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LESSONS FROM FISHERIES DEVELOPMENT IN WEST AFRICA

OYSTER CULTURE PROJECT, SIERRA LEONE

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PREFACE

This is one of five working papers that evaluates fisheries development projects in West Africa. Working paper # 9 presents an overview of fisheries development projects in West Africa, summarizes the conclusions of the four case studies presented in the other working papers, and suggests some recommendations for future fisheries development planning in West Africa. Working paper # 10 evaluates the purse seine/trawler construction project in Ghana, and compares the financial data obtained from the operations of the 10 vessels that were constructed by the project with the estimates made during the appraisal of the project. Working paper # 11 evaluates the oyster culture project in Sierra Leone, and discusses the possible factors that led to the non-implementation of the extension phase of the project. Working paper # 12 evaluates the artisanal fisheries project implemented at Cacheu in Guinea-Bissau, and discusses the project's contribution to employment and protein supply in Cacheu. Working paper # 13 evaluates artisanal fisheries projects in Senegal and discusses their contribution to national income and Gross National Product (GNP).

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1. Introduction and Background

As the population of Sierra Leone grows rapidly and other sources of animal protein become increasingly scarce, the sea grows more important as a potential source of animal protein. In response, the Government of Sierra Leone committed itself to increase the production of fish and other aquatic living resources in its Five-Year National Development Plan for 1974-79 (Sierra Leone Government, 1973).

The Plan emphasized development of the small scale fishery since it provides approximately 75 percent of the fish consumed locally. Synthetic fishing twine was introduced to replace the natural fibres used to make fishing nets, and outboard engines were introduced to enable fishermen to increase the range of fishing operations. Along with these developments, the government encouraged cultivation of fish farms in rural areas, and studies in other aquaculture activities. Oyster culture is one such activity which the government sought to develop in order to increase the supply of protein, and to create employment for the rural population.

Wild oysters grow on mangrove roots on the fringes of river estuaries and lagoons, and are harvested mainly by coastal fishermen. Harvesting is done on a subsistence level by fishermen and their families at low tide and during periods of low fishing activity. Mangrove roots with oysters attached are cut by men using dug-out canoes to get to the areas. The oysters are boiled in a large drum, shucked, and sold on roads adjacent to the sites, and at markets.

Oyster culture research in Sierra Leone started in 1954 with biological studies on mangrove and mud oysters by Golley-Morgan in the Bontne area (Anon, 1954; 1955). Due to high oyster mortalities in the rainy season, and inaccessibility of the area, the work was discontinued. As a result of recommendations made by two oyster culture experts from Taiwan who made a short visit to Sierra Leone in 1955 (Anon, 1955), further studies were resumed in 1956 by Hunter in the Sierra Leone River Estuary. Hunter (1969) surveyed the oyster population and identified possible culture methods. A long hiatus in oyster culture research elapsed before the next studies began in 1974. These later studies, and development efforts referred to as the Oyster Culture Project, are analysed in this paper.

One principal objective is to evaluate the Oyster Culture Project. A description of the project is presented in section 2. Section 3 contains a financial analysis of cultured oyster production by the raft method. A

socio-economic evaluation of the project is presented in section 4, and the paper concludes with a summary of results of the evaluation.

2. Description of the Project

The project consisted of three phases. Phase one was from February 1974 to May 1978, phase two from May 1978 to May 1981, and phase three was planned to last from May 1981 to 1984. The entire project spans 10 years.

a. Objectives of phase one were to increase the yield (growth rates and sizes) of local mangrove oysters and to establish a practical and economic system for oyster cultivation by identifying suitable techniques, relevant biological studies to enhance oyster production, and to establish appropriate oyster processing techniques for local market.

b. Objectives of phase two were to complete biological studies of phase one, and to undertake extension work to involve local entrepreneurs in oyster culture. The monitoring of growth rates, fouling, and other biological factors were planned to be maintained.

c. Objectives of phase three were to generate sufficient interest by private individuals in villages to undertake oyster culture, and thus spread oyster culture along the country's entire coastline.

Three groups of people are identified as principal beneficiaries: the coastal fishermen and their families in Sierra Leone, consumers of oysters in Sierra Leone, and aquaculture researchers.

