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ECONOMIC EVALUATION OF BRAZIL AQUACULTURE PROJECT

by

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INTRODUCTION

As part of a more general appraisal of its aquaculture project in Brazil underdeveloped Northeast, Auburn University requested the assistance of the National Marine Fisheries Service, Southeast Region's economist to evaluate its economic viability and prospects for local commercialization. This report omits any treatment of the background, history, local context, technical considerations, and general overview of the project. It is understood that this economic evaluation will become part of a more general report of all aspects of the project to be prepared by the Auburn University staff.

Drs. Lovell, Rodgers, and Greenfield (NMFS economist) traveled together to Fortaleza, Brazil, as a team and worked from November 19 through December 3, 1973, with the resident Auburn staff and their DNOCS counterparts (See Itinerary, Appendix 1).

OBJECTIVES AND GOALS

The general objective of the economist's visit to the project site was to provide for the economic evaluation and business analysis necessary to judge the viability of a commercial aquaculture enterprise and to develop a concept for establishing and operating a commercial fish culture industry.

The specific goals were to:

(1) Develop a proforma profit and loss analysis and capital budget for a farmer-owned and operated production unit.

(2) Outline a plan for providing information about the marketplace on which the project depends.

(3) Assist in developing an operating concept, general plan, and schedule for proceeding to actual commercialization.

(4) Review with the Auburn-DNOCS staff alternative business and economic training options potentially available to foreign national fishery economists.

(5) Assist the Federal University of Ceara in developing a fisheries economics course.

(6) Present lectures to the Federal University of Ceara fisheries students on (a) the economics of fish culture in the DNOCS project area and (b) the business characteristics of the U.S. catfish farming industry.

(7) Provide an overall approach to economic and business analysis that is responsive to DNOCS' needs and that can be employed by the resident economist in future projects.

ACCOMPLISHMENTS

GOAL I

Economic Analysis of A Farmer-Owned Fish Culture Venture

DNOCS' field research results clearly indicated that a recent hybrid of tilapia hornorum and tilapia nilotica represent the optimum culture opportunity to date. General discussions with DNOCS personnel further confirmed the wisdom of this choice in that the species fits both the local market and the irrigation development plans of DNOCS. Although this species could be cultured in the smaller irrigation or livestock reservoirs, the primary opportunity is in the construction of fish culture ponds to be operated by smaller farmers (colonists), (1) as part of a general crop system, or (2) as a discreet agricultural project on lands below the larger irrigation reservoirs less suitable for terrestial crop farming.

The economic evaluation was based upon a concept where each farmer would build and operate a single, 1 hectare pond on land that would be provided on a long-term lease or grant arrangement. No cost would be incurred by the farmer for the unimproved land itself. All other costs of improvements and operations to be incurred by the farmer were budgeted, including certain costs presently borne as subsidies by DNOCS. It is important for DNOCS to see the actual economic consequences of the project to the farmer, whether or not DNOCS ultimately decides to transfer all real costs directly to the farmer.

Initially, it is assumed that each farmer will harvest and market his own fish. There are several small cities within a 50 kilometer radius of most of DNOCS' major reservoirs under consideration as water sources for fish culture. All of these markets handle at least some quantity of wild fish 6 days a week and all are open to direct fisherman sales.

In most markets, Saturday accounts for the major volume. It is assumed that the farmers' harvests could be scheduled over a 2-week period, embracing three Saturday markets, by seining twice before draining the pond for the last harvest. It is further assumed that DNOCS would be in a position to operate a hatchery, sell farmers their fingerling requirements at cost and assist them in acquiring access to feedstuffs. The farmers would be part of a general agricultural cooperative in their development district and DNOCS would plan to assist farmers by supplying the cooperative with fingerlings, technical extension assistance, and feed purchasing advice. The cooperative would endeavor to help farmers schedule their harvests so production would be staggered over the year. The nonseasonality of the climate and predictability of the weather should make harvest scheduling relatively easy.

Investment

Assuming that raw land is available to the farmer without cost and that the pond unit could be located adjacent to an irrigation lateral, an adequate operating unit could be constructed at a total cost of about CR$ 17,000 per hectare. In addition to pond and water system construction, only a nominal amount of operating equipment is required. A simple metal or tile roofed shelter to protect feed supplies from the weather, a seine, and a few hand tools are all that is required.

Table I

Direct Investment

	CR$/Hectare
Fixed	
Unimproved land	0
Pond and water system improvements	15,935
Feed shelter	300
Other	
Seine	500
Misc. tools and equipment	150
Total	16,885

Costs

Conservative estimates were made for all costs to be incurred by the farmer, both fixed and variable.

