers by ordinary countrymen. Extensionists who identify and cooperate with this type of leader enhance chances for project success. PGs are also best served by mildly supportive to indifferent non-representatives who reside outside the community. Given the countrymen's past experience with government sponsored projects, however, little will avail unless GOP and DINAAC maintain their commitment to the project.

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Chapter IV
Economic Evaluation

C.R. Engle[1] and Upton Hatch

In 1980, the United States Agency for International Development initiated a project designed to develop a simple fish culture system emphasizing farmer self-sufficiency in fish seed production for either home consumption or sale (*12*). The basic human need among the target population was a source of low-cost animal protein. A secondary consideration was the desire for increased cash income. In order to minimize production costs and to maximize benefits to the community, fish ponds were integrated with other types of livestock and agricultural enterprises (*17*). Budget and rate-of-return analyses are used to estimate returns for the various production combinations. These analyses are based on primary and secondary production data.

The integrated approach has been attempted and documented in several locales (16). Feasibility analyses have been undertaken for integrated aquaculture systems with pigs (*2,11,22*), with ducks (*22*), and with livestock and fowl (*6*). Appropriate fertilizing rates for aquaculture systems have been investigated in Israel (*10*) and in China (*8*). The economic potential of small-scale integrated systems has been studied in Thailand (*3*). In addition, an effort has been made to make research more responsive to farmer needs. This "farming systems research" approach has been applied in Panama to assist in the transfer of pesticide and fertilizer technologies (*13*) and has potential in the development of integrated agro-aquaculture (*15*).

BUDGET ANALYSIS

The impact of integrating livestock with fish enterprises is analyzed by first budgeting each activity separately and then in association. In the case of fish, investment and production costs were estimated for fish alone by estimating the cost of collecting and transporting different types of manure to the fish pond. Investment and production costs were also budgeted for cattle, hog, chicken, and duck enterprises alone. Budgets were then prepared for the fish-cattle, fish-chicken, fish-duck, and fish-hog combinations.

In addition to providing information on the profitabilities of the enterprises independently and in association with each other, this analysis provides the basis for calculating the respective cost of animal protein production.

The following data were collected directly from the projects: pond construction costs; hog, duck, and cattle corral construction costs; fish, hog, and duck production costs; and marketing costs and prices for fish, hogs, and ducks. Investment, production, and marketing costs for cattle and chicken were obtained through secondary data of the Department of Livestock Production within the Agriculture Development Ministry (*14*).

The average pond size and cost of the projects were used in all analyses. This eliminated variation caused by varying pond construction costs for larger and smaller ponds. Management of the livestock systems is detailed in Chapter I.

It is important to note some inherent variation among the projects. The chicken and cattle enterprises were already established prior to construction of fish ponds. These were viable economic units independent of fish culture. While both were commercial undertakings, chickens were managed intensively whereas cattle were managed on an extensive, open range level of management. On the other hand, the hog and duck enterprises were initiated with the fish ponds; they were designed to accommodate fish production. Both ducks and hogs were managed on a semi-commercial scale, but the lack of experience with these animals, the lack of established market channels, and access to inputs introduces a bias in comparing ducks and hogs to the more traditional cattle and chicken enterprises.

FISH ALONE

The fish production system is described in detail in Chapter I. The following analysis is based on the 3-pond module, figure 1.

Capital Investment

Data were collected on expenses incurred during construction of the modules. These data include costs of PVC pipe, materials and transportation of equipment and materials. Earth-moving costs were charged at B/. 40.00 per tractor-hour.[2] Only new projects are included in capital investment analysis. Improved projects are not included because grow-out ponds existed before project intervention.

The average total area of water surface for the projects was 4,191 square meters, table 1. The average total cost of pond construction was B/. 2,970.05 with an average total cost of B/. 0.70/m^2 for total pond area and B/. 1.12/m^2 for grow-out pond area. The average labor

[1] Funded by Interamerican Development Bank—Contract IDB-BNP-MIDA-No. 98IC-PN.

[2] B/. = Balboa, the Panamanian currency. 1 Balboa = U.S. $1.00.

TABLE 1. CONSTRUCTION COSTS AND SURFACE AREA OF A.I.D. MODULAR PONDS BY PROJECT

Location	Total area m^2	Grow-out area m^2	Costs: Construction materiales B/	Earth moving B/.	Labor @ B/. 4.00 per man-day	Transportation B/.	Total B/.
Cascajal	3,690	2,500	626.12	1,400	112.50	400	2,538.62
Chumical	2,580	1,980	957.65	1,800	184.50	350	3,292.15
Pedregoso	2,205	1,805	329.47	1,404	92.50	350	2,175.97
Los Higos	3,969	3,423	610.33	2,040	136.50	250	3,036.83
Guayabito	3,350	2,071	514.29	2,475	142.50	250	3,381.79
Espavecito	4,802	4,051	526.91	2,655	168.00	400	3,749.91
Remedios	16,675	4,118	564.72	2,940	219.00	300	4,023.72
Bayano	4,890	3,966	511.00	1,800	140.00	400	2,851.00
La Miel	3,314	2,655	727.93	1,920	105.00	300	3,052.93
Montañita	3,940	3,128	754.30	2,160	120.00	300	3,334.30
La Arena	2,075	1,845	712.36	1,040	99.00	300	2,151.36
Majarilla	9,209	3,010	542.05	3,400	127.50	200	4,269.55
Mata Palo	2,808	2,450	234.57	1,755	204.75	300	2,494.32
Las Trancas	3,317	3,029	564.63	1,600	120.00	400	2,684.63
El Barrero	2,180	1,900	544.35	1,760	106.00	200	2,610.35
La Pitaloza	2,000	1,478	664.44	1,600	100.00	500	2,864.44
Mogollon	2,604	2,000	730.05	2,240	136.50	400	3,306.55
Las Fuentes	4,310	3,570	621.50	1,908	126.12	100	2,753.62
Pino del Cobre	1,700	1,500	560.70	1,020	126.12	150	1,856.82
Total	79,627	50,479	11,297.37	36,717	2,566.49	5,850	56,430.86
Average[1]	4,191	2,657	594.60	1,932	135.08	308	2,970.05

[1]Average cost/m^2: Total = B/. 0.71; Grow-out = B/. 1.12/.

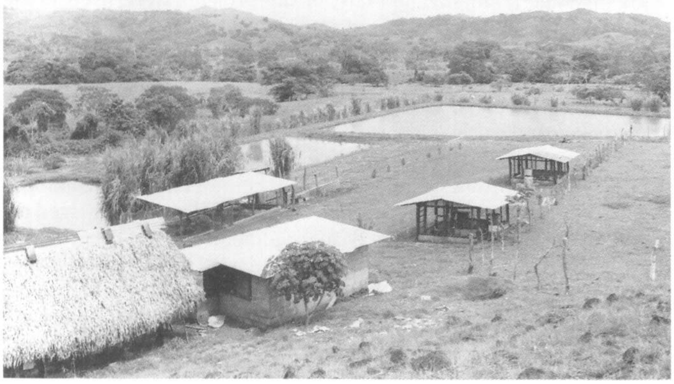

FIG. 1. A three-pond module located in Tole, Chiriqui. This church sponsored project raises fish,ducks, pigs, chickens, rabbits, and vegetables to provide for their school. Students learn the principles of agroaquaculture by caring for the animals and garden.

cost was B/. 135.08, earth-moving cost B/. 1,932, and construction materials cost B/. 594.60. This last item has an average estimated useful life of 20 years, which results in an annual depreciation of B/. 29.73. Earth-moving contributed 50 percent of the total cost, labor 26 percent, materials 16 percent, and transportation 8 percent. Earth-moving costs were B/. 0.82 per cubic meter. Earth-moving costs were recorded in machine-hours and included clearing the top soil, pond excavation and leveling, and cutting water diversion ditches and access roads.

A cinder block storage shed (12-15 square meters area) was constructed at each project for storage of equipment and feed. The average total cost was B/. 448.43, with the cost of materials averaging B/. 364.70 and labor, B/. 83.73. The estimated useful life of the storage shed was estimated to be 20 years, which results in an annual depreciation charge of B/. 51.73.

The management of the module system requires a seine for harvesting the reproduction, nursery, and pre-fattening ponds and to assist with the total harvests of the grow-out ponds. In the partial harvests, a 120-foot gill net is utilized. A 50-foot seine, 6 feet deep with 1/2-inch mesh would be sufficient for the small ponds and to finish the total harvests of the fattening pond. Other necessary equipment includes dip nets, buckets, and cages or net pens to hold fish for grow-out stocking. This equipment has a total cost of B/. 360.50 with an annual depreciation of B/. 66.02, table 2.

The modular system of fish production includes on-farm tilapia seed production. Given that the farmer is primarily interested in grow-out and harvest, the analysis includes buying tilapia seed the

TABLE 2. INVESTMENT COSTS FOR FISH PRODUCTION (GROW-OUT AREA = 2,657 m²)

Item	Description	Unit	Cost/unit, B/.	Quantity	Total cost, B/.	Useful life, years	Annual depreciation, B/.
Ponds							
Earth-moving		tractor-hour	40.00	48.30	1,932.00		
Materials	pipes, PVC, acces.	total	595.00	1.00	595.00	20	29.75
Transportation		total	308.00	1.00	308.00		
Subtotal					2,835.		
Storage shed							
Materials	cement, wood, roofing	total	364.70	1.00	364.70	20	18.24
Equipment							
Seine	50 ft., 6 ft. deep, 1/2-in. mesh with bag	c/u	192.00	1.00	192.00	5	38.40
Gill net	120 ft. long, 8 ft. deep, 3-in. mesh	c/u	125.00	1.00	125.00	8	15.62
Dip net	large	c/u	15.00	1.00	15.00	10	1.50
Buckets		c/u	3.00	2.00	6.00	1	6.00
Net pens		c/u	7.50	3.00	22.50	5	4.50
Subtotal					360.50		66.02
Broodstock							
Tilapia		c/u	0.02	3,390.00[1]	67.80		[2]
Total					3,628.00		11.01

[1]Stocked at the equivalent of 11,463/ha that the project averaged.
[2]Tilapia seed is an initial start-up cost. Broodstock are then selected from the females to be discarded after sexing. Hence, there is no depreciation.

TABLE 3. ANNUAL COSTS OF SEED AND INORGANIC FERTILIZER FOR FISH PRODUCTION

Item	Description	Unit	Cost/unit, B/.	Quantity	Cost/cycle,[1] B/.	Yearly cost, B/.
Seed						
Common carp		c/u	0.02[2]	120[3]	2.40	
Hybrid carp	silver x bighead	c/u	0.02[2]	385[4]	7.70	
Transportation		trip	24.00	1	24.00	
Subtotal					34.10	22.73
Fertilizer						
Inorganic	12-24-12 (60 kg/ha)	cwt.	17.125	0.55[5]	9.42	6.28
Total					43.52	29.01

[1]A production cycle is 18 months.
[2]The hatchery charges B/. 0.01 per inch of fingerling and distribute fingerings of 2 inches in size.
[3]Stocked at the equivalent of 450/ha, the average stocking density in the projects.
[4]Stocked at the equivalent of 1,450/ha, the average stocking density in the projects.
[5]Total average water surface area (including brood, nursery, and grow-out ponds) is 4,191 m², or 0.4191 ha fertilized at 60 kg/ha.

first year. Broodstock are then selected from the first grow-out harvests to stock in the brood ponds. Future broodstock are obtained from the grow-out pond. The initial investment in tilapia stock is B/. 67.80, table 2.

Production Costs

The pond is stocked with tilapia as the principal species in polyculture with common carp, and the bighead and silver carp hybrid. The carp seed is purchased at the beginning of each production cycle at a cost of one cent per inch. With an average stocking size of 2 inches, each carp seed costs B/. 0.02, table 3. The average transportation cost is B/. 24.00 per trip.

The fish production cycle varied greatly between projects. The actual cycles were averaged to obtain the 18-month cycles utilized in the analysis. The first partial harvest was done with gill nets at approximately 4 months after stocking the pond. Thereafter, the grow-out ponds were harvested monthly. Annual costs were determined by multiplying the total costs per cycle by 12 and dividing by 18.

At the onset of each production cycle, the pond was fertilized once with an inorganic fertilizer to stimulate the rapid development of natural food organisms in the pond. The fertilizer applied was 12-24-12 at a rate of 60 kilograms per hectare for each 18-month production cycle.

Labor

In order to analyze the relative profitability of the fish production component alone, the value of the labor necessary to collect the manure and apply it to the pond was estimated. This analysis assumes that the livestock enterprise already exists on the farm but is not associated directly with the fish production unit.