Two principal sources provided funds for the project. The International Development Research Centre (IDRC) of

Canada provided U.S. \$318,500 for phases one and two, and Sierra Leone Government (SLG) provided U.S. \$114,500 for phases one and two, and U.S. \$400,000 for phase three.

The project paper justifies the project by observing that coastal villages are generally economically depressed with most of the active population engaging in small scale or subsistence fishing and farming. Therefore, oyster culture will provide additional income and employment, and make more protein available in the country.

The project inputs include:

- a. Scientific studies on the biology of oysters and culture techniques.
- b. Experimental rafts for oyster culturists.
- c. Extension activities for growing and processing oysters.

The project outputs include:

- a. Increased production of oysters due to suitable culture techniques.
- b. Improved quality of oysters by upgrading processing methods.
- c. Additional income to oyster culturists.
- d. Additional employment in coastal areas.

During phase one, four sites were established as experimental stations for culturing oysters. These sites were located at No.2 River on the west coast of Freetown Peninsula, at Jui on the east coast of Freetown Peninsula near the Bunce river, at Pothko, approximately 25 km.

north-east of Freetown on the Sierra Leone River Estuary, and at Dare, 10 km. north-east of Pothko.

The raft method was identified as the most suitable method for culturing oysters. The average growth rate of raft-cultured oysters was about three to four times greater than wild oysters. The growing period was limited to between seven and eight months because of high mortalities caused by low salinity in the rainy season. Average meat weight of raft-cultured oysters was five grams. This compares favorably to average meat weight of wild mangrove oysters which was 1.5 grams (Kamara, 1932).

Biological studies were completed during phase two of the project and oysters were grown mainly to assess profitability for potential culturists. The extension aspect of the second phase was not undertaken, and phase three never got off the ground.

3. Financial Analysis

The financial analysis consists of an evaluation of the costs and benefits of oyster culture using the raft method. Since benefits from the results of the scientific studies are distributed over several years and not confined to Sierra Leone, they cannot be computed and no attempt is made to analyze this aspect.

The data available from project reports (unpublished) are for the 1973/79 growing season. Five rafts each of oysters were cultured at No.2 River and Jui stations, and

twelve rafts at Potnko and Dare stations combined. (Potnko and Dare are combined because oysters from both stations were mixed together after harvesting and it was impossible to separate them at the processing site).

Table 1 gives the cost of constructing one raft and processing its 200 strings of oysters. Two materials (nylon ropes, used as strings and oil drums) account for over 50 percent of the total cost of production and processing. With proper care, drums can be used for two growing seasons, but nylon ropes can last longer. However, it is difficult to undo all the knots along the length of the rope. (The knots are used to separate oyster clusters from each other).

Table 2 gives the number of strings harvested from the stations, the weight of whole oysters, and the meat weight. One important factor is the number of strings lost during the growing and harvesting periods. The No.2 River station lost 22 strings, an average of five strings (2.5 percent) per raft, the Jui station lost 56 strings, an average of 11 strings (5.5 percent) per raft, and the Potnko and Dare stations lost 941 strings, an average of 73 strings (39 percent) per raft. Some environmental factors are given as reasons for these losses (Kamara, 1932). However, the high percentage loss for Potnko and Dare is exceptional and one possible explanation is that there was pilfering of some of the strings of oysters during the growing season and during harvesting.

TABLE 1. CONSTRUCTION AND PROCESSING COSTS OF ONE RAFT (LEONES)*
 OYSTER CULTURE PROJECT

Synthetic Rope (200 Strings)	22.50	
One Bundle "Kurason" No. 24 for Assembling Raft Frame	9.00	
Anchor Rope	6.00	
Oil Drums (Floats)	20.00	
Tar-Pitch Mixture for Painting Drums	6.00	
Bamboo Canes	1.00	
Firewood	6.00	
Plastic Bags	1.00	
Salt	0.15	
Sieves, Shucking Knives, Etc.	<u>8.35</u>	
TOTAL COST		<u><u>80.00</u></u>

*Labor cost is excluded.