Table II

	Annual Cost CR$/Hectare
I. Fixed	
A. DNOCS administrative surcharge	111
B. Pond and equipment maintenance	350
C. Amortization, real estate	1,514
D. Amortization, personal property	112
II. Variable	**Monthly Unit Costs**
A. Start-up costs:	
1. Initial fertilization, 60 Kg triplesuperphosphate at CR$ 1.33	CR$ 80
2. Water cost, initial filling	212
3. Fingerlings, 9,000 @ CR$ .06 (20 gm each)	540

B. Operating Costs:

1. Feed cost @ 25.4 days feeding at 3 percent of last month's body weight with feed priced at $ .32/Kg

Month	Cost Per Month	Accumulative Cost
1	CR$ 45	CR$ 45
2	150	195
3	211	406
4	262	668
5	325	993
6	434	1,427
7	541	1,968
8	650	2,618
9	758	3,376
10	860	4,236
11	958	5,194
12	1,048	6,242

2. Interest on working capital

Month	Cash Outlay	Accumulative Cash Outlay	Monthly Interest
1	CR$ 1,203	CR$ 1,203	CR$ 18
2	494	1,697	25
3	544	2,241	34
4	596	2,837	43
5	660	3,497	52
6	770	4,267	64
7	879	5,146	77
8	989	6,135	92
9	1,099	7,234	109
10	1,209	8,443	127
11	1,319	9,762	146
12	1,429	11,191	168

3. Water, to replace evaporation CR$35

4. Fertilizer, 60 Kg at CR$ 1.33 per Kg CR$80

5. Operator's labor CR$26

6. Misc. & contingencies CR$20

7. Harvesting and marketing costs:

   a. The DNOCS surcharge presently is a function (1%) of gross revenue. The basis for charging farmers for DNOCS support services is subject to considerable revision and may become a function of acreage. Since acreage is more closely associated with actual DNOCS expense than gross income, it was arbitratily assumed that this would become fact. The surcharge, therefore, is treated as a fixed cost.

   b. Hauling expense was based on the assumption that the farmer already owns a vehicle and that fish hauling is a marginal expense based on unused, surplus vehicle time:

Gasoline: 80 Km/trip @ 5 Km/l @CR$. 7719, 3 trips/harvest, 2 harvests/year	$ 64
Added truck maintenance	50
Farmer's labor, 6 days @CR$10	60
Total	CR$ 174

It would seem likely that cattle manure would be the lowest cost source of enrichment for fish culture in irrigated areas where livestock are part of the general farming scheme. Surprisingly, in the rare instances where manure is sold on the open market, it appears to have a higher value in crop agriculture where its organic content is an important advantage. Chemical inorganic fertilizer is budgeted for this project on a least cost basis, acknowledging that individual farmers may choose to use animal manure where its value in other applications is low.

DNOCS preferred to treat debt servicing, both principle and interest, as a fixed cost. Labor furnished by the farmer and his family is treated as a variable cost at the prevailing rate for semi-skilled agricultural labor. Net income or profit would then reflect cash income accruing to the farmer as a return to his management and risk.

Total benefit to the farmer and his family will be the sum of his net income (or profit), his increase in equity (capital gain) arising from payments of principle on his debt, and operator's (family) labor income.

Analysis

Although the optimum choice of species for culture in the DNOCS service area is already clear, research is not yet complete and the optimum growing period is yet to be determined. Growth rates have remained almost linear through the first 8 months. Moreover, there appears to be little price discrimination among sizes of individual fish in the marketplace. A proforma optimization analysis was prepared from the actual growth rates through 8 months, together with conservative estimates of what might be expected in the remaining 4 months of the year. Some reduction in the rate of growth is expected to occur during this period.

There is always question about the applicability of experimental results to actual field conditions. This experiment, however, is being conducted under circumstances very much like actual field conditions. Even a minimum extension effort by the cooperative should insure that farmers feed and fertilize on schedule. Dissolved oxygen level and other water conditions have been as adverse and variable in the experimental ponds as can be expected under field conditions. Almost no further habitat management is required of the farmer beyond maintenance of reasonable water levels.

Some variation might be introduced when ponds are scaled up to a full hectare in size. Feed and fertilizer almost certainly will be less evenly distributed than in the experimental ponds. Security conditions are also likely to be less stringent and theft may become a major area of loss. Both problems lend themselves to solution, however, through careful management and training. Neither problem involves any difficult concepts and it should be relatively easy to make farmers conscious of these potential problems.