Hog manure had the highest collection costs, B/. 182.48, table 4. Ducks and chicken manure costs were identical, B/. 136.88, with cattle manure costs being the lowest, B/. 117.00. Cattle manure was collected only three times per week, whereas the other manures were collected daily.

The majority of the labor utilized in the modules was provided by the group that managed the project. Data on labor were recorded only during the construction phase, and production labor was estimated.

In the 2-pond system, total annual labor was estimated to be 51.5 man-hours, table 5, for fish production alone. In the 3-pond system, the labor is almost tripled because of sex identification to select males. In the 4-pond system, labor is greater yet for the double sexing. The second separation of sexes is less time consuming because a large percentage of males are selected in the first procedure.

Labor values were averaged to obtain a standardized value to compare the different types of livestock-fish associations. The low number of pond replicates precludes more rigorous analysis.

Yield and Return

Fish production data from the livestock-fish associations were utilized in the fish only budgets. The manure charged to the budgets was equivalent to the quantities of manure produced by the animals actually on the ponds in order to utilize that fish production data. Fish production was calculated in units of kilograms per hectare per year in order to compare the different types of livestock-fish associations. The highest fish production, 3,460 kilograms per hectare per year was obtained in the duck-fish association. The lowest fish production, 1,727 kilograms per hectare per year, was produced in the cattle-fish association, while the hog-fish association produced 2,197 kilograms per hectare per year of fish. The chicken-fish association resulted in fish production of 2,329 kilograms per hectare.

The value of the fish produced was estimated to be B/. 0.40 per pound.[3] This is the actual sales price of the fish in the communities.

Fish produced with duck manure resulted in net returns to capital, land, and management of B/. 529.10, table 6. This was followed by B/. 264.42 with chicken manure, B/. 188.19 with hog manure and B/. 143.78 with cattle manure.

[3] The unit of measure in Panama is the pound. For ease of understanding and comparison, prices per pound are not converted to prices per kilogram.

TABLE 4. YEARLY QUANTITY AND VALUE OF MANURE COLLECTION, TRANSPORTATION, AND APPLICATION (FISH PRODUCTION ALONE)

Animal	Hours daily	Hours yearly	Man-days[1]	Value of man-day, B/.	Total value, B/.
Hogs	1.00	365.00	45.62	4.00	182.48
Cattle	1.50	234.00[2]	29.25	4.00	117.00
Ducks	.75	273.75	34.22	4.00	136.88
Chickens ..	.75	273.75	34.22	4.00	136.88

[1]A man-day is equivalent to 8 hours.
[2]Cattle manure is collected only 3 days per week.

TABLE 5. YEARLY VALUE OF LABOR UTILIZED IN FISH PRODUCTION BY NUMBER OF PONDS IN SYSTEM

System	Man-hours: Brood: Stocking	Brood: Harvest	Nursery: Harvest and sexing	Pre-grow-out: Harvest and sexing	Grow-out[1]: Partial harvest	Grow-out[1]: Total harvest	Total	Man-days	Value of man-day, B/.	Total cost, B/.
Two ponds										
Per cycle ...	0.5	6			2	20				
Yearly	1.5	18			18.67[2]	13.33	51.5	6.44	4.00	25.76
Three ponds										
Per cycle ...	.5	6	32		2	20				
Yearly	1.5	18	96		18.67	13.33	147.5	18.44	4.00	73.76
Four ponds										
Per cycle ...	.5	6	32	12	2	20				
Yearly	1.5	18	96	36	18.67	13.33	183.5	22.94	4.00	91.76

[1]18-month cycle.
[2]Partial harvests are initiated the fourth month after stocking for 14 months, at which time grow-out pond is totally harvested—12 [(2•14) ÷ 18] = 18.67.

TABLE 6. ANNUAL NET RETURNS TO CAPITAL, LAND AND MANAGEMENT FOR FISH PRODUCTION ALONE FERTILIZED WITH DIFFERENT MANURES (GROW-OUT AREA = 2,657 m²)

Manure source	Fish production, kg	Sales price fish, B/./kg	Gross returns B/.	Annual fixed costs, B/.	Variable costs: Seed, B/.	Variable costs: Manure, B/.	Variable costs: Total, B/.	Total annual costs, B/.	Net returns to capital, land, and management, B/.
Hogs	583.74	0.88	513.69	114.01	29.01	182.48	211.48	325.50	188.19
Cattle............	458.86	.88	403.80	114.01	29.01	117.00	146.01	260.02	143.78
Ducks	919.32	.88	809.00	114.01	29.01	136.88	165.89	279.90	529.10
Chickens	618.55	.88	544.32	114.01	29.01	136.88	165.89	279.90	264.43

Hogs Alone

Capital Investment

Pigsties were constructed with concrete floors, pig wire, and a zinc roof with an average total cost of B/. 662.00, table 7. With an estimated useful life of 10 years, the annual depreciation is B/. 66.21. A block storage shed (12-15 square meters) was also constructed to store feed and equipment at a total cost of B/. 364.70. With an estimated useful life of 20 years, the annual depreciation is B/. 18.24.

Hog production requires several additional tools, such as picks (2 years useful life), shovels (2 years useful life), and a wheelbarrow (5 years useful life), to construct the pigsty. Total equipment cost is B/. 133.10 with an annual depreciation of B/. 35.05.

Production Costs

Hog production costs were analyzed based on a production unit of 20 animals. This was the average number of animals per average project size. Feeder pigs were purchased at an average weight of 30 pounds and an average price of B/. 1.205 per pound. Each feeder pig cost approximately B/. 36.15, table 8.

The feeding regime varied greatly by project. Some projects fed starter, grower, and fattening rations, while other projects fed only grower and fattening rations. To standardize the analysis, the quantities of feed were weighted according to the different prices to obtain a weighted average of the feed price. This is the price applied in the analysis.

Theoretically, a hog production cycle is 120 days with 3 possible cycles per year. Nevertheless, the average hog production cycle was 1.5 per year. This slow turnover was due to logistical problems of transportation and loan agreements. Per cycle production costs are multiplied by 1.5 to obtain annual costs.

Net returns to capital, land and management were B/. 175.70.

Cattle Alone

Capital Investment

The cattle corrals cost, on the average, B/. 381.00, table 9. The estimated useful life was 5 years with an annual depreciation of B/. 76.22.

Cattle production also requires additional fencing and, in many instances, re-establishment of pasture. Total investment costs are B/. 1,520.11 with an annual depreciation of B/. 164.02, table 9.

Production Costs

In the modular projects associated with cattle, the cattle enterprise was already established. For this reason, the only economic data collected were the construction and labor costs for the corral and collection of manure. The data included in the analysis are secondary and were obtained from the Departamento de Produccion Pecuaria of MIDA.

The analysis is based on a production unit of 20 head of cattle. This was the average number of cattle corraled at night to collect manure. Table 10 details the production costs.

The income from cattle production is based on a survival of 95 percent, an average weight of 900 pounds per head of cattle, and a price of B/. 0.40 per pound, table 10. Net returns to capital, land and management were B/. 791.90.

Ducks Alone

Capital Investment

The ducks were corraled in a way that provided free access to part of the pond. The duck corrals cost an average of B/. 540.30, table 11.

TABLE 7. INVESTMENT COSTS FOR HOG PRODUCTION (UNIT OF 20 FEEDER PIGS)

Item	Description	Unit	Cost/unit, B/.	Quantity	Total cost, B/.	Useful life, years	Annual depreciation, B/.
Pigsty							
Materials	pig wire, concrete floor, zinc roof	total	662.12	1	662.12	10	66.21
Equipment							
Buckets		c/u	3.00	2	6.00	1	6.00
Storage shed	materials	total	364.70	1	364.70	20	18.24
Shovels		c/u	6.65	2	13.30	2	6.65
Picks		c/u	9.40	2	18.80	2	9.40
Wheelbarrow		c/u	95.00	1	95.00	5	19.00
Total					1,159.92		125.50

TABLE 8. ANNUAL COSTS AND RETURNS FOR HOG PRODUCTION (UNIT OF 20 HOGS, 1.5 CYCLES PER YEAR)

Item	Description	Unit	Cost/unit, B/.	Quantity	Total cost, B/.
Returns					
Hogs	Average weight of 115.9 lb., average price B/. 1.031/lb.	hog	119.50	29.4[1]	3,513.30
Costs					
Fixed					
Annual Depreciation					125.50
Variable					
Feeder pigs	Average weight of 30 lb. average price of B/. 1.205/lb.	hog	36.15	30	1,084.50
Feed	Grower and fattening	cwt.	12.50	135	1,687.50
Medication		hog	2.01	30	60.30
Transportation	For animals and feed	total			193.50
Taxes	Slaughtering and municipal	hog	4.42	30	132.60
Insurance		hog	2.00	30	60.00
Interest (9%)					58.20
Total annual costs					3,337.60
Annual net returns to capital, land, and management					175.70

[1]Projects averaged 2 percent mortality of hogs.

The useful life was estimated to be 5 years with an annual depreciation of B/. 108.06.

Ducks were the only livestock alternative that was marketed in a processed form. Hogs, chickens, and cattle were all marketed live. Duck processing required an investment in equipment that included a 55-gallon barrel for boiling water to clean the ducks, tweezers for plucking, and a cooler for transporting processed ducks. Total cost was B/. 645.30 with an annual depreciation of B/. 122.56, table 11.

Production Costs

The projects associated with ducks had an average of 150 ducks per project. This is the production unit utilized in the analysis.

Processing and marketing costs were B/. 272.66 per year, or B/. 0.21 per duck, table 12. Stocking costs were only B/. 276.00 and feed costs were B/. 1,162.20. These costs are the actual costs recorded in the projects.

Duck production was 566.3 pounds per unit of 150 ducks. Mortality was 3.2 percent and average weight was 3.9 pounds per cleaned duck. The theoretical production cycle is 11 weeks. However, the projects achieved only two cycles per year. Net returns to capital, land and management were negative, B/. -345.90.

CHICKENS
Capital Investment

Chicken production units were already functioning when the modules were built. Investment costs were estimated for a unit of 2,000 chickens. The projects with chickens had several units of this size and always had extra manure. Capital investment included construction of the chicken house, well drilling, pump installation, reserve tanks, labor, feeders and waterers. Total investment cost was B/. 6,341.70 with annual depreciation of B/. 698.17, table 13.

Production Costs

Chicken production costs were estimated from secondary data obtained from the Department of Livestock Production. Theoreti-

TABLE 9. INVESTMENT COSTS FOR CATTLE PRODUCTION (UNIT OF 20 STOCKERS)

Item	Description	Unit	Cost/unit, B/.	Quantity	Total cost, B/.	Useful life, years	Annual depreciation, B/.
Fences (3 km)[1]							
Live stakes		c/u	0.25	1,200	300.00	—	—
Barbed wire		roll	31.25	12	375.00	5	75.00
Staples	50-pound box	box	32.00	2	64.00	5	12.80
Transportation[2]		total			20.00	—	—
Subtotal					759.00	—	87.80
Corral[3]		total			381.00	5	76.22
Pasture improvement							
Seed		cwt.	6.00	60	360.00	—	—
Transportation		total			20.00	—	—
Subtotal					380.00	—	—
Total					1,520.11		164.02

[1]The majority of the farms and fences established. These costs are fence improvements.
[2]The farm is assumed to be 30 km from source of supply.
[3]Average construction costs in the projects.

TABLE 10. ANNUAL COSTS AND RETURNS FOR CATTLE PRODUCTION (UNIT OF 20 STOCKERS)

Item	Description	Unit	Cost/unit, B/.	Quantity	Total cost, B/.
Returns					
Stockers		pound	0.40	17,100[1]	6,840.00
Costs					
Fixed					
Annual depreciation					164.02
Variable					
Stocker calves		c/u	250.00	20	5,000.00
Deparasitization		total	—		100.00
Mineralized salt		cwt.	14.90	3.2	54.08
Urea		gal.	.25	400	100.00
Insurance		head	7.50	20	150.00
Transportation		head	12.00	40	480.00
Subtotal					5,884.08
Total annual costs					6,048.10
Annual net returns to capital, land, and management					791.90

[1]Market weight averaged 900 pounds per stocker. Mortality was estimated at 5 percent.

TABLE 11. INVESTMENT COSTS OF DUCK PRODUCTION (UNIT OF 150 DUCKS)

Item	Description	Unit	Cost/unit, B/.	Quantity	Total cost, B/.	Useful life, years	Annual depreciation, B/.
Corral							
Materials		total	540.30	1	540.30	5	108.06
Marketing							
Drum	55-gallon	c/u	10.00	2	20.00	4	5.00
Tweezers		total	10.00	1	10.00	5	2.00
Cooler		c/u	75.00	1	75.00	10	7.50
Total					645.30		122.56

cally, four cycles of chicken could be produced per year. However, as the hogs and ducks only achieved half of what is theoretically possible, the chickens were also analyzed on the basis of two production cycles per year. Net returns to capital, land and management were B/. 858.14, table 14.

