FISONS

FISHERIES SOCIETY OF NIGERIA

FISON

1986 FISON CONFERENCE PROCEEDINGS

Price: ₦35.00

ISBN 978 - 2345 - 00 -

PROCEEDINGS OF THE 5TH ANNUAL CONFERENCE OF THE FISHERIES SOCIETY OF NIGERIA (FISON), ILORIN, SEPT. 22 ND – 25TH, 1986

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PUBLISHED BY

FISHERIES SOCIETY OF NIGERIA
P. O. BOX 71228, VICTORIA ISLAND,
LAGOS – NIGERIA.

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SECTION 1: OPENING CEREMONY

WELCOME ADDRESS PRESENTED BY THE DIRECTOR OF KAINJI LAKE RESEARCH INSTITUTE, DR. J.S.O. AYENI AT THE OPENING CEREMONY OF THE FIFTH ANNUAL CONFERENCE OF THE FISHERIES SOCIETY OF NIGERIA (FISON) AT THE UNIVERSITY OF ILORIN, ON 22ND - 25TH SEPTEMBER, 1986

The Military Governor of Kwara State,
Lt. Col. Ahmed Abdullahi

My Lords Temporal and Spiritual

The Honourable Minister of Science and Technology, Prof. E.U. Emovon (FAS)

The Vice Chancellor

The Director of Federal Department of Fisheries

The Directors and Heads of Department of Fisheries based Research Institutes and Universities

The President of FISON, Fellow Participants

Distinguished Guests, Ladies and Gentlemen

It is with great pleasure and joy that I welcome this distinguished audience to the formal opening ceremony of the Fisheries Society of Nigeria (FISON) Fifth Annual Conference. It is worthy of note that for the first time scientists, technical experts, veteran administrators and resource managers are assembled to exchange views on Investment Opportunities in Fisheries. This is a step in the right direction in view of present Government emphasis on self reliance in food, particularly protein production in Nigeria.

The aim of contributions at this Conference is to focus attention on the development of fisheries with the aim of achieving rational utilization of fisheries resources for the establishment and development of a virile fishing industry based on sustained yield management principles. The achievement of these objectives has become imperative because to ignore them any longer may be disastrous nutritionally and could increase the balance of payment problems of Nigeria. Experts in the field have assembled enough data to convince governments on the need for fish conservation in all Nigerian water bodies. It has been shown for instance that the out-put from Nigerian water masses can be increased five-fold through the application of research results in aquacultural practices; stocking of rivers, lakes and ponds with suitable species of fish; and through edict by elimination of over-fishing particularly of immature fishes. The prospects for increased out-put call for increased direct government funding and fiscal measures in the fishing industry.

Kainji Lake Research Institute

The Institute started in the late sixties as a project to study and recommend solutions to problems likely to arise from the creation of the Kainji Lake, the first, and largest man-made lake in Nigeria. At present, the work of this Institute has extended to cover most of the aspirations of the modern day farmer. The modern farmer wishes to have a parcel of land on which to grow some crops, graze livestock, keep fishes in ponds and keep physically healthy to enjoy the fruits of his socio-economic endeavours. Thus, as a model the Kainji Lake Research Institute is a most successful multi-disciplinary-multi-commodity Institution working on basins ecological system, and housing under the same roof experts in Fisheries, Boat Building, Net Construction, Wildlife Biology, Range Management, Animal Production, Irrigation Agriculture, Fish Processing, Extension, Public Health and Socio-Economics, who work indepth in their specialised areas, but are coordinated towards producing results and recommendations immediately relevant to the local communities in any Nigerian River Basin.

Mandate and Achievements

The mandate of Kainji Lake Research Institute includes researching into the different facets of the following disciplines: Fisheries; Limnology; Wildlife Conservation, Range Management; Irrigated Agriculture; Socio-Economics effects of the construction of lakes on their neighbouring rural populations, and dissemination of research findings to end-users around all rivers and man-made lakes in Nigeria.

Fisheries Research

Remarkable achievements have been made in pursuance of the fisheries mandate as summarized below:

(i) Determination of the biological characteristics of major commercial fish families as well as the identification of small scale fisheries of high potential within Kainji Lake.

(ii) Fisheries and limnological feasibility studies have been carried out on Tiga Dam in Kano State, Bakolori Dam in Sokoto State and the fish stock assessment and management of I.I.T.A. in Ibadan and Lafia Agricultural Project in Plateau State; and also, Jebba and Oguta Lakes etc.

(iii) Design and fabrication of nets and boats suitable for transportation and fishing in Nigerian waters have been accomplished. Establishments which have patronized this section are amongst others, IITA Ibadan, Federal Department of Fisheries at Yelwa in Sokoto State, Hadeija, and Niger River Basin Development Authorities; Bayero, and ABU Universities etc. The Institute designed and constructed a fish smoking kiln which is already patented.

(iv) Studies of water quality and productivity as well as the establishment of inland Freshwater Fisheries School to train sub-technical grade fisheries personnel for Nigeria.

(v) Comprehensive checklist of all ponds, lakes and rivers in Nigeria have been produced. Functional fish hatcheries, ponds, cages and enclosures for aquaculture practices have already been developed at the Kainji Lake Research Institute headquarters.

I wish to use this forum to emphasize that meaningful break-through in science calls for collaboration, coordination and integrated research work and efforts because of scarcity of money and personnel. In line with this realization, our Institute has initiated collaborative projects with the following organizations:-

(a) Imo State MANR (Fisheries Division) - Collaboration is in the area of fish seed multiplication and fish cage culture.

(b) Ondo State MANR (Fisheries Division) - Collaboration is in fish seed multiplication and out door hatchery development.

(c) Department of Wildlife and Fisheries Management, University of Ibadan - Collaboration is in the area of reservoir management survey and fish hatchery management.

(d) Institute of Oceanography, University of Calabar - Collaboration is in the area of clupeid research and transplantation and Oguta hatchery management.

I am therefore, calling on fellow scientists and the different State and Federal organizations to explore possible areas of further collabration since such a venture will pool resources together for maximum utilization and positive results.

Wildlife Research

(i) Research in wildlife has resulted into creation of the first and only National Park for Nigeria, the Kainji Lake National Park and the establishment of a School of Wildlife Management by FRIN.

(ii) Work on guineafowl has given an insight into successful domestication of guineafowl for large scale multiplication and production.

(iii) Studies on the Niger Grass on Lake Kainji has resulted in management proposal for harvesting and utilizing the grass as livestock hay.

(iv) The establishment and development of experimental pasture and grazing reserves in Kwara and Sokoto States at Nweri and Birnin Yauri respectively have been a blessing to the Fulani within Kainji Basin.

Agriculture Research

Research in the Agriculture Division has yielded the following results:-

(i) Development of multiple all-year-round cropping technology through maize-cowpea-maize-cowpea-maize rotation under rainfed combined with irrigated agriculture.

(ii) Cowpea has been identified as the most lucrative crop for the Kainji Lake Basin and irrigation requirements for other crops have been determined.

(iii) The Division has formulated fertilizer requirements and crop protection package of input and improved culture for maize, rice and sorghum on the basis for available brands of local fertilizer, herbicides and pesticides for the Lake Basin.

Socio-Economics and Extension Services Division

Efforts of this Division have also yielded very encouraging results as enumerated below:

(i) As a result of findings from this Division, it has been ascertained from the data collected that resettlement where primary innovations were given had about 75% chances of success. This result which could serve as a model for future resettlement programmes in Nigeria has been document in a book titled "Adjustment to Resettlement: A Study of Resettled Peoples in Kainji Lake Basin".

(ii) The Extension Services Unit has helped to increase guineafowl production by distributing young keets to farmers in the basin thereby, increasing their income and protein intake as well. The production of Ife-brown cowpea has been similarly successfully extended within the Basin.

(iii) Attention has been drawn to the decline of fish catch below the Kainji Dam as far as Lokoja and the consequent loss in income and the need to cater for those below any reservoir in future development of large scale impoundment programmes.

(iv) As a result of a decline in fish catch in Kainji Lake, after an initial boom period, about 36% of the fishermen were found to combine fishing with farming. Therefore, the Institute has recommended that at the planning stage, alternative occupation be thought of for the people in reservoir resettlement programmes.

Publications

A list of publications arising from research work at the Institute are attached to this address. Copies of the publications may be obtained from the Librarian of the Institute.

I also like to inform the Conference that a Post-Conference tour is organised to enable participants visit New Bussa where the Conference host, Kainji Lake Research Institute has its headquarters. The tour is to allow participants see our work on inland fisheries research, boat building, manpower training and both cage and pond aquacultural practices. You will no doubt have heard of the poor condition of our road between Mokwa and New Bussa. I am glad to inform you that something is being positively done to the road and future Conferences and Seminars may be held utilizing the Institute's facilities at New Bussa. You are invited to visit the small beautiful resettlement town of New Bussa, the Kainji Lake National Park, and to have a cruise on the Kainji Lake.

Closing Remarks

In closing, I wish to recognise and welcome certain individuals who are either present or are represented here:-

(i) Firstly, I welcome the Military Governor of Kwara State, Lt. Col. Ahmed Abdullahi; who despite the strains of recent assumption in office has honoured the Society with his presnece as the Chair-person. Very shortly he will be declaring open this Conference. You are welcome, Sir.

(ii) Secondly, I welcome the Honourable Minister of Science and Technology, Prof. E.U. Emovon (FAS) who despite his tight schedule of official engagements agreed to present a special address to this Conference at very short notice. We believe both the Governor and Minister are the best "routes" for sending the outcome of our deliberations to the Government. By your presence Sirs, we consider FISON 1986 very lucky.

(iii) The Director, Federal Department of Fisheries, Alhaji D.D. Apampa, and the Chief Fisheries Officers of States together with the General Managers of Nigerian River Basins and Rural Development form the third group. This is the distinguished group of professionals who are responsible for planning and coordinating Fisheries resources development, and management policies in Nigeria. We hope you will find at this Conference the interaction with industrialists exploiting your resources very useful.

(iv) The Director and Heads of Departments respectively of Fisheries based Research Institutes and Universities. We hope that with your presentations

it will be seen the vital link your group plays between and in enlightenment of those who sell fish and those that buy fish.

(v) The industrialists, at the fore-front among which are the President and Grand Patron of FISON, Mr. N.O. Fadayomi and Chief (Dr.) M. Ibru respectively are welcome. A mini-trade fair has been organised for this group of participants to be declared open by the Grand Patron shortly. We hope that guests and particularly the Governor and Minister will note the limitations placed on industrialists by the inflated high costs of nets, outboard engines, resins etc., even before SFEM is fully operational. Also, the industrialists, we hope, will after this Conference realise that until they agree to plough back some of their huge profits to carry out research in their companies or by contracting out investigations and inventions to Research Institutes and Universities may they hope for local raw material substitution at lower costs.

(vi) Finally, of course, as eaters of fish and fish products, everyone of us here present is specially welcome. Your suggestions and contributions will go a long way in achieving the aims and objectives of this Conference.

Distinguished Ladies and Gentlemen, I wish once more to welcome you to this Conference, and to thank you all for gracing the occasion with your presence. Your presence at this Conference is very encouraging indeed and re-assuring that with God on our side, our efforts during the next three days here would not be in vain.

Thank you very much.

List of Publications

Proceedings and Books

KAINJI LAKE RESEARCH INSTITUTE
Proceedings of the International Conference on Kainji Lake and River Basins Development in Africa, Ibadan, 11 - 17 December, 1977. Vols.I & II 612 pp

SANFORD, W.W. et al (Ed.)
Nigerian Savanna: Selected Papers from the Man and Biosphere State of Knowledge Workshop. Sponsored by the Nigerian National Man and Biosphere Committee, U.N.E.S.C.O and the Kainji Lake Research Insitute, New Bussa. V, 440 p. 1982

AYENI, J.S.O. et al (Eds.)
The helmet guinea fowl Numida Meleagris galeata Pallas. Ed. by J.S.O. Ayeni, Co-eds., J.A. Olomu and T.A. Aire. IX, 219 p. ill. 1983

AYENI, J.S.O. et al
Introductory handbook on Nigerian Wildlife by J.S.O. Ayeni, T.A. Afolayan and S.S. Ajayi. New Bussa, 80 p. Ill. 1982

OYEDIPE, F.P.A.
Adjustment to resettlement. A study of the resettled peoples in the Kainji Lake Basin. Ibadan University Press xiii, 167 p. 1983

KAINJI LAKE RESEARCH INSTITUTE
Pre-Impoundment Studies of Jebba Lake. ii, 86p. 1983

Technical Report Series and Occasional Papers

ITA, E.O.
Preliminary report on the fish stock assessment and management proposal for the IITA Ibadan Irrigation and Domestic water suppy reservoir. Kainji Lake Research Institute Technical Report Series No.1, 1978, 16p

YARO IBRAHIM
A practical approach to the design, construction and operation of mid-water trawl used in Kainji Lake, Nigeria. Kainji Lake Research Institute Technical Report Series No.2, 1979. 9p.

IBEUN, M.O.
Kainji Lake Basin, Nigeria: A multi-disciplinary bibliography 1957 - 1978. Kainji Lake Research Institute Technical Report Series No.4, 1979. 72 p.

ITA, E.O.
A review of recent advances in warm water aquaculture research and a proposed experimental design for maximizing fish production in Nigerian fish ponds. Kainji Lake Research Institute Technical Report Series No. 5, 1980

IBEUN, M.O.
An index to the proceedings of the International Conference on Kainji Lake and River Basins Development in Africa, Ibadan. 11-17 December, 1977. Kainji Lake Research Institute Technical Report Series No.6, 1980. 20 p

EYO, A.A.
The construction and operation of a new mechanical gas smoking kiln (Kainji Gas Kiln). Kaini Lake Research Institute Technical Report Series No.7, 1981. 13 p.

ITA, E.O.
Biological indices of overfishing in Kainji Lake and the management proposal for the lake fishery. Kainji Lake Research Institute Technical Report Series No.8, 1982, 31p.

IBEUN, M.O.
A preliminary report on the construction and use of a simple optical coincidence device in Kainji Lake Research Institute's Library. Kainji Lake Research Institute Technical Report Series No.9, 1983. 16 p.

CHAUDHRY, A.B. et al

Determination of optimum irrigation frequency for various field crops in the Kainji Lake region of the Nigerian Savanna. I. Onions (Allium cepa L). Kainji Lake Research Institute Technical Report Series No.10, 1983. 10p.

CHAUDHRY, A.B. et al
Determination of optimum irrigation frequency for various field crops in the Kainji Lake Region of the Nigerian Savanna. II. Cowpea (Vigna unguiculata (L) WALP). Kainji Lake Research Institute Technical Report Series No. 11, 1983

CHAUDHRY, A.B. et al
Determination of a package of inputs for maize (Zea mays L) Crop in the Kainji Lake Basin of Nigeria Savanna. Kainji Lake Research Institute Technical Report Series No.12, 1984. 15 p.

OBOT, E.A. et al
A computer programme for calculating the area colonized by emergent macrophytes in Lake Kainji. Kainji Lake Research Institute Technical Report Series No.13, 1984. 18p

ITA, E.O. et al
Inventory survey of Nigeria inland waters and their fishery resources. I. A preliminary checklist of inland water bodies in Nigeria with special reference to ponds, lakes, reservoirs and major rivers. Kainji Lake Research Institute Technical Report Series No.14, 1985.

IBEUN, M.O.
Nigerian Wildlife: A bibliography and bibliometric analysis 1930 - 1982. Kainji Lake Research Institute Technical Report Series No.15, 1985. 63p.

OBOT, E.A.
The management of aquatic macrophytes for livestock fodder: A case study on Echinochloa stagnina (Retz) P. Beauv. in in Lake Kainji, Nigeria. Kainji Lake Research Institute Technical Report Series No.16, 1985. 32 p.

OPENING ADDRESS BY THE MILITARY GOVERNOR OF KWARA STATE, LT. COL. AHMED ABDULLAHI TO DECLARE OPEN THE FIFTH ANNUAL CONFERENCE OF THE FISHERIES SOCIETY OF NIGERIA AT THE UNIVERSITY OF ILORIN ON 22ND SEPTEMBER, 1986 - DELIVERED BY THE HONOURABLE COMMISSIONER FOR AGRICULTURE

The President of the Fisheries Society of Nigeria (FISON)

Members of the Fisheries Society of Nigeria

Distinguished Ladies and Gentlemen

It gives me great pleasure to be in your midst to declare open the Fifth Annual Conference of the Fisheries Society of Nigeria (FISON) holding in Ilorin today. I am particularly delighted to note that your Society is trying to distinguish itself as one of the professional bodies in the country that are striving after improved professional practice. There is no gain-saying that the ultimate beneficiary from these efforts is the national economy. That is why the Kwara State Government is always eager to associate with and contribute towards the success of occasions like this.

You are no doubt aware that presently, Nigeria is facing series of nutritional problems. Recent occurrences like desert encroachment, the sahelian drought, the outbreak of rinderpest and the inability of the nation to meet the poultry feed components locally have all constituted serious constraints to our livestock development and thereby aggravating the problem of protein deficiency in the diet of the generality of our people. One of the very few alternatives open to this nation is to develop its fishery resources extensively. There are, therefore, high expectations that the Fishery sub-sector will rise up to the challenges posed by the inadequate supply of the livestock sub-sector. More than ever before, the members of your Society should appreciate the challenges thus posed to their dedication, resourcefulness and professional expertise. You owe it a duty to yourselves and to the nation to face these challenges with the determination to succeed.

To meet these challenges here in Kwara State, our Fishery sub-sector has, for example, taken a lot of measures to ensure the transferring of modern fishing techniques and equipment to fishermen throughout the State. Also, in line with the Federal Government's objectives of mass participation in the various aspects of our agriculture, we have evolved, through our extension programmes, an integrated small-scale fisheries and aquaculture development plan with maximum participation by the local target population.

Futhermore, it is realized that the National Agricultural programmes, including the Fisheries sub-sector, places a very high premium on self-reliance and the search for home-grown solutions to identified problems. In keeping with this national posture and strategy, we have set in motion measures to facilitate the early attainment of the ultimate goal of growing our own fish by utilizing the vast aquaculture sites that abound in the country. This is, however, one vital area where the support and participation of our Research Institutes and the Private Sector will continue to be required.

I have no doubt in my mind that all the State Governments in the country are as committed as we are in Kwara State to providing necessary incentives to private entrepreneurs coming to set up ventures in their States. This assurance is enough to encourage investors to combine aquaculture projects with other agricultural ventures to ensure the recycling of farm and agro-allied by-products that could have been left to waste. Although, it is appreciated that considerable financial outlay will be required initially, it will ultimately reduce the present acute shortage of fish seed, the usually high cost of production and make the final product more easily affordable to the consumer.

In order to encourage a greater number of entrepreneurs to go into these highly demanding aquaculture projects, Financial Houses and Government should show greater interest and involvement. In particular, the Federal Government should take urgent and decisive steps to ensure:-

(a) easy flow of loan at low interest to investors in this sub-sector;

(b) that good prices are guaranteed for the products as a means of providing ready markets for them;

(c) that policies are made to encourage fish processing industries all over the country;

(d) that sound ligislations are made to protect/ guarantee a healthy survival of the sector.

Finally, I hope that by the time you end this Conference, your Society would have been able to evolve sound resolutions that will give rise to better management and adequate coverage of the nation's water bodies for increased fish production. Such policies will enable us utilize our abundant water resources to produce the much needed fish for the country.

I now have the pleasure to formally declare open the Fifth Annual Conference of the Fisheries Society of Nigeria. I wish you fruitful deliberations.

Thank you.

AN ADDRESS BY THE HONOURABLE MINISTER OF SCIENCE AND TECHNOLOGY, PROF. E.U. EMOVON, ON THE OCCASION OF THE FIFTH ANNUAL CONFERENCE OF THE FISHERIES SOCIETY OF NIGERIA (FISON), HELD AT THE PERMANENT SITE OF THE UNIVERSITY OF ILORIN, KWARA STATE 22ND - 25TH SEPTEMBER, 1986 - DELIVERED BY MR. B.S.K. ONWELUZO, DIRECTOR, FEDERAL MINISTRY OF SCIENCE AND TECHNOLOGY

The Military Governor of Kwara State

Honourable State Commissioners and Dignataries

President, Grand Patron and Patrons of FISON

Distinguished Guests

Ladies and Gentlemen

I am pleased to be invited to address you at the opening session of the 5th Annual Conference of your Society. I consider this occasion very important, inview of the present Administrations's policy to make our nation self sufficient in food production. I also consider the theme of this conference which is "Investment Opportunities in Nigerian Fisheries" and the topic for the symposium, Commercial Aquaculture in Nigeria", not only relevant but timely and appropriate at this critical period of our nation's economic history.

In the fisheries sub-sector, my Ministry has three Institutes which have facilities for research and the training of technicians and other middle level manpower for the fishery industry. These Institutes are:-

(i) the Nigerian Institute for Oceanography and Marine Research (NIOMR) in Lagos, which is charged with the responsibility for marine and brackish water fisheries research and aquaculture. The School attached to NIOMR trains Fisheries Operatives such as fishermen, coxwain, mates, motormen and diploma holders at Ordinary and Higher levels. It also offers annual Induction Courses and continuing education for Fisheries and Research Officers in the employ of both Federal and State Governments;

(ii) the Kainji Lake Research Institute (KLRI) at New Bussa (the host for this Conference) has as one of its mandates, research into man-made lakes and major rivers in the country, as well as undertake training in freshwater fisheries and aquaculture;

(iii) the Lake Chad Research Institute at Maiduguri which also has as part of its mandate, research and training programmes in fisheries and aquaculture.

I must stress, however, that the training programmes a these institutes have practical orientation and this has been assisted by the collaboration of the private sector, through industrial attachment of the students. While expressing appreciation to the private sector for this gesture, I wish to appeal to all commercial fishing entrepreneurs, particularly the Nigerian Fishing Trawlers Association, to intensify their cooperation with the Fisheries Schools, by accepting more students on the mandatory attachments to expose them to all aspects of practical fishing.

In our continued effort to improve the training facilities in these schools, my Ministry has recently set up an Interministerial Committee to review the syllabi and assess the training facilites at the Lagos Fisheries School and the Nautical College at Oron. This exercise will facilitate the pooling of resources for the training of Nigerian Skippers locally. The Committe comprises the following:-

- The Nigerian Navy,
- The Nigerian Fishing Trawlers Association,
- The Federal Ministry of Transport and Aviation, Maritime Division,
- The Federal Department of Fisheries of the Federal Ministry of Agriculture, Water Resources and Rural Development, and
- My Ministry including N.I.O.M.R.

It is pertinent to note that the Nigerian fishing industry is presently dominated by foreign fishermen and skippers. In fact, up till now, the few Nigerian skippers available have been trained abroad at great expense with scarce foreign exchange. Yet, the combined facilities at NIOMR and Oron are comparable to those available in some of the institutions we patronise in other countries. In the desire towards self-reliance, we need to pool our (private sector and government) resources together to build up the fisheries industry to a higher standard.

As you may be aware, total fish production from local sources in the country has shown a gradual decline from a high level of 538,350 metric tonnes in 1983 to 366,630 and 349,230 metric tonnes in 1984 and 1985 respectively. On the other hand, the estimated national demand is put at between 1.5 and 2.0 million metric tonnes per annum. This situation of shortfall of supply relative to demand need not occur and definitely should not be allowed to continue in this country where protein deficiency and its resultant malnutrition have stunted full physical and mental development. The country has, for a long time. made up this gap by massive importation of fish, giving rise to what became known as the 'fish armada' invading our shores. This importation was supported by the foreign exchange earning from crude oil. It was the

easier way out of the short supply. This course of action was not due to lack of adequate knowledge and skill in fish production in the country. I am aware that there is a wealth of information, knowledge and skills in fisheries in our research institutes and institutions of higher learning. Therefore, considering this Adminstration's commitment to self sufficiency in food production, including protein production, there should be a tightening of the noose on fish importation. Our entrepreneurs should make use of the existing local expertise to invest more in marine and inland fisheries.

Some Nigerian fishery entrepreneurs singly or in partnership with foreign companies, are today, involved in extensive shrimp fishing, the bulk of which are exported overseas, thereby earning considerable foreign exchange for their companies and the nation. The survey data on shrimp resources of Nigeria's territorial waters, for example, was provided by one of my Ministry's Research Institutes, the Nigerian Institute for Oceanography and Marine Research in the early 1970's. This information was a challenge to entrepreneurs and it has yielded dividend. Similar surveys have been made in the case of the tuna fish and the data is now available in the same Institute. The data show conclusively that commercial stocks of tuna and tuna-like fishes are available within and immediately outside the Nigerian Exclusive Economic Zone (EEZ). This survey has estimated that about 10,000 metric tonnes of tuna can be harvested annually without depleting the stocks.

Although tuna fishing is quite technical and cost intensive, it is of interest to note that tuna ranks next to shrimps as two of the most valuable products in the world's fishery export market. Tuna, like shrimps has high foreign exchange earning capacity. There is also abundance of other ingredients such as soya bean oil, water, tomatoes and pepper, to support a tuna-canning industry in Nigeria. Canned tuna has been shown to enjoy wide acceptability by generality of Nigerians. Not only will canned tuna be a good substitute for imported canned sardines, the cannery wastes can be converted into high quality feeds for our poultry industry.

There is, however, a limit beyond which fish production from natural sources alone (both marine and inland waters) cannot be stepped up to meet national demand, without serious damage to our fishery resources. It is, therefore, of relevance that this Conference is discussing "Commercial Aquaculture" as a possible alternative source of supplementing natural production. There is enough evidence to show that although local fishermen not only spend long days at sea, their catches are so small in sizes and quantity that minimal income is realised from sales.

It is hoped that with the information from this Conference, many private investors would be encouraged to establish more commercial fish farms either singly or in partnership

with foreign investors. Small scale fishermen could also pool their resources together, possibly through formation of cooperatives, to take advantage of Agricultural Loan Scheme and go into fish farming, making use of the fresh or brackish waters that surround their fishing villages. Fisheries scientists in three of the Research Institutes under my Ministry, not only offer advisory and consultancy services in these areas of aquaculture, but the Institutes also produce fish seed and fingerlings for stocking fish ponds, as well as feeds for the fishes raised in ponds.

Experience in China, India, and Indonesia have shown that where aquaculture has been properly managed, it can be a major protein-sourced industry. It has also been demonstrated that labour intensive rural aquaculture can provide full or part-time gainful employment for a considerable number of people, thereby enhancing the economic activities and standard of living of the rural population.

Through the National Directorate of Food, Roads and Rural Infrastructure, the Federal Military Government intends to encourage interested commercial fish farmers through the provision of basic infrastructures like pipe-born water, good roads and electricity in the rural areas. With these facilities and financial assistance from the Agricultural Loan Scheme, our teeming unemployed graduates and young secondary school leavers can take up fish farming as noble occupation. This can help reduce the rate of unemployment as well as contribute to the production of high quality protein foods for the country, and thus help reduce our dependence on fish importation.

I congratulate the organisers of this Conference and assure you of my Ministry's continued service in research and dissemination of research results for the development of the fishery sub-sector of our economy. I consider the information that will emanate from this Conference very vital to the nation in the areas of "Investment Opportunitie in the Fishing Industry" and look forward to receiving your recommendations.

I thank you for your attention and wish the participants at this Conference a very successful deliberation.

Thank you.

KEYNOTE ADDRESS BY CHIEF M.C.O. IBRU, O.F.R. AT THE OPENING OF THE 5TH ANNUAL CONFERENCE OF THE FISHERIES SOCIETY OF NIGERIA (FISON) HELD AT ILORIN FROM SEPTEMBER 22ND - 25TH, 1986 - DELIVERED BY MR. J.E. UDUEHI, CHIEF EXECUTIVE, IBRU ORGANIZATION

The Military Governor of Kwara State
Lt. Col. Ahmed Abdullahi

Honourable Minister of Science and Technology

Distinguished Guests.

The President and other Council Members of FISON

Ladies and Gentlemen

This is the second time that I shall be having the honour and privilege of addressing you as the Grand Patron of the Fisheries Society of Nigeria. The first time was at the Inaugural Conference of the Society in Lagos in January 1976. It is significant that this opportunity has come again after 10 years.

2. From all indications and reports, this promises to be the most well thought-out and planned Conference of FISON so far. The theme, the venue, and the calibre and variety of delegates are very appropriate for a successful meeting. I congratulate the planners and the Society for the progress so far recorded.

3. We formed this Society in 1976 with the following objectives:-

(i) To foster interest in fisheries and fishery industries in Nigeria.

(ii) To provide the necessary forum for exchange of ideas among the various individuals and organisations engaged in fisheries activities in Nigeria.

(iii) To disseminate fisheries knowledge through publications, lectures, seminars, symposia, films and exhibitions.

(iv) To be in close collaboration with Societies having related interest both in Nigeria and other parts of the world, and

(v) To promote research and development and utilization of fisheries resources of Nigeria.

4. Looking back a decade since the formation of our Society, it is difficult to determine to what extent if at all, the objectives of the Society have been wholly or even partially achieved through the deliberate activities of the Society itself. Honestly, I do not think that, as a society, we have collectively done much to advance the development of fisheries in Nigeria. The organisational problems of the Society have no doubt contributed in large measure to this failure. However, we seem lately, to have become better organised and I hope that, henceforth, we shall pursue vigorously, the attainment of the noble objectives which we set for ourselves in 1976.

5. The theme of this Conference, "Investment Opportunities in Nigerian Fisheries", is a very appropriate one for Nigeria's present economic position. The economic down-turn demands judicious investment of scarce financial resources.

6. The importance of fish to our nation cannot be overemphasised. Fish has been, or perhaps I should say, fish used to be the cheapest and most wholesome source of animal protein available to the common man in Nigeria. When 25 years ago we of the IBRU Organisation went into the frozen fish business, it was because we were convinced of its nutritive values and the fact that it would help in no small measure in reducing the protein deficiency in the average Nigerian diet since it was so cheap that it could easily be afforded by the common man. Until recently when the price of fish rose as a result of the widening gap between supply and demand, it was estimated that more than 40% of the animal protein consumed by the average Nigerian came from fish. However, the continued shortage of meat owing to the Sahellian drought and rinderpest attacks on livestocks have brought increasing pressure on more fish supply for human consumption in the country.

7. Unfortunately, fish production in Nigeria from available statistics started declining since 1983 when the local production declined from 540,000 tonnes to about 350,000 tonnes in 1984. The total National fish demand for 1985 (see FAO Fisheries Technical Paper No.221 page 17) was projected at 1.9 million tonnes, while the total domestic producting including industrial, coastal, and inland fisheries was estimated at 0.6 million tonnes. The seriousness of the shortfall between demand and supply for a commodity that used to be the cheapest source of animal protein available to the Nigerian populace is immediately obvious; and if adequate measures are not taken to narrow the gap between supply and demand, widespread malnutrition with disastrous consequences would be inevitable.

8. It is against this background that I would like us to examine the opportunities for investment in Nigerian Fisheries. Two major groups of investors are envisaged, namely the Government on the one hand and the

Private Sector investment on the other. Government investments in Nigerian fisheries have largely been in the provision of inputs to and infrastructure for the support of the Artisanal Sub-sector of the Nigerian Fishing Industry. Significantly, about 70% of the total domestic production is attributable to Artisanal fisheries. More encouragement should therefore, be given to this sub-sector to enable it increase its contribution towards domestic production and to enhance the socio-economic status of the artisanal fisheries.

9. Some of the major constraints hampering the rapid development of fisheries with particular reference to the Artisanal sub-sector have been identified as follows:

(i) Inadequacy of modern inputs for fishing;

(ii) Lack of shore based infrastructures at fishing settlements, such as landing jetties, repair workshops, net lofts, fuel and water supply facilities;

(iii) Poor and most often non-existing access roads and other means of communication between key production areas and marketing as well as administrative centres;

(iv) Lack of proper processing, storage, distribution and marketing facilities resulting in post-harvest losses; Antiquated fishing craft and gear; lack of capital with which to purchase modern fishing inputs;

(v) Inadequate provision of boat-yard facilities;

(vi) Poorly organised and badly managed fishermen organisations or cooperatives.

(vii) Absence of Fisheries Resources surveys in perennial freshwater bodies, lagoons, and flood plains which have high potentials for fish production.

(viii) Absence of an acoustic survey of pelagic resources off Nigeria's coastline.

(ix) Antiquated harzardous and inefficient canoes operated by small-scale fishermen.

(x) Non-functional, ineffective and unviable local fishermen marketing cooperative societies.

(xi) Grossly inadequate facilities for building fishing boats in Nigeria.

(xii) Lack of encouragement to existing fishing gear manufacturing companies so that acquisition of craft and engines may be meaningful in terms of effective fishing operations while a facelift should be given to the existing companies with the aim of producing fishing nets with greater percentage of the required raw materials from Nigeria.

(xiii) Absence of a comprehensive manpower Development and Training programme for the following cadres:

- Fishing vessel Engineers;
- Fishing Vessel Deck Officers and Skippers;
- Ice Plant and Cold Storage Operators;
- Establishment of Fishermen Training Centres (Mechanics, Fishing gear and Fishing boat Operators);
- Refresher Courses for old Fishermen and Extension Workers.

10. Private Sector investments in Nigerian Fisheries so far have been largely in the:-

- Coastal marine fishing sub-sector;
- Deepsea marine fishing sub-sector; and more recently in Aquaculture.

These areas particularly aquaculture can contribute significantly toward bridging the widening gap between local production and demand. However, there are serious problems with industrial marine fisheries. In spite of the often repeated ascertion that "Nigeria is rich in marine and freshwater fisheries resources", it is really not true that Nigeria is rich in marine resources. The Nigerian continental shelf is unfortunately very narrow and does not harbour enough fish even for the relatively few vessels now operating in our coastal waters. The situation is not much different within the EEZ limit as our trawling experience so far seems to indicate that the stock of fish within our territorial waters is commercially unviable. The position is further worsened by pollution of different kinds and unchecked poaching. There is therefore, an urgent need for a stock assessment of commercially important species of fish not only in our coastal waters but also within the entire economic zone limit.

11. Apart from the fact that the Nigerian territorial waters are not a rich resource zone, industrial marine fishing is capital intensive and unless sufficient incentives are provided by Government, prospective investors will continue to find the industry unvaible.

It is pointless encouraging the building of a massive fleet unless our marine fish resources are fairly well established or other fishing grounds are found for our fishing vessels.

12. The reluctance of commercial banks to invest in industrial marine fishing projects in this country may have something to do with the lack of statistical data on fish population against which the viability of the projects can be measured or assessed.

13. Other areas of difficulty being faced by industrial marine fisheries include the following:-

(i) The fishing industry generally does not enjoy the same special treatment being given by the Government and banking institutions to other agricultural activities such as grain production, livestock production, etc. For example, it is hard to understand that at a time when every effort is needed to bring about the much desired self-sufficiency in food production, duty is being imposed on fish caught and landed by Nigerian Flag Vessels. Banking institutions on the other hand charge maximum lending interest rates on loans granted to the industry.

(ii) Although the Federal Government has in recent years commissioned some fishing terminals, they are by far too few and too ill-equipped to serve the growing needs of the Marine Fishing Industry. More fishing terminals need to be constructed notably in Lagos.

(iii) Nigerian Flag Fishing Vessels depend heavily on foreign crew at the moment to man their trawlers owing to the shortage of trained Nigerian personnel. Special attention ought to be given to Manpower Development for the Industrial Marine Fishery sector to produce sufficiently motivated and specialised manpower to manage and operate the fisheries.

(iv) The price of automative gas oil is too high to make the operations viable. Some other countries give direct subsidies to fishing vessels to make their operations more competitive and viable.

14. The gaps pointed out above should not be construed as indicative that government has, in the main, folded its arms. Government has indeed been playing an increasing role in the fisheries sub-sector.

It is noteworthy that a complete package subsidised inputs for artisanal fishermen was provided for during the Third and the Fourth National Development Plans. The Government has also tried to uplift the status of fishermen

cooperatives along the coast of Nigeria by the provision of infrastural facilities such as the establishment of fishing terminals for industrial fisheries.

15. However, past government efforts notwithstanding, much assistance is still required from the Government if the Industrial Marine Fishery subsector is to contribute effectively and substantially towards the national aspiration of self-sufficiency in fish production.

16. Another sub-sector which offers great investment opportunities because of its potential for rapid and substantial fish production is Aquaculture, which can be practised virtually everywhere in the country. Here again, however, there are problems relating to:-

- manpower development,
- infrastructural development,
- provision of the necessary inputs such as fingerlings and fries, fish feeds, etc.,

which need to be seriously addressed before the sub-sector can make the desired impact.

17. Earlier, in connection with industrial marine fishery, the need for indigenising our fishing manpower resource had been mooted. What is really needed is a comprehensive and progressive training programme to cater for the requirements of the various fisheries sub-sectors, which is only possible when a national policy for fisheries education is formulated. It is unbelievable that in spite of several workshops and seminars and their useful recommendations, successive governments have not found it necessary to formalise a national policy for fisheries or indeed agricultural education. Until such a policy is formulated and legalised, the often talked about domination of the fishing industry by foreigners will continue.

18. There is also the need for prompt dissemination of new technologies in fishing and fisheries to the commercial sector of the industry by an effective liaison network between fisheries research, development, and the commercial sector. The working relationship between the fisheries research institutes and the development departments require a reappraisal for better effective achievement. How many fishing companies are using the human and material resources in our Research Institutes? The best most of these companies know about these Research Institutes are their Training Schools to which their junior and middle-level staff are sent for basic training. How much useful research information has been passed to the industry? Very little, if any at all. The machinery for technological transfer between the research institutes and the industry needs overhauling. More frequent workshops, seminars, exhibitions and personal visits are required.

19. I am certain that during the course of this Conference various opportunities for investments in Nigerian Fisheries will unfold themselves; but so also will the various problems being encountered by those who are already in the industry. It is important that our recommendations should be put before the appropriate authorities and I should like to leave you with the following recommendations for consideration along with others in your proposals to Government:-

(i) The mounting of Fisheries Resources surveys in perennial freshwater bodies, lagoons, and flood plains because they are of high potentials for fish production.

(ii) Undertaking as a matter of urgency acoustic survey of pelagic resources off Nigeria coastline.

(iii) Modernisation of traditional dug-out canoes operated by small-scale fishermen into fibre glass boats of 6 m - 10 m LOA. This could be followed by mechanisation of various types of small and medium sized craft suitable for operation in difficult coastlines, open beaches and inland waters.

(iv) Organisation of local fishermen into viable functional and productive marketing cooperative societies.

(v) Establishment of facilities for building fishing boats in Nigeria as a long term measure and in the the interest of fishing industry. Existing boatyards would need to be developed and strengthened. The Federal Military Government should look into the production problems being faced by private FRP boat building organisations in order to produce enough fibre glass boats locally and at affordable prices for the fishermen to discourage importation of the finished products. Prompt action by the Government at this critical time may help to conserve scarce foreign reserve and bring this basic fishing input within the reach of fishermen. Local production/assembly of Outboard engines is a point to be looked into by the Federal Military Government too.

(vi) The Federal Military Government should encourage the existing fishing gear manufacturing companies so that acquisition of craft and engines may be meaningful in terms of effective fishing operations while a face-lift should be given to the existing companies with the aim of producing fishing nets with greater percentage of the required raw materials

from Nigeria. With the availability of enough and cheap fishing nets locally, efforts should be re-doubled in developing modern and efficient gear design and fabrication to enhance increased production.

(vii) Massive manpower development and training of the following cadres:-

- Fishing Vessel Engineers;
- Fishing Vessel Deck Officers and Skippers;
- Ice Plant and Cold Storage Operators;
- Establishment of Fishermen Training Centres (Mechanics, Fishing gear and Fishing boat operators);
- Refresher courses for old fishermen and Extension workers.

(viii) The Federal Government should re-double efforts to secure fishing grounds for Nigerian Fishing vessels and organisations with other countries.

(ix) The Federal Government should reconsider the duties and taxes levied on fish catches and landing by indigenous fishing concerns as a way of bringing fish and fish products within the reach of the common man.

(x) The Federal Government should seriously tackle the problem of oil polution especially in oil producing creeks and along our coastline.

(xi) The Federal Government should evolve a bold long term programme of fish regeneration in Nigeria's coastal and inland waters.

(xii) The Federal Government should devise a mechanism for making available to fish farmers and fishermen the benefit of research and new technologies from the research institutes. At present, both groups appear to work separately, oblivious of each other.

(xiii) With the impending introduction of SFEM the Federal Government should ensure the protection of the fledgling local fishing industries against devious and direct fish importation.

(xiv) The Federal Government should urgently consider evolving a national policy on fisheries and fisheries education.

20. We should not forget that because of scarce foreign exchange, it is now becoming extremely difficult to bring more Fishing Vessels and needed spare parts into the country. It is necessary therefore, that the Private Sector should make every effort to establish in joint partnership Boatyards that can construct small and medium size fishing vessels and fabricate spare parts.

21. Gentlemen, the above suggestions are by no means exhaustive. However, I consider them adequate as a launching pad for further and more detailed discussion of the fishing and fish problems of this country. I wish you successful deliberation.

SECTION 2: CAPTURE FISHERIES INVESTMENT PROSPECTS

INVESTMENT PROSPECTS IN INLAND CAPTURE FISHERIES WITH SPECIAL REFERENCE TO SMALL RESERVOIRS: THE EXCLUSIVE FISHING RIGHT LICENCE MODEL

by

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ABSTRACT

The paper discusses simple methods of estimating fish yield from small reservoirs and establishes two indices of fish yield based on:-

(i) the relationship between the catch per boat in artisanal commercial fish landing and the catch per unit effort in experimental gill-net survey and also,

(ii) the relationship between standing crop of fish in reservoirs and catch per unit effort in experimental gill-net survey.

The paper then elaborates on the methods of utilizing these simple relationships in managing small reservoirs based on the principle of exlcusive fishing right licence with the objective of attracting investors into this viable inland fishery investment project hitherto untapped.

INTRODUCTION

The creation of States and establishment of River Basin Authorities in the country have given rise to series of rural development schemes in the form of agricultural development, which necessitate the storage of water in small to medium size reservoirs. Ita et al (1985) have listed all such reservoirs in all the States of Nigeria stating their location, surface area and ownership. With the exception of some reservoirs owned by River Basin Authorities in the country, with some Fishery Development Schemes as one of their major objectives, none of the other agencies that construct reservoirs have any fishery development objectives in their proposal.

Ita et al (1982) noted that even in the cases of some reservoirs owned by River Basin Athorities where the feasibility report indicated substantial fishery benefits, the participation of fishery experts often come much too late in the planning process thus, fishery problems are not usually considered in the engineering design or provided for in the basin development plans.

One possible reason why fisheries development is not always included in reservoir projects plans is that most fisheries feasibility reports do not always express the benefits to be derived from reservoirs in economic terms besides indicating the possible tonnage of fish to be produced. Most policy makers and decision takers for reservoir projects are not usually conversant with the market value of fish and hence the conversion ratio of fish tonnage into Naira and Kobo. They are of course familiar with converting the volume of stored water into possible irrigation field area, and electricity generation and/or number of households to be supplied with treated water and possible rates to be collected. Because of these reasons, the fishery projections are usually left untreated.

Although, major decisions such as possible areas of the reservoir to be cleared of trees and stumps to permit smooth active fishing and inclusion of fish passes in the dam design to permit upstream and downstream migration of spawning fishes require decision taking at the pre-impoundment level, nevertheless fisheries management and development are always possible in all reservoirs after impoundment.

This paper attempts to justify the above contention and to outline in simple non-technical terms the prospects of commercial fisheries in most reservoirs currently lying fallow in the country using the strategy of exclusive fishing right licence method of management and development.

BACKGROUND INFORMATION

Numerous small reservoirs are already in existence in the country majority of which are owned either by the Water Corporation of most States or the River Basin Authorities for their massive irrigation projects. Those constructed by the National Electric Power Athority (NEPA) are too big to be utilized for the proposed "Exclusive Fishing Right License Scheme". Similarly, some of those constructed either by the River Basin Authorities or Water Corporation of some States are also too big for the proposed scheme being in excess of 1,000 hectares. Table 1 shows a list of such reservoirs indicating their location, surface area and ownership. These reservoirs are better managed for public utility with the requisite number of fishermen registered and licensed to fish in them under speified laws and regulations.

Table 2 shows the existing number of small reservoirs measuring below 1,000 hectares (10 km²) in most States of the Federation. A few of these reservoirs have been surveyed by the Kainji Lake Research Institute and would therefore, be utilized for the discussion on the "Exclusive Fishing Right License Model".

MATERIALS AND METHODS

Short term surveys were carried out in some of the reservoirs to determine the species composition of the naturally occurring fishes in the water bodies. The surveys included:

(i) Experimental Gill-net Survey

Experimental gill-net survey using a standard fleet of gill-nets with graded mesh sizes comprising 25.4, 50.8, 63.5, 76.2, 88.9, 101.6, 127.0, and 177.8 mm stretched mesh sizes. The 25.4 mm mesh net was added to the traditional sampling fleet of seven mesh sizes (2, 2½, 3, 3½, 4, 5 and 7 inch stretched mesh sizes) each measuring 30 meters long and 3 meters deep giving a total fleet surface area of 630 m². The catch per fleet was usually extrapolated to catch per 1,000 m² of net surface area for the purpose of standardization of the catch per unit effort (catch per night). The 25.4 mm (1 inch) mesh was added for the purpose of compiling a complete list of species in the reservoirs including the small adult species not usually captured in 50.8 mm (2 inch) stretched mesh size.

(ii) Frame and Catch Assessment Surveys of Commercial Fisheries

Statistical frame and catch assessment surveys of the commercial fisheries were usually conducted simultaneously with the experimental gill-net survey in order to determine the total number of artisanal fishermen exlploiting the fisheries of the small lakes and their mean catch per boat. The methods for the above surveys are as described in Bazigos (1972) and Ekwemalor (1977). The objective of such a comparison was to establish some relationship between the catch per boat in commercial landing and the catch per 1,000 m² of graded fleet of net in experimental surveys. This was intended to cut down expenditure in field surveys by using one to extrapolate the other.

(iii) Standing Crop Estimates

Cove rotenone sampling using fish toxicants were usually conducted in the larger reservoirs in the country not utilized for drinking water. The survey involved the blocking of unit areas of the littoral zones preferably coves or inlets and applying the requisite amount of fish toxicant to kill all the fish in the blocked area.

The total number and weight of fish collected in the blocked areas were then scaled up to biomass or standing crop per hectare of the shoreline sampled. Often, the stations chosen in most lakes for rotenone survey corresponded with the stations sampled with the gill-net fleets. In most cases, the two surveys were conducted simultaneously for purposes of direct comparison.

The comparision was also intended to save cost and labour in field surveys if it became possible to extrapolate one from the other. Since it is not advisable to conduct cove rotenone surveys in small drinking water reservoirs, such conversion would be very useful in determining the standing crop of fish in small reservoirs simply by converting the catch per 1,000 m^2 of net per night to the corresponding standing crop (density and biomass of fish per hectare). Such estimates were intended to supply information on the current fish production status of the reservoirs in order to determine the possible line of management to adopt. The quantity of fish that would be needed to stock any reservoir could then be determined if the current fish density and biomass in the reservoir were known.

RESULTS AND DISCUSSION

Relationship of Commercial Catch per Boat to Experimental Catch per 1,000 m^2 of Net Fleet

Figure 1 shows a positive correlation between the catch per boat in the artisanal commercial fish landing and the experimental catch per 1,000 m^2 of graded multifleet gill-nets with a regression equation

$Y = 2.8 + 1.3 x$ and correlation coefficinet

$r = 0.7219$

One possible reason for the observed higher commercial catch per boat compared with the experimental catch per 1,000 m^2 of gill-net fleet is that the artisanal commercial fishermen spend more time fishing on the lake with assorted fishing gears such as gill-nets, cast-nets, hooks and traps than is usual with experimental sampling. Also, fishermen invest more in the mesh size of gill-net that catches the greatest number of fish whereas the experimental fleet is aimed at catching assorted sizes of fish with the aim of identifying the most abundant size groups for the various species. However, if the catch in any of the popular meshes of the experimental gill-net fleet is scaled up to catch per 1,000 m^2 for the particular mesh size, the result would always reflect a higher catch per unit effort equal to or greater than the artisanal commercial catch per boat.

The experimental catch per 1,000 m² of the gill-net fleet was, however, kept constant in all sampling occasions because of the inability of the research team to compete with the commercial fishermen in both effort and assorted gear types used by them. The philosophy behind the constant experimental sampling method was that the experimental catch per 1,000 m² of gill-net fleet could be a good index of fish abundance in any of the water bodies sampled. Therefore, a high catch per 1,000 m² of the experimental gill-net fleet would indicate a corresponding high catch per boat in the artisanal commercial fish landing.

Care should, however, be taken in utilizing the regression equation since the comparision is limited strictly to artisanal small-scale canoe fisheries in inland waters with relatively low efficiency gears but with increased fishing effort. The regression does not apply in the case of active fishing gears as observed in Jakara Reservoir, Kano State, where the mean catch per commercial boat utilizing beach seine net was as high as 110.7 kg compared with 4.5kg per boat for those utilizing gill-nets, cast-nets and hooks. The high catch per boat with beach seine was attributed to the small mesh size of the seine net used (25.4 mm) thus, catching mostly immature tilapias. Similarly, catch per boat of artisanal fishermen using specialized lift net or ring net in the brackish water areas for catching schooling populations of migratory fishes could be relatively higher than is reflected in the regression equation in this paper. Mechanization of the fishing craft does not, however, affect the catch per boat in the equation since the statistics was usually collected from both mechanized and unmechanized boats.

The significance of this comparison lies in the fact that if a new reservoir is sampled experimentally, it would be possible to predict what the artisanal fisherman was likely to catch in the absence of a statistical survey team. This information is important in the sense that a private owner of a reservoir would be able to determine the estimated effort of a commercial fisherman fishing in his reservoir using the experimental catch record as an occasional spot check.

Relationship of Standing Crop to Catch per 1,000m² of Gill-net Fleet

Figures 2 and 3 show two positive correlations between the standing crop of fish sampled and the catch per 1,000 m² of gill-net in experimental gill-net fleets. The regression equations and correlation coefficinets are

$$Y = 10.0 + 17.7X,$$

$$r = 0.7922 \text{ and } Y = 13.2 + 17.7X,$$

$$r = 0.8118 \text{ respectively.}$$

Figure 2 shows the relationship based on simultaneous sampling programmes with the gill-net fleet set along the shore very close to the cove rotenone station while Figure 3 reflects a combination of the data in Figure 2 with records of gill-net data collected within the same month after sampling the same locality with rotenone. Contrary to expectation, a lower positive correlation is observed for the former, possibly because the sample size is small, than the latter. This notwithstanding, the two regression equations give comparatively similar conversions when Y is substituted for.

The significance of this comparison lies in the fact that it would be possible to estimate, even with a limited degree of accuracy, the expected standing crop of fish in domestic water reservoirs not usually sampled with fish toxicants. Since the standing crop has been observed to be highly correlated with fish density (Ita, 1984) as shown in Figure 4, it would be possible to estimate approxomately, the expected fish density in the inshore habitats of any reservoir sampled with the gill-net fleet. This information is useful in determining the level of investment needed in the quantity of fish fingerlings for stocking reservoirs.

Exclusive Fishing Right Licence Model

Exclusive Fishing Right Licence refers to the process by which a prospective investor contacts the owner of any reservoir in his State or any other State in the Country to negotiate for an exclusive fishing right in the reservoir before proceeding to invest money in the management of the reservoir. Currently, most reservoirs in the country are fished by a few or many artisanal fishermen whose only interest is to catch whaterver fish is naturally occurring in the reservoir without any regards to the management of the water body for increased fish production.

In a few of such reservoirs in the country, some artisanal fishermen are licensed to fish by paying a token monthly or annual levy to either the Water Corporation or the Local Authority of the area. Such fishermen depend exclusively on the natural productivity of the reservoirs and because of the absence of Inland Fisheries Laws stipulating rules and regulations for the fisheries of such water bodies, they tend to over-exploit in order to maximize profit.

In Fisheries Management, the major consideration should be to maximize production in terms of fish landings without necessarily depleting the stock. Maximization of the catch in African reservoirs has been observed to be possible with a maximum of 2 fishermen per boat per Km^2 beyond which the catch rate was observed to drop (Henderson and Welcomme, 1974). Often, when there is a proposal for the State Fisheries Departments to regulate the fisheries of their water bodies by licensing the fishermen and eliminating

the excess number of fishermen, there is usually the outcry for a possible loss of employment by most fishermen. Experience has however, shown that all fishermen are part-time farmers but not all farmers living along a lake shore are part-time fishermen. In the event of registration and licensing of fishermen, most part-time fishermen would take to full-time farming if they find the licence fee uneconomical. It is believed that the States would gain immensely both in terms of increased fish production from their water bodies and revenue from licensing if the requisite number of fishermen are licensed to fish in the bigger reservoirs measuring more than 10 Km^2 in surface area.

In smaller reservoirs measuring below 10 Km^2 in surface area, it is proposed that such reservoirs be given to prospective investors who are willing to pay not just a token licence fee, but a computed annual rate in proportion to the surface area of the reservoir in question.

Given an exclusinve fishing right licence, how can a prospective investor manage the reservoir to obtain sufficient catch to offset his investment? Ita and Sado (1985) have estimated the potential yield of small reservoirs to be about 100 Kg/ha/yr with little or no mangement and about 500 Kg/ha/yr with adequate management. This in effect means that given a reservoir of about 100 hectares (1 km^2) in surface area, it is possible to harvest between 10 - 50 tonnes of fish each year from such a reservoir. Estimated at the current market value of fish at a an average of ₦3.00 per kilogram, it is possible to realize between ₦30,000.00 and ₦150,000.00 a year on fish sales from such a reservoir with minimal input during the first year of operation.

Table 3 shows the financial analysis for the mangement of a typical irrigation reservoir of size 100 hectares during the first year of operation. Although the profit margin after tax appears to be lower during the first year, there is minimum input during the second year mostly recurrent and some replacement of fishing materials. If the reservoir is adequately stocked during the first year, no additional investment would be incurred subsequently since the fish would adapt and reproduce in the reservoir.

Table 4, however, shows three financial profitability indicators used to assess the project. The first is the Net Present Value (NPV) of the project which is positive at ₦122,080.45. The second is the pay-back period obtained at 2.1 years. This indicates that the loan of ₦90,000.00 to be sought from bank for the project will be defrayed in 25 months. The last is the Internal Rate of Returns (IRR) calculated at 40%. This shows that the business will multiply itself at more than tripple rate of the bank loan rate. The business is therefore, worth undertaking by any interested individuals or company.

Other relevant tables used in obtaining these three indicators are shown in the Appendices 1 - 3.

CONCLUSION

The potentials of small reservoirs currently lying fallow in the country have been highlighted together with feasible methods of managing them as small scale investment projects using the method of exclusive fishing right licence.
It is hoped that investors will explore this viable area of inland fisheries investment currently untapped in the country.

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ACKNOWLEDGEMENT

The financial analysis for this paper was carried out by Mr. J.O. Ayanda, the Economist, Kainji Lake Research Institute, New Bussa.

Table 1 - List of existing reservoirs in the country larger than 10 Km² or 1,000 hectares (From Ita et al, 1985)

Reservoirs	State	Surface Area (Km²)	Onwership
Kainji Reservoir	Kwara, Niger & Sokoto	1270	N.E.P.A.
Jebba Reservoir	Niger & Kwara	350	N.E.P.A.
Shiroro Reservoir	Niger	312	N.E.P.A.
Chalawa Gorge	Kano	101	W.R.E.C.A. of Kano State
Gari Reservoir	Kano	33	-do-
Jakara Reservoir	Kano	17	-do-
Ruwan Kanya Reservoir	Kano	15	-do-
Tiga Reservoir	Kano	178	-do-
Thomas Reservoir	Kano	15	-do-
Kontagora Reservoir	Niger	35	Niger Basin Authority
Oyun Reservoir	Ogun	40	Ogun Oshun Bas. Authority
Owena Reservoir	Ondo	15	State Water Corporation
Asejire Reservoir	Oyo	24	State Water Corporation
Doma Reservoir	Plateau	12	L/Benue Basin Authority
Bakolori Reservoir	Sokoto	80	Sokoto Basin Authority
Goronyo Reservoir	Sokoto	200	-do-
Kauranamoda Reservoir	Sokoto	22	Min. of Water & Elect Supply

Table 2 - Number and total surface area of available small reservoirs not exeeding 10 Km² (1000 ha) each in surface area in various States in the Country

(Extracted from Ita et al, 1985)

State	Number of small Reservoirs	Total Area (Ha.)	Mean Surface Area (Ha.)	Remarks
1. Anambra	15	5,038	335.1	
2. Bauchi	18	1,281	71.2	2 above 20 km² each
3. Bendel	3	329	109.7	
4. Benue	2	20	10.0	
5. Borno	3	34	11.3	
6. Cross River	5	916	183.2	Some big natural lakes .
7. Gongola	Nil	-	-	One above 10 Km²
8. Imo	9	3,524	391.6	
9. Kaduna	34	13,444	395.4	Plus numerous cattle dams
10. Kano	21	13,041	621.0	2 above 10 Km² each
11. Kwara	14	1,971	140.8	Some with unknown area
12. Lagos	Nil	-	-	
13. Niger	6	5,744	957.3	2 above 30 Km² each
14. Ogun	3	128	42.7	3 with unknown area
15. Ondo	3	2,550	850.0	
16. Oyo	14	3,435	245.4	
17. Plateau	17	2,495	146.8	Plus some natural lakes
18. Rivers	Nil	-	-	
19. Sokoto	11	4,222	383.8	
Total	178			

Table 3 - Projected profit and Loss Account (₦:K)

Particulars	Years				
	1	2	3	4	5
Sale of fish (income)	105,000	105,000	105,000	105,000	105,000
Less operating cost	24,000	24,000	24,000	24,000	24,000
Operating Profit	81,000	81,000	81,000	81,000	81,000
Less Depreciation	6,000	6,000	6,000	6,000	6,000
	75,000	75,000	75,000	75,000	75,000
Less interest on loan at 14%	12,600	10,080	7,756	5,04..	2,520
Profit before Tax	62,400	64,920	67,440	69,960	72,480
Less 45% Company Tax	28,080	29,214	30,348	31,482	32,616
Net Profit after Tax	34,320	35,706	37,092	38,478	39,864

Table 4 - Financial profitability indicators (₦:K)

Year	Income		Expenditure		Benefit	
	Actual	Discounted value at 14%	Actual	Discounted value at 14%	Actual	Discounted value at 14%
0	-	-	66,000	66,000	66,000	66,000
1	105,000	92,106.00	54,600	47,895.12	50,400	44,210.88
2	105,000	80,797.50	52,080	40,075.56	52,920	40,721.94
3	105,000	70,875.00	49,560	33,453.00	55,440	37,422.00
4	105,000	62,160.00	47,040	27,847.68	57,960	34,312.32
5	105,000	54,537.00	44,520	23,123.69	6 ,480	31,413.31
			N P V =	122,080.45		

Payback period: 2.1 years IRR = 47%

Appendix 1 - CASH FLOW STATEMENTS

Particulars	Years				
	1	2	3	4	5
A) Cash Receipts					
Loan from Bank	90,000	-	-	-	-
Sales of fish	105,000	105,000	105,000	105,000	105,000
Total	195,000	105,000	105,000	105,000	105,000
B) Cash Payments					
Fixed Capital Building (Store & Guard Post)	10,000	-	-	-	-
1 Boat	2,000	-	-	-	-
1 25 H.P Engine	2,000	-	-	-	-
1 Freezer	2,000	-	-	-	-
1 Pick-up Van	20,000	-	-	-	-
Fingerlings (100,000 @ 30K each)	30,000	-	-	-	-
Total	66,000	-	-	-	-
C) Operating Capital					
Fishing nets	3,000	3,000	3,000	3,000	3,000
Poultry manure (50 tons)	5,000	5,000	5,000	5,000	5,000
Labour	8,400	8,400	8,400	8,400	8,400
Contingency	4,600	4,600	4,600	4,600	4,600
Fuel and Lubricants	3,000	3,000	3,000	3,000	3,000
Total	24,000	24,000	24,000	24,000	24,000
D) Loan Repayment plus interest at 14%	30,600	28,080	25,560	23,040	20,520
D) Total Cash Cashflow (B + C + D)	120,600	52,080	49,560	47,040	44,520
F) Expected Cash inflow	74,400	52,920	55,440	57,960	60,480

APPENDIX II - Loan Repayment schedule

Years	Principal	Interest at 14%	Outstanding Balance
0	-	-	90,000
1	18,000	12,000	72,000
2	18,000	10,080	54,000
3	18,000	7,560	36,000
4	18,000	5,040	18,000
5	18,000	2,520	-
Total	90,000	37,000	

APPENDIX III - Depreciation

Item	Value	Life Span	Annual Depreciation Value				
			1	2	3	4	5
Building (Store house and Guard post	10,000	25	400	400	400	400	400
Boat	2,000	10	200	200	200	200	200
One 25 H.P. Engine	3,000	5	400	400	400	400	400
Freezer (1)	2,000	5	400	400	400	400	400
Pick-up Van	20,000	5	4,000	4,000	4,000	4,000	4,000
Fingerlings for stocking (100,000)	30,000	5	-	-	-	-	-
Nets	3,000		600	600	600	600	600
Total	69,000	-	6,000	6,000	6,000	6,000	6,000

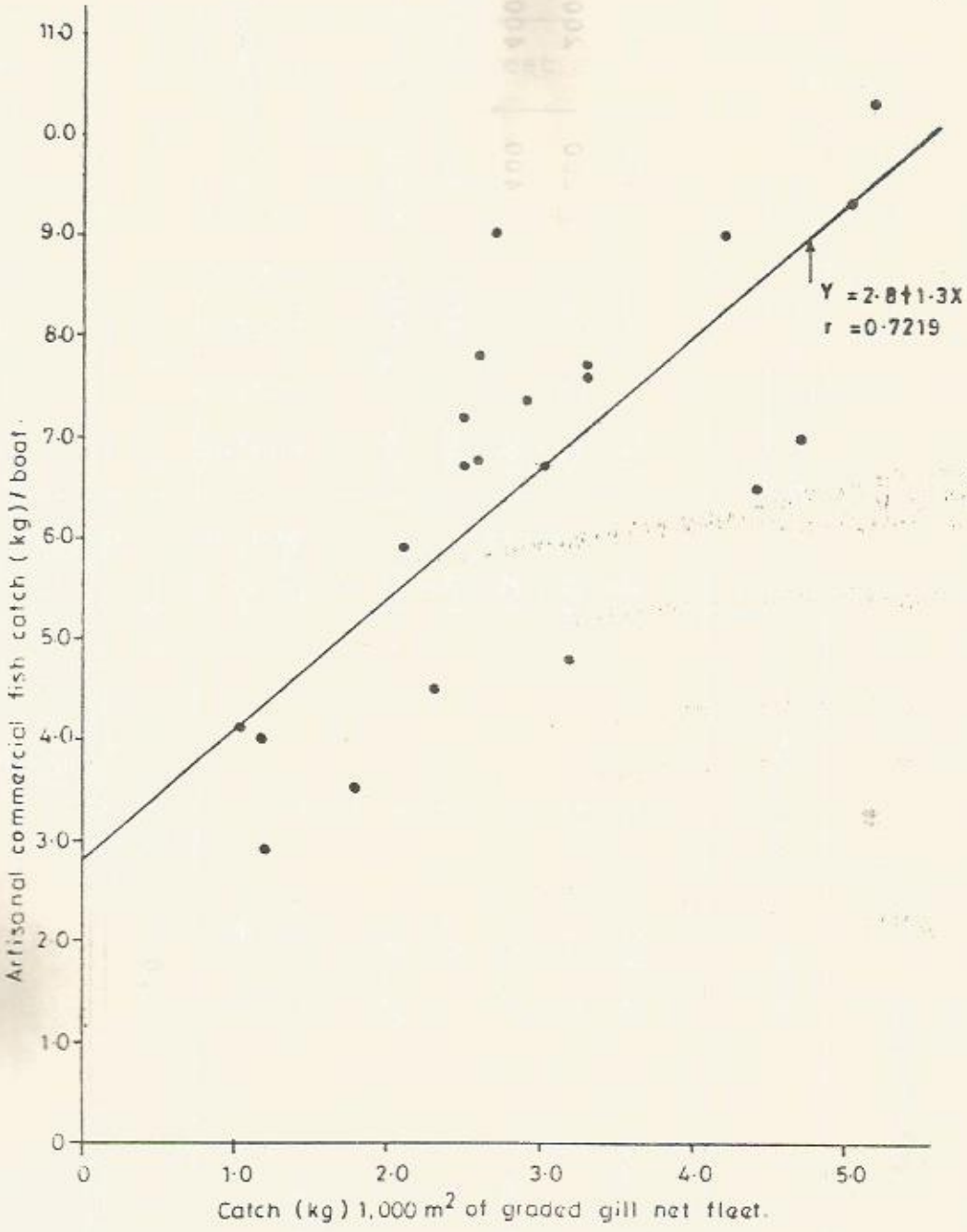


Fig. 1. Comparison of the artisanal commercial daily fish catch per boat (kg) and simultaneous catch per 1000 m^2 in graded experimental gill-net fleets. (Data from Jebba Reservoir and some reservoirs in Kano State).

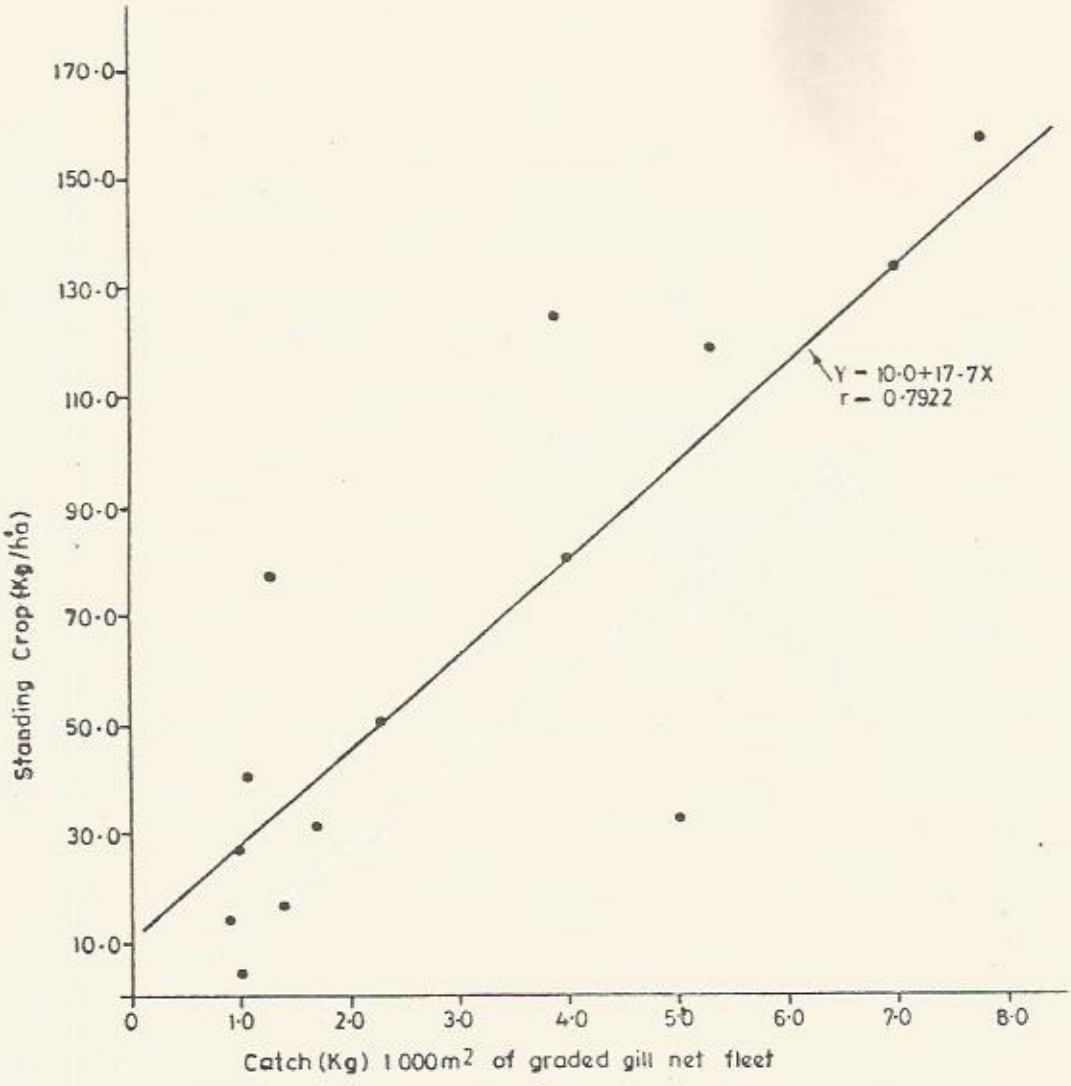


Fig. 2. Comparison of standing crop of fish per hectare in rotenone samples and simultaneous catch per 1,000m² of graded experimental gill-net fleet at Tiga and Oguta Lakes.

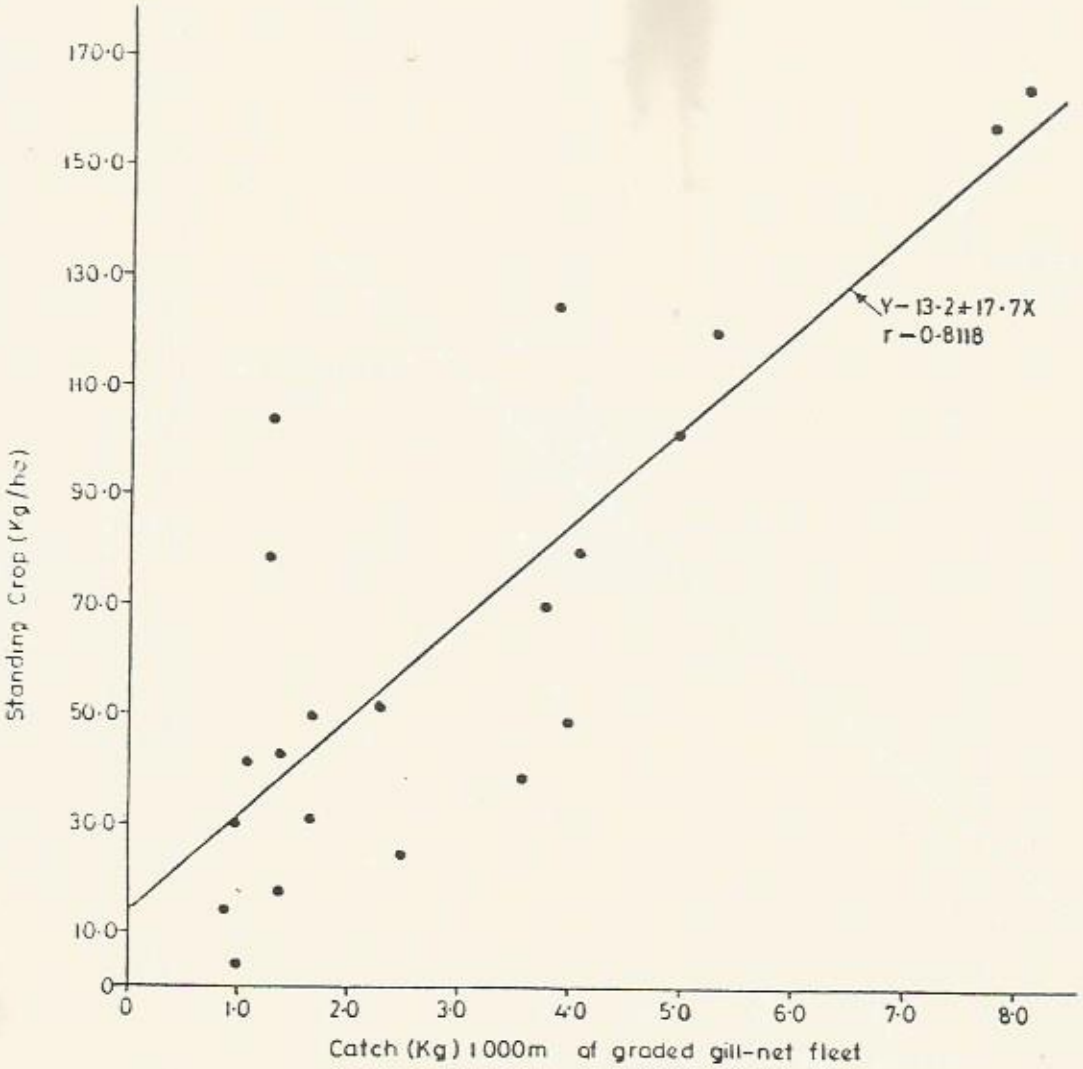


Fig. 3. Comparison of standing crop of fish per hectare in rotenone samples and catch per 1,000m² of graded experimental gill-net fleet at Kainji* Tiga and Oguta Lakes.
* Samples from Kainji Lake were not collected simultaneously but within the same month and at related stations.

