

THE ECONOMICS OF OYSTER CULTURE IN SIERRA LEONE

Josie W Elliot
Economist, Fourah Bay College
University of Sierra Leone
Freetown, Sierra Leone

1. INTRODUCTION

One of the major objectives outlined by the Sierra Leone Government is that of reducing food deficiency and the attainment of self-sufficiency in domestic food production. Meat and fish have provided the traditional sources of protein for most household diets. With the rapid inflationary rate that the economy is experiencing it is evident that fish and meat are fastly being priced out of the reach of most low-income earners. The inability of most low income households to purchase the required amounts of these traditional protein sources means that additional sources have to be encouraged or developed if the minimum protein requirements are to be satisfied in their diet. Oysters are rich in protein and usually serve as a good complement in enriching the household diet.

The rapid rate of increase of the population together with poor performance in the agricultural sector has exacerbated the food deficiency problem in the country. This has resulted in massive food imports to satisfy the food demands of the population. A consequence of the rapid population increase has been an increase in the demand for fish which (because of its relatively low price) has provided most protein requirements. Currently the bulk of the fish supplies is provided by marine fish with fresh water fish, aquaculturally produced products and imported tinned fish providing the rest of fish supplies.

Interest in aquaculture on a commercial scale is at its initial stages in Sierra Leone as is the case in most states in West Africa. Such enterprises are often constrained by lack of trained manpower, inadequate funds and a conspicuous absence of the most basic infrastructure. This is in contrast to the advanced industrialised countries where aquaculture products are generally regarded as

luxury food items and the profit motive has provided the drive in most of these enterprising aquaculture business concerns.

In recent years, trawler fleet have accounted for the bulk of fish supplies. Estimated catch from trawlers is suspect due to the large quantities that are exported without the knowledge of customs officials. A not insignificant amount of fish supplies is from an estimated 12,000 artisanal fulltime and part-time fishermen operating about 6,000 canoes and estimated catch of 36,000 metric tons¹.

The numerous rivers and estuaries that are found in Sierra Leone provide an ideal breeding ground for the cultivation of wild oysters; among these the Sherbro, Rokel and Scarcies river are well known. Wild oysters are classified as mangrove oyster, rock oyster or mud oyster according to where they grow. Yields from mangrove oyster is low and of poorer quality, this being a consequence of exposure to heat, insufficient food and overcrowding on the aerial mangrove roots.

Serious consideration towards the large-scale production of oysters was pioneered by studies conducted by Golley-Morgan in 1964 examining the biology of mangrove and mud oysters around the Bonthe area. Various difficulties encountered in this area made production economically non-viable. In 1973 there was a proposal for the current Oyster Culture Project to be jointly financed by the Sierra Leone government's Fisheries Division and the International Development and Research Centre (IDRC). The Oyster Culture Project was intended to take advantage of the availability of oysters in the numerous rivers and estuaries with the expressed purpose 'to increase the yield ... of mangrove oysters and to establish a practical and economic system for their cultivation through various culture systems, biological investigations, processing studies and sanitary and bacteriological surveys'².

It is expected that the large-scale commercial production of oysters will have substantial benefits for both consumers and sellers. In the first place, oyster is usually part of the daily diet of most residents in the coastal areas. For most consumers in urban areas, oyster is used as a complement with fish or meat. Thus the development of better quality oyster would mean an enriched household diet and an improvement in nutritional standards. Furthermore additional income is created for these coastal and other rural inhabitants who usually sell the oysters in local markets. Sellers would also be assured of the required quantities they may need for sale at any time.

There is need and much scope for research on the market possibilities of establishing efficiently run large-scale enterprises involved in the cultivation of oysters. A research of this nature will involve the estimation of various elasticities which will give an indication of consumers' response to certain variables that are believed to be important decision-making variables in determining the quantity of oyster households will buy. This study will attempt to provide such

assessments and make the necessary policy recommendations geared towards attaining government's objective. It is hoped that these policy recommendations would provide guidelines for public and private participation in a commercial cultivation of oysters.

2. BACKGROUND INFORMATION

Sierra Leone has an area of approximately 28,000 square miles and a population of about 3.5 million. A low lying coastline strewn by rivers and estuaries runs for about 340 km characterised by mangrove swamps. The country lies on the West African coast between latitudes 6°55' and 10°N, and longitudes 10°16' and 13°8'w. The continental shelf extends for approximately 20 miles to the South close to the Liberian border and approximately 40 miles to the north near the border with Guinea. Three major estuaries are found in the country; these are the Scarcies in the North, the Rokel river in the middle and the Sherbro in the South. The country experiences a tropical climate with a wet season running from May to October and a dry season from November to April.