2.50 Leones = U.S; \$1.00 (USAID Country Profile, 1983).

Source: Project Report Unpublished

TABLE 2. OYSTER PRODUCTION FROM RAFT CULTURE (KG.)
OYSTER CULTURE PROJECT

No. of Rafts	Stations		
	JUI	No. 2 River	Pothko & Dare
	5	5	12
No. of Strings Harvested	944	978	1459
Wt. of Strings Harvested	5474	4739	3552
Wt. of Empty Shells	3732	3473	2485
Wt. of Oyster Meat	233	172	127
Wt. of Whole Oysters/String	5.8	4.9	2.4
Wt. of Oyster Meat/	0.3	0.2	0.1
Wt. of Empty Shell/String	4.0	3.6	1.7

Source: Project Report Unpublished

Table 3 gives the break-even prices for cultured oysters. The results show that at a market price of Le.0.25 per packet, oysters harvested from the Jui station are just at the break-even price. Oysters harvested from other stations cannot break-even at that market price. To be attractive to private individuals, oyster culture must offer financial benefits. At present levels of technology and economics, oyster culture does not seem financially feasible.

One solution is to increase the market price of cultured oysters by 20 percent so that the break-even prices for oysters harvested at Jui and No.2 River are below the market price. (For Pothko and Dare, ways must be found to get around the pilfering problem, otherwise oyster culture is not likely to be profitable at those stations). Two factors are worth noting with this solution. Cultured oysters have to compete with wild oysters in the market, and in the absence of information on consumers' preference for cultured oysters, it is impossible to predict how the market would respond to a price increase.

The second solution is to adopt measures to reduce the cost of culturing oysters. The drums can be used for two growing seasons, thus the cost can be distributed only over this period of use. If the drums are used for two seasons, the break-even prices (given the current harvesting levels) are Le.0.22 for Jui, Le.0.24 for No.2 River, and Le.0.31 for Pothko and Dare stations.

TABLE 3. BREAK-EVEN PRICES FOR CULTURED OYSTERS (LEONES)
OYSTER CULTURE PROJECT

	Stations		
	JUI	No. 2 River	Pothko & Dare
No. of Rafts	5	5	12
Av. No. of Strings Harvested/Raft	189	196	122
Av. Wt. of Whole Oysters/Raft (KG.)	1094.7	947.8	296.0
Av. Wt. of One String (KG.)	5.8	4.9	2.4
Total No. of Packeted Oysters	1578	1473	1033
Av. No. of Packets/Raft	316.0	295.0	86.0
Meat Produced/Raft (KG.)	46.6	34.3	10.6
Meat Wt./100 KG. of Whole Oysters (KG.)	4.3	3.6	3.6
Cost/One Raft Oysters (Raft Construction & Oyster Processing)	80	80	80
Av. Cost of Oysters/Raft at le. 0.25¢/Packet	78.9	73.7	21.5
Break-Even Price	0.25	0.27	0.93

2.50 Leones = U.S. \$1.00 (USAID Country Profile, 1983).

Source: Project Report Unpublished.

Clearly, this measure does not affect the break-even prices significantly. Another measure is to determine the optimum harvest time so that losses could be minimized. Kanara et al., 1975 (p.45) show a relationship between average weight per oyster in shell, and percentage surviving, over a nine month growing season. This relationship shows that the optimum harvest time is approximately five to six months. However, the studies fail to show how much losses per raft could be avoided by harvesting at five or six months rather than at eight months, thus it is impossible to determine the break-even prices if such a measure were adopted.

It seems likely that for oyster culture to be financially attractive to the villagers, a combination of both measures should be used. However, villagers can harvest wild oysters, and the only cost involved is processing. With this option available to villagers, profit margins from culturing oysters must be wide enough to be attractive.

4. Socio-Economic Evaluation

The socio-economic evaluation of the project consists of an evaluation of the project's objectives to determine whether the project succeeded in fulfilling them, or if not, what factors are responsible for its failure. The first part evaluates the project's actual performance, and the second part looks at some factors relevant to the project's success or acceptance that were not considered by the

project.

a. Evaluation of Project Objectives

The project succeeded in identifying methods to improve the yield of oysters. Oysters grown on rafts took seven to eight months to reach an average meat weight of five grams, compared to wild oysters which reach an average meat weight of 1.5 grams after a growth period of approximately 2.5 years (Kamara, 1982).