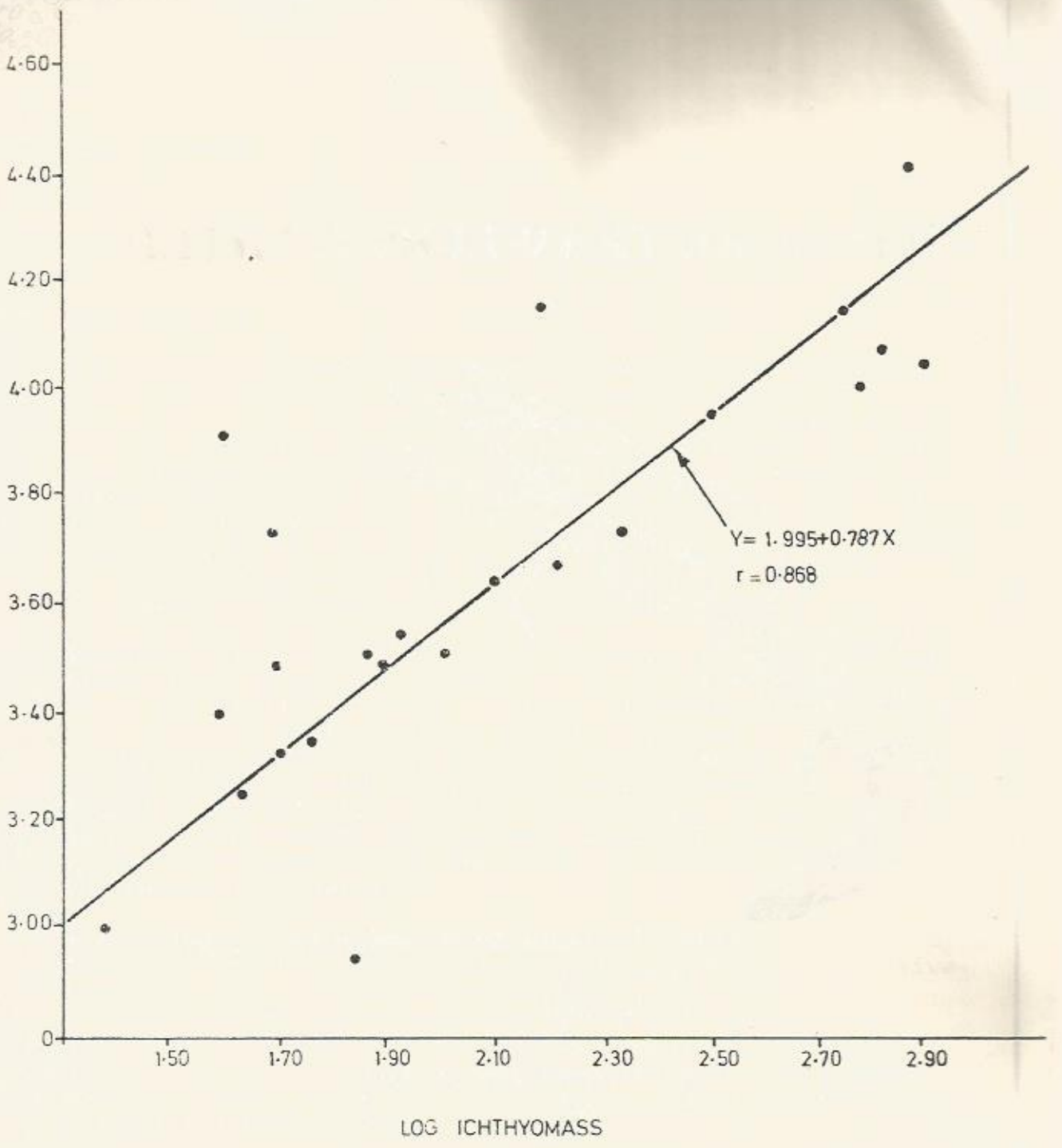
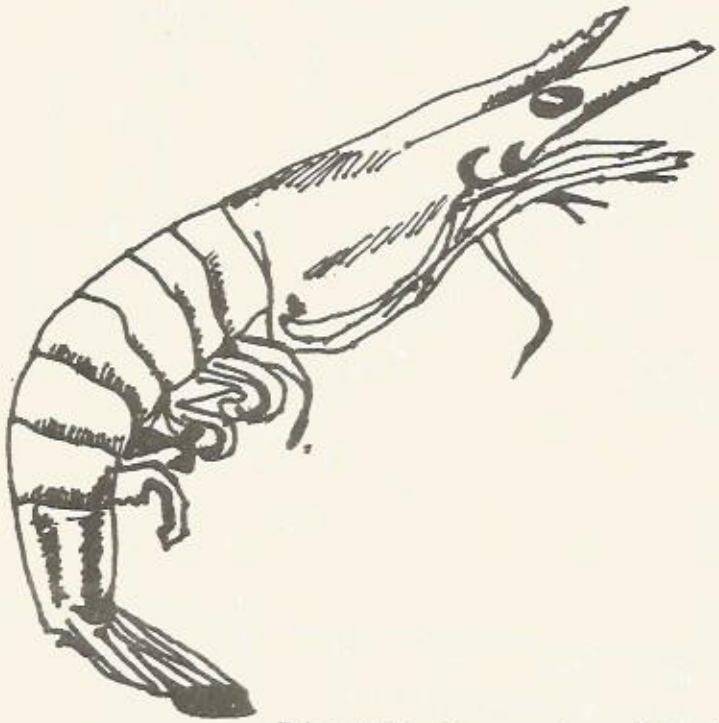


Fig. 4 Relationship between the ichthyomass and density of fish sampled by rotenone in blocked areas in Kainji Lake (1976).

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INVESTMENT PROSPECTS IN MARINE CAPTURE FISHERIES

by

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INTRODUCTION

A Nigerian prospective investor in marine fish capture is often discouraged by negative statements such as "the Nigerian waters have been overfished; the fishermen sell fish at sea, thus leaving the investor with nothing; and that the investor runs the risk of the entire vessel being taken away by the crew". While some of these allegations are not unfounded, the risk inherent in marine fish capture fisheries is not as grave as all that. In fact, the returns on investment are so high that the risks are hardly discussed by investors already in the business.

However, owing to the fact that Nigeria occupies what you might refer to as the backwaters of the gulf of guinea, where no upwelling occurs, Nigeria is seemingly the poorest area of the Eastern Central Atlantic in term of fisheries resources. Although the tropical waters are poor relative to the temperate and subtropical waters, seasonal upwelling taking place off Ivory Coast, Ghana, Togo, Gabon and Congo do help in enriching the surface waters to bring about appreciable increases in the standing crop of the waters of the respective countries.

Nevetheless, the extension of Nigeria's area of jurisdiction from 12 miles of territorial sea to 200 miles of Exclusive Economic Zone, coupled with the fact that Nigeria has entered into bilateral fishing rights agreements with Mauritania, Senegal, Guinea Bussau, Guinea Conakry and Equitorial Guinea, have appreciably expanded the prospects for investment in marine fish capture within the East Central Atlantic generally.

NIGERIAN MARINE FISHERIES
A CASE FOR NEW INVESTMENT

The Nigerian Marine Fisheries Resources and their exploitation shall be discussed under three main categories:-

(a) Inshore Demersal Fishery - (bottom)

(b) Inshore Pelagic Fishery - (top), and

(c) Off-shore Pelagic Fishery.

Inshore Demersal Fishery

Appreciable work has been done on the stock assessment of Scaenids, in particular, Sparids and Penaeid shrimps of the Nigerian waters, although most of these efforts were concentrated in the area between 10 and 50 metres depth.

The Nigerian Institute for Oceanography and Marine Research, Lagos summarised the results of these efforts and estimated the annual potential of the Inshore Demersal Fish Resources at 27,500 tonnes. Further work by Williams (1968) revealed that beyond the 50 metres depth is another stock of big-eyes, Brachydeuterus auritus, having an annual potential of between 3,000 and 4,000 tonnes. Therefore, it could be said that the annual potential of the Inshore Demrsal Fin-fish fishery of Nigeria is between 30,500 and 31,500 tonnes.

Although exploitation of these resources has been on the increase again in 1984 during which production was estimated at 22,255 tonnes, after a drop in 1983 estimated at 13,572 tonnes, the Federal Department of Fisheries Statistics revealed that the total fish production from this fishery by 116 registered vessels was 23,768 tonnes during 1985. Given the total annual potential of 31,500 tonnes for this fishery, shortfall between the maximum sustainable yield and the level of exploitation is about 7,000 tonnes, which as at today's prices, is put at ₦14 million. This shortfall can be exploited by any prospective investor without serious consequencies on the resources. It should be pointed out that the deep water big-eyes are not tapped at all. Subject to acceptability, however, investors might wish to exploit the big-eyes for the three canneries established in Nigeria which, in the nearest future, might face very serious raw material problems.

As for the Panaeid shrimps, only Penaeus duorarum has been assessed. Parapenaeopsis atlantica, occupying shallow inshore waters and Parapenaeus longirostris occupying the deep inshore waters are yet to be properly assessed. It is not unlikely that they are capable of lending themselves to commercial exploitation.

The Nigerian Institute for Oceanography and Marine Research puts the maximum sustainable yield for Penaeus duorarum at 3,500 tonnes, although the Institute remarked that about 4,500 tonnes could be caught annually.

Statistics obtained from the Federal Department of Fisheries revealed that 1,485 tonnes of shrimps were caught by 47 registered vessels in 1985. This estimate appears low. If one considers shrimps production figures from 1971, the mean annual production stands at 1,902 tonnes.

Given that maximum sustainable yield of the Penaid shrimps estimated at 3,500 tonnes per annum and having regard to the fact that a mean production of 1,902 tonnes has been recorded in the last 15 years, the shortfall which is still

available for exploitation could be put at about 1,000 per annum, allowing for good years during which productions greater than the mean are attained. Thus, as at today's prices, shrimp resources valued at over ₦5 million still remain to be exploited annually in our Inshore Waters.

Inshore Pelagic Fishery

The target species of this fishery are Sardinella maderensis, encountered at the western part of Lagos and Ethmalosa fimbriata found mainly at the eastern part of Nigeria. Another species, Sardinella eba is the mainstay of another major artisanal fishery. The Nigerian Institute of Oceanography and Marine Research estimated the maximum sustainable yield of Ethmalosa fimbriata at over 100,000 tonnes annually.

The fish production statistics published by the Federal Department of Fisheries lumps together the fish production figures of the artisanal subsector from Coastal and Brackish Waters. Besides, there are no data on how much of this production consists of Ethmalosa fimbriata or Sardinella eba or Sardinella maderensis. Judging by the fact that most of the artisanal fishermen use passive gear for their operations, it is not likely that the fishermen are able to exploit more than 50% of these resources. Hence, it is believed that the resources of this fishery are under-utilized.

So far, no fresh-fish market has been developed for this fishery. All the fish caught are smoked and sold in that form.

In view of the impending problems which the three fish canneries in Nigeria might face when the Second-Tier Foreign Exchange Market comes on stream, investors are hereby encouraged to invest in the exploitation of these pelagic resources as a substitute for Mackerel - Scomber scombrus and Sardines - Sardina pilchardus, which they presently process and pack in cans.

Assuming that about 50,000 tonnes of these resources are available for exploitation and, that they could be sold at 50 Kobo a Kilogramme at the fresh fish market, additional potential earnings accruable to new investments in this fishery are estimated at ₦25 million. I would like to urge the Nigerian Institute for Oceanography and Marine Research to forestall the prospective Investors by embarking on a fish-canning pilot project, using the principal species of this fishery as the raw materials.

Off-Shore Pelagic Fishery

The target fish of this fishery are the Tuna resources which are encountered as near as 10 Km off-shore down to about 220 Km off-shore. These are highly migratory fish species criss-crossing Nigeria's Exclusive Economic Zone (EEZ) at different seasons of the year.

The Nigerian Institute for Oceanography and Marine Research Lagos working through a firm of Fisheries Consultants - FISESCO Limited succeeded in establishing that these tuna-like fish resources are found in the Nigerian Waters all year-round and that they can be exploited on a commercial scale. The relative abundance of the Tuna-like species encountered during the one year Resources Survey is as follows:-

Katsuwonus pelamis	-	75.3%
Thunnus albacares	-	17.8%
Thunnus obesus	-	2.9%
Auxis thazard	-	1.4%
Euthynnus alleteratus	-	1.7%
Coryphaena hippurus	-	0.7%
Elegatis bipinnulata	-	0.7%
Caranx crysos	-	0.1%

The resources survey report puts the annual potential of the Tuna resource at about 20,000 tonnes.

The Tuna resources are export commodities. A local market is yet to develop for whole-frozen Tuna. Besides, with the SFEM in the offing, an investor is better off exporting the Tuna to Europe, U.S.A. and Japan where big markets exist. Unfortunately, since the Tuna resources survey was concluded, no Nigerian fishing company has taken advantage of this prospect so far.

Assuming that a tonne of Tuna sells for 800 U.S. Dollars in the international market. The potential earnings that may acrue to investors in the Tuna fishery is estimated at about U.S. $16 million per annum.

MARINE FISHERIES RESOURCES OF COUNTRIES WITH WHICH NIGERIA HAS BILATERAL FISHING RIGHTS AGREEMENT - A CASE FOR NIGERIAN INVESTMENT

Apart from Senegal and Mauritania, there are very little fishing activities going on at the countries with which Nigeria has bilateral fishing rights relations, although all these countries have very rich fishing grounds.

Equatorial Guinea

No official data on the fish resources are available. In fact, neither the private nor public sectors of the country's economy has any fishing vessel for the exploitation of the fisheries resources. Until about three years ago, it was understood that only the Soviets were fishing under licence and exporting from a coastal town abandoned by the Spaniards. As of 1984, all industrial fishing activities had ceased.

By virtue of the fact that half of the country is an Island ocean current divergencies do occur, as a result of which nutrients are constantly upwelled. Big schools of juvenile sardines are easily observed from the sea edge, besides, artisanal fishermen are able to catch as much as a canoe load of fish within less than 1 hour fishing with ring nets and set gill-nets.
Although, there is no country data to go by, the Guinean Trawling Survey report puts production prospects at about 250-500 Kg/hr. Among the species of fish found in commercial quantities are Grunters, Pomadasys spp., Ilisha africana and Spade fish, Drepane africana.

Following the signing of fishing rights agreement, no Nigerian Company has taken advantage, in spite ofthe fact that the Government of Equatorial Guinea is willing to allow as many as 20 fishing vessels into its waters from Nigeria.

Assuming each of the vessels can catch up to 60 tonnes of fish per month and that they operate for 10 months in the year, about 6,000 tonnes of fish could be caught from Equatorial Guinea. Allowing 20% for local tax, a total of 4,800 tonnes of fish estimated at ₦9.6 million could be realised per annum by prospective Nigerian investors.

Guinea Conakry

There is a fairly developed artisnal fishery in that country. Neither the Government nor the private people are involved in industrial fisheries. A few Japanese distant-water vessels and, in the last one year 2 Nigeria-owned double-rigged trawlers are fishing under licence off Conakry. It should be recalled that Guinea Conakry has a shelf area of about 50,000 square kilometers, harbouring very rich fish resources. The northern part of Guinea around Kamsar is part of the area of the East Central Atlantic considered to be the richest in fish resources, where catches of 1 metric tonne an hour could be attained, whilst the southern part is also capable of yielding a catch of between 500 and 1,000 kg an hour.

This area is very rich in choicy exportable fish species such as Sparids (breams), among which are Pagrus ehrenbergi Catfish, Arius spp. and Brachydeuterus auritus and Pomadasys spp. These resources are grossly underfished.

A two-month turn-round is possible between any Nigerian Port and Guinea Conakry, using a fairly big distant-water vessel of say, 300 tonnes cargo-carrying capacity. About 10 such vessels of Nigeria origin could be licenced to fish there. Catching about 300 tonnes in 2 months and making 5 trips a year, a vessel can land about 1,500 tonnes of fish per annum. Allowing for 20% local tax, a total quantity of 12,000 tonnes valued at about ₦24 million could be realised.

Guinea Bissau

This country has more fish resources than Guinea Conakry. The entire country falls within the oceanographic area capable of yielding a catch of more than 1 metric tonne an hour (according to the G.T.S. report). Unfortunately, these resources have barely been tapped. With a shelf area of 45 000 sq. kilometres, and given the wealth of fisheries resources in this area, this endowment could support more than 500 industrial fishing vessels. Among the commercially exploitable species of fish in these waters are Catfish, Arius spp, Threadfin, Galeoides decadactylus, Grunters, Pomadasys spp, Breams, Pagrus coupei in particular and some Carangids such as Trachurus trachurus.

As recommended for Guinea Conakry, distant-water vessels with a fish hold of, say, 300 tonnes should be used for fishing in this area from a Nigerian base. And assuming that only ten fishing vessels operate in this area, a Nigeria-based fleet could realise about 12,000 tonnes of fish valued at ₦24 million per annum.

Senegal and Mauritania

These two countries are almost equally rich in fish resources. They are the richest countries within the East Central Atlantic. Although local participation in the exploitation of these resources is minimal, a lot of foreign countries, including Nigeria are allowed to fish in these waters for a fee.

It is interesting to note that in 1985 the annual potentials of commercially important species of Mauritania were put at:-

Pelagic species	-	440,000 tonnes
Deepwater species	-	100,000 tonnes
Cephalopods	-	42,000 tonnes
Tuna	-	10,000 tonnes
Whitefish	-	10,000 tonnes
Langoustinos	-	700 tonnes
Deepwater shrimps		4,000 tonnes
Total	=	606,700 tonnes

Out of the 606,700 tonnes of annual potential, only 268,000 was caught in 1984 (according to International Herald Tribune of Thursday, December 19, 1985). It is interesting to note that a variety of pelagic fish species such as

Mackerel, Horse mackerel, Round sardines and Tuna do exist in these waters. And, it is my opinion that raw materials for Nigeria's three canneries can be obtained from these waters, apart from the fact that choicy fish species like Red snappers, Breams, Groupers/Barracudas, to mention a few, are abundant.

Assuming that a fleet of 20 Nigerian vessels is deployed to both Senegal and Mauritania, with each vessel catching about 1,500 tonnes a year a total of 30,000 tonnes valued at about ₦60 million could be realised annually.

FISHING GEAR AND METHODS

The fishing methods to be adopted for the exploitation of the fisheries resources identified within and outside Nigerian waters vary in form and in cost. A few examples are hereby given:

Inshore Demersal Fishery

The double-rigged fishing method is now popularly adopted in Nigeria because investors prefer to catch fish and shrimps simultaneously. New investors could acquire similar vessels if desired. Statutorily, these vessels should have a length not more than 25 meters and the fishing gear used should have a minimum of 76 mm codend mesh-size. Where fin-fish is desired by Investors, a stern trawler may be acquired for this purpose.

Vessels of the size mentioned above, which are capable of freezing, processing and storage on board cost about $700,000 to $900,000 F.O.B. as at now, excluding fishing gear and spare-parts.

Good vessels in this class can be obtained from U.S.A., Poland, Spain and Holland.

Inshore Pelagic Fishery

Because the Bonga and the sardine resources are encountered at shallow areas of the shelf, small purse seiners of say, 5 m are also recommended for this fishery. Because the fish is meant for the cannery, the seiners need not have freezing facilities on board. An insulated ice hold will suffice, as it is intended that the fish should be preserved in ice in order to retain its freshness.

A vessel of this type, fully equipped with two dorries and a set of purse seine gear will cost about $500,000 F.O.B.

Off-shore Pelagic Fishery

A pole and line vessel was used with success during the Tuna Resources Survey exercise, although baits could not be found in sufficient quantity. If baits do not

constitute a constraint, I wish to recommend the Pole-and-line vessel for this fishery because it is cheap and capable of absorbing substantial labour.

Otherwise a purse seiner of about 50 metres L.O.A. may be acquired. A 50 m pole-and-line vessel costs about $3.5 million U.S. Dollars, whilst a 50 m purse seiner costs between $5 million to $9 million depending on whether or not an aircraft is included for fish finding.

Second hand vessels are available in the market for those investors who are not as rich. A good second-hand vessel together with repairs and complete fishing gear can be acquired for about $2.5 million.

Distant Water Fishery

Vessels that have sufficient endurance for a 2-months-operation and fishhold of not less than 300 tonnes should be acquired for this fishery. The vessels could be purse seiners if they are to be used for the exploitation of pelagic resources of Mauritania, Senegal and Guinea Bissau or Stern or side trawlers if they are to be used for demersal fishing at these waters.

These vessels must be fully equipped for fish handling, processing and packaging on board. In short, they must be factory vessels of some sort.

A new purse seiner recommended for this fishery will cost about $4 to $7 million if it is for Sardines or Mackerel, although a second-hand one could be got for about half this price.

A new Stern/side trawler could be acquired for between $3 to $4 million. Second hand ones are also available for between $1 and $2 million, mostly in Europe.

MANPOWER REQUIREMENTS

Inshore Demersal Fishery

A reasonable number of deck officers with mate (Fishing) certificate of competency have been trained by the Federal Fisheries School, Lagos. These category of officers can captain Inshore Fishing vessels, which are mostly below 100 ft - the statutory length of vessels that could be manned by Mate (Fishing) Certificate holders.

It is my opinion that the Federal Fisheries School can produce enough captains that the Inshore Demersal Fishery requires in future.

In like manner, Fishing Vessel Mechanics are being trained by the School for the industry, whilst examinations are being conducted for trainee mechanics who have had prescribed sea service, for the award of Motorman (Fishing)

Certificate of Competency. The Fisheries School is capable of meeting the requirements of this fishery, with the necessary financial and institutional support.

Inshore Pelagic Fishery

Small-Purse-seiners have been recommended for the exploitation of this fishery. Although the size of vessels contemplated fall within the class a Mate Certificate holder can handle, no Nigerian fisherman has experience in the handling of purse-seiners and purse-seine gear. While it is recommended that the Federal Fisheries School should intensify training in this fishing method, prospective investors are advised to recruit Ghanaians who are quite experienced in purse-seining for sardines and anchovy in Ghanaian waters.

Off-shore Pelagic Fishery

As mentioned earlier, Tuna and Tuna-like fishes are the target species of this fishery. Both pole- and-line fishing method and Purse-seining method could be adopted for this fishery. Although 22 Nigerian fishermen were trained by NIOMR during the Tuna Resources Survey on Pole-and-line vessel, prospective investors shall have to employ mostly Ghanaian fishermen and, Japanese or Korean officers.

The same is true for purse-seining method. Ghanaian or Togolese fishermen shall have to be recruited in the first instance, while Nigerians are being trained. Officers of the purse-seiners shall have to be recruited from Japan, South Korea or Spain.

Distant-Water Fishery

There are Nigerians with Master (foreign going) Certificate of Competency that could man distant-water vessels. More of such officers are being trained at the Nautical College, Oron, Cross River State. However, these grades of officers are not useful for fishing. As such, officers with skipper (fishing) Certificate of Competency should be recruited to assume the position of Fishing Masters on board the distant water vessels. Although a few Nigerians have the Skipper (fishing) Certificate of Competency almost all of them do not have experience in distant-water fishing. It is hoped that with the introduction of the Skipper (fishing) Certificate Course by the Federal Fisheries School, a new breed of Nigerian Fishing Masters will emerge.

In the interim, investors are advised to recruit key officers for this fishery from Europe or Asia.

MARKET POTENTIALS FOR FISH PRODUCTS

Enormous markets for fish and fishery products exist at home and abroad. The short-fall between effective demand and supply in Nigeria is put at over 500,000 tonnes a year. If the available fish resources between predicted MSY and the current level of exploitation were to be exploited, only a very little part of this shortfall can be satisfied after all. To satisfy this demand, a huge investment must be made in distant water fishery.

As regards shrimp resource, an insatiable market exist in U.S.A., Europe and Japan. As of now, FISESCO Ltd has an order for 300 tonnes of both pink and guinea shrimps per month from European buyers. I am sure that other fishing companies have similar orders. But unfortunately, less than 10% of these orders could be met as of now.

As far as Sardines and Bonga are concerned, the local canneries will be too willing to enter into a long term contract with would-be producers since their raw materials are presently being imported from Europe.

Tuna market is international and very large. The frozen Tuna can be exported to canneries in USA, France and Japan. Besides, our local canneries shall be too delighted to have them, because they are also in need of raw materials. The canned Tuna has a large market within and outside Nigeria.

PROFITABILITY

All the fisheries discussed in this paper are economically and financially viable. Because Nigeria has an insatiable market for fish, the seller dictates the price. The buyer normally bears the burden of any cost increases in factors of production.

A number of feasibility studies have been conducted on these fisheries and the following are indications of the level of investment attractiveness as at current prices using the Financial Internal Rate of Return as index of estimation:-

Inshore Demersal Fishery	-	FIRR : 35% - 45%
Inshore Pelagic Fishery	-	FIRR : 25% - 40%
Off-shore Pelagic Fishery	-	FIRR : 25% - 35%
Distant Water Fishery	-	FIRR : 30% - 40%

Taking the Financial Internal Rate of Return as the rate of interest that is obtained when the discounted value of stream of revenue accrueing to a project is exactly equal to the discoutned value of the capital and recurrent costs, it is evident that investments on the

above fisheries are highly viable and lucrative. This is so, because the FIRR(s) arrived at in respect of these fisheries are greater than the stipulated interest rates of most major Merchant and Commercial Banks in Nigeria. In other words, these FIRR(s) are capable of competing favourably and effectively with the opportunity cost of investing scarce capital resources on alternative ventures.

INVESTMENT PROSPECTS IN INSHORE TRAWLING IN NIGERIA

By

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ABSTRACT

Commercial trawling for finfish in Nigeria's inshore water is a recent activity. Intensive industrial trawling started when the Federal Government distributed trawlers to viable fishermen cooperatives during the Third National Development Plan Period (1975-80). Hitherto, industrial fisheries development in the country focused on the assessment of the potential fish stock on Nigeria's continental shelf and measures to increase artisanal production. As a result of increasing demand for fish and shortage of foreign exchange to import fish, measures to increase fish supply leaned towards industrial exploitation of the fisheries potentials of Nigeria's continental shelf. Based on this background, this paper examines the investment prospects of trawling for fish in inshore waters. The fisheries potentials of the inshore zone of Nigeria are identified. Catch efficiency and profitability of inshore trawling are estimated. Measures that can safeguard the longterm interest of the trawling industry are recommended.

INTRODUCTION

The active promotion of industrial fishing in Nigeria is a recent event. The Exclusive Economic Zone (EEZ) declaration which has been incorporated into the New International Law of the Sea has given coastal states extended jurisdiction over living resources within a 200-mile zone - the EEZ. The extension of national jurisdiction offers Nigeria increased opportunities to benefit from its fish resources.

Traditionally, fish is one of the sources of protein in the Nigerian diet. It was estimated that fish and shell fish comprise 40% of the total animal protein consumed by Nigerians. With Nigeria's population estimated to grow at a rate of approximately 3% per annum in the eighties, the projected demand for fish for the years 1985-2000 was estimated at more than one million metric tonnes (Tobor, 1985). Table 1 shows projected Nigerian population, per caput consumption of fish and fish demand for the years 1985-2000.

TABLE 1 - PROJECTED NIGERIA POPULATION, PER CAPUT CONSUMPTION OF FISH AND FISH DEMAND, 1985 - 2000

Year	Projected human population (millions)	Projected per caput consumption (kg)	Projected fish demand (million tonnes)
1985	96.126	10.59	1.018
1986	98.596	10.85	1.070
1987	101.207	11.11	1.123
1988	103.693	11.37	1.179
1989	106.345	11.63	1.237
1990	109.067	11.89	1.297
1991	111.858	12.15	1.359
1992	114.720	12.41	1.424
1993	117.657	12.67	1.491
1994	120.669	12.93	1.560
1995	123.759	12.19	1.632
1996	126.929	13.45	1.707
1997	130.180	13.71	1.785
1998	133.516	13.97	1.865
1999	136.933	14.23	1.949
2000	140.446	14.29	2.035

Source: Projected human population adopted from mid-year population projected 1963-2000. National population Bureau, Demographic Division, Lagos. (After Okpanefe M.O. 1982).
Projected Fish Demand (Tobor 1985).

Historical evidence shows that the present sources of Nigeria's domestic fish supply only provide between 54-60 per cent of our demand. Table 2 shows recent trend in domestic fish production as a percentage of fish demand in Nigeria between 1980-1983.

As a result of inadequate development and utilization of domestic fisheries potentials, Nigeria increased its fish imports in the 1970s. Table 3 shows Nigerian fish imports and values between 1973-1980. However, in recent times, the dwindling foreign exchange earnings from export products (oil, cash crops) has led to a reduction in imports. Thus, as a means of reducing the shortfall created by reduced subvention for fish imports, fisheries development policies of governments are designed to encourage private investment in the exploitation and utilization of domestic fisheries potentials. Among the strategies adopted by governments to induce increased domestic fish production are; provision of technical assistance free of charge, infrastructural development of shore and land based fisheries facilities, low annual vessel licence fee, and distribution of trawlers at 50 per cent subsidy to viable fishermen cooperatives. For example the Federal Government, through the Federal Department of Fisheries, distributed 13-meter stern trawlers to viable fishermen cooperatives between 1979 and 1983.

Based on a survey of the industrial trawling activities of the beneficiaries of the trawler distribution scheme, this paper examines the investment prospects of inshore trawling specifically by looking at the profitability of trawling for finfish in Nigeria's inshore zone.

INSHORE FISHERIES POTENTIALS

Nigeria is endowed with approximately 800 km coastline and EEZ of about 256,000 km^2. Within the EEZ, the 50-m isobath delimits the inshore fishing zone from the offshore. FAO (1979) estimated the area of Nigeria's trawlable fishing ground and the offshore fishing ground in the EEZ at 26700 km^2 amd 1400 km^2 respectively. The width of the trawlable zone varies with greatest area occuring around the Niger Delta and the Cross River State.

Based on global model, Ajayi (1982) estimated annual demersal inshore finfish potential that is harvestable by industrial trawl fleet at between 18000-20000 metric tonnes. The major commercial inshore finfishes are represented by the families: Sciaenidae (West African croakers), Cynoglossidae (Tropical sole), Polynemidae (lesser African threadfin), Pomadysydidae (Bigeye grunt), Aniidae (Marine catfish), and Sphyraenidae (Barracuda). Others include Carcharhinidae (Sharks) and Carangidae (moonfish). Although shrimps may occur in the catch in the inshore zone, its industrial prospect requires trawling in deeper waters

TABLE 3 NIGERIAN FISH IMPORTS AND VALUES, 1973 - 1980

Year	Imported Fish (tonnes)	Value (₦)
1973	106,111	7,054,633
1974	92,042	6,693,754
1975	288,626	38,771,162
1976	274,618	76,802,789
1977	289,458	77,836,841
1978	374,835	140,634,192
1979	445,147	143,548,433
1980	444,156	265,099,906

Source: Tobor (1985).

(above 50m) during its seasons of abundance by use of medium and large trawlers (20m LOA) with special shrimp processing and preservation facilities to increase the shelflife of catch.

The annual abundance and distribution of major commercial finfishes in the inshore zone are related to the influence of temperature, food abundance and the effect of thermocline. Although the distribution of the finfish occurs from the surface to about 60m depth which represents the lowest limit of the thermocline, only the croakers (Fam: Sciaenidae) show any satisfactory and regular cycle of seasonal distribution (Longhurst, 1964; Bayagbona, 1963A; Tobor, 1973). Longhurst (1964) and recent surveys show that the peak catch rate for croakers occurs in August and September and this trend is sustained more or less until the turn of the year when a decline sets in until a minimum is reached at the start of the rainy season in April and May.

The Nigerian inshore fishery is a croaker fishery. The species of the Family Sciaenidae (Pseudotolithus elongatus, P. typus, P. senegalensis) are dominant over all other species in the inshore commercial catch with some less valuable species occuring as subsidiary (Tobor, 1973; Ajayi, 1982; Akinyemi et al, 1986).

According to Nsentip (1982), the family Sciaenidae (West African croakers) accounted for 44.88 per cent of total marine trawl landings between 1971-1979. For the same period, Elasmobranchs accounted for 12.88 per cent, Bigeye 4.47 per cent, catfishes 2.92 per cent, soles 2.90 per cent, threadfins 2.37 per cent and prawns 0.84 per cent.

Bayagbona (1963), Balogun et al (1986) used the proportion of croakers (Fam: Sciaenidae) in the commercial catch as an index for determining the profit margin that may acrue to the fishing industry. In industrial trawl fishery, total catch is related to the amount of expended fishing effort, depth and time of trawling. Revenue from fishing is related to demand and supply. For instance, within the Nigeria's inshore fishing zone, empirical evidence shows that catch rate decreases as the depth of trawling increases, with best catches occuring in shallow depths ranging between 7 - 40 meters (Tobor, 1973, Akinyemi et al, 1986). Usually, day catch rates are higher than night catch rates during trawling for finfishes (Akinyemi et al, 1986; Parish et al, 1964).

In Nigeria's inshore zone, catch rates range between 41.5 kg/hr and 94.0 kg/hr (Tobor, 1973; Williams, 1968). In recent surveys, catch rate is less than 41.5 kg/hr due to intense competition for inshore finfishes by artisanal fishermen and industrial trawlers in the inshore zone.

Nigeria's fish market shows preference for fish over 24cm total length (White Fish Authority, 1980). Thus, commercial catch is classified and created according to length class

rating: 24-38cm (small), 29-35cm (medium), 36-60cm (large), above 60cm (extra large). For the commercial catch within Nigeria's inshore zone, the small length class rating (24-28 cm) is dominant over other length class ratings (Akinyemi et al, 1986).

For the purpose of conservation and avoidance of conflicts between artisanal fishermen and trawling industry, the existing fisheries regulations stipulate that trawlers (except canoes) shall not fish within the first two nautical miles of the waters of the Nigerian continental shelf. Trawlers are obliged to use 77 mm codend mesh size for fin fish fishing and 44 mm codend for shrimp fishing. The sea fisheries legislation (Sea Fishing Regulations) provides great prospects for high total catch as it places no restrictions on volume of each and time of fishing (no time limitation or closed season).

INDUSTRIAL TRAWL DEVELOPMENT

In an attempt to modernize the exploitation of domestic fisheries potentials, the Federal Government, through its agencies (Federal Department of Fisheries, State Fisheries Divisions) provided material and technical assistance to the fishery industry in the country. Over the last decade, the assistance include supply of fishing inputs at subsidized prices and development of shore facilities (berthing facilities, cold-storage and ice plant, fuel depot and net loft) at strategic locations for the take off of industrial trawling. The locations of principal shore facilities for industrial trawling in Nigeria are presented in Table 4. In addition, there are dry dock facilities in Nigeria for vessel maintenance.

Table 4 - Locations of industrial trawling shore facilities in Nigeria

State	Location
Cross River State	Uta-Ewa
Lagos State	Yovoyan
Ogun State	Igbekki/Iwopin
Ondo State	Orioke-Iwamimo/Igbokoda
Bendel State	Warri/Ogheye
Rivers State	Elembekinkiri/Oyorokot

The availability of fishing inputs in the seventies and the recent development of shore based facilities had encouraged intensive fishing in Nigeria's inshore zone. The number of vessel licences issued for inshore finfish trawling increased from 13 in 1971 to more than 40 at the beginning of the 1980s.

From research findings, vessels that ranged between 10-20m length-overall (LOA) have been recommended for efficient inshore finfish trawling on Nigeria's continental shelf. A narrow overall length range (size) of vessel is recommended for ease of management (e.g. small crew size) and superior manouverability in indented coastline and shallow waters. The shallow waters represent the zones of croakers abundance on Nigeria's continental shelf.

In the seventies, a Polish shipyard designed a 13-meter stern trawler which the Federal Department of Fisheries approved for inshore industrial fishing. The next section examines the industrial performace of this trawler.

PERFORMANCE OF THE TRAWLING INDUSTRY

In a trawling industry, some factors affecting cost of operation and ultimate profit have been identified as vessel parameters. The size of vessel, holding capacity and engine power have been considered the most important vessel parameters. These three factors govern the economic efficiency of fishing operation and the economic returns on the invested capital. According to Engvall (1969), the catching capacity is a function of all the listed three parameters. The size of vessel determines the gear, and therefore, the catch rate; the holding capacity in combination with size, fuel capacity and length of trips, provides an upper limit to catch quantity; the engine horse power determines the speed and thus, steaming time and time available for fishing.

For the Nigerian trawling industry, a 13-meter trawler designed for inshore industrial fishing was distributed by the Federal Department of Fisheries among viable fishermen cooperatives in the six maritime States of Nigeria between 1979 - 1983. The characteristics of the vessel are as follows:

Length overall - 13 m

Length of perpendicular - 11.5 m

Breadth LW - 4.4 m

Breadth on deck - 4.6 m

Moulded depth (depth MLD): 2.2 m

Draught MLD: 1.65 m

Keel Drag: 0.6 m

Fishhold capacity: 23 m^3

Fuel Tank capacity: 2.5 m^3

Engine capacity: 125 H.P

Gross tonnage: 29.29

Body: Steel

In a study by Mabawonku et al (1984), the performance of this trawler was assessed by using the information gathered from its various users. Eleven users of this trawler were interviewed by questionnaires. Table 5 shows the cost incurred by operators in the six maritime States of Nigeria (i.e. cost of fishing). Among the users, the costs of maintenance of vessel/gear and staff salaries represent the major factor inputs in the total cost of operating the vessel (total cost of fishing). Staff salaries (ground staff and crew) ranged from 18 per cent to 48 per cent. Craft and gear maintenance constituted about 17 per cent of operating cost and the range is from 10 per cent to 25 per cent in some cases. Fuel consumption ranged between 2.3 per cent to as high as 25 per cent depending on frequency of fishing trips, fishing range and fishing duration (trawling duration).

The profitability of fishing is used as a measure of commercial vaibility of vessel (trawler) operation. Table 6 shows costs and returns on trawler operation in six maritime States of Nigeria. The declared total incomes less total operation costs by users ranged from a loss of about ₦13000 within an operational period of 8 months to a profit of ₦13000. Five out of the eleven users examined operated at a loss. Mabawonku et al (1984) observed that in nearly all the cases examined, operating costs were inflated while actual incomes were underdeclared or depressed.

In order to verify the actual profit accruing to users, Mabawonku et al (op. cit.) recalculated incomes based on the information that the users of the trawlers supplied in the questionnaire designed to estimate catch efficiency per fishing trip. In this case, the number of voyages, number of fishing days, number of operating months and landing figures were used. Table 7 shows recalculated income/profit (loss) based on the declared landings (catch) at an assumed market price of ₦1.50 per kg of fish (Market Survey, 1984). The recalculated incomes show that only two of the users incurred losses. For example, the reported loss of over ₦10,000 by one of the users of the trawler in Ondo State (Table 1) became a net positive profit of over ₦50,000 per annum. A net profit in inshore industrial finfish trawling ectivity has been confirmed in a similar survey by Balogun et al (1986).

From the survey by Mabawonku et al (op. cit.), the profit recorded by users depends on the efficiency of management and technological know-how. In addition, the number of

TABLE 5 - OPERATING COSTS OF 13-METER TRAWLER IN SIX MARITIME STATES OF NIGERIA

EXPENDITURE	OGUN STATE		LAGOS STATE						ONDO STATE			
TRAWLER NUMBER	1		2		3		4		5		6	
	₦	%	₦	%	₦	%	₦	%	₦	%	₦	%
Ground Crew and Staff Salary	6400.00	19.0	6240.0	6.4	15680.00	24.2	3540.00	9.9	7200.00	11.9	2400.0	4.6
Floating Crew Salary	9900.00	29.4	19500.0	19.9	5960.00	9.2	5390.00	15.1	16200.00	26.8	15180.0	29.3
Fuel Consumption	7488.00	22.2	14400.0	14.7	15552.00	24.0	5760.00	16.1	1400.00	2.3	5416.0	10.5
On-Board Feeding	3840.00	11.4	4800.0	4.9	3600.00	5.6	1920.00	5.4	4800.00	7.9	3371.0	6.5
Custom Duty	-		1500.00	1.5	-		-		-		-	
Tax	-		1500.00	1.5	-		-		-		-	
Insurance	1086.20	3.2	4000.00	4.1	2100.00	3.2	-		400.00	0.7	-	
Loan Repayment												
(i) Capital	-		10000.00	10.2	10000.00	15.5	11000.00	30.8	5640.00	9.3	10000.0	19.3
ii) Interest Charges	-		-		-		-		-		-	
Administrative Costs	-		3000.00	3.1	3600.00	5.6	353.80	1.0	-		1624.00	3.1
Maintenance of Craft/Gear	3380.00	10.0	12000.00	12.2	7000.00	10.8	6897.00	19.3	24000.00	39.6	13093.00	25.3
Other Charges	163.00	0.4	18000.00	18.3	-		-		-		-	
Rent of Jetty	-		1200.00	1.2	1200.00	1.9	600.00	1.7	900.00	1.5	720.00	1.4
Shore Handling	1440.00	4.3	2000.00	2.0	-		300.00	0.8	-		-	
Declared Total Expenditure	33697.20	100.0	98200.00	100.0	64692.00	100.0	35760.80	100.0	60540.00	100.0	51804.0	100.0

Source: Mabawonku et. al. (1984)

TABLE 5 (CONT'D)

EXPENDITURE	ONDO STATE				(CROSS RIVER STATE)		(BENDEL STATE)		(RIVERS STATE)	
TRAWLER NUMBER	7		8		9		10		11	
	₦	%	₦	%	₦	%	₦	%	₦	%
Ground Crew and Staff Salary	4200.00	7.5	1920.00	4.6	18000.00	11.0	8800.00	82.3	-	-
Floating Crew Salary	15000.00	26.7	5520.00	13.3	25000.00	15.3	15000.00	14.1	41015.00*	70.3
Fuel Consumption	14400.00	25.6	5400.00	13.0	13440.00*	8.2	320.00	3.0	5700.00*	9.8
On-board Feeding	2400.00	4.3	2400.00	5.8	3600.00*	2.2	-	-	5525.00*	9.5
Custom Duty	-	-	-	-	-	-	-	-	-	-
Tax	-	-	-	-	-	-	-	-	-	-
Insurance	1200.00	2.1	-	-	-	-	-	-	50000.00	8.6
Loan Repayment										
i) Capital	10000.00	17.8	10200.00	24.6	10000.00	6.4	-	-	-	-
ii) Interest Charges	-	-	-	-	-	-	-	-	-	-
Administrative Costs	3187.00	5.7	3142.00	7.6	84000.00*	51.5	-	-	200.00	0.3
Maintenance of Craft/Gear	4800.00	8.5	10176.00	24.5	3000.00*	1.8	-	-	925.00	1.6
Other charges	725.00	1.3	-	-	4008(2)	2.5	-	-	-	-
Rent of Jetty	240.00	0.4	2400.00	5.8	-	-	-	-	-	-
Shore Handling	-	-	320.00	0.8	1600.00	1.0	-	-	-	-
Total Expenditure	56152.00	100.0	41478.00	100.0	163140.00*	100.0	10620.00	100.0	53365.00	100.00

* Average for 4 years

(2) - Dry Docking

TABLE 6 - COSTS AND RETURNS ON 13-METER TRAWLER IN SIX MARITIME STATES OF NIGERIA

EXPENDITURE	OGUN STATE	LAGOS STATE			ONDO STATE				(CROSS RIVER STATE)	(BENDEL STATE	(RIVERS STATE)
TRAWLER NUMBER	1	2	3	4	5	6	7	8	9	10	11
Declared Total Income(N)	20700.00	12000.00	54000.00	40952.90	57739.00	60071.00	82400.86	57798.00	80000.00	13699.50	71528.65
Declared Total Expenditure (N)	33697.20	98200.00	64692.00	35760.80	60540.00	51804.00	66152.00	41478.00	163140.00	10620.00	58365.00
Declared Total Profit(N)	(12997.20)	(86200.00)	(10692.00)	5192.00	(2801.00)	8267.00	26248.86	16320.00	(83140.00)	3079.50	13163.65

TABLE 7 - CALCULATED CATCH AND INCOME (FROM CATCH DATA DECLARED BY BENEFICIARIES)

No. of Operational Months	8	3	9	6	11	11	12	8	10	3.5	9
No. of Voyages	192	6	27	24	24	44	240	N.A.	624	N.A.	128
No. of Days fished	64	N.A.	189	120	180	222	160	200	264	52	128
Total Landing (Kg.)	58880.0	14595	76500	42900.0	72000.0	N.A.	446360.0	N.A.	96000.0	N.A.	384000.0
Estimated Catch (Kg)/ Fishing Day	920.0	N.A.	404.8	358.0	400.0	N.A.	2790.0	N.A.	354.0	N.A.	3000.0
Calculated Total Sales (N) (1)	88320.80	21892.5	114750.0	64350.0	108000.0	60071.0	669540.0	67798.0	144000.0	13669.50	576000.0
Profit at Declared Total Expenditure(N)	54622.80	76307.5	50058.00	28589.20	47460.00	8267.00	613388.00	16320.0	(19140.00)	3049.50	517635.00
Profit Per Month (N)	6827.9	25435.8	5562.0	4764.8	4314.5	751.5	51115.6	2040.00	(1914.00)	871.3	57515.00

1) With price of 1 kg of 'Fish' fixed at N1.50 per kg irrespective of species.
2) Compiled from 1984 catch landing data at the rate of two voyages per month.
N.A. Dat Not Available.

SOURCE: Mabawonku et. al. (1984)

fishing trips and skill of skipper have bearing on total catch, total income and profit. In the cases where losses were-recorded, it was mainly affected by lack of adequate technical skills in the operation of the trawlers. Frequent breakdown of vessel limits the number of fishing trips and high cost of vessel maintenance eroded profit. Similarly, these problems have led to the collapse of some trawl fishing companies in the Cross River State (Essein, 1982).

INVESTMENT PROSPECTS

Based on Fisheries Statistics data (1980), Nsentip (1982) estimated total domestic trawl landings of fisheries from 1971-79 at 38562 metric tonnes. That is on the average, total annual trawl landings was 4284.7 metric tonnes (Table 8). This suggests that each year about 21.4 per cent of the estimated 18000 - 20000 annual demersal finfish potential was harvested during the period and more fishing licence can be issued to trawlers in order to fully exploit the potentials of demersal inshore finfishes. Table 8 shows number of licences, total annual trawl landings and average annual catch per trawler in metric tonnes (1971 - 1979).

Table 8 - Number of licence issued and annual landings of inshore trawlers, 1971 - 1979

Year	No. of licence issued to inshore finfish trawlers*	Total annual trawl landings (metric t.)**	Average annual landing per trawler (metric tonnes)
1971	13	1090	83.0
1972	26	1404	54.0
1973	27	2012	74.5
1974	33	3267	99.0
1975	33	4231	128.2
1976	30	5464	182.1
1977	43	7727	179.7
1978	38	7475	196.7
1979	44	5892	133.9
Total	287	38562	1131.9
Average/annum	32.0	4284.7	125.77

* Nsentip (1982)

** Fisheries Statistics of Nigeria (1980)

There is prospect for higher catch and increased profit to the trawling industry if the trend of licences issued in the 1970s are maintained through the 1980s.

With respect to landings from the industry, the restriction placed on the importation of animal protein (fish and meat) by Government and the apparent gap between domestic fish supply and demand forecasts for the 1985-2000 indicate a promising market for fish in the country. In addition, the declining livestock production relative to population growth has increased the relative substitution value and the demand for fish.

However, the future of the industry needs protection by government. It is recommended that government policies should support the inshore trawling industry in the following ways:

(i) Assistance to entrepreneurs in the procurement of trawlers.

(ii) Adequate provision of spare parts.

(iii) Effective enforcement of mesh-size regulation and protection of the inshore fishing zone from poachers.

(iv) Effective control of the fishing range of trawling industry to prevent conflicts between artisanal fishermen and the trawling industry.

(v) Adequate protection of the breeding grounds of inshore fishes from trawling activities.

(vi) Monitoring of total annual landings from the trawling industry and effective regulation of fishing effort (Number of licences issued) to prevent overfishing.

(vii) Effective monitoring and control of the activities of the oil industry to minimize latent environmental pollution and major blow out.

CONCLUSION

Although Nigeria's continental shelf is not among the major fishing areas of the world, it however has potential demersal finfishes that can sustain a viable trawling industry if effort in capitalization (overfishing) is prevented from manifesting itself in the industry.

The inshore trawling industry may seem threathened by the large artisanal fishermen population in the inshore zone, nevertheless, the different fishing techniques and

different fishing ranges exploited by these competitors (artisanal fishermen/trawling industry) offers prospect of good catch to the trawling industry. While the artisanal fishermen use set gillnets, beach seine and longline to exploit pelagic fish communities, the trawling industry uses bottom trawlnet to exploit demersal fish communities of the inshore zone.

The problems of management and technological know-how which beseiged the industry in recent times would disappear through the experience the investors acquire from learning and the availability of trained fisheries personnel to manage the industry.

Finally, the establishment of a proper managerial set-up in a trawling industry, the availability of shore facilities and the fish potentials of the inshore zone offer prospect for a viable inshore trawling industry in Nigeria.

ACKNOWLEDGEMENT

The authors wish to acknowledge the Federal Department of Fisheries for commissioning thesurvey on which fishing costs and revenue of trawler operation are based.

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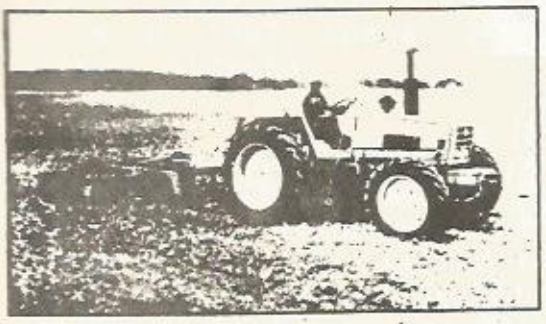
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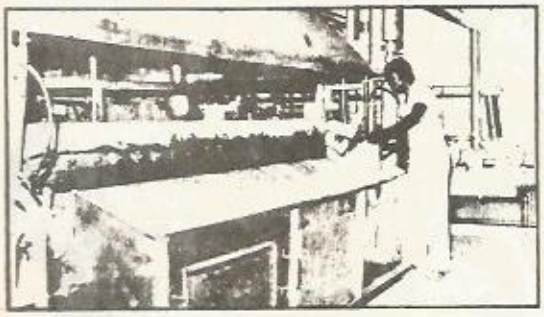
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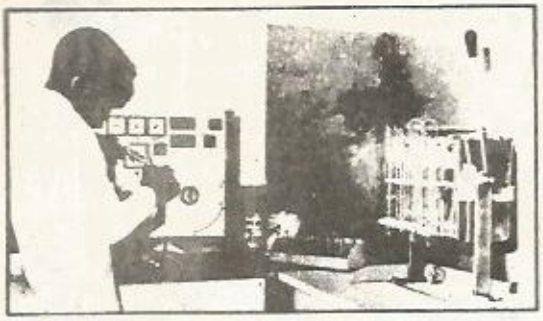
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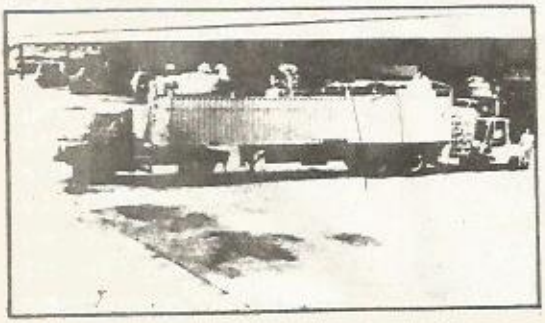
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PRESENT STATUS AND POTENTIALS OF INSHORE AND OFFSHORE PELAGIC FISHES IN THE CAPTURE AND PROCESSING INDUSTRIES OF NIGERIA

by

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ABSTRACT

Apart from activities of some foreign-based vessels, commercial exploitation of pelagic fishery resources in Nigeria has been limited to inland and inshore waters. Estimated potential for the inshore pelagic fishery is 70,000 - 90,000 tonnes while the small pelagic resources in the near offshore as well as tuna and tuna-like fishes further offshore have potentials of about 10,000 metric tonnes each. Despite the abundance of tuna within and adjoining the Nigerian EEZ, and its importance in the international market, only foreign - flagged vessels take advantage. In addition, the inshore pelagic fisheries in Nigeria have for long remained underexploited.

Principally, due to the numerous intermuscular bones characteristic of the major inshore pelagic species, they are poorly utilised in preparation of fishery products. The most common processing method has thus remained the age-old traditional smoke - drying. This method is inadequate resulting in colossal waste through denaturation and incessant infestations by insects and moulds among other causes.

The employ of modern smoking techniques coupled with effective distribution systems can undoubtedly reduce waste. However, these are often not within the reach of most artisanal processors. It is proposed that the organised private sector should invest on simple but proven processing equipment such as smoking kilns. The inshore pelagic fish species and other small fishes can sustain cottage canning industries sited in fishing villages/settlements while larger canning factories should be based on offshore resources. Modalities for successful investments are highlighted, while a major consideration is given to joint ventures.

INTRODUCTION

In Nigeria, there were recorded increases in local fish production during the 70s and early 80s. These were primarily due to mechanisation of artisanal fishing. These productions however satisfied only 50 - 60 percent of fish demand in the country, the percentage decreased gradually between 1981 and 1983 (Tobor, 1984). Thereafter, total fish production in the country had actually been on a decline.

Although shortage and high costs of spare parts, fishing boats and other fishing implements contribute to the decline in fish production, the situation is further aggravated by the enormous losses of fish due to poor preservation and processing methods. This condition, in 1983 alone, was said to have resulted in a loss of 45 percent of fish production, an equivalent of 225,503 tonnes worth about ₦112.76 million (Tobor, 1984). While it is widely advocated that tremendous increases in fish production in Nigeria can be achieved by improving aquaculture practises, it is contended that the inshore and offshore capture fisheries can also be better harnessed. More importantly, improved preservation and processing methods for fishes landed would further enhance not only the quantity but also the quality of fishes that are eventually available to consumers. It is in this regard that the present levels of exploitation of inshore and offshore pelagic fishery resources in Nigeria are examined and their potentialities in the capture and processing industries analysed.

INSHORE PELAGIC FISHERY RESOURCES

The Fishery

More than 90 percent of recorded fish production in Nigeria emanates from the artisanal fisheries sector (marine, brackish and inland), table 1 refers. Most of these catches are marine in origin. The principal pelagic fishes in inshore artisanal catches are bonga (Ethmalosa fimbriata) and sardine (Sardinella maderensis) while the most common semi-pelagic species is the shad (Ilisha africana). Maximum sustainable yield (MSY) for pelagic fishes at sea in Nigeria was put at 60,000 tonnes by FAO (1967) while Ajayi and Talabi (1984) summed up the yield of the fishery in coastal and brackish waters to be 70,000-90,000 tonnes. Although an annual landing of 40,000 tonnes was projected for the fishery at sea during 1975 - 1980, far less catches were made. The most important inshore pelagic species, E. fimbriata, had a total production of 30,000 tonnes while catch estimates for other species put together were much less. Catches of E. fimbriata in Nigeria has however remained the highest in West Africa (Table 2).

E. fimbriata is encountered more in estuaries and shallow coastal waters east of Lekki while S. maderensis occurs more in coastal waters west of Lekki. Both species are more abundant in catches between October and May, reaching peak production about January - March. The seasonality and areas of abundance for bonga and sardines are related to prevalent biological production and hydrographic conditions; bonga a plankton feeder is more suited to the existing conditions in areas east of Lekki where there are numerous estuaries (Fig. 1). The abundance of nutrients in the estuaries and adjacent sea enhance heavy plankton bloom particularly during the dry season when temperatures are relatively high (Longhurst, 1961; Scott, 1966; Nsentip, 1982). Generally, abundance of Sardinella spp. is closely

associated with upwelling. Although there are no regular upwellings in the Nigerian waters, the relative abundance of S. maderensis west of Lekki is closely linked with its abundance in neighbouring Ghana where there is substantial seasonal upwelling. There are indications that S. maderensis (E. eba = S. cameronensis) seems to avoid cold water and moves during upwelling to warmer parts of the neighbourhood (Zei, 1965). E. maderensis is tolerant of salinity and occurs more in the open sea but also in estuaries to some extent. I. africana, with a wider scope of food including fishes, molluscs, shrimps and other crustaceans. (Marcus, in press), is justifiably encountered with greater uniformity of abundance in the entire coastal waters of Nigeria and at all seasons.

Ring gill net (encircling net) is the oldest and most widely used artisanal gear for bonga and Sardinella fishing. Fishing at sea is more or less exclusive to it due to its acclaimed success. Other successful gears used in fishing for pelagic fishes include drift nets, particularly in the Niger Delta area, set gill nets, beach seines and cast nets. Recorded catches with purse seines were poor (FAO, 1969). In any case, it is pertinent that at this stage, even semi-industrial purse seiners should not be introduced. Rather, a better efficiency of the artisanal gears presently in use should be ensured.

Preservation and Processing:

Fish preservation and processing methods practised in Nigeria have been extensively reviewed (Tobor, 1985). The methods include chilling, freezing, smoke-drying, sun-drying, salting and sun-drying as well as scorching before sun-drying. Several researches have improved these methods.

Attention has also been focussed on development of fishery products, particularly from underutilised fishes with low market acceptability. Already developed products include mince, fish cakes, fish sausages, fish meals, fish concentrates, fish burgers and fish fingers. Development of most of these products are directly relevant to and provide a diversity in the urban market. However, the importance of smoking in rural fishing settlements and villages where most of the fish are produced must not be underscored. Fish smoking appears to be the most practicable, given the present set up of rural coastal areas in Nigeria. It requires the least technological expertise and can guarantee fish supply to interlands in good quality condition. Furthermore, smoking equipment are also simple, usually requiring no complicated maintainance. 'Altona' smoking kiln was introduced for its greater efficiency over the traditional kilns. However, due to the introduction of mechanisation which resulted in increased artisanal landings, it became imperative to improve on them, hence the design and construction of kilns with greater capacity and more efficient heating characteristics which ensured better quality products. Although such kilns have been patented and demonstrations have beem satisfactory, adoption has

been poor. A major reason for this has been economic constraint on the part of the artisanal fishermen. Observation in the field indicate that fishermen have mostly continued with the age-old smoking methods which though are more laborious and time consuming are also less efficient and with low profitability to fishermen. There are collossal wastes of fish, particularly small sized inshore fish species, notably the pelagic and semi-pelagic species which are mostly sold in smoked forms. Losses occur principally through insect and mould infestations, denaturation due to charring and loss of edible portions in the form of head, skin and tail.

With the realisation that ownership of efficient smoking kilns is not within easy reach of most artisans, and the present distribution system is very limited, it becomes imperative that the organised private sector should make an impact both in processing fishes and marketing of fish products. The NIOMR smoking kiln which utilises wood is capable of smoking 250kg of fish in 3-6 hours while it costs about ₦1,000 (Ibinosun, pers. comm.) Hard wood is preferable and the equipment can be adapted to utilise charcoal. Progressive development on the prototype has recently resulted in the production of a gas - operated smoking kiln which achieves adequate smoking within a shorter period.

To ensure the success of such processing concerns as described, it is desirable that the processor (organised private sector) should reach some form of agreement with artisanal fishermen in the area of operation. It is proposed that such an agreement should be similar to that of the Nigeria Tobacco Company (NTC) with crop farmers, a condition which had existed since 1932. The venture would entail the supply of gears, crafts and motor engines by the private sector, according to the varying needs of the fishermen. Costs of these would be offset instalmentally. In addition, it would be mandatory that the fishermen sell their catches to the processor at previously agreed prices. In such a circumstance, while the processor is assured of adequate and constant supply of raw materials at fixed prices, the fishermen have, adequate implements to fish with, a condition that is presently rare to come by. The fishermen are also assured of prompt and commensurate prices for their catches. For best results, transactions with artisanal fishermen should be done through their cooperative societies. Although the processor may at will operate an artisanal fishing company whereby a number of fishermen are employed to fish, the success of such a venture would greatly depend on his level of management capability. The former option appears preferable. The costs of one unit each of craft, gear and motor engine are set out along with costs of processing with two units of smoking kilns.

On a long-term basis, improved utilisation of the pelagic and semi-pelagic species along with other small-sized inshore fishes caught during artisanal fishing, could be attained by canning. This ensures a wider distribution for the fishery product in good quality condition than has ever been the case

with any of the developed fishery products. Although the technology of canning inshore fishes is available in Nigeria (Adetunji, 1986) and possible varieties include fish in oil, in tomatoe sauce and brine, in view of the limit of these resources and their bony characteristics production of canned fish spread appears to be the most favourable. Such a canning venture can be sited in the fishing villages or settlements. It is estimated that a minimum supply of 1.5 tonnes of small-sized fishes daily can be conveniently available within a fishing village or settlement to sustain such a cottage canning industry that is capable of producing 8,000 - 9,000 cans of fish spread each working day. Some fishing villages may infact be able to support a higher production level. Such ventures would not only have high profitability but they would promote development and employment opportunities in rural areas. While there is no doubt that higher profitabily is assured by operating larger factories such as that capable of producing 8,000 cans of fish spread per hour, the sustainance by the inshore fishery (small sized fishes) is questionable. Such large factories could be based on the unexploited resources in the offshore waters. A major advantage of such large production are high profitability and the cheaper rate at which the products can be available. The procedures for production of fish spread are set out in flow-sheet No. 1 while estimates for operating a cottage canning industry with a production capacity of 8,000 cans daily are set out in work sheet No. 2. For profitability, each can of about 150g would sell for about ₦1.0. This is still cheaper than the present price of any canned fish product in the market. It is pertinent to note that while these raw materials (fish) are not the best of fishes, the nutritional value of such products has been found to be similar to those of other canned products. A greater profitability for the company can be ensured by operating two lines, one for fish canning and the other for canning fruits that are abundant and easily obtainable.

OFFSHORE PELAGIC FISHERY RESOURCES

The Fishery:

The extent of small pelagic fishery resources in the immediate offshore waters of Nigeria were estimated during cruises of Fiolent 1976 Eastern Central Atlantic coastal fishery resource survey and R/V Dr. Fridtjof Nansen Survey, among others. The biomass was estimated to be 44,600 mt and 55,000t (55,880mt) respectively. These figures give a potential estimate of 8920 - 11176 mt with a mean of about 10,000mt. The most occurring species during the Fridtjof Nansen Survey were silver rag-fish *Ariomma bondi*, sardine *Sardinella maderensis* and mackerel *Scomiberomorus tritor* (Stromme et al, 1983). This community is presently not being exploited and exploitation of the fishery resources could service fish spread canning industries.

Evidences abound that pelagic fishery resources are abundant further offshore within and adjoining the Nigeria exclusive economic zone (EEZ). Except for NIOMR's pole and line bait-boat, these resources are presently not being exploted by any

Nigeria - Flagged vessel. Ajayi (1984) analysed catch records of tuna boats operating in the Gulf of Guinea and their tuna fishing activities within the Nigerian EEZ. He concluded that tuna was available in the Nigerian waters. The pole and line tuna survey by NIOMR in 1982 - 1983 further confirmed the abundance of tuna and tuna-like fishes within the Nigerian EEZ. With an estimated annual potential of about 10,000 mt for tuna and tuna-like fishes within the Nigerian EEZ, it has been concluded that the fishery can sustain a Nigerian tuna fleet (Ajayi and Talabi, 1984). This figure excludes some 70,000 mt presumed to be outside all nations' jurisdiction in the East Atlantic and available to all vessels with sufficient range (Ajayi, 1984). The most common tuna in the Nigerian waters is the skipjack (Katsuwonus pelamis) which constitutes about 70 percent of catches.

Modalities of operating tuna fishing enterprise in Nigeria have been dealt with by Ajayi (1984). Optional fishing methods include pole and line, purse seining and longlining. While baitboat would have been most favourable for tuna fishing in Nigeria because of its advantages, the fact that adequate quantities of suitable baitfishes have not been found in the Nigerian waters tilts a choice in favour of the purse seine. Considering purse seiners and baitboat of comparable carrying capacities, investment on the latter is lower, maintenance is lower and less complicated and oftentimes less frequent. Although a purse seiner does not require baits and therefore it may have a wider fishing range than a baitboat of comparable carrying capacity, its initial, operational and maintenance costs are higher. Purse seining entails very specialised skills, ratings and renumeration of officers are higher. While a comprehensive bait survey in Nigeria seems inevitable, for the present, except there is a concluded arrangement to obtain baitfishes from a neighbouring coastal country, the most favoured option is purse seining. Ajayi (1984) estimated the cost of a new purse seiner (500 - 600 GRT) to be about U.S. $ 3.0 million.

As Nigerian industrialists are inexperienced in tuna fishing, joint ventures with foreign partners with fishing experience in the Gulf of Guinea appear inevitable. While the Japanese and Koreans have a distinguished mastery of the pole and line technique, the French and Spanish are good in purse seining.

Processing of tuna and tuna-like fishes

Much of tuna product development has been largely in developed countries where such fishes are highly cherished. In Nigeria, progressive development has taken place since the 1982 - 1983 tuna survey.

Skipjack, the most abundant species in the Nigerian EEZ is least preferred for consumption in Nigeria and other nations in fresh form. A consumption survey in Japan between 1963 and 1977 indicated that consumption of Skipjack in fresh form was low and no increases were observed during the period. However, consumption of other tunas were higher and progressively increased during the period. Unlike other

tunas, skipjack tends to deteriorate even in low temperature and the quality and colour of the meat easily changes during thawing. The types of products to be prepared from skipjack are therefore of considerable importance in determing the method of preservation on board fishing vessels. Salt penetration into tissues of skipjack during brine freezing reduces the quality of the tuna and such fish are usually processed into dried or canned forms. Skipjack preserved in brine commands low market prices. The "frozen skipjack cutter" developed in Japan is used to fillet tuna in frozen state such that the browning of the tissue in skipjack during thawing can be prevented. The most acceptable preservation method on board fishing vessels now is quick freezing (-50°c) a condition which preserves the quality of tunas much better than brine freezing.

Canned tuna is popular in developed countries and some developing nations such as Ghana where tuna is being canned for export. Canned tuna products have also been developed in Nigeria. Products developed include tuna in brine, in oil and tomatoe sauce (Akande, pers. comm.) Organoleptic tests indicate their acceptability to Nigerians while products also satisfy microbiological tests. The light meat is canned in solid packs which will be acceptable in the export market while the dark meat could be canned in chunks or flakes for the local market. Tuna - like fishes can also be canned for the local market. Offals from the canned fishes transform into fish meals ideal for poultry and fish culture industries. To maximise profit and forestall inadequate supply of tuna particularly during the off season (about January to July) canning factories could be operated on two lines, one each for fish and fruit canning. A best choice of fruit should be from amongst those that are abundant during the season. A suitable choice could be made from mango, tomatoe, orange and grape fruits.

Apart from frozen fillets and canned products, another avenue of utilising tuna is smoking. This aims at gradual removal of water from fillets, removal of excessive fat and prevention of propagation of micro-organisms thus ensuring good flavour as a seasoning food. With adequate drying, a hard product is obtained which keeps on the shelf for a considerable period. Diversifications from this include packed dried flakes and light roasting of the fish for immediate consumption. A local survey has shown that smoked tuna is highly acceptable in Nigeria.

CONCLUSION

While relatively lower capital is required for inshore fishing and processing, higher capital costs are inevitable for exploiting and processing offshore resources. Profits are however commensurate to investment. With an estimated annual profit of 20 - 25 percent it is expected that a tuna purse seiner may be able to pay back its cost in a few years out of its 15 - 20 years longevity while an annual profit of 25 - 30 percent of total proceed is envisaged for the baitboat as asserted by Ajayi (1984). Similar profits accrue from the canneries. There is the opportunity for local canning industries operating presently, to base their

productions on locally available fishes.

Finally to forestall shortage of raw materials during the offseason for the pelagic fish species, tuna in particular, and to maximise usage and hence profits of the factories, the canneries could operate two processing lines one each for fish and locally available fruits. Such fruits should be those that are abundant and easily available in the vicinity. Suitable choices could be made from fruits such as mangoes, oranges, grapes and tomatoes. Canned forms of these fruits command good demand and prices in local and export markets.