There appear to be relatively few areas of risk likely to become catastrophic in nature. With proper engineering, flooding should not be a problem. There are no known disease, parasite, or predator problems capable of becoming uncontrollable. Water conditions are already as adverse under experimental conditions as they are likely to become at any time under field conditions. There appears to be an appreciation of the potential danger to fish from crop pesticide use and it is likely to be only a minor risk in areas where fish culture will be encouraged.

Although a number of other minor risks could be cited, there should be relatively little change in risk or culture conditions in moving up from experimental to commercial scale operations.

The following budget was prepared to illustrate a format for analysis, approximating as closely as possible expected growth response and its impact on cost, income, and profit. It is already clear that a farm business based upon actual results would break even during the fourth month of operations (See Table 3 and Figure 1).

Gross income and total cost figures for each month were computed assuming that the crop was terminated, harvesting and marketing expenses incurred, and income from sales realized at that point. Costs are accumulative and income is based on the accumulative weight of the fish and their value at that size. Marginal income and marginal cost for each month were computed as the added income and cost resulting from delaying harvest one more month.

Table III

OPTIMIZATION ANALYSIS
(Per Hectare)

	Month	Weight 1/ Based on Original Stocking	Weight 1/ Adjusted for 10% Mortality	Unit Value or Price per Kg 2/	Gross Income 3/	Marginal Income 4/	Fixed Cost	Variable Cost	Total Cost	Marginal Cost 5/	Net Income or Profit 6/
	Start	184 Kg	166 Kg	CR$ 2.9	CR$ 480	CR$ -	CR$ -	CR$ 1,006	CR$ 1,006	CR$ -	CR$ -526
Actual	1	613	552	1.0	552	72	174	1,307	1,481	475	-929
	2	865	779	1.5	1,168	616	348	1,625	1,973	492	-805
	3	1,075	968	2.2	2,127	959	522	2,006	2,528	555	-401
	4	1,332	1,199	3.0	3,597	1,470	696	2,438	3,134	606	463
	5	1,780	1,602	3.3	5,287	1,690	870	2,933	3,803	669	1,484
	6	2,219	1,997	3.4	6,790	1,503	1,044	3,540	4,584	781	2,206
	7	2,668	2,401	3.5	8,404	1,614	1,218	4,255	5,473	889	2,931
	8	3,108	2,797	3.6	9,790	1,386	1,392	5,081	6,473	1,000	3,317
Estimated	9	3,528	3,175	3.6	11,430	1,640	1,566	6,017	7,583	1,110	3,847
	10	3,928	3,535	3.6	12,726	1,296	1,740	7,056	8,796	1,213	3,930
	11	4,298	3,868	3.6	13,925	1,199	1,914	8,194	10,108	1,312	3,817
	12	4,628	4,165	3.6	14,994	1,069	2,087	9,425	11,512	1,404	3,482

Footnotes to Table III:

1/ The sum of fish weights at the end of the month of both experimental ponds #23 and #25 was multiplied by 14.3 to obtain weight in KG/Ha.

2/ The average size of fish was obtained by dividing total weight per hectare by the stocking rate. Market value was estimated from field observations of local retail and wholesale markets.

3/ Gross revenue is obtained by multiplying total weight by unit value.

4/ The previous month's gross revenue was subtracted from the current month's gross revenue to obtain marginal income.

5/ Marginal cost was obtained by subtracting the previous month's total cost.

6/ Net income, or profit, is obtained by subtracting total cost from gross income.