TABLE 12. ANNUAL COSTS AND RETURNS FROM DUCK PRODUCTION (UNIT OF 150 DUCKS, 2 CYCLES PER YEAR)

Item	Unit	Cost/unit, B/.	Quantity	Total cost, B/.
Returns				
Ducks	lb.	1.44	1,132.6[1]	1,630.94
Costs				
Fixed				
Annual depreciation				122.56
Variable				
Ducklings	c/u	.92	300	276.00
Feed	cwt.	14.90	78	1,162.20
Marketing	total	136.33	2	272.66
Transportation				109.72
Interest				33.70
Total annual cost				1,976.84
Annual net returns to capital, land, and management				-345.90

[1]300 ducks with 96.8 percent survival at an average weight of 3.9 pounds per duck.

LIVESTOCK-FISH ASSOCIATION

Integration of livestock with fish provides certain economies of scale. The storage shed for animal feed can be used for hanging up seines and other nets. Livestock confinement facilitates milking of cows and also facilitates disease control and disease prevention measures. The same buckets used for feeding swine can be used for harvesting fish. The hog manure is utilized as a fertilizer for fish production and the pond is a sanitary means of waste disposal of the manure. Cleaning the pigsty and fertilizing the fish pond is the same task in integrated systems and economizes labor.

The integrated systems were analyzed as a whole to avoid subjective considerations in allocating use of capital items to different components of the system. These results are then compared directly to the analyses of the activities as independent enterprises.

HOG-FISH ASSOCIATION

The total investment cost of the integrated hog-fish system is B/. 4,417.22 with an annual depreciation of B/. 215.27, table 15. Annual production costs were B/. 3,462.68 with net returns to capital, land and management of B/. 564.31, figure 2.

CHICKEN-FISH ASSOCIATION

The total cash investment was B/. 9,969.70, table 16, with an annual depreciation of B/. 812.18. The annual total costs were B/. 6,972.00 with net returns to capital, land, and management of B/. 1,259.44, table 16.

TABLE 13. INVESTMENT COSTS FOR CHICKEN PRODUCTION (UNIT OF 2,000 CHICKENS)

Item	Description	Unit	Cost/unit, B/.	Quantity	Total cost, B/.	Useful life, years	Annual depreciation, B/.
Construction	chicken house				3,871.70	10	387.17
Well and pump		c/u	1,800.00	1	1,800.00	10	180.00
Reserve tanks					300.00	10	30.00
Waterers	gallon	c/u	3.00	20	60.00	2	30.00
	automatic				280.00	5	56.00
Feeders					30.00	2	15.00
Total					6,341.70		698.17

TABLE 14. ANNUAL COSTS AND RETURNS TO CHICKEN PRODUCTION (UNIT OF 2,000 CHICKENS, TWO CYCLES PER YEAR)

Item	Unit	Cost/unit, B/.	Quantity	Total value or cost, B/.
Returns				
Chickens	lb.	0.53	14,504[1]	7,687.12
Costs				
Fixed				
Annual depreciation				698.17
Variables				
Chicks	each	.24	4,000	960.00
Vaccinations				
Chicken pox	bottle	2.75	8	22.00
Newcastle	bottle	2.35	8	18.80
Deparasitation	lb.	4.50	4	18.00
Vitamins	packet	2.85	8	22.80
Feed				
Starter	cwt.	15.35	100	1,535.00
Finisher	cwt.	14.55	220	3,201.00
Maintenance	total			11.21
Bedding	sack	.25	200	50.00
Disinfectant	bottle	1.00	16	16.00
Cloth	yard	.50	200	100.00
Transportation				176.00
Total variable costs				6,130.81
Total annual costs				6,828.98
Annual net returns to capital, land, and management				858.14

[1]Average weight of 3.7 pounds.

CATTLE-FISH ASSOCIATION

The total cash investment was B/. 5,148.11 with an annual depreciation of B/. 278.03, table 17. The total annual costs were B/. 6,191.12 with total net returns to capital, land, and management of B/. 1,052.68, table 17.

FIG. 10. A two-pond module located in Las Penitas, Cocle. A pigsty (under palm trees) and goat corral (far or distant background) provide the manure for this agroaquaculture project with the motto, "Food is Peace".

TABLE 15. ANNUAL COSTS AND RETURNS FOR HOG-FISH PRODUCTION

Item	Total value or cost, B/.	Annual depreciation, B/.
Annual returns		
Fish	513.69	
Hogs.	3,513.30	
Total annual returns	4,026.99	
Fixed costs		
Pond.	2,835.00	29.75
Storage shed	364.70	18.24
Broodstock.	67.80	—
Pigsty	662.12	66.21
Equipment	487.60	101.07
Subtotal	4,417.22	215.27
Variable costs		
Fish seed	22.73	
Feeder pigs	1,084.50	
Fertilizer	6.28	
Feed.	1,687.50	
Medication	60.30	
Insurance.	60.00	
Transportation.	193.50	
Taxes	132.60	
Subtotal	3,247.41	
Total annual costs	3,462.68	
Annual net returns to capital, land, and management	564.31	

TABLE 16. ANNUAL COSTS AND RETURNS FOR CHICKEN-FISH PRODUCTION

Item	Total value or cost, B/.	Annual depreciation, B/.
Annual returns		
Fish	544.32	
Chicken	7,687.12	
Total annual returns	8,231.44	
Fixed costs		
Ponds	2,835.00	29.75
Storage shed	364.70	18.24
Equipment	730.50	167.02
Broodstock.	67.80	—
Chicken house	3,871.50	387.17
Pump, well, tank	2,100.00	210.00
Subtotal	9,969.70	812.18
Variable costs		
Fish seed	22.73	
Chicks	960.00	
Fertilizer	6.28	
Animal health	81.60	
Feed.	4,736.00	
Transportation.	176.00	
Maintenance	177.21	
Subtotal	6,159.82	
Total annual costs	6,972.00	
Annual net returns to capital, land, and management	1,259.44	

DUCK-FISH ASSOCIATION

The cash investment was B/. 4,273.30 with annual depreciation of B/. 236.57, table 18. The total annual costs are B/. 2,119.86, table 18. Net returns to capital, land, and management are B/. 320.08.

Summary of Budget Analysis

Budget analysis indicates the general profitability of a productive activity by comparing the average costs and returns in a given year. Comparing the different alternatives considered, the "chick-fish" alternative yielded the highest net return to capital, land and management, B/. 1,259.44, table 20. The least profitable was fish raised alone with cattle manure, B/. 143.78. Only one activity, duck production alone, was not profitable.

TABLE 17. ANNUAL COSTS AND RETURNS FOR CATTLE-FISH PRODUCTION

Item	Total value or cost, B/.	Annual depreciation, B/.
Annual returns		
Fish	403.80	
Cattle	6,840.00	
Total annual returns	7,243.80	
Fixed costs		
Ponds	2,825.00	29.75
Storage shed	364.70	18.24
Equipment	360.50	66.02
Broodstock.	67.80	—
Corral.	381.11	76.22
Fencing	759.00	87.80
Pasture improvement	380.00	—
Subtotal	5,148.11	278.03
Variable costs		
Fish seed	22.73	
Fertilizer	6.28	
Stockers	5,000.00	
Supplemental feed . . .	254.08	
Insurance.	150.00	
Transportation.	480.00	
Subtotal	5,913.09	
Total annual costs	6,191.12	
Annual net returns to capital, land, and management	1,052.68	

TABLE 18. ANNUAL COSTS AND RETURNS FOR DUCK-FISH PRODUCTION

Item	Total value or cost, B/.	Annual depreciation, B/.
Annual returns		
Fish	809.00	
Ducks.	1,630.94	
Total annual returns	2,439.94	
Fixed costs		
Ponds	2,835.00	29.75
Storage shed	364.70	18.24
Equipment	465.50	80.52
Broodstock.	67.80	—
Corral.	540.30	108.06
Subtotal	4,273.30	236.57
Variable costs		
Fish seed	22.73	
Ducklings	276.00	
Fertilizer	6.28	
Feed.	1,162.20	
Marketing	272.66	
Transportation.	109.72	
Interest	33.70	
Subtotal	1,823.29	
Total annual costs	2,119.86	
Annual net returns to capital, land, and management	320.08	

Production Costs Per Pound of Meat Produced

Given that the initial goal of the project was to produce animal protein at a low cost, the production costs of the different types of meat produced were calculated for the alternatives considered. The quantity of meat produced in each integrated system was added to the fish production (all in live weight) and this number divided into the total annual cost for each respective system.

The costs per pound of meat varied between B/. 0.14 per pound of fish (with duck manure) to B/. 1.75 per pound of duck meat, table 19. Fish meat produced without animal integration was always cheaper than the other meats considered. Integrating the livestock operations with fish lowered the cost per pound of meat in every case. For example, pork production alone had a production cost of B/. 0.98 per pound but when fish were integrated with hogs, the cost dropped to B/. 0.74 per pound.

TABLE 19. PER POUND PRODUCTION COSTS OF ANIMAL PROTEIN (LIVE WEIGHT)

Alternative	Annual production costs, B/.	Live weight of animals, lb.	Cost per pound meat produced, B/./lb.
1. Fish alone ..... (duck manure)	279.90	2,022.50	0.14
2. Fish alone ..... (chicken manure)	279.90	1,360.81	.21
3. Fish alone ..... (hog manure)	325.50	1,284.23	.25
4. Fish-cattle	6,191.12		
Fish		685.67	
Cattle		17,100.00	
Total		17,785.67	.35
5. Cattle	6,048.10	17,100.00	.35
6. Fish alone ..... (cattle manure)	260.02	685.67	.38
7. Fish-chickens ..	6,983.21		
Fish		1,360.81	
Chickens		14,504.00	
Total		15,864.81	.44
8. Chicken	6,840.29	14,504.00	.47
9. Fish-ducks	2,119.86		
Fish		2,022.50	
Ducks		1,132.60	
Total		3,155.10	.67
10. Fish-hogs	3,462.68		
Fish		1,284.23	
Hogs		3,407.46	
Total		4,691.69	.74
11. Hogs	3,337.60	3,407.46	.98
12. Duck	1,976.84	1,132.60	1.75

TABLE 20. SUMMARY OF NET RETURNS TO CAPITAL, LAND, AND MANAGEMENT

Alternative	Net returns to capital, land, and management, B/.
1. Fish-chicken	1,259.44
2. Fish-cattle	1,052.68
3. Chicken	858.14
4. Cattle	791.90
5. Fish-hogs	564.31
6. Fish alone (duck manure)	529.10
7. Fish-ducks	320.08
8. Fish alone (chicken manure)......	264.42
9. Fish alone (hog manure)	188.19
10. Hogs	175.70
11. Fish alone (cattle manure)	143.78
12. Ducks	-345.90

Rate of Return Analysis

The internal rate of return is a useful tool for analyzing the efficiency of capital use in different projects throughout the respective lives of the projects. Traditional economic analysis focuses on efficiency or income maximization for project selection (*20*). An additional unit of consumption will give the poor man more additional utility in society's eyes than it would to the rich man (*5*). Project evaluation calls for making adjustments in the calculations of economic profitability on the basis of income distribution considerations and effects of project on government income and savings. With these, a social profitability criterion is derived(*4*).

In the absence of sufficient data to assess the social profitability of the project, financial rates of return were estimated to provide some indications of the efficiency of resource use. For lack of complete data, however, these rates of return cannot be interpreted as conclusive.

Rates of return were estimated for the four different types of fish-livestock associations as well as both the fish and livestock components in isolation. Interest on working capital was charged at the 9 percent level charged by the Agricultural Development Bank of Panama in the project.

Tables 21-24 present the stream of incremental net benefits for a 20-year period for the four combinations, analyzing the fish enterprise independently of the whole. Tables 25-28 present an overall analysis that includes costs and returns for both fish and livestock enterprises. Tables 29-32 present annual benefits for the livestock components in isolation.

In the first year, the first 6 months are devoted to construction. The fish and other animals are stocked on July 1. The only income the first year is from two partial harvests of fish (November and December) and one cycle each of ducks and chickens. Hogs and cattle would not be marketed until the second year.

The first total harvest of fish is December of the second year. Two harvests of hogs, ducks, and chickens and one of cattle are achieved the second year. The feed for each cycle of hogs, ducks, and chickens is purchased at one time to economize on transportation and is stored in the storage shed

Labor is provided by the community, so it is not a cash expense of the project. Rather, the returns are returns to the management who also provide the labor. Financial rates of return are calculated with and without operator's labor, to assess both the situation from the farmer's perspective and the efficiency of labor utilization.