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Table 1. Domestic Fish Production by Sector 1974 - 1984 Based on records of Federal Department (of) Fisheries, Lagos)

YEAR	INDUSTRIAL SECTOR (Metric Tonnes)	% OF TOTAL DOMESTIC PRODUCTION	ARTISANAL SECTOR (Metric Tonnes)	% OF TOTAL DOMESTIC PRODUCTION
1974	5768	1.22	465354	98.78
1975	8057	1.74	456062	98.26
1976	8725	1.77	484278	98.23
1977	13767	2.74	488022	97.26
1978	15245	2.95	501412	97.05
1979	9406	1.76	524127	98.24
1980	16342	3.42	461364	96.58
1981	12435	2.52	481783	97.48
1982	15052	2.96	493338	97.04
1983	13572	2.63	501927	97.57
1984	22255	6.50	320086	93.50

Table 2. 1977 Annual Landings of bonga (Ethmalosa fimbriata) in West African Countries

Source: Fischer et al (1981)

Country	Landing (tonnes)
Nigeria	30000
Senegal	25000
Sierra-Leone	15000
Ivory Coast	14000
Gambia	7000
Gabon	600
Ghana	100

FLOWSHEET NO. 1

THE TECHNOLOGICAL SCHEME FOR A SARDINE SPREAD CANNING LINE

Auxiliary Supply	Phases of the Technological Process	Residue
	FRESH SARDINES	
	WEIGHING	
water ——>	NOBBING (fish body without head & viscera)	——> offal water, heads and viscera
water ——>	WASHING	——> offal water
water, margarine, ——>	PRECOOKING (Precooked sardines and ingredients)	——> offal water, steam
garlic, Na-caseinate spices ——>	CUTTING & MINCING (Fish spread mass)	
	COMMINUTING (Fish spread ready for packing in cans)	
	TRANSPORT TO THE FILLING MACHINE	
steam, water empty cans		
washing of cans ——>	FILLING OF CANS	——> offal water
Rids		
Coding of lids ——>	SEAMING OF CANS	
water, steam ——>	WASHING OF CANS	——> offal water, steam
water, steam ——>	RETORTING	——> offal water, steam
water, steam, air ——>	WASHING AND DRYING OF CANS	——> offal water, steam, hot air
cartons ——>	PACKING IN CARTONS	
	INSPECTION	
individual cartons ——>	PACKING IN INDIVIDUAL CARTONS	
	STORING	
	DELIVERING	

FLOWSHEET NO. 2

THE TECHNOLOGICAL SCHEME FOR A TUNA CANNING LINE

Auxiliary Supply	Phases of the Technological Process	Residue
	Reception of frozen fish	
	PRETREATMENT	
	Frozen fish	
water →	Thawing	→ waste water
	Cutting in pieces or loins	→ tail, waste meat
water →	Washing	→ waste water
	Filling in stainless steel grills and trays	
	PRECOOKING	
steam →	Precooking in steam	→ condensed wate
	Cooling and drying	
	PACKING	
	Separation of bones, skin and dark meat	→ bones, skin, dark meat
clean empty cans →	Meat forming	
	packing in cans (solid pack, fillets, flakes and chunks, fish and vegetables)	
dry salt →	Salting (Optional)	
oil or brine →	Oil or brine filling	→ waste oil or brine
	SEAMING	
lid → coding →	Seaming	
	Recovery of oil (Optional)	→ water + oil purification
steam, water →	Can washing	→ waste water
	STERILIZATION	
	Basket loading	
steam, water →	Sterilization under pressure	→ waste water
	Basket discharging	
	FINAL OPERATION	
	etc. as on sardine canning line	

WORK SHEET 1

INSHORE PELAGIC FISHING AND PROCESSING

FISHING		₦
	YAMAHA BOAT) MOTOR ENGINE)	20,000
	SURROUNDING GILL NET	15,000
		35,000

PROCESSING SMOKE - DRYING

INPUT		₦
	SMOKING KILN (2 units)	5,000
	RAW FISH	250,000
	500KG x 5 (DAYS) x 50 (WEEKS) x 2.0 (₦) WAGES FOR 2 PERSONS	4,000
	OTHER EXPENDITURE (including infrastructure)	40,000
		299,000
	INTEREST (14%)	41,860
	TOTAL =	340,860

OUTPUT		₦
	SALE OF 62,500KG OF PROCESSED FISH @ ₦6.00 PER KILOGRAM =	375,000
PROFIT = ₦375,000 - ₦340,860 =		34,140

WORK SHEET 2

CANNING PRODUCTION OF FISH SPREAD

(FIRST YEAR)

INPUT	₦
CANNING EQUIPMENT	200,000
ELECTRICITY GENERATOR	50,000
COLD ROOM	50,000
BORE - HOLE WATER SUPPLY	50,000
INFRASTRUCTURE	50,000
VEHICLE	50,000
FISH SUPPLY (1500(kg) x 5 (days) x 50 (weeks) x ₦2.00)	750,000
OTHER COSTS (including cans, garlic, spices) (packaging etc.)	250,000
WAGES	100,000
	1,550,000
INTEREST ON LOAN (14%)	217,000
	1,767,000

OUTPUT

SALE OF 2,250,000 CANS OF FISH SPREAD
@ ₦1.00 PER CAN

YIELD = ₦2,250,000

PROFIT

₦2,250,000 - ₦1,767,000

= ₦483,000

WORK SHEET 3

TUNA FISHING - POLE AND LINE BOAT

(Source: Ajayi 1983 figures)

(FIRST YEAR)

		US.$	
A.	Cost of pole and line bait boat	2.0 million	
B.	WAGES	US.$	
	FISH MASTER	30,000)	
	CHIEF ENGINEER	30,000)	JAPANESE
	CAPTAIN	25,000)	KOREAN
	FIRST ENGINEER	25,000)	PANAMANIAN
	FIRST DECK OFFICER	25,000)	
(2)	SECOND DECK OFFICER	40,000)	
(20)	CREW	80,000	NIGERIAN
	TOTAL	= 255,000	
C.	OPERATIONAL COSTS:	US.$	
	FUEL	200,000	
	BRINE.	50,000	
	PROVISIONS	50,000	
	PORT FEES	50,000	
	OVERHEAD	100,000	
	OTHERS	100,000	
		550,000	

EXPENDITURE = COST OF BOAT + WAGES + OPERATIONAL COSTS + BANK REPAYMENT

= 2.0 million + 255,000 + 550,000 + 50,000

= 805,000 US.$

EARNINGS	US.$
EXPORT	500,000
LOCAL	500,000
	1,000,000

WORK SHEET 4

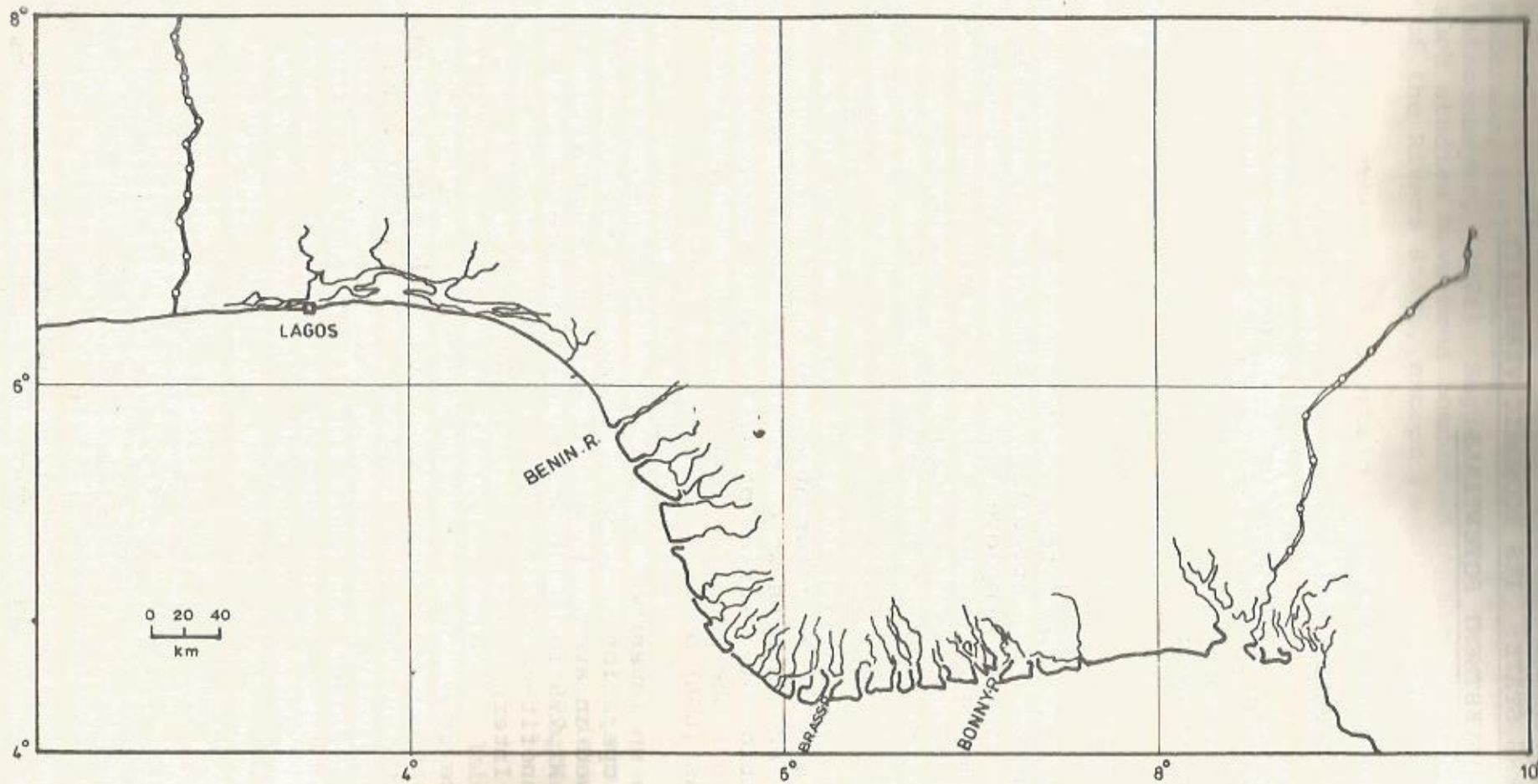
TUNA CANNING

EXPENDITURE	₦
COLD ROOM	500,000
ELECTRICITY GENERATOR	200,000
BORE - HOLE WATER SUPPLY	100,000
WAGES	100,000
FISH (appx. 1.5t daily, x 5 days x 5 weeks)	1,200,000
EQUIPMENT	1,000,000
VEHICLES	100,000
INFRASTRUCTURE	500,000
OTHERS	500,000
	4,100,000
INTEREST ON LOAN	574,000
	4,674,000

EARNINGS	
2,125,000 cans of solid pack @ ₦2.00 per can	4,250,000
525,000 cans of chunks or flakes @ ₦1.00 per can	525,000
	4,775,000

*PROFIT ₦4,775,000 - ₦4,674,000 = ₦101,000

*Higher profits when more raw materials are utilised.


8°
6°
4°
4°
6°
8°
10°
LAGOS
BENIN R.
BRASS
BONNY R.
0 20 40
km

ARTISANAL CANOE FISHING INDUSTRY OF THE RIVERS STATE: ITS ECONOMIC VIABILITY AND INVESTMENT POTENTIALS

by

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ABSTRACT

Consequent upon the present national call on all and sundry to go back to agriculture including fishing, most retrenched workers and unemployed youths from the riverine areas are taking up fishing as a legitimate and gainful livelihood. To sustain this tempo and attract more investment, the economic viability of such projects must be known. This study is an attempt to document the profitability and investment potential of artisanal canoe fishing.

Socio-economic information including catches, operational cost and returns were obtained through a personal interview questionnaire survey of 240 randomly selected artisanal canoe fishermen from Bonny, Brass and Degema Local Government Areas (LGA) of the State and analyzed.

With an investment cost of about ₦8,135, ₦8,490 and ₦6,571 and operation cost of ₦750, ₦776 and ₦627, the analysis showed an average monthly gross income of ₦1,869, ₦3,221 and ₦1,775 for the three Local Government Areas respectively. A benefit-cost-ratio of 1 : 8, Net Present Value of ₦400,603 and Internal Rate of Return greater than 50% were obtained.

Since capital invested in fisheries is not tied up for long before benefits start flowing, coupled with the high IRR, it is concluded that artisanal canoe fishing would be an economically viable venture if well managed.

INTRODUCTION

Consequent upon the present national call on all and sundry to go back to farming, fishing and other forms of legitimate and gainful livelihood, people who are situated in the riverine States have re-assessed and regarded fishing as a legitimate and gainful industry. To sustain the tempo of interest that is gaining momentum, we need to demonstrate to the would-be fishermen and financial institutions, the financial and economic viability of the industry. Many studies have been conducted on fisheries economics world-wide including Crutchfield and Zellner, (1962); Bromley, (1969):

Arnold and Bromley, (1970); Gates and Norton, (1974); Bishop, (1975); Abrall, (1975); Craig, (1975); Anderson, (1973); Brander, (1978); Anderson, (1977); Lacker, (1977); Shang, (1978); Kuranchie, (1973); Leinsenmeyer, (1976); Sagua, (1976); Mboma et al, (1981); but few such studies have been conducted on the artisanal fishing industry of the Rivers State, except Fawumi, (1983).

This study is an attempt to ascertain the costs, returns and the profitability of the artisanal fishing industry in the Rivers State. This hopefully would assist would-be fishermen, businessmen, financial institutions and government in their investment decisions regarding artisanal fishing project.

METHODOLOGY

The Study Area

The Rivers State is one of the smaller States within the Federation of Nigeria with ten local government areas (LGA) and with an estimated area of 30,000 square kilometers. It is enclosed within the Niger Delta hence, 75% of the area is made up of water and swamplands. The result of this geographical structure, fishing is a main occupation of the riverine people of the State.

Because of lack of precise data, it is not possible to give an accurate picture of the present fishery activities of the State. However, current activities can be grouped under three broad categories; industrial fisheries, artisanal fisheries and fish farming.

The Industrial fisheries consist of inshore and limited distance-water trawling. This sector is so capital intensive that it is dominated by foreign-owned trawlers who operate under charter arrangements with some Nigerian companies. Recently, a few indigenous fishing companies have started exploiting our inshore waters.

On the other hand, the artisanal fisheries sector is labour-intensive and involves almost all riverine people. The sector is composed of four major fisheries:-

(a) Coastal Canoe fishery: which operates from scattered fishing villages along the Atlantic coastline, using large dug-out canoes, some of which are motorized. The popular fishing gear are set nets, drift net and beach seines.

(b) Brackishwater canoe fishery: this includes fishing operations in the creeks and lagoons using smaller canoes than the coastal fishery. The most popular fishing gear of this fishery consist of set nets, cast nets, hooks and traps of various kinds.

(c) Freshwater fishery: operating from the freshwater rivers and the few lakes (artificial and man-made) within the Niger Delta System.

The fishing gear used are similar to those of the brackishwater canoe fishery including spears; and

(d) Flood plain fishery: operating on the flood plains during the rainy season when the major rivers overflow their banks. Popular gear used include spears, fish fence, hooks, set nets, and traps of various kinds.

This study is however, based on the coastal and brackishwater fisheries. The basic operating unit of these fisheries is the indigenous dug-out canoes which are either hand-paddled and often assisted with windsail or motorized with out-board engines. The extent of the coastal canoe fishery is determined by the magnitude of the continental shelf and is limited mainly to the dry season when the locally made dug-out canoes could safely operate out in the sea. Whereas, in the brackishwater fishery, fishing is for all-year-round. Catches from the combined artisanal fisheries are mainly bonga, Ethmolosa spp; croakers, Sciaeniedae; threadfin, Polynemidae; grunters, Pomadasidae; sole, Cynoglossidae; mullets, Mugil spp; catfishes, Ariidae; Chrysichthys sp. and sardines, Sardinella spp.

Data Collection

A 3-stage random sampling framework was adopted to administer questionnaires to fishermen in three riverine Local Government Areas (LGA), Bonny, Brass and Degema. In each LGA, 6 fishing settlements were randomly selected and 8 fishermen from each settlement were interviewed. On the whole, a total of 30 fishing settlements and 240 artisanal fishermen were randomly selected and interviewed. Also, as much as possible, direct observations were made and direct participation in fishing operations were undertaken in 1985.

Theoretical Considerations

To facilitate economic analysis, the following concepts were defined as:-

(a) Investment cost: cost of purchasing canoes, gear, outboard engines, buildings and any other capital items owned by the artisanal fishermen.

(b) Operation costs: cost incurred during fishing i.e. cost of fuel, engine oil, gear oil and food expended per fishing trip. Others are regular maintenance and repair of boat engines and gear.

(c) Catches, Yield and revenue: items in these groups include catches per fishing trip, value of catch per trip, prevailing market prices for different fishes, number of fishing trips per month.

(d) Miscellaneous items include the amount of fish consumed at home or used for other purposes than revenue yielding, percentage loss/damage due to spoilage and insect infestation and amount of fish marketed regularly.

It must be cautioned that record keeping is an exception rather than a rule. Hence, the validity of most information obtained from the fishermen were cross-checked in the market as far as possible.

RESULTS AND DISCUSSION

The results ofthe study are given in Tables 1, 2, 3 and 4. From Table 1, the average investment cost for the LGA are ₦8,135.43, ₦8,490.80 and ₦6,510.55 for Bonny, Brass and Degema respectively. The average investment cost of fishing in the study area is ₦7,712.26. It was also observed that investment cost increases with the use of motorized fishing canoes. For instance, investment cost for a motorized fishing canoe unit is ₦10,702.22, while a non-motorized fishing unit costs ₦3,667.00.

In terms of operational costs, the mean value for the study area is ₦713.50 per month. The values for the LGAs', Bonny, Brass and Degema are ₦739.8, ₦776.2 and ₦626.5 respectively. The monthly operational cost for a motorized fishing unit is ₦1,096.5 whereas for a non-motorized fishing unit it was observed to be ₦166.3. This amount is used mostly for food and other stipends.

Fishermen's catches were given in kilogram in Table 1. Actually, for this study, the local standards of measurement and sales were used to estimate catch and revenues. For instance, in all three LGA's, sales of fish is in fish cards for most fishes (in set of twenty) or by pieces of twenty cut up pieces or whole fish.

The mean catch per trip per fishing unit in the study was observed to be 49.9 kg. However, based on the local units of measurements, the mean catch per canoe per trip ranges for 30 - 50 fish cards during off-season and between 60 - 300 and above during the on-season. Based on selling price of ₦3.50 per card for bonga, ₦2.00 per card for sardines, ₦4.00 for croakers and ₦2.00 for mixed fishes of twenty in one set, the mean monthly gross income per fishing unit in the area is ₦2,321.61. The mean monthly gross income for the various LGAs, Bonny, Brass and Degema stood at ₦1,868.53, ₦3,320.89 and ₦1,775.42 respectively. The mean monthly gross revenue for a motorized fishing unit is ₦2,694.33, while non-motorized fishing unit realizes a gross revenue of ₦1,272.8. The difference is attributable to the wider scope of operation of the motorized canoe fishermen.

To obtain a fairly accurate estimate of fishermen's net income, the value of fish consumed by the fishermen and their crew, and other operational costs incurred in fishing were deducted from the total gross income.

Also, depreciation of capital assets - engines, canoes, gear was calculated using the straightline method and deducted. Following this line of thought, the estimated mean monthly net income per artisanal fishing unit in the study area is ₦1,175.60 with an operational and fixed total costs of ₦202.5 and ₦230 per month respectively (Table 2). This net revenue of ₦1,175.60 represents the return to management and capital including the value of fish consumed by fishermen and their crew.

INVESTMENT POTENTIALS

The investment potentials for the artisanal fishing industry was derived by applying a model investment plan. The model obtains its data base from the cost-return analysis of the 3 LGAs in the study area. For easy application, the model has the following assumptions:

(i) Fishing unit under consideration is operated by a single individual or group of not less than 12 members.

(ii) Each unit has at least 6 motorized fishing canoes.

(iii) The principal gear in use is gillnet while the main fishes caught are bonga, sardines, croakers.

(iv) Fishing period is for about 4 - 6 monthsper year and 5 days per week.

(v) Average catch per fishing unit per trip is 200 fish cards and sold at ₦3.50 per card for bonga, ₦2.00 per card for sardine, and ₦4.00 for croakers and ₦2.00 for mixed fish of a set of twenty; and

(vi) Funds for the implementation of this model fishing unit is to be borrowed from a commercial bank. That is, a loan of ₦105,232.8 is to be raised at an annual interest of 9% to be repaid fully in 10 years with one year of grace.

The results of the cash flow analysis (Table 3) showed that the Internal Rate of Return (IRR) is greater than 50%, the Net Present Value (NPV) is ₦400,603.28 for the 10 years and a Benefit Cost Ratio (BCR) of 1 : 8. These results, especially the IRR indicates that the proposed investment would be high yielding. Also, the results showed a favourable output - input price relation. Consequently, capital invested is not tied up for long in building assets hence, substantial benefits begin to flow early in the life of the project and debt servicing is not onerous. In fact, Brown (1982) showed that projects with the above characteristics are indicative of projects with very high rate of return because the cash flow becomes positive quite early in the life of the project.

With an estimated NPV of ₦400,603.28 investment in artisanal fishing operations in the study area, one would enjoy a return to capital and management of about ₦40,060.3 per year and ₦3,338.4 per month if implemented by a single individual. However, if the project is operated by a group of fishermen, the return to each individual's capital and management would be ₦278,2 per month.

If this return is added to one's opportunity cost of labour, then the return to each individual for his labour, management and capital would be ₦481.2 per month.

When the results are subjected to a sensitivity analysis (Table 4), it was observed to be very responsive to a 10% change in cost. This implies that a drastic reduction of market price for fish or actual reduction of catch would adversely affect the rate of return and hence profitability.

CONCLUSION

Traditionally, artisanal fishermen are often regarded as the poorest individuals in any society. In fact, Sagua (1976) and Mboma et al (1981) attributed the apathy of private investors to investment in fisheries projects to the low level of returns from fishing operations. Contrary to this view, the results of this study show that the mean monthly income of ₦1,186.90 for artisanal fishermen in this study area compares favourably with incomes of most white-collar jobs in the country.

Given the high rate of unemployment in the country, and the estimated high artisanal fishermen's annual income in the study area, fishing could be an attractive business with a high tendency of new comers. For this move to have any positive effect on the overall national economy, the right incentives must be provided and commercial banks should be encouraged to liberalize their loan policies. In addition, this anticipated mass movement to fishing would only be successful if the governments of the country would as a matter of urgency undertake a more comprehensive survey of the fisheries resources potentials of her coastal waters and come up with sound management strategies aimed at utilizing the resources more wisely.

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Table 1 - Mean monthly catches, investmet and operational costs and gross earnings for artisanal canoe fishermen in some selected Local Government Areas of the Rivers State.

Selected LGAs	Mean monthly catches (kg) x 10	Investment ₦ : K	Operational Cost ₦ : K	Gross Earnings ₦ : K	Proprietors Earnings ₦ : K	Canoe-men Earnings ₦ : K
Bonny LGA	50.9	7135.44	639.78	1868.53	678.39	178.83
Brass LGA	59.0	7490.80	676.20	2320.90	1472.63	261.85
Degema LGA	39.5	5510.55	526.50	1775.42	662.68	165.85
Total =	144.4	23136.78	2142.48	6964.84	2813.64	606.53
Mean =	49.8	7712.26	714.16	2321.6	937.90	202.18

Table 2 - Estimated Mean monthly costs and returns for artisanal fisheries in some selected LGAs in the Rivers State

Costs and Returns	₦ : K
A. Fixed Costs	
Depreciation at 10%	
a) Canoe	28.00
b) Outboard engines	84.00
c) Fishing gear	34.00
d) Buildings and others	84.00
Total Fixed Costs (a + b + c + d)	₦230.00
B. Operational Costs	600.50
a) Fuel and Oil	600.50
b) Food on board	113.00
c) Canoe men's earnings	202.50
Total Operational Costs	916.00
Total Costs (A + B)	1,146.00
C. Gross Revenue	
a) Gross fish sales	1,625.10
b) Value of fish consumed by fishermen and crew	696.50
Total Gross Revenue (a + b)	2,321.60
D. Net Revenue (C - B)	1,175.60

Table 3 - Projected cash flow for a model artisanal fishing unit (x 000₦)

Sources and Use of Fund	. Project Life (Years)									
	0	1-2	3	4	5	6	7	8	9	10
	₦	₦	₦	₦	₦	₦	₦	₦	₦	₦
1. Cash Inflow										
a) Revenue		139.2	139.2	139.2	139.2	139.2	139.2	139.2	139.2	139.2
b) Loan	105.233	-	-	-	-	-	-	-	-	-
	105.233	139.2	139.2	139.2	139.2	139.2	139.2	139.2	139.2	139.2
2. Cash Outflow										
A. Investment Costs										
a) Buildings	4.5	-	-	-	-	-	-	-	-	-
b) Motorized Canoe	5.0	-	-	-	-	5.0	-	-	-	-
c) Fishing Gear	10.0	-	10.0	-	10.0	-	10.0	-	10.0	-
d) Outboard Engine	18.0	-	-	-	-	-	18.0	-	-	-
e) Miscellaneous	2.4	-	-	-	-	2.4	-	-	-	-
f) Contingency (5%)	1.995	-	0.5	-	0.5	-	1.4	-	0.5	-
Total Investment Costs	41.895	-	10.5	-	10.5	7.4	29.4	-	10.5	-

Table 3 (Contd.)

B. Operational Costs										
a) Fuel and oil	-	22.46	22.46	22.46	22.46	22.46	22.46	22.46	22.46	22.46
b) Gear oil	-	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
c) Feed offshore	-	3.64	3.64	3.64	3.64	3.64	3.64	3.64	3.64	3.64
d) Electric bill	-	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
e) Labour cost	-	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2
f) Miscellaneous	-	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
g) Contingency (5%)	-	3.012	3.012	3.012	3.012	3.012	3.012	3.012	3.012	3.012
Total Operational Costs	-	63.212	63.212	63.212	63.212	63.121	63.212	63.212	63.212	63.212
Total Cash Outflow (A+B)	41.895	63.212	73.712	63.212	73.712	70.612	92.612	63.212	73.712	63.212
3. Net Cash flow										
1 - 2	63.338	75.988	65.488	75.988	65.488	68.588	46.588	75.988	65.488.	75.988
4. Loan Repayment										
Principal	-	27.05	27.05	27.05	27.05	-	-	-	-	-
Interest	-	2.43	2.43	2.43	2.43	-	-	-	-	-
Total	-	29.48	29.48	29.48	29.48	-	-	-	-	-
5. Net Balance	46.47	35.97	46.47	35.97	66 16	43.55	75.95	75.95	65.45	73.55

Table 4 - Sensitivity analysis

Viability Indicators	Value at 10% Increase Costs	Value at 10% Decrease in Revenue
IRR	50%	50%
NPV	352993.91	312782.3
BCR	1.65	1.63

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INVESTMENT PROSPECTS IN INLAND CAPTURE FISHERIES - REVOLVING LOAN SCHEME TO ARTISANAL FISHERMEN

by

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ABSTRACT

Fishing inputs in form of netting materials, boats and outboard engines were issued to twenty fishermen on revolving loan basis at two centres - Shagunu and Monai along the western bank of Kainji Lake. The agreement was that the recipients should sell all their catches to the Institute and surrender 20% as part payment of the loan, until they offset the loan after which the inputs would become theirs'. The scheme was monitored for five years during which time most recipients had completed payment. It was observed that adequate revenue could be made from the scheme provided there was effective supervision. A proposal has been made for large scale supply of fishing inputs to one hundred fishermen. The scheme is laudable as a means of improving the lot of the fishermen and implementing management proposals in water bodies through the recipients.

INTRODUCTION

Government-sponsored agricultural credit schemes have been one of the major programmes that have been designed to help farmers and fishermen increase their incomes and improve their well-being. Such programmes are also viewed as useful tools for transfering resources to farmers and fishermen as well as for stimulating the adoption of improved production practices. However, studies carried out on the performance of most of these schemes in West Africa have shown that most of the programmes have proven unsuccessful (Osuntogun, 1973). This has been attributed to various factors such as high costs of operation as a result of the fact that the institutions do not charge their recipients the market value for the services rendered and secondly, the nature of administering small farmer credit schemes is such that it requires a greater amount of supervision.

At present, there is a lot of controversy over the rates of interest chargeable on such schemes. It has often been argued that these rates should be higher than the existing market rates in order to attract more investment funds in

agriculture. On the other hand, some people are of the opinion that these rates, if and when charged at all should be lower than the market rates in order not to drive away the small scale farmers or fishermen. The basic argument is that a scheme with high repayment rate and high participation rate might not be enough. Any scheme must improve the welfare and the income of the recipients .

Credit and loan schemes have frequently been initiated for various reasons. At times, they are initiated in order to increase output or to transfer improved technology.

In this context, the revolving loan or fund is defined after Thomas (1965) as "a loan fund constituted through the allocation of a capital sum; a fund, which once created, revolves indefinitely by re-investment of repayments in further loans".

The revolving loan scheme was primarily initiated as a trial management proposal to curtail overfishing the Kainji Lake. With good management and sufficient funds, however, there is no reason why the fishermen's output cannot be increased through improved technology transfer.

BACKGROUND INFORMATION

The inland capture fisheries is dominated by artisanal fishermen who exploit the resources by applying traditional fishing methods. The fishing gears are of different types - ranging from fishing traps, hooks and line to gill-nets of assorted mesh sizes. Some of these fishing methods allow the capture of juveniles and immature fishes, thereby reducing further recruitment into the fishery. At the impoundment of a lake or a discovery of a new fishing ground, fishermen often arrive in large numbers and fish indiscriminately; departing when the catches have been depleted. Such over-exploitation of our water bodies has led to a substantial reduction in catch per unit effort and low returns to the fishermen. The complete absence of any large scale fishery development programme in inland water bodies, necessitated the experimental trial of the revolving loan scheme to artisanal fishermen operating in Kainji Lake.

Study Area

Kainji Lake was formed in 1968 as a result of the damming of the River Niger. This artificial lake has a surface of 1,270 km² and maximum depth of 60 m (11 m mean) and favours the proliferation of over 80 fish species. Early post-impoundment studies on commercial landings indicate that fish landing from about 1,800 boats in 1969 amounted to 16,000 metric tonnes. Between 1970 and 1971 when the number of boats in the lake doubled (from 1,800 to 3,300 boats) there was also a proportionate increase in fish landings from about 16,000 to 30,000 metric tonnes. Recent estimates have shown a subsequent decrease in the commercial landings from 30,000 in 1971 to about 11,000

tonnes in 1972 (Bazigos, 1972) and to 5,000 metric tonnes in 1978 (Ekwemalor, 1978). The low catches have been attributed to the high population density of the fishermen and the absence of effective fishery regulations on the lake based on active extension and liaison services. The complete absence of any large scale fishery development programme on the lake has brought about the incentive for the experimental trial of the revolving loan scheme to some fishermen operating on the lake.

Most fishermen operating within Kainji Lake are from the neighbouring Sokoto, Niger and Kwara States with a few itinerant fishermen from Bendel State.

Due to the heterogeneity of fishermen along the Kainji Lake, interactions among them are quite minimal. Consequently, fishermen do not form themselves into co-operate bodies which would have eased dispensation of information and extension services (Ita and Eyo, 1982).

Objective

The objective of the scheme was threefold:-

(i) To improve the conditions of the artisanal fishermen by supplying them with inputs on a revolving loan basis,

(ii) To gather fishermen into effective and functional units and thus, ease the implementation of fisheries management proposals through direct dealings with fishermen, and

(iii) To determine the problems involved in setting up a revolving loan scheme to fishermen and recommend ways of making the scheme beneficial to the agency for the purpose of creating investment opportunities for governmental and non-governmental organizations.

The scheme was first introduced in Shagunu (Figure 1) in May 1980 for the benefit of ten selected fishermen living within the locality. It was later extended to Monai close to the Institute's Headquarters in July 1981 with inputs supplied to ten fishermen.

The initial inputs were nets, twines and hooks at cost prices, while boats and engines were later supplied to fishermen whose earlier returns were in tune with the ideal of the scheme. Plates 1, 2, and 3 show fishermen with their inputs.

METHOD OF OPERATION

The registraton of the fishermen was followed by the issuance of a loan application form to the fishermen. The fishermen were given a period of 2 - 4 weeks during which their daily records were obtained for proficiency test. Suitable fishermen for the scheme were shortlisted based on their individual performances during this period.

On acceptance of a fisherman, a daily record log book was opened for him. The record log book indicated the daily landings of the fisherman and the amount deducted for loan repayment from fish sales to the scheme.

In order to avoid ambiguity in the purchase of fish from the fishermen, fish prices were standardized (with slight modifications depending on season) after due consultations with the fishermen involved in the scheme. Fish prices were tentatively fixed at prices ranging from ₦0.50 (for Labeo and Tilapia species) to ₦2.00 for Lates, Gymnarchus, Bagrus and Clarias sp. The prices were subject to change depending on relative abundance or scarcity of the species with season.

Servicing and repairs of boats and engines were carried out free with fishermen supplying the necessary spare parts, loan repayments was effected by surrendering 20% of the daily catch or by cash payment.

INVESTMENT ON INPUTS

Details of the investment schedule for the various options of input supply were as follows:-

A) With fibre glass wooden boat, engine, nets and twine supplied

(i)	1 fibre glass flat bottom wooden boat @ ₦600.00 each	₦600.00
(ii)	1 16-H.P outboard engine @ ₦800 each	800.00
(iii)	12 bundles of net @ ₦40 each	480.00
(iv)	100 cords of twine @ ₦1 each	100.00
	Amount of loan advanced =	₦1,980.00

B) With local wooden boat, engine nets and twine supplied

(i)	1 local wooden boat	₦300.00
(ii)	1 16-H.P outboard engine @ ₦800 each	800.00
(iii)	12 bundles of net @ ₦40 each	480.00

(iv)	100 cords of twine ₦1 each		₦100.00
	Amount of loan advanced	=	₦1,680.00

C) With only local wooden boat, nets and twine supplied

(i)	1 local wooden boat @ ₦300 each		₦300.00
(ii)	12 bundles of net @ ₦40 each		480.00
(ii)	100 cords of twine @ ₦1 each		100.00
	Amount of loan advanced	=	₦880.00

D) With fibre glass wooden boat, nets and twine supplied

(i)	1 fibre glass wooden boat @ ₦600 each		₦600.00
(ii)	12 bundles of net @ ₦40 each		480.00
(iii)	100 cords of twine @ ₦1 each		100.00
	Amount of loan advanced	=	₦1,180.00

RESULTS AND DISCUSSION

Loan Repayment

The data in Table 1 indicate the returns from registered fishermen in Shagunu area. Of the ten fishermen earlier supplied with inputs, eight of them are recorded in the table. The two fishermen whose loans were left out had their boats and engines confiscated following irregular repayment of the loan. Their inputs were handed over to two other fishermen who were eager to pay the balance owed to the Institute and willing to operate within the terms of agreement. Thus, within a period of 2½ years (April 1980 to October 1982), the total amount advanced to the fishermen was ₦7,530.00 of which ₦4,630.95 was repaid representing 61.5% of the loan.

Of the ₦12,255.00 advanced to ten fishermen in Monai sector, ₦3,638.35 representing 29.7% of the loan was repaid within 1½ years. One fisherman was, however, deceased within the period and since he was issued with only netting materials, his loan was written off. Table 3 shows the financial returns for Monai sector.

Table 3 shows the returns of the ten fishermen from the Monai sector in 1985, four years after the inputs were issued to them. Five of the fishermen who were issued with boats and engines had completed payment and were awarded

able to the station. The fish thawed at ambient temperature during transportation. They were again frozen in cabinet freezers in New Bussa and sold straight from the freezer or transported in refrigerated pick-up van to the consumers. Due to the bad road between Shagunu and New Bussa, the Refrigerated pick-up van was not used in transporting fish from the substation inorder to avoid damage to the refrigerated body of the pick-up.

Identified Areas for Improvement

In view of the foregoing, it was reported (Ita and Eyo, 1982) that the following improvements were needed for the successful implementation of the scheme.

(a) Transportation

There was need to attach another vehicle to Shagunu in addition to the existing old Land Rover which was constantly under repairs.

(b) Freezers

The cabinet freezers are quite slow in lowering the temperature of the fish and as mentioned earlier, spoilage could set in even before the fish are frozen. There was need for the installation of blast freezers both at Shagunu and the headquarters (New Bussa) for quick freezing of fresh fish before they were transported to the consumers or stored in the cold store.

(c) Power suppy

In order to ensure continuous power supply in Shagunu, there was need for the provision of a stand-by generator in the event of the existing one breaking down or needing servicing.

(d) Cold storage facilities

A cold store was needed at the headquarters so that excess fish could be stored during the glut season and sold out during the period of scarcity.

Appraisal of the Scheme

(i) Management of the Lake Fishery

Following an initial proposal of the scheme (Ita, 1978), the Niger River Basin Development Authority (NRBDA) decided to operate a loan scheme from their base at the western shore, close to the dam. Ita (1982) has proposed management strategies for the lake for enforcement jointly by the NRBDA and other Fisheries Agencies if the problem of overfishing in Kainji Lake is to be controlled. These proposals include free registration

of fishing boats and issue of fishing licences to fishermen, expansion of the revolving loan scheme to other States bordering the lake, establishment of supply and servicing units together with processing units, and minimum mesh size regulation to prevent over exploitation of young fish before they attain sexual maturity. The recommended mesh size is 7.5 cm (3 inches) and above for effective cropping of sexually matured Tilapia. The implementation of these recommendations are within the mandate of the Authority whose scope covers the Kainji Lake Basin and the State Governments bordering the lake.

(ii) Method of repayment

There is a limit to the amount of loan which a fisherman will be expected to repay within a particular period. From the estimated total catch per boat per year shown on Table 6, it is expected that a fisherman will crop an average of 1.4 metric tonnes of fish per year. Assuming that fish is sold at an average of ₦1.00 per kilogram, each fisherman will recover about ₦1,400.00 per year from fish sales. If the fisherman does not have any other source of revenue, it means that this amount will take charge of the cost of fuel and servicing of the engine, family maintenance and loan repayment. In a case in which the fisherman is issued with a boat, an engine and nets, it is recommended that loan repayment should be extended to a period of about 5 years. This will be achieved by deducting 20% of the daily catch of each fisherman for loan repayment up to a minimum repayment of ₦40.00 per month or ₦2.00 per day for 20 fishing days a month as cash payment.

The Ideal Model

The success of any loan scheme to fishermen depends to a considerable extent on the provision of adequate infrastructure to facilitate extended shelf-life of the fish right from the moment the fish are harvested until they are marketed to the consumers. Since the authorities will expect the fishermen to repay their loans at the expected time, the provision of such facilities should be inbuilt into the machinery if wastage from losses through spoilage is to be discouraged. An ideal model should therefore, incorporate the following facilities:-

(i) Provision of chilling storage facilities

Fishermen often experience considerable losses resulting from spoilage of fish, from the time the fish are hauled to the time they arrive at the port. Generally, the fishing grounds are far away from the port and considerable time is wasted in a canoe fishery before the fishermen finally get to the port. It is therefore, essential that ice should be provided to the fishermen in insulated boxes at the port before they move to their respective fishing

grounds. An ice machine located at the port to serve the fishermen involved in the scheme will serve the purpose. Provision of ice and boxes will also reduce contamination of fish which are often kept in the dirty water that normally rests on the bottom of canoes. It is worth noting that before ice is provided a feasibility study should be conducted by the authorities concerned in order to decide whether or not the quantity of fish landed warrants the investment on an ice plant.

Cold stores are very essential in a small-scale fishery especially during the glut season when the catches are good and there is no ready market for them in the fresh state. Such fish could be stored after they have been dully frozen in the blast freezers and then sold out during the period of scarcity. Fish are known to keep for about 6 months in the cold store that is well managed and when such fish are thawed, they are seen to be indistinguishable from fresh fish. This, as well as the life of the cold store, depend on the training of the operator with regards to efficient cold store management.

(ii) Model market

This market should be located in front of the chilling storage complex so that consumers can walk in and out without disturbing other sections of the complex. Fresh fish should be left in the chiller and sold out to consumers on demand. There should be a screen of mosquito netting behind the door, to prevent entry of flies and other insects. Cleanliness should be enforced at all times in the market to prevent the outbreak of disease among consumers.

(iii) Smoking kiln room

A separate building close to the storage complex should be erected to house the smoking kilns. As much as possible, traditional smoking kilns should be avoided because of losses commonly encountered by this type of smoking. The NIOMR Kiln or Altona type kiln could be erected using bricks. The Kainji Gas Kiln (Eyo, 1981) is cheap and should be added in the building. The Torry Kiln is quite useful but could be costly. Fishermen should be encouraged to smoke their catches in the kilns whenever they desire.

RECOMMENDATIONS

The following recommendations are to serve as guides to future investors in the scheme:-

(i) Inputs suppy: Institutions should ensure that inputs are supplied to real and enterprising fishermen by observing their performances in the trade over a period of time before short listing them for the loan.

(ii) Regular monitoring: The recipients should be closely monitored because of the migratory disposition of fishermen and their scattered living patterns. This should be done through:

a) Holding of regular meetings with the recipients.

b) Involving the district and village heads right from the planning stages especially during the selection of qualified recipients.

c) Regular visits of field staff to the fishermen camp.

(iii) Terms of agreement: The method of loan repayment should be clearly spelt out in the terms of agreement after consultation with the recipients. Concrete legal backing may be essential to scare away potential defaulters. Any intention to alter the mode of payment should be with full participation of the recipients.

(iv) Records of transactions: Proper records of loans disbursed and amount recovered should be kept up to date by field staff. Recipients should be encouraged to keep their own records and endorse the records kept by the institution regularly, after ascertaining the accuracy. Fishermen should have access to institution's record at all times.

(v) Sales strategy: In a system where the recipients will be required to sell all their catches to the institution, the price of fish in the open market will determine the price at which the fishermen will sell to the institution. Fishermen will be more inclined to surrender cash in lieu of fish if the selling price of fish in the open market is higher.

(iv) Utilizing available facilities: In view of the fact that the Federal Department of Fisheries, through its Accelerated Fish Production Programme has already established fish storage and chilling complexes in suitable locations in inland waters including Amfani at Kainji Lake and Rurum at Tiga Lake, it is recommended that a joint operation of the scheme be initiated between the Federal Department of Fisheries and the Institute or any other institution of their choice in order to guarantee optimum utilization of the available facilities.

CONCLUSION

This report has put forward the technique for operating a small scale revolving loan scheme to fishermen based on our experience in Kainji Lake. With good preservation methods and a ready market, it is possible for the investor to make adequate profit from sales of fish provided the recipients supply the fish. This could only be done successfully if the recipients are effectively monitored. The technique has added advantages of

improving the lot of the fishermen, bringing the fishermen into an effective and functional unit and aiding the enforcement of fisheries laws and regulations.

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Table 1 - Returns from Pilot Scheme Fisheries Project at Shagunu station

Name	Loan Advanced ₦	Loan Repaid ₦	Balance ₦	Outstanding Balance % %
1. Manu Shugaba	1,960.00	938.69	1,021.31	52.11
2. Alhaji Dogo	2,117.00	1,762.50	345.50	16.32
3. Tuni Shugaba Yumu	1,944.00	963.20	980.80	50.45
4. Muhammed Jirgi	270.00	51.00	219.00	81.11
5. Alhaji Garba Shagunu	510.00	444.56	165.44	32.44
6. Ango Na Allah	270.00	75.00	195.00	72.22
7. Alhaji Moh. Mohammed	270.00	207.00	63.00	23.23
8. Alhaji Manu Shagunu	189.00	189.00	Nil	Nil
Total	₦7,530.00	₦4,630.95	₦2,990.05	

Table 2 - Returns from Pilot Scheme Fisheries Project at Monai station

Names	Total Loan Given	Amount Repaid	Balance	Outstanding Loan %
	₦	₦	₦	%
1. Musa Biyo	2,096.00	523.42	1,572.42	75.03%
2. Sule Musa	1,608.00	538.45	1,069.55	66.51%
3. Alhaji Shuaibu Tada	288.00	178.70	119.30	40.03%
4. Garba Goge	438.00	216.30	221.30	50.62%
5. Sarki Eng. Tada	2,040.00	620.04	1,427.96	69.73%
6. Umaru Kantama	1,910.00	381.96	1,528.04	80.00%
7. Umaru Sani	1,600.00	561.64	1,126.36	66.71%
8. Alh. Moh. Adama	461.00	161.80	299.20	64.90%
9. Dantello	1,700,00	456.04	1,251.96	73.30%
Total	₦12,255.00	₦3,638.35	₦8,616.65	

Table 3 - Summary of payment by registered fishermen.
Fisheries Pilot Scheme: Monai Sector

	Names	Total Loan Given ₦	Amount Repaid ₦	Balance ₦	Date	Remarks
1.	Garba Goge	1,538.00	343.34	1,194.66		Materials confiscated 14/12/83
2.	Mohammed Yunusa	1,260.00	1,260.00	-	20/3/85	Payment completed
3.	Mohammed Adama	461.00	210.00	251.00		Written off
4.	Umaru Sanni	1,848.00	1,844.74	-	13/11/84	Payment completed
5.	Sule Musa	1,768.00	1,774.76	-	30/9/84	Payment completed
6.	Shuaibu Tada	298.00	229.00	69.00		Written off
7.	Mohammed Jibril	1,000.00	1,048.00	-	31/10/84	Payment completed ₦48.00 refunded
8.	Musa Biyo	2,096.00	560.00	1,536.00		Materials confiscated in 1982
9.	Dantello Mohammed	2,068.00	2,068.00	-	21/10/85	Payment completed
10.	Umaru Sabuke	388.00	134.16	253.84		Deceased. Materials written off
	Total	₦12,725.00	₦9,472.00			Total Write off = ₦573.84 = 4.5%

Table 4 - Summary of payment by registered fishermen.
Fisheries Pilot Scheme: Shagunu Sector

	Names	Total Loan Given ₦	Amount Repaid ₦	Balance ₦	Date	Remarks
1.	Manu Shugaba	1,690.00	1,690.00	-	23/10/85	Payment completed
2.	Dogo Camp	1,400.00	1,400.00	-	21/10/83	Payment completed
3.	Alhaji Marafa	1,400.00	447.83	957.17		Materials confiscated
4.	Isa Ruwa	1,580.00	471.89	1,108.11		Materials confiscated
5.	Tuni Shugaba	1,674.00	1,674.00	-	20/4/85	Payment completed
6.	Mohammed Jirgi	270.00	116.00	154.00		Written off
7.	Manu Shagunu	240.00	240.00	-	19/11/81	Payment completed
8.	Garba Shagunu	150.00	465.00	45.00		Written off
9.	Ango Na Allah	270.00	129.00	141.00		Written off
10.	Ahmed Moh. Mohammed	270.00	222.00	48.00		Written off
	Total	₦9,304.00	₦6,855.00			Total written off = ₦388.00 = 4.1%

Table 5 - Capital and Recurrent expenditure for a revolving loan scheme to 100 scheme

	Items		Amount
	Capital Extimate		₦
1.	Office and Store		₦10,000.00
2.	Smoking kilns (Kainji Gas kiln; Traditional kiln) (2)		2,000.00
3.	Cold Sotre 20 tons (1)		25,000.00
4.	Freezers (2)		3,000.00
5.	Cold vans (2)		40,000.00
	Total =		₦70,000.00
	Recurrent Estimate		
1.	Fisheries Superintendent (1)	GL.08	₦3,564.00
2.	Fisheries Assistants (2)	GL.04	2,640.00
3.	Motor Drivers (2)	GL.04	2,640.00
4.	Labourers (2)	GL.01	1,692.00
5.	Vehicle running cost	-	2,000.00
6.	Guards (2)	GL.01	1,692.00
	Total =		₦14,228.00

APPENDIX '4' - Cost of inputs to 100 fishermen

Equipment	Unit Cost	Number of Fishermen	Total Cost
	₦	No	₦
Boat	600	100	60,000.00
Engine	800	100	80,000.00
6 Bundles of Nets	40	100	24,000.00
50 Cords of Twine	1	100	5,000.00

APPENDIX '5' - Projected profit and loss account

Particulars	Year				
	1	2	3	4	5
Sales	2700000	2700000	2700000	2700000	2700000
Less cost of goods sold	1800000	1800000	1800000	1800000	1800000
Revenue	900000	900000	900000	900000	900000
Less operating expenses	183228	183228	183228	183228	183228
Gross profit	716772	716772	716772	716772	716772
Less 45% Tax	322547	322547	322547	322547	322547
Net Profit =	394225	394225	394225	394225	394225

Payback period = 9 months

IRR = 111%

Note: This projection assumes that:

(i) Depreciation rate equals the rate of capital allowance

(ii) Inflation rate is constant throughout the 5 year period

(iii) The same rate in (ii) above is achieved as increase in sales each year

APPENDIX "6" - Loan repayment schedule

Year	Principal	Interest at 14%	Outstanding Balance
0	-	-	300,000
1	60,000	42,000	240,000
2	60,000	33,600	180,000
3	60,000	25,200	120,000
4	60,000	16,800	60,000
5	60,000	8,400	-
Total	300,000	126,000	

KAINJI LAKE RESEARCH INSTITUTE
P.M.B. 666, NEW BUSSA, KWARA STATE

PILOT FISHERIES DEVELOPMENT PROJECT
(MONAI/SHAGUNU SECTOR)
REVOLVING LOAN SCHEME TO FISHERMEN

C E R T I F I C A T E O F C O M P L E T I O N

This is to certify that Alh/Mall/Mr.:

ALHAJI MANU SHUGABA

of Monai/Shagunu Village was one of the beneficiaries of the above Loan Scheme and has successfully completed repayment of the sum of ONE THOUSAND, SIX HUNDRED AND NINETY NAIRA (₦1,690.00) advanced to him in kind in the form of Boat. Outboard engine and Netting materials on 23RD MARCH, 1981

All equipment and materials earlier loaned to him are henceforth his personal belongings.

Signed:

E.O. ITA
Head of Fisheries Division

Signed 23/10/81

R. AWOOJEBI
Supervisor

Date: 23rd day of October 19 81

KAINJI LAKE RESEARCH INSTITUTE
P.M.B. 666, NEW BUSSA, KWARA STATE

PILOT FISHERIES DEVELOPMENT PROJECT
(MONAI/SHAGUNU SECTOR)
REVOLVING LOAN SCHEME TO FISHERMEN

C E R T I F I C A T E OF C O M P L E T I O N

This is to certify that Alh/Mall/Mr.:

SULE MUSA

of Monai/Shagunu Village was one of the beneficiaries of the above Loan Scheme and has successfully completed repayment of the sum of ONE THOUSAND, SEVEN HUNDRED AND SIXTY-EIGHT NAIRA (₦1,768.00) advanced to him in kind in the form of Boat, Outboard engine and Netting materials between:

APRIL, 1981 and 30TH SEPTEMBER, 1984

All equipment and materials earlier loaned to him are henceforth his personal belongings.

Signed:-

E.O. ITA
Head of Fisheries Division

R. AWOOJEBI
Supervisor

Dated: 2nd day of Sept. 1984.

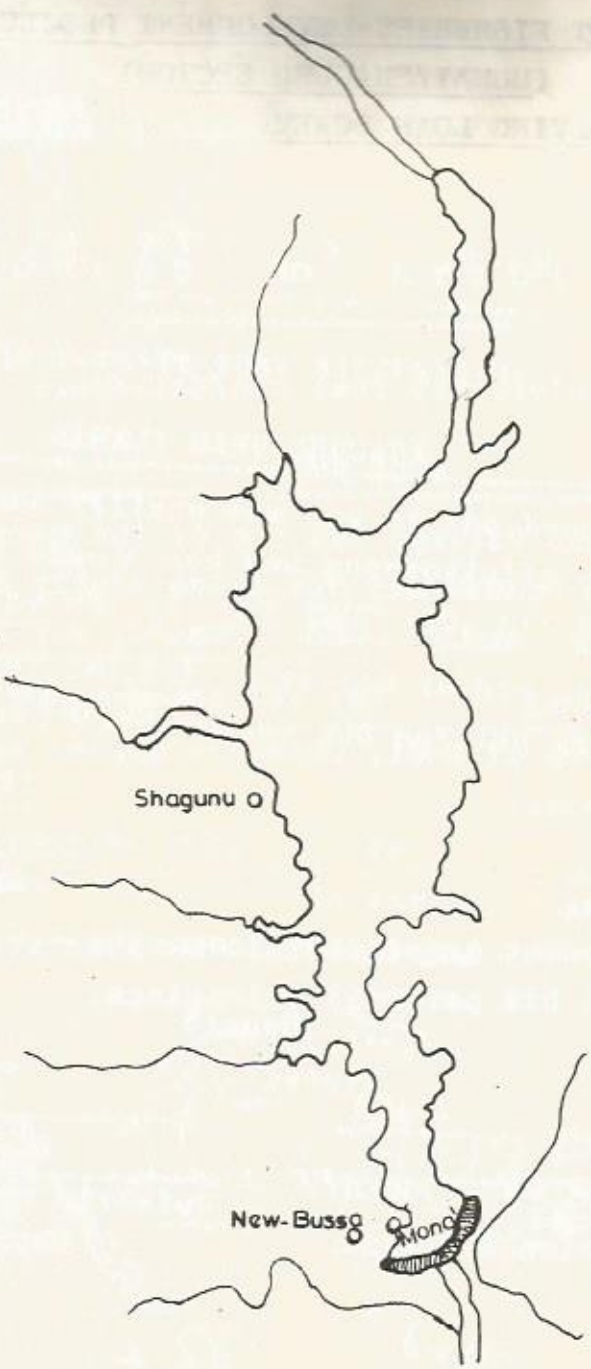


Fig. 1. Map of Kainji Lake Showing Location of Shagunu and Monai



PLATE I. PILOT SCHEME FISHERMEN POSE FOR A PHOTOGRAPH WITH RECIPIENTS OF TWO OUTBOARD ENGINES.



PLATE 2. PILOT SCHEME FISHERMAN ACCEPTS THE TERMS OF THE LOAN BY INDICATING HIS THUMB PRINT ON THE REGISTER IN THE PRESENCE OF WITNESSES.



PLATE 3. A PILOT SCHEME FISHERMAN ABOUT TO TEST - DRIVE HIS NEW ENGINE AND BOAT ISSUED TO HIM ON REVOLVING LOAN BASIS.

AN EVALUATION OF THE ARTISANAL FISHERIES RESOURCES OF THE CROSS RIVER STATE OF NIGERIA

by

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ABSTRACT

The Cross River State marine and freshwater artisanal capture fisheries are divided into four categories according to the type of resources being exploited. Schaefer's production model is applied to each of the fisheries to estimate the maximum sustainable yields (Ymax). The total potential yield for all the Fisheries in natural waters is 178,650 tonnes year^{-1}. This potential is unlikely to be achieved as more fishermen are abandoning the occupation due to the scarcity of boats, outboard engines and nets. Even if the full potentials were realized the production would still be short of what the State should produce by about 30.5%. Investment opportunities which, if effected can help to narrow the gap between the available and the desired level of production are enumerated.

INTRODUCTION

The coastal and riverine communities of that part of Nigeria now known as the Cross River State (formerly South-Eastern State) have been fishing from time immemorial. Catches from the State play a significant role in the National and State economy. According to the latest statistics available at the Federal Department of Fisheries, in 1983, the Corss River State (CRS) caught 157,376 tonnes (t) of fish, representing 31.4% of the total national catch for that year. The contribution of artisanal fisheries to Nigeria's domestic fish production is 97% (indicating that only about 3% comes from industrial fisheries). In the CRS, almost 100% of the domestic fish output is from artisanal fisheries, there being no functional industrial fishing enterprise in the State at present. This paper deals with the resources available to the small scale (artisanal) fisheries of the Cross River State marine and inland waters.

Potential yield estimates are essential not only for the management but also for rational planning of the fishery resource exploitation and utilization. Earlier attempts to estimate the potentials of the CRS fisheries have been

made by Moses (1979; 1980; 1981a; 1981b; 1986b) and Canovex Ltd (1979). A considerable amount of literature now exist on the fisheries potentials of Nigeria of which the CRS forms a part: Longhurst (1961; 1965), Williams (1978), Bayagbona et al (1971), Domain (1980), Bayagbona and Ajayi (1980), Ajayi (1982), Ajayi and Talabi (1984). Some of these estimates have been based on very scanty or no data at all. Detailed long series of catch-effort statistics now available for several water bodies in different parts of the country tend to reveal how unrealistic some of these estimates have been. Longhurst (1961) for example, gives the maximum potential yield of Nigeria inshore waters as 28,500 t. yr^{-1} (made up of only 25,000 t from artisanal and 3,500 t from industrial fisheries); but it is now known that catches from this source exceed 200,000 t yearly. Similarly, Canovex Ltd of Canada (1979) after due consultation with Longhurst and Gulland, came out with a figure of $5tkm^{-2}y^{-1}$ "as a reasonable estimate" of the potential of marine fish catch off the CRS. But as pointed out by Moses (1981a), available statistics in the area in 1979 indicate a catch rate of 30.7 $tkm^{-2}yr^{-1}$, a much higher figure than those predicted by Longurst or Canovex. Because of the great importance of fisheries in the economy of this State, it is necessary to re-evaluate the resource potentials in the light of the present availabe data.

In the present paper, 17 years data series of catch-effort statistics (1969 - 1985) are fitted into Schaefer's production model to obtain the maximum sustainable yield (Y_{max}) of the various artisanal fisheries, which, for this purpose, are classified as follows:-

1. Coastal pelagic (bonga, Illisha and sardinella) fishery
2. Demersal finfish fishery
3. Crayfish fishery, and
4. Freshwater fishery.

The four categories are sufficiently different and important (See Table 1) to allow each to be treated as a distinct fishery and apply the production model. At present, other models which put heavy demand on data - such as of demographic composition, growth, mortality, recruitment and absolute biomass, are not suitable for application to these fisheries because such data do not exist.

Geographical Setting

The Cross River State with a surface area of 28,585 km^2 is located at the south-eastern corner of Nigeria (Latitude $4°25^1$ - $7°00^1$N; Longitude $7°17^1$ - $9°30^1$C). It is bounded in the south by the Atlantic Ocean, in the east by the

Republic of Cameroun and in the west and north by Rivers, Imo, Anambra and Benue States. The official (projected) population (from the Statistics Division of the State Ministry of Finance and Economic Planning) for 1986 is 5.8 million.

The physiography is rather simple: two spurs from the Cameroun highlands, in a horse-shoe shaped fashion, form the Obudu Hills in the north and Oban Hills in the south respectively. Stretching away from inside the "horse-shoe" first in a westward direction and then southwards to the coast is the fairly extensive Cross River plain (Figure 1). The State as a whole is well watered, principally by the Cross River; the two other river systems are the Qua Iboe with its drainage basin mainly in the State and the Imo whose drainage basin lies mainly outside the State.

The climate is tropical with rather well marked dry season (October/November-April) and wet season (May-September/October). Table 2 summarizes the mean climatic conditions of the area. The vegetation varies from mangrove swamp forest in the coastal area through tropical evergreen forest (dominated by oil palm) to derived savanna in the northern zone.

Hydrography

The length of the coastline is 129 km. Generally, the Nigerian continental shelf is narrow; its greatest width is attained off the Cross River State where the 200 m isobath is 76 km off the Imo River and 140 km off the Cross River. The total shelf area is 8,005 km² (Moses, 1981a). The Cross, Qua Iboe and Imo Rivers all open into the sea with no or very little delta formation. For this reason, large quantities of organic debris are brought into the coastal waters and this is an important factor in the enrichment of these waters. The bottom deposit is mainly silt (mud) mixed in some places with sand. Thus, inspite of the fact that this area does not experience appreciable upwelling, primary productivity is high (200 g Cm^{-2}) (Moses, 1981a) and the ecological conditions created are particularly favourable to the occurrence of two of the most important living resources of the CRS, viz, the bonga, Ethmalosa fimbriata and shrimp, particularly Penaeus notialis). However, the area is not completely devoid of phenomena that help to mix the water and bring nutrients up to the euphotic zone; for it has been observed that during the rainy season (corresponding to the northern summer) a branch of the eastward flowing Guinea Current meets a westward current from Cameroun off the Cross River estuary. The hydrographic disturbance caused by this phenomenon is strong enough to make the depth of the bottom in this area quite irregular with hollows in several places - a condition that often seem to discourage shrimpers trawling for shrimps in the area.

Hydrologically, the whole Cross River State is dominated by the Cross River, a flood river with numerous tributaries, a drainage basin (within Nigeria) of 40,000 km² and a fairly extensive flood plain covering some

2,500 km². The mean annual fish catch from this system (17 year data series) is 5,500 t. It has been shown that for this system, the catch in a particular year (T) is strongly correlated with the intensity of flooding and draw-down (in time and space) measured one year earlier than T (i.e. in year T-1) (Moses, 1986a). The second river system is the Qua Iboe River which rises near Umudike but has most of its drainage basin within the CRS. Its area of flood plain is small. Statistics of catch in this system are poor; it is estimated that annual freshwater catch does not exceed 100 t. The third river system, the Imo River, has its main drainage basin outside the CRS, which shares only the lower course and estuary with Imo and Rivers State. Its contribution to the CRS freshwater fish production is insignificant but its estuarine and barackishwater zone yield large quantities of fish, particularly bonga, catfish (Chrysichthys), snappers and mullets. Estimated catch from the system is about 300 t yr^{-1}.

METHODOLOGY - DATA BASE

The catch-effort statistical data used in this paper were derived from two sources:

a) Most of the data presented were collected by the CRS Fisheries under the State's fisheries statistics programme directed by the author. Details of the method used are described in Moses (1986a; 1986b).

b) The second source is the statistics collected by the Federal Department of Fisheries and NIOMR (see Tobor et al, 1977; FDF, 1980). The methodology employed in (a) and (b) had certain features in common: there was first a frame survey followed by catch assessment surveys; proportional probability sampling was used in both cases in selecting landing sites (as the primary sampling unit). However, while the Federal programme in the State was limited in time and personnel (data collectors), quite a large number of data collectors were available for the State programme and the data were collected regularly every month during the period 1969 - 1982. The method used in the State also differed from the Federal one in that the landing sites to be visited in the former were selected fresh every month whereas in the latter, the sites were fixed.

Status of CRS Artisanal Fisheries

Pre-civil war statistics of fish catch do not exist because the CRS was not created by then. However, Moses (1980) reviewing the subject concludes that such catches amounted to about 40,600 t yr^{-1}. During the Civil War, fishing, particularly in the coastal waters was reduced to an insignificant level and there are no statistics for that period. Table 3 shows the transition of the CRS fish production between 1969 and 1985. The main features of the State fisheries are illustrated in Figures 2, 3 and 4.

Estimation of Maximum Sustainable Yield (Y_{max})

Figures 5a, 5b, 5c and 5d are Schaefer plots for the four categories of the CRS fisheries to determine the maximum sustainable yield (Y_{max}). In Table 4, the results are compared with the (Y_{max}) estimated by other methods (where such figures exist). The last column of this table shows the revaluated estimate (based on the Schaefer's method, calculations from primary productivity and other available estimates) considered reasonably good by this paper bearing in mind the present state of knowledge.

DISCUSSION

Figures 2 shows that there has been a general continuous rise in the CRS fish production. During the period 1969 - 1971, the fishery was struggling to recover from the effect of the Nigerian Civil War. Full recovery occurred in 1972. The importance of the CRS fisheries to the economy of the country can be deduced from the fact that less than 40% of the catch is consumed within the State while over 60% go to other States of the Federation. The four categories into which the fisheries have been divided are discussed:

Coastal Pelagic (Clupeid) Fishery

Catches from this fishery include bonga (Ethmalosa fimbriata) which forms 33.1%, shad (Ilisha africana) and, in very minimal quantities, the flat sardinella (Sardinella maderensis) (= Sardinella eba/cameronensis) which together make up about 16.9% of the total clupeids. The mean catch of this group of coastal pelagics is 30,620 t and the Y_{max} is estimated at 45,000 t. Other coastal pelagics - the carongids are not included in this estimate. The most abundant and commercially important species of the clupeids is E. fimbriata. Perhaps because of this, more research effort has been concentrated on the species and more is known about the ecology, biology, growth and population dynamics. E. fimbriata occurs throughout West Africa from Mauritania to Angola with very high concentrations in the non-upwelling zones off Sierra Leone - Liberia and Nigeria - Cameroun (Irvine, 1948; FAO, 1984; Shotton, 1984; Boely and Freon, 1980). The fish prefers areas with muddy bottom, especially where rivers open widely into the sea and bring in large quantities of organic debris; tolerates high fluctuations in salinity (5% - 35%) and warm water (temperature > 25°C). In Nigeria, the highest biomass concentration is found in the area east of the Niger Delta between Imo and the Cross River estuaries. Recent studies in this area (Moses, 1986b) using the length-frequency method developed by Pauly (1983), give the data shown in Table 5. The present mean catch of bonga (25,030 t) is about 83% of the Y_{max} and close to its optimum economic yield (Y_{ec}). According to Gulland (1971), the optimum yield of a fishery is taken when the fishing mortality

Table 1 - Mean specific composition of catches of Cross River State artisanal fisheries 1973 - 1982

Type of fish	Mean Catch (t)	Mean Catch (%)	Price N.kg^{-1}	Nominal Value (Million Naira)
Barracuda (Sphyraenidae)	3337	2.8	1.0	5.3
Bonga (Ethmalosa fimbriata) and other Clupeids	30815	26.2	0.72	23.8
Catfishes (Chrysichthys, Airus)	9456	8.0	1.00	9.5
Crayfish	19690	16.8	0.60	12.5
Croakers (Sciaenidae	9567	8.1	1.00	9.6
Grunters (Pomadasyidae)	1112	0.9	1.20	1.3
Horse macherels (Carangidae)	3115	2.7	1.20	3.7
Mullets (Mugilidae)	3226	2.7	0.70	2.3
Rays and Skates	4561	3.9	1.00	4.6
Sharks	5673	4.8	1.00	5.7
Snappers (Lutjanidae)	3894	3.3	1.60	6.2
Soles and other flat fishes (Pleuronectiformes)	3894	3.3	1.00	3.9
Threadfins (Mainly Polydactylus quadrifilis)	7898	6.7	1.60	12.6
Cichlidae	556	0.5	0.50	0.3

Other Marine fishes not included eslewhere	4894	4.2	0.50	2.4
Freshwater fishes	5800	4.9	1.00	5.8
Total	117488	100%		104.0

Table 2 - Average climatic conditions of the Cross River State

Month	Temperature °C			Relative Humidity (%)	Evaporation rate ($mm.dy^{-1}$)	Hours of Sunshine Calabar	Rainfall	
	Max.	Min.	Mean				Calabar	Ikot Okpora
January	32.8	23.9	28.4	84	3.9	5.4	39	15
February	33.2	23.8	28.5	82	4.3	5.7	60	35
March	32.1	23.5	27.8	85	4.0	4.6	123	115
April	31.7	23.3	27.5	87	3.9	4.8	212	210
May	30.9	23.3	27.1	88	3.6	4.8	244	225
June	29.9	22.9	26.4	90	3.1	3.7	324	380
July	28.0	22.4	25.4	92	2.3	2.2	444	325
August	27.4	22.4	24.9	92	2.4	1.7	460	445
September	27.4	22.2	24.8	92	2.6	2.0	423	540
October	28.2	22.5	25.4	90	3.1	3.5	260	265
November	29.7	22.8	26.3	89	3.4	4.6	100	135
December	31.3	22.5	26.9	85	3.7	5.3	46	35
Total								

Table 3 - Fish catch in the Cross River State, 1969 - 1985

Year	Fish Catch by Type						
	Demersal fin fish	Crayfish	Bonga (Ethmalosa)	Sardinellas & other Clupeids	Total Marine fish catch	Total Fresh water fish catch	Grand Total
1969	9.1	1.4	2.5		12.7	2.8	15.8
1970	7.8	1.6	3.6		13.2	2.8	15.8
1971	9.6	3.1	6.4		19.1	3.2	22.2
1972	42.3	10.0	18.9		71.2	4.2	75.4
1973	37.4	12.4	19.8	4.4	74.0	4.8	78.8
1974	54.3	14.5	27.3	6.1	102.1	4.9	107.1
1975	62.6	11.9	17.2	4.7	96.4	3.6	100.0
1976	78.3	18.8	20.8	5.1	123.0	4.9	127.9
1977	89.3	19.5	23.6	4.6	137.0	4.6	141.6
1978	80.0	20.1	27.3	4.6	132.0	5.4	137.4
1979	81.5	20.9	28.9	4.7	136.0	7.6	143.6
1980	56.9	25.1	28.5	5.1	115.6	6.9	122.5
1981	60.1	19.3	27.7	5.0	112.1	5.0	117.1
1982	73.8	23.9	29.0	5.7	132.4	5.8	138.2
1983	86.0	25.1	34.8	6.6	152.5	4.9	157.4
1984	45.2	18.4	21.6	4.4	89.6	7.1	96.7
1985	34.2	15.0	19.5	4.0	72.7	7.2	79.9

Table 4 - Estimates of maximum sustainable yields (Y_{max}) of Cross River State artisanal capture fisheries

Fishery	Mean catch (17 year data series	Available potential yield estimates Y_{max} x 10^3t	Reference and methodology	Y_{max} by Scaefer's model x 10^3t	Revaluated Y_{max} x 10^3t
Marine fisheries					
1. Coastal pleagic (bonga, Ilisha and sardinella fishery	30.6	131.1	Moses (1980) Schaefer's model based on 8 years data series; Moses (1980a), Schaefer's	44.8	45.0
2. Coastal and estuarine finfish fishery	61.9	139.9	model based on 11 years data series and on	96.3	96.3
3. Crayfish fishery	18.2	194.4	primary productivity respectively.	24.2	29.5
Total marine fisheries	110.7	155.1		165.3	170.8
Freshwater fisheries					
4. Cross River system	5.5	7.6	Moses (1981b) based on (i) mean yield from	7.65	7.7
5. Qua Iboe, Imo River systems	0.3	0.3	other African flood rivers; (ii) relationship between catch and basin area (see Welcomme (1975; 1979).	-	0.3
Total freshwater fisheries	5.8	7.9			8.0
GRAND TOTAL (CRS artisanal fisheries)	116.5	163.0			178.8

Table 5 - Size at age, growth, mortality, exploitation and maximum sustainable yield of *E. fimbriata* of the Cross River inshore waters

Age Group (yr)	0	I	II	III	IV	V
Total length (cm)	5.0	13.7	19.5	23.5	26.5	27.7

Growth parameters: $L\infty$ = 30.0 cm; K = 0.43; t_o = - 0.20

Length-weight relationship: $\log w = 1.67 + 2.98 \log l$ where w = weight (g), l = total length (cm)

Mortality coefficients: Z = 1.26; M = 0.49; F = 0.66

Exploitation ratio, $E = \frac{F}{Z} = 0.57$

Present mean catch = 25030 t yr^{-1}

Maximum sustainable yield (Y_{max}) = 30075 t yr^{-1}

Optimum economic yield (Y_{ec}) = 24000 t yr^{-1}

Source: Moses (1986 b)

Table 6 - Growth parameters for some species of demersal fish exploited in Nigerian inshore waters

Species	$L\infty$ (cm)	K	t_o	L_{max} (cm)	References
Pseudotolithus elongatus	48.04	0.28	-0.04	45.6	Nawa (1986)
Chrysichthys nigrodigitatus	68.38	2.39	-0.29	62.0	Nawa (1986)
Cynoglossus goreensis	82.10	0.097	-0.01	78.0	Nawa (1986)
Pseudotolithus typus ←	61.2	0.37			Longhurst (1964)
	103.0	0.29			Bayagbona (1968)

(F) is about equal to the natural mortality (M), or $E = \frac{F}{Z} = 0.5$ since $Z = F + M$. Considering the level of the present mean catch and the exploitation ratio ($E = 0.57$) it is concluded that the present level of exploitation of E. fimbriata is about optimum.

No comparable data for the other clupeids of Nigerian waters are available. However FAO (1980) gives the following inrespect of Sardinella maderensis of the nearby Gabon - Angolan waters:-

Growth parameters: $L_{oo} = 24.92cm$, $K = 0.984$, $t_o = 0.287$
Fecundity (F_c) = 418W - 18974. Where W_6 = weight (g).
Length-weight relationship $W = 5.94 \times 10^{-6} L^{3.183}$.

Length at first capture (l_c) = 21.24cm

Total mortality coefficient (Z) = 1.93.

There is need for more research on the breeding cycle spawning grounds, growth, mortality, gear selectivity, recruitment and biomass estimation not only of E. fimbriata but also of the other clupeids (particularly of Ilisha africana) of the Nigerian inshore waters in order to formulate rational exploitation and management policies for these very valuable species.

Coastal demersal finfish fishery

The artisanal fishery exploits mostly the community of demersals that Fager and Longhurst (1968), Longhurst (1965) and Williams (1968) refer to as estuarine sciaenid sub-community. The catch is dominated by the croakers (Pseudotolithus elongatus, Pseudotolithus typus, and Pseudotolithus brachygnathus), catfishes (Chrysichthys nigrodigitatus, Arius spp) sole (Cynoglossus goreensis), snappers (Lutjanus spp), shinynose (Polydactylus quadrifilis), groupers (Epinephelus spp) grunters (Pomadasys jubilini) and the ray (Trygon).

Fishing is carried out mainly with bottom set gillnets. Catches are higher in the dry season than in the wet season. The present mean catch is 61900t yr^{-1} and the potential estimated by the Schaefer plot is 96300t. Biological data for most of the species involved do not exist.

Table 6 gives the growth parameters of a few species, the first three of which were obtained for the stock in the Cross River estuary.

The estimated maximum sustainable yield of 96,300t for this fishery is equivalent to a catch of 12.0t km^{-2} and appears to be reasonable considering the relatively high yield of artisanal coastal/estuarine fisheries on which the estimate is based. Earlier low estimates of 3.0 - 5.0t km^{-2} of Longhurst and Canovex must be seen as referring primarily to stocks available to bottom trawl fishery which is not considered in this paper.

Crayfish fishery

Although there is a high standing crop of penaeid shrimps off the coast of Cross River State (Bayagbona et. al. 1971) and artisanal fishermen in this sector often catch large size penaeid as well as palaemonid shrimps, the population of crustaceans exploited by artisanal and subsistence fishermen here consists of tiny carideid shrimps (Palaemonidae) and juveniles of Penaeus notialis which use the sediment rich coastal, estuarine and brackishwater mangrove swamps as their nursery grounds. (Moses 1972, 1980, 1985). Large quantities of these

tiny crayfish are caught yearly (18200t yr-1, based on 17 year data series). The smoke-dried product is commonly known in Nigeria as Crayfish. Crayfish and smoked bonga bonga are the mainstay of CRS fisheries. Although several species are exploited in the fishery, ecologically all the species form a sufficiently distinct community exploitable with the same type of gear. The fishery is suitable for the application of the Schaefer model by means of which a maximum sustainable yield (Y_{max}) of 29,500t yr-1 has been derived. Most of the crayfish marketed in Nigeria comes from the CRS. There is room for further expansion of this fishery. There is also the possibility of diversifying the product offered to consumers. Already there is a product that is being marketed with the trade mark "Obu" and appear to be pure ground crayfish.