The optimum periods for oyster seed collection, and harvesting were also identified. However, no consideration was given to translating biological information obtained from the studies for practical use at the local level. For example, the optimum harvest time was identified, but was not applied to determine its significance to reducing percentage loss of oysters.

The processing method used by the project for cultured oysters is essentially the same one used for wild oysters by coastal fishermen. The only difference is in the storage method. Cultured oysters are packaged in plastic bags, heat sealed, and frozen before sold, while wild oysters are sold in open baskets (after boiling and shucking), exposed to insects, dust, etc. The storage method used by the project is not suitable for the villagers to adopt for financial and technological reasons. The storage cost is not included in the processing cost, and it is likely that this cost per raft is higher than Le.30 (total cost of production and

processing per raft) depending on the length of time the oysters are kept frozen. Including storage cost would make the break-even prices at least double. Also, even if market price increases to cover this added cost, refrigeration facilities are lacking in some areas where oysters can be cultured. Thus, despite the identification of storage method to improve the quality of the oysters to consumers, this method is not feasible for the villagers.

The next objective of the project was to undertake extension work so that the technology could be transferred to villagers for undertaking oyster culture. No extension work was carried out by the project. Only one new experimental station was established at Shenge, south of the Freetown Peninsula. Villagers did not express interest in undertaking oyster culture. Several factors responsible for their lack of interest are discussed in the next section of this evaluation.

b. Evaluation of Factors that Contributed to the Failure of the Project's Extension Phase

The project did not establish whether there is an extensive market for oysters, and whether it can absorb a large scale increase in production. Unless villagers see a potential market for oysters, one which enables them to obtain some financial benefits, they will be less likely to culture oysters.

No studies were undertaken by the project to determine

the benefits and costs of fishermen's operations, and to compare them with that of oyster culture. In order to attract fishermen to oyster culture activity, the benefits from this activity should at least equal the benefits from their fishing operation. This does not seem likely under the current situation.

Oysters appear to be a substitute for fish, and the demand for oysters increases when fish is in short supply. (For some, consumption is very occasional, and the demand is negligible). The price of oysters is thus influenced by the market supply of fish. Given this situation, villagers only harvest wild oysters in large quantities when they expect shortage in the supply of fish, often due to bad weather conditions. This is mainly to supplement their incomes when they cannot go out to fish.

The project assumed that fishermen and their families would be willing to use their leisure time for oyster culture activity in order to increase their incomes. This is not necessarily true. Pollnac (1982) asserts that temporal demands of new technologies must be congruent with the time allocated for productive work by the target group(s), otherwise these demands will meet resistance.

Institutional support was also lacking. There is no evidence that the extension staff made attempts to transfer the technology to the fishermen. Two possible reasons could be given for this lack of support. There could have been a breakdown in communication since they were not involved at

the initial stage of the project, or facilities for extension work are inadequate, or a combination of both.

Kamara (1932) mentions possible conflicts between aquaculture and fishing that may arise. Some of the channels in rivers and lagoons that provide access to fishing grounds are narrow, and oyster culture rafts in such channels may restrict, if not block, the movement of fishing boats.

The lack of private property rights to the brackish water resources may lead to problems of economic inefficiency. In this situation, space for both collecting oyster seeds and growing oysters would be allocated on a first-come basis and it is likely that some firms acquiring space would not be the most efficient in operation. Thus, production would not be economically efficient.

5. Conclusion

The project developed a suitable culture method that increased the average meat weight of cultured oysters by over three times the average meat weight of wild oysters, and in one-third the time it takes the wild oysters to grow to that average meat weight. However, villagers did not show interest in oyster culture activity, and the project failed to increase the supply of animal protein in Sierra Leone. Even if the extension staff was active in their efforts to transfer the technology, it is unlikely to have been successful. Villagers are usually reluctant to take

risks in investing in new technology especially when they could derive additional income from harvesting wild oysters.

One point clearly emerges from the results of this case study. The biological reasons for justifying the implementation of the project were sound, and indeed the results concur with this assessment. However, this is a case where biological considerations appear to have been over riding factors for project analysts. Economic factors were not given adequate consideration. The result of this inadequacy is that oyster culture technology is unlikely to be accepted by the villagers.

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