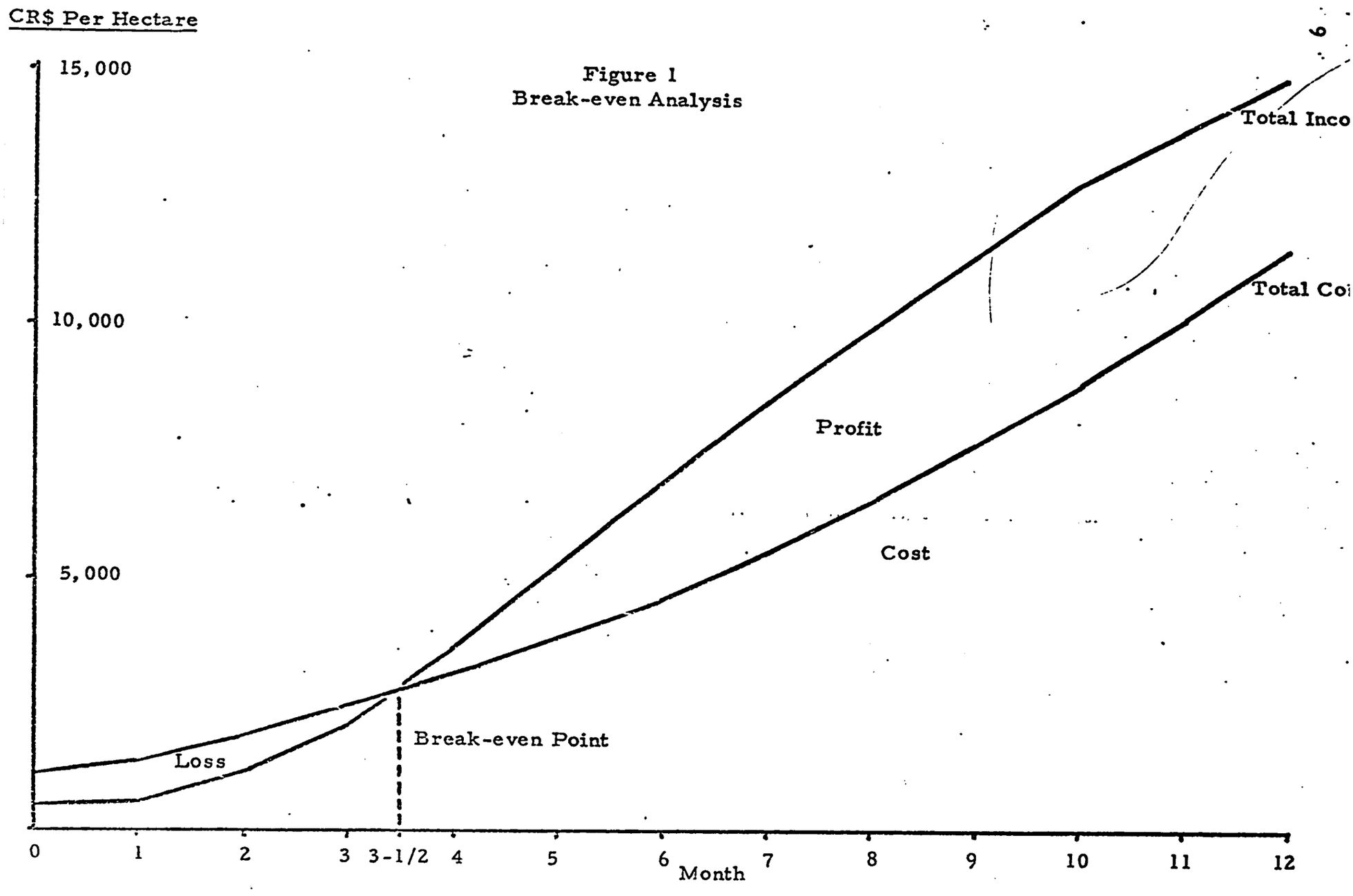


Figure 1
Break-even Analysis

If the projection of growth rate is approximately correct, this analysis would indicate an optimum growing period of about 10-1/3 months. At this point, net income (or profit) is maximized (see Table III and Figure 2) and marginal income is equal to marginal cost.