Freshwater fishery

Fish production from freshwater capture fisheries is of high economic value not only to the riverine people of the CRS but also to non-riverine hinterland communities in and outside that state. A study of the movements of freshwater fish caught in the state shows that such products are sold as far as Enugu and Umuahia (Fig. 6). The present mean catch is 550t and the potential is estimated at 8050t. The catch is, however, highly affected by hydrometeorological conditions existing a year prior to the time of recording; and unless the floodplains are modified through the construction of dams, fish farms or by the culture of fish in certain other enclosures (such as fish cages) production from this sector is unlikely to reach this potential. It was shown, however, that if the reservoirs sites identified by ENPLAN in the Cross River Basin (see Moses 1979) were developed (with fish production in mind) yield from such reservoirs could reach 21000t.

General Comments

The present mean catch of fish in the CRS (based on 17 year data series) is 115730t. Of these 44000t or a little less than 40%) is available for consumption within the state, while the rest (some 71730t) are exported to other parts of the Federation. It is estimated that about 16,400 of frozen fish, tinned fish and other imported fish products are also available for consumption in the State making the total 60400t. With a population of 5.8 million the per caput consumption of fish is 10.4 kg yr-1 (=28.5g dy-1). Since edible portion of fish (i.e. flesh less bone scales and entrails) contains 20% protein this consumption rate converts to 5.7g fish protein per caput per day. Olayide et. al. (1972) gives 12g per caput per day for CRS in 1969. If this figure is to be taken seriously it is obvious that the rate of fish consumption has fallen drastically in recent years. This may be due to reduced importation of frozen fish. The mean fish protein consumption for Nigeria is 10g per caput per day. If this national average is to be attained in the CRS, then the present demand for fish protein stands at 21170t which converts to 10585t whole fish. This means that even when the domestic catch is being supplemented by the consumption of imported fish products the deficit in the State still stands at about 35000t. The CRS which has more resources than the neighbouring inland states ought to produce sufficient fish to satisfy the demand of these states which is estimated to be about 18000t. That is, assuming that importation of fish cannot be stopped completely but would, for the foreseeable future, continue to make up not less than 10% of the total consumed fish, the CRS should be able to produce about 257000t of fish for herself and her neighbours.

of course from the analysis and discussion in this paper the potentials for production from artisanal capture fisheries (which stands at only 178600t cannot meet this demand even if the full potentials are developed; but it would appreciably lower the gap between demand and supply.

As pointed out by Moses (1983) there is a lot of waste of the present fish catch in Nigeria due to post harvest losses. The causes of such losses are numerous and include the size of dugout canoes, fishing method, poor handling, processing and preservation of the processed fish among others. Post harvest losses effectively reduce the amount of fish available for consumption. Presently, the problem of the availability of fish is being aggravated by the scarcity and high cost of fishing nets. Some daring fishermen in the CRS travel as far as to Gabon to smuggle in some nets. These problems could be alleviated if investment were to be intensified in the following areas:

(a) Bulk smoking of fish, particularly of bonga.

(b) Canning of bonga.

(c) Canning of ground crayfish (which has already been started and is being marketed under the trade mark "Obu".

(d) Boat building. There is need for small wooden boats slightly larger than the dugout, but with prices within the reach of the average artisanal fishermen. The FRP boats produced by ALMARINE are too expensive for the ordinary local fishermen.

(e) Outboard motors assembly plant. Most of the bonga fishermen in the CRS have become so used to the motorization of their boats that now that they can no longer acquire this item the number of fishermen entering the fishery is reducing.

(f) Net manufacturing. Many fishermen have abundoned fishing because of the scarcity of nets. Others who still have serviceable outboard motors resort to meeting trawlers mid-sea to buy from them trash fish for sale on land.

(g) Culture of fish in cages.

Conclusion

Although the fisheries resources of the CRS waters are not as rich as the resources of areas that experience coastal upwelling the potentials of the different categories of fisheries have not been fully exploited. There is even much reduction in effort due to the present state of the nation's economy which causes the scarcity and high cost of essential fishing equipment such as nets, boats and outboard motors. It is necessary to increase investment in the various areas of fisheries if the protein requirement of the country is to be met. Opprotunities for such investment in the various aspects of CRS fisheries exist.

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ANNEXURE

PAPER: "An evaluation of Artisanal Fisheries ..." by B.S. MOSES. Although this paper is concerned with the resources available to the artisanal fisheries, no detailed study of the economics of operation of the small scale fisheries is available. Also no detailed cash flow of any industrial fishing venture that is operating in the Cross River State is accessible because companies do not open their books to any intruder.

The cash flow shown in this annexure is extracted from the feasibility report prepared in the middle 1970s for the exploitation of the rather rich shrimp resources of the inshore waters east of the Niger Delta. In 1973-74 the Cross River State (then South Eastern State) government in colloboration with two Japanese companies (Nichiro Gyoko Kaisha Fisheries Company and Mitsubishi Corporation) carried out a pre-investment study and resource survey of the shrimp resources of this area with a chartered Japanese shrimp trawler Nisshin Maru No. 56 (30m double-rigged). The result of the exercise was very encouraging (see Moses 1980). For 180 days operation, the vessel caught 53,000kg shrimps and 95,000kg fish by-catch (which included some quantity of cephalopods).

Based on the encouraging results obtained, a shrimp fishing project feasibility was prepared. The feasibility report was accepted; the project was not executed because the Government and the Japanese group failed to agree on the management fee the Japanese group was going to charge. The resource situation has not changed and the feasibility study is still valid provided adjustments are made to take account of the present depressed economy.

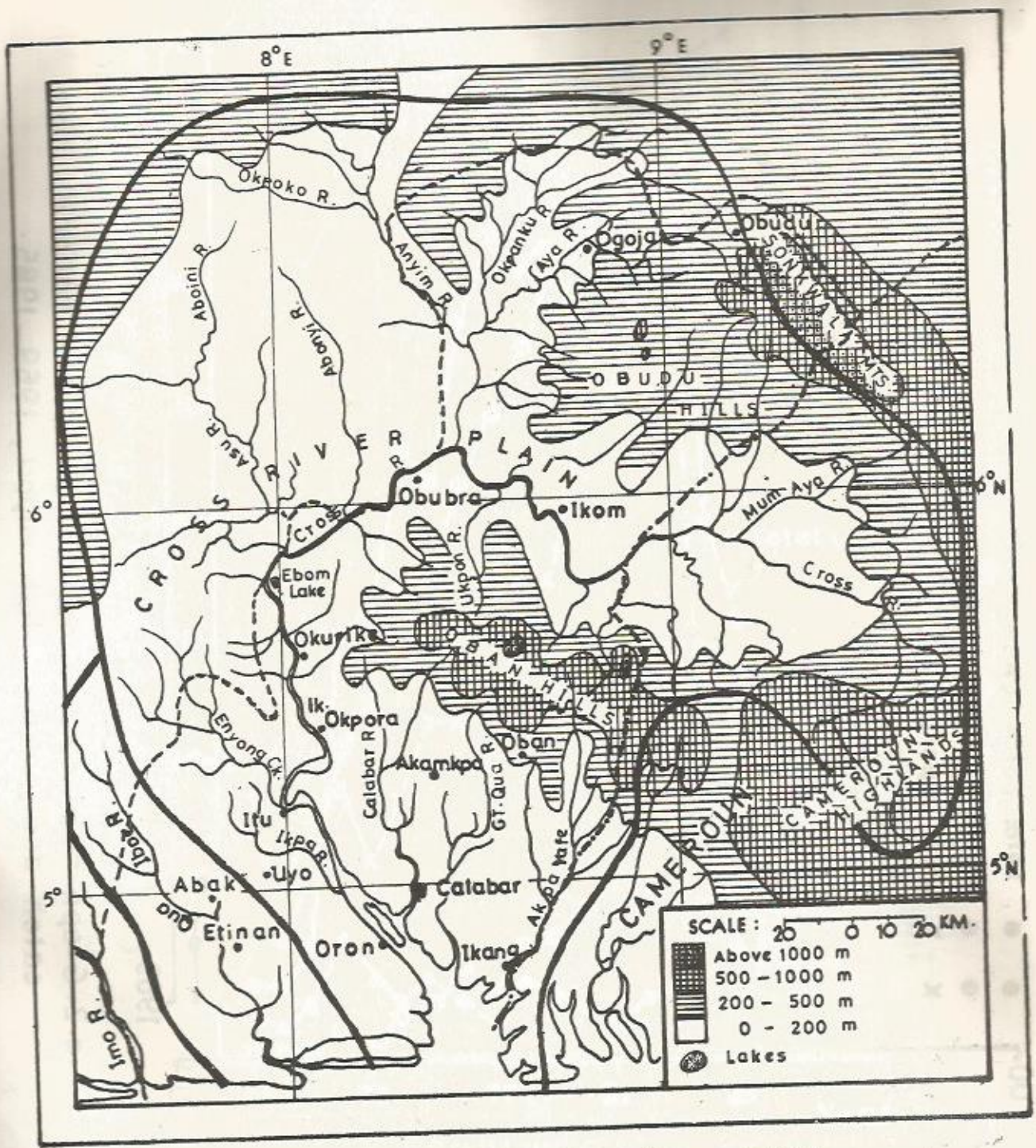
Feasibility of Shrimp Trawling Venture in the Cross River State

Cash Flow/Summary of Expenditure & Profit (Unit = 1000)

Item		1st Year	2nd Year	3rd Year	4th Year	5th Year
A.	Income					
1.	Equity Capital					
1.1.	Capital	600				
1.2.	Loan	2750				
2.	Sales of fish and shrimps	2953	3443	3861	4300	4908
		6303	3443	3861	4300	4908
B.	Expenditure					
1.	Equipments & Materials					
1.1.	10 D/R 135GT trawlers	3003				
1.2.	Office building, fixtures vehicles, etc.	647				
1.3.	Fishing nets & equipment	63	69	73	76	80
1.4.	Fuel and lubrication	1041	1139	1196	1256	1318
1.5.	Other consumable items: Spare parts, etc.	128	140	147	154	162
	Sub-Total	4819	1348	1416	1486	1560

ANNEXURE (CONTD.)

2.	Labour Expenses					
2.1.	Salary	212	263	280	337	357
2.2.	Sea going allowance	91	114	136	164	196
2.3.	Foodstuff	88	96	101	106	111
2.4.	Welfare	7	9	11	13	15
2.5.	Provision of retiring benefits	40	51	63	75	90
2.6.	Other expenses on crew	28	35	36	43	41
	Sub-Total	466	568	627	738	810
3.	Loan Repayment & Interest					
3.1	Loan repayment	300	600	600	600	650
3.2	Interest on Loan	150	120	97	75	67
	Sub-Total	450	720	697	675	717
4.	Other Expenses					
4.1.	Repairs & Maintenance of vessels and plants	2	25	50	75	100
4.2.	Administration	144	132	151	174	200
4.3.	Cold storage charges	89	90	92	96	101
4.4.	Miscellaneous expenses	65	122	127	113	120
4.5.	Depreciation	640	508	401	317	252
	Sub-Total	940	877	821	775	773
	Expenditure Total	6675	3513	3561	3674	3860
C.	Profit after depreciation but before tax	(372)	(70)	300	626	1048



Fig·1 Map showing the CRS river systems and their drainage basins.

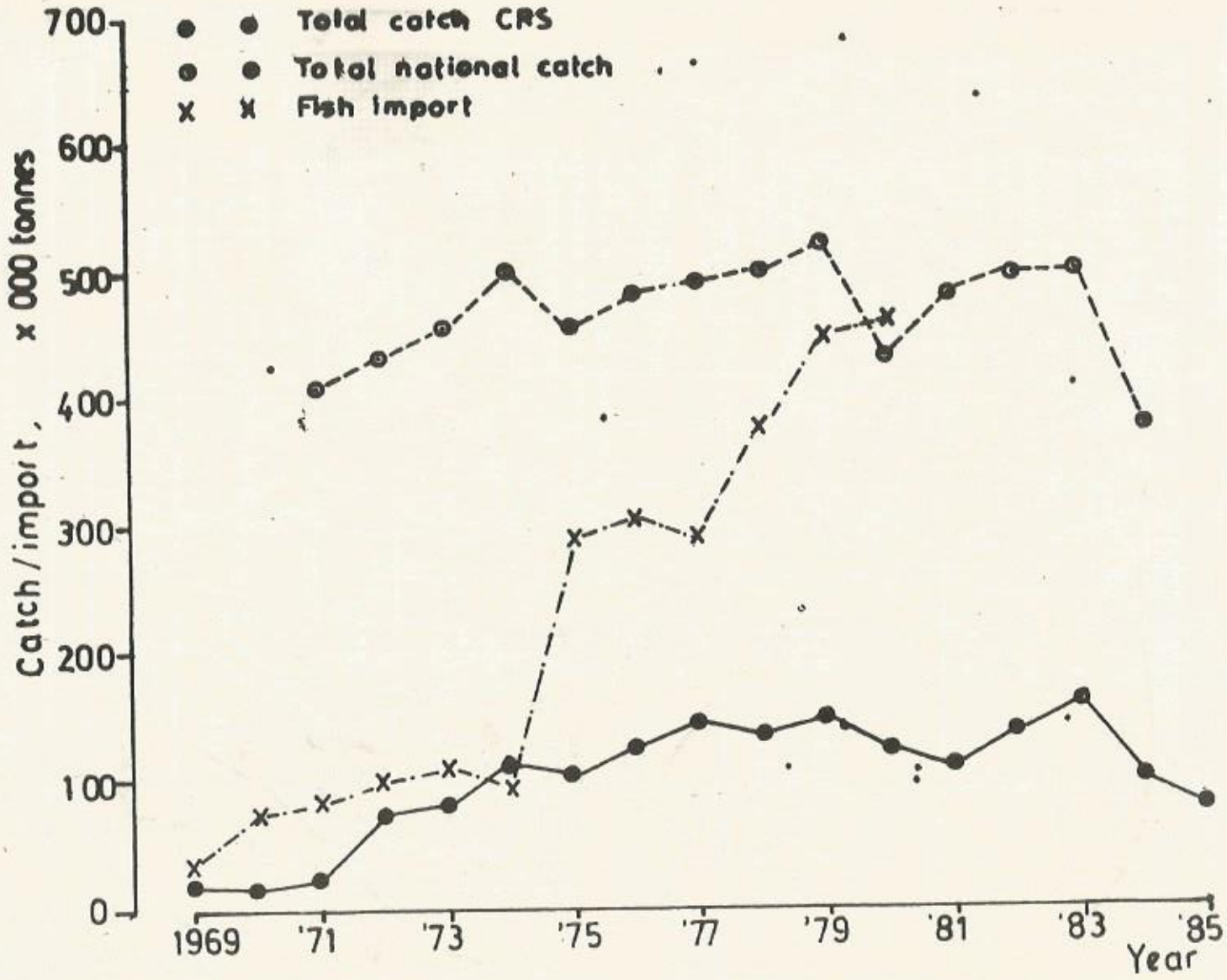


Fig. 2. Graph showing the Cross River State and national fish catch and national fish import, 1969–1985.

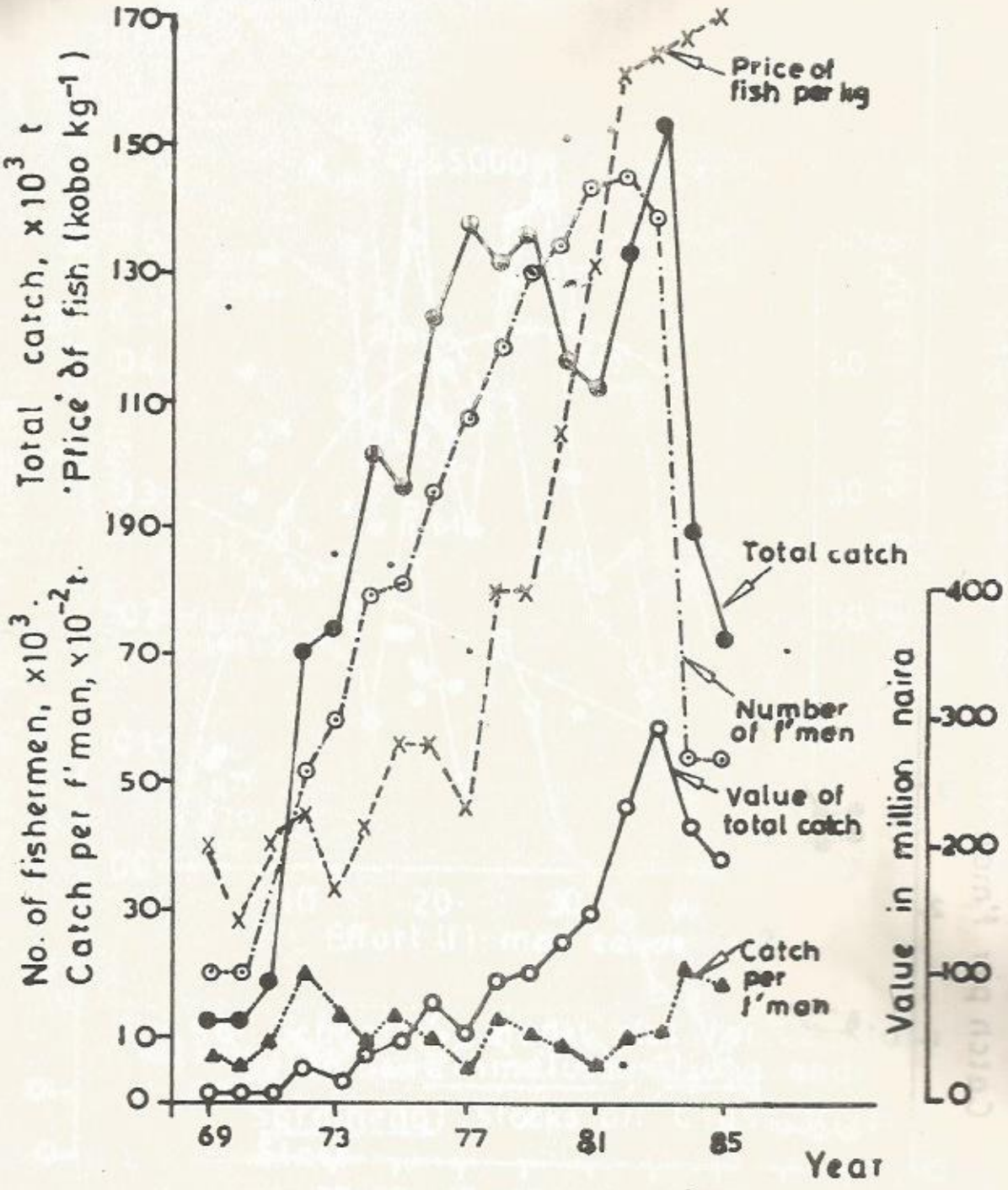
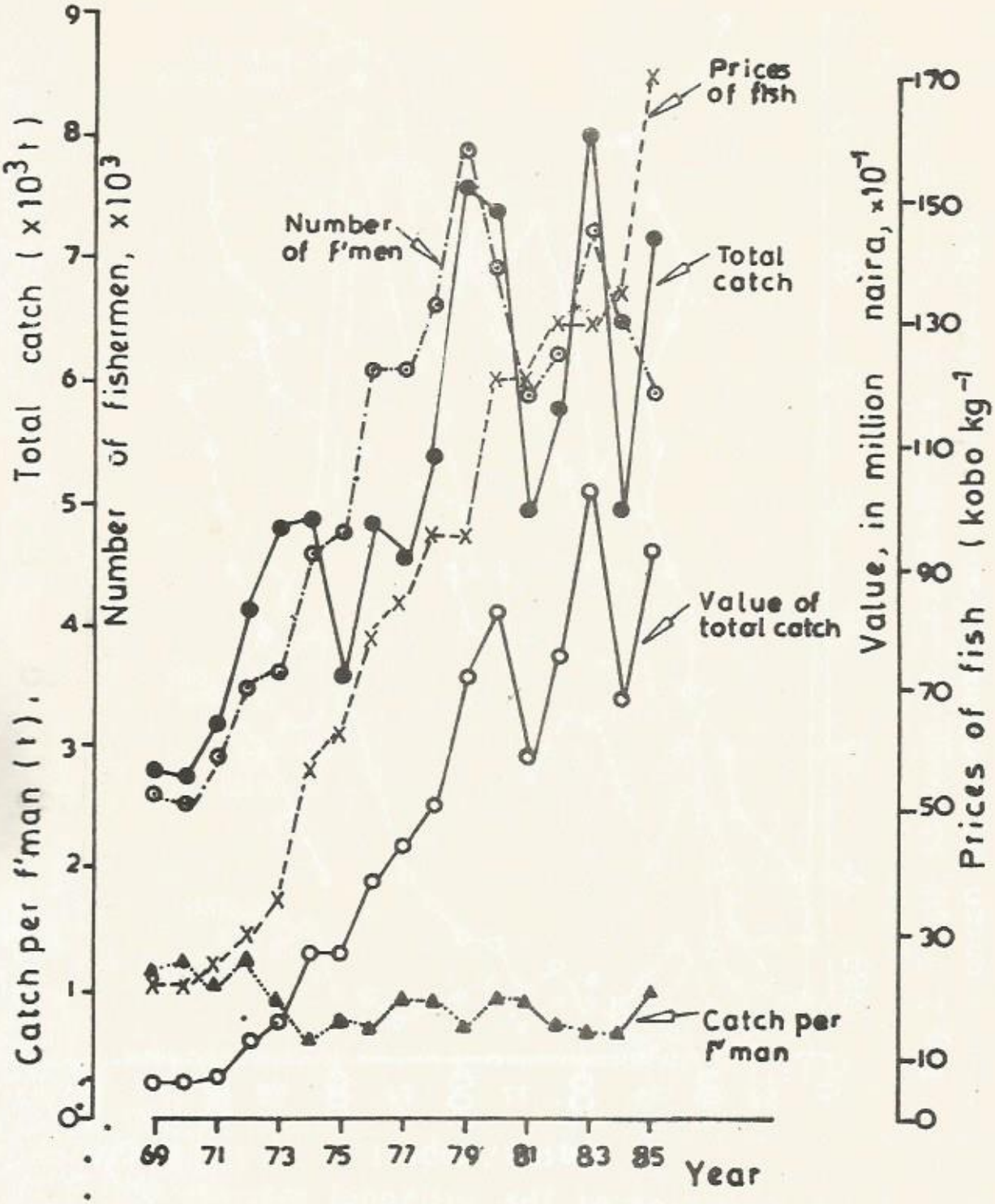


Fig.3 Evolution of the artisanal marine fisheries of the Cross River State of Nigeria, 1969-1985.



Fig·4 Evolution of the artisanal freshwater fisheries of the Cross River system, C.R.State, Nigeria (1969 - 1985)

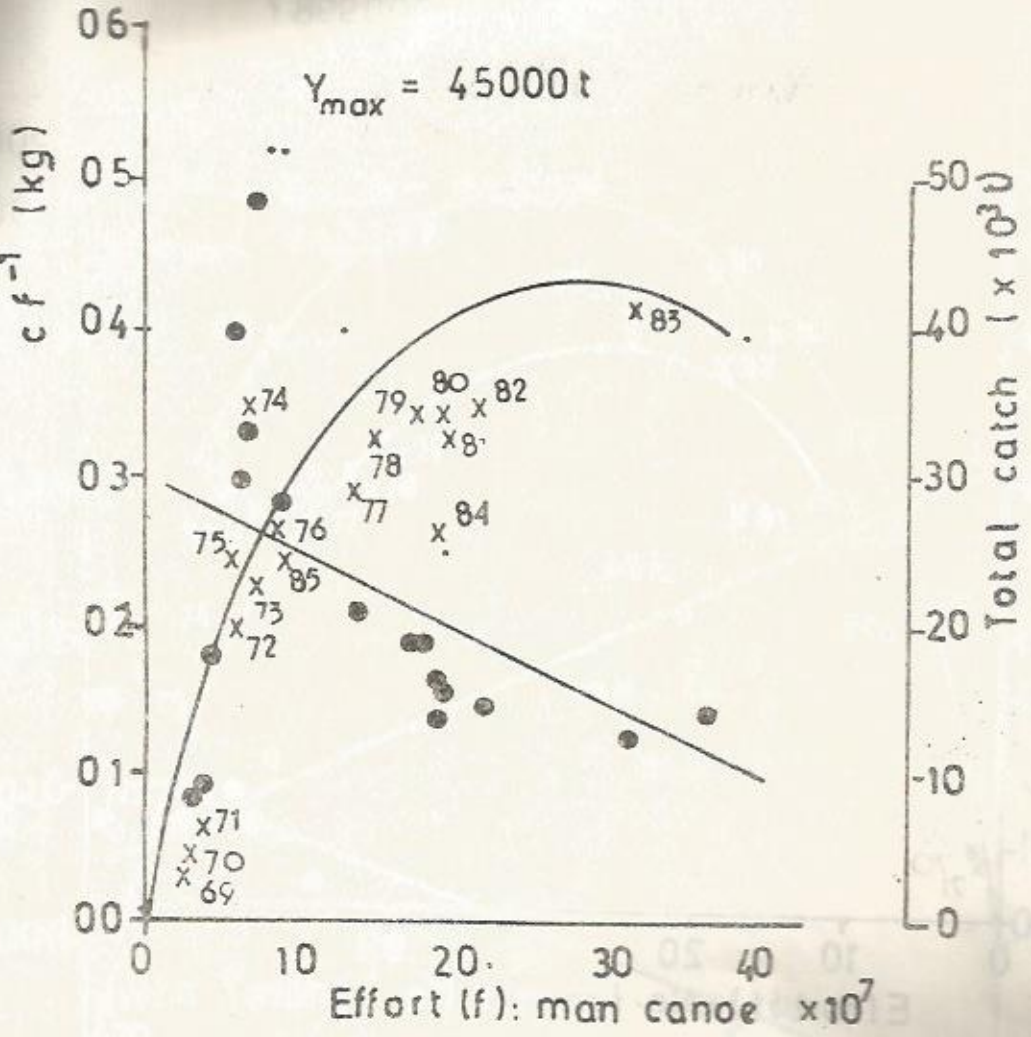


Fig. 5a. Schaefer's model plot for coastal pelagics (*Ethmalosa*, *Ilisha* and *Sardinella*) stocks off Cross River State.

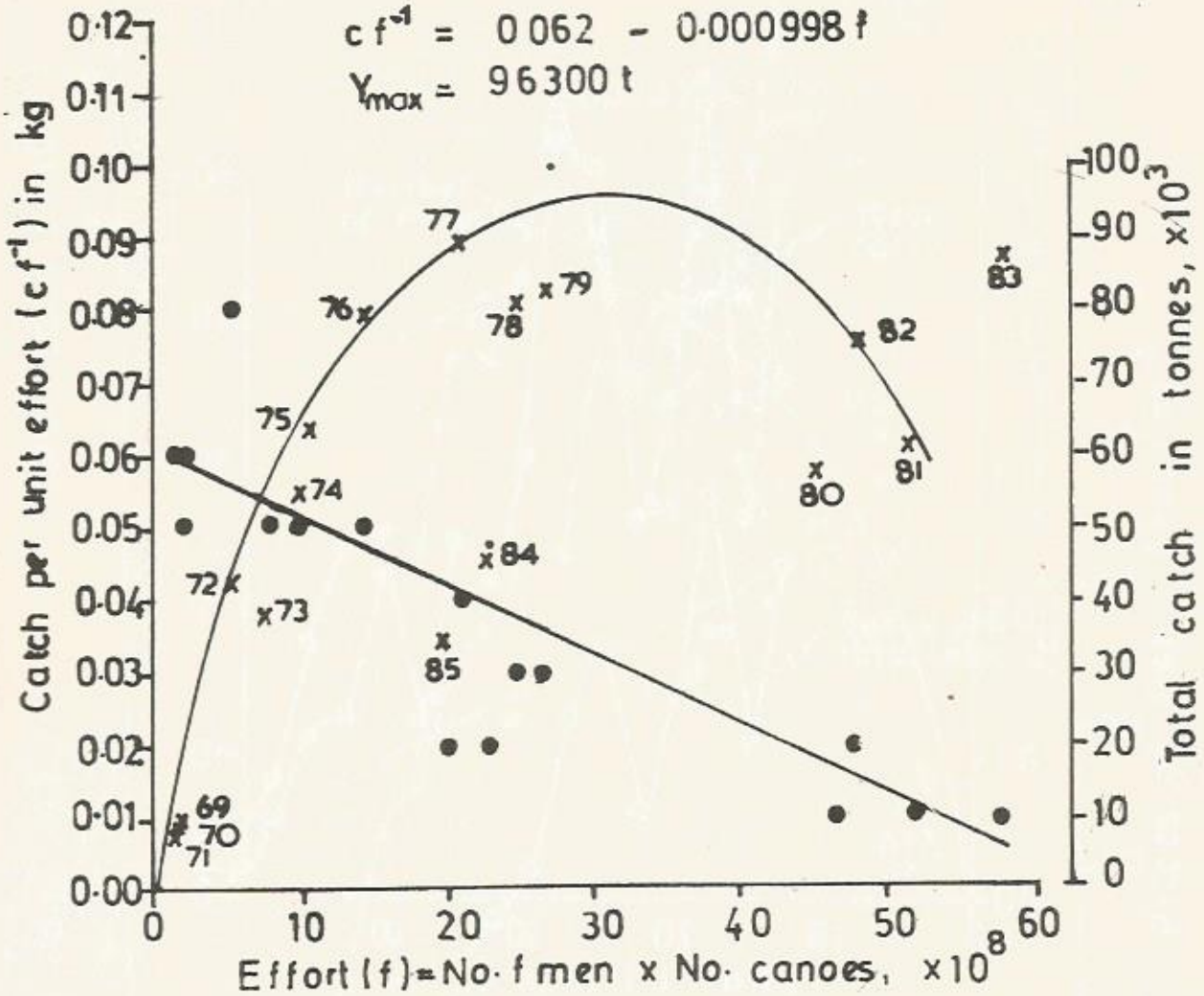
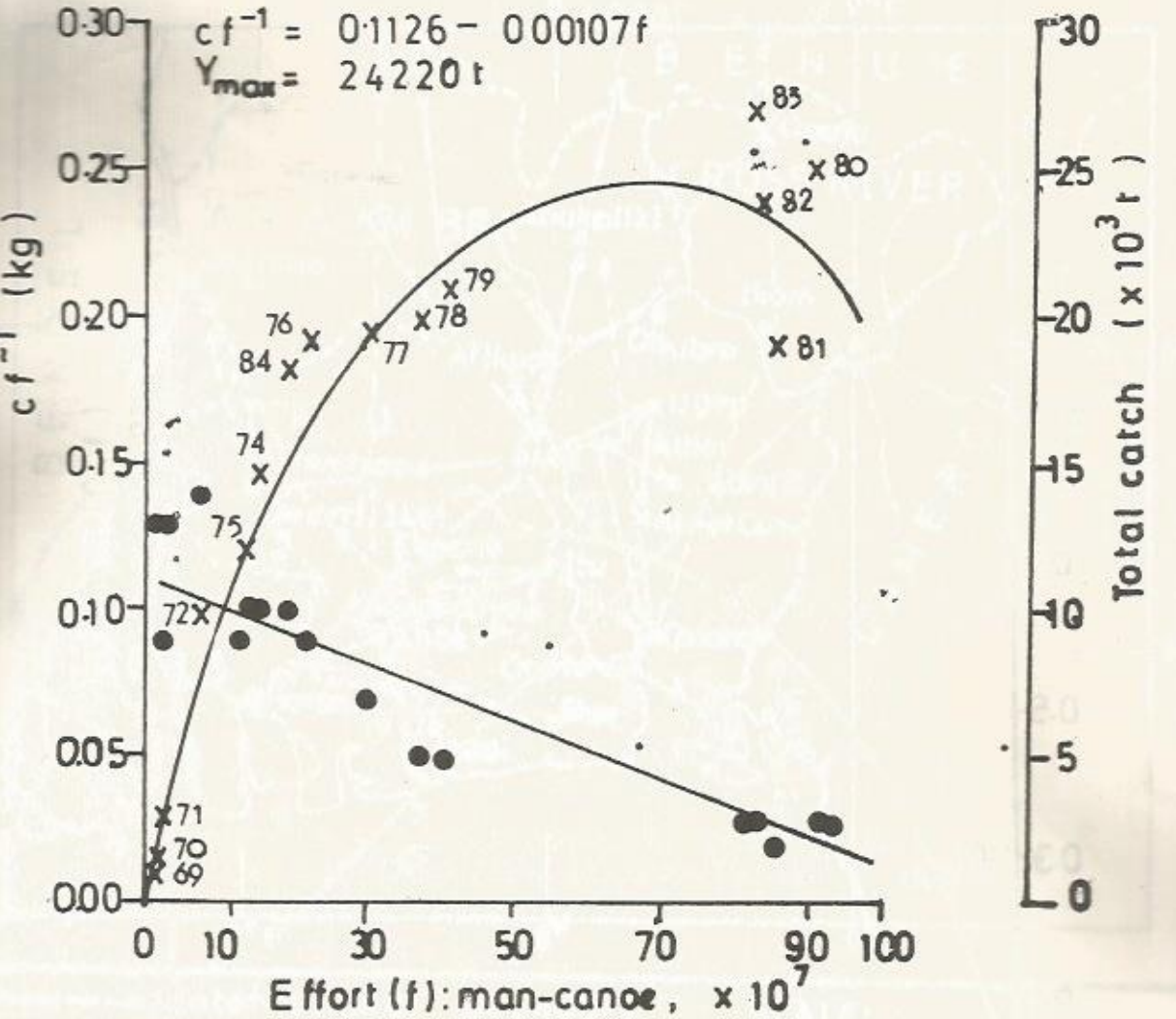


Fig. 5b. Schaefer's model plot for CRS artisanal demersal fishery



Fig·5. c· Schaefer's model plot for crayfish fishery of CRS·

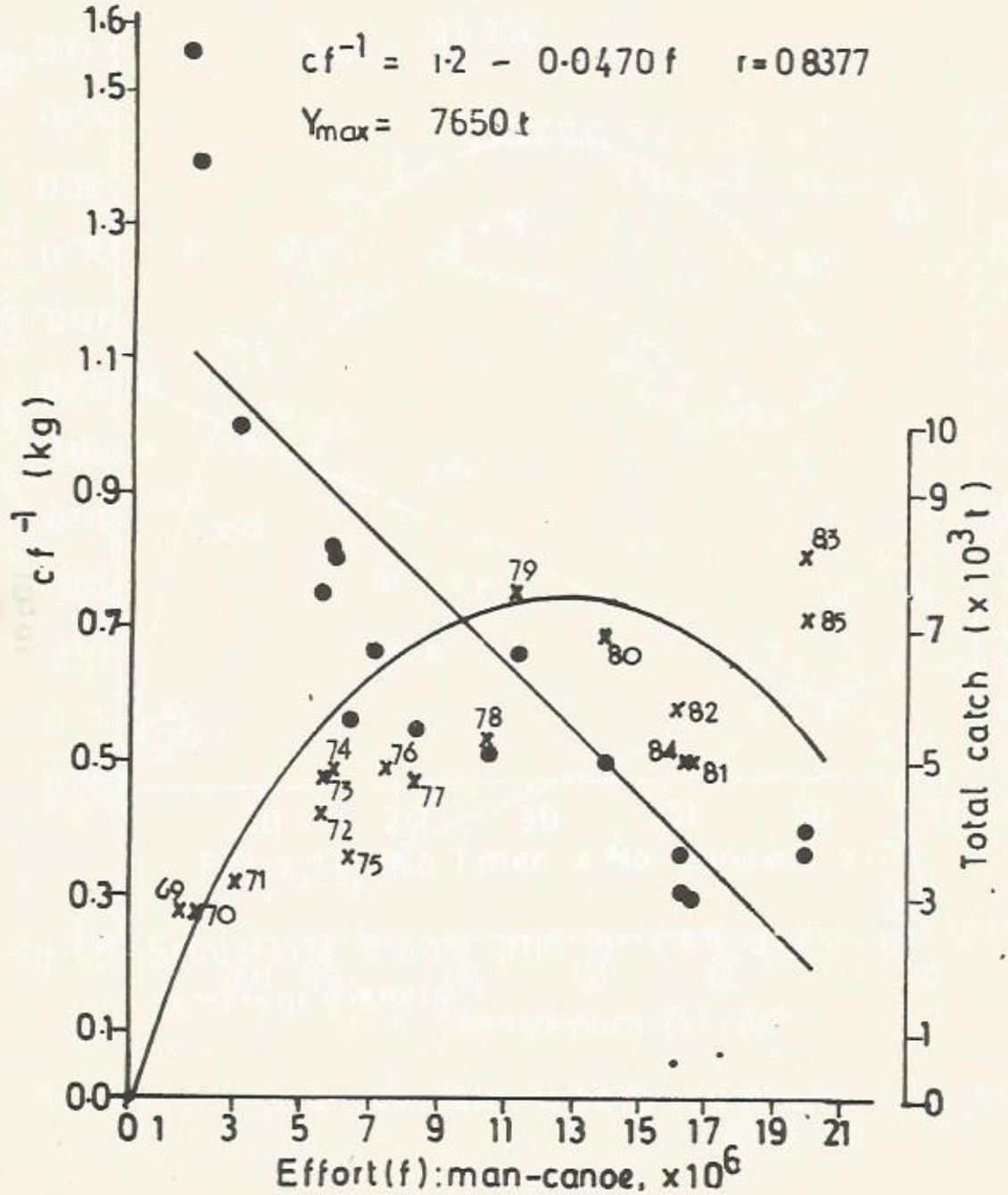


Fig.5 d. Schaefer's model plot for CRS freshwater fishery.

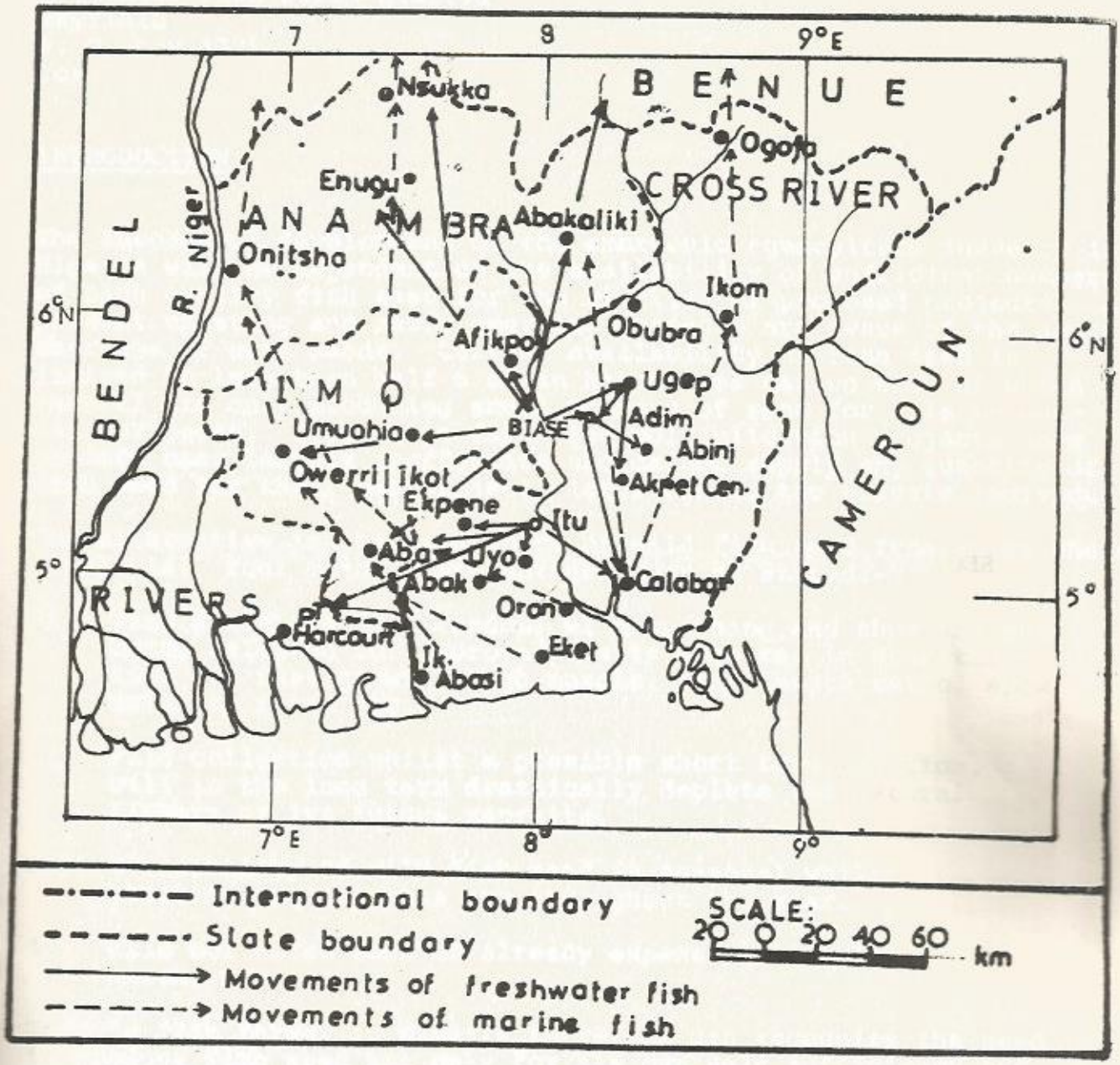


Fig. 6 Map of the eastern states of Nigeria showing the distribution of fish from Cross River State.

SECTION 3: INVESTMENT PROSPECTS IN FISHERIES TECHNOLOGY

INVESTMENT OPPORTUNITIES IN FISH SEED TECHNOLOGY

by

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INTRODUCTION

The successful development of the embryonic aquaculture industry in Nigeria will be dependent on the availability of sufficient numbers of high quality fish seed for the stocking of proposed projects. At present existing and newly emerging projects are aware of the acute shortage of such seeds. Current availability of fish seed is limited to less than half a dozen hatcheries nation wide of which several are only producing small numbers of seed for sale to outside projects. Government fish seed multiplication projects have to date been largely ineffective and cannot supply any quantity of fish seed for their own projects let alone to the private individual.

One alternative is the collection of wild fish seed from areas where available. Four major disadvantages must be stated:-

i) Fish seeds are from random, wild spawning and thus are not being selected for improved traits required in domestication e.g fast growth, high muscle: body length ratio, slow maturity rates etc.

ii) Wild collection whilst a possible short term solution, will in the long term drastically deplete the natural fishery of its future recruits.

iii) Availability of wild fish seed is seasonal whilst stocking requirements are throughout the year.

iv) Wild collected seed is already expensive and will become more so.

Today's fish farmer in Nigeria therefore can recognise the need to produce fish seed not only for his own self sufficiency but also as a means of extra income by the sales of fry to outside projects (N.B even Government Projects). The rapidly increasing number of newly developing aquaculture projects of varying sizes within the country is leading to a rapid increase in demand for fish seed. Certainly the fish seed market is booming and prices currently being paid for fingerlings by many new projects are artifically high. Therefore in terms of the fish seed market the first investors into the business will enjoy the possible temporary high prices being obtained for fish fry of any quality provided.

However, for the purpose of this paper I am looking only at the establishment of projects which intend to not only provide quantities of seedlings but also of the highest quality. The trust placed by a client in a seed supplier is great and he relies on

the fact that what he asks for is what he is provided with. Fish fry produced from inferior broodstock will themselves be of the same low quality e.g. slow growing, early maturing etc. Such fry are easily sold as "premium quality" seed with the consequent disappointment to the buyer only becoming apparent many months later.

SPECIES SELECTION - WHAT SPECIES OF FISH ARE TO BE GROWN?

Production of fish seed may be to supply one of two markets in

a) Food fish

b) Ornamental and aquarium fish.

In this context ornamental fish are considered in the world market sense as fish for outdoor "Cool" water ponds. Species involved are principally Koi Carp and the various types of Gold - Fish. Aquarium fish are generally tropical warm water types of which there are thousands of species e.g. Guppies, Mollies, Platys, Gouramis, etc.

In the case of food fish the seed producer is looking to supply principally Nigeria aquaculture projects, although with suitable access to air transport services a potential market within West Africa also exists. However tapping this market may be very difficult from the logistic and marketing stand points.

2.1 Fish culture at present in Nigeria uses many indigenous and principally one exotic species of fish. Of the indigenous species only one or two species are propagated successfully under controlled condition. The first of these is Tilapia and at present most Tilapia stocked are obtained from natural spawning not controlled propagation. However, as will be discussed further, its controlled propagation has been extensively developed elsewhere in the world and that technology is now being employed in Nigeria. Secondly Clarias lazera, the mudfish (catfish) can be bred by artificial propagation. However, this fish is new to fish culture and it is only within the last 10 years that its controlled propagation has been developed. In Nigeria no single fish farm can say that it is producing Clarias fingerlings on an as yet commercial scale, (i.e. over 100,000 per year).

The exotic species that is cultured in Nigeria is Cyprinus carpio - the common carp. This fish originating from the great rivers of China has been cultured for some 600 years. Its culture under controlled conditions is precisely known and it is therefore certainly one of the principal species that will be utilized in the developing system of aquaculture in NIgeria.

The freshwater of Nigeria is very rich in the diversity of fish to be found. Some 200 species are known at present and undoubtedly a few more lesser species are yet to be described. Of these many are known to have a real potential for future developement as cultured species, leading candidates amongst the fish of Nigeria for such developement are:

i) Heterotis niloticus

ii) Gymnarchus niloticus

iii) Labeo coubie

iv) Heterobranchus spp.

v) Bagrus dogmac

vi) Chrysichthys nigrodigitaus

vii) Channa obscura

viii) Lates niloticus

However, it must be strongly re-emphasised that none of these species, as yet, have been developed into culture species. Certainly the breeding of such species as above is little known and in some cases even unknown. Thus no commercial operation can start off with the intention of initially mass producing any of these. Only Carp and Tilapia are sufficiently developed for commercial production of their fry. Even Clarias still remains to be fully developed.

Consequently this document will concentrate on the propagational requirements for only Carp and Tilapia as a commercial proposition. The development of the other species is in the eventual interest of fish farmers in Nigeria but cannot be supported as part of a newly developing commercial project.

2.2 CARP - CYPRINUS CARPIO

The fecundity or reproductive potential of the common carp is very high. Single females of 1kg can provide up to 100,000 eggs. Normally a broodstock of 50 female breeders of 3kg average weight is capable of providing a minimum 1,500,000 fingerlings per annum. This broodstock is continually being replaced with young selected fish from the same genetic line. Older broodstock above 4-5 years gradually become less productive and should be sold off.

A female brood herd of 50 fish with total biomass of 150kg can be kept in a broodstock pond of 0.15 ha. Breeder males which will be kept separately are used at a smaller size, generally around 0.8 - 1.0kg 100 males are more than adequate to service a female breeding herd of 50 fish. A further broodstock pond of 0.1 ha. is required for the male breeder herd. This means that the total pond area required for the maintenance of such a carp breeding herd is 0.25 ha.

Sources of broodstock in the country are very few and one or two farms only exist where blood lines of improved carp are maintained.

Any new fish seed project intending to directly purchase its broodstock ready for breeding must expect to pay a price commensurate to the fry that will be obtained as a result of propagation.

The alternative is to obtain fry or fingerlings and rear and select to produce the broodstock obviously a delay of at least one year will occur prior to first spawning.

Blood stock within Nigeria of carp is generally poor due to many years of uncontrolled spawning of original stocks brought in during the 1950's and 1960's. However, some selected lines are now being re-established both at Rockwater Fish Farm, Jos and a few other places.

Importation of fast growing strains from overseas is the third alternative but certainly will entail provision of carp fry for on growing and broodstock selection.

2.3 TILAPIA

Tilapia is known as an excellent fish for fish culture operations having a high quality flesh, good growth rate as well as being tolerant to high water temperatures, high levels of ammonia and nitrite and low dissolved oxygen levels. Their principal disadvantage is early maturation in ponds and subsequent wild spawning and over population. This over population causes a dramatic reduction in the yield of the pond.

Three steps can be taken to control this problem, either singly or, most efficiently together.

i) Prevent the entry of wild fish into the pond during water transfer. This will involve the use of screens or gravel filters to exclude even the smallest fry and, in some species, the fertilized planktonic eggs.

ii) Stocking of predators to remove weed fish and any Tilapia fry resulting from breeding within the pond. Principal problems here are critical stocking sizes of predator e.g. Clarias lazera relative to stocked fish.

iii) Stocking of single sex populations of Tilapia to prevent breeding. Also in Tilapia, generally, the male fish is faster ingrowth rate than the female. Consequently stocking of only male Tilapia is desirable. Such male populations of Tilapia may be obtained in one of three ways.

a) Hand sexing of a juvenile population: This method is labour intensive, wasteful (females discarded) and liable to operator error.

a) Hormone treatment of fry. Until recently this method has been limited to pilot scale production due to technical problems. These have now largely beeen solved and such production is reaching a commercial scale in countries such as Israel, Phillipines etc. It is necessary that this method be practised and developed in this project.

c) Hybridization. This method has the added advantage that the off-spring exhibit hybrid vigour. Whilst simple in theory; the realization of commercial production is complicated in practise and certain stages of production

must be carefully monitored. Production of hybrid fry is described in detail later. However, the broodstock requirements may be detailed at this stage.

Many species have been found to be suitable for hybridization. The most frequently used crosses are:- Oreochromis mossambicus x Oreochromis hornorum.
Oreochromis niloticus x Oreochromis aureus.
Oreochromis niloticus x Oreochromis hornorum.

Use of the O. niloticus x O. aureus cross is most common although in the constantly warm water temperatures of Bendel State the O. niloticus x O. hornorum cross may also thrive.

For such hybrid production two lines of meticulously isolated grand parent broodstock must be maintained in order to provide true line parents for the hybrid cross.

The total number of fry that can be recovered from 300-400g parents is, at most, 1500 fry per female per season. Thus, in order to guarantee a production of 500,000 hybrid fry per year a female broodstock of 400 fish will be required and similar number of males.

The pure line grand parent stock required to produce these breeders will be small but highly selected. Some 20 pairs of each will provide enough fry and sufficient population strength for self maintenance and selection. Again this will be continually replaced with true line elected.

Removal of hybrid fry from the brood ponds must be continuous in order to prevent cross breeding of parents and fry. This is usually accomplished by the complete harvesting of all fry every two weeks. It is convenient to have a second broodstock pond prepared ready for restocking of the breeders immediately after removal from the first broodstock pond.

Broodstock pond requirements for Tilapia production of 500,000 fry are as follows:-

i) Grand parent stock - O. niloticus 1 pond 0.05 ha.

ii) Grand parent stock - O. aureus 1 pond 0.05 ha.

iii) Hybrid breeding pond 3 x 0.1 ha = 0.3 ha.

Total area = 0.4 ha.

In conclusion the broodstock pond requirements for the production of 1,500,000 carp fingerlings and 500,000 Tilapia fingerlings is 0.65 ha. water area. It is intended to provide an additional 3 ponds each of 0.1 ha. for the growth of potential broodstock of other local species such as Clarias, Heterotis etc, etc., resulting in broodstock ponds covering a total water area of 0.95 ha.

2.4 NURSERY PONDS

It is estimated therefore that the hatchery will produce up to 2,000,000 carp and tilapia fry per annum. Instantaneous stocking of all 2 million fry at a normal stocking density of 700,000 fry per hectare would require a total of 2.8 ha. of nursery ponds. However, as such production is not instantaneous but stagered throughout the season a total of 15 ponds will provide a more than adequate facility or total area 2 ha. This number of ponds will allow suitable flexibility for stock management and manipulation.

TABLE SERVICE PONDS

Broodstock ponds	No of ponds	Pond area	Total area (ha
a) Carp ♀♀	1	0.15	0.15
Carp ♂♂	1	0.1	0.1
O. aureus grand parent ♂♂ & ♀♀	1	0.05	0.05
O. niloticus grand parent ♂♂ & ♀♀	1	0.5	0.5
Hybrid breeding ♀♀ O. niloticus O. aureus ♂♂	3	0.1	0.3
b) NURSERY PONDS			
Large nursery ponds	5	0.2	1.0
Small nursery ponds	10	0.1	1.0
Total service pond			2.65

2.5 ORNAMENTAL & TROPICAL FISH

Whilst an increasing demand exists in Nigeria, especially for Tropical aquarium fish, it is and is likely to remain in the nearest future a quite small market. Any successful producer is likely to quickly flood the local market.

The principal market considered here is the export market to Europe. Breeding of the following and comments on their present supply may be of interest:-

i) Koi Carp and Gold Fish

Koi Carp are merely coloured varieties of Common Carp (Cyprinus Carpio) and are bred under exactly the same

conditions. Their price in Europe has been high (£0.50-0.70p wholesale price per 7-8cm. fish).

In the past all fish have come from Japan and the far East. The Israeli fish farmers, however, have now entered this part of the market in a big way in the last year or so and are already pushing down the prices providing high quality Koi from Israeli - less than 5 hours flying time to Europe. It must be moted that Koi do not breed 'true' and from any crossing up to 40-50% may be discarded as sub standard quality.

Many varieties of Goldfish (Carasscus auratus) exist e.g. comet, veil-tail, shubunkin, Oranda etc. Their sale value depending on the variety, which too is linked with the difficulty of rearing some of the varieties. Common Red Comet Goldfish may only fetch £0.10 to the breeder whereas some of the exotic Oranda's and Shubunkin's up to £1.00.

Breeding of these is normally carried out in semi natural conditions with subsequent transfer of the fertilized, deposited eggs on spawning mats, into prepared nursery ponds.

Both Koi and Goldfish breed best under seasonal conditions where a rise in water temperatures from below 18°C to approximately 20-21°C may be experienced. This limits ideal Koi and Goldfish production to certain parts of the Country.

ii) Tropical Aquarium Fish

Most of these are small species that are bred under natural conditions in small ponds. Current European supply of farmed tropical fish is from Singapore, Malaya etc. specializing in species such as Guppies (Poecilia reticulata) platys (Xiphorus maculatus) Mollies (Poecilia vellifera etc.) Gourami's (Trichopterus spp). Siamese Fighting Fish (Beta splenden) etc.

Prices obtainable for these are variable between £0.10 and £0.60 per unit.

Interestingly the market for African tropical fish which has been restricted to specialist fish - keepers for many years, is beginning to open up. At present most if not all the West African fish sent to Europe are captured wild. Unfortunately the buyers in Europe complain bitterly about the quality of the shipments that they receive. It does not surprise me. Techniques capture storage, transportation, packaging and despatch are for the most cases deplorable.

A clear opportunity exists for some one to propagate some of the more popular and valuable species under controlled, hygeinic conditions and export them enmasse. Possibilities include certain Synodontis spp., Pantodon buccholzi (Butterfly fish), Pelmatachromis spp. Para auchenoglanis spp. Schilbe mystus - etc.

HATCHERY FACILITIES

Three main facilities must be considered:-

a) WATER SUPPLY

Frequently the most negelected aspect in the design of fish seed projects but undoubtedly the most important. It is not possible to "make do" with a water supply system to a hatchery.

If you are going to invest heavily in a hatchery project the investment must be safe-gaurded by sufficient capital out lay to find a site that can provide enough water of suitable quality. If necessary water treatment may be required as may possible recirculation.

The smothering effect of suspended solids on fish eggs and newly hatched larvae is one of the commonest causes of mortalities in many poorly designed hatcheries. The use of primary sedimentation ponds, aquatic macrophytes and gravel filters are the simplest solutions that can be employed to remove inorganic suspensions.

Organic suspensions, frequently accompanied by high bacterial loads will normally require some form of biological treatment system e.g. biological filter, biodrums etc. Many of the highly sophisticated bacterial reducing systems are not only very expensive but frequently disappointing in their efficiency e.g. Ozone reducers, U.V. sterilizers.

The quantity of water required is obviously finally dependent on whether any recirculation is taking place. However, total input requirements for a medium sized hatchery and accompanying service ponds are of the order of 2,000m^3/day.

A single large pump (minimum 6" suction) pumping for a few hours a day may be considered in preference to a smaller pump working all most continuously:

The use of boreholes is possible but the required volume of water may dictate one more large volume units.

b) HATCHERY

Hatchery designs are many and are generally custom designed for any intended project. It should be noted that they can be built entirely from available materials without the importation of specialist hatchery equipments. However, depending on the limit of sophistication required certain imported components may be required (e.g. water quality monitors, automatic feeders etc.).

Egg incubators if required can be made locally and work efficiently based on a modified zoog jar design. However, it is necessary for these to have not only sufficient water but also a constant pressure supply to avoid over or under - irrigation of the developing egg which can be disasterous.

Fry tanks can be made very easily and effectively using fine rendered concrete blocks and plastic and galvanized piping for the water control and filtration system. Whilst not portable as are glass fibre tanks, they are economical, efficient, strong and easily maintained. Concrete asbestors tanks are available in limited sizes and designs. They have the advantage of being cheap and portable. They are however, brittle and care needs to be taken in their use to prevent breakages.

The question of roofing hatcheries is a complex one. Ideally a hatchery should be roofed to protect the fry tanks from climatic excesses. The hatchery can however be operated with partly open air facilities. Rockwater Fish Farm on the Jos Plateau has the main fry tanks and holding tanks out doors with indoor facilities for controlled breeding, egg incubation, laboratory facilities and Artemia culture.

c) PONDS

These include the broodstock and nursery ponds and in requirement terms have been discussed previously. Construction methods are standard for earthen ponds using small monks or turn down pipes for water control.

In terms of design ideally many small ponds facilitate the separate stocking of varying batches of fry produced from the hatchery. Fry of different ages should never be stocked in the same pond inorder to prevent cannibalism of the smaller fry.

4 HATCHERY MANAGEMENT

Without a totally dedicated, well trained and concientious staff any Fish Hatchery Project is doomed to failure. This may well be seen as one of the principal current constraints to the developement of such projects at present.

Quite simply the only hatchery technicians available at present in Nigeria are those trained and working at the few developed hatcheries in Nigeria e.g. Rockwater. More than training however is the importance of dedication, interest and concientiousness.

Working in the hatchery regularly is at any hour of the day on any day of the week. Few projects will be able to pay a salary of the level that would fully compensate the efforts of a good hatchery worker. In the end fish hatchery technicians give effort over and above the requirements of their paid salaries. Staff must live on the hatchery site in order to be constantly available.

5 SUMMARY

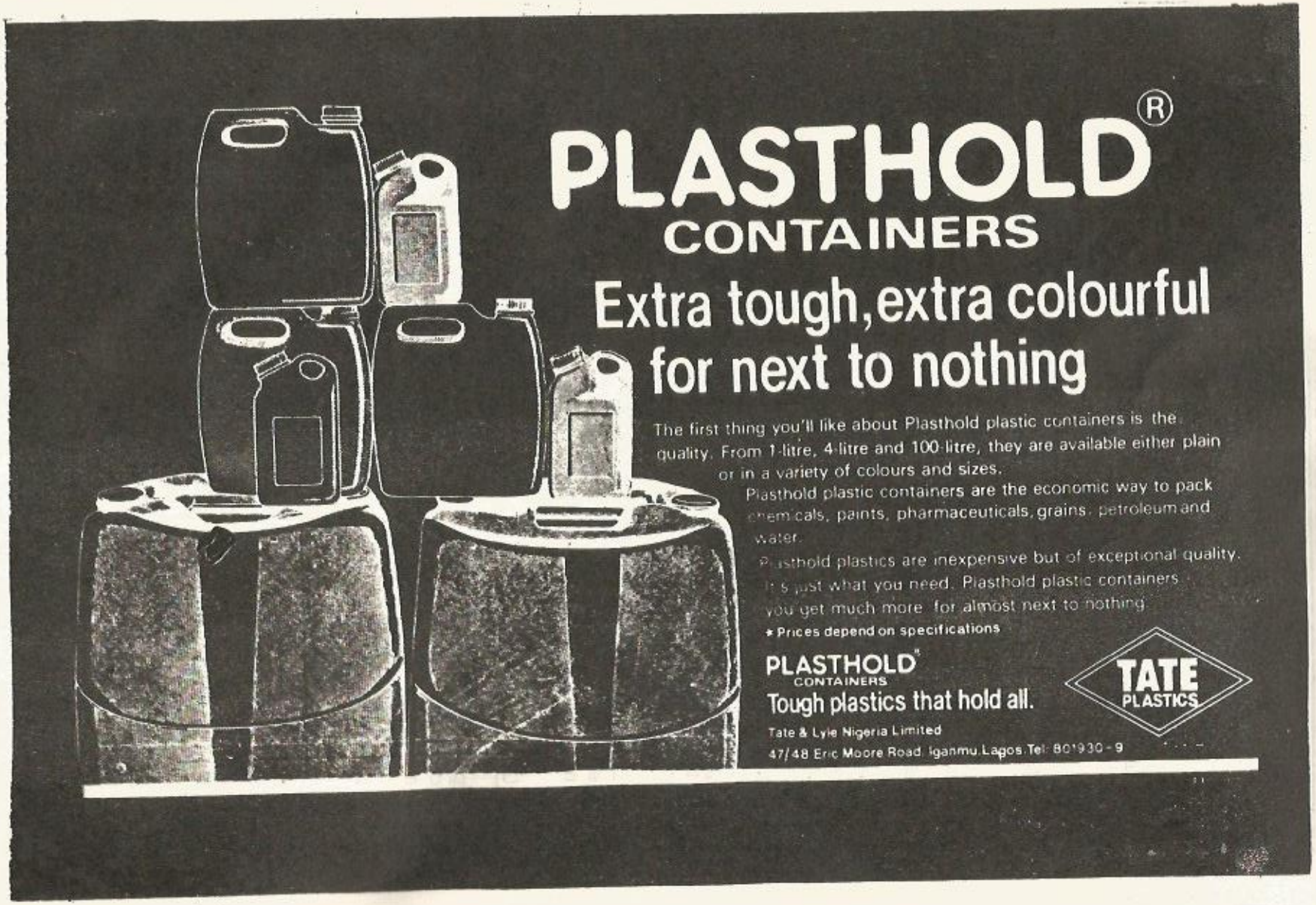
The operation of a successful Fish Hatchery and fry production system will depend on the following:

i) Correct initial planning for intended production (both species and intended numbers).

ii) Design of the appropriate facilities to enable required production.

iii) Selection of top calibre, dedicated and experienced hatchery staff.

iv) The ethical responsibility taken by the hatchery management to produce only the highest quality seed under the best possible conditions. Purchasing farmers are dependent on this.


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SMALL SCALE COMMERCIAL PRODUCTION OF TILAPIA FINGERLINGS IN FLOATING BAMBOO NET-HAPAS

by

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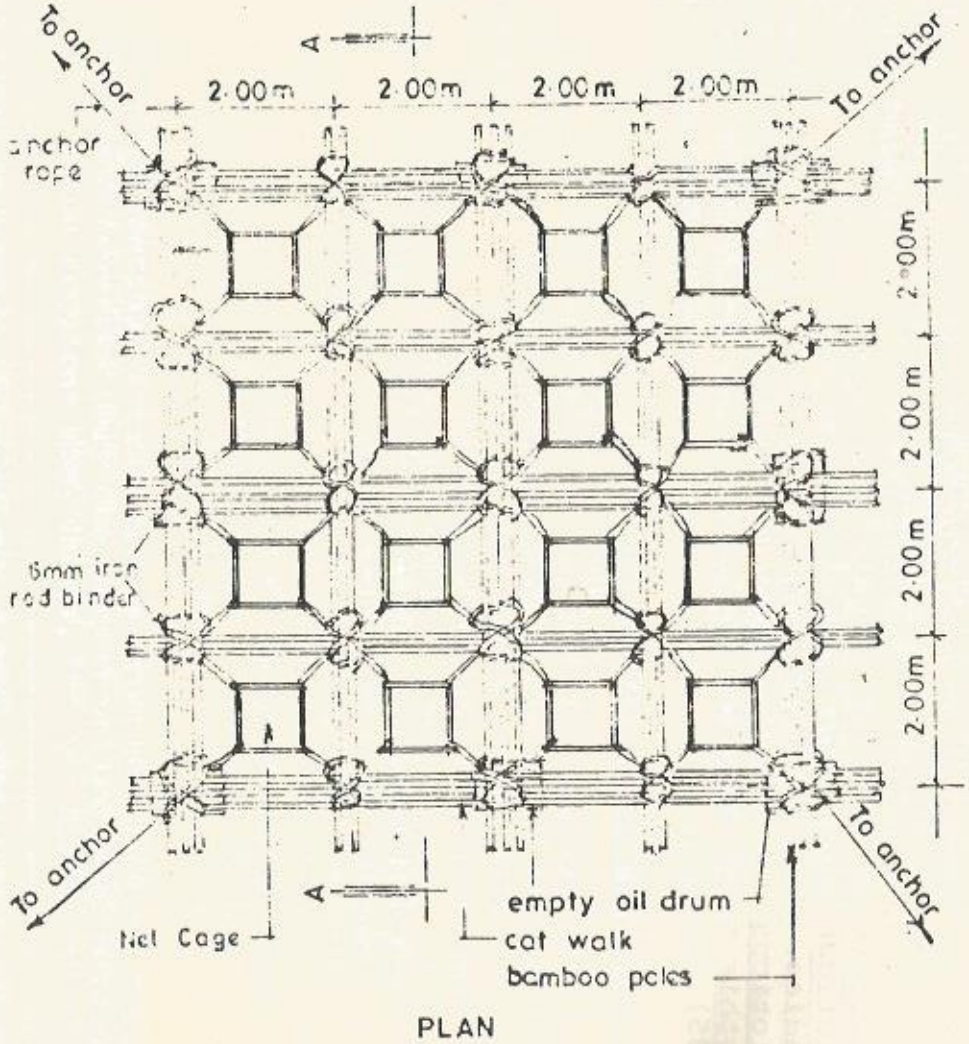
ABSTRACT

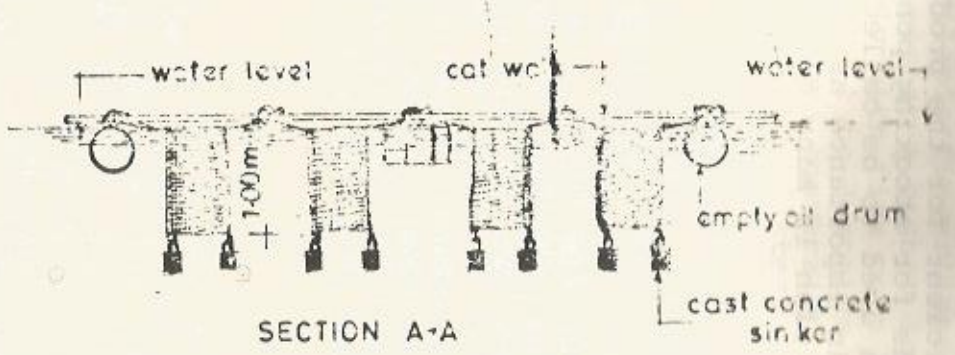
The inadequate supply of tilapia seed is considered as one of the major present constraints to the development of the culture industry. The floating bamboo net-hapa hatchery/nursery system was observed to be very efficient in the mass production of tilapia fry and fingerlings at Kainji Lake Research Institute. This system was therefore, recommended for small-scale (artisanal) commercial operators consisting of fishermen families in order to increase their productivity and hasten development of rural communities. The economic analysis of this system showed that loan obtained for the recommended scale of operation can be amortized within two years of the project. It was emphasized that the operational and managerial skills of the fish farm operators account largely to the production cost and profitability of the enterprise.

INTRODUCTION

Development of and assistance to small-scale fisheries is a policy of very high priority in countries in South and South-east Asia. Within recent years, some breakthroughs in certain aspects of aquaculture, which are of small-scale nature, were achieved. One of these is the operation of shrimp/prawn hatcheries in some countries in the region (FAO, 1982). In some countries such as Taiwan, Philippines and Thailand, there are several "backyard hatcheries" managed by experienced small farmers contributing significantly to the national total fish seed supply.

Economically productive fish culture, like in terrestrial animal husbandry like livestock and poultry production, is heavily dependent upon an adequate supply of good quality and quantity seed with which to stock aquaculture systems like cages, ponds, raceways, enclosures etc. One of the major constraints to increased fish production through aquaculture in Nigeria has been identified to be inadequate supply of fish seed. It is surprising to observe that the supply of the "common" Tilapia (known to be very prolific) fingerlings for stocking the existing aquaculture systems is inadequate. The floating bamboo net-hapa hatchery/nursery system developed at Kainji Lake Research Institute,





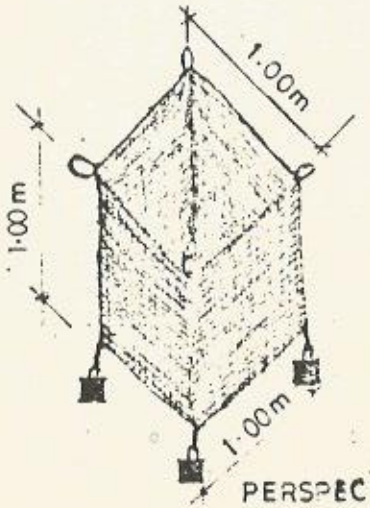


Fig 1 16 Units Bamboo Floating Cages

has been found to be very efficient for the production of high quality Tilapia fish seeds for stocking ponds, cages, enclosures etc. Tilapia which used to be called "poor man's fish", now ranks first in importance as a cultured fish and a highly priced food fish in many developing countries.

In capture fishery, the artisanal (small-scale) is, however, still the most important sub-sector consistently accounting for well over 90%of the total domestic production in Nigeria (West, 1986). The vast unpolluted inland water bodies of Nigeria provide great opportunities for the establishment of small scale floating hatchery/nursery. While the body of literature on the biological and technological aspects of aquaculture in the tropics is steadily increasing, little information on economic aspects is available (IDRC, 1982). The aim of this paper, therefore, is to provide information on the economics (input-output) of operating a small-scale commercial Tilapia fingerlings production in floating bamboo net-hapas.

BACK GROUND

Fish cage culture can be described as the husbandry of fish stocks, generally from juvenile to market size, in a totally enclosed water volume through which a free water circulation is maintained.

In the floating bamboo hatchery/nursery system, fine mesh nylon or "mosquito" net cages commonly referred to as hapas are used to breed Tilapia. In Kainji Lake Research Institute, successful breeding was observed using Sarotherodon (= Tilapia) galilaeus, Oreochromis (= Tilapia) niloticus and combination of the two in hybridization studies. In this paper, only the breeding of Oreochromis niloticus will be discussed since much work has been done on this species at the Institute (Otubusin and Opeloye, 1985).

Fry and Fingerling Production in Net-Hapas

This activity was carried out in a freshwater reservoir (Kigera III) built for domestic water supply to the KLRI Estate. This reservoir is already described in Otubusin (1985).

A module of 16-units consisting of floating bamboo raft[1] (9 x 9 m) and 16, 1 x 1 x 1 m hapas was used in the production of Oreochromis (= Tilapia) niloticus fingerlings (Figure 1). Tilapia breeders (60.0 to 72.0g for females and 106.0 to 150.0g for males) were stocked at the rate of 12/hapa and were fed with 50% blood meal pelleted feed as described in Otubusin (1985). School of fry was first observed 18 days after stocking. Male : female breeders ratio of 1 : 3 was found to be the most advantageous sex ratio. The average monthly prcduction of O. niloticus fry was 1,000/cage.

[1] Nine 100L plastic kegs (Tate & Lyle KWALIPIPE) adequate as floats for a module

To produce Tilapia fingerlings, these fry are further reared in hapas at a higher density (1,000/m^3) feeding supplementally with fine corn bran until transfer to grow out cages after 1 to 2 months. Corn bran was observed to give the best feed conversion ratio, highest average final weight and the fastest growth rate in raising Tilapia fry to fingerlings at Kainji Lake Research Institute (Otubusin and Opeloye, 1985).

INVESTMENT PROSPECTS

Based on the above information, investment prospects in small scale commercial Tilapia fingerling production in floating hapas will be analyzed economically.

4 modules of 16-unit hapas 1 x 1 x 1m (hatchery) and another 4 modules of 16-unit hapas 1 x 1 x 1m (nursery) will be the least requirements for this small-scale commercial venture. The other details are as in Table 1.