3. OYSTER CULTURE METHODS

Experiments conducted on oyster culture by the Oyster Culture Project involved various techniques. These can be broadly classified under the suspended and bottom culture. Experience with bottom culture techniques revealed a high mortality rate of wild oysters caused by preying from other sea animals.

The suspended culture technique involves the rack culture; wooden trays; nets and plastic vexar mesh; mangrove roots with oysters attached and the raft culture. The results of these experiments disqualified wooden trays, nets and plastic vexar mesh and mangrove roots techniques for large-scale commercial production of oysters because of high cost, difficulties in producing large quantities and attack from predators. Two culture techniques that are worth further investigation are the rack culture technique and the raft culture. These have been adopted by the Oyster Culture Project and are known to have produced good results.

In most cases bamboo or mangrove trees are used in the construction of racks. There is a strong preference for using mangrove trees for rack construction since they are readily available in the construction areas and last longer. Straight posts with a 'Y' at one end are used as vertical posts. The straight ends are sunk about 1m into the earth allowing the Y-end of the post to remain at the surface. Two posts are driven along the shore, a straight pole fitted across the top vertical Y

VARIABLE COST (Processing Cost)

i.	Firewood	50.00	
ii.	Plastic bags	4.00	
iii.	Salt	.40	
iv.	Other requirements (handtools, knives, etc.)	32.00	86.40
	Total Cost		614.40

Using the cost and output figure one is able to calculate unit costs of break-even prices per kilo.

Average yield of oysters per string = 7kg*. A raft has approximately 200 strings. This implies an average weight of 1400 kg yield per raft.

$$\begin{aligned}\text{Unit Cost} &= \frac{614.40}{1400} \\ &= \text{Le}0.45 = 45 \text{ cents per kilo}\end{aligned}$$

An estimated 5 cents per kilo is used as mark-up for transportation charges.

If this is included in the unit cost the break-even price works out at 50 cents per kilo using the raft culture.

The rack culture technique on the other hand is less expensive than the raft culture technique. Most of the mangrove trees used to build the racks are readily available near the construction sites. This technique is more labour-intensive and as such labour charges are the dominant costs involved in the use of this technique. A break down of the construction cost will be helpful in making a comparative analysis.

Even though the raft culture technique is more expensive and involves higher unit cost it has the advantage of faster growth and better quality meat.

5. THE DEMAND FOR OYSTERS

The term 'demand' is often very loosely used reflecting the various disciplines under which the concept is examined. The demand for food quite often is used to describe nutritional requirements rather than demand in a strict economic sense. It is thus of importance to distinguish between the two concepts.

A country like Sierra Leone, which has an age distribution heavily skewed towards children would require more protein intake to meet the requirements dictated by rapid body growth and tissue replacement of the growing population - lack of sufficient protein or suitable

* Yield here refers to meat yield i.e. Oyster meat wt.
Whole oyster wt.

proteins resulting in a deficiency of essential amino-acids, leads to a disease known as kwashiorkor which is fairly widespread in many Third World countries.

A notable trend which has been observed by several commentators³ is the strong preference for diets rich in animal protein. The consequence of this is that there tends to be a strong positive correlation between sustained increases in income and the consumption of food derived from animal sources.

The most important source of animal protein is that of fish. It has been estimated approximately that 24,000 people are employed in small-scale fishing (linsenmeyer, [1974]), which has a number of distinct advantages over commercial fishing in terms of the employment generation and unit costs per investments compared to the rates of return to investments (Beck, [1989]).

The proportion of total expenditures spent on oyster consumption is relatively much smaller when compared to meat and fish. The survey found that in fact the mean value spent on oyster purchase per household was about Le3.31 which constitutes about 6 percentage of total food expenditure. Its demand could be considered as being *occasional* as distinct from being *basic*. The survey also found that oyster consumption tends to conform to certain socio-cultural consumption patterns. Oyster consumption tends largely to be urban oriented and is biased towards consumers in the middle and upper income classes. This would be expected.

6. ECONOMIC DEMAND ANALYSIS

The methodology employed in this study was the cross-sectional demand analysis. This technique of analysis focuses upon the demand by individual consuming units - households. For the purposes of this study, the household is defined as a group of persons who eat from the 'same' pot⁴. It is usual to include data on household expenditures, age-sex composition; plus those factors which are considered necessary to explain inter-household differences in expenditure patterns. Within the confines of Neo-Classical economic theory it is usually assumed that all households belong to an identified, well functioning, single market. This would imply that all households are faced with identical prices unless price differentials introduced principally due to transport costs. Hence prices are usually discarded in cross-sectional demand analysis.