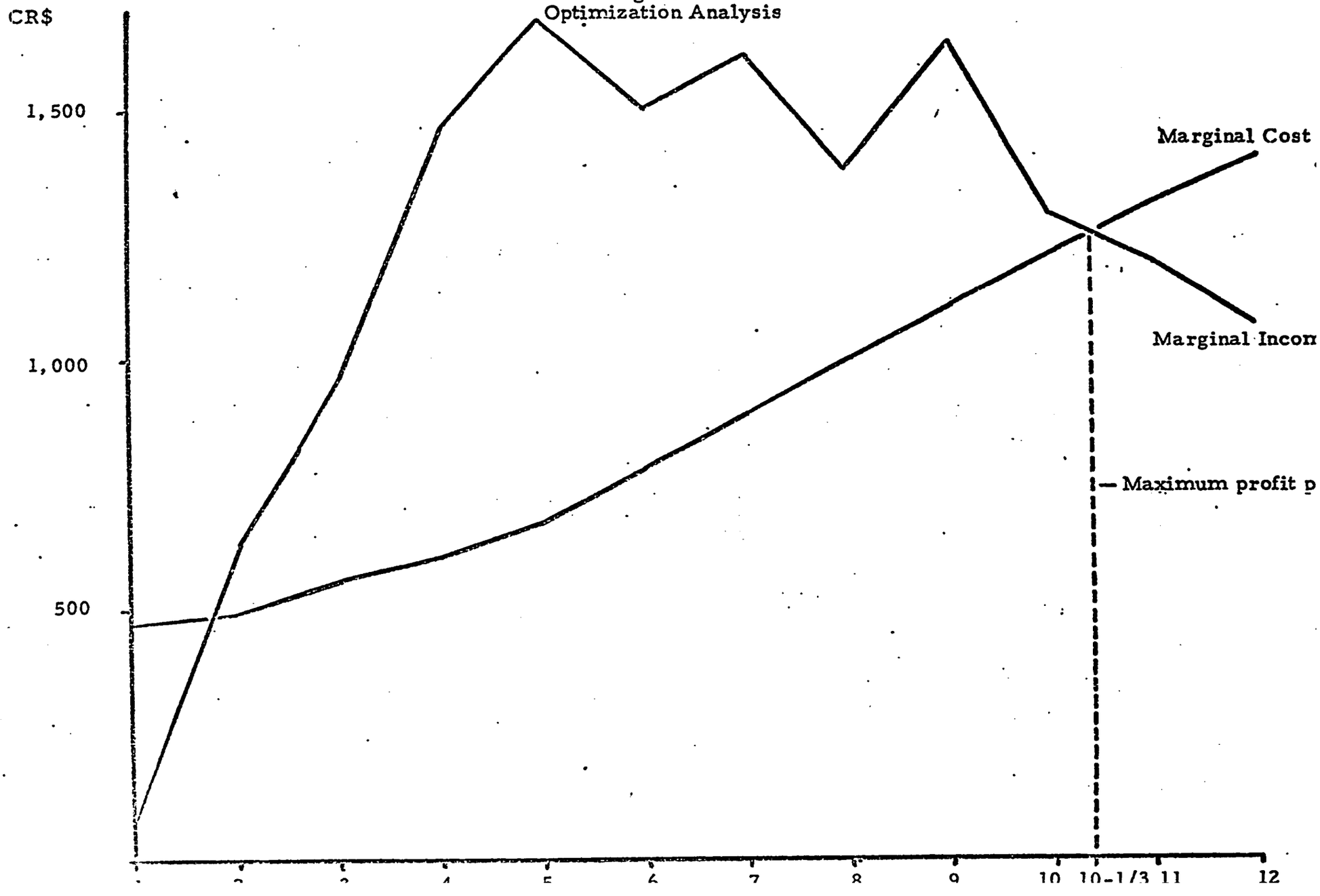
This analysis should be updated at the end of each month as actual data from the experiment beyond 8 months are available. Assuming that the pond remains dry for the remainder of the 11th month, a new crop cycle could begin with the 12th month. The following proforma profit and loss statement (See Table IV) would apply to a farmer growing one hectare of fish on an 11-month production cycle.

Table IV

Profit and Loss Analysis

Fixed Cost	11-Month Production Cycle	Annual Basis
DNOCS Administrative Surcharge	CR$ 102	CR$ 111
Pond and Gear Maintenance	321	350
Amortization, Real Estate	1,388	1,514
Amortization, Equipment	103	112
Total Fixed Cost	1,914	2,087
Variable Cost		
Feed	CR$ 4,476	CR$ 4,883
Fertilizer	820	895
Water	571	623
Fingerlings	540	589
Interest on Working Capital	146	159
Operator's Labor	286	312
Hired Harvesting Labor	42	46
Hired Pond Bottom Maintenance Labor	35	38
Hauling and Marketing Expense	174	190
Misc. and Contingencies	220	240
Total Variable Cost	7,310	7,975
Total Cost	CR$ 9,224	CR$10,062
Total Income @ $3.6/Kg	$13,726	$14,974
Profit	4,502	4,912

Figure 2
Optimization Analysis



The impact of this kind of fish culture enterprise on the earning capacity of the farmer is profound. In addition to a substantial operating profit of CR$ 4,912, the farmer also receives a small cash income of CR $312 for his own labor. In addition, he benefits from a capital gain averaging almost CR$ 800 per year from payment of principle on real estate debt. Cash income and capital gain total about CR$ 6,000 per year (See Table V

Excluding labor income, the enterprise produces total income of CR$ 5,709 from profit and capital gains. This is an annual rate of return of 34 percent on a total investment in plant and equipment of CR$ 16,855. Considering the fact that this venture involves no more risk, and perhaps less than terrestial crop agriculture, this rate of return is extremely attractive. Although no comparable rates of return are available for terrestial crops, they are probably much lower.