DISCUSSION

From Table 1, it can be observed that a small-scale operator utilizing the specified number of modules (hatchery/nrsery) can surely amortize the loan he takes for the venture under two years of operation. It is pertinent to note that the site to be selected for this system must meet the requirements for good growth, production and safety of the infrastructure and the fish stock. The basic principles considered in site selection are good water quality, adequate water exchange and freedom from predators and natural hazards.

Since the demand for good quality fish fingerlings for stocking aquaculture systems is high, the operation of many small scale commercial floating hatchery/nursery will be a reliable and regular source of supply to meet this demand. This fingerling production systems has the following advantages:-

- involves low capital outlay
- uses an existing water body
- ensures total harvest of clean, high quality stock (fingerlings) unlike beach seining in the pond which is not total, injures the fish resulting in high mortality and the fingerlings are often not mud-free
- The highest recoverable number of fingerlings (Tilapia) has been observed in this system (Otubusin and Opeloye, 1985)
- harvesting of fingerlings from the hapa is fast and requires only one person unlike pond seining which requires many hands.

Table 1 - Annual operating and maintenance costs and prospects for modules of floating bamboo hatchery/nursery in small-scale commercial Tilapia fingerling production*

	Item	Amount (₦)
I	4 Modules of 16-unit hapas (Hatchery)	₦4,000.00
II	4 Modules of 16-unit hapas (Nursery)	4,000.00
III	Tilapia breeders (220/module) ₦1 each (3 sets)	2,640.00
IV	Feed (from agric & ind. wastes)	800.00
V	Maintenance/Repairs	400.00
VI	20% annual depreciation on infrastructure	1,600.00
VII	Miscellaneous	1,344.00
	Total =	₦14,784.00

Cost/Benefit Analysis:

(i)	Total Annual Receipts from Fish sales 80,000 fingerlings/module at 10k each	32,000.00
(ii)	Total operating and maintenance cost	14,784.00
(iii)	- Net Profit (1st Year)	17,216.00
	- Return on Investment = 116.5%	
	- Net Profit (2nd Year)	25,216.00
	- Return on Investment = 371.7%	

* Based on the following assumptions:

1. Production period: 10 months
2. Expected life span of hapas is 5 years
3. Stocking density: 12 Breeders/hapa and 1,000 fry per hapa and 62.5% survival from fry to fingerlings
4. Labour will be supplied by members of the family of the small-scale operator.

Overall, the success of this small-scale industry, assuring that the project will be readily funded by a loan from a financial institution, depends on the careful management of this semi-intensive culture system.

The prospects from this small-scale commercial Tilapia fingerling production are quite high. This system is therefore, recommended for small-scale operators at fishermen (farmers) family level in order to increase the productivity of these peasants and enhance the development of rural communities.

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SMALL-SCALE COMMERCIAL PRODUCTION OF TILAPIA FRY AND FINGERLINGS IN CONCRETE RACEWAYS

by

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ABSTRACT

This paper discusses the investment prospects in Tilapia fry and fingerling production in raceways created from the concrete drainage channel of a raservoir or pond of an existing fish farm. With an initial capital of ₦1,300 and an annual operating cost of ₦310 spent on procurement of fish feed and brood stock for a 10 m² raceway per se, a net profit of ₦4,100 and ₦5,090 would be realized from S. galilaeus in the first year and subsequent years of production respectively, assuming that the fingerling production rate has been maintained through the production period.

It is concluded that the application of this approach of optimizing the use of available resources in the fish farm for the productive breeding of Tilapia fry and fingerlings will apart from alleviating the problem of scarcity of stocking materials in the country, increase the profit margin accruing to the fish farmer.

INTRODUCTION

The recent upsurge in aquaculture investment in Nigeria is traceable to the slump in the poultry industry coupled with the restriction on the importation of frozen fish and stockfish as a result of the country's meagre foreign exchange earnings. Aquaculture is used in this context to mean "Fish Culture" which Mires (1983) defined as "the commercial raring of fish done in conditions where all the basic means of production can be controlled within their respective limitations and from which producers aim to obtain optimal economical results". Although many fish species are being cultured, the tilapias are regarded (CIFA, 1975) as the main-stay of aquaculture production systems in the African Region. But unfortunately, it is the fish that has not attracted adequate breeding manipulations to enhance its spawning potential. This attitude stems from their established prolific breeding habit and their ubiquitous nature which give a general impression that their juveniles (fry and fingerlings) could be collected in required quantity from the wild for stocking ponds and reservoirs. Experience has however, shown the contrary because of the difficulty encountered in their exploitation in natural waters.

The need for a regular source of fingerling supply in a commercial fish farm cannot be overemphasized as lack of it could reduce such a venture to a monumental waste and consequently discourage further financial investments in fish culture.

Hora and Pillay (1962) stated that fry could be artificially produced but that the consensus of opinion among fishery biologists is that the production from natural spawning is definitely superior to the meagre production of artificial hatching. Hughes & Behrends (1983) pointed out that the most important requirements for the advancement of tilapia culture is the development of systems for mass production of seed which Dadzie (pers. comm.) mentioned as the basis for every successful aquaculture practice. This paper therefore discusses optimal utilization of water in the drainage channel of a pond/ reservoir for small scale commercial production of tilapia fry and fingerlings from the point of view of brood stock management as a modest investment option for small scale fish farmers.

Raceway Design and Cultural Utility

Raceways are open channels or ponds of earthen or concrete conformation with considerably longer dimension than their width. Their maximum width and depth are 6m and 2m, respectively. There are different layout of raceways but the commonest arrangements are series raceway design and parallel raceway design, in which water flow increases in direct proportion to the number of raceways.

Although raceways are usually utilized for rearing growout in hatcheries, they could also be used for fry and fingerling production. The approach here is centred on the partitioning of water drainage channel of earthen reservoir or pond into compartments by means of screened sluice gates to give small-sized series of raceways with surface area range of 10 - 20 m^2 and a width of 1 m each. The drainage channel along which the raceways are constructed consists of concrete floor of 15 cm thick and non-hollowed blocks (cement bricks) of 15 cm.

Since the small-sized raceways are constructed adjacent to one another in a series along the drainage canal of a pond or reservoir, water effluent from the pond or reservoir flows through the raceways such that the outlet of the upper raceway is the inlet of the lower one with the outflow (the fall) of the former providing energy for aerating the immediate inlet vicinity of the latter. By this arrangement, surface water flow will be slow but a fast under water current is created which favours oxygenation of the bottom stratum of the culture system.

Sex Combination Ratio, Size and Replacement Rate of Tilapia Brooders

The most commonly cultured Tilapia species in Nigeria are Oreochromis (Sarotherodon) niloticus and Sarotherodon galilaeus in fresh water; Tilapia guineensis (melanopleura) and Sarotherodon melanotheron (heudolotti) in brackish water environment. The present report focuses on the spawning potential of S. galilaeus based on the data and observations recorded by Sado (1985).

From published information in available literature, there does not seem to be a consensus on the size and standard sex combination ratio for stocking Tilapia brooders in concrete tanks and raceways for fry and fingerling production. However, Guerrero (1983) reported that a 1 : 3 male to female ratio was acceptable for fry production in terms of breeding efficiency and economy in feed and maintenance cost. His result corraborated the observations of Uchida and King (1962) on O. mossambicus.

Sado (1985) found a 1 : 2 male to female sex ratio of S. galilaeus most suitable in terms of fry production in a 10 m² concrete raceway. He obtained an average of 3,000 fry in outdoor concrete raceways with a water depth of 0.41 m in five months (June - October). It is important to note that sex ratio alone cannot be the only yardstick for assessing the fecundity and fertility of broodstocks. The complex interaction between environmental and physiological factors such as physiological disposition of brooders, brood fish nutrition, age and size, species of fish and water quality are factors to be considered for rational deductions to be made. Nevertheless, a sex combination of 1 : 2 (3 brooders m²) sex ratio of S. galilaeus have been recommended as a working sex ratio for broodfish combination of these species in a 10 m² raceway with a minimum water depth of 0.45 m.

S. galilaeus breeders weighing between 220.9g and 355g and combined in a 1:2 male to female ratio produced an average of 3,000 fry in five months (Sado, 1985). The breeders were replaced after each spawning season. Guerrero (1983) reported the stocking of O. niloticus breeders weighing 50-450g in the breeding ponds of Fresh water Fish Hatchery of the BFAR-USAID in Munoz, Nueva Ecija in the Philippines, while small - scale hatchery operators in Bay Laguna used O. niloticus breeders weighing 50 - 100g. Breeders were replaced when they attained 250 - 350 g each.

Feed and Feeding Rates of Tilapia Breeders

Tilapia breeders can be sustained on natural foods in the raceway but supplemental feeding could be adopted if the water is not sufficiently rich in natural foods. Pelleted artificial feed compounded from 10% fish powder (ground whole fish) and 90% mixed flour (3 parts corn bran + 1 part chicken layer concentrate) could be fed to fish at 3% body weight. In the absence of these ingredients poultry mash or broiler starter could be fed to fish at the same feeding rate twice daily (morning and evening).

Stocking Rate of Tilapia Breeders and Fry Production

At a stocking rate of 3 breeders /m² (1:2 male to female ratio), 30 breeders of S. galilaeus would be required to stock a 10m² concrete raceway. Going by the fry production rates of S. galilaeus documented by Sado (1985) for the species (Table 1), 30,000 fry of S. galilaeus would be produced in five months. This author observed that August was the peak fry production period for this species.

Ideally, breeding raceways should be checked for fresh spawns every other day by pulling a 2mm mesh dip net (0.8 x 0.3) through the compartment and lifting at short distances for observation. Fry are collected into plastic bowls containing some quantity of water and counted before being transferred into a nursery where they are reared to fingerlings. Fry collection should be regular to avoid loss due to cannibalism.

Fingerling Production

In farms where fish nurseries do not exist, another raceway could be provided for use as nursery. In situations of poor primary production in the nursery, 25% fish powder and 75% mixed powder could be fed to the fry in pulverized form at 8% of body weight supplied to fish as two meals morning and evening daily until a weight range of 20 - 25 g is attained. Poultry mash could also be used to supplement natural foods.

From projected annual estimates, about 27,000 fingerlings of S. galilaeus, less 10% mortality would be produced from a 10 m² raceway. At a stocking rate of 200 fry/m², a nursery of 150 - 300 m² would be required.

Cost Benefit Analysis Of Fingerling Production In Concrete Raceway

The cost benefit analysis of producing fingerlings of S. galilaeus in a 10 m² concrete raceway for a five year period is presented in Table 2.

An initial capital of ₦1,300 is required for producing S. galilaeus fingerlings. In the subsequent years, operating costs on S. galilaeus would be ₦310 representing the re-current expenditure on procurement of broodstock and fish feed. This financial analysis does not take into account other financial inputs such as staff emolument, vehicle maintenance etc. as it is assumed that all these expenditures have been taken care of in the running of an existing fish farm. All the costing here are strictly based on the construction and stocking of a raceway created along an already existing drainage canal in the farm.

Assuming that the fingerling production rate of this Tilapia species has been maintained in five years, a net profit of ₦4,100 would be realized from S. galilaeus in the first year of production. Thereafter, the net profits from the species would be ₦5,090, respectively, for the next four years.

CONCLUSION

It seems from available literature that S. galilaeus is very fecund and this possibly explains its preponderance in natural waters. There are also indications from recent investigation at the IITA, Ibadan, reservoirs (Ita, pers. comm.) that S. galilaeus compares very favourably with O. niloticus in terms of growth rate in the presence of suitable natural foods. This observation therefore reinforces the selection of S. galilaeus as a culture species.

It is however hoped that with this approach of optimizing the use of available resources in the fish farm for the productive breeding of Tilapia fry and fingerlings, the present short supply of stocking materials in the country will immensely improve while at the same time enhancing the economic returns to the fish farmer.

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Table 1 - Stocking density of breeders of S. galilaeus and fry/ fingerling production rates in a 10 m² concrete raceway

Species	No. of breeders	Male to Female sex ratio per m²	Fry production rate	Fingerling production (less 10% mortality)
Sarotherodon galilaeus	30	1.2	30,000	27,000

Table 2 - Financial analysis of construction of 10 m² concrete raceway and fry/fingerlings production of S. galilaeus

YEAR		1	2	3	4	6
CONSTRUCTION COST						
a)	Mass concrete	300.00	-	-	-	-
b)	Brickwork (non-hollow cement blocks)	500.00	-	-	-	-
c)	One sluice gate	40.00	-	-	-	-
d)	Labour (6 man/day)	150.00	-	-	-	-
	Sub-Total	990.00	-	-	-	-
ANNUAL OPERATING COST						
i)	Broodstock 30 S. galilaeus @ ₦2.00 a piece (weight 250 - 350)	60.00	60.00	60.00	60.00	60.00
ii)	Feed	250.00	250.00	250.00	250.00	250.00
	Total Expenditure	1,300.00	310.00	310.00	310.00	310.00
ECONOMIC RETURNS						
Fingerling sales	27,000 S. galilaeus @ 20k per fingerling	5,400.00	5,400.00	5,400.00	5,400.00	5,400.00
	Net Profit	4,100.00	5,090.00	5,090.00	5,090.00	5,090.00

COMMERCIAL PRODUCTION OF *Clarias* FRY AND FINGERLINGS IN INDOOR AND OUTDOOR CONCRETE TANK SYSTEMS

by

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ABSTRACT

Induced breeding technique by hypophysation is being applied at the Kainji Lake Research Institute Fisheries Division Hatchery complex for the production of *Clarias* fry and fingerlings in indoor and outdoor concrete tank systems. The hatchlings are fed on livefood (zooplankton) and artificial feed. Source of zooplankton is from cultured stock which is maintained throughout the breeding season by fertilization.

Production values show that an average of over 4,000 hatchlings (larvae) can be produced by a female breeder (over-700g wt) and percentage survival after two months ranges between 70 to 75%. With the proposed modification and expansion project, an estimated production of over 0.5 million fingerlings per breeding season is projected.

INTRODUCTION

Reliable and consistent source of fingerlings (fish seeds) especially for the commercially important species is a pre-requisite for successful fish farming. *Clarias* spp (the mudfishes) are highly esteemed group of fishes in Nigeria and command very high commercial values in our markets but unfortunately, the source of their fingerlings poses a major problem to fish farmers. The mudfishes do not reproduce readily in captivity and when they breed in the wild, the survival of the offsprings (hatchlings) is extremely very low due to climatic and biological hazards associated with the wild. Various management techniques such as environmental and hormone-induced breeding in tanks, cages and ponds, artificial propagation (or stripping technique) have therefore been developed for the mass production of *Clarias* fry and fingerlings under controlled conditions (De Kimpe and Micha, 1974; Huisman *et al*, 1976; Keller and Vincke, 1976; Hogendoorn, 1979; Adigun *et al*, 1983; Hogendoorn, 1983; Madu *et al*, 1984; Viveen *et al*, undated).

In this paper, controlled mass production of *Clarias* fry and fingerlings using indoor and outdoor concrete tanks will be discussed. A proposal for modifying and expanding the existing set-up will also be highlighted as a positive step towards maximising production.

MATERIALS AND METHODS

The Clarias fry and fingerling production exercise takes place in the Kainji Lake Research Institute Fish Hatchery Complex, New Bussa. The complex is made up of an indoor and outdoor hatchery management systems.

(a) The Indoor Hatchery

The indoor hatchery consists of two sets of six concrete tanks (3 x 2 x 1 m) and 2 x 2 x 1 m - length x width x depth) enclosed in a building (Figure 1).

At one end of the building are two rooms, a store and an office/laboratory while the other end is open for indoor experiments with aquaria, fibre glass tanks, wooden and plastic tanks and other movable equipment. The two sets of concrete tanks are centrally located giving enough allowances for the free movement of workers. Each tank has provisions for water inlet and drainage. Proper illumination and ventilation are ensured by a generous supply of fluorescent light and ceiling fans. Also, the long sides of the house are not walled to the roof but to about three quarters, the rest being completed with mosquito wire mesh. Water supply to the indoor hatchery is from a perennial water reservoir, the Kigera III reservoir 50m away. The water is first pumped up into four overhead tanks of about 1,000 gallons (about 4,500 litres) each and located just beside the hatchery. From there, the water is then distributed through a network of pipes into the indoor concrete tanks. The indoor hatchery is used mainly for induced breeding and nursery of hatchlings up to one month old.

(b) The Outdoor Hatchery

As the name suggests, the outdoor hatchery is located outdoors and consists of two sets of concrete tanks/ponds, 6 x 6 x 1.3m and 5 x 4 x 1.3m in size. Only five of the later have been completed and are presently in use. Water is supplied by pumping through pipes connected from Kigera III reservoir. The outdoor tanks are used mainly for livefood culture and rearing of hatchlings/fry after one month old.

(c) Breeding and Fry Rearing Exercises

Induced breeding by hypophysation technique is presently being applied. Mature breeders are usually collected from the Institute's pond reservoir and from broodstock earthen ponds specifically reserved for Clarias spp. The breeders are then transferred to the indoor hatchery where they are classified into species, sexed and tested for ripeness. A female is selected as ripe if it shows a rounded abdomen and the release of eggs when pressed slightly on the abdomen. Ripe males are agile and reddish at the tip of their genital papillae.

(i) Hypophysation: Only breeders of the same species are paired for induced breeding and the three major species of Clarias in Nigeria (i.e. Clarias gariepinus, C. anguillaris and C. submarginatus - White, 1965; Mill, 1966; Reed et al, 1967) can be identified using their vomerine teeth. Ripe males and females are matched closely by weight and the females injected intraperitoneally with dry carp pituitary at a dose of 4mg/kg of body weight or with a mixture of dry carp pituitary and fresh Clarias pituitary. The males receive half the female dose. Gravid females are usually sacrificed for fresh pituitary.

Injected males and females are introduced into prepared spawning tanks (laid with gravels and/or spawning mats made from jute bags) at a male to female sex ratio of either one to one or preferrably 2 : 1, and the water levels in the tanks gradually increased through the night. The tanks are also usually aerated using aerators and diffusers.

Spawning takes place in the night (under 24 hours) and the eggs hatch 2-3 days later depending on the water temperature. At 30 - 32°C hatching takes place within 2 days. The hatchlings are later distributed to various tanks for ease of feeding.

(ii) Fry rearing (nursery operations): Clarias (mudfish) hatchlings feed exclusively on livefood (zooplankton) within the first 12 - 15 days of life. A steady source of zooplankton must therefore, be ensured before any induced spawning exercise could be embarked upon. Zooplankton is cultured in the outdoor concrete tanks. About two weeks before the initiation of induced breeding exercises, the tanks are half filled with water and fertilized with organic (fermented chicken manure) and inorganic (superphosphate + Urea or NPK 15.15.15) fertilizers. When the water is about to turn greenish in colour, zooplankton are trawled for at the reservoirs and inoculated into the fertilized tanks. The zooplankton multiply and bloom within one week and are then collected daily to feed the fry. The tanks are subsequently fertilized weekly to sustain a steady population of zooplankton.

For the first one month of life, the hatchlings are usually fed intensively inside the indoor concrete tanks. Thereafter, the fry are transferred to the outdoor concrete tanks where they grow on the abundant zooplankton, and aquatic insects. Zooplankton feeding is also supplemented with a high protein artificial feed from the third week of life. Growth at the outdoor tanks is fast and at 2 months old, the fingerlings are ready for sale to fish farmers or for transfer to grow-out earthen ponds.

RESULTS AND DISCUSSION

Breeding exercise commences with the onset of rainy from May/June to September/October, but the grow-out fingerlings continue all the year round. Table 1 shows the average production values for a breeding season.

There is a high prospect for Clarias fry and fingerling production in the Kainji Lake Research Institute Fisheries Division Hatchery Complex. The production, survival and growth records are very attractive and compare favourably with Clarias fry production by other workers (Hogendoorn, 1983; Viveen et al, undated). Production could be maximized with additional and improved facilities. The hatchery complex has no filteration system and the few mortalities experienced among the hatchlings are being attributed to poor water quality and insufficient feeding. Percentage spawning and hatching success are also affected by water quality. The use of small aerators and diffusers are inadequate for a large scale production of this type and should be replaced with a central blowing system (blowers). Concrete grow-out and broodstock ponds are also needed since water seepage is a major problem in our earthen ponds. A design for the modification and expansion of the Hatchery Complex to take care of these problems are being proposed for external funding.

CONCLUSION

Production of Clarias fry and fingerlings in indoor and outdoor concrete tanks is a promising source of Clarias fingerlings in Nigeria. Although other advanced methods like the stripping technique can be adopted, induced breeding in concrete tanks does not involve complex technicalities and equipment and can therefore, be easily practised by fish farmers. The male stock are not usually depleted by sacrificing them for milt as in stripping technique. The production values are also very high and compares favourably with other breeding techniques. With the proposed modification and expansion project, production is being projected at over 0.5 million fingerlings per breeding season.

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Table 1 - Present production values for *Clarias* fry and fingerlings

1.	Species of *Clarias* commonly produced	(a) *Clarias anguillaris* (b) *Clarias gariepinus*
2.	Rate of induced breeding exercise:	Forthnightly (twice a month for 3-4 months June/July to September/October
3.	Average No. of breeders per breeding exercise	- 6 males and 3 females
4.	Percentage spawning success	- 66 to 100%
5.	Percentage Hatching success	- 75 to 85%
6.	Average No. of Hatchings per female breeder (above 700 g wt.)	- Over 4,000
7.	Percentage survival after one month	- 70 to 80%
8.	Percentage survival after 2 months	- 70 to 75%
9.	Growth performace:-	

	Less than One day Old	One month Old (4 wks)	Two months Old (8 wks)
Average weight:	1 - 2 mg	0.8g(80mg)	6 - 10 g
Average total length	6 - 7 mm	28 mm	8 - 12 cm

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INVESTMENT PROSPECTS IN THE PRODUCTION OF THE COMMON CARP (*Cyprinus carpio*) FINGERLINGS IN FRESHWATER PONDS

by

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ABSTRACT

Since the introduction of Common carp *Cyprinus carpio* in Oyo State from Israel in 1964, various local breeding methods have been employed in Carp rearing to improve the survival rate at all stages of development during breeding. The physico-chemical parameters of the ponds which were simultaneously investigated for carp rearing in this study includes temperature (t), dissolved oxygen (DO) and hydrogen-ion concentration (pH). However, high rates of water displacement in the breeding ponds were unfavourable to the development of zooplankton which play important role in the food web of *Cyprinus carpio*.

The survival rates of 15.88 - 69.50% and 19.60 - 33.83% obtained for the egg - hatchling and hatchling - fingerling stages respectively were encouraging. A breeding performance of this magnitude was found to be viable, breaking even in the fourth year. However, an increase in size of this trial project would be more profitable and increase fingerling supply as well as provide employment opportunities.

This study thereby provides some baseline information on some local techniques and progress in the propagation of *C. carpio* and scope for further improvement.

INTRODUCTION

The knowledge and techniques of artificial propagation of fish is becoming increasingly important, and is in a state of fast progress. This has resulted from the global expansion of fish farming and production intensity, which has consequently led to a higher demand for fish fry required for stocking purposes (Falaye, 1986). Of all the

fish species utilized by man, the common carp (Cyprinus carpio) has the longest history of culture. In West Africa, the common carp was introduced rather late. For instance, it was not introduced to Nigeria until 1954 when some fingerlings from Austria were stocked in ponds in Panyam Fish Farm, Jos (Olaniyan, 1961). Ten years later (in 1964), 220 fingerlings were imported from Israel for breeding in the former Western Region, part of which is now Oyo State. In spite of the successful performance of C. carpio in ponds in Nigeria, there is little information on the breeding techniques being used to propagate the species since its introduction into Nigeria. Bardach et al (1972) observed that the adaptability of carp is expressed not only in its wide distribution and long history of culture and enormous global production, but also by the wide variety of techniques employed in Carp farming.

This paper therefore, reports the practice and success of Carp breeding in Agodi fish farm, Ibadan.

MATERIALS AND METHODS

Type of Ponds

Three different types of ponds comprising of segregation, spawning and nursery ponds were used for this study. Table 1 shows size anddepth of the ponds. Water was supplied by gravity from a mini reservoir through a continuous flow to maintain adequate water level in the ponds.

Description	Type of Ponds			
	Mini Reservoir	Segregation	Spawning	Nursery
Size (Ha)	0.43	0.047	0.047	0.047
Average Depth (M)	2.4	1.30	1.32	1.30

Table 1 - Characteristics of ponds used for Cyprinus carpio breeding at Agodi, Ibadan breeding centre

Spawning trials were carried out in hapa of 0.7 x 0.35m x 0.45m dimension, between November 1978 and April 1979. Aquatic plants (Ceratophyllum sp.) were placed as breeding substrates in the hapas at about 1 kg of plant per hapa.

Brooders

The brooders were differentiated according to their sexe and stocked at a ratio of 2 males to 1 female per hapa. Each male brooder weighed 0.5 kg while each female bro weighed 1.0 kg. Brooders were introduced into the hap. 18.00 hrs and covered with a sheet of netting material. The hapa was examined for spawning success after twelve hours.

Water Quality

Physico-chemical parameters of the pond water which are critical to carp breeding and survival were monitored during the spawning trials. Daily water temperatures (°C) were measured by means of a measuring thermometer at six hour intervals between 06.00 hr, and 18.00 hrs. Dissolved oxygen (DO_2) levels and the hydrogen-ion concentration (pH) were determined according to Mackereth (1963) at 06.00 hr, 12.00 hr and 18.00 hr daily. Alkalinity was also assessed daily after Mackereth (op. cit).

Phyto plankton population in the rearing ponds were identified and estimated by direct count (No/litre of water samples) with the aid of a microscope.

Fecundity and Fingerlings Survival

Fecundity estimate was conducted by direct egg count; while hatchlings were estimated by number, using the method described by Bardach et. al (1972). The hatchlings were later transferred into nursery ponds where supplementary feeding was done with cooked egg yolk and chicken mash at 250 kg/ha for 15 days. Surviving fry were later transferred into rearing ponds at an average weight of 4 - 6 gm and mean length 3.5 - 5.0 cm. Hatchlings that survived to fingerling stage were estimated to compute the percentage survival at each stage of development.

Financial analysis

A financial analysis of 4 months of fingerling production (breeding cycle) in this study was projected for one year to estimate annual profit.

RESULTS

Water quality factors

The results of the examined physico-chemical parameters of pond water samples are shown in Table 2. The monthly mean water temperatures were generally high in the ponds, ranging between 26.1°C and 28.8°C. Hydrogen-ion concentration (pH) showed little diurnal variation. However, all pH values fell within bromothymol-blue range of 6.0 - 7.6. All the ponds appeared to be well oxygenated throughout the study period, but with a slight decrease of

dissolved oxygen (DO) at the peak of the dry season (Table 2). Dissolved Oxygen values range between 5.1 to 6.9 mg/l..

The phyto-plankton abundance was generally high, while the zooplankton population were found to be poor.

Fecundity and Fingerlings Survival

The egg production of Cyprinus carpio during this breeding trial is presented in Table 3. Female carp of 0.5 kg produced between 30,000 - 35,000 eggs while female of 1.0kg produced between 130,000 - 135,000 eggs during the spawning trial. The observed fecundity followed the general egg production pattern in fishing with the largest females producing the greatest number of eggs (Bardach et al, 1972).

The survival rate from egg to hatchling stage ranged between 15.88 to 69.50 per cent. Remarkably, higher survival of hatchlings were obtained in November and December than in the subsequent months of January and April, even though the fecundities recorded for the former months were much lower than the later (Table 3).

Mortality during fry rearing was slightly higher than in the egg - hatchling stage. The mean percentage survival of hatchlings to fingerlings stage was 27 per cent.

Financial analysis

Financial analysis of projected annual fingerling production is presented in Table 4. The major expenditure will be incurred in the first year during the development of the hatchery facilities. This was estimated at ₦63,445.00. Thereafter, annual cost of production ranges between ₦11,000.00 and ₦14,000.00. From an estimated 60,336 annual fingerling production, a revenue of more than ₦20,000.00 is expected over the years, assuming the present high demand for carp fingerlings in the country.

DISCUSSION

Bardach et al (1972) have described in detail the various specialised fish breeding techniques in aquaculture. In this exercise however, only Ceratophyllum sp. was used for attachment of eggs. The could have contributed to the improved survival rate of the fertilized eggs. Hora and Pillay (1962) reported the use of submerged aquatic weeds such as Ceratophyllum sp, Myriophyllum sp. and Eichohornia crassipes (water hyacinth) for attachment of carp eggs as an improvement on breeding technique in China.

Out of all environmental factors; Chaudhuri (1966) observed that light and temperature have the most pronounced influence on maturity and spawning of fish. Although light

intensity was not measured during this investigation, however, the period of study falls within the dry season (November - April) when sunshine was abundant. Therefore, it is unlikely that light was limiting to fish spawning at this time. The temperature regime of the ponds remained fairly constant (Table 2); and also unlikely to be limiting to the spawning and breeding processes.

The pond water was not only high in concentration of Dissolved Oxygen (DO_2) but of high percentage saturation values which are favourable for breeding of fish. Influx of water from rainfall and flood with increased levels of Dissolved Oxygen and pH have been shown to be important external factors responsible for stimulating spawning in fish (Khan, 1945). Prufinin (1966) reported that pH may not affect thegrowth of carp directly, but it influences the growth of food organisms in the water.

Also, the fry have to be fed before complete resorption of the yolk sac to provide energy sources while extreme temperature fluctuations should be eliminated during this critical stages (Tamas and Horvath, 1979).

The observed percentage survival rate of between 15.88 - 69.50 (egg - hatchling) and 19.60 - 33.83 (hatchling - fingerling) conforms with the findings of Le Cren (1962). Le Cren (op. cit) showed that mortality was highest during the first year of fish development. In addition, Runa (1986) observed that physical characteristics and bio-chemical composition of egg are other factors affecting the success of fish breeding. Although Ricker and Foerster (1948) found the survival rate of hatchery-reared Sockeye (salmon) fry to range between 3.87 and 13.13 per cent in different years; and with varying degrees of predation; modern hatchery methods tend to reduce the environmental hazards thereby increasing fish survival.

Bardach et al (1972) identified four major causes of poor survival of carp eggs. These causes are predation by parents, low fertilization rates, low temperature and fungal infection. Apart from fungal attack, none of these causes were noticed to have affected survival of carp fingerling during this study.

Financial considerations for this fingerling production trials show high profit relative to cost of production. With the high scale of capital investment in the first year of production, the venture should break-even by the 4th year (Table 4).

High profit in fingerling production is expected due to low cost of input and short production cycle of fingerlings under effective management; thus allowing about three production cycles in one year. Whereas, production of table fish requires annual high cost of input and longer production cycle (ranging between 6 - 12 months depending on fish species).

In this breeding trial , the rates of hatching, spawning and breeding success compare favourably with other breeding trials in the developing countries where little habitat manipulation have been practised. With further environmental manipulation, availability of improved fish seed, feed and effective pond management, increase in survival rate and profit can be attained by using this breeding technique.

ACKNOWLEDGEMENTS

The authors would like to express their gratitude to the staff of the Ministry of Agriculture and Natural Resources, Fisheries Division at Agodi Fish Farm and most especially to Mr. J.O. Olaniyan, the Principal Fish Farmer who assisted in the field work and data collection and also to Mrs. A.E. Arowolo for typing the manuscripts. Our thanks also go to a colleague and friend, Mr. H.A. Ayodele of the Department of Biology, The Polytechnic, Ibadan for the classification of the zooplankton .

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Table 2 - Physico-chemical characteristics of the Carp breeding ponds

Characteristics	Ponds			
	Mini Reservoir	Segregation	Spawning	Nursery
Temperature (°C)	26.1	27.0	25.2	28.8
pH	7.4	7.4	7.2	7.4
Dissolved Oxygen (mg /1)	6.4	6.6	5.6	6.4
Zooplankton (No/litre)				
Polyarthra spp.	8	-	-	NA
Cyclopoid copepod	8	-	-	NA
Brachionus angularis	-	64	8	NA
Trichocerca sp	-	48	-	NA
Keratella tropica	-	128	24	NA

Table 3 - Production data of Cyprinus carpio during the breeding trial

Month	Weight of Male	Weight of Female	Fecundity (No. of Eggs)	Hatchlings (No)	Egg-hatch ling survival(%)	Finger-ling (No)	Hatchling Fingerling survival (%)
November 1978	300 200	500 -	54,180	37,648	69.50	10,444	27.74
December 1978	200 300	500	29,923	10,344	34.50	3,500	33.83
January 1979	500 500	1,000	128,435	28,440	22.10	5,500	19.60
April 1979	500 500	1,000	135,000	20,652	15.88	5,696	27.58

Table 4 - Financial analysis of fingerling production based on the Carp breeding trials at the Agodi Fish Farm, Ibadan

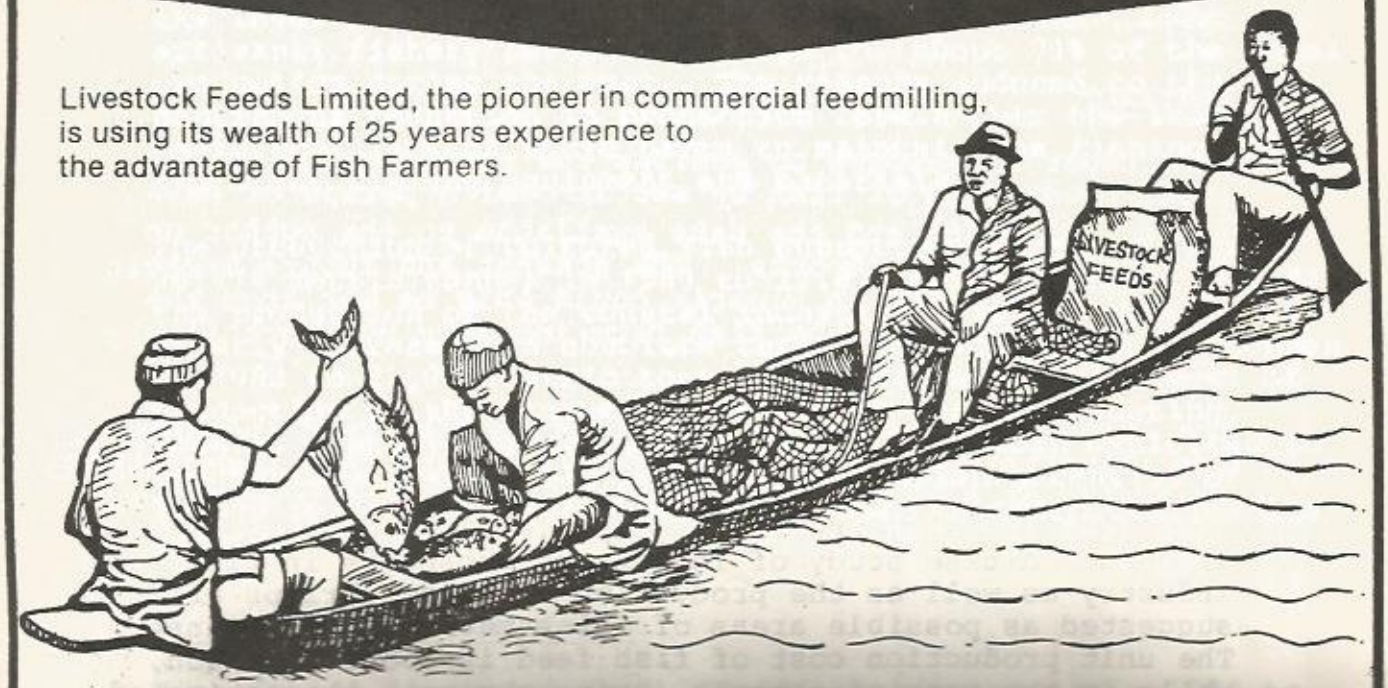
Year	1 ₦:K	2 ₦:K	3 ₦:K	4 ₦:K	5 ₦:K
A. CAPITAL EXPENDITURE					
i) Land Development					
(a) 0.5 Ha reservoir	20,000.00	-	-	-	-
(b) 3-0.047 Nursery/ breeding pond	15,000.00	-	-	-	-
ii) Farm buildings					
(a) One farm house (Store and Office)	12,000.00	-	-	-	-
iii) Hatchery facilities	2,000.00	-	-	-	-
iv) Water Pump	1,000.00	-	-	-	-
v) Miscellaneous farm equipment	2,000.00	-	-	-	-
Total (A)	52,000.00	-	-	-	-

B. OPERATING EXPENDITURE					
i) Brood stock. 36 breeders of Carp (C. carpio)@ ₦20 each	720.00	-	-	-	-
ii) Supplementary Feed: 1 tonne @ ₦1000/ton	1,000.00	1,200.00	1,400.00	1,600.00	1,800.00
iii) Fertilizers:					
(a) Organic: 1 t (cow/chicken droppings)	100.00	100.00	100.00	100.00	100.00
(b) Inorganic: 5 bags @ ₦5 each	25.00	25.00	25.00	25.00	25.00
iv) Pesticides	100.00	100.00	100.00	100.00	100.00
Total (B)	1,945.00	1,425.00	1,625.00	1,825.00	2,025.00
C. FIXED EXPENSES					
i) Labour: Salaries -					
1 Superintendent (GL.07)	3,600.00	3,800.00	4,000.00	4,200.00	4,400.00
2 Labourers (GL.01)	3,600.00	3,800.00	4,000.00	4,200.00	4,400.00
1 Night guard (GL.01)	1,800.00	1,900.00	2,000.00	2,100.00	2,200.00
ii) Repair and Maintenance	500.00	600.00	800.00	1,000.00	1,200.00
Total (C)	9,500.00	10,100.00	10,800.00	11,500.00	12,200.00
Grand Total (A+B+C) =	63,445.00	11,525.00	12,425.00	13,325.00	14,225.00
Gross Benefit: Yield fingerlings, 75420 less 20% mortality = 60,336 @ ₦0.35*	21,118.00	24,738.00	28,961.00	33,788.00	39,218.00
Net Benefit before Tax	43,327.00	13,213.00	16,536.00	20,463.00	24,993.00

* With an annual increase at 16.7% in price of fingerlings.

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INVESTMENT PROSPECTS IN FISH FEED TECHNOLOGY

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ABSTRACT

This paper endeavours to analyse the recent trend in the local production of fish by sector over a period of five years, 1980-1985 and the data available to the author on the Nigerian fish imports. The present and future deficit in fish production in Nigeria could only be met from the capture fishery and the fish farm industry but more likely from the latter.

The production techniques involved in fish feed industry are illustrated in this paper with standard feed formulations to arrive at a suitable fish diet. Associated problems of fish feed industry and their possible solutions are highlighted. A case study of investment prospects in fish feed industry as well as the production of brine shrimps are suggested as possible areas of investmetns in the industry. The unit production cost of fish feed is about ₦700/ton, while in the case of artemia (brine shrimp), the estimated unit cost if about ₦400/ton.

INTRODUCTION

It has been confirmed that the national development plans for raising the standard of living of the population have not been met partly because of low levels of food consumption and poor nutritional standards. In spite of the vast potential of the agricultural sector for food production, there still remains an acute shortage of food supply, inadequate quality and quantity. One area of this shortage which is of great importance is the inadequacy in supply of animal protein. In a bid to bridge the gap between demand and supply of animal protein to the people, the drive has been towards an increase in production of livestock and fisheries. However, the livestock and fishery sectors have failed to keep supply sufficiently growing to adequately meet demand and/or national requirements for all classes of livestock and fishery products. The failure to meet the demand has accounted for the rising importation of such products. Due to the relatively cheaper cost and general acceptability of fish, emphasis on methods of increased production in the fishery sector would be a move in the right direction.

RECENT TREND IN LOCAL FISH PRODUCTION

An examination of the fish production trend by sectors from 1980 to 1983 shows an increase in production of 64,000 metric tonnes, or a 9% growth over the period (Table 1).

The artisanal fishery sector still accounts for 97.7% of local production, while the proportionate share of the coastal and brackishwater canoe fishing in the artisanal fishery sector is placed at an average of 56%. In 1984, there was a drop in production from 777,204 metric tonnes in the preceeding year to 511,472 metric tonnes and in 1985, the level of production was 303,348 metric tonnes. The artisanal fishery sector accounted for about 71% of the total production during the year. The reasons adduced to the continuous reduction in production levels over the last two years are: lack of spare parts to maintain the fishing crafts and other fishing equipment and materials.

The production of cultured fish subsector increased from 20,476 metric tonnes in 1983 to 22,012 metric tonnes in 1984. The production of the coastal industrial fishery sub-sector greatly increased in absolute terms from 13,572 metric tonnes in 1983 to 22,255 metric tonnes in 1984, while the level of production in the preceeding years has been fluctuating. Coastal fishery resources seem not to have been exploited to the optimum sustainable level as production potential of 20,000 to 30,000 metric tonnes per year is indicated for the coastal industrial fishing areas.

RECENT FISH IMPORT TRENDS

Fish import increased from 234,000 metric tonnes in 1980 to 244,408 metric tonnes in 1982, a difference of 10,408 metric tonnes over two years. Total imports rose from 349,183 metric tonnes in 1979 to 824,274 metric tonnes in 1982 with a marked increase of approximately 240% from 1979 to 1982 (Table 2). The distant water vessel landings accounted for 64% of total imports in 1979 and remained at an increasing rate up to 1981 when it was about 45% of the total imports. Conversely, the stockfish imports comprised only 4.9% of total imports in 1979 and yet increased to more than 11 % in 1982. The other forms of fish imports including fresh, chilled or frozen fish, salted, dried or smoked and canned fish, showed an upward trend. This clearly indicates the growing heavy dependence on fish imports to satisfy the national demand for fish.

The economic stabilization policy of Governments between 1982 and 1984 has caused substantial reduction in fish imports.

THE POTENTIAL ROLE OF FISH FARMING IN BRIDGING THE SUPPLY GAP

Various estimates of the fishery resources situation have been provided by experts from their studies, in which empirical considerations were applied to data from surveys; and while it may look relevant to examine the different

views in the paper, it is felt that the general trend in the conclusion will suffice in order that we may not loose the subject of this paper in the ensuing controversies over the micro details of the estimates.

It is clear from all the estimates and pronouncements that the fish supply deficit in Nigeria is related to the level of fish importation which obtained when we had access to considerable foreign exchange. This statement is made with due consideration for the smuggling out of imported fish taking place during the hay days of our massive food importation. Our intrinsic population growth rate is a big factor which is still allowing the supply gap to be very much with us. If we assume a supply gap of 450,000 tonnes for the purpose of planning and expect a growth rate of 3% in local capture fish production and a population growth rate of 3%, it implies that we will be faced with a 450,000 tonnes supply gap until the fishery resources, (to which the capture fishery has access), reaches the ESY, and due to possible over exploitation, starts to dwindle. Beyond this point, our supply gap would then start to increase.

Clearly, from my simple analysis, it is obvious that we must embark on a number of management strategies to enable us first and foremost, resolve our deficit situation. The most obvious and practicable approach is for us to harness our several million hectares of water masses for the cultivation of fish and shell fishes as a means of bridging our supply gap. Fish farming and fishing must consequently be seen as a complementary effort at supplying fish to Nigerians now and indeed forever.

Increase in efforts in fish farming development would definitely lead to substantial demand for fish feed since most of the cultured fish are to be fed intensively. To maximize weight gain, reduce disease syndrome and wastage; efforts should be geared towards the expansion of fish feed industry in the country.

FISH FEED MATERIALS AND REQUIREMENTS

Nutrient Requirements of Fish

Fish are living animal organisms and therefore, require nutrients as other animals. The primary objective of fish farming is to produce fish flesh which is proteinaceous; therefore proteins and amino acids would obviously be the determinant for growth and survival, success or failure. Unfortunately, there is very little fundamental work on qualitative amino acid and protein requirements of fish in general and of tropical fish in Nigeria. This is due to the extremely difficult problem of obtaining and employing purified amino-acids for these studies. Even in the U.S.A, it was only in the last 32 years that successful experiments in this direction had been carried out. Based on these results, we now have a general idea of which of the amino-acids must be present in fish diet. These are argine,

histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. These indispensable amino acids must therefore, be in proper proportion for successful rearing of fish under intensive management. Variations based on the feeding class would of course be a significant factor for consideration. Thus, herbivores may require less lysine, methionine and histidine than carnivores. With omnivores, they tend to respond best to generalized amino-acid supply.

Data on protein requirements reflected by the indispensable amino-acid pattern is also dependent on the energy requirements of the fish. Consequently, the concept of protein requirements of the fish is incorrect and should strictly be the calorie/protein requirements of fish.

Two major sources of energy are available to fish and these are: fats and carbohydrates. With carbohydrates like corn and wheat, high energy intake levels are attained when they are fed to fish. Some minerals and proteins are also available. With fats, very high energy levels are available and in addition, growth factors including vitamins are available. Indeed, it is imperative that practical diets should contain some fat especially fish oil or semi-drying vegetable oils with high levels of unsaturation.

In addition to energy and protein, vitamins and minerals are also very important in fish nutrition. A comprehensive list of the typical vitamin deficiency syndromes was presented in the Table 2.6 of the paper presented last year by the author. Since vitamins are delicate compounds and occur in nature in small concentration, they tend to be destroyed easily and could be lacking in many biomaterials. Sometimes, therefore, fish feeds may require vitamin supplementation. The functions of proteins, fats and vitamins are interrelated in fish. From the point of view of the fish farmer, they are all directed at producing growth and ultimately fish flesh. However, it is worthwhile to note that fats occupy a peculiarly unique position in the nutrient requirement of fish. This is essentially because of the greater complexity of the body fats as compared to other animals.

Fats have at least three different functions in the organisms:

- They are high energy carriers
- They are serve as metabolic regulators
- Some of them are structural elements in the cells and indeed, their presence is absolutely required for normal functioning of structures, for example, mitochondria, endoplasmic reticulum and the plasma membranes.

For instance, increasing the fat content of the diet of Chrysichthys nigrodigitatus from 5-10% resulted in substantial improvement of growth, food conversion and protein utilization.

Sources of Feed Materials Available in Nigeria

Tropical countries are blessed with a very wide variety of feed materials which like other resources are yet to be tapped. Tables 3 to 6 present the tremendous array of nutrients which are available on land for the feeding of fish and for conversion to fish flesh. Faced with this, the feed producer and fish farmer should not have much problem in feeding fish in fish farms. The decision as to which feed materials to combine to arrive at a compounded feed is that of the feed producer.

This will of necessity depend on the nutrient requirements of the fish to be cultured. The feed producer obviously wants to produce the compound at the least possible cost; the author, therefore, looks at the chemical composition of the materials and their going market prices at the same time. These two important factors continuously interplay to determine the choice of any feed material and the formulation.

Fish Feed Formulation and Linear Programming for Formulation

With the wide range of feed materials available in the country, the problem envisaged is one of obtaining a minimum proportion that would satisfy all the nutrient requirements of the fish and be of least cost. An essential prerequisite to formulating least cost fish feed is the knowledge of the nutritional value and technological properties of each feed ingredient. For some processed feedstuffs, individual samples can differ widely in their nutritive value. Such differences may be attributed in part to the quality of the raw materials and in part to the damaging effects of the processing methods employed. Unless the amount and availability of nutrients supplied by the ingredients are known with a reasonable degree of accuracy, formulation of efficient diet becomes very difficult. A knowledge of the technological properties of feed ingredients is required if the produced feed is to remain stable in water and float or sink as desired thus reducing feed wastage.

In the feed production industry, the producer is given a number of parameters which guide his formulation. Lower and higher limits are set for some of the ingredients and the relevant important nutrients. With these limits, an empirical solution to the optimization problem accompanying their objective becomes positive. Take for example, a feed producer requested to produce a feed with the following specifications:-

Crude protein content	22% min
Crude fat content	10% min
Ash content	10% max
Crude fibre	8% max
Digestible energy	2800 Kcal/kg min.

Materials available are Soyabean, Maize, Brewers grain, Rice bran and fish meal. Fish meal content of the feed should not be less than 8%.

INGREDIENTS

	(S) Soyabean	(M) Maize	(B) Brewers grain	(F) Fishmeal	(R) Rice bran
Crude protein	44	7.5	25	60	12.5
Crude fat	19	3	6	17	13
Ash	5.1	15	4	19	12.5
Crude fibre	5.7	8.2	14	2.5	13
Digestible energy	3425	2850.9	2112	3016	1892
Price	650	520	450	1250	400

For the production of 1 kg of this feed, the standard prodedure is as follows:

Assuming X_S, X_M, X_B, X_F, X_R, to be the amount of ingredients necessary for the production of the feed, the aim of the feed producer is to minize cost i.e. Minise

$$.65X_S + .52X_M + .45X_B + 1.25X_F + .40X_R = \text{Total cost} \quad (1)$$

Subject to the following constraints:

$$X_S + X_M + X_B + X_F + X_R = 1 \quad (2)$$

$$44X_S + 7.5X_M + 25X_B + 60X_F + 12.5X_R \geq 22 \quad (3)$$

$$19X_S + 3X_M + 6X_B + 17X_F + 13X_R \geq 10 \quad (4)$$

$$5.1X_S + 15X_M + 4X_B + 19X_F + 12.5X_R \leq 10 \quad (5)$$

$$5.7X_S + 8.2X_M + 14X_B + 2.5X_F + 13X_R \leq 8 \quad (6)$$

$$3425X_S + 2850X_M + 2112X_B + 3016X_F + 1892X_R \geq 2800 \quad (7)$$

$$X_S, X_M, X_B, X_F, X_R \geq 0 \quad (8)$$

$$X_F \geq 0.08 \quad (9)$$

Equation 1: Says that the objective is to minimise cost.

Equation 2: States the amount to be produced.

Equations 3-7: States the particular nutrient requirement to be met.

Equation 8: States that the amount of the various ingredients should be non negative

Equation 9: gives minimum limit of fish meal in feed.

Solution of equations 2 - 7 gives possible combinations and cost comparison of these options, thus produces the ultimate choice.

The solutions of the above equations are tabulated in Table 7.

From the three options available, the least cost option is chosen. It must however, be stressed at this point that the energy levels of the diets play an important role in the selection of which feed should be produced. It has been shown in numerous experiments that fish eat to a set energy level. If a feed is diluted by raw materials which provides no energy, the fish will simply eat more to compensate for the fact that each unit weight of feed contains less energy. Thus, considering the three options obtained and comparing the energy cost efficiency for each, the results in Table 8 are obtained.

From this table, it seems that though diet C cost less in Naira, it has higher energy cost than diet B which is therefore, a better feed and can be sold at a higher price.

FISH FEED PRODUCTION TECHNOLOGY

Animal feeds which are manufactured in Nigeria include those for poultry, pigs, cattle and pelleted feeds which are suitable for rabbits, mice, horses and fish, but the author's major concern in this chapter is the presentation of production techniques of fish feed.

Fish feeds generally, can be presented to fish, pelleted or unpelleted either in the dry, semi-dry or moist form; whichever form, it must be stable in water and must ensure that the feed ingredients are well mixed and are presented to the fish in the same proportion as has been calculated out for the fish. The choice of dry or moist feed depends on the mechanism of feeding in the farm. For the tropics, unless low temperature facilities or fresh feeds are available, wet feeds should be discouraged. Dry pelleted feeds are better than unpelleted feed since pelleting ensures that feed components reach the fish in the calculated proportion. It also reduces feed loss through dustiness and economises available space for storage.

In broad sense, five ways of producing dry particles formulated mainly from organic raw materials are discussed below. It should be noted also that if a wet or moist production phase is included, drying afterwards is inevitable.

(a) Pelleting and Crumbling

This method is ideal for the formulations of fish feeds for fry from 100mg to reproduction sizes of many kilograms. The feed particles are simply compressed units from blends of finely ground raw materials balanced up to all nutritional standards known. Fractionalization of crumbs from pellets provides necessary sizes for different classes of fish. Composition of these feeds is adapted to the requirements of species and life cycles.

(b) Meals to Produce Dough

This could be used both for wet and semi-moist feeds, it is possible to start with blends of dry ingredients specially prepared and formulated to enable dough feeding. Kneading meal and water will produce water repellent smaller or larger masses of a certain consistency that are used to feed eels and also other types of bottom feeders. Extrusion through plates with holes will produce vermicelli that can be chopped into moist pellets. Blending together with wet ingredients like homogenised fish, meat, molluscs or other fresh products will enhance acceptability during adaptation.

(c) Extruder Process

In addition to its use in fish feed manufacture, it is a well known procedure in the production of human snacks and pet foods. Principally, this method is pressure-cooking of semi-moist dough mixed from dry or wet-ground ingredients. During extrusion, hot spaghetti of foamy structure leaves the machine. Chopping, drying, crumbling and fractionalization will deliver the sizes we prefer. The advantage lies in particles that are water resistant for a longer period, while the disadvantages are the higher production costs and less freedom in feed formulation.

(d) Roller Production

This method is already known as the roller process in drying blood, skimmed milk, etc and is rather expensive per unit weight of product and should be regulated fairly skillfully to avoid overheating of the end product and therefore loss of nutritive value. As indicated for other methods, homogenous water-resistant particles are produced.

(e) Baking or Oven-drying

Baking or oven-drying method preserves quality by lowering the moisture content down to 12% or less. A dough-like mix of ingredients is always started with and during heating of thin layers of the dough on belts of plates, cohesion is increased. The dry layer can be crumbled and fractionated.

PROBLEMS ASSOCIATED WITH FISH FEED INDUSTRY

Presently, there seems to be an unresolved controversy over the capability of Nigeria to meet its animal feed raw materials. This is partly borne out of the long standing tradition of importation of most of the raw materials by the existing feed producers. A rapid expansion of our fish farms in a bid to bridge the demand and supply gap of fish should not be allowed to face the feed raw material problem which almost crippled the poultry industry. Notable amongst the major constraints impeding the fish feed industry in Nigeria are highlighted briefly under the following headings:

Availability of raw materials

The seasonal variation in production of grains and grain legumes and other raw materials for the fish feed industry coupled with acute storage problems during bumper harvest creates a fluctuation in the availability of raw materials for the industry. This results in plant operating at low level of capacity utilization.

Availability of machinery and Spare parts for the fish feed industry

Difficulty in obtaining import licence for the importation of feed mill equipment like extruders and pelleting machines discourages potential investors. The cost of fabricating such equipments here in Nigeria is prohibitive. It is however, hoped that with the commencement of the Second-Tier Foreigh Exchange Market (SFEM), availability of foreign funds would encourage the importation of machinery and spare parts for the feed mill industry.

Availability of Capital

This is a general problem in setting up any manufacturing industry. The huge initial capital layout is always difficult to come by and the financial institutions and other lending agents are refusing many people loan facilities. This is due to lack of confidence and adequate information on the profitability potential of such ventures by the financial houses.

Availability of skilled manpower

Even with some plants and machinery being used, the technical know-how of experts is still needed. This is lacking in the area of maintenance. Once a small portion of a plant breaks down, it becomes difficult for production to continue as scheduled. Lack of skilled manpower to monitor and ensure proper running and maintenance of installed plants and equipment has therefore, constituted a major set back in the industry.

POSSIBLE SOLUTIONS TO THE ASSOCIATED PROBLEMS

In the consideration of the author's strategies for solving the major problems of fish feed industry to meet the future requirements of fish feeds in Nigeria, the following solutions are preferred and outlined briefly below:

- Stimulate the awareness of the feed producers towards large scale production of oil seeds. This could be achieved through establishment of own farms and/or making contract with outgrowers for the production of basic raw materials.

- Recognition by government of the close similarity between the requirements of fish feed industry and poultry feed industry such that adequately high loan facilities can be extended to the industry as to poultry.

- Promotion of fish feed industry by government through mass media to create public awareness and deliberate programme of education to include finance houses on the profitability of the venture, hence instilling confidence for loan advancement.

- Training of skilled manpower for proper maintenance to handling of the essential plants and equipment. There is also need for locally developed technologies and know-how. This is, however, dependent on the availability of flat sheets for the fabrication of equipment.

- Restructuring Research Institutes: Information emanating from our research institutes that would engender to the rapid development of fish feed industry in Nigeria must be disseminated without delay by means of well coordinated extension research liason services.

- Cost reducing measures:-

(i) The potential investors can either buy up or team up with the existing feed millers and purchase extruders and pelleting units to augment the existing machines so as to produce pelleted fish feed.

(ii) Small medium size fish farms should have feed processing units of a capacity of about 1 - 2 tonnes capacity/hour capable of satisfying their fish feed needs. Units of this sort can be procured and installed through some consultancy firms; one of which is the author's company - TALON Nigeria Limited.

(iii) Through the inclusion of low cost, high quality plant protein like Soybean to replace the very expensive animal protein sources like blood meal, fish meal etc.

Diets where fish meal has been substituted by soybean had been tried by Research Scientists in NIOMR and found to be adequate for C. nigrodigitatus (Catfish), if the soybean has been roasted prior to milling.

CASE STUDY OF INVESTMENT PROSPECTS IN FISH FEED INDUSTRY

In this chapter, the author presents a breakdown of the cost analysis and the level of profitability of investment prospects in fish feed industry taking into consideration raw materials used in diet B of chapter 3 and an extruder plant capable of producing 1 tonne of feed per hour running for 16 hours/day and a total staff strength of 8 men.

	₦
(A) Capital items and Costs	
Extruder (1 ton/hour) Volumetric feeder/blender Syntron hopper Electric motor Particlizer cutter Cooler with fan and Cyclone	₦150,000
Storage facilities	50,000
Building and other construction	130,000
Vehicles	20,000
Total Capital Cost	350,000

(b) Recurrent Items and Cost

	Unit Cost ₦/t	Quantity	Cost (₦)
1) Raw materials:-			
. Soyabeans (cake)	650	1,600	104,000
. Maize	520	1,680	873,600
. Brewer's grains	450	200	95,000
. Fish meal	1,250	340	425,000
. Rice bran	400	120	48,000
. Intensive concentrate	2,600	6	150,000

Items	Unit Cost ₦/t	Quantity	Cost (₦)
(B) Contd.			
2) Labour/Salaries	-	-	₦30,000
3) Packaging	-	-	10,000
4) Sales and Distribution	-	-	10,000
5) Factory running cost	-	-	40,000
Total Recurrent cost	=		₦2,722,000

(C) Revenue

Items	Unit Cost (₦/t)	Quantity (t)	Cost (₦)
Fish Feed	860	3964	3,409,040
Total Revenue	-		3,409,040

(D) Profit

Total Cost	=	₦3,072,600
Revenue	=	₦3,409,040
Profit	=	336,440

CASE STUDY (B): LIVE FISH FEED (BRINE SHRIMPS)

The production of live feed for fish is a practice which has been around from the start of fish farming. Live fish feeds range from worms, e.g. Ragworms, earthworms etc. to maggot. Also, in maritime areas, krills, brine shrimps and ocean plankton have been harvested or cultivated for fish feed.

The brine shrimp has been found to be excellent fodder for both fish and other livestock. With a protein content of 60% dry weight and significant concentration of vitamins hormones and carotenoids, it is an important raw material for the feed industry as well as a feed on its own. The production of brine shrimps in Maritime states with plenty of salt water is recommended.

Potential of the Mass Production of Brine Shrimps

The findings in the 1930's that the 0:4mm nauplius larva of the brine shrimp constitutes an excellent fodder for new born fish larvae, resulted in a significant breakthrough in hatchery aquaculture.

The reproduction i s prolific from experiments in other countries, 5 grams of brine shrimps in $1m^3$ warm salt water increase to 15kg in 15 days. In a friendly environment, the brine shrimp is viviparous and gives birth to larva capable of reproducing after 15 days. In hostile environment, it becomes oviparous, the offspring being cysts. The well dried cysts can be kept for years and hatched by soaking in water for a short period of time.

As a result of its very unique characteristics, the brine shrimp offers great potential for mass production, i.e.

- the brine shrimp grows from larva to adult in about 2 weeks
- its requirements do not change throughout its development
- brine shrimps have a high fecundity rate (more than 100 offsprings every 4 days) and a lifespan of about 6 or more months
- brine shrimps can be cultured with a wide range of cheap food stuffs e.g. organic manure, agricultural by-products etc.
- they can be grown in very high densities (more than 10,000 per litre)
- the adult artemia has a high nutritional value as earlier stated
- in fish and crustacean farming, the adult brine shrimp is considered to be the best diet for the post larval stages
- sun dried brine shrimp can be fed to fish or used in the livestock feed industry. It can even be consumed by man.

With present culture techniques in the U.S, it has been estimated that for a production unit of 10,000 tonnes per year, the cost of 1 tonne live weight brine shrimp will be about $400.

With these figures, our research institutes should explore the possibility of producing the brine shrimp in Nigeria and probably using it to replace fish meal and other high cost animal protein in the livestock feed industry.

TABLE - 1

NIGERIAN FISH PRODUCTION BY SECTORS IN TONNES 1980 - 1985

ITEMS	1980	1981	1982	1983	1984	1985
1. ARTISANAL:						
i. Coastal & Brackish-water	266m935	317,779	369,750	370,040	227,659	140,873
ii Inland River & Lakes	194,429	164,004	127,460	131,887	99,552	60,510
iii. Fish Farm	-	-	-	20,476	22,012	15,000
2. INSHORE:						
i. Fish	16,342	12,435	15,052	13,572	22,255	23,766
ii. Shrimp	1,890	2,003	3,525	2,375	2,277	1,485
3. DISTANT: (Import)	234,000	245,000	244,403	238,854	137,717	61,714
TOTAL	713,596	741,221	760,195	777,204	511,472	303,348

SOURCE: Federal Department of Fisheries, Lagos.

TABLE - 2 ESTIMATED NIGERIAN FISH IMPORTS 1979-1982 (METRIC TONNES)

COMMODITY	1979	1980	1981	1982	1983	1984	1985
Fish, (fresh, chilled or frozen)	54,621.41	117,091.78	189,221.10	443,101.27	n.a	n.a	n.a
Salted fish, dried or smoked	1,241.35	1,295.51	1,444.49	768.31	n.a	n.a	n.a
Canned fish (Sardine & others)	49,498.22	29,652.46	41,163.40	39,099.35	n.a	n.a	n.a
Stock fish (dried)	17,822.16	6,068.91	65,759.18	96,897	n.a	n.a	n.a
Distant water vessel landings	218,000	234,000	245,000	244,408	n.a	n.a	n.a
Grand Total	341,183.14	388,108.66	542,588.24	824,274.16	238,854	137,717	61,714

n.a = not available

A

Average Chemical Composition as Determined (Per cent of Dry Matter)

No.	Common Name	Scientific Name	Dry Matter	Crude Protein	True Protein	Ether Extract	Crude Fibre	Nitrogen Extratives	Total Ash	Silica Free Ash
	ROOTS, TUBERS AND GREE LEAVES									
1.	Cassava (Manioc) Roots (Bitter Var.)	Manihot utillissina Pohl.	31.94	2.71	1.68	0.53	3.09	91.01	2.66	2.41
2.	Cassava Root (Peeled)	-do-	28.50	2.58	2.58	0.46	0.43	94.12	2.41	2.29
3.	Cassava Root (Peels only)	-do-	27.94	5.29	4.57	1.18	20.97	66.63	5.93	4.60
4.	Cassava (Manioc) Roots unpeeled (Sweet Var.)	-do-	31.94	2.38	1.30	0.65	1.95	92.13	2.89	2.73
5.	Sweet Cassava Root (peeled)	-do-	28.50	1.66	1.66	0.65	1.80	90.86	5.23	4.96
6.	Sweet Cassava Roots (peels only)	-do-	27.94	5.61	2.37	1.39	10.31	78.25	4.44	3.83
7.	Sweet Potato Tuber (Unpeeled)	-do-	28.72	5.24	3.81	0.46	0.14	91.43	2.67	2.60
8.	Sweet Potato Tuber (Peels)	-do-	11.73	6.33	5.73	1.34	0.34	87.44	4.55	4.18
9.	Talinum Leaves (Green)	Talinim triangulare Wild.	9.68	21.09	14.99	1.47	10.34	32.54	34.56	33.49
10.	Sweet Potato Young Leaves	-do-	12.45	24.65	22.58	3.58	9.10	51.20	11.47	9.48
11.	Telfairia Leaves (Green)	Telfairia occidentalis Hook.	13.63	21.17	18.58	12.94	12.79	39.24	13.86	12.78
12.	Rice Bran with Little Husk	-do-	89.00	7.62	-	7.59	36.62	36.87	11.30	4.32
13.	Soya Bean	Glycine max Merr	93.23	44.08	40.81	19.10	5.71	26.05	5.06	4.40
14.	Sunflower seed	Helianthusannuns Linn.	94.23	16.01	14.15	33.39	28.09	19.65	2.86	1.66
15.	Sunn Hemp Seed	Crotalaria juncea Linn.	95.99	40.27	31.69	1.41	9.99	42.72	5.61	4.56
16.	African Locust Bean (Pod only)	Parkia filicoidea Welw	93.60	4.68	3.98	1.17	24.03	61.25	8.87	5.70
17.	Cocoa Bean (Husk)	Theobroma cacao Linn.	11.41	6.51	5.00	1.10	30.25	48.71	13.43	13.17
18.	Cowpea Husk	Vigna unguiculata Walp	92.55	12.97	8.89	0.65	33.40	45.74	7.24	7.14
19.	Green Gram Husk	Phaseolus aureus Linn.	90.33	8.24	7.26	0.55	35.84	47.67	7.70	6.59
20.	Groundnut Husk	Arachis hypogaea Linn.	82.31	4.88	4.66	0.62	68.36	18.75	7.39	3.68
21.	Maize, Yellow Husk	Zea mays Linn.	92.63	2.60	2.37	0.97	31.59	60.92	3.92	2.26
22.	Rice Husk	Oryza sativa Linn.	92.83	4.85	4.45	1.68	42.28	38.92	13.27	1.30
23.	Oyster Shells	-	99.60	1.43	1.32	0.83	0.30	89.19	8.25	5.78
24.	Amaranthus (tete) spp.	Amaranthus spp.	11.4	26.3	-	5.3	8.8	40.3	19.3	-
25.	Prickly Amaranthus (tete elegun)	Amaranthus spinosus	19.4	31.9	-	3.7	9.8	39.5	15.1	-

Calculated Digestible ...
(Per cent of Dry Matter)

No.	Common Name	Digestible Crude Protein	Digestible True Protein	Digestible (Oil) Ether Extract	Digestible Fibre	Digestible Nitrogen Free Extractives
	ROOTS, TUBERS AND GREEN LEAVES					
1.	Cassava (Manioc) Roots (Bitter Var.)	1.73	0.98	0.28	1.19	77.36
2.	Cassava Root (Peeled)	1.99	1.76	0.24	0.29	80.00
3.	Cassava Root (Peels only)	1.98	1.50	-	-	-
4.	Cassava (Manioc) Roots unpeeled (Sweet Var.)	1.66	0.70	0.34	1.11	78.31
5.	Sweet Cassava Root (peeled)	1.37	1.18	0.34	0.91	77.23
6.	Sweet Cassava Roots (peels only)	3.59	2.92	-	-	-
7.	Sweet Potato Tuber (unpeeled)	4.76	3.33	0.25	0.07	85.00
8.	Sweet Potato Tuber (Peels)	4.42	3.88	0.52	0.05	81.32
9.	Talinum Leaves (Green)	-	-	-	-	-
10.	Sweet Potato Young Leaves	9.61	8.81	2.00	5.55	29.18
11.	Telfairia Leaves (Green)	14.61	12.82	5.69	10.36	34.14
12.	Rice Bran with Little Husk	5.18	-	6.30	10.25	28.02
13.	Soya Bean	39.23	36.32	6. 1	4.17	17.45
14.	Sunflower seed	13.77	12.17	21.37	14.05	18.05
15.	Sunn Hemp Seed	34.63	27.25	0.90	5.00	39.73
16.	African Locust Bean (Pod only)	2.48	2.11	0.67	18.98	50.84
17.	Cocoa Bean (Husk)	-	-	-	-	-
18.	Cowpea Husk	-	-	-	-	-
19.	Green Gram Husk	5.36	4.72	0.38	18.28	30.51
20.	Groundnut Husk	3.17	3.03	0.43	34.86	12.00
21.	Maize, Yellow Husk	1.12	1.02	0.65	19.27	37.16
22.	Rice Husk	1.94	1.78	0.79	2.54	8.95
23.	Oyster Shells	-	-	-	-	-
24.	Amaranthus (tete) spp.	-	-	-	-	-
25.	Prickly Amaranthus (tete eiegun)	-	-	-	-	-
26.	Breadnut (Breadfruit) seed	-	-	-	-	-

Calculated from Digestible Nutrients

No.	Common Name	1: Nutrive Ratio	'Y' Correlation Factor	Per 100 lb. of food: Protein Equivalent	Per 100 lb. of food: Starch Equivalent	Per 100 lb. of food: Total Digestible Nutrient	No.
	ROOTS, TUBERS AND GREEN LEAVES						
1.	Cassava (Manioc) Roots (Bitter Var.)	45.76	-	0.43	-	25.84	1
2.	Cassava Root (Peeled)	40.60	-	0.54	-	23.59	2
3.	Cassava Root (Peels only)	-	-	0.49	-	-	3
4.	Cassava (Manioc) Roots unpeeled (Sweet Var.)	48.31	-	0.38	-	26.14	4
5.	Sweet Cassava Root (peeled)	57.61	-	0.36	-	22.88	5
6.	Sweet Cassava Roots (peels only)	-	-	0.91	-	-	6
7.	Sweet Potato Tuber (unpeeled)	18.01	100	4.16	25.88	25.99	7
8.	Sweet Potato Tuber (Peels)	18.68	78	0.49	7.92	10.20	8
9.	Talinum Leaves (Green)	-	-	-	-	-	9
10.	Sweet Potato Young Leaves	1.09	-	1.15	-	6.10	10
11.	Telfairia Leaves (Green)	3.94	-	1.87	-	9.80	11
12.	Rice Bran with Little Husk	10.13	-	-	-	57.63	12
13.	Soya Bean	1.54	98	35.22	90.46	91.99	13
14.	Sunflower seed	5.92	92	12.22	83.83	88.74	14
15.	Sunn Hemp Seed	1.36	96	29.70	72.97	78.13	15
16.	African Locust Bean (Pod only)	28.77	-	2.15	-	69.09	16
17.	Cocoa Bean (Husk)	-	-	-	-	-	17
18.	Cowpea Husk	-	-	-	-	-	18
19.	Green Gram Husk	7.81	-	4.55	-	50.13	19
20.	Groundnut Husk	15.09	-	2.55	-	41.98	20
21.	Maize, Yellow Husk	51.72	-	0.99	-	54.66	21
22.	Rice Husk	6.86	22	1.74	3.03	14.12	22
23.	Oyster Shells	-	-	-	-	-	23
24.	Amaranthus (tete) spp.	-	-	-	-	-	24
25.	Prickly Amaranthus (tete elegun)	-	-	-	-	-	25
26.	Breadnut (Breadfruit) seed	-	-	-	-	-	26

The machines required in each fish feed preparation process stage are listed below:

TABLE 3.1 MACHINES REQUIRED FOR FISH FEED PREPARATION PROCESS

Preparation State	Equipment Required
1. Receiving	Receiving scales capable of weighing the different feed ingredients, Conveyor belt for moving the raw materials from the receiving area to the distribution area
2. Distribution	Sorting machines for sorting and grading each class of raw materials. The sorting is done on some physical parameter e.g. size
3. Cleaning	Air blowers, water spray and seives as may be required for each class of materials For fish, this stage is preceeded by a scaling unit to scale the various fish sizes.
4. Storage	Silos, Coldrooms etc. to store the raw materials separately
5. Grinding, flaking and Cracking	Hammer milling machine is used on each of the raw materials to achieve the required consistency, fines and form essential for a good mix
6. Mixing	Tanks for holding each ingredient. Batch mixing equipment
7. Pelleting	Conveyor to collect the mixed ingredients Surge bin (Hopper). Pellet mill
8. Cooling	Pellet cooler Cooker fan

TABLE 3.1 (Continued)

9. Bagging	Separating screen for separating various pellet sizes Bagging bin (hopper) Bagging scale to weigh the quantity of feed per bag Bagging machine
10. Storage	Bulk storage facility e.g. Silo for feed not bagged Barn for storing bagged feed.