The allocation of labor between fish culture and the husbandry activities is presented in tables 29-30. Because of the symbiotic nature of the integrated activities, a clear delineation of labor used by activity is difficult. However, the data presented represent best estimates and are supported by a description of and accounting of all labor activities attributed to each animal combination, table 33.

Daily pond maintenance and water control, pond harvest and fingerling production, and pond maintenance and drainage per production cycle involve the same labor activities for each animal combination. Differences in labor allocation among the combinations arise as a result of pond fertilization activities. More effort was needed to fertilize with cattle manure because of the time required to corral the animals and clean the enclosures. Chickens demand less time because manure was bagged at the end of each fattening cycle, stored, and then applied once a week. Hog manure was applied to the ponds daily when the sties were cleaned. No time was spent fertilizing duck ponds since the ducks were located on the pond and dropped their wastes directly into the water. Annual differences result from the 18-month production cycle.

Cash flows are calculated using the accounting convention of allocating all entries on the last day of the period. Incremental working capital is included in the financial analyses to make expenditures during the period. The incremental residual value is the increased value of the land assuming the module will keep 75 percent of its new value with included maintenance.

The labor used in the project is generally an underemployed resource, thus its real social value is less than wage rates prevalent in the country. Adult male participants have seasonal employment opportunities in sugar harvesting and other farm labor. Much of the labor used in the project is done by young males and females who have limited employment opportunities. Thus, the opportunity cost of labor was estimated at B/. 2.15 per day (*17*).

SUMMARY OF RATES OF RETURN

A summary of the rates of return derived for the alternative animal combinations is presented in table 35. For each combination, the system is self-sustaining because returns cover variable costs.

The fish-duck systems achieved the highest rates of return (23 percent) for the fish only alternative, table 35. Fish production was considerably higher with ducks than with the other livestock alternatives. The analysis, however, assumes a ready market for the ducks which does not currently exist in Panama.

Fish-chicken systems obtained the second-best results of any of the combinations. The financial return of 14 percent, table 35, is above the 12 percent cutoff rate for capital established by the Planabove the 12 percent cutoff rate for capital established by the Planning Ministry in Panama. Efficient resource use is indicated by the high economic returns that provide significant incentive for participation.

The fish-hog system analyzing fish alone yielded a rate of return of 13 percent, also above the accepted 12 percent cutoff rate. The low profitability of raising hogs in Panama decreases the rate of return to 6 percent in the overall analysis.

The fish-cattle systems had the lowest rates of return with 9 percent for fish analyzed separately. This lower rate of return is consistent with the lower fish yields obtained with cattle manure.

Analysis of the system as a whole yielded lower rates of return than the fish enterprises analyzed separately for each livestock alternative. The rates of return were: 10 percent for the fish-chicken enterprise, 6 percent for the fish-hogs enterprise, 8 percent for the fish-ducks enterprise, and 2 percent for the fish-cattle enterprise. The change in rates of return indicates that fish have higher returns than the livestock alternatives considered in these areas.

The lowest rates of return were those of the livestock component in isolation. Chickens alone had a rate of return of 5 percent, hogs alone—6 percent, and cattle—4 percent. Ducks alone had negative returns for each year so that the rate of return could not be calculated.

DISCUSSION

Direct comparisons of the different alternatives would lead to biased conclusions. Chickens were the only enterprise managed on a commercial scale. The only valid comparison would be to look at free-ranging chickens or chickens housed in a cage directly over the ponds.

Internal rates of return cannot be used to rank projects (9). The rate of return should be compared only to the cutoff rate to decide whether to accept or reject the project. The higher rate of return for chickens does not mean that chickens should always be selected over hogs, but rather that both chickens and hogs are viable if their rates of return are above the accepted opportunity cost of capital.

The fish-chicken systems yielded the highest net returns and acceptable rates of return. Chicken manure is easy to handle and store and the animals are raised in a confined area. The chicken operations were already in existence; fish culture provided a productive use of the chicken manure and water for an irrigated garden. The success of this combination indicates probable success of integrated systems for small commercial poultry operations.

The results with hogs were less conclusive. Hogs, independently of fish, are marginally profitable in Panama. This system puts particular strains on traditional farmers in the form of additional credit and transport requirements. Whereas the chicken processors provided these services to chicken producers, the farmers with hogs had no comparable service. Traditional farmers are not accustomed to banking operations and bank personnel are not accustomed to dealing with traditional farmers. Even with favorable credit terms, traditional farmers' risk aversion and the possibility of default make this system difficult for farmers in remote areas.

Farmers with good access to transportation could work with hogs, but the hogs should be stocked at least at 100 per hectare (as compared to the current use of 75 per hectare). Hopkins et al. (*11*) achieved highest fish yields at 103 hogs per hectare and highest net returns at 100 hogs per hectare. This ensures sufficient pond fertility and utilizes more efficiently the capital investment in the pigsty and water control structures (7).

The rate of return for the fish-duck combination was high. This analysis, however, assumes a value for duck meat. If the ducks are neither sold nor consumed, they would have little or no value as a source of meat. In this case, they would then be viewed as a cost to fish culture. The Panamanian diet, except for Oriental populations, does not generally include duck. Thus, duck in traditional communities may have a low value. Marketing ducks to restaurants in Panama City would require a large consistent production far in excess of production capabilities in these communities. Chicken processors would be the most likely distributors of duck, but such distribution would require minimum shipments that would be beyond the capability of small producers. These current marketing constraints make intensive duck-fish combinations unfeasible under the present conditions in Panama. However, if other countries have a developed market outlet for duck meat, this combination would be feasible. For farmers whose families would consume a certain quantity of intensively raised ducks per year, it would still be advisable to stock a small number on the ponds in addition to other livestock for home consumption.

The rate of return for the cattle projects, although below the established cutoff rate for capital investments in Panama, demonstrated that the rate of return is increased by integrating fish production with cattle. The fertilizing quality of unprocessed cow manure as an organic fertilizer for aquaculture is lower than that of hog, chicken, and duck manure (*8,10*). In this project, the cattle enterprises required corraling dispersed herds. The labor effort and logistics involved may have led to the lower level of pond fertilization and fish production. However, in isolated communities with poor road access and an established cattle herd, fertilizing fish ponds with cattle manure is the only available method to intensify fish production. This analysis indicates that farmers with cattle would achieve higher rates of return by combining fish production with cattle operations.

Fish-cattle exceed the 12 percent mark if the price of fish is B/. 0.60 per pound. Other fish prices for lower-quality fish transported from the coast range from B/. 0.35 to B/. 1.00 per pound in the region.

The rate of return of the fish enterprises alone is highly sensitive to changes in the price of fish. A B/. 0.10 increase in price produced an almost doubling of the rate of return in most cases.

The addition of a value for operator's labor in the rate of return analysis causes a considerable drop in the rates of return. The labor intensity of daily fertilization and animal care, when handled in the classical manner, is a significant cost in a small-scale project. Subsistence or near-subsistence farmers, however, do not generally make decisions on their distribution of family labor in the classical economic fashion. Evidence in the Philippines shows that fishpen culture in the Laguna de Baye is not feasible if operator's labor is included (*19*). Yet, these operators are making money and expanding businesses, and new operators are entering the industry. "Peasant families will work unimaginably hard and long for the smallest increments in production. They will continue to work long after a prudent capitalist would move on" (*18*). Clearly, economics has not yet developed an adequate theory or tool to determine the value of an operator's labor in a near-subsistence context.

In all cases, the fish enterprise considered alone yielded a higher rate of return than the overall rate. This indicates that it is worthwhile and feasible to integrate fish culture with these livestock alternatives.

TABLE 21. FLOW OF INCREMENTAL NET BENEFITS FOR FISH-CHICKEN MODULE, FISH ONLY

Financial item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Fixed Costs									
Pond[1]	$2,835.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Storage Shed	364.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equipment	360.50	6.00	6.00	6.00	6.00	220.50	6.00	6.00	131.00
Broodstock[1]	67.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	3,628.00	6.00	6.00	6.00	6.00	220.50	6.00	6.00	131.00
Contingency (10%)	362.80	0.60	0.60	0.60	0.60	22.05	0.60	0.60	13.10
Subtotal	$3,990.80	$6.60	$6.60	$6.60	$6.60	242.55	$6.60	$6.60	$144.10
Variable Costs									
Fish Seed[1]	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10
Fertilizer	9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	9.42
Interest Working Cap.	3.92	0.00	3.92	3.92	0.00	3.92	3.92	0.00	3.92
Subtotal	$47.44	$0.00	$47.44	$47.44	0.00	$47.44	$47.44	$0.00	$47.44
Total Cost	$4,038.24	$6.60	$54.04	$54.04	$6.60	$289.99	$54.04	$6.60	$191.54
Gross Returns	$116.64	$769.80	$564.56	$564.56	$846.84	$564.56	$564.56	$846.84	$564.56
Net Returns To Capital, Land, and Management (Without Operator's Labor)	($3,921.60)	$763.20	$510.52	$510.52	$840.24	$274.57	$510.52	$840.24	$373.02
Operator's Labor	$103.20	$233.28	$290.25	$290.25	$233.28	$290.25	$290.25	$233.28	$290.25
Net Returns to Capital and Land	($4,024.80)	$529.92	$220.27	$220.27	$606.96	($15.68)	$220.27	$606.96	$82.77

[1]Includes transport.

TABLE 22. FLOW OF INCREMENTAL NET BENEFITS FOR FISH-HOGS MODULE, FISH ONLY

Financial item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Fixed Costs									
Pond[1]	$2,835.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Storage Shed	364.70	0.00	0.00	0.00	0.00	$0.00	0.00	0.00	0.00
Equipment	360.50	6.00	6.00	6.00	6.00	220.50	6.00	6.00	131.00
Broodstock[1]	67.80	0.00	0.00	0.00	0.00	$0.00	0.00	0.00	0.00
Subtotal	3,628.00	6.00	6.00	6.00	6.00	220.50	6.00	6.00	131.00
Contingency (10%)	362.80	0.60	0.60	0.60	0.60	22.05	0.60	0.60	13.10
Subtotal	$3,990.80	$6.60	$6.60	$6.60	$6.60	$242.50	$6.60	$6.60	$144.10
Variable Costs									
Fish Seed[1]	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10		$0.00	$34.10
Fertilizer	9.42	0.00	9.42	9.42	0.00	9.42	$34.10	0.00	9.42
Interest Working Cap.	3.92	0.00	3.92	3.92	0.00	3.92	9.42	0.00	3.92
Subtotal	$47.44	$0.00	$47.44	$47.44	$0.00	$47.44	$47.44	$0.00	$47.44
Total Cost	$4,038.24	$6.60	$54.04	$54.04	$6.60	$289.99	$54.04	$6.60	$191.54
Gross Returns	$110.08	$726.48	$532.80	$532.80	$799.20	$532.80	$532.80	$799.20	$532.80
Net Returns To Capital, Land, and Management (Without Operator's Labor)	($3,928.16)	$719.88	$478.76	$478.76	$792.60	$242.81	$478.76	$792.60	$341.26
Operator's Labor	$95.68	$217.15	$261.22	$277.35	$201.02	$277.35	$261.22	$217.15	$261.22
Net Returns to Capital and Land	($4,023.84)	$502.73	$217.54	$201.41	$591.58	($34.54)	$217.54	$575.45	$80.04

[1]Includes transport.