In the survey conducted, it was adequately demonstrated that prices faced by consumers tend to be different in the different markets. In fact the standard deviation around mean prices (P) of oysters was estimated at 7.24 which is quite substantial.

This emphasises the fragmentary nature of the market in Freetown and provides justification for the inclusion of the price parameter in estimating the potential demand for oysters.

Household expenditure on food is used here as a proxy variable for household income. The difficulties in obtaining accurate figures for household income in less developed countries (LDC) cannot be over-emphasised.

The size of the household is also used as an explanatory variable in the demand model generated. It was observed that its net contribution is not quite significant since the relationship between household size and food expenditure is weak.

The cross-sectional data revealed that the multi-collinearity between the variables was low which enabled the researcher to obtain the relevant demand coefficients by the Ordinary Least Squares (OLS) method⁵. The household survey also provided estimates of expenditure elasticities on meat, fish and oysters.

The constant term (A) embodied both the biogenic and psychogenic factors determining the demand for these food items. The former includes factors such as age-sex composition of household whilst the latter, taste preference due to social class, ethnic patterns of demand and other psycho-sociological variables.

7. INTERPRETATION AND ANALYSES OF RESULTS

It must be admitted at the on-set that the use of the partial analyses method, which in this study centres around oyster demand behaviour in the Freetown area, introduces certain omissions as to the factors influencing household demand. This obviously imposes certain limitations in interpreting the empirical results obtained. Ideally, a complete systems demand model is required. However in practice, a trade-off must be made between the accuracy of the results and predictions and the danger of oversophistication of the model. In this vein, the estimations and projections based on this model should be viewed in terms of its delicacy in providing a framework for analysing the size of the market for oysters in the Freetown area which can be used for constructing a projection into the future demand for this commodity.

The regression run at the 1st stage level of specification of the model showed that the coefficients obtained was only significant at a 1% significance level. This is due to the small proportions spent on oyster consumption by households in the Freetown area. The R^2 is very low i.e. .12 which manifests the limited explanatory capability provided in the 1st stage level of specification of the model. The price elasticity at mean prices was estimated at .48, was insignificant using t-test analysis. Food expenditure elasticity showed very weak positive correlation at 0.25, this also proves statistically insignificant. The household elasticity

at .46 is more revealing. It reflects the fact that on the whole, large families tend to consume more oysters as would be expected, also that there is some economies of scale in its consumption i.e. large household spend less per person on oysters relative to smaller households.

At the second-stage of specification, estimation yielded more statistically meaningful results. The R^{-2} was improved to .53 at 5% level of significance. The food expenditure elasticity estimated at 0.95 is negative which has economic validity implying that the share of expenditures on oysters fall as total food expenditures increase.

Comparison of estimated expenditure elasticities in other African consumption studies is difficult to make due to the specification of the model and commodity groupings.

It however favourably compares with King and Byerlee [1977] estimate of -0.93 for food in rural households in Sierra Leone and also the estimate of -1.27 for Eastern Nigeria by Hay [1966].

8. ESTIMATION OF THE CURRENT DOMESTIC MARKET FOR OYSTERS AND MARKET PROJECTION

8.1 Current Estimates

Using the budget share progression equation obtained for oyster expenditures and the mean values of the predictor variables, the current weekly budget share of oysters consumed can be computed.

$$\ln Q_i + \ln P_i - \ln E_j = -1.2768 + .4800 \ln P - .9476 \ln E + \dots + .4614 \ln H_s$$

The results show that roughly 6% of total food expenditures for households is spent on oysters.

Taking the number of households in the Freetown area at approximately 64,640 (Thomas 1973) and average household expenditures Le40.00 per month, the estimated market potential of oysters amounts approximately to Le1,861,600* pr 31 metric tons of oysters.

8.2 Projections

Market projections based on cross-sectional analyses are fraught with a host of intactable problems. In order to estimate this projection, use was made of the time series data showing oyster production. The assumption is made that the market provides the necessary absorptive capacity.