TABLE - 4 Minerals and vitamin content of some tropical foods and feeding-stuffs (mg per 100 gm food)

Food or Feeding-stuff						Vitamins				
Common Name	Scientific Name	Calcium	Phosphorus	Iron	Carotene (I.U.) or Vitamin A	Ascorbid acid	Thiamino	Riboflawin	Niacin	Source
ROOTS, TUBERS AND GREEN LEAVES										
Sweet cassava	Manihot utillissima	10.00	35.00	0.5	7.800 (a/100g)	35	0.04	0.02	0.6	133
Cassava leaves	-do-	-	-	-	-	-	-	-	-	-
Cocoyam (Taro)	Colocesia esculenta	24.00	53.00	0.72	1.200	14	0.08	0.03	0.83	134
Pawpaw (green)	Carica papaya	58.60	26.30	0.31	0.31	22.00	0.11	0.02	0.22	134
Amaranthus (tete)	Amaranthus chlorostachys	190	39.00	4.6	4.6	68.00	0.12	0.19	0.57	137
Amaranthus (tete elegun)	Amaranthus spinosus	5.94	79.00	25.03	-	81.00	-	0.31	1.83	138
Water melon	Cicrus vulgaris					3.50			-	-
Locust seed bean	Parkia filicoidea welw	310.00	260.00	-	-	-	-	T -	-	-
Green gram	Phaseolus aureus linn.	91.00	320.00	6.30	40.00	15.25	0.68	0.21	2.0	94
Pigeon pea	Cajanus cajan druce	129.00	280.00	5.80	130.00	4.00	0.50	0.14	2.3	94
Kidney bean	Phaseolus vulgaris	120.00	450.00	8.00	30.00	40.00	0.45	0.15	2.1	94
Garden pea	Pisum sativum	64.00	320.00	4.80	100.00	4.00	0.72	0.15	2.40	94
Coconut	Cocos nucifera	25.00	75.00	-	-	2.00	0.15	0.10	0.1	133
Cashew nuts	Amacardium occidentale	-	-	-	-	179.80	-	0.190	-	-
Maize, dry	Zea maize	6.00	300.00	2.5	0.015	11.40	0.50	0.08	2.0	133
Guinea corn	Sorghum vulgare	23.00	71.00	0.37	-	29.10	-	-	-	-
Ladies fingers (okro)	Hibiscus esculentus	82.00	62.00	0.7	740	30.00	0.08	0.07	1.1	139
Millet, bulrush (whole grain, edible portion)	Pennisetum glaucum	50.00	358.00	9.0	-	0.00	0.31	0.04	1.8	139
Rice, brown	Oryza sativa	12.00	290.00	2.00	0.00	0.00	0.32	0.05	4.6	139

TABLE 5 - ESSENTIAL AMINO ACID CONTENT OF SOME TROPICAL FOODS AND FEEDING STUFF (mg/gn)

Food or feeding-stuff		Arginine	Histidine	Isoleuch	Leucine	Lysine	Phenyla-lanine	Tyrosine	Cystine	Methio-nine	Threo-nine	Trypto-phan	Valine	Scarce
Common Name	Scientific Name													
ROOTS AND TUBERS														
Cassava root	Manihot utilissima Pohl	931	106	113	181	244	131	100	-	63	175	-	163	47
Cassava flour (gari)	-do-	931	119	125	200	250	144	119	-	81	181	-	163	47
Cassava leaves	"	313	131	313	544	225	319	244	-	138	288	-	369	47
"Potato" yam	Dioscorea bulbifera	300	106	281	588	275	344	238	113	94	294	-	369	47
Yam, yellow	Dioscorea cayanensis	519	113	219	344	300	281	181	75	131	200	56	250	47
Cowpeas	Vigna unguiculata	444	194	256	456	304	325	190	106	119	238	60	325	94
Groundnut, whole	Arachis hypogoea	775	150	250	438	319	325	220	81	88	244	70	313	91
Groundnut protein (Arachin)	-do-	763	119	413	425	250	344	300	81	38	144	56	244	131
Soyabean meal	Glycine max	519	175	306	488	406	306	200	94	94	244	81	319	91
Lima bean	Phaseolus lunatus	388	206	350	556	431	400	160	61	119	300	56	363	94
Bambara nut	Voandzeia subterranea	394	188	275	494	400	350	219	180	113	219	-	331	94
Sunflower seed	Helianthus annuns	513	137	356	419	238	313	163	88	210	250	81	331	94
Geocarpa seed	Kerstingiella geocarpa	425	181	275	494	388	359	220	63	94	244	-	406	94
Stenocarpa seed	Sphenos-tylis Stenocarpa	388	231	275	481	425	331	270	94	119	256	-	350	94
Locust bean	Parkia biglobosa	-	-	300	500	440	380	310	50	100	210	-	-	94
Coconut seed protein(globulin)	Cocos nucifera	1,046	151	277	449	273	319	-	-	126	254	41	370	133
Coconut seed meal	-do-	673	98	295	493	186	246	118	-	94	183	60	303	74
Coconut seed copra	"	688	97	331	378	163	244	250	-	78	194	47	322	74
Cotton seed	Gossypium spp.	706	169	250	375	219	375	200	138	106	188	81	300	131
Cotton seed flour	-do-	706	161	246	369	260	325	-	-	101	210	97	303	74
Palm-kernel cake	Elacis guineensis	1,075	113	313	519	294	300	-	-	144	250	50	400	74
Guinea corn grain	Sorghum vulgare	293	110	324	827	162	325	260	58	129	197	64	295	74
Maize grain whole	Zea mays	300	156	400	938	144	313	375	94	194	231	38	331	131
Maize gluten	-do-	194	131	319	1,000	94	413	394	94	156	250	38	356	131
Maize germ	"	506	188	263	444	363	313	313-375	75	100	275	81	331	131
Maize protein Zein	Zea mays	113	106	465	1,481	-	400	-	63	144	188	6	188	131
Millet, bulrush	Pennisetum typhoideum	-	119	369	606	244	256	-	-	106	-	119	400	132
Rice, whole grain	Oryza sativa	450	106	325	513	200	313	-	-	188	238	81	388	74
Rice, brown	-do-	538	156	281	563	281	288	363	-	138	200	69	400	74
Rice bran	"	625	206	329	481	384	302	343	76	233	254	247	419	125
Wheat bran	"	393	129	239	346	268	196	182	-	39	164	93	243	74
Wheat germ	"	375	156	281	419	344	180	200	-	24	201	93	252	74

TABLE - 6 Nutrient composition of the grains in commonest use from different sources

NUTRIENT	Maize	Rice	Guinea Corn	Millet
Calories (g/100g)	409.65	397.14	394.09	413.79
Total Digestible Nutrients (per 100lb.)	84.97	82.97	74.92	81.22
Carbohydrate by difference (%)	83.88	90.18	79.12	83.86
Oil (%)	4.09	0.14	3.25	4.99
Protein (N x 6.25) (%)	10.65	12.51	15.03	9.02
Ash (%)	3.13	0.38	2.36	1.09
MINERAL ELEMENTS				
Calcium (mg/100g)	6.00	12.00	23.00	50.00
Phosphorus (mg/100g)	300.00	290.00	71.00	358.00
Magnesium (mg/100g)	160.00	119.00	230.00	180.00
Potassium (mg/100g)	400.00	342.00	370.00	310.00
Sodium (mg/100g)	50.00	78.00	20.00	10.00
Chlorine (mg/100g)	70.00	23.00	-	-
Sulphur (mg/100g)	140.00	-	-	-
Iron (mg/100g)	2.50	2.00	0.37	9.00
Manganese (p.p.m.)	6.83	10.14	27.00	14.00
Copper (p.p.m.)	4.49	3.60	7.00	5.00
AMINO ACIDS (g/16gN)				
Arginine	4.8	7.2	4.1	5.2
Histidine	2.5	1.7	2.5	2.5
Isoleucine	6.4	5.2	3.9	4.4
Leucine	15.0	8.2	13.3	9.9
Lysine	2.3	3.9	2.3	3.9
Cystine	1.5	1.3	2.2	2.4
Methionine	3.1	3.0	2.1	2.4
Methionine & Cystine	4.6	4.3	4.3	4.8
Phenylalanine	5.0	5.0	5.2	5.1
Tyrosine	6.0	5.7	4.1	3.5
Phenylalanine + Tyrosine	11.0	10.7	9.3	8.6
Tryptophan	0.6	1.3	1.0	2.0
Threonine	3.7	3.8	3.3	4.0
Valine	5.3	6.2	5.3	5.7

TABLE - 6 (Continued)

VITAMINS				
Vitamin A (i.u)	510.00	0.5-1.0	-	0
Thiamine (mg/100g)	0.38	0.32	0.38	0.31
Riboflavin (mg/100g)	0.11	0.05	0.15	0.14
Niacin (mg/100g)	2.00	4.60	3.90	1.80
Pantothenic acid (P.P.M)	8.00	17.00	-	-
Pyridoxine (p.p.m)	-	10.3	-	-

TABLE - 7

	FEED NUTRIENT CONTENT (KG/KG OF FEED)					FEED MATERIAL CONTENTS (KG/KG OF FEED)				
Diet	Crude Protein	Crude fat	Ash	Crude fibre	Digestible Energy	Soya bean	Maize	Brewers grains	Fish meal	Rice bran
A	0.357	0.135	0.091	0.076	2825	0.40	0.1	0.2	0.185	0.10
B	0.274	0.11	0.10	0.07	2986.14	0.40	0.42	0.05	0.085	0.03
C	0.283	0.11	0.099	0.073	2949.19	0.40	0.37	0.1	0.085	0.03

The cost of producing diets A, B, and C are No. 68, No. 619 and No. 615 per unit kg of feed respectively.

TABLE - 8 ENERGY COST EFFICIENCY

Diet	Energy level (Kcal/Kg)	Cost (N/kg)	Energy Cost (N/mcal)
A	2825	0.68	0.24
B	2986.14	0.619	0.207
C	2949.19	0.615	0.209

THE POTENTIALS FOR COMMERCIAL PRODUCTION OF FISH FEEDS IN NIGERIA

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ABSTRACT

Studies in fish feed technology revealed that there is a potential for big time investment into fish feed production and marketing in view of the growing awareness of fish farming.

Intensification of aquaculture is one of the primary methods of food (fin fish) production which requires technical knowledge and expertise in the formulation and manufacture of adequate feeds for the cultured species. Studies also revealed that all sort of food items were used by fish farmers ranging from animal dung, groundnut cake etc, to culture fishes to table size because of non-availability of rightly prepared feeds.

Inadequate knowledge of detailed requirements of tropical cultured species was found to pose a hindrance to formulation despite the fact that a lot has been accumulated in terms of biochemical -and nutritive values of food sources in Nigeria.

The investigation further revealed the challenges posed to researchers in aquaculture, fish nutritionists and fisheries biologists among others to elucidate the complete requirements of local fish species in terms of their protein, lipid and carbohydrate requirements such that their patents could be made available to companies like PFIZER, IBRU etc, and individuals alike to make commercialization of fish feeds a reality.

It was also found that unlike poultry feeds which has penetrated every nook and corner in terms of availability of fish feeds are yet to enjoy similar status hence there is high prospect for its investment.

INTRODUCTION

In keeping with the policy of self sufficiency in food production and all facets of life in Nigeria, it is desirable that technological growth must begin with research and development. There is an increasing awareness of fish farming in Nigeria both in the private and public sectors so much that the Federal Government has pumped millions of Naira into making the objective of blue (water) revolution a reality (Adekeye, 1981).

Aquaculture being one of the primary methods of increasing fish, prawn etc, production requires technical knowledge and experience in the formulation and manufacture of adequate feeds for the cultured species (Adekeye, 1982). A great deal of researches have been accomplished in Nigeria on the studies of biological characteristics of some freshwater species notable among the researches are Ita (1971), Fagade (1971), Olatunde (1977), Otobo (1977), Arawomo (1972), Elliot (1975) and Awachie (1975) etc, but not much has been carried out on meeting their feeding requirements in captivity.

Unlike the raising of terrestical animals where the environment is fairly constant, the environment of fish is subject to large variations especially the temperature and physico-chemical properties like DO, pH, salinity etc, which in turn affect the nutrients requirements.

Fish at different stages of their development require different levels of dietary nutrients. The protein or lipid requirement of each species changes with development.

PAST AND PRESENT STATUS OF FISH FEEDS

Aquaculture is relatively young in Nigeria hence the evolution of fish feed is yet to march the enthusiasm of fish farmers because of lack of technical know-how. Many workers have observed that one of the hindrances to Fisheries Development in Nigeria is the lack of availability of commercial feeds in Nigeria.

The earliest fish meal plant was installed and commissioned at the Nigerian Institute for Oceanography and Marine Research (NIOMR), Lagos which was to be the base for the take-off of pelleted feeds. It was believed that the large capacity of the equipment will enable the Institute to achieve economic scale both in production of fish feed and in the feed trials. Ita (1975) surveyed the activities of Inland cultures in Northern Region and found out that feeds utilized included deteriorated groundnut cakes, palm kernel, guineacorn, millets, cow dung and commercial fertilizers.

From a recent survey carried out by this author, the present status of fish feed has not changed much as use is still being made of brewery waste, groundnut cake, fertilizers and brewers grain.

It is gratifying to note that researches are now responding to call of investigating fish feed requirements of our local species. Some of the works are far short of the comprehensive

feed requirements for each species. Even where workers carry out investigations, there are no continuity to conclusively elucidate fish requirements. For instance Faturoti (1986) investigated the growth responses of Clarias lazera using PFIZER produced commercial feeds while Ufodike et al (1986) tested the effect of DOCA and carp pituitary on fecundity and fertility of Clarias lazera. Here, the materials utilized may not readily be available to investors. Also, there is need for coordination of research activities to build up the requirements of species as researchers do investigate different aspects e.g., Okoye et al (1986) investigated the utilization of various lipids by Oreochromis niloticus while Faturoti et al (1986) studied the growth responses and nutrient utilization in Oreochromis niloticus fed varving levels of dietary cassava level.

Since with exception of good water quality, no single factor is of more importance in determining the success of rearing fish in captivity than the dietary composition, it is therefore necessary that attention be paid to the production of adequate feeds for rearing fish.

MATERIALS AND METHODS

The potentials for commercial production of fish feeds in Nigeria was elucidated by surveying and travelling to some parts of the country investigating the mode of operation of the available fish ponds. Questionnaires were prepared to demand location of fish ponds, species of fish cultured, size of farms, types of feeds provided, source of feeds (Pfizer, Private) etc.

These questionnaires were sent to State Ministries, Fisheries Departments, Research Institutes, River Basin Development Authorities etc. In addition, use was made of related journals and publications.

RESULTS AND DISCUSSION

The survey revealed that thousands of Nigerians are interested in owning a fish pond or fish farm and the Fisheries Extension workers confirmed that technical know-how of feeds has always been a stumbling block.

Fish feed is beset with a lot of hind rances in that there is not a generalized pattern for all the fishes as each species requirement has to be established independently. Ita et al (1985) stated that Nigeria is blessed with over 12.5 million hectares of water surface which a good percentage could be turned to gold mines if the right feeds could be produced to meet aquaculture and cage culture development.

In Table 1 is the distribution of manageable fish farm/ponds in Nigeria on State basis. On the whole 569 fish pond/farm size (0 - 4 hectares) are scattered all over the country. This figure is not by any means exhaustive as there are many

Table 1 - State survey: Distribution of manageable fish farm/ponds in Nigeria (on State basis 0 - 4 Ha)

Anambra State		18
Bauchi State		23
Bendel State		24
Benue State		14
Borno State		10
Cross River State		17
Gongola State		2
Imo State		44
Kaduna State		14
Kano State		17
Kwara State		30
Lagos State		12
Niger State		9
Ogun State		31
Ondo State		58
Oyo State		183
Plateau State		15
Rivers State		44
Sokoto State		4
Total	=	569

flood ponds and community ponds which an investigator might not be able to reach. It suffices to say that if fish feed is readily available as the poultry feed, aquacultural developments could have gone far.

For instance, there is hardly any big town in Nigeria not having poultry feed mill. Table 2 shows the distribution of franchised millers of Pfizer Poultry feeds. In addition to Pfizer, there are many individual millers with distribution net-work all over the country.

The increasing popularity and development in aviary is brought about by the break through in feed manufacturing. One can hardly move a 50 km distance in most parts of the country without coming across poultry feed sales department.

Backyard fish farming is practicable as fish can be stocked in tank, or cemented ponds. More modern homes can boast of fish aquarium because they readily get the fish feeds in departmental stores around. If feeds for tropical fishes abound a lot more could be willing to have backyard fish ponds.

The challenges posed to our researchers are immense in the sense that results of their endeavour would culminate in rapid transformation of aquacultural development.

It is now more than ever that attention has to be paid to formulating balanced rations from available raw materials like soybeans, groundnut cake, thrash fish etc by the institutes, universities, fisheries research organizations and River Basin Development Authorities.

The government has an important role to play by assisting Research Institutes to be able to evolve the required technology for the take-off. In the alternative, the patents of break through could be sold to enterprising private firms like Pfizer, IBRU Organization etc to champion the commercialization of fish feeds in Nigeria.

AKNOWLEDGEMENTS

I wish to thank Dr. Adegoke, Acting Head of Department of Zoology, University of Ife for permitting the use of some departmental facilites and Dr. F.A. Arawomo for his guidance in executing this project. My sincere appreciation goes to my wife, Lara for putting up with my frequent travellings and encouraging every endeavours.

Table 2 - Location of PFIZER franchised Millers in Nigeria

Anambra State	2
Bauchi State	-
Bendel State	1
Benue State	-
Borno State	-
Cross River State	1
Gongola State	1
Imo State	1
Kaduna State	2
Kano State	-
Kwara State	3
Lagos State	4
Niger State	2
Ogun State	5
Ondo State	5
Oyo State	5
Plateau State	1
Rivers State	-
Sokoto State	1

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COMMERCIAL PRODUCTION OF NATURAL FRESHWATER FISH-FOOD

by

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INTRODUCTION

The availability of living food resources in intensive fish culture system has been shown to be a major handicap in the rearing of fingerlings of commercial fish species all over the world. Kirk and Howel (1972), Kirk (1972) and Kinne (1977) have shown that young fish, especially their larvae, live and grow better on living food than on non-living or artificially formulated feeds. Such non-living diets include those made from groundnut cakes, cotton seed cakes, rice, corn and wheat brans and a host of other artificially formulated feeds. There is hardly any known species of fish that does not utilize natural food at one stage or the other of its life cycle. In mass fish seed (fingerlings) production, therefore, one of the most important factors governing survival and growth of larvae, fry and fingerlings, is the availability and constant supply of live food.

These live foods are mostly the microscopic phyto-plankton and zooplankton which are normally present in many natural aquatic systems and form the most valuable natural food resources for aquatic predators, especially fish. The extensive fish farmer has all along depended on the benefit of these microscopic organisms. In intensive fish culture systems, however, where these organisms are not naturally present, they have to be collected from the wild, propagated and properly managed in enclosures to ensure their constant supply, especially in fish hatchery operations.

A highly simplified predator-prey relationship which exists between phytoplankton, zooplankton and fish is shown below:-

$$\text{Phytoplankton} \xrightarrow[\text{prey to}]{} \text{Zooplankton} \xrightarrow[\text{prey to}]{} \text{Fish}$$

The abundance of the zooplankton is in most cases dependent on the abundance and quality of the phytoplankton, while the growth, survival and well-being of the fish is dependent on the availability and abundance of the zooplankton.

To a great extent, therefore, there should be a sort of ecological equilibrium between the phytoplankton and the zooplankton to ensure successful fish production in any fish culture system.

It appears that the mass cultivation of natural fish-food only gained ground in the last couple of decades judging from what is available in the literature. Since then however, there has been some major thrust in fish-food aquaculture especially in those parts of the world such as the Philippines, Japan , USSR etc. where fish culture has been most intensively practised. These works have focussed on the cultivation of algae and zooplankton as food for fish larvae, fry and fingerlings. The algae is usually cultured as a food organism for the zooplankton which is the preferred live food for the young fish as most larvae cannot rely on phytoplankton as their sole food source (Uhlig, 1981).

Objective

The objective of this paper, therefore, is to review some of the methods that can been used for mass cultivation of natural fish-food, the types of organisms that are cultured and finally to give some examples of successful case histories in the mass cultivation of natural fish-food in order to stimulate the interest of Nigerian scientists on research activities that will encourage large scale production of live fish-food for use by fish farmers in this country.

METHODS FOR CULTURE OF LIVE FISH-FOOD

In starting up a fish-food culture, four important parameters should be considered. These include the species and scurce of the organism to be cultured, the nutrient source, the culture vessel, and the inoculation technique.

Species, Source and Isolation

One of the major problems of life fish food culture is the isolation of desirable species of algae from the wild for feeding the zooplankton which is ultimately used to feed the fish especially where the fish is not herbivorous. Also, in developing countries like Nigeria where algal banks are not available, it is necessary to produce pure cultures of algae whenever desired. The isolation of an algal unit into a medium suitable for growth is required to establish a unialgal culture. There are various methods of isolation such as capillary pipette, agar plating, cover glass attachment, repeated subculture etc. In our laboratory at Kainji Lake Research Institute pure culture of Scenedesmus has been produced by using the repeated subculture technique of Aujero (1981). This method involves inoculation of a mixed phytoplankton population into a known nutrient medium and the culture left to stand with continuous illumination from fluorescent tubes and aeration using air pumps. At the end of every three days, a

sub-sample was removed and inoculated into a fresh medium. This subculturing was repeated several times until a unialgal culture was established. Details of the utilisation of this technique by Kainji Lake Research Institute is available in Ovie et al (1986, in press).

Nutrient Source

All algae require a chemical environment for growth. Such environment is a dilute solution from which all the raw materials necessary for their structural and protoplasmic synthesis are drawn. Several standard laboratory algal nutrients are available for the culture of microalgae. Some of these include media formulations of Pravossoli et al (1957), Gullard and Ryther (1962), Walne (1974) and the modified Hirata (1979) medium. Others include standard CHO number 10 medium, Watanabe nitrogen free medium, SM_1 and SM_2 medium etc. Most algae as chlorophyll-bearing plants require N, P, K, C, O, Ca, Fe, Mg, Mn, Bo, Zn, Cu, and Co. Diatoms require silicates, while some algae require vitamins such as thiamine, cyanocobalamin and biotin. The reagent grade chemicals that make up these nutrient formulations are not only expensive but are also difficult to obtain as most of them have to be imported. In view of this, the Kainji Lake Research Institute (KLRI) is currently exploring the possibility of using local raw materials such as chicken droppings as nutrient source. The two most important components of algal nutrient are phosphates (phosphorus source) and nitrates (nitrogen source). An analysis of the chicken droppings collected from a poultry farm in the Kainji Lake area showed adequate concentrations of phosphate (2.2 mg/l) and nitrate (45 mg/l) in the extract. This extract was found by Ovie et al (1986, in press) to compare very favourably with standard CHO No.10 laboratory nutrient in the growth characteristics of Scenedesmus species isolated in the Kainji Lake Research Institute laboratory.

The chicken droppings extract was obtained by soaking about 3 kg of chicken droppings in 15 litres of water and making sure that droppings were completely covered with water. The droppings were allowed to 'ferment' for 2 - 3 days with occasional stirring once or twice a day and finally filtered, with the residue rinsed two or three times with water, through a clean white nylon cloth into a bowl.

The above concentrated filtrate has been found by Ovie et al (op. cit.) to produce a bloom of Scenedesmus sp. in a tank which is 5 x 4 x 0.5m or $10m^3$ (i.e. 10,000 litres of culture volume).

Culture Vessels

Culture vessels for natural fish-food production are of various shapes and sizes and the volume of each vessel depends on the magnitude of feeding to be performed.

For small-scale feeding programmes, circular or conical tanks approximately 0.5 m^3 capacity made of fibre glass can be used. Rectangular iron tanks 1.23 x 0.885 x.6m approximately 650 litres capacity is currently being used in KLRI laboratory. Concrete tanks are, however, recommended for large-scale feeding programmes. The concrete tanks that are currently being used in our hatchery complex at Kainji Lake Research Institute are 5 x 4 x 1.5m which is approximately 30,000 litres at full capacity. However, it is recommended that such tanks should only be filled to the 0.5m depth mark to ensure maximum light penetration and ease of manual stirring if mechanical aerators are not available.

Inoculation

To initiate a batch culture, a small volume (50 or 100 mls) of the pure isolated algal stock is inoculated into a 1 or 2 litre flat bottom flask containing the nutrient medium. After 2 - 3 days when culture has bloomed, the culture volume is increased by using a bigger vessel. For large scale cultures, the culture vessels are gradually increased and greater amount of algal inoculum added for faster turnover of algal cells. A bloom is assumed to have occurred when the culture medium turns green. Just prior to (when the cells are still actively dividing) or at the end of the exponential phase, the vessel is inoculated with zooplankton. The exponential phase could be determined microscopically by direct algal count or by chlorophyll analysis using the spectrophotometric method. The chlorophyll analysis has been found to be a more reliable method for identifying the various stages in the growth curve. Once the zooplankton are inoculated into the vessel, they feed actively and reproduce very rapidly, thus increasing the zooplankton population density. At the peak of their population density, the zooplankton culture is harvested and fed to the fish larvae, fry or fingerlings. The whole cycle of algal-zooplankton development takes approximately 7 - 8 days in the case of small-scale culture. However, in outside concrete tanks where cultures could be left going for weeks, only a fraction of the culture is harvested at each feeding time.

Harvesting

Algae could be harvested by concentrating with sand filters and backwashing with filtered water (Yap, 1979). Hand plankton nets with very fine mesh size (153 or 180 µm) are usually applied for harvesting zooplankton. In small-scale culture, the entire culture volume is filtered through the net bucket, is emptied into a plastic or any suitable container for onward transfer to the tanks holding the fish larvae, fry or fingerlings. For large-scale cultures in concrete tanks, the plankton net is towed from one end of the tank to the other to concentrate the zooplankton.

Concrete tanks are drained, washed and dried periodically to avoid pollution of the bottom layer resulting from accumulation of nutrients and dead decaying organisms. If pollution is allowed to build up, oxygen depletion will occur to such an extent that the organisms may become stressed and eventually die.

Fertilization and aeration have been identified as two important parameters that affect algal and zooplankton development in culture media.

Fertilization

Periodic fertilization with nutrients at every two weeks interval or when algal population density is observed to be decreasing, is applied to ensure adequate supply of nutrients for algal growth.

One obvoius effect of fertilization is the rapid increase in the population density of phytoplankton and it is common knowledge that the rate of bloom is proportional to the level of fertilization. In other words, high phytoplankton densities are achieved at higher levels of fertilization. Heisig (1979) however, found the reverse to be the case with zooplankton development. He found that in highly fertilized ponds with 10.28 and 8.19 mg PO_4-P/l respectively, zooplankton density never exceeded 160 individuals/litre. In another pair of moderately fertilized ponds (5.98 and 3.86 mg PO_4-P/l) densities of up to 260 Daphnias per litre were achieved. The highest density (425 Daphnias per litre) was recorded in the least fertilized ponds containing 1.10 - 1.63 mg PO_4-P/l. This inverse relationship has been attributed to a temporary oxygen deficiency and increase in pH values caused by phytoplankton metabolism which tends to inhibit zooplankton development. Furthermore, it has also been shown that every high densities of food particles (algal cells) inhibit uptake by the zooplankton.

In general, the population density of zooplankton follows very closely that of phytoplankton population until such a point when the density of the latter becomes inhibitory. The goal of fertilization should, therefore, be to obtain optimum algal cell concentration that guarantees optimum zooplankton production.

Aeration

Aeration which is tbe bubbling of gaseous air through cultures, prevents stratification of cells, makes provision for gas and heat transfer, dispersion of dissolved nutrients and prevents adherence of cells to the walls of the culture vessels. Uhlig (1981) maintained that aeration increases cell size of organisms. Heisig (1979) compared the effect of aeration on primary production and zooplankton development in two ponds in which one was aerated and the other was not. He found that aeration increased algal

production and consequently, led to increased egg production in Daphnia. The number of egg-bearing females and the number of eggs per egg-bearing females was found to be considerably higher in the aerated than in the unaerated ponds. While the aerated pond attained an average density of more than 500 individuals per litre, the unaerated pond had only half of that population density. It is therefore, recommended that aeration should be provided in order to achieve maximum zooplankton population in fish-food culture. This is most important in indoor hatcheries where atmospheric reoxygenation is highly limited.

SOME COMMONLY CULTURED NATURAL FISH FOOD

Different species of phytoplankton and zooplankton have been employed in aquacultural practices (Kirk and Howel, 1972; Kirk, 1972; Kinne, 1979, Hirata, 1979; Heisig, 1979). Some of the algae commonly cultured include Chlorella, Scenedesmus, Closterium, Chlamydomonas, Skeletonema, Rhizosolenia, Chaetoceros etc. The first four genera are members of the Chlorophyceae (Green Algae), while the last three genera belong to the Bacillariophyceae (Diatoms). Others include small flagellates such as Platymonas viridis, Dunaliella tertiolecta, D. viridis etc. Members of the Cyanophyceae (blue-greens) are not normally cultured for use in fish culture systems because they produce toxic alkaloids, cyclic polypeptides etc (Darley, 1982) and are also difficult to digest because of the outer-coat of mucus surrounding their cells.

Although there is a wide spectrum of potentially available live fish-food organisms, these organisms must satisfy certain basic aquacultural requirements before they can be employed for aquacultural purposes. Some of these basic requirements are:-

- Easy availability of the organism
- High reproductive potential
- Short regeneration time
- High nutritional quality, and above all
- Acceptability of organism by fish larvae, fry or fingerlings.

SOME SUCCESSFUL CASE HISTORIES

Heisig (1979) described the successful mass cultivation of Daphnia pulex in ponds measuring 50 m^2. These ponds were situated in a line and were interconnected by vertical pipes that serve to maintain the water level constant at 1.1 m. The ponds were aerated and fertilized

periodically at an interval of 3 or 2 weeks, first with potassium nitrate and later with calcium nitrate. A population density of 500 individuals per litre was achieved in this culture.

Hirata (1979) in Japan described the mass production of rotifers notably Brachionus sp. This rotifer was found to be the best food for the larvae of the Ayu fish, Plecoglossus altivelis, and this has also been used as food for the larvae of the prawn, Penaeus japonicus. The rotifers were grown both in small (1.5 m^3) wooden tanks and in outdoor concrete tanks measuring 100 or 200 m^3. A population density of over 514 individuals/ml was achieved in the outdoor concrete tanks while the small tank had a maximum population density of 80 individuals per ml. Chlorella grown on Hirata medium (Hirata, 1979) or on the modified medium by Villegas (1981) consisting of 10g/ton of ammonium sulphate, 12 g/ton of urea, and 30 g/ton of N.P.K. in the proportion of 14-14-14- along with yeast formed the basic food of rotifer.

Debeljak et al (1979) described the rearing of cyprinid fish fry and a mixed population of zooplankton as fish-food in 70 litres aquaria, and in 4m^3 and 8m^3 plastic tanks. N.P.K. in the proportion of 17 : 8 : 9 was used as the fertilizing agent, with baker's yeast as the major food item for the zooplankton. In the aquaria, a nine fold increase was obtained from an initial inoculation density of 352 individuals per litre. Maximum biomass of 68 g/m^3 and 89g/m^3 respectively were noted in the 4 m^3 tanks and a 2 - 17 fold increase in biomass was achieved in the 8m^3 tank. Uhlig (1981) also reported the mass cultivation of the heterotrichous ciliate Fabrea salina and the hepaticoid copepod, Tisbe holothuriae in continuously running food flow system and in enclosed flat culture systems respectively. F. salina and T. holothuriae reached a population density of 400 individuals/ml and 121 individuals/ml respectively.

CONCLUSION

The above account and the examples of successful cultivation of algae and zooplankton as natural fish-food are not exhaustive. Other examples can be found in some of the works cited in this paper. It is however, important to add that the cultivation of natural fish food in fresh-water and also in developing countries like Nigeria is quite new and a concerted effort by all interested scientists is likely to be the best solution to the present low level of work in this area of applied limnological research so that useful information can be made available to our fish farmers for the utilisation of our local natural fish-food in fish production.

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POSSIBLE INCLUSION OF FISH WASTE (SCALES AND FINS) IN THE DIET OF FISHES IN AQUACULTURE

by

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ABSTRACT

The scales and fins of some freshwater fish species were analysed for their organic and inorganic matter . The aim of such study is to determine the usefulness of these waste parts of the fish in fish feed preparation. In all instances, the inorganic matter was found to be quite high in the fish exoskeleton, and calcium formed the highest element in the scales and the fins. These waste materials are therefore, considered as possible replacement for mineral sources in fish feed and probably the feed for other livestock.

INTRODUCTION

The scales, the fins and the viscera of fishes are considered as waste parts of fish in Nigeria though in many other countries, they are used for various purposes. In fact, some people in this country do not eat the head of fishes.

Scales are employed to some degrees in classification of fishes and they are also important in the estimation of the age and growth. The biological functions of scales is for protection, while the fin serves the purpose of locomotion.

The chemical analysis of fish scales indicated that the scales generally contained 41% to 81% organic protein and up to 16 - 59% mineral residue in dry matter.. The former consisted mainly of ichthylepidin and collagen (Van Oosten, 1957). The relative amounts of these two albuminoids when both present is nearly constant in scales of different teleost fishes, about 76% ichthylepidin and 24% collagen.

Percentage composition of (ash) mineral residue of scales had been determined for many fishes. Alosa sp. contained about 98.38% $Ca_3(PO_4)_2$, 1.79% $Mg_3(PO_4)_2$, Cyprinus sp. contained 56.74% $Ca_3(PO_4)_2$, 1.68% $Mg_3(PO_4)_4$, 41.57% $CaCo_3$. Other elements including boron, fluorine, bromine, lithium, strontium have been found in scales of marine fishes. The concentration of all these materials varies with environments.

No importance has been attached to the exoskeleton and offal of fishes. We have not thought of many useful ways to which these items can be put.

The author had seen these supposedly useless fish parts forming large heaps near processing huts or put in baskets and bowls for disposal. It is therefore, the aim of this study to determine the proportion the wastes form in the fish, to analyse them and evalute them in feed preparation for fishes in aquaculture. The aspect of this study already carried out is hereby reported.

MATERIALS AND METHODS

Five species of fishes namely Sarotherodon galilaeus, Oreochromis niloticus, Tilapia zillii, Barbus callipterus and Hemichromis fasciatus, were caught from Kainji Lake, Opa Reservoir, Teaching and Research Farm Reservoir both at the University of Ife and fish collection was done between 1982 and 1985. Before the scales and the fins were removed and before the fishes were cut open, the normal routine like identification, measurement and weighing were carried out. The moisture content was determined by drying the scales and fins separately to constant weight.

The ash content was determined by incineration of weighed and oven dried scales and fins. The mineral determination was carried out using Golterman's et al (1978) methods.

RESULTS

Table 1 shows the number of each fish species used for this investigation.

Table 1 - Number of each fish species used

Family	Fish Species	Number of Specimens Examined	Range in Standard Length
Cyprinidae	B. callipterus	29	6.0-7.9
Cichlidae	O. niloticus	24	7.6-15.0
	S. galilaeus	64	6.7-14.0
	T. zillii	26	7.9-11.5
	H. fasciatus	44	0.9-10.8

Table 2 - Proportion of fish exoskeleton to the total body weight

Fish Species	Range in Wt. of scales (gm)	Mean % of the Body formed by Scales	Range in Wt. of Fin (gm)	Mean % of the Body formed by Fins
B. callipterus	0.1358 - 0.3680	2.57 ± 0.12	0.0531 - 0.0872	0.75 ± 0.03
O. niloticus	0.4001 - 2.7042	3.04 ± 0.82	0.3437 - 2.1969	1.74 ± 0.24
S. galilaeus	0.2163 - 3.7245	3.44 ± 0.15	0.1173 - 1.5536	1.43 ± 0.05
T. zillii	0.3747 - 1.5400	2.66 ± 0.16	0.2711 - 0.9632	1.51 ± 0.06
H. tasciatus	0.3688 - 2.1055	6.64 ± 0.41	0.1124 - 0.6365	2.14 ± 0.22

Proportion of Scales and Fins to the Fish Body

Table 2 shows the proportion of the body formed by scales and fins (in respect of weights).

The proportion of the scales to the body weight was found to be highest (6.64%) in H. fasciatus, while the only Cyprinid, Barbus callipterus gave the lowest value. Similar result was obtained for the fins of the fishes. The weight of the scales and fins were found to increase with the fish body weight.

The Composition of the Scales and Fins

Tables 3 and 4 show the results on moisture and organic composition of the materials. It is evident from these tables that organic compound can be as high as 50% and 41% in the scales and the fins respectively.

Inorganic Fraction of the Scales and Fins

Tables 3 and 4 show the ratios of water and organic matter in the scales and fins. From the tables, inorganic matter formed 46.28%, 43.11%, 39.70% 46.71% and 44.22% of the scales of B. callipterus, O. niloticus, S. galilaeus, H. fasciatus and T. zillii respectively. Similarly, these values were 40.20%, 54.02%, 55.20%, 52.59% and 47.71% in the fins of the fishes in the same order.

Table 5 shows the amount of cations in the scales and fins of the fishes while Table 6 shows the amount of scales and fins needed to produce each of the cation analysed.

Economic analysis of the feed prepared with the fish waste as a component was analysed and compared with current production cost price (see Tables 7 and 8).

DISCUSSIONS

Provision of cheap and balanced diet that will give accellerated growth is the most needed item in fish culture. A nation that develops easily is the one that does not believe in waste. That is nothing should be regarded as being useless. Locally produced materials, un-consumable parts of animals and plants should be used to make feed for fish at this point in time when it is becoming more impossible to import things in Nigeria. In many instances waste parts of fish can be obtained almost free of charge. Many companies in Nigeria now advertise waste parts of fish at give away prices. In many fish huts, people will be glad to give away the waste parts of fish, and the amount spent will be just that incurred on transportation.

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The fact that many fishes feed on fish as parts or as a whole in natural habitats shows that diet containing fish parts will be very ideal for fishes. Moreover, the cations so far analysed in fish wastes are very important for good growth, blood formation and strong bones not only in fishes but also in other vertebrates (Halver, 1972).

The use of fish waste has huge economic implications especially for the fish feed manufacturing industry. Ogunfowora et al (1975) found out that the rate of expansion of intensive livestock enterprises in Nigeria had been greatly reduced due principally to high costs of feeds arising largely from rising price of raw materials. They observed that the cost of feed representing about 80% of the total cost of intensive production was following an upward trend due to high cost of feed ingredients most especially specialised components like fish meal. Webber and Riordan (1976) contended that since the feed cost represents such a high proportion of the operating expenses, the economics of the aquaculture industry are particularly sensitive to variability in cost of the commodities which enter into feed formulation.

As shown in Table 7, the composition of ingredients used in the formulation of feeds has fish meal as an important component. The fish meal provides the needed protein source very rich in essential amino acids, vitamins and minerals. The material cost for compounding the fish feed is shown in Table 7. The average market price for one tonne of fish meal utilizing various fish parts is ₦880/tonne or 88k/kg.

More detailed investigations revealed that about 51% of the cost of this feed is accounted for by the fish parts used. However, a comparative analysis shows that with the use of fins and scales (fish wastes), the percentage contribution of fish parts is greatly reduced with concommitant reduction in the overall cost of the final product. The cost analysis shows that the final price comes to 68K/kg and that is allowing for increased profit margin from 10% (9 Kobo) to about 15% (i.e. 10 Kobo) of final market price (Table 8).

In sum, the paper reveals the technical as well as economic implications of adopting the use of fish wastes such as scales and fins in the production of fish meal.

ACKNOWLEDGEMENTS

I am most grateful to Mr. O.O. Oludimu of the Department of Agricultural Economics, who carried out the economic analysis of the data for this paper. I thank my post graduate students also for their various contributions.

Table 3 - Variations in the moistures, ash and organic contents of the scales in the fish species

Fish Species	Range in moisture content (%)	Mean % Moisture content	Range in ash content (%)	Mean % Ash content	Range in Organic Matter (%)	Mean % Organic Matter
B. callipterus	2.5 - 11.0	5.76 ± 0.52	39.5 - 58.4	46.28 ± 0.64	38.7 - 56.6	47.96 ± .70
S. niloticus	5.9 - 13.6	10.22 ±0.64	41.5 - 56.5	43.11 ± 1.26	33.6 - 58.5	46.67 ± 1.61
S.galilaeus	6.0 - 13.2	10.42 ±0.77	31.2 - 53.3	39.70 ± 0.61	37.0 - 58.5	49.88 ± 0.64
H. fasciatus	0.7 - 15.6	9.12 ± 0.86	39.9.- 55.6	46.71 ± 0.79	31.8 - 61.4	44.16 ± 1.06
T. zillii	0.1 - 9.9	5.11 ± 1.15	28.6 - 50.9	44.42 ± ±.24	44.1 - 71.1	50.47 ± 1.60

Table 4 - Variations in the moisture, ash and organic contents of the fin fish species

Fish species	Range in moisture content (%)	Mean % moisture content	Range in Ash content (%)	Mean % Ash content	Range in Organic Matter (%)	Mean % Organic Matter
B. callipterus	16.3 - 48.9	22.36 ± 1.28	31.7 - 46.9	40.20 ± 0.70	1.29 - 50.4	37.44 ± 1.27
S. niloticus	8.6 - 14.0	12.5 ± 0.29	50.0 - 58.5	53.02 ± 0.71	31.0 - 38.5	34.48 ± .0.60
S. galilaeus	7.0 - 18.0	10.13 ± 0.28	49.6 - 69.4	55.20 ± 0.67	20.1 - 41.0	34.67 ± 0.85
H. fasciatus	1.1 - 15.6	8.60 ± 0.54	39.4 - 64.4	52.59 ± 1.83	26.8 - 53.4	38.81 ± 1.69
T. zillii	10.2 - 12.3	11.46 ± 0.13	43.2 - 52.2	47.71 ± 0.54	36.2 - 44.6	40.83 ± 0.53

Table 5 - Cations ratio (% in materials)

Fish Species	K^+		Na^+		Ca^+		Mg^{2+}		Fe^{3+}		P^{3+}	
	Scales	Fins	Scales	Fins	Scales	Fins	Scales	Fins	Scales	Fins	Scales	Fins
B. callipterus	1.7	1.5	4.37	3.79	26.19	22.75	1.2	0.95	3.27	2.84	9.60	6.34
O. niloticus	1.62	2.03	4.07	5.09	24.40	30.58	1.02	1.27	3.05	3.82	8.95	9.21
S. galilaeus	1.49	2.08	3.75	5.21	22.47	31.20	0.94	1.30	2.81	3.90	8.24	9.46
H. fasciatus	1.76	1.98	4.41	4.96	26.44	29.76	1.10	1.24	3.30	3.72	9.69	9.91
T. zillii	1.66	1.80	4.17	4.5	22.50	27.00	1.04	1.12	3.13	3.38	9.17	7.90

This result shows that calcium has the highest value in the exoskeleton of these fishes (22.47 - 26.44 in scales; 22.75 - 31.20 in fins) and this is followed by phosphorus. There is no element out of those determined that does not form close to 1% at least of the total scales or fins. There was no statistical difference in these elements in the fishes caught from the three environments.

Table 6 - Amount of scales and fins (in Kg) needed to produce 1 kg of cation

Fish species	F^{+}		Na^{+}		Ca^{2+}		Mg^{2+}		Fe^{3+}		P^{3+}	
	Amount of Scales	Amount of Fins	Amount of Scales	Amount of Fins	Amount of Scales	Amount of Fins	Amount of Scales	Amount of Fins	Amount of Scales	Amount of Fins	Amount of Scales	Amount of Fins
B. callipterus	58.80	66.67	22.88	26.39	3.82	4.40	83.33	105.26	30.58	35.21	10.42	15.77
O. niloticus	61.73	49.26	24.57	19.65	4.09	3.27	98.04	78.74	32.79	26.18	11.17	10.86
S. galilaeus	67.11	48.08	26.67	19.19	4.45	3.31	106.38	76.92	35.59	25.64	12.14	10.57
H. fasciatus	56.82	50.51	22.68	20.16	3.78	3.36	90.91	80.65	30.30	26.88	10.32	10.09
T. zillii	60.24	55.56	23.99	22.22	4.44	3.70	96.15	89.29	31.95	29.59	10.91	12.66

This table shows the weights of scales and fins that can be used to produce 1 kg of each of the six cations so far analysed. This amount varies with the type of cation as well as the fish type.

Table 7 - Material cost for compounding a tonne of fish feed using fish waste as source of minerals

Ingredients	% in the Fish feed	Cost per tonne of feed (₦)	Quantity need/tonne of Feed(kg)	Value in ₦
Maize	40.50	470.0	300	141.0
Wheat offals	7.50	100.0	100	10.0
Groundnut cake	20.50	405.0	200	81.0
Soybean cake	15.00	450.0	150	67.5
Fish meal	6.00	880.0	880	70.4
Rice bran	4.50	85.0	60	5.1
Fish scales and fins	5.50	240.0	60	14.4
Vitamin/ mineral mix	0.50	450.0	50	14.4
Total	100.00		1,000	403.3

Table 8 - Cost component of 1 kg of fish meal, 1987

Components	Whole fish		Fish wastes	
	Amount (Kobo)	%	Amount (Kobo)	%
Labour	16	18.2	21	30.9
Depreciation on Capital Stock	6	6.8	6	8.8
Fish parts	45	51.1	18	26.5
Operating Capital	12	13.7	13	19.1
Profit margin	9	10.2	10	14.7
Total	88	100.0	68	100.0

Source: Field survey, Oyo State; reproduced with kind permission of O. Oludimu

COMMERCIAL PRODUCTION OF FISH MEAL FROM FISH WASTE

by

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ABSTRACT

The importance of fish meal production as a means of reducing fish waste currently being experienced in the fisheries subsector is discussed. Cost estimate of establishing a fish meal manufacturing plant and suggestions on rational execution of the project are presented. If properly located and well managed, the project will serve to convert fish waste to cash in the industrial fishery.

INTRODUCTION

The deficiency of animal protein in the face of growing human population has raised public interest in the need to intensify production so that animal protein supply could meet increasing demand. Fish, an important source of animal protein because of its abundance and low cost is similarly facing a shortfall due to restrictions in importation, decline in domestic production and wastage which alone accounts for 15 - 50% of post-harvest losses in marine and freshwater fisheries. Fish wastage occur as a result of poor handling resulting in spoilage and dumping of 'trash' fish or deliberately discarding fish at sea after capture.

In industrial fisheries, a major portion of catch by fish and shrimp trawlers comprise species known as by-catch that are discarded at sea. An estimated 5 million tonnes per annum of fish by-catch comprising between 70 and 200 species are discarded at sea in the tropics (Allsopp, 1977). In Nigeria, shrimp by-catch estimated at 7,000 tonnes/annum are frozen or jettisoned at sea. Among the discards are small sized adult fish mainly Brachydenterus auritus (Ajayi and Talabi, 1984). Apart from this, tonnes of fish offals and spoiled fish are dumped daily in fishing companies within the industrial marine fishery.

With the reported increase in fish wastage and the alarming estimates of the discards at sea, the need to reintroduce this resource into the human food chain should be of immediate concern to fisheries investors. Processing the spoilt, underutilized or unused fish species into fish meal which could be incorporated into animal feeds is an effective way of expanding the livestock industry and increasing the protein intake of the nation.

Fish meal is a carefully produced component of animal feedstuffs which is mixed with vegetable proteins usually by fish mixing companies and farmers (Barlow, 1976). It is used for feeding poultry especially broilers and layers and for pigs and piglets. It is also used in rearing fish and other livestock. Fish meal is invaluable in the ration of livestock because of its high content of essential amino acids especially lysine and methionine which are limiting in other feed components. Fish meal is also rich in vitamins and minerals which are deficient in the diets of domestic animals. It is very easily digestible and contains an unidentified growth factor (UGF) called also Animal Protein Factor (APF) or vitamin B12 which promotes the growth of livestock more than those fed other protein components by assisting assimilation of vegetable albumin (Kordyl, 1975). Experiments have shown that fish meal supplements to compound feeds can raise the rate of growth of pigs and chickens by up to 20 per cent compared with that of animals fed on an exclusively vegetable diet (Anon, undated). This means that by using fish meal in the feed, the farmer can obtain an increase of about 20% in weight in the course of the same feeding period. Alternatively, he can cut down the feeding period by about 20 per cent and obtain the same weight of meat. This makes fish meal production one of the most efficient ways of utilizing fish protein resources, resulting in products of high acceptability e.g. chicken, eggs, milk and beef which are essential in meeting the current high animal protein demand. It is in realization of this role that one-third of the world's fish catches is devoted to fish meal production (FAO, 1979). Table 1 indicates a higher protein content in fish meal than in other meals commonly used for animal feeds.

Table 1 - Proximate composition of meals frequently used in animal feeds

	Protein %	Fat %	Water %	Salt %	Ash %
Herring meal	72	8	9	2	9
Groundnut meal	50	7	9	0.1	6
Soyabean meal	45	7	9	0.1	6.7

Source: Atlas Stord

MANUFACTURE OF FISH MEAL

Figure 1 shows a diagram of the operation of a typical fish meal and fish oil plant. The process starts at the hasher (A) where large fish are chopped before entering the steam cooker (C) through the feeder (B). The cooking coagulates protein and ruptures the tissues in the flesh so that oil and physiologically bound water are removed during processing.

From the cooker, the product passes by combined stainer conveyor (D) to the twin-screw press (E) which removes oil and water. The press cake and press water so formed are then treated as follows:-

The press cake is disintegrated in a tearing machine (F) dried in a dryer (G) before passing through a vibrating screen with magnet (H) where foreign matter is removed. The meal is ground in a hammer mill (J) weighed (K) and bagged.

The press liquor passes through a decanter (N) which removes insoluble dry matter or sludge. The press liquor enter a buffer tank (O) before oil is extracted by centrifuge (P). The oil-free stickwater which remains is evaporated in a concentrated plant (R) and returned to the drier (G) where it is mixed with the press cake to form whole meal.

Figure 2 shows an outline of a manufacturing process for fish meal. Out of the 1,000 kg of raw fish fed into the plant, 212 kg of fish meal was produced. 108 kg of oil was also produced during the process. The fish oil produced is valuable for the soap, paint and margarine industries and also in the production of leather.

COST ESTIMATE

Table 2 shows the cost estimate for a 12.5-tonne capacity fish meal plant. The costing is based on a model on pre-investment analysis for fish meal plants developed for F.A.O (da Costa, 1975).

The cost of a 12.5 tonne fish meal plant based on a quotation received from a supplier in the United States, estimated at ₦[illegible] is made up of the following major components including shipping and installation.

(i) Basic fish meal plant

(ii) separation unit

(iii) deodourizing unit

(iv) evaporating unit

(v) steam boiler

The cost of building construction ror the fish meal plant, fish meal and fish oil store and an office including a stand-by generator, and miscellaneous expenses have been estimated at ₦100,000.00. The total cost is shown in the table. It must be noted that there are bound to be a great difference in all costs depending on unavoidable factors such as inflation, location of the plant, method of payment, supplier, type and make, labour cost, existing rate at the foreign exchange market etc.

Table 2 - Cost Estimate for a 12.5 tonne capacity fish meal plant

Items		Amount ₦
Capacity per day (24 hours): 12.5 tonnes		
Fish offal with about 8% oil content output per day: (24 hours)		
Fish meal:	2.3 tonnes	
Fish Oil:	0.75 tonnes	
Operation Costs per Day		
Fuel oil at ₦0.10/kg (500kg)		₦50.00
Plastic bags ₦0.50/pc. (250 pcs)		125.00
Lubricants, etc.		10.00
Operators: 2 persons per shift (Total 6 persons)		60.00
Operation Costs per Day	=	₦245.00
Overhead Cost per Year		
10 years depreciation of total investment (Building, plant, generator, Misc.) ₦200,000		₦20,000
Interest of 14% of the total investment (₦100,000)		28,000
Maintenance 2% of ₦200,000		4,000
Insurance, Share of Admin. Cost:		4,000
Total Overhead Cost per Year	=	₦ 56,000
Overhead Cost Per Day		
For 250 working days per year the overhead cost will be: $\frac{56,000}{250}$		₦224.00
Income per Day		
Fish meal at ₦400/t (2.3 tonnes)		920.00
Fish Oil at ₦450/t (0.75 tonnes)		337.50
		₦1,257.50

Table 2 (contd.)

Total Income per Day		
Less Operation		₦245.00
Overhead Cost per day		+ 224.00
Overhead Cost per day	=	469.00
Raw Material		
(Fish offal) at ₦30/tonne 12.5t =		₦375.00

Net Profit per day = ₦1,257.50 - ₦469.00

= ₦788.50

Net Profit per Year = ₦197,125.00

Foot Note:

Fish meal plant without stickwater concentrating plant. Plants equipped with stickwater concentrating plant yield 20 to 30 times more fish meal per day.

SOME USEFUL HINTS TO POTENTIAL INVESTORS

Though the profit margin in the foregoing proposal is quite attractive, potential investors should not lose sight of the following details:-

(1) Raw Material

The price and availability of raw materials at regular intervals determine the feasibility of a fish meal plant. Too costly a raw material will reduce the projected profit margin, and deficiency in regular supply of raw material will lead the industry towards liquidation. The yield of the final product is determined by the quality of raw material. Poor quality raw material will give low fish meal content. Raw materials with high fat content are usually prefered since the fat is held against water and not against protein. The fat after extraction will increase revenue from sale of fish oil.

(ii) Market for fish meal

This must be considered at the initial planning stage. With the prevailing high demand on livestock feeds, there appear to be a ready market for fish meal. Investors must be able to locate the feed mixing companies and work out the potential demand before commencing production. A pilot fish meal plant at the initial stages might be necessary to study the market for fish meal, rather than an outright engagement on large scale production.

(iii) Location of Plant

A fish meal plant should be sited close to the source of raw material to prevent incurring additional cost on transportation. There should be constant supply of electricity and water. The main source of electricity should be from the national power grid and a stand-by generator should be available to serve during power cuts. The plant should be located away from the residential areas to prevent off-odours reaching the areas.

(iv) Packaging Materials

The packaging material should be such that would protect the meal against insect infestation, seepage and rapid movement of water vapour and oxygen which encourages growth of moulds and bacteria. The use of jute bags as packaging materials should be discouraged because the holes in the bag allow destruction of the meal. Plastic bags are safe but the meal must be packed and stored immediately it emerges from the drier.

(v) Storage of Fish Meal

Fish meal with high oil content usually presents a problem during storage due to fat oxidation accompanied by a rise in temperature. This might lead to fire outbreak if the

bags are stacked. Antioxidants could be used to stabilize the meal after leaving the drier. 400-700 ppm ethoxyguine should be added to the dried meal to prevent oxidation.

(vi) Pollution

The breakdown of fish flesh caused by bacterial activity and enzymes produces obnoxious odours which could be unpleasant to those living in the neighbourhood of the plant. Some of the gases produced such as hydrogen sulphide are very harmful. The effluent air could be deodourized before leaving the factory by installing a deodourising equipment.

CONCLUSION

The production of fish meal from fish waste which are of minor value as food for human consumption has been recommended as a profitable means of arresting the losses currently being experienced in the fishing industry. Potential investors should ensure that the raw materials and market for the finished products are guaranteed before investing on large scale production of fish meal.

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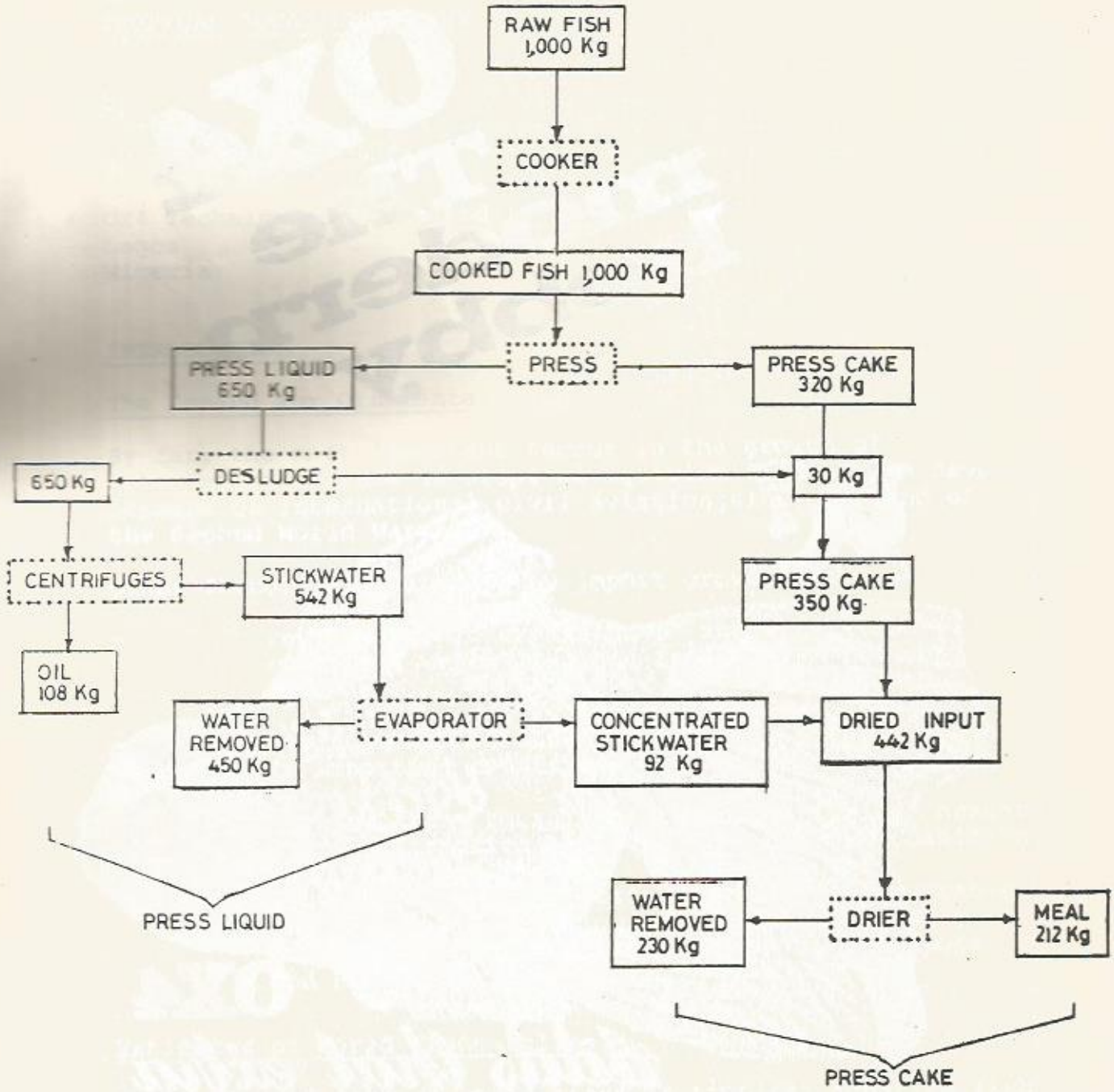
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Fig. 2. Outline of a Typical Manufacturing process for Fish Meal.



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INVESTMENT OPPORTUNITY IN AQUARIUM TECHNOLOGY - EXPORT MARKETING OF TROPICAL AQUARIUM FISHES

by

O. Odunaiya

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Nigeria

INTRODUCTION

The Demand for Ornamental Fish

By far, the most important factor in the growth of international trade in tropical aquarium fish is the development of international civil aviation since the end of the Second World War.

Other factors contributing to import growth are:-

- rapid economic expansion of industrialised countries which resulted in improved living standards.
- rising costs of breeding tropical aquarium fish in importing countries.
- the inability to raise more than a limited number of exotic species outside their national habitats.
- improved supplies of tropical fish at favourable prices, by some developing countries, notably those in South-East Asia, especially Singapore and Hong Kong.

Estimates of World Trade Volume

Comprehensive data on world trade in tropical aquarium fish are not available. However, in a study conducted by the International Trade Centre in 1979, world trade in tropical aquarium fish was estimated at about:

i) 600 million dollars annually at wholesale level.

ii) 200 million dollars annually (C&F) in terms of imports and

iii) 120 million dollars annually f.o.b.

These estimates were based mainly on discussions held with representatives of the trade in the market surveyed.

The study further revealed that the demand for aquarium fish in the markets surveyed has grown since the 1960's at an average annual rate of 10 - 15 per cent.

Taking into account the growth in demand and also the negative impact of the global economic recession, the general increase in airfreight rates and the upheavals in the foreign exchange markets in recent years, the current world trade in tropical aquarium fish may be conservatively estimated as follows:-

i) 1,157 million dollars annually at whole sales level

ii) 385 million dollars annually in terms of imports (C&F); and

iii) 231 million dollars annually f.o.b. values to exporting countries.

THE MAJOR MARKETS

The major importing countries are the United States, Japan, the Federal Republic of Germany, the United Kingdom, and the Netherlands in that order. The U.S.A. alone accounts for 54% of the estimated wholesale trade in tropical fish. The corresponding percentage for Japan and Western Europe are 8 and 21% respectively.

THE SUPPLY OF ORNAMENTAL FISH

Present Supply Patterns

Exports of tropical aquarium fishes originate as follows:

Asia -	60%
South America -	30%
Africa, Caribbean and other Areas -	10%

Nigeria's share of the exports in Africa is about 20% - in other words, 2% of world total. Thus, although Nigeria has vast natural resources of tropical aquatic life and the right climate to breed same, her exports of fish are estimated at only 5% of the total potential. Thus the potential market for Nigeria's species is only beginning to be explored.

The state or condition of the ornamental fish export trade in Nigeria is yet far from satisfactory. This is due mainly to lake of technical know-how concerning:

1. Breeding

2. Collection and packaging methods.

Lack of adequate market information and suitable air transport to some target markets are also linking factors.

Virtually, all freshwater species currently exported from Nigeria are caught wild, whereas in the leading areas of tropical fish export, e.g. South-East Asia, most of the freshwater species exported are bred in captivity. Exports from Hong Kong and Singapore, for example, include not only native species but also varieties raised from breeding stock imported from other parts of the world.

This trend in leading exporter countries, of course, has tremendous implications for fish farms in Nigeria wishing to go into the aquarium fish export trade. If the required facilities and technical know-how for breeding is present, Nigerian species whose export are limited to certain seasons of the year may now be exported as and when required. Furthermore, tropical species not naturally available in Nigeria can now be bred for export. Indeed, certain cold water-fishes, in particular the Koi Carp have already been successfully bred in Nigeria. But it would appear that the fish farms that have achieved that success are yet to realise its commercial importance both in local and export trade.

CONCLUSIONS AND RECOMMENDATIONS

The reality of today suggests the need to take more positive action in promoting Nigeria's non-oil exports.

In order to build up exports of tropical aquarium fish, the following recommendations should be noted:

(i) Importation of essential equipment for the trade should be duty-free. Such equipment include - air-pumps, prophylactic and curative drugs, specialised lighting, power-filters, pH and hardness testing kits, generators and outboard motors.

(ii) There should be an accelerated programme to assess and identify the ornamental fish available in Nigeria. Such programme should be spearheaded by the Fisheries Department.

(iii) There is need for a nation-wide drive to popularise ornamental fish in the country.

(iv) The Fisheries Department should train selected volunteers from the public and private sectors for advanced field and laboratory study in all aspects of ornamental fish and plants, small frogs, lizards and other elements of interest to the pet trade abroad.

(v) Universities that offer courses in aquarium technology should lay emphasis on tropical fish exports.

(vi) Exporters' Guide and Importers' Guide

There is a need to compile an "Exporters' Guide"

i.e. a list of names and addressess of reliable importers/wholesalers of tropical aquarium fish in the major markets so that exporters in Nigeria may be able to avoid dealing with casual and unethical importers. Similarly, an "Importers' Guide" listing names and addresses of reliable Nigerian exporters of tropical aquarium fishes.

(vii) Trade Association

All Nigerian exporters of ornamental fish should come together to form a trade association. Such association would represent their interests and promote the development of the industry and of the trade.

Such association may for instance:-

a) decide for uniform pricing

b) negotiate with airlines to ensure satisfactory transport at reasonable costs.

COMMERCIAL PRACTICES

(i) Relations Between Importers and Exporters

Established wholesalers tend to be very selective with regard to their suppliers, and are generally faithful to reliable exporters. However, long-term contractual agreement between a supplier and an importer do not exist.

(ii) Payment

There are no set patterns for payment for imported fish. But letters of credit are rarely used.

(iii) Deduction for Losses

Some importers invariably deduct the cost of dead fish, although many adopt a more lenient approach to their regular suppliers.

(iv) Communication

Communication between the importer and exporters is generally by telex, telephone or cable.

(v) Unethical Business Practices

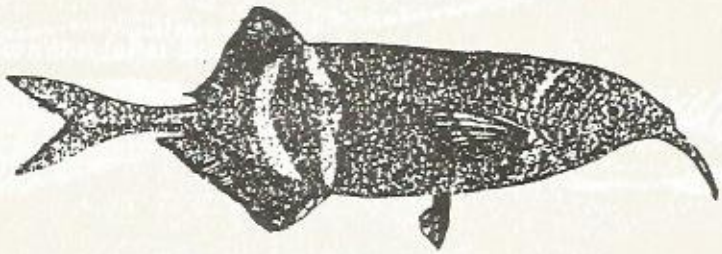
Casual importers often fail to pay for supplies received. Similarly, some regular importers eager to obtain cheaper fish have lost money by making advance payment to some unreliable exporters. On balance, exporters have incurred bigger losses.

(vi) Selling Prices and Margins

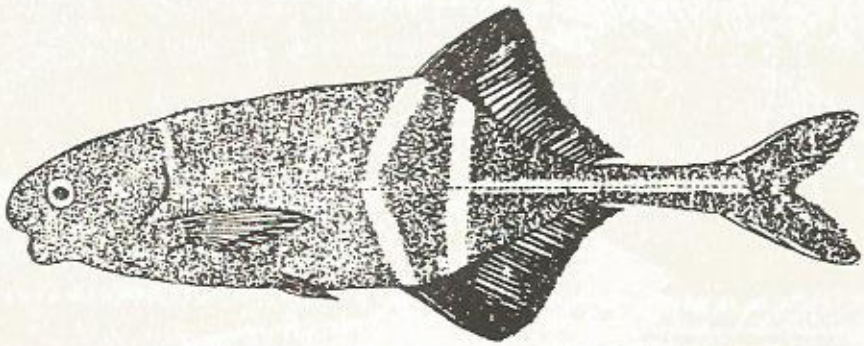
In f.o.b. terms, there has been little changes in the prices of fish since the late 1960's.

APPENDIX 1

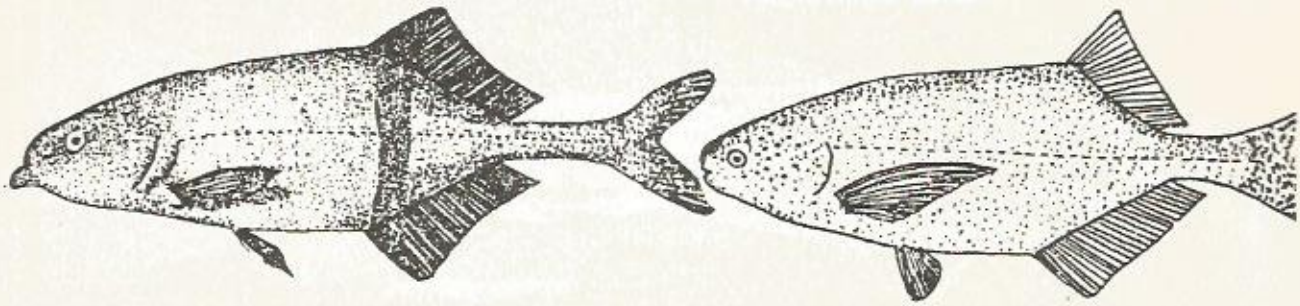
SOME TROPICAL AQUARIUM FISH AVAILABLE WILD IN NIGERIAN WATERS



Gnathonemus petersii

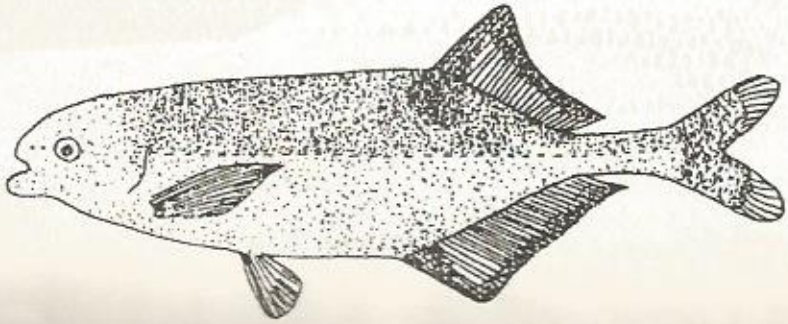


Gnathonemus pictus



Gnathonemus deboensis

Gnathonemus niger

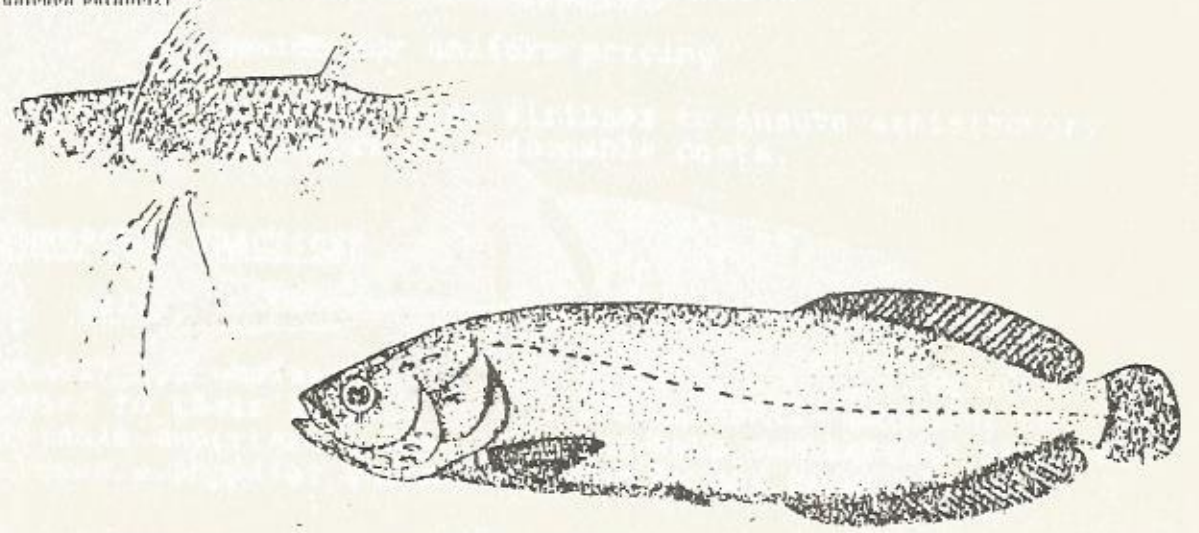


Gnathonemus senegalensis

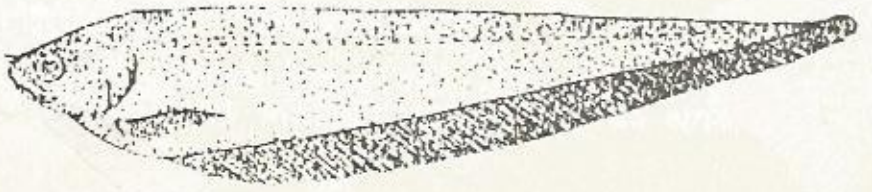


Butterflyfish
Pantodon buchholzi

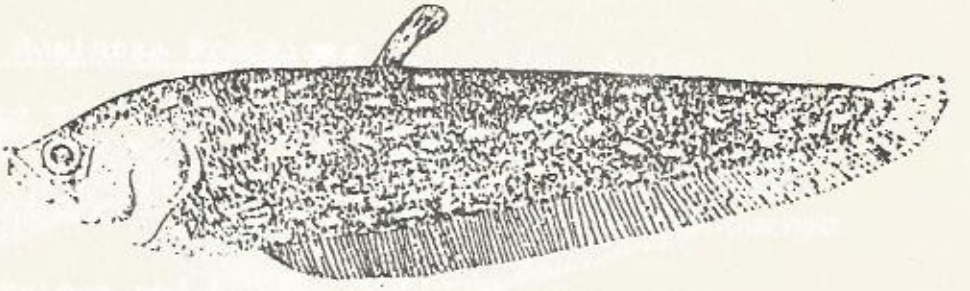
Gymnarchus niloticus



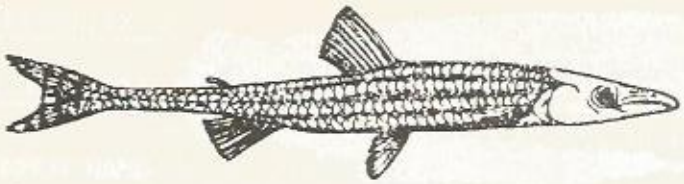
Heterotis niloticus



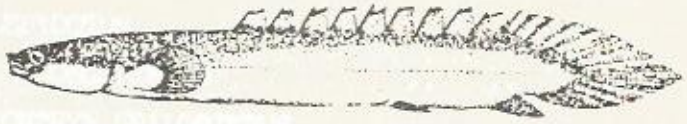
Xenomystus nigri



Papyrocranus afer



Phago loricatus (after Boulenger).