Table V

Potential Impact on The Farmer's Income

Cash Income	CR$/Year
Return to personal labor	312
Profit	4,912
Total Cash Income	5,224
Capital Gain	
Average annual increase in real estate equity	797
Total Income	$6,021

GOAL II

The need for further research to document the nature of demand for tilapia was discussed with the DNOCS staff and the New Mexico staff in support of the University of the Northeast. It was generally decided that the major marketing variables were, in order of importance: (1) the effect of price on quantity purchased, (2) the effect of volume on price, (3) the effect of size of individual fish on price, and (4) the effect of degree of freshness on price. Although the specific projects to determine the effect of these variables will be developed as individual Master's Degree projects at the University, one rough design was developed to illustrate the general type of study that is to be conducted. A copy of these notes is attached as Appendix II.

GOAL III

The need for scheduling the sequence of activities and events involved in each of the major project functions was emphasized. Although Dr. Lovshin was out of the country at the time of these discussions, some notes of our tentative thinking were left for his consideration (See Appendix III). Mr. Jensen planned to discuss the need for developing a planning regime with Dr. Lovshin upon his return.

GOAL IV

The desirability of adapting one of the USDA training programs each year or two for specific application to fish culture economics was strongly endorsed. The resident DNOCS economist and a newly acquired professor of economics on the University staff would be immediate candidates. I am confident that the DNOCS economist could benefit immediately from this kind of program.

GOAL V

Course and curriculum outlines for fishery economics, a list of texts and references, and a guide to all U.S. programs in natural resource economics were mailed to Mr. Jensen in early January as requested by the head of the Department of Economics at the University. It was suggested that half the course emphasis be devoted to the economic analysis, management, and development of Ceara's natural fishery resources and half to the development of fish culture enterprises.

GOAL VI

The lectures were part of a full day of presentations by all three visiting Auburn staff members. They were well attended and generated considerable discussion and dialogue.

GOAL VII

The resident DNOCS economist has already taken the analysis represented in this report under Goal I and rewritten it in his own format in Portugese. There is every indication that with some added incentive from the acceptance of his present work, he can expand his analysis to other projects in the future. For example, there will be a need to analyze a cooperative support business, to supply feed and fingerlings to farmers and to assist in the scheduling of production. The size of this unit will depend upon the configuration of each production project DNOCS sponsors. The initial project may include only 10 to 20 farmers in a single irrigation project, where there may or may not be an existing cooperative. This level of analysis must await a decision to sponsor a specific development at a known location. It is enough, at present, to know that the enterprise can be very profitable at the farmer level.

There will eventually be a need to evaluate the macro effects of fish culture development on the total economy of the State of Ceara and the Northeast. As fish culture grows, elasticity of demand will require much more study.

Plans were made to include the DNOCS economist as a co-author for a popular article based on this project in the Catfish Farmers' magazine. Mr. Jensen will coordinate this project by subbesting appropriate authorship and arranging for introductory, descriptive augmentation of the analysis presented in this report under Goal I.

Appendix I

ITINERARY

November 20, 1973	Arrived Fortaleza, Ceara, DNOCS staff meetings
November 21, 1973	Visit to agricultural irrigation project--conference with cooperative staff, Morada Nova, Ceara
November 22, 1973	Visit to DNOCS fiedl research station, Pentacoste, Ceara
November 23, 1973	DNOCS Office, Fortaleza, Ceara
November 26, 1973	DNOCS Office, Fortaleza, Ceara
November 27, 1973	Lectures, Federal University of Ceara
November 28, 1973	DNOCS Office, Fortaleza, Ceara
November 29, 1973	DNOCS Office, Fortaleza, Ceara
November 30, 1973	DNOCS Office, Fortaleza, Ceara

Appendix II

Test to Determine Price Quanitity

Relationships for Tilapia

OBJECTIVE

To establish the relationship between price and quantity sold in the aggregate, and per capita, among the rural and small city dwellers of the Northeast; within the range of 2 and 6 CR$ per kilogram.

TEST DESIGN & METHODOLOGY

Compare quantity response to price changes under two pricing strategies, one where price is increased slowly then reduced rapidly, and, one where price is reduced slowly then increased rapidly. Both strategies are to be compared with a control where price does not vary. The experiment begins with a familiarization period of 4 weeks followed by a series of 8 weekly price changes. The experimental matrix is 3 strategies X 12 weeks X 2 replications. Quantity response to price will be measured by the time it takes to sell a known quantity of fish (25 Kg/Mkt/Mkt Day X 72 = 1,800 Kg of tilapia).