** Ideally the demand and supply estimates must be equal. The prospect of this happening in real-life is remote. In the study the divergence is about Le1,714 which is regarded as not being very significant.*

TABLE 1
PRODUCTION LEVEL FOR BOTH WILD AND CULTURED
OYSTER – (1979 – 1982)

YEAR	PRODUCTION	(Whole Oysters)
1979	18.3	
1980	36.3	
1981	19.0	
1982	21.0	

Source: Fisheries Division – Ministry of Agriculture
and Natural Resources

The figures show the variation in the production of oysters. Since traditional methods yield roughly constant returns, the fluctuation is mainly due to cultured oysters. Apart from the sharp increase in 1980, one can discern a slightly increasing trend in its production.

Holding 1982 as the base year the following demographic and macro-economic projections were made on the assumption that the average annual growth rates remain constant.

TABLE 2
DEMOGRAPHIC/MACRO-ECONOMIC PROJECTIONS

Population (millions)	1982 (BASE YEAR)	1984	1986	1988	1990	Average annual growth rate (%)
Total	3.356	3.533	3.719	3.915	4.121	2.6
Urban	0.839	0.943	1.059	1.190	1.337	6.0
Rural	2.517	2.624	2.735	2.851	2.972	2.1
(Freetown)	0.474	.543	.623	.711	.814	6.0
Persons per household						
Total	8.4	8.4	8.4	8.4	8.4	–
Gross Domestic Product (GDP)						
Le(m)	1,264.5	1,305.3	1,347.4	1,390.9	1,435.7	1.6
Gross Domestic Product (GDP)						
per capital (Le)	376.8	384.4	392.1	400.1	408.0	–1

The curve shows that in all likelihood, the production which would equate demand for oysters must be in the neighbourhood of 50 metric tons. This is held ceteris-paribus that all other factors remaining the same especially the price differentials between oysters and the other traditional protein sources.

9. POLICY RECOMMENDATIONS AND CONCLUSION

The principal aim of this study is that of assessing the size of the domestic market provided by the Freetown area for oysters and make a tentative projection as to future demand. In order to promote the establishment of economically viable large scale production of oysters as envisaged in the oyster culture project, it is necessary to assess the absorptive capacity of the market with a view to observing salient constraints.

The study shows that there is a sizeable domestic market for oysters which could enable production to attain scale economies. The present estimate of 31 metric tons of oysters to meet consumer demand and the projection of roughly 50 metric tons by the end of the decade adequately manifests the size of this potential market.

There are a host of problems however which must be tackled in order to attain these economies.

The first problem is that of coping with the perishability of oysters. In the survey it was estimated that processed oysters without preservatives or storage go bad in roughly 48 hours. This imposes a considerable constraint on sellers willingness to procure large stocks of this product. Research is necessary to enquire into the possibility of improving storage. For instance, oysters can be preserved in a brine solution, however this might not meet the taste requirements of consumers. It would also be necessary to provide refrigerated vehicles which would dramatically cut down the problems of perishability.

The second problem is that of distribution and sales. The present method appears most unsatisfactory since oysters are usually sold in the evenings around Krootown Road market. Attempts must be made in diversifying selling locations so that a wider market can be catered for.

Given the profitability of oyster culturing, the private sector must be provided the necessary incentives to go into this line of production. The expanded scale of production would not only serve the domestic market but also the export market. This would involve some amount of quality control and assured distribution outlets. In this vein, a concerted promotional campaign must be mounted which could serve to attract private investors. Technical assistance could be requested from international organisations such as the IDRC to help in the establishment of this venture.

In order to circumvent protectionist measures in industrial markets, recourse must be made in exploring the trade possibilities of exporting under the aegis of the Mano River Union or ECOWAS, to neighbouring West African countries.

It is the considered opinion of the author therefore that oyster culturing offers tremendous opportunities for Sierra Leone.

NOTES

1. Due to the paucity of data on estimated catch the figure represents a conservative estimate based partly on the demand for fish which has an estimated elasticity of 0.9.
2. Quoted from the terms of reference in the establishment of the Oyster Culture Project funded by the International Development Research Centre (IDRC).
3. See for instance, W J Thomas (ed.) *The Demand for Food*, Manchester University Press, 1972 especially chapter 2 by J M Currie also L Goreux: *Income and Food Consumption*, FAO, *Monthly Bulletin of Agricultural Economics and Statistics*, Vol. IX No. 10, October, 1960 et. al.
4. This definition tends to be widely used in household studies in many developing countries. This reflects the extended family system found in most of these countries. It also avoids to some extent the semantics involved in obtaining a definition of the household which conforms to its sociological, psychological and economic aspects.
5. This is in consonance with the views expressed by Massell (1969) which assumes that consumption and production decisions are independent. This is due to the insignificant levels of auto-consumption in the food items studied.

Le 1 = £0.36