Polypterus senegal[illegible]egalus



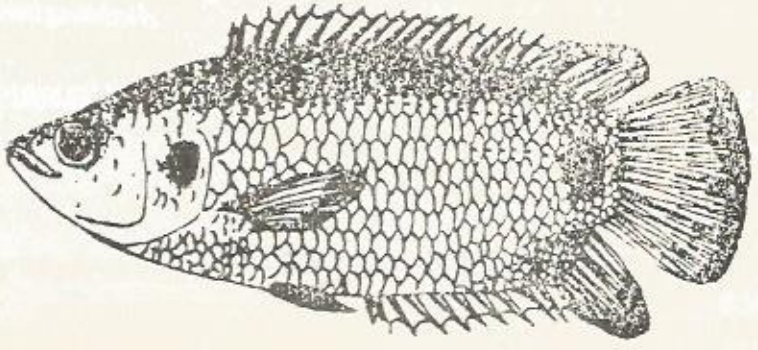
Calamichthys calabaricus



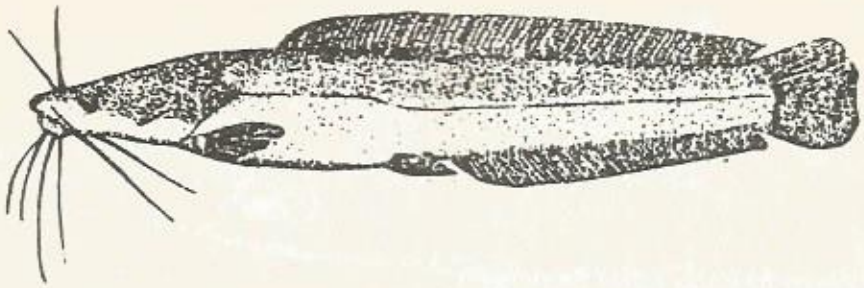
Polypterus bichir laprade



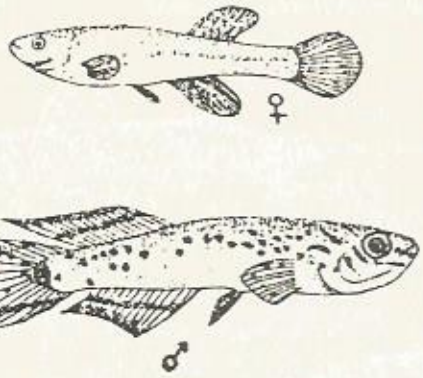
Polypterus ansorgei



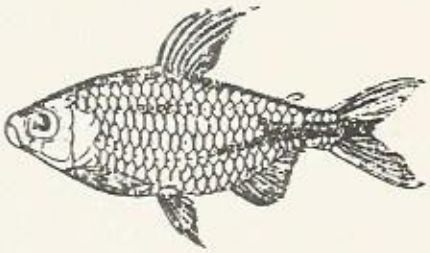
Ctenopoma kingsleyae



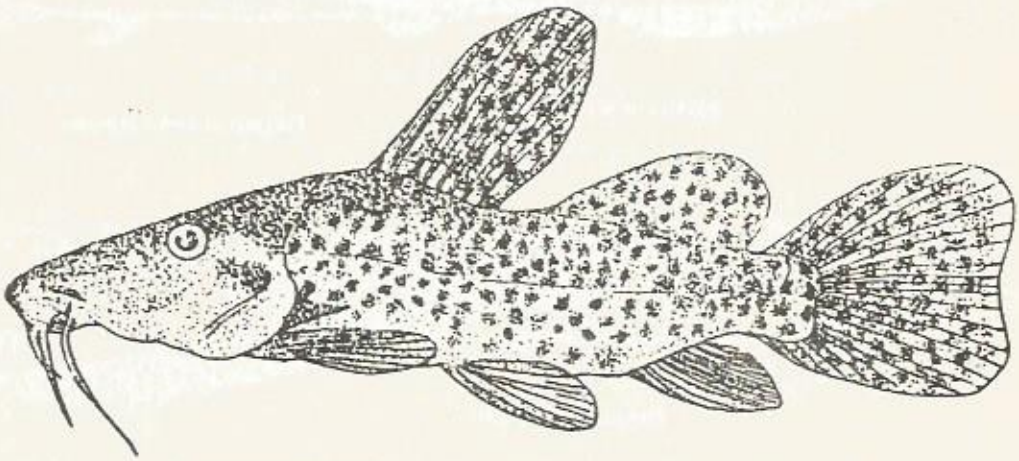
Clarias lazera



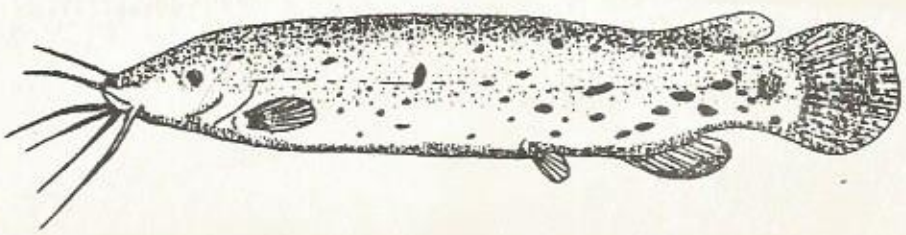
Aphyosemion gardneri, male and female



Alestes longipinnis



Auchenoglanis occidentalis



Malapterurus electricus

APPENDIX 2

A TYPICAL EXPORT PRICE LIST OF SELECTED TROPICAL AQUARIUM FISHES

	COMMON NAME	SCIENTIFIC NAME	PRICE PER FISH
1.	LONG NOSE	GNATHONEMUS PETERSI	$1.00
2.	SHORT NOSE	GNATHONEMUS MOORI/SCHILTHUISI	50c
3.	ROUND NOSE	RACROLEPIDOTUS	50c
4.	ALESTES	ALESTES LONGIPINNIS	40c
5.	REDEYE	AROLDICHTHYS SPILOPTERUS	50c
6.	SNAKE FISH (REED)	CALABARICUS CALAMOICHTHYS	50c
7.	BUTTERFLY	PANTODON BUCHOLZI	50c
8.	KRIBENSIS	PLEMATOCHROMIS KAIBEMISIS	50c
9.	UPSIDEDOWN CAT	SYNODONTIS NIGRIVENTRIS	50c
10.	sorted CAT	OARACGEYGKABTUS NACRISTINA	50c
11.	ALUMINIUM CAT	SYNODONTIS NUMMIFER	40c
12.	CLARIAS CAT	- -	40c
13.	ELECTRIC FISH	MALAPTERUNIDAE ELECTRICUS	$1.80
14.	KNIFE FISH	XENOMYSTUS NIGAI	50c
15.	SPINY EEL	MASTOCEMBELUS ARGUS	50c
16.	JEWEL	HEMICHROMIS	40c
17.	DEBAUWIE	ENTROPIELLA DEBAUWIE	30c
18.	GRASSCUTTERS	SCHILBE MYSTUS	30c
19.	SNAKE HEAD	OPHIOCERPHALUS SENEGALUS	50c
20.	MUD SKIPPERS	PERIOPHTHALMUS BARBARUS	50c
21.	MONO	MONO SABAE	$1.00
22.	APHYOSEMIOM	APHYOSEMION (VARIOUS)	40c
23.	BLUE FISH	- -	30c
24.	GLASS FISH	KRYRTOPTERUS BIGRRHIS	40c
25.	LAMP EYE	- -	30c
26.	PENCHAX	EPIPLATUS SEXFASCIATUS	30c
27.	GOBY	- -	30c
28.	ZEBRA	- -	30c
29.	BUSH FISH	- -	30c
30.	POLYPTERUS	POLYPTERUS PALMAS	$1.00
31.	ABA	GYMNARCHUS NILOTICUS	$1.00 $36.00
32.	FROGS	- -	50c
33.	AFRICAN LEAF FISH	CTENOPOMA ACUTIROSTRE	30c
34.	AROWANA	- -	$36.00
35.	LUNG FISH	- -	$10.00

ECONOMIC ANALYSIS OF UTILISING KAINJI GAS KILN FOR FISH SMOKING IN THE KAINJI LAKE BASIN OF NIGERIA

by

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ABSTRACT

Marketing of smoked fish in the Kainji Lake Basin has been found to be complex, traditional and inefficient. It is also said to be limited in scope due to poor handling and processing techniques, lack of storage facilities and inadequate marketing informations.

The invention of Kainji Gas Kiln has been found suitable to overcoming poor handling and processing techniques.

This paper discusses the feasibility of operating Kainji Gas Kiln commercially supported with adequate storage facilities and competent management hands. The financial indicators of Net Present value (NPV) ₦47,481.11, Internal Rate of Return (IRR) 24% and Payback Period of 2.3 years that are calculated confirmed that the commercial use of Kainji Gas Kiln is indeed profitably feasible.

INTRODUCTION

Lake Kainji, to most Nigerian households is synonymous with FISH as workers from New Bussa to any part of Nigeria would always be accused of not taking fish along with them. Although such accusations are usually in a form of jokes, indeed, it is an indication of shortage of fish supply from the lake basin to meet the demands in other parts of the country.

This claim needs further investigation as to whether or not it is the distribution channels of fish from Lake Kainji that creates the short supply and also whether or not it is the question that fish is not just in the lake.

Ita (1982) provided us with an answer to the second part of the question raised in this assurance that the fish yield from Lake Kainji seems to have stabilised between 4,000 - 6,000 metric tonnes per year. This meant that with adequate fishing technology and distribution channels, a lot of fish catch could still be expected from the lake although the current daily catch per unit effort of a fisherman is estimated at 10 kg. Since there is no law regulating either

the number of fishermen that could fish or the quantity to catch in any day, the yield of a fisherman entirely depends on his fishing technology and effort. The claim could then be that there is fish in the lake but the distribution channel is faulty.

Babalola (1972) looked into the distribution techniques of fresh fish from the lake and concluded that inefficient marketing organization, inadequate market information and poor handling are the major problems militating against disposing the fishermen's catch. This then confirms the assertion that it might be the distribution channels that is faulty.

Anthonio (1973) in his studies of smoked fish marketing in Yelwa, noted a number of problems. These problems include inadequate marketing facilities and inefficient traditional processing and storage techniques. He further highlighted that fishermen travel long distances before reaching the market and that grading, packaging and transportation facilities are the major limiting problems to rapid expansion of the distribution of fish.

Whilst Anthonio's studies were on the Eastern side of the lake, Jawando (Personal Communication) also made a similar study on the Western side of the lake covering Old-Bussa-Rofia with similar conclusions to those of Anthonio.

Eyo (1983) made vivid exposition of improved techniques on fish processing, handling, storage and transportation which he identified as limiting problems of fish distribution in the Kainji Lake Basin. Notable amongst his contributions was his invention of Kainji Gas Kiln which can be used for smoking of fish (Eyo, 1981).

A commercial proposal of this Kiln is now made to afford any interested business concern an opportunity of marketing fish smoked with the Kainji Gas Kiln so that a wider Nigerian population will be disposed to appreciate the taste and flavour of smoked fish landing from Kainji Lake. This proposal was made on a study conducted by the authors to identify a number of fish landing centres that are viable as collection centres for the project (Figure 1).

STUDY AREA

The Kainji Lake is situated between latitudes 9° 50' - 10° 57' North and longitudes 4° 25' - 4° 45' East. The lake which was impounded on 2nd August 1968 is 136.8 km maximum length and 24.1 km maximum width. Its surface area has been variously quoted as approximately 1,300 km^2. At full volume, the water level is at altitude 142 m and at low volume, the water level is 133 m. It is 1,014.3 km by river from the sea along river Niger and about 563.5 km by road from Lagos.

METHODOLOGY

In carrying out this study, motor-cars, motorcycles, canoes mounted with outboard engines and bicycles depending on locations, were used to move in between villages covered in the study. For example, canoe was used to cross from Rofia to Zamare enroute to Yelwa in Sokoto State. Other materials include spring balance, scales for weighing both fresh and dried fish. Baskets and plastic containers were used for samples of units of packaging before sale. In addition, a questionnaire jointly prepared by the authors were administered in all the centres shown in Figure 1. A total of 116 respondents were interviewed comprising 39 full-time fishermen, 24 fish sellers (middlemen and women), 40 fish consumers, 2 fisheries officer, 4 superintendents and 8 extension field staff. The questionnaires sought to know the role of each group of the respondents, their problems and prospects.

The questionnaires were also administered at the Dam Site to fish traders from Ilorin and Ibadan. Some of these traders went as far as Shagunu, Rofia and Yauri markets. These distant traders come to buy smoked fish mainly and it was on this observation that our proposal was based.

RESULTS AND DISCUSSIONS

This proposal requires the following inputs:

(a) 2 Kainji Gas Kilns (Size 0.92 x 0.76m x 1.24 each) (Figure 2)

(b) 1 Freezer

(c) 1 Generator (1.5 kv)

(d) 2 Cold vans

(e) 4 Gas cylinders

(f) 2 Fisheries Assistants

2 Labourers and 2 Drivers

(g) Building.

Each of this is explained to indicate their relevance(s) to the proposal.

(a) Kainji Gas Kiln

The technicalities in the use and operation of Kainji Gas Kiln have been explained by Eyo (1981). The smoking capacity of each kiln is 80 kg per 4 hours or 160 kg per man-working day of 8 hours. In this proposal, it is not intended to use the kiln to capacity but rather each kiln will smoke 50 kg of fresh fish per 4 hours. A 12-hour man-working day is

envisaged and it is believed that about 150 kg of fish can be smoked per kiln thus, giving a total of 300 kg for the two kilns per 12 hours man-working day. The two kilns are expected to work for 260 days in a year excluding weekends.

(b) Freezer

The freezer will be stationed at the smoking centre in New Bussa. It will be used to store excess fresh fish which the kilns may not handle during any particular day. This will ensure that the fish are kept wholesome especially during weekends when the smoking kilns will not be in use.

(c) Generator

One generator of capacity 1.5 kv will be required as standby in case there is power failure from NEPA to the smoking centre

(d) Cold van

Cold van is particularly favoured for this proposal because it could be used to transport cold smoked or hot smoked fish by switching the Thermo-king on or off. It can also be used to transport fresh fish to meet customers request who may need fresh fish at the marketing centres. An open Pick-up van may not be ideal for transporting fresh fish without adequate freezing facilities.

Two cold vans are, therefore, required for this project. One will go round to collect fresh fish from different landing centres as far as Shagunu to the smoking centre. The other will be used to transport the smoked fish to the marketing centres possibly Ilorin and Ibadan three times in a week.

(e) Labour

The services of two Fisheries Assistants and two Labourers will be required, a labourer to an assistant.

One assistant and a labourer will man one cold van that will collect fresh fish from different landing centres whilst the other pair of labour will man the smoking centres. The Fisheries Assistants will be on Grade Level 04 (₦1,800), while the labourers will be on Grade Level 01 (₦1,500). The two drivers who will drive the two cold vans will be placed on Grade Level 03 (₦1,600) each.

(f) Building

The building is expected to be cement floored to cover an area of 8 x 6 m. Out of this unit, a store of size 2 x 6m will be partitioned to hold the smoked fish before being transported to the marketing centres. This building is estimated at ₦4,000.00

Purchases

An average of ₦5.00/kg of fresh fish is suggested for this proposal in order to encourage and to ensure the patronage of fishermen in various landing centres shown in Figure 1. This is because the average price of ₦5.00 is considered enough to penetrate the fishermen that are interested in disposing of their daily catches. Market women prices is about an average of ₦4.00 per kilogramme. It should be mentioned that this price takes cognisance of price differentials offered to various fish species. For example, the price of Lates niloticus cannot be the same as the price offered to Tilapias. On the total average price of purchases, an estimate of ₦5.00 per kilogramme is considered an acceptable market price.

An estimated 320 kg daily pruchases of fresh fish is proposed from all over the lake basin. The purchases will be made on Saturdays and Sundays inclusive. On this basis, it is expected that 116.8 tonnes of fresh fish will be purchased in a year at an estimated cost of ₦584,000.00

Sales

Only marketing of smoked fish is proposed and as such all sales have to be smoked fish except on occasions when fresh fish is specially requested. Of the 116.8 tonnes of fresh fish to be purchased in a year, 3% is written off to spoilage which may be accidental. Of the remainder, 20% is written off to loss in weight due to smoking. It is expected that a total of 90.6 tonnes of smoked fish will be sold at ₦7.50 per kg. This price is considered very low but for purposes of uncertainty in proposals, it is believed to be a good offer. The turn over in one year will then be ₦679,776.00.

ECONOMIC ASPECTS

The business proposal as indicated is expected to provide employment for five men on full-time basis. It is expected to lead to effective, rational and sustainable use of fisheries resources in Kainji Lake.

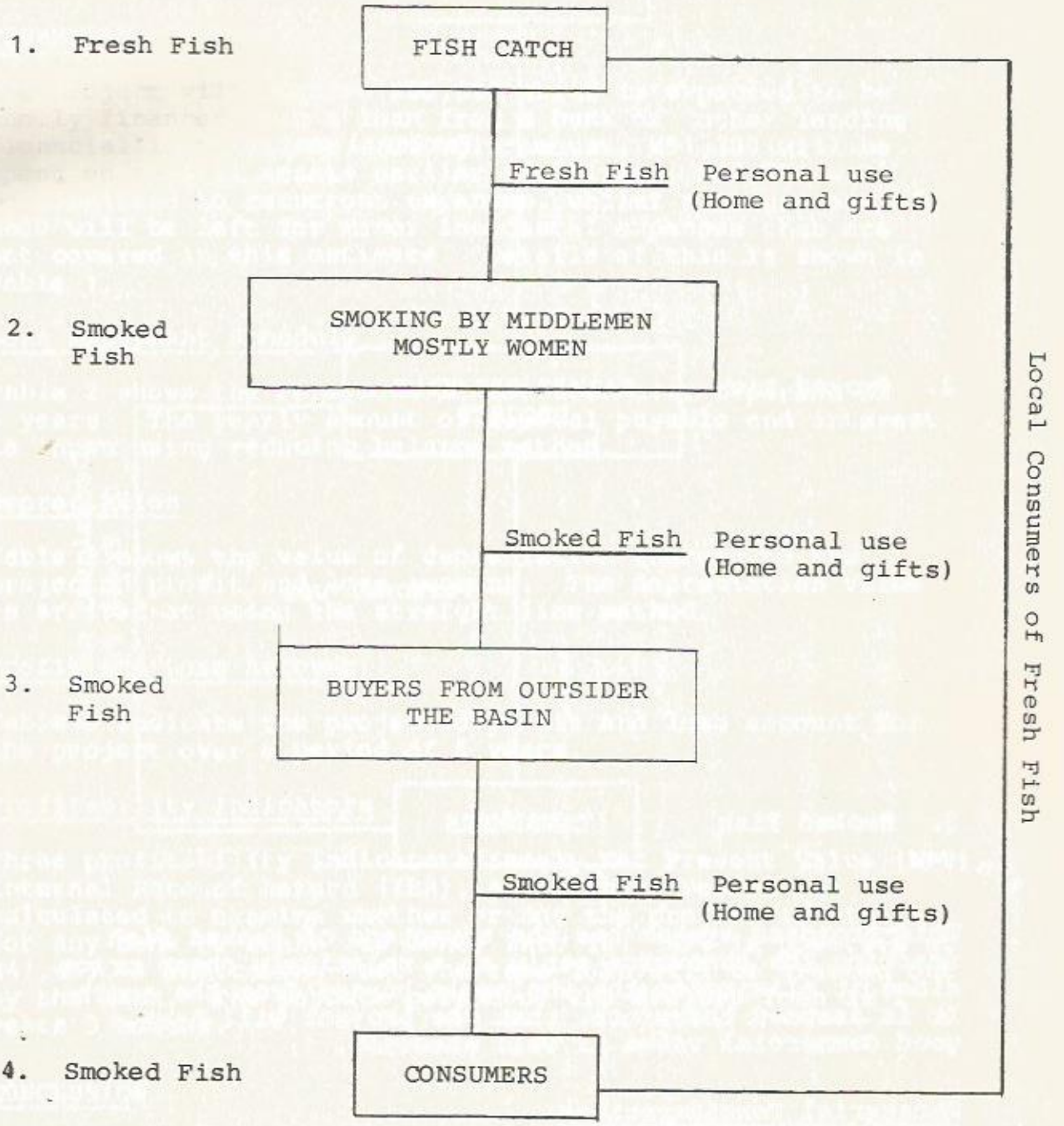
Besides the components which will go into assembling Cold Vans by Peugeot Automobile of Nigeria (PAN) and ALUMACO (Nig) Ltd, there is no other equipment in use that will be imported. Thus, the proposal draws little or nothing on foreign exchange reserves of the Federal Government of Nigeria.

When in operation, the proposal will be an increased source of revenue for the Government since a steady income is ensured to the fishermen who will in turn pay their community taxes promptly and also company tax of 45% to be paid by the project. Thus, it can be said that the proposal presents economic opportunities in terms of revenue, employment and rational use of resources to the nation.

Commercial Considerations

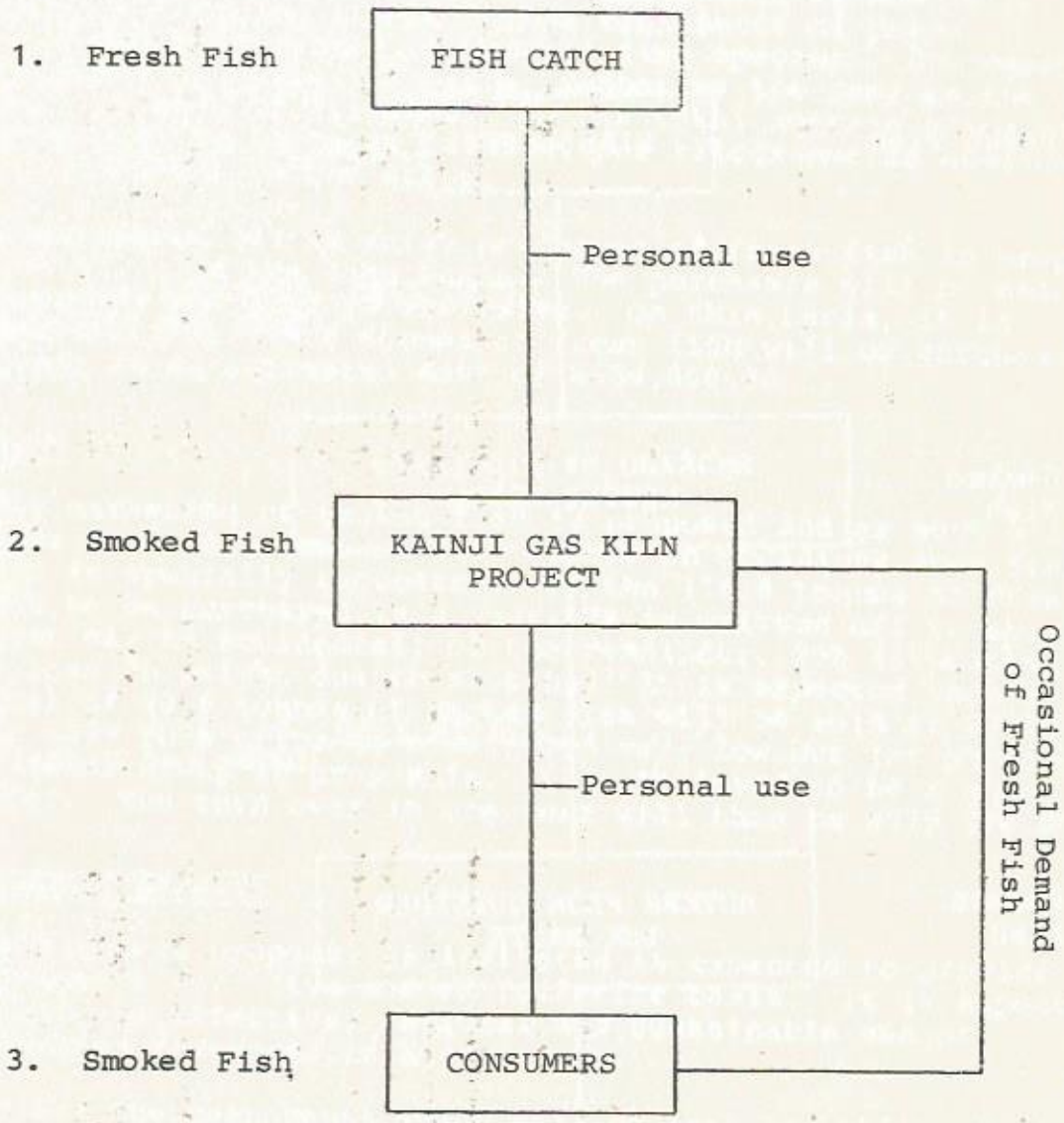
The existing system of fish distribution and marketing in the Kainji Lake basin can be diagrammatically represented as follows:-

Figure 2: Existing channels of Fish Distribution in Kainji Lake Basin



This system has been described inefficient, traditional and complex by various authors earlier mentioned. To overcome this, this proposal will combine stages 2 and 3 to become:-

Figure 3: Proposed Structure of Marketing Smoked Fish in the Kainji Lake Basin



This proposed system has the advantage of smoked fish reaching the consumers early at a relatively cheap price since it eliminates the wholesale buyers from the south. It is assumed therefore, that the project will have a good commercial value if well executed.

Managerial Considerations

The project will be manned by two trained Fisheries Assistants who will ensure that the fish are properly handled before smoking. The assistants will supervise the dressing, brining and smoking at the centre. The labourers will be engaged in doing routine jobs.

The overall control of the unit will be by the Managing Director, or individual that goes in for a loan to start off the project

At the apex of the line of authority is the Managing Director who takes the loan. Next is the Fisheries Assistants, the Drivers and the Labourers. The drivers and the labourers will be under the control of the Fisheries Assistants to ensure discipline and timely discharge of duty.

FINANCIAL PLAN

The project will require ₦80,000 which is expected to be wholly financed with a loan from a bank or other lending financial institutions. Of this amount, ₦51,300 will be spent on capital assets earlier identified, ₦28,700 will be committed to recurrent expenses, whilst a meagre sum of ₦800 will be left for minor incidental expenses that are not covered in this estimate. Details of this is shown in Table 1.

Loan Repayment Schedule

Table 2 shows the repayment of the loan over a period of 5 years. The yearly amount of capital payable and interest is shown using reducing balance method.

Depreciation

Table 3 shows the value of depreciation charged to the projected profit and loss account. The depreciation value is arrived at using the straight line method.

Profit and Loss Account

Table 4 indicate the projected profit and loss account for the project over a period of 5 years.

Profitability Indicators

Three profitability indicators namely Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period are calculated to examine whether or not the project is viable for any bank to stake its money into it. NPV is positive at ₦47,481.11 indicating that the rate loan will be granted out by the bank. The payback period of the ₦80,000 loan is 2 years 3 months.

CONCLUSION

It is important to note here that utilising the Kainji Gas Kiln for smoking fish in the Kainji Lake Basin is a profitable venture. The authors therefore, consider it worthwhile to recommend its establishment to any interested individuals. The amount of loan required for it is within the limit offered to small-scale enterprises and therefore, the three indicators above are sufficient criteria for a bank to honour a request for such a loan.

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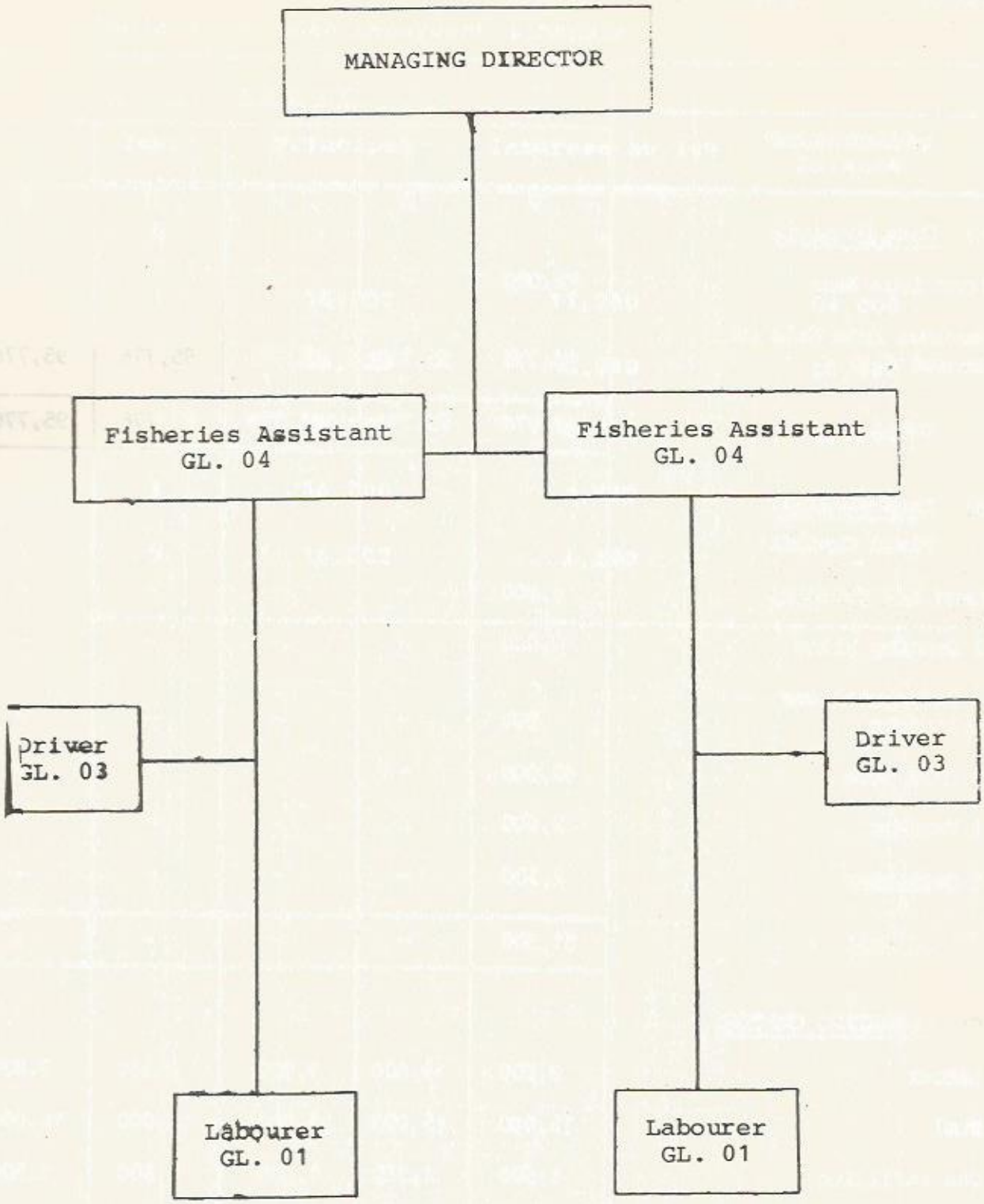


Fig. 4: Organizational Chart of Smoked Fish Marketing Proposal

Table 1 - Cash flow statements

PARTICULARS	YEARS				
	1	2	3	4	5
	₦	₦	₦	₦	₦
A) Cash Receipts					
Loan from Bank	80,000	-	-	-	-
Revenue from Sale of smoked fish	95,776	95,776	95,776	95,776	95,776
Total =	175,776	95,776	95,776	95,776	95,776
B) Cash Payment:					
Fixed Capital:					
Land and Building	4,000	-	-	-	-
2 Smoking kilns	2,000	-	-	-	-
4 Industrial Gas cylinders	800	-	-	-	-
2 Cold vans	40,000	-	-	-	-
1 Freezer	2,000		-	-	-
1 Generator	2,500	-	-	-	-
Total =	51,300	-	-	-	-
C) OPERATING CAPITAL					
Labour	9,800	9,800	9,800	9,800	9.800
Fuel	15,000	15,000	15,000	15,000	15.000
Gas refilling	1,500	1,500	1,500	1,500	1.500
Cartons & Film bags	1,600	1,600	1,600	1,600	1,600
Contingency	800	800	800	800	800
Total =	28,700	28,700	28,700	28,700	28,700
D) Personal Drawings	15,000	15,000	15,000	15,000	15,000
E) Loan Repayment Plus Interest at 14%	27,200	24,960	22,720	20,480	18,240
F) Total Cash Outflow (B + C + D + E)	122,200	68,660	66,420	64,180	61,940
G) Expected Cash Inflow (A - F)	53,576	27,116	29,356	31,596	33,836

Table 2 - Loan repayment schedule

Year	Principal	Interest at 14%	Outstanding Balance
0	-	-	80,000
1	16,000	11,200	64,000
2	16,000	8,960	48,000
3	16,000	6,720	32,000
4	16,000	4,480	16,000
5	16,000	2,240	-

Table 3 - Depreciation

Type of Equipment	Value	Expected Life Span (years)	Depreciation Rate %	Annual Depreciation Value				
				1	2	3	4	5
Building (8m x 6m)	4,000	10	25	400	400	400	400	400
Smoking kilns (2)	2,000	15	10	133	133	133	133	133
Industrial gas Cylinders	800	30	5	26	26	26	26	26
Cold Vans (2)	40,000	5	30	8,000	8,000	8,000	8,000	8,000
Freezer (1)	2,000	5	25	400	400	400	400	400
Generator (1.5 kv)	2,500	10	15	250	250	250	250	250
Total =	51,300	-	-	9,209	9,209	9,209	9,209	9,209

Table 4 - Projected profit and loss account

Particulars	YEARS				
	1	2	3	4	5
	₦	₦	₦	₦	₦
Revenue from sale of smoked fish	95,776	95,776	95,776	95,776	95,776
Less Operating Capital	28,700	28,700	28,700	28,700	28,700
Operating Profit	67,076	67,076	67,076	67,076	67,076
Less Depreciation	9,209	9,209	9,209	9,209	9,209
Gross Profit	57,869	57,869	57,869	57,869	57,869
Less Interest on Loan at 14%	11,200	8,960	6,720	4,480	2,240
Net Profit before Tax	46,667	48,907	51,387	53,387	55,627
Less Company Tax at 45%	21,000	22,008	13,016	24,024	25,032
Net Profit After Tax	25,667	26,899	28,131	29,363	30,595

Table 5 - Economic viability indicators

Year	INCOME		EXPENDITURE		BENEFITS	
	Actual	Discounted value at 14%	Actual	Discounted value at 14%	Actual	Discounted value at 14%
0	-	-	51,300	51,300.00	51,300	51,300.00
1	95,776	84,013.75	70,900	62,192.77	24,876	21,820.98
2	95,776	73,696.76	68,660	52,831.81	27,116	20,864.95
3	95,776	64,645.93	66,420	44,831.51	29,356	19,814.42
4	95,776	56,707.05	64,180	37,999.69	31,596	18,707.36
5	95,776	49,743.18	61,940	32,169.78	33,836	17,573.40

N P V = 47,481.11

Payback period = 2.3 years. IRR = 24%

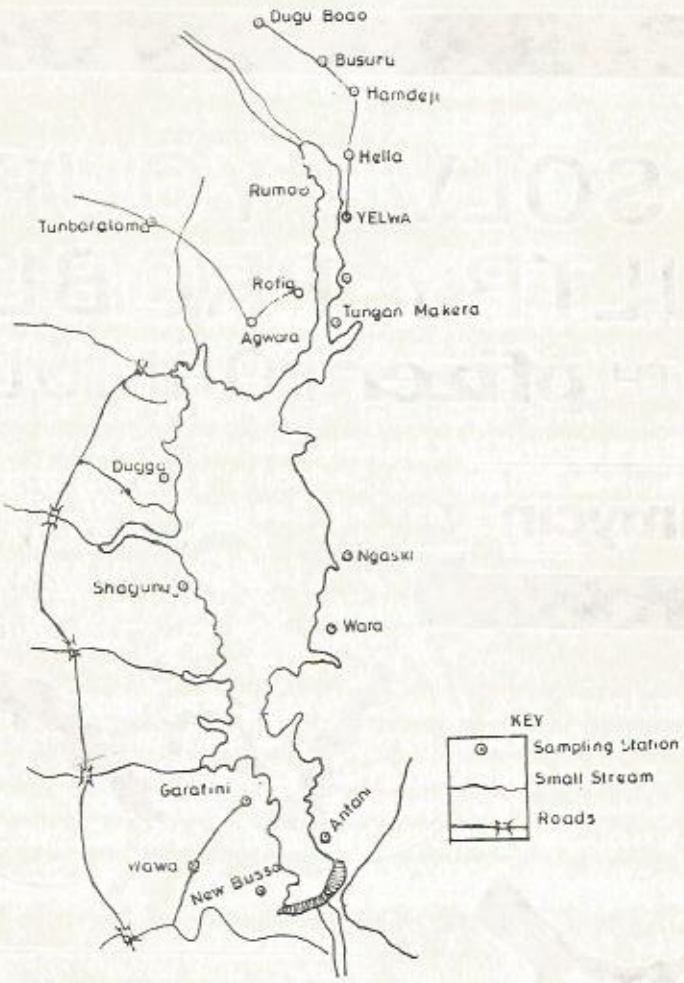
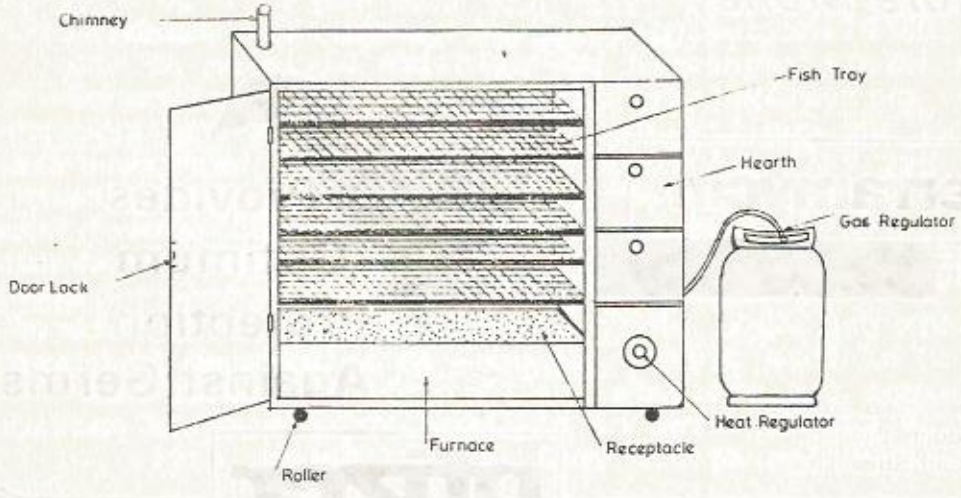


Fig. 1 Map of Kainji Lake Showing Sampling Locations.

Fig. 2 Diagram of the completed medium size Kainji Gas Kiln



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SECTION 4: INVESTMENT PROSPECTS IN FISH FARMING

INVESTMENT PROSPECTS IN INTEGRATED FISH AND POULTRY FARMING PROJECT: THE KAINJI LAKE RESEARCH INSTITUTE INTEGRATED FISH AND POULTRY FARM MODEL

by

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ABSTRACT

The paper examines the feasibility of a small scale integrated fish and poultry farming project based on an existing experimental model currently in operation at the Kainji Lake Research Institute, New Bussa. The Financial analysis reveals a viable investment based on the output from a two hectare fish pond or reservoir.

INTRODUCTION

Ita (1980) reviewed the major advances in warm water aquaculture research and emphasized the increasing popularity of the combination of animal rearing with fish culture because the animals also reproduce and increase the economic prospects of fish farming. Otubusin (1983) also reviewed extensively, the literature on the combination of poultry with fish farming and proposed an integrated guinea-fowl and fish culture in Lake Kainji.

In 1981, the Fisheries Division of Kainji Lake Research Institute (KLRI) requested the Wildlife Division of the Institute, currently investigating on the production of guinea-fowl and poultry, to estimate the daily poultry droppings per unit weight of layers so as to determine the number of layers that could be raised to fertilize a fish pond of a given surface area. Wickliffe (1981) showed that a layer of average body weight of 1kg may produce between 0.09 - 0.10kg of droppings per day or between 0.7 - 0.8kg of droppings per week. With this knowledge of the rate of application of this organic manure, an integrated fish and poultry farmer can estimate the population size of his poultry, the surface area of his pond and can set a particular level of production as his goal (Wickliffe op. cit).

As cited in Ita (1980), Centre Technique Forestier Tropical (CTFT) (1972b) in Gabon on a similar tropical belt with Nigeria proved an application rate of 154kg of poultry manure per hectare of fish pond per week as excellent. Wickliffe (op. cit), therefore, concluded from her study that about 226 layers of average weight of 1kg each would be needed to fertilize one hectare of fish pond effectively in Nigeria.

Based on the conclusions of the above study, the Fisheries Division of Kainji Lake Research Institute (KLRI) commissioned the construction of a poultry house with a capacity for about 576 birds in battery cages over the newly completed 1.5 hectare reservoir intended to store water for channeling into barrage ponds behind it by gravity. The reservoir was intensively stocked for utilization as a sport fishing reservoir as discussed in Ita et. al. (1984).

The objective of this report is to give an economic appraisal of the project with a view to recommending such additional investment to prospective fish farmers.

MATERIALS AND METHODS

A 1.5 hectare fish pond located within the Kainji Lake Research Institute Housing Estate was constructed in 1981 at a cost of about ₦9,000.00 (Nine thousand Naira) approximately $13,600.00 U.S. dollars at the time of completion). Similarly, an airy wooden poultry house of about 85 m^2 with concrete pillars (Pl. 1) was constructed at a cost of about ₦12,000.00 (Twelve thousand naira) with capacity for about 576 hens in battery cages. The house is connected with a bridge to one embankment and designed in such a way that the chicken droppings fall directly through the cages and poultry house into the pond water to serve as organic manure. Three battery cages with capacity for 288 birds were installed initially. About 90 Guinea fowls and 70 fowls were introduced into the cages with a total daily dropping of about 14kg (98kg/week). This was supplemented with cow manure at the rate of 51kg per week and later with inorganic manure NPK 15-15-15 at the rate of 25kg per week.

The reservoir was stocked with about 22,600 tilapias (mostly Sarotherodon galilaeus fry and fingerlings collected from the shore of Kainji Lake). About 4,000 Clarias (mostly C. lazera and C. anguillaris) and about 134 Heterotis were initially introduced into the reservoir in April, 1984. In August, 1985 about 1,200 Carp (Cyprinus carpio) and about 300 Heterobranchus bidorsalis were also introduced to provide breeders for subsequent production of fingerlings for stocking the reservoir and the adjacent ponds.

RESULTS AND DISCUSSION

Fish Production

The growth performance of the fish stocked in the reservoir was monitored throughout 1984 and in September, 1984 the reservoir was inaugurated for leisure sport fishing as described in Ita et. al. (1984). The introduced Tilapia grew from 26 gm average weight in April, 1984 to about 100gm average weight in November, 1984 (7 months) giving a total estimated standing crop of about 2.2 metric tonnes of Tilapia or about 1.8 metric tonnes less 20% mortality valued at ₦3,600.00 at an average selling price of ₦2.00/kg. Clarias grew from 19 gm average weight in April, 1984 to about 874 gm average weight in April, 1986 (24 months) with a total estimated standing crop of about 3496 kg valued at ₦13,984.00 at an average selling price of ₦4.00 per kg. The Heterotis grew from 15 gm average weight in 1984 to about 2,775 gm average weight in December, 1985 (20 months). Carp introduced in August, 1985 at a mean weight of 10 gm grew to an average weight of about 806 gm by April, 1986 (8 months) giving a total standing crop of about 967 kg valued at about ₦2,901.00 estimated at an average selling price of about ₦3.00/kg.

Table 1 shows the estimated fish production figure based on the observed daily growth rate of the introduced fish. Although, the growth rate of Clarias was found to be low in this study (1.2 gm/day), other workers have reported more encouraging results. El-Bolock (1975) reported an average daily growth rate of 0.34 - 0.41 gm/day in ponds with no supplementary feeding. Elliot (1974) observed a growth rate of 2.9 gm/day for the first eight months and 4.88 gm/day for the next four months for Clarias of average weight of 59 gm. The fish grew from 598 gm to 1.36 kg within a period of one year. The low growth rate observed in this study could be attributed to the fact that the fingerlings were obtained from the wild and could therefore, have been obtained from mixed staunted breeding populations. Besides, the mean size at stocking can significantly affect the growth rate of Clarias. The growth rate has been observed to be slow in the early months prior to the evolution of active carnivorous habits with fish forming a higher percentage of the food items in the stomach.

The recommended stocking density of 10,000 fish per hectare is far below the stocking density used in the experimental reservoir of about 27,000 fish per/ha comprising mostly of Sarotherodon galileaus. The relatively low average daily growth rate of the tilapia (0.3 gm/day) could be attributed to the high stocking density which was intended to serve as food for the Clarias at a ratio of 7:1 (Tilapia to Clarias respectively) and also sustain intensive capture by sport fishermen. The objective was not fulfilled because the tilapia had a much faster growth rate than the Clarias and were therefore, not preyed upon before they were mature to reproduce within the first six (6) months of introduction.

In view of the relatively low market price for small tilapia, and higher prices for Clarias, Heterotis and Carp. the recommended stocking density in Table 1 would make the project more viable than observed in the first experimental trial.

Egg Production

Table 2 shows the estimated egg production based on the number of layers in the cages. An average daily egg production of 55% of the total number of layers was observed during the experimental period using commercial layers mash with 16.5% crude protein and 2850 Kcal/kg feed. The egg production started with a daily average production of 19.6% of the number of hens housed, reached a peak of 78.8% by the 22nd week and then dropped to about 40.4% at about the 45th week before they were sold off.

The mortality rate was observed to be 3.2% and falls within the range reported by other authors showing that housing the birds over the reservoir had no serious effect on their survival. The average weight of the birds at the start of the experiment was 1.74 ± 0.13 kg and 1.91 ± 0.17 kg at the time of disposal.

Feasibility Analysis

Table 3 shows the financial analysis for the whole project giving the input and output.

Table 3 - Financial Analysis for the Integrated Fish and Poultry Project at the Kainji Lake Research Institute (1982 price)

Items	Amount
Fixed Capital Inputs	
Pond development	₦ 9,000.00
Poultry house development	11,800.00
Four battery cages @ ₦1000/cage	4,000.00
One fibre glass boat	1,500.00
Farm house and store	3,000.00
Sub-Total	29,300.00

Items	Amount
Material Inputs	
	₦
2,000 fingerlings of Clarias @ 30k each	600.00
3,000 fingerlings of Heterotis @ 30k each	900.00
3,000 fingerlings of Carp @ 30k each	900.00
2,000 fingerlings of Tilapia @ 20k each	400.00
1 beach seine net for cropping fish	2,500.00
350 layers @ ₦7.50/bird	2,625.00
270 bags of layers' mash @ ₦15.50/bag	4,185.00
50 bags of inorganic manure @ ₦10/bag	500.00
Sub-Total	12,610.00
Recurrent Inputs	
One poultry attendant/fisherman	1,800.00
One Night guard	1,500.00
Sub-Total	3,300.00
GRAND TOTAL INPUT	45,210.00
Returns From Sales	
Fish Per Hectare Production:	
	₦
686.0 kg of Clarias @ ₦4/kg	2,744.00
3771.0 kg of Heterotis @ ₦3.00/kg	11,313.00
214.0 kg of Tilapia @ ₦2.00/kg	428.00
2703.0 kg of Carp @ ₦4.00/kg	10,812.00
Sub-Total	25,297.00

Poultry Per Hectare Production:

	₦
33,480 eggs @ ₦8.00/30 eggs	8,928.00
215 spent layers @ ₦8.00/each	1,720.00
	10,648.00
GRAND TOTAL REVENUE	35,955.00

Although the financial analysis in Table 3 shows a deficit of ₦9,255.00 between the input and output for the first year of the project, it should be noted that the reservoir is 1.5 ha in surface area and that a two hectare reservoir could be constructed for the same amount. Similarly, the poultry house was solidly constructed to cater for 576 birds needed for fertilizing a two hectare reservoir.

Table 4 shows the financial analysis based on the output from a two hectare reservoir with only a slight increase in the capital input. The investment prospects looks brighter when based on a two hectare production output with an internal rate of return (IRR) of 42%, Payback period of 2-4 years and a Net Present Value of ₦68,347.00. Other relevant financial calculations are shown in the appendices 1-4.

CONCLUSION

The construction of a poultry house over a small reservoir to fertilize the water for fish production has been shown to be a viable investment yielding revenue both from sales of fish and eggs. With a minimum of two hectares surface area, the return on investment is high with limited inputs and management needs.

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TABLE 1 - Estimated Fish Production and Income per Hectare of Reservoir/Pond in an Integrated Fish and Poultry Farming System

Species	Observed mean Daily growth rate (gm)	Estimated Production Per Fish (gm) after 270 days (9 months) plus initial weight	Recommended Stocking Density	Estimated Total Production (kg)/ha	Expected Revenue (₦ : K) at Unit Price/kg
Clarias	1.2	324.0 + 19.0 = 343.0 gm	2,000/ha	686.0	2,744.0 @ ₦4.00/kg
Heterotis	4.6	1242.0 + 15.0 = 1257.0 gm	3,000/ha	3771.0	11,313.0 @ ₦4.00/kg
Tilapia	0.3	81.0 + 26.0 = 107.0 gm	2,000/kg	214.0	128.0 @ ₦2.00/kg
Carp	3.3	891.0 + 10.0 = 901.0 gm	3,000/kg	2703.0	10,312.0 @ ₦4.00/kg
TOTAL			10,000/ha	6785.4	25,297.0

TABLE 2 - Estimated egg production and revenue from sales of eggs in an integrated fish and poultry farming system

Number of layers per Hectare	Observed Average Number of eggs/day	Estimated No. of eggs in 270 days	Expected Revenue (₦ : K) at a Unit Price per 30 eggs
226	124	33,480	₦8,928.00 @ ₦8.00/crate

TABLE 4 - Financial Profitability Indicators

Year	Income		Expenditure		Benefits	
	Actual	Discounted Value at 14%	Actual	Discounted Value at 14%	Actual	Discounted Value at 14%
0	-	-	32,300	32,300	32,300	32,300
1	61,580	54,017.98	34,700	30,438.84	26,880	23,579.14
2	61,580	47,387.81	33,300	25,624.35	28,280	21,761.46
3	61,580	41,566.50	31,900	21,532.50	29,680	20,034.00
4	61,580	36,461.52	30,500	18,059.05	31,080	18,402.47
5	61,580	31,984.65	29,100	15,114.54	32,480	16,870.11

NPV = 68,347.18

Payback Period = 2.4 years

IRR = 42%

APPENDIX 1 - CASH FLOW STATEMENTS

Particulars	Years				
	1	2	3	4	5
A. CASH RECEIPTS					
Loan from Bank	50,000	-	-	-	-
Sale of Fish per hect. Production	40,284	40,284	40,284	40,284	40,284
Sale of Eggs	17,856	17,856	17,856	17,856	17,856
Sale of Spent layers	3,440	3,440	3,440	3,440	3,440
Total	111,580	61,580	61,580	61,580	61,580
B. CASH PAYMENT					
Fixed Capital					
Pond for 2 hectares	10,000	-	-	-	-
Poultry House	11,800	-	-	-	-
Battery Cages	6,000	-	-	-	-
Building (Farm House & Store)	3,000	-	-	-	-
Boat (Fibre glass type)	1,500	-	-	-	-
Total	32,300	-	-	-	-
C. OPERATING COST					
Material Inputs	12,610	12,610	12,610	12,610	12,610
Labour	3,300	3,300	3,300	3,300	3,300
Contingency	1,790	1,790	1,790	1,790	1,790
Total	17,700	17,700	17,700	17,700	17,700
D. Loan Repayment plus Interest at 14%	17,000	15,600	14,200	12,800	11,400
E. Total Cash Out flow (B + C + D)	67,000	33,300	31,900	30,500	21,900
F. Expected Cash inflow	44,580	28,280	29,680	31,080	32,480

APPENDIX 2 - LOAN REPAYMENT SCHEDULE

Year	Principal	Interest at 14%	Outstanding Balance
	-	-	50,000
1	10,000	7,000	40,000
2	10,000	5,600	30,000
3	10,000	4,200	20,000
4	10,000	2,800	10,000
5	10,000	1,400	-

APPENDIX 3 - PROJECTED PROFIT AND LOSS ACCOUNT

Particulars	Years				
	1	2	3	4	5
Sale of Fish	40,284	40,284	40,284	40,284	40,284
Sale of Eggs	17,856	17,856	17,856	17,856	17,856
Sale of Spent Layers	3,440	3,440	3,440	3,440	3,440
Total Income	61,580	61,580	61,580	61,580	61,580
Less Operating Cost	17,700	17,700	17,700	17,700	17,700
Operating Profit	43,880	43,880	43,880	43,880	43,880
Less Depreciation	1,617	1,617	1,617	1,617	1,617
Gross Profit	42,263	42,263	42,263	42,263	42,263
Less Interest on Loan at 14%	7,000	5,600	4,200	2,800	1,400
Profit Before Tax	35,263	36,663	38,063	39,463	40,863
Less Company Tax at 45%	15,868	16,489	17,128	17,758	18,388
Net Profit after Tax	19,395	20,165	20,935	21,705	22,473

APPENDIX 4 - DEPRECIATION

Type of Equipment	Value	Life Span	Annual Depreciation Value				
			1	2	3	4	5
Pond	9,000	25	360	360	360	360	360
Poultry House	11,800	15	787	787	787	787	787
Battery Cages (4)	4,000	20	200	200	200	200	200
Fibre glass boat	1,500	10	150	150	150	150	150
Farm House & Store	3,000	25	120	120	120	120	120
TOTAL			1,617	1,617	1,617	1,617	1,617

INVESTMENT PROSPECTS OF FISH FARMING IN THE JOS-PLATEAU, NIGERIA

by

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ABSTRACT

The investment prospects of fish farming in the Jos-Plateau, strategically located in about the centre of the country are discussed with special reference to its numerous abandoned mine lakes and the tripartite role of government, universities and individuals. In the Jos-Plateau, about 17.0 km² is covered by these disused mine lakes, making up about 20-30% of the area covered. In such enterprise, problems commonly encountered, like population growth and government planning policies, fish demand and supply, manpower, feed and seed availability, preservation, processing and marketing are discussed. Inspite of these, prospects still abound with regards to land-use of these numerous disused mine lakes and feed availability based on the principles of using both industrial and farm bye-products for fish culture, processing and marketing. These potentials if properly harnessed will help to supplement the protein insufficiency in the diet of the populace. In this regard , proposals on the economics of production and sales, strategies for achieving these development goals, cost-benefit analysis and their implications in further development of fish culture are discussed.

KEY WORDS: INVESTMENT PROSPECTS. MINE LAKES. FISH FARMING.

INTRODUCTION

In Nigeria and most developing countries in the world, there are problems of insufficient food production and the populace suffer from protein deficiency in diet. Countries like Japan, China, U.S.A. to mention a few have recognized the importance of fish farming as a strategy for increasing production to meet the protein demand of their

populace. There is little or no participation in fish farming from the private sector possibly due to lack of enlightenment on the numerous investment opportunities existing in Nigeria capture and culture fisheries enterprises and their affiliated industries like outboard engines, boats, gears and net manufacturing and processing industries together with import and export business in fisheries. The few government fish farms have not played prominent role in supplementing the fish demand and encouraging the private sector.

Protein intake in Nigeria stands at less than 40%. The per-capita consumption of animal protein was only about 28.6kg/annum, and of these, 10.6kg or 37% was derived from fish (Federal Dept. of Fisheries, Statistics Report, 1980). Importation increased steadily since 1971 from 54,416 metric tonnes (or 11.7% of the toal fish production) to over 218,000 metric tonnes (or 28.9% of the total fish production) in the early 1980's. However, by 1983, total import fell to 153,394 metric tonnes due to import restriction following the economic stabilization policy of the Federal Government. This restriction is expected to be an incentive to large scale inland fisheries and other animal production. Okpanefe (1983) put the estimated demand for Nigerian fisheries at about one (1) million tonnes/annum and by the year 2,000, the demand is expected to double. The current demand for fish in Nigeria today is about twice the level of local production from all sources and it is unlikely even in some years to come for Nigeria to resume large scale importation in this period of serious economic predicament and significant drop in foreign exchange earning.

In Nigeria, vast area of land is covered by water which is available in the forms of rivers, lakes or ponds and to a great extent, brackish and sea water at the coastal regions. These water bodies are the main medium through which different animal species can be cultured. The advantage in utilizing these water resources is that both seasonal and perennial culture practices can be undertaken in which water is delivered naturally. The challenge facing Nigeria today is one of solving problems of inadequate food supply and discovery of new protein sources. Different management practices have to be worked out and fish farming must be developed.

In the Jos Plateau, between 20-30% of the land areas is covered by water bodies, particularly the disused mine lakes which number about 1,000. (Patterson & Okechukwu, 1986, Pers. Comm.). Past research work have been directed towards assessing the physico-chemical qualities of the water bodies and their suitability for fish production (Chidobem,1982; Khan & Ejike, 1984; Wade,1985; Anadu et al (1986); Wade & Anadu (1986A, B). Similarly, substantive research findings on the suitability of local farm products like cassava,

potato, rice, corn for fish culture have been reported by Ufodike and Matty (1983), Faturoti & Akibote (1986), Otisi & Ufodike (1986), Ufodike (1986).

In the past, decision-making were made with poorly defined channels of control and weak linkages. Infact fisheries has been mostly considered as an after thought. Fish stocking programmes in man-made lakes by government agencies have been with no bench-mark ecological data, no previous biological studies, no stock data and catch statistics. These have been due to poor policy directives and management. After the efforts at fish stocking there is seldom subsequent activity to determine its success or failure, thereby rendering futile any attempt to make a thorough evaluation of the merits of this fisheries management programme.

One of the problems that have often hindered private sector participation in development of inland fisheries include lack of knowledge on the potential of the available resources (Olatunde, 1983). A well planned intensive fish farming has the potential of offering a new and major food source for the populace. The biological and economic problems likely to be encountered, the prospects for such a viable investment and strategies for accomplishing such a task and the tripartite role of government, universities and individuals based on the past experiences of developed nations is reviewed in substantive part of this paper.

INVESTMENT PROBLEMS AND PROSPECTS

PROBLEMS

The need for increased food production has arisen from the problem of population growth and government planning policies which have no up-to-date data which are pre-requisite for national development planning. This has often led to the failure of viable agricultural development programmes. With regards to population growth vis-a-vis fish demand and supply in Nigeria, this seem to be increasing in geometrical progression while food demand (and cost) is in arithmetical progression. If such a planning policy with unreliable data is to continue, demand for fish for the teeming population will not be met.

Man power has also been a constraint to development of fish farming. Until recently few people were trained in the area of fisheries. Lack of qualified manpower makes it difficult for prospective farmers to get required expert advice and assistance; especially on latest practices which would improve performance and increase output. Manpower draws upon multidisciplinary areas of the sciences like Biology, Ecology, Genetics, Biochemistry, Microbiology, Chemistry, Agriculture and Veterinary Science. In addition, biotechnological engineering and managerial skills are required for construction of suitable farms.

With regards to feeds, supplementary feeds ensure healthy and fast growth. Non availability of these is tantamount to poor management of fish farming, and until cheap and hutritionally better feeds are available, this factor will continue to inhibit mass production of these aqua-foods. However, a lot of research work have been done on production of cheap feed for aquaculture in the tropics and developing countries. In the case of seeds availability, for any venture of this nature to succeed, there has to be mass production of fish seeds. This is one problem in Nigeria where little effort is made in induced spawning of fish in captivity. Hatchery technology is not well developed either. Japan, China, U.S.A. to mention a few were able to make a break-through in aquaculture due to successful large scale production of fish fry or seeds. In Nigeria, where hatchery facilities are available, e.g. Panyam fish farm in Plateau State, they are either under utilized or not functioning at all. Any dependence on the slow natural process of reproduction will definitely retard the progress of this enterprise.

For any product to be acceptable, the need for preservation cannot be overemphasized. One major problem affecting preservation is the absence or inadequate cold storage facilities. However, the prospect is brighter with establishment of fishing companies in different parts of the country by private organization which have been able to provide storage facilities like cold rooms. Crude methods of fish processing like sundrying and smoking coupled with poor storage facilities have often resulted in the animal products being exposed to insect pests. These cause spoilage and deterioration. Better processing facilities are now being developed in technology units of Nigeria Institute for Oceanography and Marine Research, N.I.O.M.R., (Tobor 1985, Pers. Com.) and at the Federal Institute of Industrial Research, Oshodi.

The problem of product marketing lies in inefficient transportation network. In the final marketing stage, there is also the problem of middlemen buying at cheap prices from the farmers and selling to final consumers at exhorbitant prices. However, with improved net work of roads, there is brighter prospect of transportation and marketing of these products direct to consumers at minimum cost. Some developing nations like Nigeria are begining to have bitter experiences of effects of pollution. This is in the form of oil, sewage and other forms of pollution originating from industrial and agricultural practices including the use of herbicides, pesticides and other chemicals. Oil pollution like in coastal areas of Nigeria has the threat of getting into swamps and rivers, thereby affecting the lives of organisms (Wade, 1983). Sewage pollution have also been found to affect lives of aquatic organisms (Oladimeji & Wade. 1984) unless well treated before disposal.

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Disease outbreak can adversely affect fish production. This problem can be easily overcome if drugs are made available to farmers. The threat of disease outbreak and subsequent cure also extends to the farmer as an occupational hazard, considering the fact that health services has not effectively reached majority of the populace in the rural areas of most developing nations.

PROSPECTS

As the population increases, coupled with increasing demand for protein diet, fish and fish products will continue to play very important role. Apart from its role as food source, fish is an important source of income through the inducement it provides for the establishment of other industries. Some investment prospects of fish farming in the Jos - Plateau are:

DISUSED MINE LAKES

There are numerous abandoned or disused tin mine lakes on the Jos-Plateau. Majority of these lakes date back to 1905 when early mining activities started (Bingel, 1978). The lakes which have considerable volume of water all year round number about 1,000 making up about 20-30% of the area covered (Patterson & Okechukwu 1986, Pers. Com.). Although some of these lakes could be as deep as 20 meters, which in conventional fisheries management practices cannot be regarded as conducive, we envisage that any prospective farmer could use these ponds as reservoirs from which the lake waters could be fed into well constructed fish ponds. This type of practice has been a considerable success with the Rock Water Fish Farm, which is the only indigenous or private fish farm utilising the potentials of these numerous mine lakes. Moreover, with the industrialization programme of the Plateau State government, there are incentives for the private organizations with regards to land acquisition for such enterprises. These mine lakes also provide potentials for development of sports fisheries with respect to tourism and/or recreation (Wade 1986).

Previous research work on the water quality characteristics of disused mine lakes in relation to fish production have shown a considerable promise for a viable investment on fish production (Wade 1985, Anadu et. al. 1986, Wade & Anadu 1986a), although some better management practices like fertilization or nutrient enrichment will still be required to enhance production at a more profitable level.

MANPOWER

Although the problem of high skilled manpower in the fisheries industry is glaring, we speculate that considerable efforts being made in our various institutions like the Universities, Fisheries Schools etc. will help provide skilled manpower.

Meanwhile, in the short supply of manpower, consultancy serv_ces offered by our Universities in the area of fish husbandry will help the prospective farmer in the establishment and management of the farms.

FEED AVAILABILITY

The prospect for feed availability for fish farming enterprise is bright in view of the wide variety of local food sources which are in abundance. Industrial bye-products like the brewery wastes are very rich in nutrients required for fish growth and are cheap. Some of these industrial sources of feeds include the Jos International Brewery Ltd. (J.I.B), N.A.S.C.O. Foods Ltd. For example, the nutrient composition of the spent grains (barley malt chaff) on dry weight basis is as follows: Protein - 22.0% carbohydrate - 48.0%, Fibre - 17.6%, Oil - 7.9%, Ash - 4.5%. Several research findings on cheap feeds for aquaculture in the tropics and developing countries have proved to be promising. Shireman et. al. (1978) reported that grass carp (Ctenopharyngodon idella) fed natural diet of duck weed (Lemna minima) under intensive culture show a high biomass, excellent growth and satisfactory survival rates. Ufodike and Matty (1983) in studies on growth responses and nutrient digestibility in the mirror carp (Cyprinus carpio) fed different levels of cassava and rice reported that fish grew best on the 45.0% rice diet, while carbohydrate digestibility when cassava or rice was added to diet was high and ranged between 86.0% & 97.0%, but was very low (17.0%) when no cassava or rice was added. Similarly, protein digestibility was slightly raised from 76.0% to between 83.5% and 88.0% with the addition of cassava or rice to the diets. These carbohydrates and other food sources are cheaply available in Nigeria.

SEEDS AVAILABILITY

The current overall production of fish seeds or fingerlings is grossly inadequate, although it is hoped that with completion of some hatchery facilities in the Panyam Fish Farm, Plateau State, and other parts of the Federation, production and sales of seeds to private farmers would have enhanced investment opportunities in the fishing industry.

PRESERVATION

With the recent developments in fish technology, processing and preservation equipment have been developed in both the Nigeria Institute for Oceanography and Marine Research (NIOMR), Lagos and the Federal Institute of Industrial Research (FIIR), Oshodi-Lagos (Tobor, 1985, Pers. Comm.). These technological developments will greatly overcome the problems of loss in farm products.

TRANSPORTATION AND MARKETING

Considering the fact that road development in Nigeria have not until recently been given much priority, especially in the rural areas, this has often resulted in deterioration of farm products before getting to the market, thereby causing considerable loss to the farmer. However, we envisage that apart from the fairly good road network here in the Jos Plateau, it is strategically located in about the centre of the country with the result that it is accessible to all parts of the country by air, road and rail. Market for fish will no doubt be very high, as the present supply, especially in developing countries like Nigeria is far less than demand.

MULTIPURPOSE USE OF RESOURCES

The effective conservation of our water bodies could involve utilization of alternative sources of the lake water for other purposes like irrigation. In this respect, we propose fish farming in multiple use of resources, with special reference to fish-cum-animal-cum-crop farming. This proposal is based on the observations and success of dry season irrigation using these pond waters. A prospective fish farmer can go into vegetable-cum-animal farming. In any case, if fish is to be in short supply in any given area, not only could such an area be stocked with different fish species, but livestock and poultry could be reared. The basic principles in the rearing of such other animals and fish is that the latter can feed on the part of food wasted by animal and on their organic faeces sometimes very rich in in-completely digested foodstuff. Apart from the waste of these animals being utilized for fish growth, the animals themselves contribute substantial amount of edible protein. A well planned fish-cum-animal farming has the potential of offering a new and major food source.

The benefits of fish-cum-animal-cum-crop farming with reference to food availability is presented in a schematic form (Fig. 1). Combination with other types of farming makes for greater overall effeciency, as bye-products from some of the activities are used. An ideal situation is to combine fish with vegetable garden, perhaps under irrigation and some form of intensive live-stock raising like pigs and poultry. Waste from the vegetable garden could be used for fish, as well as manure. Small, undersized fish and fish offal can be fed to the animals, while excess mud from the pond bottom can be used for fertilizing the garden. It often happens that much of the fertility in a pond becomes locked in the soil and does not affect fish growth, and is wasted unless used elsewhere.

DEVELOPMENT STRATEGIES

Numerous development strategies for fish farming can be adopted. These include integrated development policy and planning and availability of credit facilities (Wade 1985b). In this discussion, emphasis will be made on the tripartite role of government, Universities and individuals in achieving this goal.

INTEGRATED DEVELOPMENT

In integrated development, fish farming can gain consolidating efforts of small scale fisheries into one whole. In this case, a simultaneous attack must be made on the various aspects of vicious cycle of poverty, productivity in the mixed farming and marketing as well as welfare problems. The aims of any integrated development strategy include:

a) helping to preserve and strengthen fish farming industry;

b) increasing alternative employment opportunity for the populace.

c) constructing a self sustaining system of private and co-operative fishing activities, which with government aid would continue to promote economic development in a socially and economically balanced fashion.

Most small scale private farmers are typically rural dwellers which need to be incorporated in integrated rural development which can be initiated by external integrations like the fishermen co-operative society or by government through extension workers. Benefits of this integration, as also proposed by Garhardsen (1977) include:

a) co-ordination of successive production process with regards to processing and marketing;

b) risk reduction and income stabilization;

c) better opportunities for changing production methods;

d) better opportunities for securing markets for final products.

Some strategies for ensuring integrated development through the role of government and universities include:

a) integrating fish-cum-animal-cum-crop farming, strengthening co-operation and co-ordinate at village level various fisheries activities with agriculture;

b) the government providing incentives to the prospective farmer through the co-ordination of the various stages of fisheries activities with general infrastructural arrangements like access roads, transport, electricity, portable water, good housing and special fish servicing activities like gears, seeds, feeds (Olatunde, 1983). To attract prospective farmers, the government could establish "model projects" as a demonstration of improvement and economic opportunities before them. Welfare schemes should be worked out as a "package programme" for fishery development for the rural dwellers;

c) both state and federal governments should contribute adequately in providing research grants to universities through a co-operative fisheries research unit which should be an embodiment of personnel from universities, Federal and State fisheries department. There should also be acknowledgement of specific research information need by aquaculturalists or fish farmers and agents at grassroot levels, identifying and transmitting such information through the extension systems to researchers. There should also be mobilization and training of private fish farmer by government and fish training institutions;

d) Nigerian Universities involved in fisheries researches and training are expected to show excellent results of research in the areas of nutrition and feeds development, reproductive physiology, genetics and selective breeding, infectious diseases - identification, prevention and control, toxicology, intensive culture systems and transportation, processing and preservation of products.

Otisi (1986) proposed that universities should acquire some hectares of land, about 10-15ha, to establish fish farms and research centres where results are put to commercial use for pilot testing before being disseminated to the public. The future roles of both governments and universities should overlap, as there cannot be proper divorce between each other in the management of our aquatic resources.

POLICY AND PLANNING

These are multidisciplinary efforts directed towards the attainment of resource quantified output. Policy embraces stages of development, communication, implementation and

evaluation, while planning is mainly preparing a scheme of action which in fisheries management is a process done prior to implementation, and devoted clearly to identifying and determining the best alternative course of necessary action required to achieve determined goals and objectives. The process of planning and policy analysis are dynamic, demanding constant reviews of laws, rules, regulations and guidelines and use all available knowledge and skill to assess and re-assess alternative ways of achieving identified goals and objectives. Policy makers and planners in both government and private agencies can adapt a strategy of optimum utilization of natural resources through intuitive judgement and decision making. This calls for broader application of expertise of a multitude of disciplines in a rigorous frame work of planning, policy formulation and analysis in respect to investment opportunities in fish farming.

CREDIT FACILITIES

Credit facilities as a strategy in developing fish farming enterprise in Nigeria could play a key role in achieving growth targets (Hamlisch, 1976). It is imperative to set up specialised credit schemes for reducing financial burdens, for a major development project like this. Fish farmers may require funds either for improvements in their installations and facilities to prevent deterioration and raise operation effeciency. Experience has shown that small smale operators are mainly in the low income group and experience difficulties in raising credit funds on a continuing basis due to inability to provide collaterals, pay prevailing commercial interest rates (Hamlisch 1976). Most credit facilities granted to small scale farmers are short term which do not take cognisance of other commitments. This results in diversion of such loans to meet family financial commitments like expenses for housing, school fees and hospital bills.