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Residual value
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,932.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	235.50	6.00	6.00	6.00	6.00	220.50	131.00	6.00	6.00	6.00	60.25
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67.80
6.00	235.50	6.00	6.00	6.00	6.00	220.50	131.00	6.00	6.00	6.00	0.00
0.60	23.55	0.60	0.60	0.60	0.60	22.05	13.10	0.60	0.60	0.60	0.00
$6.60	259.05	$6.60	$6.60	$6.60	$6.60	$242.55	$144.10	$6.60	$6.60	$6.60	$0.00
$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$0.00
9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	0.00
3.92	0.00	3.92	3.92	0.00	3.92	3.92	0.00	3.92	3.92	0.00	0.00
$47.44	$0.00	$47.44	$47.44	$0.00	$47.44	$47.44	$0.00	$47.44	$47.44	$0.00	$0.00
$54.04	$259.05	$54.04	$54.04	$6.60	$54.04	$289.99	$144.10	$54.04	$54.04	$6.60	$0.00
564.56	$846.84	$564.56	$564.56	$846.84	$564.56	$564.56	$846.84	$564.56	$564.56	$2,906.89	$0.00
$510.52	$587.79	$510.52	$510.52	$840.24	$510.52	$274.57	$702.74	$510.52	$510.52	$2,900.29	$0.00
$290.25	$233.28	$290.25	$290.25	$233.28	$290.25	$290.25	$233.28	$290.25	$290.25	$233.28	$0.00
$220.27	$354.51	$220.27	$220.27	$606.96	$220.27	($15.68)	$469.46	$220.27	$220.27	$2,667.01	$0.00

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Residual value
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,932.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	235.50	6.00	6.00	6.00	6.00	220.50	131.00	6.00	6.00	6.00	60.25
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67.80
6.00	235.50	6.00	6.00	6.00	6.00	220.50	131.00	6.00	6.00	6.00	0.00
0.60	23.55	0.60	0.60	0.60	0.60	22.05	13.10	0.60	0.60	0.60	0.00
$6.60	$259.05	$6.60	$6.60	$6.60	$6.60	$242.55	$144.10	$6.60	$6.60	$6.60	$0.00
$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$0.00
9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	0.00
3.92	0.00	3.92	3.92	0.00	3.92	3.92	0.00	3.92	3.92	0.00	0.00
$47.44	$0.00	$47.44	$47.44	$0.00	$47.44	$47.44	$0.00	$47.44	$47.44	$0.00	$0.00
$54.04	$259.05	$54.04	$54.04	$6.60	$54.04	$289.99	$144.10	$54.04	$54.04	$6.60	$0.00
$532.80	$1,258.56	$839.04	$839.04	$1,258.56	$839.04	$839.04	$1,258.56	$839.04	$839.04	$3,318.61	$0.00
$478.76	$999.51	$785.00	$785.01	$1,251.96	$785.00	$549.05	$1,114.46	$785.00	$785.00	$3,312.01	$0.00
$277.35	$184.90	$245.10	$245.10	$184.90	$245.10	$245.10	$184.90	$245.10	$245.10	$184.90	$0.00
$201.41	$814.61	$539.90	$539.91	$1,067.06	$539.90	$303.95	$929.56	$539.90	$539.90	$3,127.11	$0.00

TABLE 23. FLOW OF INCREMENTAL NET BENEFITS FOR FISH-DUCK MODULE, FISH ONLY

Financial item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Fixed Costs									
Pond[1]	$2,835.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Storage Shed	364.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equipment	360.50	6.00	6.00	6.00	6.00	220.50	6.00	6.00	131.00
Broodstock[1]	67.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	3,628.00	6.00	6.00	6.00	6.00	220.50	6.00	6.00	131.00
Contingency (10%)	362.80	0.60	0.60	0.60	0.60	22.05	0.60	0.60	13.10
Subtotal	$3,990.80	$6.60	$6.60	$6.60	$6.60	$242.55	$6.60	$6.60	$144.10
Variable Costs									
Fish Seed[1]	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10
Fertilizer	9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	9.42
Interest Working Cap.	3.92	0.00	3.92	3.92	0.00	3.92	3.92	0.00	3.92
Subtotal	$47.44	$0.00	$47.44	$47.44	$0.00	$47.44	$47.44	$0.00	$47.44
Total Cost	$4,038.24	$6.60	$54.04	$54.04	$6.60	$289.99	$54.04	$6.60	$191.54
Gross Returns	$173.36	$1,144.20	$839.04	$839.04	$1,258.56	$839.04	$839.04	$1,258.56	$839.04
Net Returns To Capital, Land, and Management (Without Operator's Labor)	(3,864.88)	$1,137.60	$785.00	$785.00	$1,251.96	$549.05	$785.00	$1,251.96	$647.50
Operator's Labor	$79.55	$184.90	$245.10	$245.10	$184.90	$245.10	$245.10	$184.90	$245.10
Net Returns to Capital and Land	($3,944.43)	$952.70	$539.90	$539.90	$1,067.06	$303.95	$539.90	$1,067.06	$402.40

[1]Includes transport.

TABLE 24. FLOW OF INCREMENTAL NET BENEFITS FOR FISH-CATTLE MODULE, FISH ONLY

Financial item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Fixed Costs									
Pond[1]	$2,835.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Storage Shed	364.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equipment	360.50	6.00	6.00	6.00	6.00	220.50	6.00	6.00	131.00
Broodstock[1]	67.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	3,628.00	6.00	6.00	6.00	6.00	220.50	6.00	6.00	131.00
Contingency (10%)	362.80	0.60	0.60	0.60	0.60	22.05	0.60	0.60	13.10
Subtotal	$3,990.80	$6.60	$6.60	$6.60	$6.60	$242.55	$6.60	$6.60	$144.10
Variable Costs									
Fish Seed[1]	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10
Fertilizer	9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	9.42
Interest Working Cap.	3.92	0.00	3.92	3.92	0.00	3.92	3.92	0.00	3.92
Subtotal	$47.44	$0.00	$47.44	$47.44	$0.00	$47.44	$47.44	$0.00	$47.44
Total Cost	$4,038.24	$6.60	$54.04	$54.04	$6.60	$289.99	$54.04	$6.60	$191.54
Gross Returns	$86.53	$570.96	$418.72	$418.72	$628.08	$418.72	$418.72	$628.08	$418.72
Net Returns To Capital, Land, and Management (Without Operator's Labor)	($3,951.71)	$564.36	$364.68	$364.68	$621.48	$128.73	$364.68	$621.48	$227.18
Operator's Labor	$131.15	$288.10	$339.70	$339.70	$288.10	$339.70	$339.70	$288.10	$339.70
Net Returns to Capital and Land	($4,082.86)	$276.26	$24.98	$24.98	$333.38	($210.97)	$24.98	$333.38	($112.52)

[1]Includes transport.

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Residual value
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,932.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	235.50	6.00	6.00	6.00	6.00	220.50	131.00	6.00	6.00	6.00	60.25
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67.80
6.00	235.50	6.00	6.00	6.00	6.00	220.50	131.00	6.00	6.00	6.00	0.00
0.60	23.55	0.60	0.60	0.60	0.60	22.05	13.10	0.60	0.60	0.60	0.00
$6.60	$259.05	$6.60	$6.60	$6.60	$6.60	$242.55	$144.10	$6.60	$6.60	$6.60	$0.00
$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$0.00
9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	0.00
3.92	0.00	3.92	3.92	0.00	3.92	3.92	0.00	3.92	3.92	0.00	
$47.44	$0.00	$47.44	$47.44	$0.00	$47.44	$47.44	$0.00	$47.44	$47.44	$0.00	$0.00
$54.04	$259.05	$54.04	$54.04	$6.60	$54.04	$289.99	$144.10	$54.04	$54.04	$6.60	$0.00
$839.04	$799.20	$532.80	$532.80	$799.20	$532.80	$532.80	$799.20	$532.80	$532.80	$2,859.25	$0.00
$785.00	$540.15	$478.76	$478.76	$792.60	$478.76	$242.81	$655.10	$478.76	$478.76	$2,852.65	$0.00
$245.10	$201.02	$277.35	$261.22	$217.15	$261.22	$277.35	$201.02	$277.35	$261.22	$217.15	$0.00
$539.90	$339.13	$201.41	$217.54	$575.45	$217.54	($34.54)	$454.08	$201.41	$217.54	$2,635.50	$0.00

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Residual value
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,932.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	235.50	6.00	6.00	6.00	6.00	220.50	131.00	6.00	6.00	6.00	60.25
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67.80
6.00	235.50	6.00	6.00	6.00	6.00	220.50	131.00	6.00	6.00	6.00	0.00
0.60	23.55	0.60	0.60	0.60	0.60	22.05	13.10	0.60	0.60	0.60	0.00
$6.60	$259.05	$6.60	$6.60	$6.60	$6.60	$242.55	$144.10	$6.60	$6.60	$6.60	$0.00
$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$0.00
9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	0.00
3.92	0.00	3.92	3.92	0.00	3.92	3.92	0.00	3.92	3.92	0.00	0.00
$47.44	$0.00	$47.44	$47.44	$0.00	$47.44	$47.44	$0.00	$47.44	$47.44	$0.00	$0.00
$54.04	$259.05	$54.04	$54.04	$6.60	$54.04	$289.99	$144.10	$54.04	$54.04	$6.60	$0.00
$418.72	$628.08	$418.72	$418.72	$628.08	$418.72	$418.72	$628.08	$418.72	$418.72	$2,688.13	$0.00
$364.68	$369.03	$364.68	$364.68	$621.48	$364.68	$128.73	$483.98	$364.68	$364.68	$2,681.53	$0.00
$339.70	$288.10	$339.70	$339.70	$288.10	$339.70	$339.70	$288.10	$339.70	$339.70	$288.10	$0.00
$24.98	$80.93	$24.98	$24.98	$333.38	$24.98	($210.97)	$195.88	$24.98	$24.98	$2,393.43	$0.00

TABLE 25. FLOW OF INCREMENTAL NET BENEFITS FOR FISH-CHICKEN MODULE

Financial item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Fixed Costs									
Pond[1]	$2,835.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Storage Shed	364.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equipment	730.50	6.00	96.00	6.00	96.00	500.50	96.00	6.00	221.00
Chicken House	3,871.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Broodstock[1]	67.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pumps, Tanks	2,100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	9,969.70	6.00	96.00	6.00	96.00	500.50	96.00	6.00	221.00
Contingency (10%)	996.97	0.60	9.60	0.60	9.60	50.05	9.60	0.60	22.10
Subtotal	$10,966.67	$6.60	$105.60	$6.60	$105.60	$550.55	$105.60	$6.60	$243.10
Variable Costs									
Fish Seed[1]	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10
Chicks	480.00	960.00	960.00	960.00	960.00	960.00	960.00	960.00	960.00
Fertilizer	9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	9.42
Feed	2,368.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00
Vaccinations	40.80	81.60	81.60	81.60	81.60	81.60	81.60	81.60	81.60
Transportation	88.00	176.00	176.00	176.00	176.00	176.00	176.00	176.00	176.00
Sanitation	83.00	166.00	166.00	166.00	166.00	166.00	166.00	166.00	166.00
Maintenance	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21
Interest Working Cap.	280.31	551.68	555.60	555.60	551.68	555.60	555.60	551.68	555.60
Subtotal	$3,394.84	$6,681.49	$6,728.93	$6,728.93	$6,681.49	$6,728.93	$6,728.93	$6,681.49	$6,728.93
Total Cost	$14,361.51	$6,688.09	$6,834.53	$6,735.53	$6,787.09	$7,279.48	$6,834.53	$6,688.09	$6,972.03
Gross Returns	$3,960.20	$8,456.92	$8,251.68	$8,251.68	$8,533.96	$8,251.68	$8,251.68	$8,533.96	$8,251.68
Net Returns To Capital, Land, and Management (Without Operator's Labor)	($10,401.31)	$1,768.83	$1,417.15	$1,516.15	$1,746.87	$972.20	$1,417.15	$1,845.87	$1,279.65
Operator's Labor									
Fish	$103.20	$233.28	$290.25	$290.25	$233.28	$290.25	$290.25	$233.28	$290.25
Chickens	$785.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00
Net Returns to Capital and Land	($11,289.51)	($34.45)	($443.10)	($344.10)	($56.41)	($888.05)	($443.10)	$42.59	($580.60)

[1]Includes transport.

TABLE 26. FLOW OF INCREMENTAL NET BENEFITS FOR FISH-HOG MODULE

Financial item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Fixed Costs									
Pond[1]	$2,835.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Storage Shed	364.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equipment	487.60	6.00	6.00	6.00	6.00	220.50	6.00	6.00	131.00
Pigsty	662.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Broodstock[1]	67.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	4,417.22	6.00	6.00	6.00	6.00	220.50	6.00	6.00	131.00
Contingency (10%)	441.72	0.60	0.60	0.60	0.60	22.05	0.60	0.60	13.10
Subtotal	$4,858.94	$6.60	$6.60	$6.60	$6.60	$242.55	$6.60	$6.60	$144.10
Variable Costs									
Fish Seed[1]	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10
Feeder Pigs	723.00	1,446.00	723.00	1,446.00	723.00	1,446.00	723.00	1,446.00	723.00
Fertilizer	9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	9.42
Feed	1,125.00	2,250.00	1,125.00	2,250.00	1,125.00	2,250.00	1,125.00	2,250.00	1,125.00
Medications	30.15	60.30	60.30	60.30	60.60	60.30	60.30	60.30	60.30
Crop Insurance	40.00	80.00	40.00	80.00	40.00	80.00	40.00	80.00	40.00
Transportation	65.00	250.00	125.00	250.00	125.00	250.00	125.00	250.00	125.00
Interest Working Cap.	182.40	367.77	190.51	371.68	186.60	371.68	190.51	367.77	190.51
Taxes	0.00	176.80	88.40	176.80	88.40	176.80	88.40	176.80	88.40
Subtotal	$2,209.07	$4,630.87	$2,395.73	$4,678.30	$2,348.30	$4,678.30	$2,395.73	$4,630.87	$2,395.73
Total Cost	$7,068.01	$4,637.47	$2,402.33	$4,684.90	$2,354.90	$4,920.85	$2,402.33	$4,637.47	$2,539.83
Gross Returns	$110.88	$5,416.21	$2,878.86	$5,221.06	$3,147.19	$5,221.00	$2,878.86	$5,489.39	$2,878.86
Net Returns To Capital, Land And Management (Without Operator's Labor)	($6,957.13)	$778.74	$476.53	$536.16	$792.29	$300.15	$476.53	$851.92	$339.03
Operator's Labor									
Fish	$95.68	$217.15	$261.22	$277.35	$201.02	$277.35	$261.22	$217.15	$261.22
Hogs	$16.00	$32.00	$16.00	$32.00	$16.00	$32.00	$16.00	$32.00	$16.00
Net Returns To Capital and Land	($7,068.81)	$529.59	$199.31	$226.81	$575.27	($9.20)	$199.31	$602.77	$61.81

[1]Includes transport.