Price Strategy
(CR$/Kg)

Test City	1st four Saturdays	5th	6th	7th	8th	9th	10th	11th	12
#1(control)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.
#2	4.0	4.5	5.0	5.5	6.0	5.0	4.0	3.0	2.
#3	4.0	3.5	3.0	2.5	2.0	3.0	4.0	5.0	6.
#4(control)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.
#5	4.0	4.5	5.0	5.5	6.0	5.0	4.0	3.0	2.
#6	4.0	3.5	3.0	2.5	2.0	3.0	4.0	5.0	6.

TEST MARKET CITY REQUIREMENTS

- Small enough to have only one central fish market with a minimum of door-to-door selling.
- Known population.
- Known income parameters similar.
- One major market day for fish.
- History of stable fish volume.
- Within adequate trade radius of source of fish.
- Tilapia must be known, to some extent.

VARIABLES TO BE HELD CONSTANT

- Daily volume of tilapia (25 Kg).
- Size of tilapia (250 grams).
- Location in market.
- Selling effort and service by dealer.
- Starting time relative to market opening.
- Approximate level of competing supply.
- Size of booth or shop.

MEASUREMENTS

By Observation

- Time required to sell 25 Kg.
- Number who inquire, but don't buy.
- Number who buy.
- Size of each purchase.
- Number of each type of comment volunteered.
- Estimate of total market fish volume.

By Interview of Buyers (Customers or Consumers)

- Number of repeat purchasers.
- Previous awareness of tilapia.
- Distance to home.
- Other days on which customer bought fish this week.

Appendix III

General Planning Needs

1. Develop a plan for integrating the physical research, social research, and actual production to reach a decision in the quickest time. (See attached example.)

2. Identify individual responsibilities within the plan for each specific project.

3. Review the plan with DNOCS management for concurrence and endorsement.

4. Obtain support and commitment from other supporting agencies such as the Arizona Project.

(EXAMPLE)

TILAPIA PROJECT DEVELOPMENT PLAN

PHASE	PROJECT	DURATION	LEADER
I	1. COMPLETE CURRENT PRODUCTION RESEARCH PROJECT UNTIL GROWTH RESPONSE DECLINES SIGNIFICANTLY.	5 TO 7 MONTHS	LOVSHIN
	2. AS SOON AS GROWTH RESPONSE BEGINS TO DECLINE, ESTIMATE PRODUCTION AVAILABLE AND PLAN TEST MARKET TO DETERMINE EFFECT OF PRICE ON ~~ON VALUE OF (1) PRICE~~ ~~(2)~~ QUANTITY.	2-3 MONTHS	LIRA + ARIZONA PROJECT MS. CANDIDATE
	3. COMPLETE BASIC FEASABILITY STUDY	2 MONTHS	GREENFIELD, LIRA, ET AL
II	1. CONDUCT MARKET TEST	3-4 MONTHS	JENSEN, LIRA + ARIZONA PROJECT MS. CANDI
	2. INITIATE ANOTHER GROWTH RESPONSE PROJECT TO IMPROVE PRODUCTION EFFICIENCY.	8-14 MONTHS	LOVSHIN
III	1. BASED ON TEST MARKET RESULTS (1) CALCULATE	2 MONTHS	LIRA

OPTIMUM SIZE OF FISH AND
(2) OPTIMUM SIZE OF CENTRAL
SERVICE COOPERATIVE (IN
TERMS OF TOTAL PRODUCTION)
NECESSARY TO SERVICE
A RESERVOIR SYSTEM.

2. PRORATE COOPERATIVE COST BACK TO FARMERS AS A SERVICE FEE AND RECALCULATE FARMER'S ECONOMICS. — 1 MONTH — LIRA

3. OBTAIN APPROVAL (DNOCS) FOR BASIC CONCEPT AND TENTATIVE SITE. — 1 MONTH — LOVSHIN

IV, 1. PREPARE DETAILED CAPITAL BUDGET, PRO-FORMA OPERATING STATEMENTS, FINANCIAL PLAN, STAFFING PLAN, ACCOUNTING SYSTEM, ETC., FOR ESTABLISHING AND OPERATING THE COOPERATIVE. — 3 MONTHS — LIRA, ET AL