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Residual value
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,932.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	605.50	6.00	96.00	6.00	96.00	500.50	221.00	6.00	96.00	6.00	62.50
0.00	3,871.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67.80
0.00	2,100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	6,577.20	6.00	96.00	6.00	96.00	500.50	221.00	6.00	96.00	6.00	0.00
0.60	657.72	0.60	9.60	0.60	9.60	50.05	22.10	0.60	9.60	0.60	0.00
$6.60	$7,234.92	$6.60	$105.60	$6.60	$105.60	$550.55	$243.10	$6.60	$105.60	$6.60	$0.00
$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$0.00
960.00	960.00	960.00	960.00	960.00	960.00	960.00	960.00	960.00	960.00	960.00	$0.00
9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	0.00
4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	0.00
81.60	81.60	81.60	81.60	81.60	81.60	81.60	81.60	81.60	81.60	81.60	0.00
176.00	176.00	176.00	176.00	176.00	176.00	176.00	176.00	176.00	176.00	176.00	0.00
166.00	166.00	166.00	166.00	166.00	166.00	166.00	166.00	166.00	166.00	166.00	0.00
11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21	0.00
555.60	551.68	555.60	555.60	551.68	555.60	555.60	551.68	555.60	555.60	551.68	0.00
$6,728.93	$6,681.49	$6,728.93	$6,728.93	$6,681.49	$6,728.93	$6,728.93	$6,681.49	$6,728.93	$6,728.93	$6,681.49	$0.00
$6,735.53	$13,916.41	$6,735.53	$6,834.53	$6,688.09	$6,834.53	$7,279.48	$6,924.59	$6,735.53	$6,834.53	$6,688.09	$0.00
$8,251.68	$8,533.96	$8,251.68	$8,251.68	$8,533.96	$8,251.68	$8,251.68	$8,533.96	$8,251.68	$8,251.68	$10,596.26	$0.00
$1,516.15	($5,382.45)	$1,516.15	$1,417.15	$1,845.87	$1,417.15	$972.20	$1,609.37	$1,516.15	$1,417.15	$3,908.17	$0.00
$290.25	$233.28	$290.25	$290.25	$233.28	$290.25	$290.25	$233.28	$290.25	$290.25	$233.28	$0.00
$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$0.00
($344.10)	($7,185.73)	($344.10)	($443.10)	$42.59	($443.10)	($888.05)	($193.91)	($344.10)	($443.10)	$2,104.89	$0.00

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Residual value
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,932.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	362.60	6.00	6.00	6.00	6.00	220.50	131.00	6.00	6.00	6.00	62.50
0.00	662.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67.80
6.00	1,024.72	6.00	6.00	6.00	6.00	220.50	131.00	6.00	6.00	6.00	0.00
0.60	102.47	0.60	0.60	0.60	0.60	22.05	13.10	0.60	0.60	0.60	0.00
$6.60	$1,127.19	$6.60	$6.60	$6.60	$6.60	$242.55	$144.10	$6.60	$6.60	$6.60	$0.00
$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$0.00
1,446.00	723.00	1,446.00	723.00	1,446.00	723.00	1,446.00	723.00	1,446.00	723.00	1,446.00	557.25
9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	0.00
2,250.00	1,125.00	2,250.00	1,125.00	2,250.00	1,125.00	2,250.00	1,125.00	2,250.00	1,125.00	2,250.00	877.50
60.30	60.30	60.30	60.30	60.30	60.30	60.30	60.30	60.30	60.30	60.30	0.00
80.00	40.00	80.00	40.00	80.00	40.00	80.00	40.00	80.00	40.00	80.00	0.00
250.00	125.00	250.00	125.00	250.00	125.00	250.00	125.00	250.00	125.00	250.00	0.00
371.68	186.60	371.68	190.51	367.77	190.51	371.68	186.60	371.68	190.51	367.77	0.00
176.80	88.40	176.80	88.40	176.80	88.40	176.80	88.40	176.80	88.40	176.80	
$4,678.30	$2,348.30	$4,678.30	$2,395.73	$4,630.87	$2,395.73	$4,678.30	$2,348.30	$4,678.30	$2,395.73	$4,630.87	$0.00
$4,684.90	$3,475.49	$4,684.90	$2,402.33	$4,637.47	$2,402.33	$4,920.85	$2,492.40	$4,684.90	$2,402.33	$4,637.47	$0.00
$5,221.06	$3,147.19	$5,221.06	$2878.86	$5,489.39	$2,878.86	$5,221.06	$3,147.19	$5,221.06	$2,878.86	$8,986.44	$0.00
$536.16	($328.30)	$536.16	$476.53	$851.92	$476.53	$300.21	$654.79	$536.16	$476.53	$4,348.97	$0.00
$277.35	$201.02	$277.35	$261.22	$217.15	$261.22	$277.35	$201.02	$277.35	$261.22	$217.15	$0.00
$32.00	$16.00	$32.00	$16.00	$32.00	$16.00	$32.00	$16.00	$32.00	$16.00	$32.00	$0.00
$226.81	($545.32)	$226.81	$199.31	$602.77	$199.31	($9.14)	$437.77	$226.81	$199.31	$4,099.82	$0.00

TABLE 27. FLOW OF INCREMENTAL NET BENEFITS FOR FISH-DUCK MODULE

Financial item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Fixed Costs									
Pond[1]	$2,835.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Storage Shed	364.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equipment	465.50	6.00	6.00	6.00	26.00	230.50	6.00	6.00	151.00
Corral	540.30	0.00	0.00	0.00	0.00	540.30	0.00	0.00	0.00
Broodstock[1]	67.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	4,273.30	6.00	6.00	6.00	26.00	770.80	6.00	6.00	151.00
Contingency (10%)	427.33	0.60	0.60	0.60	2.60	77.08	0.60	0.60	15.10
Subtotal	$4,700.63	$6.60	$6.60	$6.60	$28.60	$847.88	$6.60	$6.60	$166.10
Variable Costs									
Fish Seed[1]	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10
Ducklings[1]	148.50	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00
Fertilizer	9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	9.42
Feed[1]	600.60	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20
Marketing	161.19	322.38	322.38	322.38	322.38	322.38	322.38	322.38	322.38
Interest Working Cap.	85.84	163.85	167.77	167.77	163.85	167.77	167.77	163.85	167.77
Subtotal	$1,039.65	$1,984.43	$2,031.87	$2,031.87	$1,984.43	$2,031.87	$2,031.87	$1,984.43	$2,031.87
Total Cost	$5,740.28	$1,991.03	$2,038.47	$2,038.47	$2,013.03	$2,879.75	$2,038.47	$1,991.03	$2,197.97
Gross Return	$988.83	$2,775.14	$2,469.98	$2,469.98	$2,889.50	$2,469.98	$2,469.98	$2,889.50	$2,469.98
Net Returns to Capital, Land, And Management (Without Operator's Labor)	($4,751.45)	$784.11	$431.51	$431.51	$876.47	($409.77)	$431.51	$898.47	$272.01
Operator's Labor									
Fish	$79.55	$184.90	$245.10	$245.10	$184.90	$245.10	$245.10	$184.90	$245.10
Ducks	$229.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00
Net Returns to Capital and Land	($5,060.00)	$155.21	($257.59)	($257.59)	$247.57	($1,098.87)	($257.59)	$269.57	($417.09)

[1]Includes transport.

TABLE 28. FLOW OF INCREMENTAL NET BENEFITS FOR FISH-CATTLE MODULE

Financial item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Fixed Costs									
Pond[1]	$2,835.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Storage Shed	364.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equipment	360.50	6.00	6.00	6.00	6.00	220.50	6.00	6.00	131.00
Corral	381.11	0.00	0.00	0.00	0.00	381.11	0.00	0.00	0.00
Broodstock[1]	67.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fence Improvement	759.00	0.00	0.00	0.00	0.00	459.00	0.00	0.00	0.00
Pasture Re-estab.	380.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	5,148.11	6.00	6.00	6.00	6.00	1,060.61	6.00	6.00	131.00
Contingency (10%)	514.81	0.60	0.60	0.60	0.60	106.06	0.60	0.60	13.10
Subtotal	$5,662.92	$6.60	$6.60	$6.60	$6.60	$1,166.67	$6.60	$6.60	$144.10
Variable Costs									
Fish Seed[1]	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10
Stockers	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00
Fertilizer	9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	9.42
Feed	254.08	254.08	254.08	254.08	254.08	254.08	254.08	254.08	254.08
Crop Insurance	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00
Transportation	240.00	480.00	480.00	480.00	480.00	480.00	480.00	480.00	480.00
Interest Working Cap.	511.88	529.57	533.48	533.48	529.57	533.48	533.48	529.57	533.48
Subtotal	$6,199.48	$6,413.65	$6,461.08	$6,461.08	$6,413.65	$6,461.08	$6,461.08	$6,413.65	$6,461.08
Total Costs	$11,862.41	$6,420.25	$6,467.68	$6,467.68	$6,420.25	$7,627.76	$6,467.68	$6,420.25	$6,605.18
Gross Returns	$86.53	$7,410.96	$7,258.72	$7,258.72	$7,468.08	$7,258.72	$7,258.72	$7,468.08	$7,258.72
Net Returns to Capital, Land And Management (Without Operator's Labor)	($11,775.88)	$990.71	$791.04	$791.04	$1,047.83	($369.04)	$791.04	$1,047.83	$653.54
Operator's Labor	$131.15	$288.10	$339.70	$339.70	$288.10	$339.70	$339.70	$288.10	$339.70
Net Returns to Capital and Land	($11,907.03)	$702.61	$451.34	$451.34	$759.73	($708.74)	$451.34	$759.73	$313.84

[1]Includes transport.

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Residual value
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,932.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	320.50	6.00	26.00	6.00	6.00	230.50	145.00	6.00	6.00	6.00	62.50
0.00	540.30	0.00	0.00	0.00	0.00	540.30	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67.80
6.00	860.80	6.00	26.00	6.00	6.00	770.80	145.00	6.00	6.00	6.00	0.00
0.60	86.08	0.60	2.60	0.60	0.60	77.08	14.50	0.60	0.60	0.60	0.00
$6.60	$946.88	$6.60	$28.60	$6.60	$6.60	$847.88	$159.50	$6.60	$6.60	$6.60	$0.00
$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$0.00
297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	0.00
9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	0.00
1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	0.00
322.38	322.38	322.38	322.38	322.38	322.38	322.38	322.38	322.38	322.38	322.38	0.00
167.77	163.85	167.77	167.77	163.85	167.77	167.77	163.85	167.77	167.77	163.85	
$2,031.87	$1,984.43	$2,031.87	$2,031.87	$1,984.43	$2,031.87	$2,031.87	$1,984.43	$2,031.87	$2,031.87	$1,984.43	$0.00
$2,038.47	$2,931.31	$2,038.47	$2,060.47	$1,991.03	$2,038.47	$2,879.75	$2,143.93	$2,038.47	$2,038.47	$1,991.03	$0.00
$2,469.98	$2,889.50	$2,469.98	$2,469.98	$2,889.50	$2,469.98	$2,469.98	$2,889.50	$2,469.98	$2,469.98	$4,951.80	$0.00
$431.51	($41.81)	$431.51	$409.51	$898.47	$431.51	($409.77)	$745.57	$431.51	$431.51	$2,960.77	$0.00
$245.10	$184.90	$245.10	$245.10	$184.90	$245.10	$245.10	$184.90	$245.10	$245.10	$184.90	$0.00
$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$0.00
($257.59)	($670.71)	($257.59)	($279.59)	$269.57	($257.59)	($1,098.87)	$116.67	($257.59)	($257.59)	$2,331.87	$0.00