2. PLAN MKT. RES. TO DETERMINE EFFECT ON VALUE OF QUALITY. — 3 MONTHS — LIRA

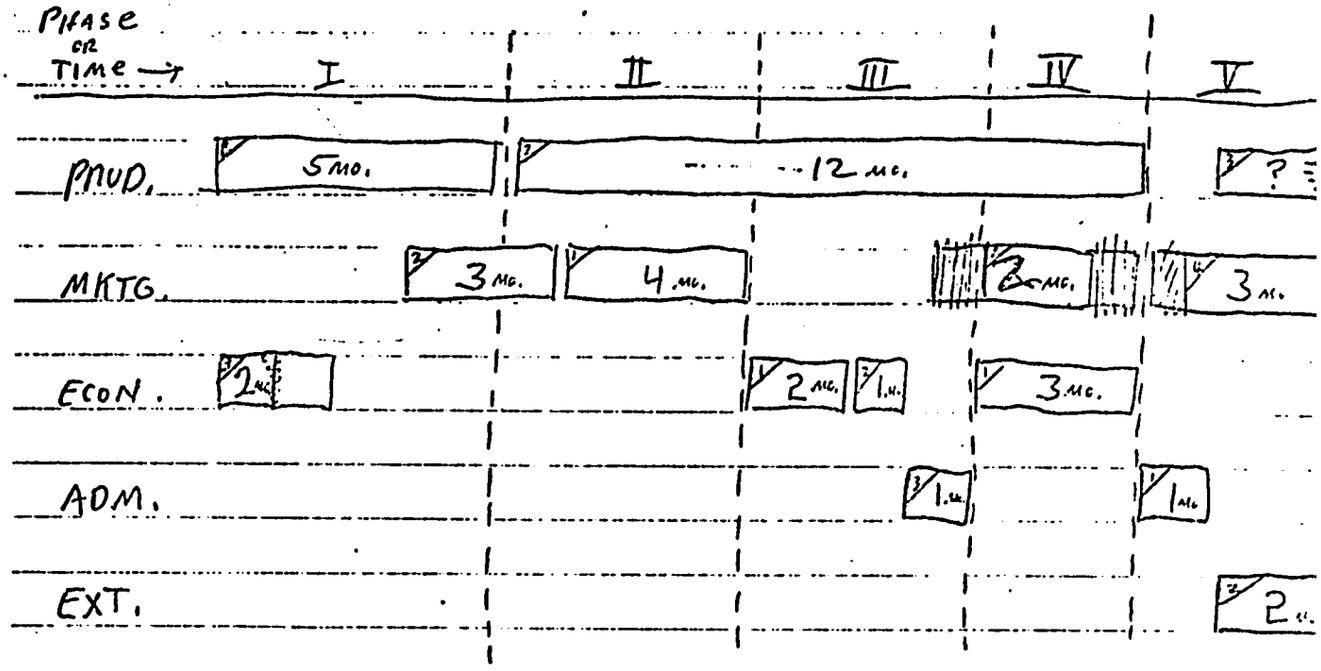
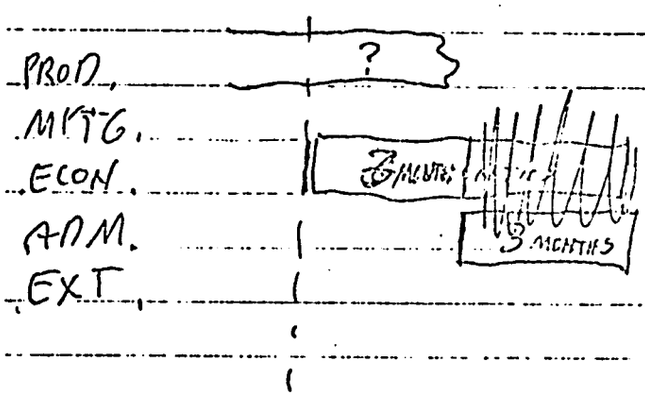
V 1. OBTAIN FINAL APPROVAL ON PROJECT (DNOCS). — 3 MONTHS — LOVSHIN

2. RECRUIT FARMERS — 2 MONTHS — JENSEN

3. PLAN & INITIATE FINGERLING PRODUCTION — ? — JENSEN, LOVSH.

	4. CONDUCT MARKET TEST	3 MONTHS	LIRA + ARIZONA PROJECT M.S. CANDIDATE
VI	1. ESTIMATE THE MACRO-ECONOMIC AND SOCIAL IMPACT ON THE STATE REGION & NATION OF PROGRAM EXPANSION	3 MONTHS	LIRA
	2. DEVELOP OVERALL NATIONAL OR REGIONAL PLAN	3 MONTHS	LIRA + DHCCS STAFF

SCHEMATIC



VI