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Residual value
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,932.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	235.50	6.00	6.00	6.00	6.00	220.50	131.00	6.00	6.00	6.00	62.50
0.00	381.11	0.00	0.00	0.00	0.00	381.11	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67.80
0.00	459.00	0.00	0.00	0.00	0.00	459.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	285.00
6.00	1,075.61	6.00	6.00	6.00	6.00	1,060.61	131.00	6.00	6.00	6.00	0.00
0.60	107.56	0.60	0.60	0.60	0.60	106.06	13.10	0.60	0.60	0.60	0.00
$6.60	$1,183.17	$6.60	$6.60	$6.60	$6.60	$1,166.67	$144.10	$6.60	$6.60	$6.60	$2,347.30
$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$34.10	$34.10	$0.00	$0.00
5,000.00	5,000.00	5,000.00	5,000.00	5,000.00	5,000.00	5,000.00	5,000.00	5,000.00	5,000.00	5,000.00	0.00
9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	9.42	9.42	0.00	0.00
254.08	254.08	254.08	254.08	254.08	254.08	254.08	254.08	254.08	254.08	254.08	0.00
150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	0.00
480.00	480.00	480.00	480.00	480.00	480.00	480.00	480.00	480.00	480.00	480.00	0.00
533.48	529.57	533.48	533.48	529.57	533.48	533.48	529.57	533.48	533.48	529.57	0.00
$6,461.08	$6,413.65	$6,461.08	$6,461.08	$6,413.65	$6,461.08	$6,461.08	$6,413.65	$6,461.08	$6,461.08	$6,413.65	$0.00
$6,467.68	$7,596.82	$6,467.68	$6,467.68	$6,420.25	$6,467.68	$7,627.76	$6,557.75	$6,467.68	$6,467.68	$6,420.25	$0.00
$7,258.72	$7,468.08	$7,258.72	$7,258.72	$7,468.08	$7,258.72	$7,258.72	$7,468.08	$7,258.72	$7,258.72	$9,815.38	$0.00
$791.04	($128.74)	$791.04	$791.04	$1,047.83	$791.04	($369.04)	$910.33	$791.04	$791.04	$3,395.13	$0.00
$339.70	$288.10	$339.70	$339.70	$288.10	$339.70	$339.70	$288.10	$339.70	$339.70	$288.10	$0.00
$451.34	($416.84)	$451.34	$451.34	$759.73	$451.34	($708.74)	$622.23	$451.34	$451.34	$3,107.03	$0.00

TABLE 29. FLOW OF INCREMENTAL NET BENEFITS FOR CHICKEN ENTERPRISE

Financial item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Fixed Costs									
Storage Shed	$364.70	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Equipment	370.00	6.00	96.00	6.00	96.00	286.00	96.00	6.00	96.00
Chicken House	3,871.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pumps, Tanks	2,100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	6,706.40	6.00	96.00	6.00	96.00	286.00	96.00	6.00	96.00
Contingency (10%)	670.64	0.60	9.60	0.60	9.60	28.60	9.60	0.60	9.60
Subtotal	$7,377.04	$6.60	$105.60	$6.60	$105.60	$314.60	$105.60	$6.60	$105.60
Variable Costs									
Chicks	$480.00	$960.00	$960.00	$960.00	$960.00	$960.00	$960.00	$960.00	$960.00
Feed	2,368.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00
Vaccinations	40.80	81.60	81.60	81.60	81.60	81.60	81.60	81.60	81.60
Transportation	88.00	176.00	176.00	176.00	176.00	176.00	176.00	176.00	176.00
Sanitation	83.00	166.00	166.00	166.00	166.00	166.00	166.00	166.00	166.00
Maintenance	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21
Interest Working Cap.	276.39	551.68	551.68	551.68	551.68	551.68	551.68	551.68	551.68
Total	$3,347.40	$6,681.49	$6,681.49	$6,681.49	$6,681.49	$6,681.49	$6,681.49	$6,681.49	$6,681.49
Subtotal Cost	$10,724.44	$6,688.09	$6,787.09	$6,688.09	$6,787.09	$6,996.09	$6,787.09	$6,688.09	$6,787.09
Gross Returns	$3,843.56	$7,687.12	$7,687.12	$7,687.12	$7,687.12	$7,687.12	$7,687.12	$7,687.12	$7,687.12
Net Returns To Capital, Land And Management (Without Operator's Labor)	($6,880.88)	$999.03	$900.03	$999.03	$900.03	$691.03	$900.03	$999.03	$900.03
Operator's Labor									
Chickens	$785.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00
Net Returns to Capital and Land	($7,665.88)	($570.97)	($669.97)	($570.97)	($669.97)	(878.97)	($669.97)	($570.97)	($669.97)

TABLE 30. FLOW OF INCREMENTAL NET BENEFITS FOR HOG ENTERPRISE

Financial item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Fixed Costs									
Storage Shed	$364.70	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Equipment	127.10	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Pigsty	662.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	1,153.92	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Contingency (10%)	115.39	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Subtotal	$1,269.31	$6.60	$6.60	$6.60	$6.60	$6.60	$6.60	$6.60	$6.60
Variable Costs									
Feeder Pigs	$723.00	$1,446.00	$723.00	$1,446.00	$723.00	$1,446.00	$723.00	$1,446.00	$723.00
Feed	1,125.00	2,250.00	1,125.00	2,250.00	1,125.00	2,250.00	1,125.00	2,250.00	1,125.00
Medications	30.15	60.30	60.30	60.30	60.30	60.30	60.30	60.30	60.30
Crop Insurance	40.00	80.00	40.00	80.00	40.00	80.00	40.00	80.00	40.00
Transportation	65.00	250.00	125.00	250.00	125.00	250.00	125.00	250.00	125.00
Interest Working Cap.	178.48	367.77	186.60	367.77	186.60	367.77	186.60	367.77	186.60
Taxes	0.00	176.80	88.40	176.80	88.40	176.80	88.40	176.80	88.40
Subtotal	$2,161.63	$4,630.87	$2,348.30	$4,630.87	$2,348.30	$4,630.87	$2,348.30	$4,630.87	$2,348.30
Total Cost	$3,430.95	$4,637.47	$2,354.90	$4,637.47	$2,354.90	$4,637.47	$2,354.90	$4,637.47	$2,354.90
Gross Returns	$0.00	$4,684.40	$2,342.20	$4,684.40	$2,342.20	$4,684.40	$2,342.20	$4,684.40	$2,342.20
Net Returns To Capital, Land And Management (Without Operator's Labor)	($3,430.95)	$46.93	($12.70)	$46.93	($12.70)	$46.93	($12.70)	$46.93	($12.70)
Operator's Labor									
Hogs	$16.00	$32.00	$16.00	$32.00	$16.00	$32.00	$16.00	$32.00	$16.00
Net Returns to Capital and Land	($3,446.95)	$14.93	($28.70)	$14.93	($28.70)	$14.93	($28.70)	$14.93	($28.70)

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Residual value
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
6.00	376.00	6.00	96.00	6.00	96.00	286.00	96.00	6.00	96.00	6.00	2.25
0.00	3,871.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2,100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	6,347.70	6.00	96.00	6.00	96.00	286.00	96.00	6.00	96.00	6.00	2.25
0.60	634.77	0.60	9.60	0.60	9.60	28.60	9.60	0.60	9.60	0.60	0.23
$6.60	$6,982.47	$6.60	$105.60	$6.60	$105.60	$314.60	$105.60	$6.60	$105.60	$6.60	$2.48
$960.00	$960.00	$960.00	$960.00	$960.00	$960.00	$960.00	$960.00	$960.00	$960.00	$960.00	$0.00
$4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	4,735.00	0.00
81.60	81.60	81.60	81.60	81.60	81.60	81.60	81.60	81.60	81.60	81.60	0.00
176.00	176.00	176.00	176.00	176.00	176.00	176.00	176.00	176.00	176.00	176.00	0.00
166.00	166.00	166.00	166.00	166.00	166.00	166.00	166.00	166.00	166.00	166.00	0.00
11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21	0.00
551.68	551.68	551.68	551.68	551.68	551.68	551.68	551.68	551.68	551.68	551.68	0.00
$6,681.49	$6,681.49	$6,681.49	$6,681.49	$6,681.49	$6,681.49	$6,681.49	$6,681.49	$6,681.49	$6,681.49	$6,681.49	$0.00
$6,688.09	$13,663.96	$6,688.09	$6,787.09	$6,688.09	$6,787.09	$6,996.09	$6,787.09	$6,688.09	$6,787.09	$6,688.09	$0.00
$7,687.12	$7,687.12	$7,687.12	$7,687.12	$7,687.12	$7,687.12	$7,687.12	$7,687.12	$7,687.12	$7,687.12	$7,689.60	$0.00
$999.03	($5,976.84)	$999.03	$900.03	$999.03	$900.03	$691.03	$900.03	$999.03	$900.03	$1,001.50	$0.00
$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$1,570.00	$0.00
($570.97)	($7,546.84)	($570.97)	(669.97)	($570.97)	($669.97)	($878.97)	($669.97)	($570.97)	($669.97)	($568.50)	$0.00

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Residual value
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
6.00	127.10	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	2.25
0.00	662.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	789.22	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	2.25
0.60	78.92	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.00
$6.60	$868.14	$6.60	$6.60	$6.60	$6.60	$6.60	$6.60	$6.60	$6.60	$6.60	$2.25
$1,446.00	$723.00	$1,446.00	$723.00	$1,446.00	$723.00	$1,446.00	$723.00	$1,44600	$723.00	$1,446.00	$557.25
2,250.00	1,125.00	2,250.00	1,125.00	2,250.00	1,125.00	2,250.00	1,125.00	2,250.00	1,125.00	2,250.00	877.50
60.30	60.30	60.30	60.30	60.30	60.30	60.30	60.30	60.30	60.30	60.30	0.00
80.00	40.00	80.00	40.00	80.00	40.00	80.00	40.00	80.00	40.00	80.00	0.00
250.00	125.00	250.00	125.00	250.00	125.00	250.00	125.00	250.00	125.00	250.00	0.00
367.77	186.60	367.77	186.60	367.77	186.60	367.77	186.60	367.77	186.60	367.77	0.00
176.80	88.40	176.80	88.40	176.80	88.40	176.80	88.40	176.80	88.40	176.80	0.00
$4,630.87	$2,348.30	$4,630.87	$2,348.30	$4,630.87	$2,348.30	$4,630.87	$2,348.30	$4,630.87	$2,348.30	$4,630.87	$1,434.75
$4,637.47	$3,216.44	$4,637.47	$2,354.90	$4,637.47	$2,354.90	$4,637.47	$2,354.90	$4,637.47	$2,354.90	$4,637.47	$0.00
$4,684.40	$2,342.20	$4,684.40	f$2,342.20	$4,684.40	$2,342.20	$4,684.40	$2,342.20	$4,684.40	$2,342.20	$6,121.40	$0.00
$46.93	($874.24)	$46.93	($12.70)	$46.93	($12.70)	$46.93	($12.70)	$46.93	($12.70)	$1,483.93	$0.00
$32.00	$16.00	$32.00	$16.00	$32.00	$16.00	$32.00	$16.00	$32.00	$16.00	$32.00	$0.00
$14.93	($890.24)	$14.93	($28.70)	$14.93	($28.70)	$14.93	($28.70)	$14.93	($28.70)	$1,451.93	$0.00

TABLE 31. FLOW OF INCREMENTAL NET BENEFITS FOR DUCK ENTERPRISE

Financial item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Fixed Costs									
Storage Shed	$364.70	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Equipment	105.00	6.00	6.00	6.00	26.00	16.00	6.00	6.00	26.00
Corral	540.30	0.00	0.00	0.00	0.00	540.30	0.00	0.00	0.00
Subtotal	1,010.00	6.00	6.00	6.00	26.00	556.30	6.00	6.00	26.00
Contingency (10%)	101.00	0.60	0.60	0.60	2.60	55.63	0.60	0.60	2.60
Subtotal	$1,111.00	$6.60	$6.60	$6.60	$28.60	$611.93	$6.60	$6.60	$28.60
Variable Costs									
Ducklings[1]	$148.50	$297.00	$297.00	$297.00	$297.00	$297.00	$297.00	$297.00	$297.00
Feed[1]	600.60	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20
Marketing	161.19	322.38	322.38	322.38	322.38	322.38	322.38	322.38	322.38
Interest Working Cap.	81.93	163.85	163.85	163.85	163.85	163.85	163.85	163.85	163.85
Subtotal	$992.22	$1,984.43	$1,984.43	$1,984.43	$1,984.43	$1,984.43	$1,984.43	$1,984.43	$1,984.43
Total Cost	$2,103.22	$1,991.03	$1,991.03	$1,991.03	$2,013.03	$2,596.36	$1,991.03	$1,991.03	$2,013.03
Gross Returns	$815.47	$1,630.94	$1,630.94	$1,630.94	$1,630.94	$1,630.94	$1,630.94	$1,630.94	$1,630.94
Net Returns to Capital, Land And Management (Without Operator's Labor)	($1,287.75)	($360.09)	($360.09)	($360.09)	($382.09)	($965.42)	($360.09)	($360.09)	($382.09)
Operator's Labor									
Ducks	$229.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00
Net Returns to Capital and Land	($1,516.75)	($804.09)	($804.09)	($804.09)	($826.09)	($1,409.42)	($804.09)	($804.09)	($826.09)

[1]Includes transport.

TABLE 32. FLOW OF INCREMENTAL NET BENEFITS FOR CATTLE ENTERPRISE.

Financial item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Fixed Costs									
Storage Shed	$364.70	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Equipment	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Corral	381.11	0.00	0.00	0.00	0.00	381.11	0.00	0.00	0.00
Fence Improvement	759.00	0.00	0.00	0.00	0.00	459.00	0.00	0.00	0.00
Pasture Re-estab.	380.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	1,890.81	6.00	6.00	6.00	6.00	846.11	6.00	6.00	6.00
Contingency (10%)	189.08	0.60	0.60	0.60	0.60	84.61	0.60	0.60	0.60
Subtotal	$2,079.89	$6.60	$6.60	$6.60	$6.60	$930.72	$6.60	$6.60	$6.60
Variable Costs									
Stockers	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00
Feed	254.08	254.08	254.08	254.08	254.08	254.08	254.08	254.08	254.08
Crop Insurance	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00
Transportation	240.00	480.00	480.00	480.00	480.00	480.00	480.00	480.00	480.00
Interest Working Cap.	507.97	529.57	529.57	529.57	529.57	529.57	529.57	529.57	529.57
Subtotal	$6,152.05	$6,413.65	$6,413.65	$6,413.65	$6,413.65	$6,413.65	$6,413.65	$6,413.65	$6,413.65
Total Costs	$8,231.94	$6,420.25	$6,420.25	$6,420.25	$6,420.25	$7,344.37	$6,420.25	$6,420.25	$6,420.25
Gross Returns	$0.00	$6,840.00	$6,840.00	$6,840.00	$6,840.00	$6,840.00	$6,840.00	$6,840.00	$6,840.00
Net Returns to Capital, Land And Management (Without Operator's Labor)	($8,231.94)	$419.75	$419.75	$419.75	$419.75	($504.37)	$419.75	$419.75	$419.75
Operator's Labor	$96.00	$192.00	$192.00	$192.00	$192.00	$192.00	$192.00	$192.00	$192.00
Net Returns to Capital And Land	($8,327.94)	$227.75	$227.75	$227.75	$227.75	($696.37)	$227.75	$227.75	$227.75

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Residual value
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
6.00	91.00	6.00	26.00	6.00	6.00	16.00	20.00	6.00	6.00	6.00	2.25
0.00	540.30	0.00	0.00	0.00	0.00	540.30	0.00	0.00	0.00	0.00	0.00
6.00	631.30	6.00	26.00	6.00	6.00	556.30	20.00	6.00	6.00	6.00	2.25
0.60	63.13	0.60	2.60	0.60	0.60	55.63	2.00	0.60	0.60	0.60	0.23
$6.60	$694.43	$6.60	$28.60	$6.60	$6.60	$611.93	$22.00	$6.60	$6.60	$6.60	$2.48
$297.00	$297.00	$297.00	$297.00	$297.00	$297.00	$297.00	$297.00	$297.00	$297.00	$297.00	$0.00
1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	1,201.20	0.00
322.38	322.38	322.38	322.38	322.38	322.38	322.38	322.38	322.38	322.38	322.38	0.00
163.85	163.85	163.85	163.85	163.85	163.85	163.85	163.85	163.85	163.85	163.85	0.00
$1,984.43	$1,984.43	$1,984.43	$1,984.43	$1,984.43	$1,984.43	$1,984.43	$1,984.43	$1,984.43	$1,984.43	$1,984.43	$0.00
$1,991.03	$2678.86	$1,991.03	$2,013.03	$1,991.03	$1,991.03	$2,596.36	$2,006.43	$1,991.03	$1,991.03	$1,991.03	$0.00
$1,630.94	$1,630.94	$1,630.94	$1,630.94	$1,630.94	$1,630.94	$1,630.94	$1,630.94	$1,630.94	$1,630.94	$1,635.67	$0.00
($360.09)	($1,047.92)	($360.09)	($382.09)	($360.09)	($360.09)	($965.42)	($375.49)	($360.09)	($360.09)	($355.37)	$0.00
$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00	$0.00
($804.09)	($1,491.92)	($804.09)	($826.09)	($804.09)	($804.09)	($1,409.42)	($819.49)	($804.09)	($804.09)	($799.37)	$0.00

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Residual value
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	0.00	0.00
0.00	381.11	0.00	0.00	0.00	0.00	381.11	0.00	0.00	0.00	0.00	0.00
0.00	459.00	0.00	0.00	0.00	0.00	459.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	285.00
6.00	846.11	6.00	6.00	6.00	6.00	846.11	6.00	6.00	6.00	6.00	285.00
0.60	84.61	0.60	0.60	0.60	0.60	84.61	0.60	0.60	0.60	0.60	0.00
$6.60	$930.72	$6.60	$6.60	$6.60	$6.60	$930.72	$6.60	$6.60	$6.60	$6.60	$285.00
$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$0.00
254.08	254.08	254.08	254.08	254.08	254.08	254.08	254.08	254.08	254.08	254.08	0.00
150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	0.00
480.00	480.00	480.00	480.00	480.00	480.00	480.00	480.00	480.00	480.00	480.00	0.00
529.57	529.57	529.57	529.57	529.57	529.57	529.57	529.57	529.57	529.57	529.57	0.00
$6,413.65	$6,413.65	$6,413.65	$6,413.65	$6,413.65	$6,413.65	$6,413.65	$6,413.65	$6,413.65	$6,413.65	$6,413.65	$0.00
$6,420.25	$7,344.37	$6,420.25	$6,420.25	$6,420.25	$6,420.25	$7,344.37	$6,420.25	$6,420.25	$6,420.25	$6,420.25	$0.00
$6,840.00	$6,840.00	$6,840.00	$6,840.00	$6,840.00	$6,840.00	$6,840.00	$6,840.00	$6,840.00	$6,840.00	$7,125.00	$0.00
$419.75	($504.37)	$419.75	$419.75	$419.75	$419.75	($504.37)	$419.75	$419.75	$419.75	$704.75	$0.00
$192.00	$192.00	$192.00	$192.00	$192.00	$192.00	$192.00	$192.00	$192.00	$192.00	$192.00	$0.00
$227.75	(696.37)	$227.75	$227.75	$227.75	$227.75	($696.37)	$227.75	$227.75	$227.75	$512.75	$0.00

TABLE 33. DESCRIPTION OF OPERATOR'S LABOR

Activity	Year	Time
A. Daily pond maintenance and water control	1	1.5 hr./day for 6 months (production begins July 1)
	2,5,8,11,etc.	1.5 hr./day for 12 months
	3,4,6,7,9,10,etc.	1.5 hr./day for 11 months (1 month down time)
B. Pond harvest and fingerling production	1	1.5 man-days/month for 2 months
	2,5,8,11,etc.	1.5 man-days/month for 12 months
	3,4,6,7,9,10,etc.	1.5 man-days/month for 8 months
C. Pond maintenance per cycle of production	3,4,6,7,9,10,etc.	40 man-days
D. Pond fertilization	1	Hogs: 1/2 hr./day for 4 months (1 hog cycle)
		Cattle: 2 hr./day; 4 days/week for 6 months
		Chickens: 1/2 hr./day for 6 months
		Ducks: 0
	Even years	Hogs: 1/2 hr./day for 8 months (2 hog cycles)
	Odd years	Hogs: 1/2 hr./day for 4 months (1 hog cycle)
	2,5,8,11,etc.	Cattle: 2 hr./day; 4 days/week for 12 months
		Chickens: 1/2 hr./day for 12 months
	3,4,6,7,9,10,etc.	Cattle: 2 hr./day; 4 days/week for 11 months
		Chickens: 2 hr./day; 4 days/week for 11 months
E. Ducks		
production	1-20	6.5 man-days/year
processing	1	100 man-days (1 cycle)
	2-20	200 man-days (2 cycles)
F. Chickens	1	2 persons full-time (6 months)
	2-20	2 persons full-time (12 months)
G. Hogs	Odd years	1/2 hr./day for 4 months
	Even years	1/2 hr./day for 8 months

TABLE 35. RATES OF RETURN

Alternative	Without operator's labor		With operator's labor	
	B/. 0.40/lb.[1]	B/. 0.60/lb.	B/. 0.40/lb.	B/. 0.60/lb.
Fish only				
Fish-chicken	14	24	6	16
Fish-hogs	13	22	6	15
Fish-ducks	23	38	17	31
Fish-cattle	9	16	-1	7
Integrated				
Fish-chicken	10	14	-23	-15
Fish-hogs	6	11	1	7
Fish-ducks	8	20	-12	3
Fish-cattle	2	5	-2	1
Livestock only				
Chickens	5		neg. returns	
Hogs	-6		-7	
Ducks	neg. returns		neg. returns	
Cattle	-4		-10	

[1]Cost of fish/lb.

TABLE 34. VALUE OF OPERATOR'S LABOR BY YEAR AND ENTERPRISE

Year	Hogs		Chickens		Cattle		Ducks	
	Man-days	$[1]	Man-days	$[1]	Man-days	$[1]	Man-days	$[1]
1	44.5	95.68	48	103.20	61	131.15	37	79.55
2	101	217.15	108.5	233.28	134	288.10	86	184.90
3	121.5	261.22	135	290.25	158	399.70	114	245.10
4	129	277.35	135	290.25	158	339.70	114	245.10
5	93.5	201.02	108.5	233.28	134	288.10	86	184.90
6	129	277.35	135	290.25	158	339.70	114	245.10
7	121.5	261.22	135	290.25	158	339.70	114	245.10
8	101	217.15	108.5	233.28	134	288.10	86	184.90
9	121.5	261.22	135	290.25	158	339.70	114	245.10
10	129	277.35	135	290.25	158	339.70	114	245.10
11	93.5	201.02	108.5	233.28	134	288.10	86	184.90
12	129	277.35	135	290.25	158	339.70	114	245.10
13	121.5	261.22	135	290.25	158	339.70	114	245.10
14	101	217.15	108.5	233.28	134	288.10	86	184.90
15	121.5	261.22	135	290.25	158	339.70	114	245.10
16	129	277.35	135	290.25	158	339.70	114	245.10
17	93.5	201.02	108.5	233.28	134	228.10	86	184.90
18	129	277.35	135	290.25	158	399.70	114	245.10
19	121.5	261.22	135	290.25	158	399.70	114	245.10
20	101	217.15	108.5	233.28	134	288.10	86	184.90

[1]$2.15 per man-day.

SUMMARY AND CONCLUSIONS

The economics of agro-aquaculture systems is complex. Sufficient data do not exist to draw a firm conclusion on the projects. One or two years of production data are highly subject to vagaries of the weather, learning curves, and political events. The data from this project, however, do provide some important indications.

Of the animal protein alternatives considered, four of the five least-cost sources involved fish production. Values ranged from B/. 0.14 to B/. 0.25 per pound for the three least-cost fish alternatives to B/. 1.75 per pound for duck meat. Integration of fish production with other types of livestock production consistently lowered the cost per pound of animal protein produced. In the case of hogs, for example, pork production alone had a production cost of B/. 0.98 per pound but when fish were integrated with hogs, the cost dropped to B/. 0.74 per pound.

The budget analyses indicate that integrated systems in impoverished rural areas are economically viable for the farmer. The chicken-fish alternative yielded highest net returns. Integration of fish culture with other livestock enterprises increased net returns in every instance.

The rates of return for the fish-chicken, fish-hog, and fish-duck combinations, analyzing the fish enterprise in isolation, are above the 12 percent cutoff rate established as the opportunity cost of capital by the Planning Ministry in Panama.

Project data serve to provide guidelines for expansion of agro-aquaculture in Panama. All of the combinations are profitable, yet some combinations will be more profitable under certain conditions than under others.

Benefits following from the irrigated gardens (for which data were not available) are not included in this analysis and have the potential of greatly improving the efficiency and profitability of the integrated approach. Within the water supply developed for the animal and agriculture enterprises, irrigated gardens can be added at a minimal expense. This additional use of the facility will also improve the efficiency and profitability of the fish culture component because some portion of the fixed costs would be allocated to the garden.

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