A comprehensive credit scheme must ensure that more important personal needs of the producer and his family are not ignored, and every effort should be made to make the prospective farmer realise that loan application for purchase of improved production tools, like better seeds, feeds etc., rather than expenditures on non-essential consumption goods will, in the long run, enable them obtain disproportionately greater satisfaction.

Some strategies for successful credit facilities are:

a) proper project feasibility study by professionals to know the magnitude of the borrowers' credit needs;

b) government taking a lead in providing necessary finance at initial stage for pilot projects until the farms become productive. This is to attract farmers and to enable banking institutions make funds available at a later stage when the project becomes operational;

c) making available credits for input acquisition through revolving fund arrangements, with the original financial allocation coming from government budgetary sources;

d) administrators of such loan schemes should make every effort to eliminate bureaucratic bottle necks not absolutely essential and, in general, speed up loan processing.

Since funding is a limiting factor, emphasis should be placed on creating, expanding or strengthening credit schemes. This depends largely on combined actions of the governments, financial institutions, private organisations, researchers and farmers in determining the utilization of this potential to meet the challenges of our time.

ECONOMIC CONSIDERATIONS

Economics of Production

There is no doubt that under planned management of resources, economics of production with regards to cost will be minimal. This type of mixed farming is flourishing in Asia and Far East especially in China, Japan (Maar et al. 1974). It provides an estimated 10% of the world's water derived protein with a harvest of 5-6 million metric tonnes/yr valued at about US $2.5 billion (Bell, 1980). As elaborate facilities are not necessarily required in this type of mixed farming, construction cost is usually low. Maximum use is made of the bye-products and nothing goes to waste. Under this system, a kilogram of fish could be produced more cheaply than a kilogram of red meat. In other words, fish tend to be better converters than land based animals. The harvest is usually high at low economic inputs. In relation to sales and thus income expected from these products, there is no doubt that there will always be a ready market, considering the important roles which fish and animal products will continue to play in decades to come.

COST-BENEFIT ANALYSIS

The cost-benefit analysis can be viewed from two perspectives; individual production and integrated farming. In both cases, the economic evaluation considered as cost which the prospective farmer will have to embrace are pond construction, water system equipment and management, irrigation, feeds, seeds harvesting, marketing and labour, as shown in Table 1.

This financial analysis is based on intensive culture in which formulated rations are fed to achieve faster growth at shorter time interval. A summary of the financial analysis shows that one (1) hectare pond construction including channels will cost an average sum of ₦6,500.00. The cost of water reservoir and/or dam construction does not arise since acquired mine ponds with large volume of water will be utilised. Total input for one hectare pond would be about ₦16,980.00; while output would be about ₦30,605.00. Financial gain or benefit to be derived in the first year will be about ₦13,625.00. Special fish servicing activities like ponds, fishing gears etc. will only be borne by the prospective investor in the first year. The input of these costs in subsequent years are added to the benefits of the investor. Other benefits of such investment include fishery and recreation (Wade 1986), better nutrition and irrigation.

With regards to the cost based on individual production (i.e where there is no integration of fish-cum-animal-cum crop farming) especially on a smaller scale, it is likely to be high with no financial returns (Ref. Table 2.5). Thus utilization of resources in terms of feeds on the farm is seldom complete, resulting in wastage and consequently low interest returns. In such a situation where the cost-benefit ratio and interest rates are not viable, such an investment will appear to be uneconomic. Bardach & Ryther (1967) gave annual return on milk fish culture alone as 10-20%, while an integrated fish-cum-pig farming yielded about 30% returns in Malaya.

Managerial methods for individual production depends on production targets, socio-economic situations and environmental conditions. In this type of production, cost is likely to be high as a result of feeds purchase compared with natural food from a polyculture system. The cost of individual production implies employing high quality feed, chemical fertilizers and other capital to stimulate production of natural foods. Inspite of cost acruing, one benefit from this is increased fish density with parallel increase of much resource competition.

Cost-benefit analysis of integrated fish-cum-animal-cum-crop farming is much more rewarding in terms of investment and management (Ref. Table 2). There is the potential of increased production resulting from better food utilization. This mixed farming could be a very lucrative business where professional and managerial skills are available. At the managerial level, feed availability will not be at a high cost vis-a-vis individual production in view of the prospects of feed availability earlier discussed.

Extra income or benefits (Table 2) to be derived from overall yields will cover other expenses, making such an enterprise worthwhile.

Certain constraints to this type of investment may be market limitation and seeds supply. The former may be imposed by marketing potential in terms of demand and by the handling capacity of the farm in terms of supply. It is therefore imperative that the farmer analyses the economic results of the previous culture and plans accordingly for the future. Infact, economic considerations should be a major factor in influencing production especially where the main thrust of development is introducing integrated fish-cum-animal-cum-crop farming rather than developing specific schemes likely to be capital intensive. We propose that in a situation with favourable natural environment like the Jos-Plateau, the initial requirements is for organizations or some agencies (government, parastatals, private) to first convince farmers of benefits of such investment, secondly, organize the supply of inputs like fish seeds and thirdly, assist with marketing. Once the commercial feasibility of a technology has been demonstrated, the other requirement is for an extension service.

This integrated farming has become a profitably modern aquacultural production system in many countries. The prospect here is bright, especially when modern methods based on sound scientific, ecological, technological and economic principles are applied. This innovation, as Garhardsen (1977) points out, on a large scale for profit in terms of better commercial and social returns on investment of money, time and human effort will be realized only by the informed and venturesome.

CONCLUSIONS

Fish farming enterprise has a very bright prospect in Nigeria, considering the need to explore and utilize the abundant inland water resources to supplement the grossly inadequate protein requirements. Such an enterprise cannot be easily achieved without tackling some attendant problems like fish supply vis-a-vis population growth, effect of income growth amongst the populace vis-a-vis fish demand and lukeworm attitude of most government policies towards effective fisheries development. Other problems are man power shortage, which draws upon multidisciplinary areas of the sciences and social sciences, threat posed by pollution, seeds availability, preservation, processing and marketing of cultured species.

Prospects however abound for this enterprise in view of the role fish play in world protein supply. The bright future abound in respect of inland water resources, feed availability from both animal and other plant sources. The economics of production and sales for this type of enterprise has shown quite encouraging results considering the

low cost of capital investment and profitable revenue that accrue based on experiences from other countries.

It is proposed that strategies for development of this enterprise include provision of credit facilities, integrated rural development as an important step to attacking the aspects of vicious cycle of poverty, productivity, marketing and welfare problems. Proper policy and planning in both government and private agencies can adopt a strategy of optimum utilization of natural resources through intuitive judgement in decision making. Based on the cost-benefit analysis, and with good management, such culture system is profitable. Implications for future trend for management, combined culture system and aid are important factors which if taken into account can result in a very successful venture.

ACKNOWLEDGEMENT

We acknowledge the assistance of Professor G.C. Okechukwu, Head, Geography and Planning Dept. and Dr. Graeme Paterson for providing some useful information on some disused mine lakes. Mr. A.O.A. Otisi, Head, Fed. Dept. of Fisheries, Jos made some useful comments on the original manuscript, while Mr. G. Obri typed the manuscript with absolute care and devotion.

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TABLE 1 - COST - BENEFIT ANALYSIS ON USE OF ONE MINE POND**

ONE HECTARE POND**	INPUT (₦)	OUTPUT	BENEFIT
1 POND CONSTRUCTION	6,500.00		
2 FISH SEEDS			
a/. Carp.			
1,666 fingerlings @ 30k each	500.00		
b/. Tilapia			
2,000 fingerlings @ 10k each	200.00		
c/. Catfish			
2,375 fingerlings @ 40k each	950.00		
3 FISHING GEARS	1,300.00		
4 FISH SEEDS			
a/. Brewery wastes - one tipper load per month @ ₦30.00/trip	360.00		
b/. Rice bran @ ₦50/ 50kg bag	2,600.00		
c/. Maize @ ₦60/50kg bag	720.00		
d/. Groundnut - ₦50/50kg bag	600.00		
5 FERTILISER/MANURE	100.00		
6 LABOUR			
a/. Management/maintenance	2,500.00		
b/. Liming/fertilizing/ stocking	50.00		
c/. Cropping	100.00		
d/. Transportation and/or marketing	500.00		
7 PRODUCTION/SALES	-	a/. Carp: 1,600kg @ ₦6/kg = ₦9,600.00 b/. Tilapia: 1,600 kg @ ₦3/kg = ₦4,800.00 c/. Clarias: 2,315kg @ ₦7/kg = ₦16,205.00	
TOTAL	16,980.00	₦30,605.00	₦13,625.

** Costing based on intensive culture over a period of one year.

TABLE 2 - COST-BENEFIT ANALYSIS ON INTEGRATED FARM AT PANKSHIN - PLATEAU*

	AGRICULTURAL PRODUCTS	INPUT (₦)	OUTPUT (₦)	BENEFIT (₦)
1	POULTRY	16,375.00	81,600.00+	65,225.00
	200 No. spent layers @ ₦10.00 each	-	2,000.00	-
2	CATTLE	14,465.00	24,000.00	-
3	GOATS	2,600.00	-	-
4	FISH**	30,980.00	95,000.00	64,020.00
5	VEGETABLE	800.00	841.00	41.60
TOTAL		65,220.00	203,441.60	138,821.00

* The farm is not yet on intensive production

** Construction cost of dam, pond, feeds and fingerlings inclusive

\+ Income obtained from sales of eggs only per year

++ Estimated income per year at an average sale of ₦5.00/kg.

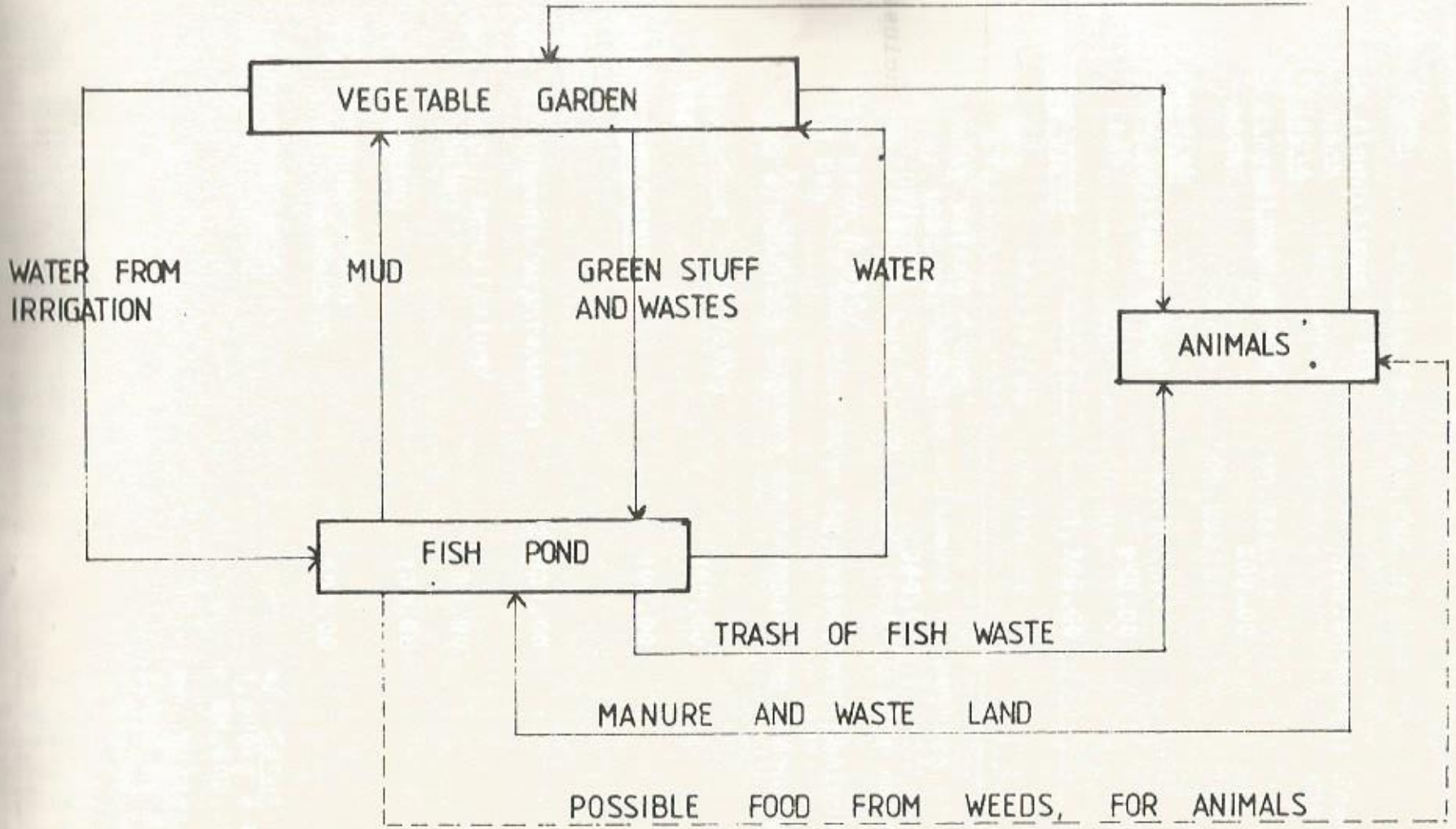


FIG. 1: COMBINED FISH, CROP AND LIVESTOCK FARMING SHOWING INTER-RELATIONSHIP (SOURCE: MODIFIED FROM MAAR et al 1974).

A PROPOSED INTEGRATED LIVESTOCK-RICE-POULTRY-CUM-FISH CULTURE IN ENCLOSURE SYSTEM

by

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ABSTRACT

Integrated agriculture-cum-fish farming has been practised profitably for ages in the Chinese small scale farming sy stem. There is a great potential for this system by utilizing the vast Nigerian flood plains (approx. 515,000ha). Dogongari Bay in Lake Kainji Basin was identified as a suitable site for this system after some extensive fish culture trials. Polyculture of Clarias spp. Heterotis niloticus and Tilapia was proposed for integration with layers in the poultry house, 2-ha upland rain-fed rice farming and indirect cattle rearing in the 5-ha enclosure site. Cost Benefit Analysis showed that the system will consistently record profit as from the second year of operation. Various complex factors were identified to affect profitability of this mixed farming system. Concerted research approach is needed to fully understand the interrelationships of the various components of this integrated system. Generous funding of research activities is very crucial in this situation.

INTRODUCTION

Agriculture-cum-fish farming is a workable system of integration as exemplified by the well-known Chinese small-scale farming system. Even in Nigeria, it is common for a fisherman to have such livestock as a few heads of cattle or goats; a small flock of chickens or guinea fowls or ducks and at the same time to engage in agriculture cultivating crops like maize, millet, groundnuts and tub ers etc. Through this practice the fisherman (or farmer) obtains a variety of products (sources of energy and protein) to meet the needs of his family and financial obligations. According to Lee (1971), integrated farming generally results in the optimal utilization of resources such as capital, labour and farm land and thus leads to higher returns, higher productivity and a more equitable distribution of farm labour.

The vast undeveloped and underutilized Nigerian flood plains (515,000ha) have great poteintials for use in integrated agriculture-cum-aquaculture system. An example of this type of flood plain is Dogongari Bay located to the west of Lake Kainji and a few kilometers from the Kainji Dam (Fig. 1). Since several ideal sites like this exist along the Lake and in many parts of Nigeria, it is intended in this paper to propose the mode of operation of such an integrated system so as to serve as a guideline for the operation of other similar systems in the country.

BACKGROUND INFORMATION

Otubusin (1983) proposed an experimental approach to the integration of guinea fowl with fish culture considering the greater efficiency in resource utilization exemplified by this farming system in Asian countries. An aspect of this proposal is already operational within the Kainji Lake Research Institute Housing Estate where a poultry house is built on top of the fish reservoir (Ita et al. 1986).

Dogongari Fish Enclosure Site

Figure 2 shows the concepts of this proposed mixed farming system. The cleared part of the enclosure is approximately 5ha. The enclosure had earlier been used for an extensive culture of wild stock of fish that came into the enclosure with the flood. Results and experience obtained from these trials metamorphosed into the modifications advanced for an efficient utilization of this flood plain (Otubusin and Opeloye, 1984). Some aspects of these modifications were implemented and promising results were recorded (Otubusin and Opeloye, 1985). This proposal therefore is the most recent approach to an efficient utilization of resources in this enclosure. This mixed farming system proposal was motivated by the fact that:

i) wild fish stock enclosed within the site were observed to have survived and grown appreciably even under extensive culture method (Otubusin and Opeloye, 1985)

ii) during the dry season, Fulani herdsmen regularly brought their herd to drink from the enclosure

iii) before the enclosure fish culture trials commenced on the site, the Agriculture Division of the Institute used to grow upland (rainy season) rice within part of the enclosure site

iv) tipper loads of chicken manure (in addition to cow dung) obtained from a local poultry farm was used in fertilizing the enclosure water for good growth of natural food.

Facilities Proposed for the Site

The enclosure will be bunded as shown such that a 2-metre gate is located along the original flood channel for water management within the enclosure. The water canal about 2 metres wide connects the gate with the fish reservoir on which the poultry house will be built.

The poultry house (15m x 5m) will be built on stilts such that its floor is at least 2 metres above the highest water level within the enclosure. Adequate flooring of the poultry house will be done to prevent humidity or any other physico-chemical factors from affecting the performance of the birds. The floor of the poultry house will be interspersed with 1sq. in battery cage wire on which the birds will lay eggs and through which the poultry waste will drop into the water (fish reservoir). Hanging feeders and water containers will be used in dispensing the feeds and water.

About 2 ha of the enclosure near the bund will be used for rice (upland) cultivation during the rainy season only.

Animals/Crop inputs

Livestock

The direct integration of livestock in this mixed system shall be optional. But herds of cattle, goats, sheep will be allowed in to drink at the enclosure. The area surrounding the enclosure can therefore serve as a range-land for the herds.

Fish

Three fish species viz: Oreochromis (= Tilapia) niloticus, Heterotis niloticus and Clarias sp. will be stocked in the enclosure at a ratio of 5 : 3 : 2 respectively.

Poultry

2,000 layers will be stocked in the poultry house. Layers mash will be dispensed using hanging feeders. Standard poultry management routine will be strictly followed.

Rice

The rice variety best suited for this environment and season will be planted under rainfed agriculture. The rice will however be fenced off to prevent the animals (cattle etc.) from browsing on it.

Management of the Integrated System

Relevant physico-chemical parameters (e.g. Dissolved oxygen, temperature, relative humidity etc.) of the culture media will be monitored regularly in order to forestall any hazard.

The rice will be given a top dressing of 30 kg N/ha after a basal dressing of 30 kg each of P and K per hectare (Ogo et. al., 1985).

The Wildlife/Range Division of the Institute will be fully involved with proper management of the poultry aspect of this system.

Tight security will be maintained on the farm to prevent poaching or infiltration by marauders.

Harvesting

The fish will be harvested by beach seining and the total yield per species will be recorded.

Eggs will be picked up everyday in the poultry house while old layers will be sold off every two years.

The rice will be harvested on maturity and processed.

INVESTMENT PROSPECTS

Table 1 shows the input-output analysis of operating a mixed farming system incorporating rice farming with poultry and fish production. In this analysis the integration of livestock will be considered as indirect because a larger space is required for a direct intensive livestock (cattle) integration.

A loss of ₦40,260 will be incurred in the first year of operation because only half of the year will be used for actual culture or farming while the first half is used for farm preparation and construction of farm facilities and infrastructure. Profits will consistently be recorded as from the second year of operation onwards. Since several complex factors can affect profitability of this mixed farming system, no strict economic analysis is done in order not to further complicate the complex system. However, it is certain that the mixed farming system gives a higher return on investment than a mono-farming system. Particularly the poultry-fish combination constitutes on the average more than 90% of the total annual returns from the whole system (Table 1). Hopkins (1982) also opined that chicken-fish systems can yield returns more than 90%. Likewise the poultry cost of production especially feed cost looks prohibitive. This may therefore be a major constraint to

integrate livestock-fish farming systems for poor farmers. Invariably, Kaewpaitoon (1982) observed that farms with larger numbers of livestock had a greater tendency to integrate livestock production with aquaculture. These wealthy farmers therefore are able to confine their livestock on or near a fish pond to enable the manure to fertilize the water. These livestock must be fed with relatively expensive, supplementary feed.

In spite of the constraints in this culture system, there are several benefits:

- no inorganic fertilization or supplementary feeds are given to the fish at any stage of this mixed system

- there is maximum and efficient utilization of space and resources

- the two major human food items (starch from rice and protein from fish, eggs and birds) are derivable all at once from the farming system. Milk can also be got from the cattle.

The case of Dogongari enclosure or any other similar enclosure is interesting in that the enclosure is linked directly into the lake and therefore can be regularly flushed. The enclosure can be used all the year round: the excavated fish reservoir (Fig. 1) is supplied with water during the rains and by the black flood during the dry season.

Since this system of farming is still in the experimental stage in Nigeria, concerted efforts towards more research approach is needed in order to understand the interrelationships of the several components of these integrated systems and to formulate management guidelines. The ban on importation of rice into the country coupled with the serious economic recession should give an impetus to generously funding research activities in this farming system. When this system is perfected the end users will include fishing/fish farming companies, fishermen co-operatives and other well organised institutions/ enterpreneurs.

ACKNOWLEDGEMENT

The assistance of the following staffers of Kainji Lake Research Institute are acknowledged for their contributions towards this paper: Messrs R.C. Ogo, K.L. Ayorinde and B.A. Falayi.

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Table 1 - Production cost and Income for the operation of the Proposed Conceptualised Integrated Rice-Poultry-Livestock-Cum-Fish Enclosure Culture*

	ITEMS	AMOUNT/YEAR 1	2	3	4	5
I	Gate and screen etc	2,000	-	-	-	-
II	Clearing, bunding and excavation of enclosure	14,000	-	-	-	-
III	Fish seeds for initial stocking (50,000)	12,500	5,000	5,000	5,000	5,000
IV	2000 layers @ ₦7 per bird	14,000	-	14,000	-	14,000
V	Poultry feed (100 t per year) @ ₦640/ton	32,000	64,000	64,000	64,000	64,000
VI	Rice seeds/fertilizer (rainy season only) 2ha	200	200	200	200	200
VII	Boat	1,500	-	-	-	-
VIII	Outboard engine	2,000	-	-	-	-
IX	Antipoaching devices	5,000	-	-	-	-
X	Beach seine net	2,300	-	-	-	-
XI	Caretaker's hut/farm house/store/working shed	30,000	-	-	-	-
XII	Poultry house and facilities	30,000	-	-	-	-
XIII	Staff salary	6,600	6,600	7,680	7,680	9,000
XIV	Casual Labour	2,000	2,000	2,000	2,000	2,000
	Sub-Total	119,100	77,800	92,880	78,880	94,200
XV	Miscellaneous	11,910	7,780	9,288	7,888	9,420
	Total	131,010	85,580	102,168	86,768	103,620

Table 1 (Continued)

ITEMS		AMOUNT/YEAR 1	2	3	4	5
REVENUE						
i)	Table size fish (10 tonnes/2 ha/year) @ ₦5/kg	25,000	50,000	50,000	50,000	50,000
ii)	Fingerlings (assorted) (50,000/enclosure/year) 25k each	6,250	12,500	12,500	12,500	12,500
iii)	Old layers, 1800 @ ₦10 each	-	18,000	-	18,000	-
iv)	Eggs (240/bird/year for 1800 birds) 432,000 @ 25k each	54,000	108,000	108,000	108,000	108,000
v)	Rice (5t/2 ha/year) @ ₦1,100/ton	5,500	5,500	5,500	5,500	5,000
	Total Annual Return	90,750	194,000	176,000	194,000	176,000
vi)	Net Profit (loss)	(40,260)	108,420	73,832	107,232	72,380

* Based on the following:

1. Production (fish & poultry) for 6 months in Year 1, but 12 months in subsequent years.
2. Livestock (Cattle) optional
3. Poultry house facilities include drinking trays, hanging feeders etc.
4. A maximum of 10% mortality of layers
5. Rice farming in rainy season only.

STRATEGIES FOR THE ESTABLISHMENT OF PROFITABLE FISH FARMS IN NIGERIA

by

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ABSTRACT

Cost projections for the establishment of fish a farm was conducted. It is shown that fish farming should be a lucrative venture. However, many private fish farms are not making the desired profits because of a variety of problems. Besides managerial incompetence, availability of fingerlings for stocking in the ponds is shown to be a serious handicap to the success of investments in a fish farm. It is suggested that where the funds are available, each farm should be equipped with facilities for raising its needs of fingerlings. Since useful capital would be involved and knowledgeable experts to run the hatcheries are few, it is recommended that fish farms within a state or adjacent states should combine to establish viable cooperative hatcheries.

INTRODUCTION

The need to increase fish production in Nigeria has become most desirable because of the exorbitant cost of beef. Thi need is further enhanced by the ban on importation of froze fish and stock fish. The source of new production will be mainly through fish farming. Fish is a rich source of some amino acids, vitamins, minerals and poly-unsaturated fatty acids not found in other sources of protein (Kent, 1984). In addition, farming fish offers some advantages over farming domesticated land animals. One of these advantages is the ability of many species of fish to convert organic wastes such as sewage, piggery wastes, poultry wastes, cow dung and other organic industrial by-products into useful protein effeciently thus contributing to the management of wastes in our environments. Another is that swampy area unsuitable for agriculture are easily utilised in pond construction. More importantly however is the fact that protein production per unit area is far higher in fish culture than in raising of beef. Fish farming is a common

practice in several parts of the world and contributes a substantial portion of the total fisheries of many countries. For example, fish production by farming makes up over 50% of the total Israeli fisheries (Sarig, 1980).

Currently, sources of capture fisheries are reaching their maximum production. Ajayi (1982) has indicated that the inshore fisheries in Nigeria still has some room for expansion but that the shrimp resources are fully exploited. Ita (1982) has produced biological indices of everfishing in the Kainji Lake. With the Sahelian drought, the volume of Lake C had decreased considerably with consequent decrease in the fisheries. Th an area of great potential for fish production is in fish farms.

CURRENT STATUS OF FISH FARMING IN NIGERIA

Tobor (1985) projected that fish demand would increase from 1.018 million tonnes in 1985 to about 2.035 million tonnes in the year 2,000 A.D. He also indicated that domestic fish production was only 54 - 60% of our demand but was of the opinion that fishery resources in Nigeria could support 80% or more of our fish demand. Since fish production in natural waters is finite while production by fish farming is elastic, efforts must be made to encourage fish farming. Les than 5% of the total available environments most suitable for fish farming was cultivated in 1983 producing 20,500 tonnes o fish which represents about 3.12% of the total fish productic for that year (Tobor, 1985). With the cultivation of 25% of 1,751,509 ha of perennial swamps and brackish water at a production rate of 1.5 tonnes/ha/year about 0.7 million (656,815 tonnes) of fish can be raised, under intensive fish farming system, production rates of 2 - 3 tonnes/ha/year have been reported in Nigeria (Sivalingam, 1974). With good management, intensive fish farming in Warm and fresh waters can yield over 3 tonnes/ha/year of fish (Savig, 1980). Also realising that land outside the swampy zones of the country is being put into aquaculture, potential fish production from aquaculture can be over 1 million tonnes a year.

REQUIREMENTS IN THE CONSTRUCTION OF A FISH FARM

The cost of the establishment of a fish farm falls under various categories as follows:-

a) Land acquisition

A primary consideration in the acquisition of land for the consturction of a fish farm is the presence of water or the cost of procurring water. The land area required for a fish farm can vary from a few hectares to several hundreds depending on the finance and project design. A fish farm that plans to sell fish everyday will require several hundreds of hectares of land while those to sell intermittently will require lesser land area. The cost of land acquisition will be influenced by the current use of the land and its relative usefulness in agriculture. Leasehold from government and government agencies costs less than ₦100 per hectare. The cost is astronominal when land is privately acquired.

b) Survey and Design

A land designated to be used for a fish farm must be surveyed to provide information on the topography of the area. This will enable accurate computation on earthmovings that need be done on each pond. A master design must be carried out for the fish farm. The design must include:

i) a reservoir. The reservoir must have a monk, a dam and a spill way.

ii) the layout of the ponds in the farm. The surface area and depth of each pond must be indicated.

iii) and office complex. This may be a simple design that will have a store, offices, laboratory (for water quality monitoring and feed formulation) and toilet facilities. The cost of survey and design will vary but should not exceed 5% of the cost of construction of the ponds.

c) Construction of Ponds

The construction of a pond involves considerable earthmoving by use of heavy equipment like Caterpillar. The volume of earth to be moved can be computed from the contour profile and the desired depth of each pond. Ideally each pond should be about 1.5 m deep. The cost of earthmoving can be computed using current rate of hiring a bulldozer at about ₦120.00 per hour.

In addition, each pond will require a dyke and a monk. The construction of each of these is determined by the size of the pond or reservoir. The cost of construction of the dyke and monk is usually about 6% of the cost of the entire pond. The walls of the pond need to be compacted and grass planted in areas expected to be above water level. The cost of this is estimated at less than 0.5% of the cost of pond construction.

In order tc ensure that water seepage is reduced to the barest minimum a clay core must be built into the walls and floor of each pond. When construction is completed, the pond floor must be limed to kill off potential pathogens, eggs of predaceous invertebrates and reduce acidic condition in the substratum to alkaline.

MANAGEMENT OF A FISH FARM

Varying facets are involved in the management of a fish farm. There is:

a) Pond Maintenance

It is essential to maintain each of the ponds in an optimal condition always. There is therefore the need to monitor the physico-chemical features of each pond on a regular basis to ensure that the parameters are well within tolerance levels of the fish species in the pond. This will eliminate stress and ensure good growth of the fishes.

In some remote areas, facilities for monitoring physico-chemical parameters may not be available. In this situation visual observations of the fish in each pond must be carried out to assess their movements and behaviour. Any fish in a stress situation will be easily noticed. Dead or dying fish must be removed immediately.

The walls of the pond must be inspected regularly especially during the rainy season. Signs of cracks, crab holes and poor grassing must be quickly corrected. Fish predators - king fishers, heron, monitor lizard, and frogs must be eliminated or prevented from the ponds. As much as possible rain run off should be prevented from flowing directly into the ponds.

Supplementary Feeding

Dissolved nutrients promoting primary and secondary productions in the natural environment are seasonal and may not occur in required proportions to meet the nutritional demand of cultured fishes. Supplementary feeding satisfies this need and ensures that the fish gets the appropriate spectrum of its basic food requirements for its maximum growth.'

Supplementary diets often called artificial foods could be mainly or partially made from natural ingredients and synthetic materials. Such preparations are made to meet the nutritional requirements of a particular fish species with provisions for fishes of different size intervals. Adequate feeding with supplementary diets improves fish resistance to diseases, ensures increased fish production and may enable more than one cropping session per year

(Dulong et. al. 1958; Mazid et. al. 1978). High protein diets are essential for juvenile fishes since they require more protein for their growth than the larger fishes. Supplementary diets must also contain appropriate fatty acids, essential minerals and vitamins. In addition, the supplementary diet must contain carbohydrates which provide most of the energy needed by the fish. Carbohydrates improve growth, food utilization, digestibility and enzyme activity in fishes (Nagayama and Saito, 1978) and act as a binder in the artificial feed (Lovell, 1971).

Materials which are cheap and available in large quantities should be used for the production of fish feeds. Such materials include palm kernelcake, groundnut cake, millet, rice bran, chicken offals, blood meal, brewers wastes and flour mill sweepings. The use of cheap feeds without reduction in effectiveness is desirable in reducing overhead expenses. There is therefore urgent need to increase research efforts aimed at formulating suitable diets for the various stages of the cultivable species and to collate information currently available in this field.

Water Quality Maintenance

Maintenance of water quality in the ponds of a fish farm should be directed towards three principal goals:

i) Control of physico-chemical features of each pond. Temperature: From all indications the high water temperatures in the tropics encourage rapid growth.

The temperature of a body of water can be controlled by reducing insolation by erecting a bamboo shed over it. Oxygen: Different fishes have different oxygen requirements but a range of 4-8 mg/l is optimal and some cichlids could withstand temporarily up to 3 mg/l or much lower in consequence of temperature and increased organic matter. Dissolved oxygen profile influences the stocking density of ponds.

Hydrogen ion concentration (pH): Alkaline ponds are more productive than acidic ones. The pH values in the range 7.0 to 8.5 are regarded as good for fish production. pH values lower than 6.0 and higher than 8.5 create uncomfortable stress situation for fishes.

Heavy metals: Heavy metals like mercury, cadmium, copper and zinc are toxic to fish even at low concentrations. Being bio-accumulated, they are also very dangerous to the consumers of the fish.

ii) Liming: This ensures pH stability. Most aquatic organisms tend not to withstand sudden or strong variation in pH. Apart from this liming has anti - parasite action, destroys some algae and aquatic plants as well as insects and larvae which are enemies to fish.

iii) Fertilization: It involves fertilization of the pond with inorganic and/or organic materials. These increase the natural food of fishes thus increasing fish production. Fertilizers containing phosphorus, potassium and nitrogen are highly favoured. Organic manures have added advantage of bringing in all nutritive substances and a favourable action on soil structure. Application of such manures must be monitored to prevent causing a dissolved oxygen deficit in the ponds.

Staff Requirement

The strength of staff required will be determined by the size of the fish farm. The minimum staff required in a fish farm are as follows:

i) Farm Manager: He is the overall boss on the farm. He overseas the day to day running of the farm. He should be well trained and have either an HND in Fisheries or a degree in Fisheries or Zoology

ii) A Supervisor: He is responsible to the Manager. He could serve as accounts clerk/ purchasing officer. He must be willing to participate in all facets of the work programmes in the farm.

iii) Two unskilled workers: They will be responsible for applying fertilizers to the ponds, providing supplementary feeding and cropping of the ponds. They must be able to swim and paddle a small canoe.

iv) Driver/Mechanic: To drive and maintain the official vehicle.

v) Consultants: A big farm may require the services of a consultant veterinary doctor and a fisheries scientist to intermittently assess the state of well being of all fish ponds and their component fish species.

vi) Two Security Men: To effect security in the farm against theft and related incidents.

Materials Required

A fish farm will require the following materials at one time or the other.

i) Nets: These should include a drag net and a cast net. If the reservoir in the farm is extensive, gill nets will be required. Hand nets are also required to remove fishes in strees condition.

ii) Canoe: A wooden, aluminium or fibre glass canoe is required for movement in each pond and in the cropping programmes.

iii) Wheel barrow: A wheel barrow is required for movement of materials (feed, fertilizer etc.) between ponds.

iv) Rainboots: At least a pair should be provided for each worker.

v) Fertilizer: The type of fertilizer required will be dependent on the nature of the water and its substratum. An expert advise is required. Inorganic fertilizers (e.g. Ammonium sulphats, NPK etc.) are quick acting in providing plankton bloom but their effect diminishes rapidly. On the other hand organic fertilizers (cow dung, poultry droppings etc.) give sustained plankton bloom when needed.

vi) Other materials required are cutlasses, spades, plastic containers, first aid kit and scale.

vii) Transportation - a pick up van.

Cropping in a Fish Farm

A pond should be cropped when the fish therein reach the acceptable size of the market. Cropping can be quarterly, half yearly or annual. The rate of growth of the fish will determine the frequency of cropping. We recommend half yearly cropping of polyculture ponds and an annual cropping of a tilapia pond.

Provision for Exigencies

In planning a fish farm there is need to allocate a reasonable amount of money to meet unexpected developments. There is the constant problem of price instability. We recommend that about 10% of the projected cost of the farm should be set aside for exigencies.

Insurance Policy

We recommend that an insurance policy be taken to cover equipment and accident to personnel and the ponds. For example, prolonged heavy rainfall can cause unexpected damage and flood in the fish farm.

Stocking

The rate at which any fish species is stocked in a pond either alone or in combination with other species depends on the productivity of the pond which is also hinged on the physico-geographical characteristics of the environment like temperature and light intensity as well as the water quality which must be high in nutrient, completely devoid of toxics and must also be well oxygenated. The stocking rate of any species is given as the product of

$$\frac{\text{Total production (kg) - Loss (mortality in number).}}{\text{Individual growth (kg)}}$$

Growth target and total productivity must be predetermined. Individual growth target of each species in the farm is got from substracting the mean weight at stocking from the mean weight at harvest. The normal limit of growth of the species is needed to fix the target. Loss due to varying causes should be computed at 5 to 10%.

Stocking a combination of species or polyculture is preferred since single species cannot exploit all available food in a pond. Proper combination will make fuller use of available food and space, reduce hazards due to predation and diseases. Priority in selection of choice species for polyculture is that combination which will include:

- a phytophagous species usually tilapia;
- a bottom feeder which can feed on detritus and benthic invertebrates;
- a predator/carnivore to control tilapia population.

The species in the later category must have restricted breeding habits, so as not to wipe out the stocks of other trophic groups. In fresh water polyculture, the readily available species and combinations are as follows:

- Tilapia - Clarias - Heterotis
- Tilapia - Channa - Heterotis

- Tilapia - Heterobranchus - Heterotis
- Tilapia - Carp (grasscarp) - Clarias
- Tilapia - Clarias - Chrysichthys.

The species composition for brackish water will primarily be as follows:

Mullet - tilapia (S. melanotheron) - snapper

Mullet - Chrysichthys - tilapia

Mullet - tilapia - megalops.

Available tilapias of food quality include T. zillii S. galilaeus, O. niloticus and S. melanotheron. All male hybrid tilapias are also being produced for intensive fish culture.

In the polyculture systems the stocking rates of the various trophic groups are not the same. The predators are usually fewer per hectare than the others. Optimum stocking rate of most fish tends to increase from natural ponds to fertilized ponds and highest in artificially fed and fertilized ponds. We recommend a stocking density of 20,000 specimens per hectare. The ratios of stocking are as follows:

Tilapia - Clarias - Heterotis	12000 - 3000 - 5000
Tilapia - Channa - Heterotis	10000 - 3000 - 7000
Tilapia - Heterobranchus - Heterotis	12000 - 3000 - 5000
Tilapia - Clarias - Carp	10000 - 3000 - 7000
Tilapia - Clarias - Chrysichthys	12000 - 3000 - 5000
Mullet - tilapia - snapper	5000 -10000 - 5000
Mullet - tilapia - Chrysichthys	5000 -10000 - 5000
Mullet - tilapia - megalops	5000 -13000 - 2000

Stocking rates can be varied to suit particular needs. For example, brooding ponds will have lower stocking density, than rearing ponds.

Estimated cost for stocking, supplementary feeding and water quality management:

Fish seed procurement:

Purchase of fingerlings are recommended if there is no hatchery centres managed by specialists to produce highly resistant brood of frys for stocking (frys usually taken as seed of size 2.5 - 5 cm and fingerlings 5 - 7.5 cm).

Tilapia 5,000 fingerlings @ 20k each	₦1,000.00
Clarias 3,000 fingerlings @ 50k each	1,500.00
Heterotis 3,000 fingerlings @ 30k each	900.00
C. nigrodigitatus 3,000 fingerlings @ 40k each	1,200.00
Common Carp 3,000 fingerlings @ 30k each	900.00
Heterobranchus 3,000 fingerlings @ 40k each	1,200.00
Supplementary feed	1,000.00
Liming	200.00
Fertilizer	250.00

In a big farm an allowance of ₦2,000.00 should be made available for consultants.

EXPECTED INCOME

Estimated total harvest from a polyculture system in the combinations given are:

Tilapia 1500kg @ ₦3.50 per kg.	5,250.00
Clarias 3,000 kg @ ₦4.50 per kg.	13,000.00
C. nigrodigitatus 4,000 kg @ ₦5.00 per kg.	20,000.00
Heterotis 4,000 kg. @ ₦4.00 per kg.	16,000.00
Heterobranchus 3,000 kg. @ ₦4.00 per kg.	12,000.00
Carp 3,000kg. @ ₦4.00 per kg.	12,000.00

Each combination is expected to yield a conservative total revenue of ₦30,000 giving room for a 5% total mortality.

CONSTRAINTS TO THE SUCCESS OF A FISH FARM PROJECT

Two main factors that can militate against the success of a fish farm are:

Management:

Several lapses in the management of a fish farm result in reduced production of fish and hence the profitability of

the entire project. Some of these include:

a) Inadequate security which will encourage poaching.

b) Poor control of predators and parasites.

c) Inproper control of flood.

d) Lack of knowledge of the status of the water quality in the ponds.

e) Use of the wrong fertilizer and

f) Irregular supplementary feeding and poor knowledge of the quantity and quality of the feed.

Stocking:

Many fish farmers do not know how many fish should be stocked in each pond. The problem is further compounded when more than one species is to be stocked in a pond. The ratio of one species to the others in usually unknown.

Many fisn farmers cannot accurately identify the fish species they are stocking in their ponds. For example, many Clarias spp. are usually stocked out only a few of these grow rapidly and reach market size. Similarly, the slow growing Chrysichthys auratus is often stocked with the fast growing Chrysichthys nigrodigitatus.

The greatest problem facing a fish farmer however is that he cannot even get enough fingerlings to stock in his ponds and often he is unable to get them when he needs them. These serious problems must be solved before a successful fish farm can take off.

RECOMMENDATIONS

While recognising the limited success achieved by the Nigerian Institute of Oceanography and Marine Research in producing pelleted fish feed, we recommend that the composition of the feed be indicated on the package and efforts should be made to produce the feed in far greater quantity than at present.

We are also of the opinion that it is necessary to have a form of short training for fish farmers in the identification of the species to be cultured. This we think is essential for the success of a fish farm project.

We recommend further that fish seed production and availability must be ensured before the commencement of the construction of a fish farm. Fish seed produced in the wild have poor growth rate and those so collected may include weed fishes. Quantity obtained are usually grossly inadequate for the need of the farm. In some species

fingerlings are produced seasonally. Then there is the added problem of accurate identification of the species involved. Fish seed are therefore best produced in a fish hatchery.

In a hatchery, the type and quality seeds required can be produced within a short time. Hatchery construction however requires a considerable capital investment and must be run by an expert. Such capital and expert may not be readily available. It is therefore desirable to have within a state or adjacent states a fish hatchery. Since considerable capital is involved and the experienced expert are too few, we recommend that a co-operative venture between fish farmers be initiated to establish a fish hatchery.

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CREDIT FINANCING OF AQUACULTURE PROGRAMMES - A REVIEW

by

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INTRODUCTION

The purpose of this paper is to assist in clarifying the role of credit financing in the development of aquaculture programmes in Nigeria. Three limiting factors of production have been identified:

i) natural resources;

ii) technology and management;

iii) capital.

Amongst these, availability of capital is the most important factor. An attempt has been made here to examine the constraints militating against credit availability to aquaculture vis-a-vis the competition between aquaculture and other agricultural and industrial sectors for the allocation of available credit facilities. We have also suggested possible ways of enhancing preferential allocation of capital to the aquaculture industry from the various sources of credit available to the Nigerian agricultural economy.

Aquaculture has developed in many countries of the world under different natural and socio-economic conditions. There are the traditionally fish farming nations whose peoples have developed the art of fish farming as a house-hold enterprise hundreds of years before. Modernization of the art is therefore, easy in terms of technology and management. To many of these nations and peoples, availability of finance has been a major constraint, even though notable progress have been made over the years. These countries include China, Japan, India and many South East Asian countries and the Pacific States.

There are also the developed nations of the world, who through advance technology and immense resources, have mostly taken to fish farming as a way of diversifying investment opportunities. Although they are not traditionally fish farmers, laudable technological and management progresses have been made through the availability of resources, notably capital.

The third group are the late comers - most of these nations have enormous natural resources conducive to fish farming but are not fish farming nations. The art is alien to them. Technology is not available and capital is either lacking or misappropriated. But in the wake of high population growth, these nations are faced with the realities of how best to fight hunger and famine. Fish farming suddenly became an alternative source of activity/investment for rural development and animal protein production - Nigeria falls into this category.

However, irrespective of the social and economic differences of these nations and groups of people, the interests of all nations are now directed towards the establishment of viable industries - the productive utilization of resources. Consequently, aquaculture, like other economic ventures, must merit their investment objectives to attract capital for development. This is the reason for a re-appraisal of aquaculture programmes in the poor, non-fish farming nations of the world to enable the industry attract necessary financial assistance for growth and development.

Need for Credit Facilities in Aquaculture Financing

There have been substantial expansion in aquaculture production in recent years because of, among other reasons, downward trends in world capture fisheries production and food economy which have made it necessary to look for new sources of animal protein supplies for human consumption. There have been tremendous development plans in aquaculture world wide. Realization of the ambitious aquaculture programmes will depend on the availability of finance.

Most aquaculture ventures are still new. There are therefore, no good prospects of generating enough funds from within the industry itself. Development programmes will undoubtedly rely on credit facilities for survival and to achieve the desired growth targets.

Constraints Militating Against Credit Financing

1. Aquaculture has always been considered by bank officials along with fish capture or agriculture, as such, risk elements - the main yardsticks for evaluating loan applications have been considered with risk factors in fisheries and agriculture. The situation does not augur well for aquaculture loan processing. In consequence, financial experts and loan application analysts who process aquaculture loan requests are not technically competent to assess loan applications. As a result, there is always a misjudgement of credit worthiness of aquaculture ventures. In Nigeria, as in many non-fish farming nations, there is a dearth of technical knowledge of aquaculture, therefore,

there are only a limited number of existing viable and successful reference projects from which officials would draw yardsticks for appraising project proposals.

2. Where ownership rights can be established for fish farm site, the value placed on such land is always minimal since sites for aquaculture are considered waste land and therefore not always useful for other purposes. This invariably affects the use of such land for security purposes in bank lending.

3. Aquaculture is disadvantaged as a new industry because it lacks appropriate organisational structures as well as the political support. Thus, aquaculture in most cases has not been able to obtain for itself, certain benefits from the State, such as production subsidies which farmers and capture fishermen have come to accept as part of what is naturally due to them.

Essential Requirements for the Enhancement of Aquaculture Credit

The problems of credit financing of aquaculture projects have plagued many fish farmers for years. Experience from different countries have therefore resulted in the recommendation of a number of requisites for the enhancement of aquaculture credit facilities, as applicable to older industrial sectors:-

1. Feasibility Study: Since aquaculture is being considered as a viable economic industry and usually in competition with other industries, the conduct of a comprehensive and thorough feasibility study would assist creditors to assess project viability irrespective of concessions given to assist in the granting ofcredit for the sector. Such study has to cover human resources and environmental constraints that may affect the implementation of an otherwise promising programme, in addition to biological, technological and economic factors. Thus, it is important that would-be investors identify capable and competent organisations in the conduct of sound feasibility studies.

2. Careful integration of loan with other development support operations in coordination between supply, marketing and other services for the achievement of aquaculture development aims is important. This shall indicate that credits are used for the purpose intended and in the most efficient manner.

3. Availability of infrastructural facilites is another essential requirement for the successful operation of a credit scheme. For instance, availability of high quality fish seeds, fish feed and other inputs are essential. If these infrastructures are seen

as constraints to the successful implementation of a project, it will jeopardise the prospect of credit approval. It is either that such infrastructure are considered as part of an integrated large fish-farm project for which credit request shall be made. In other cases, separate private companies provide these services. Infrastructural facilities are still far from being adequate for the optimum development of aquaculture prospects in Nigeria. Many private groups provide fish seed and fish feed while a lot more need to be provided in terms of research findings and extension services by government. These could pose initial problems to rapid development, they are by no means unsurmountable.

Structural Differences in Credit Financing

Creating efficient credit system for aquaculture development will depend on the type of needs to be filled by the financial request. Financial request could fall into one of the following categories:

(1) Investment: needed for the physical construction, acquisition of machinery and equipment and other fixed costs.

(2) Working Capital: for the day to day running of the enterprise.

(3) Consumption Funds: for the procurement of consumables.

Within these categories, requirements may differ substantially according to size andtype of operation and stage of development of the industry in the country of interest.

For instance, a large-scale commercial fish farmer in Nigeria will incur more initial investment costs on infrastructure. He may operate an intergrated venture, producing his own feeds, market his own products and learn more by experience. Whereas a large scale operation in Europe, America or the developed Asian countries already has well developed infrastructural system and marketing channels for disposing off his produce. In this instance, request for credit will vary in terms of need and therefore, the amount. The structural difference may be handled by different credit agencies to ease the credit management and to avoid unequal assessment of application since the conditions of request are different.

Again, large-scale fish farm operators are likely going to be individuals or cooperate bodies with substantial financial and material resources necessary to meet the cost of such projects. They may not find it difficult to secure loan funds needed for their project, since they will not lack collateral to support such application for credit extension.

Category of investment may also vary from a minimum amount such as the case where existing water area like burrow-pits, village ponds and multi-purpose community-owned water bodies are used; to substantial sums where expenditure for removal of trees, excavation, re-filling and levelling in dam construction for water supply, drainage canals and water-gates are involved. The case of Rock Water Fish Farm in Jos, a developed fish farm using burrow-pits for water supply in the old tin-mining area of Plateau State comes to mind. The operators of such farm will need minimal capital investment compared to money that would have gone into clearing, stumping, damming and construction, were the project to be embarked upon in the rain forest zone of Southern Nigeria.

In the opinion of this author, these are some of the structural differences in the credit requests that should be reflected in government guidelines and policy objectives concerning the management of credit scheme from different sources. Geographical differences, investment objectives, and scale of operation should have bearing on the merit and scale of credit facilities.

Suggestions for the Management of Credit Schemes

Success of credit scheme is an interplay between funds availability, scheme management, and funds utilization. The following credit management bodies have been suggested and the role of Fisheries Society of Nigeria (FISON) in the scheme highlighted:

1. An Aquaculture Credit Scheme:

The establishment of an aquaculture credit scheme (ACS) to be managed by a committee will be desirable. It suggested that competent members of the Fisheries Society of Nigeria (FISON) form the core of the scheme committee members who should also include bankers, preferably with academic background in the fishery sciences or agriculture.

The aquaculture credit scheme should be the administering agency for government finances for private fish farm development. Sources of funds should also include grants and financial assistance from International organisations as might be needed for small and medium scale farmers.

2. Integrated Rural Development Scheme (IRDS):

To bring development to the generality of Nigerians, the government has inaugurated a Directorate of Food, Roads and Rural Development to evolve a system of development for the rural communities where more than seventy five per cent of Nigerians live. Any good programmes of rural development usually embrace a wide range of mix of activities. In the new dispensation, this rural development body has a vital role to play in the incorporation of aquacultural programmes within the rural communities

activities in its effort to increase food supplies for domestic use and possibly later for the export market. In the planning and execution of this basic macro-economic objective, the comprehensive programme must involve the optimum use of water resources which will not be complete without the incorporation of aquacultural programmes. This should aim at producing food at minimum cost with the ultimate goal of improving the socio-economic conditions of the rural populace.

3. Fishery Bank:

The development of a fishery bank should be the ultimate goal. Although this facility might be under-utilized if immediately established, it should eventually work in collaboration with or take over the responsibilities of other coordinating agencies and the administration of funds from governmental, regional and international organisations. Achievement of the objectives of a fishery bank will depend on how ready the government is. to invest in the provision of infrastructural facilities so as to minimise the capital cost requirement of would-be investors. Timely establishment of a fishery bank will no doubt facilitate early growth for the industry.

Available Sources of Credit Facilities

1. International and Regional Institutions (e.g. FAO, UNDP, ECOWAS, EEC)

Funds are regularly disbursed from these various organs of the United Nations and other regional bodies. Although the allocation depends on the sectoral importance and development of the particular industry. Many South East Asian countries have benefited immensely from Fishery Funds. Although Nigeria has benefited substantially, an aggressive and well articulated fishery development programme can further enhance her chances.

2. The Government:

The Government has an important role to play in making funds available for credit financing of aquaculture. Apart from investment in basic infrastructural facilities, it is suggested that a "farmers assisted programme" is employed through the River Basin and Rural Development Authorities (RBRDA). This programme has been run for agricultural projects by some RBRDAs . The authorities should provide the basic infrastructures, select sites for fish farms, construct and supervise the management, while the farmers' labours are employed. During harvesting, the proceeds are sold by the authorities for the farmers while partial deduction of input and machinery costs are made over a period of time. At the end of say five years, the fish farmer must have been well skilled to look after his farms,

while obtaining input and other requirements on credit from the authority and repayment made during harvest. This will ensure grass root participation and will make the money allocated to aquaculture reach the farmers who need it since the authorities are liable to government and they must be made to account for their performances. Set target should be given to the RBRDAs on the number of farmers to be assisted or size of fish farms that must be accomplished over a period of time.

3. The Banking System

The Nigerian Banking System is important in the provision of credit facilities to fish farmers as it is important in agriculture. Since there are always more profitable outlets for banks loan funds, government should see to it that banks are instructed on the amount, schedule of release and guidelines of loan processing and management as it affects the fish farmers. Failure to meet specified amount of credit based on a percentage of bank reserve or annual loan facilities should attract a penalty. This should encourage banks to ease the processing of credit application for fish farming.

Government guidelines to banks should include the following:

(i) Concessional rate of interest, particularly during the initial stage of development. This may also vary between different types of operations (large scale and small scale, export - as in the case of shrimp culture) and domestic oriented products.

(ii) Banks should be made to employ and train fishery sciences graduates to enhance the technical evaluation of credit applications.

(iii) Because inability to produce collateral acceptable to lending institutions has in many cases prevented small scale operators from deriving full benefits of credit schemes, banks should be made to accept good and thorough feasibility studies in lieu of security. Such loans should again be guaranteed by the government. In this instance, the bank should in addition to ensuring that a feasibility study is good and realistic, if possible avoid paying money directly to fish farmers but banks should pay directly for the services and materials needed on the farm. This will avoid an abuse of the priviledge and will make banks develop expertise in the field to the advantage of the industry.

(iv) Banks should be categorised on the scale and amount of credit they can grant and according to the people they will serve. For instance Merchant and Commercial banks should be directed and guided on the granting of loans to large scale investors, while small scale investors are serviced through the rural banking

programme of the Commercial banks. For immediate development goals, the banking system shall be very useful. Government should be made to give specific instructions to enhance credit financing in aquaculture as distinct from fish capture and agriculture.

4. Estate Financing

Agricultural estates could finance credit facilites to individuals and farmers. This scheme could be similar to what the Nigerian Tobacco Company (NTC) employed in the sixties to ensure adequate raw materials sources for its factories. The Company employed and trained many agriculture technicians and superintendents. These men were used as extension workers who directed and monitored the planting, and management of tobacco farms. Only the land and labour are supplied by the farmers. The Company supplied the seeds, fertilizers and other requisites on credit to farmers. The total cost of such facilities are deducted from farmers' sales at the end of the season.

Estates financing of fish farming however, may depend on the availability of other infrastructures which government shall provide, otherwise cost of implementing the programme could be too high so that it will not be attractive to either the estate financier or the prospective fish farmers.

The IBRU Group is a prospective estate financier with regards to its vast resources and experience in food and agricultural production.

5. Suppliers of Materials

Materials and requisites suppliers could be a source of credit to farmers. For instance, the U.A.C. Group among others with its chains of distributive stores can supply equipment and materials to fish farmers on credit. Produce can be bought by the Group for its chains of supermarkets nation-wide, while the cost of supplies are deducted from the farmers.

6. Private Financing

In a situation where the basic infrastructures are available or the investment costs are reduced either as a result of the use of burrow-pits, flood plains or community reservoirs, private individuals could be good sources of credit. The fish farmer must however, ensure that efforts is going to be worth the while through adequate returns, to be able to pay both the principal and interest and as well leave enough margin for profits.

7. Oil Industry

Because the Nigerian Oil comes from the riverine states, a great deal of the indigenous fisheries potentials have been destroyed by oil pollution. The government could make the Oil companies assist the development of fish farming. A percentage of the companies earning could be made available under the Aquaculture Credit Scheme or the Integrated Rural Development Scheme.

CONCLUSION

Although there have been great technical advances in aquaculture, the growth programmes and development projects have not been fully realised. Shortage of funds is the principal problem confronting the industry.

In the early years, small projects were useful to show the potential of aquaculture industry but the need now is for projects capable of demonstrating technical and economic feasibility in order to attract investments for large scale development. The funding available for the majority of projects from national or international sources is too inadequate to achieve this objective. Aquaculture planning programmes must meet the current need of economic ventures for it to compete with other industries in funds and resources allocation.

The momentum being gathered by aquaculture development efforts requires that institutional arrangements are adopted to assist development programmes with a view to strengthening aquaculture credit schemes for the industry's requirements for investment capital, input purchase, crop financing and essential consumption expenditure of the operations.

Specific review of conditions and need of the Nigerian situation is necessary in the planning of aquaculture development programmes. Such programmes should lay emphasis on the provision of infrastructures by government and other institutions and a machinery of easy access to credit facilities by would-be investors. The banking institutions have an important role to play in the provision of credit for aquaculture. In addition to their experienced credit operations specialists, they should work in close collaboration with fish farming experts and develop their own expertise in the sector to be able to provide improved facilities and procedures for aquaculture credit administration.

The Fisheries Society of Nigeria (FISON) has to step up its activities to influence government planning programmes so that aquaculture will have a place in the national development programmes. The current lag in technical management and economic activities within the aquaculture sector may retard credit facilities, and correspondingly affect development. Efforts have to be made to urgently improve these areas so that other activities in the development programmes are not unnecessarily jeopardised.

INVESTMENT IN THE TRAINING OF TECHNOLOGISTS FOR COMMERCIAL AQUACULTURE

by

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ABSTRACT

The protein shortage in Nigeria is noted and the role of aquaculture (=fish farming) as a complement in increasing the dwindling food supply is registered. In addition, the manpower shortage especially in the technology cadre is noted and attributed to the lack of co-ordination and standard curricula especially in aquaculture.

An inventory of tasks performed in the Aquaculture industry was taken and these were classified and validated, then their final priority level was used to assess which ones were critical, important or desirable and which ones would result in disaster or not with inadequate mastery.

Based on above, recommendations are made that all critical and important tasks be included in the teaching curriculum for aquaculture in both theory and practicals: while it is advocated that all tasks listed be undertaken in fish farm operations. This will raise the competence of technologists to run the commercial aquaculture projects.

INTRODUCTION

The basic concept of protein shortage in Nigeria is well known and the role of fish as a very suitable substitute is well documented by many authors. Also the development of Aquaculture as a discipline needed to increase the dwindling food supply and to complement productivity of landed fish from both deep sea fisheries and inland fishing by local fishermen is appreciated. In the 1981 - 1985 plan period, aquaculture netted ₦12,000,000 next only to Fishing Infrastructure.

However, most authors agree that one of the most pressing factors militating against the proper fisheries development is lack of trained manpower at various levels especially at the middle level manpower,(Ita, 1980 ; NFDC, 1979 ; Ita & Sado ,, 1983 , Olaniawo,, 1983); and in virtually all specialised aspects of aquaculture (Afinowi, 1983). The manpower requirements for the aquaculture industry in Nigeria was put for 1985 at 2,936 viz:-

- 174 Fisheries Officers, 243 Superintendents, 1214 Fisheries Assistants and 1305 Artisans/Fishermen.

The manpower needs of the country in the Fisheries Subsector can only be met by designing appropriate curricula for the various programmes of training. In the design for a curriculum for Agric. Technical Education, it is important that the curriculum should be responsive to industrial needs. Thus training must be consistent with the need of the industry within a given period. The Agriculture industry of which aquaculture is one has an extremely narrow adequate technology base and so without a prescribed performance skill (Ndukwe, unpublished). The major constraints of Agricultural development and training in the developing countries include among others the following:

1. There is an adoption rather than adaptation of programme objective, and practice in Agriculture Education and training from developed societies where social, economic, cultural structures, techniques and traditions are different.

2. The curricula content of teaching methodology in many agric institutions are not sufficiently relevant to national goals but this according to Mosher (1986) as quoted by Ndukwe (unpublished) is wrong since vocational agriculture must be strongly oriented to practical training and acquisition of skills essential to successful operations of a training enterprise. In his unpublished report, Ndukwe has suggested that to formulate a programme of study the need for it must be established, as well as the need for the resulting difference between what is and what ought to be, and objectives then formulated to satisfy these needs. Olaniawo (1983) has outlined the 3 universal objectives for fisheries development:

   - to increase food supply and improve nutritional standards,
   - provide increased income earning opportunities,

- where possible expand fish exports and foreign exchange earning and suggested that manpower development in the fishing industry should at a given time be tailored to one of the above. Even though manpower problem of fisheries is the same as other sectors of the economy Cole & Hall (1973) as quoted by Olaniawo (1983) identified the main industry specific personnel of fisheries as sea going, commerce and development, research, education and economic. Nobody has done this for aquaculture.

This paper is based on identified tasks involved in aquaculture and is used here for the purpose of establishing guidelines for an appropriate curriculum in Aquaculture to suit the requirements of fish farming operations. The aim is to identify all the tasks and skills in relation to total operations in the aquaculture industry, compare these tasks identified with what already obtains in the institutions for the training of technical manpower OND/HND levels and what ought to be. At the end of the analysis, it should be possible to design a good curriculum in line with prescribed industrial skills and learning outcomes, thus guaranteeing the skills currently in use in the industry. While Olaniawo (1983) had traced the efforts in the training of manpower in the Fisheries subsector in Nigeria, he noted that there has been no effective co-ordination of training programmes due to lack of a standard curriculum, and suggested that better impact will be made if the schools concentrated on fewer areas of training excellence since no school can run all the Fisheries programmes effectively. In Nigeria, many Schools/ Colleges of Agricultural Science and Technology have been opened to meet the manpower requirements in the various sectors, most of these offer technical courses and are involved in the training of middle level manpower for Agricultural development. Because of the increasing number of schools and colleges, there are variations in physical facilities, equipment, staff strength and experience and type of course, syllabi , course content and certification, all these without co-ordiantion, Okpechi (1985) unpublished.

The National Board For Technical Education (NBTE) is currently visiting some of the Technical/Technological Schools in relation to their accreditation. Some of these colleges offer Fisheries courses. There is thus absolute need for standard criteria for a review of their fisheries curricula. This paper will therefore go a long way in helping draw up a curriculum for aquacultural education. In addition a professional body could be formed based on the curriculum to control the practice of fish-farming (Aquaculture being a branch of Agric. which is practised freely without a formally organised professional body that controls its practice through ethics formulation as if there were no possibility of malpractice).

Guidelines to an appropriate curriculum in Aquaculture training thus examines the tasks usually encountered in aquacultural practice, and their relevance at each level, their priority level having first classified and validated them in the aquaculture industry in Nigeria using Imo and Rivers States as examples. It therefore makes recommendations towards an appropriate curriculum design in aquacultural training.

METHODS

A list of tasks was drawn up based on experience and existing curricula at the School of Fisheries, Michael Okpara College of Agriculture Umuagwo, and the Federal Fisheries School Lagos. Fish Farms in Imo and Rivers States were also randomly selected and visited at every level of technical development and all operations documented and decomposed into tasks. These were then characterised, classified and validated. Final classification was done in order to determine the final priority level of each task in consonance with Skull (1979). All the items on the list were based on observations in fish farms and interviews of personnel and trainees as to what they do - and in most cases orally because of anticipated constraints including illiteracy and numerosity of tasks. Account was also taken of the components of fish culture outlined by Sagua (1983).

Analysis of these were then made using the Licket scale for task statement and the tasks were scored.

1. TASK STATEMENTS USING THE LICKET SCALE 1 - 5

   a) Whether performed (No = 1 Yes = 5)

   b) Frequency of Performance (Rare/once = 1 Once/Yr: Low = 2; 2 - 3 times/Yr: moderate = 3; Forthnightly/monthly: High = 4: Daily/Twice Daily: Very High = 5;

   c) Perceived difficulty in performance (None = 1; Low = 2; Moderate = 3; High = 4; Very High = 5).

   d) Relative benefits of Training received (No training = 1; Training of maximum benefit = 5).

2. TASK CLASSIFICATION:

   a) Name of task

   b) Task objectives (Specific to industrial operations)

   c) Learning category (cognitive/physcomotor effective)

   d) Environmental condition for tasks

   e) Equipment used

f) Completion time

g) Learning time

h) Consequences of inadequate mastery (None = 1; Negligible = 2, Significant = 3; Serious = 4; Disastrous = 5)

i) Probability of use (Rare = 1; Low = 2; Moderate = 3; High = 4; Very High = 5)

j) Importance (Desirable = 1; Important = 3; Critical = 5)

k) Reaction Speed (Over-learning = 1; Mastery = 5)

l) Proficiency (None = 1; Low = 2; Moderate = 3; High = 4; Perfect = 5)

m) Category of Worker (Labourer = 1; Sales Clerk/ pond attendant = 2; Trained tractor driver/ Fisherman = 3; OND = 4; Fish Officer HND = 5).

3. TASK VALIDATION

a) Consistency of task with outcome specification (Rare = 1; Low = 2; Moderate = 3; High = 4; Very High = 5).

b) Specification

c) Precis ion (Rare = 1; Low/Significant = 2; Moderate/Permissible = 3; High/Little or no error = 4; Very High/Accurate = 5).

d) Feasibility (Not possible = 1; Possible = 5).

e) Functionality (Not useful/Rare = 1) Low = 2; Moderate = 3; High = 4; Very High = 5).

f) Significance (Desirable = 1-3; Important = 4; Critical = 5).

g) Appropriateness (Not appropriate = 1; Low = 2; Moderate = 3; High = 4; Very High = 5).

4. FINAL PROOGY LEVEL OF TASK

a) Importance (Desirable = 1; Important = 3; Critical = 5).

b) Frequency of use (Rare = 1; once pond is under construction Low = 2; Moderate = 3; High = 4; Very High = Daily/2ice daily = 5).

c) Benefit (Rare = 1; Low = 2; Moderate = 3; High = 4; Very High = 5).

d) Consequence of inadequate mastery (None = 1; Negligible Significant = 3; Serious = 4; Disastrous = 5).

TASKS DOCUMENTED

A. LAND OPERATIONS

1. Site selection
2. Surveying
3. Clearing
4. Stumping
5. Pegging of Site

B. METHOD OF POND CONSTRUCTION

6. Excavation by bulldozer
7. By labour - digging & carrying earth
8. Raming of bunds
9. Clay Collection
10. Pilling at the Centre
11. Construction of sluice gates and monks.

C. WATER DELIVERY SYSTEM

12. Construction of channels
13. Mechanical
14. Plumbing jobs
15. Filling of pond with water
16. Stocking of the ponds
17. Determination of species and size
18. Determination of stocking density
19. Collection of Fish seed from wild
20. Importation from other farms
21. Counting and parking of fingerlings/fry
22. Transportation of fry/ brooder
23. Checking them into ponds
24. Supervision
25. Rearing of brood fish/ induced breeding

D. FEEDING

26. Determination of feeding rates
27. Weighing of feed to be administered
28. Administration of feed
29. Preparation of feed
30. Supervision

E. FERTILIZING THE POND

31. Determining the type to be used
32. Weighing out quantity to be used
33. Carry it to the pond
34. Administration of fertilizer
35. Supervision
36. Sampling

F. WATER QUALITY

37. Field tests/laboratory tests
38. Collection of sample
39. Conveyance to the laboratory
40. Determination of temperature

41. Determination of pH

42. Determination of DO , CO_2, and turbidity.

G. CROPPING

43. Draining the pond

44. Harvest using siene net

45. Separation into species

46. Placing of price tags

47. Marketing

48. Processing

49. Storing

50. Pond clearing/removal of silt layer.

H. LIMING

51. Determination of type

52. Determination of wt.

53. Carry to pond site

54. Administration of lime into pond.

I. CONTROL OF WEEDS

55. Mechanical - by labour.

56. Biological - use of fish spp

57. Chemical

58. Determination of spp to use

59. Determination of type of spray to use

60. Weed control on bunded water channels

61. Regular checks on sluice gates/monks

62. Repairs of sluice gates/ leakages

63 Clearing of inlet pipes and screens.

J. GENETICS AND HYBRIDIZATION

64. Selection of brood fish

65. Separation into breeding pond.

66. Determination of type of feed

67. Feed administration

68. Determination of gonad maturity

69. Induced breeding

K. ENVIRONMENTAL MANIPULATION

70. Raising the volume of water in pond.

L. HORMONE EXTRACTION

71. Determine spp to be used and extract the pituitary

M. INJECTION

72. Holding of the fish

73. Administration of injection

74. Putting back into pond

N. PREPARATION OF BREEDING POND

75. Put materials at bottom for eggs of female

76. Get water supply for pond at hand

77. Strip eggs and sperm from females and male

78. Mixing of the two

79. Pour into incubator troughs

O. FISH DISEASES

82. Fish Detection

83. Diagnosis

P. CONTROL OF DISEASE

84. Removal of infected individuals

85. Removal of secondary hosts

86. Determination of chemical to be used

87. Treatment by application of chemical to H_2O

88. Application of drug to infected individuals

89. Routine checks for fish enemies

90. Prevention by removal

91. Prevention by hunting for them

92. Fencing the pond

93. War Against filth = pollution

94. Trapping

95. Regular checks on water quality to prevent proliferation by ectoparasites.

RESULTS

Summary on Task inventory in Aquaculture

In Fish Farm Operations/ Aquaculture practice; 54% tasks	Levels	Licket Code	Score	%
Performed are critical	Critical	5	51	54
23% are important and 23% are desirable	Impor-tant	4	22	23
	Desirable	1 - 3	22	23

Out of a total of 95 tasks in aquacultural skills, 50 are critically required and need to be handled by trained personnel. These require knowledge and skill and category of staff are OND/HND/and Fisheries Officers. These require high proficiency as inadequate mastery will cause very serious problems or have disastrous consequences.

Some tasks on the other hand are important and cannot be overlooked. They are not critical but require capable hands to tackle them effectively. They make up 23% of the tasks documented in aquaculture.

Therefore a total of 74 tasks documented are very essential in aquacultural practice and their importance cannot be over-emphasized. Mastery and proficiency is needed for them and time allocated for proper training in theory and practicals must be adequate. Effionayi (1981) perceived the positive acquisition of appropriate skills, abilities and competences both mental and physical as a pre-requisite for development of aquacultural industrial skills. The training of workers/and or technologists should therefore be carried out bearing in mind these tasks to which attention should particularly be emphasised in the practicals, if the trainees are to become active members of the fish culture team.

About 23% of the tasks are desirable (1-3). While most of them do not require training, and mastery is not important, complete co-ordination will only be achieved when they are in practice.

* Critical tasks as selection of site (Task I) and stocking density determination (Task 16) have very disastrous consequences if omitted e.g. bad site selection results in seepage and water delivery expenses while wrong density determination, leads to over population and stunted growth.

** Important tasks as weighing out quantity of fertilizer (Task 32) and administration of fertilizer (task 33) need proficiency and are beneficial. Improper fertilizer application will lead to serious effects.

*** Desirable tasks are carrying lime to pond site.

CONCLUSION AND RECOMMENDATIONS

- Critical and important tasks outlined should be taken into serious account in designing a curriculum for Aquaculture.
- Enough time should be given for both theory and practicals to ensure high proficiency expected of the grade of workers handling these operations/tasks.
- Construction of model and standard fish ponds be encouraged in the institution to inculcate practical skills in the students.
- Students should also participate in pond construction work with the equipment provided.
- This type of analysis should be made in other areas of Fisheries from time to time to ensure that products of the Fisheries Schools will fit into the industries for which they are trained.

- A council of Registered Aquaculturists of Nigeria should be formed as a matter of urgency to regulate the practice of Aquaculture in Nigeria.

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FISH FARMING IN ANAMBRA STATE: ECONOMIC CRITERIA

by

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ABSTRACT

The paper is based on the premise that an understanding of the role and potentials of fish farming enterpreneurs in terms of their activities and expectations would enhance fish production and productitivity. To this end, the present paper investigates the activities of 24 fish farmers in Anambra State, Nigeria.

Based on the fish farmers' experience, the paper presents fish farming investments, budgets and recommendations that could ensure fish farming development as a profitable business venture and at the same time ensure greater fish production in the country.

INTRODUCTION

The farming of food fish in Nigeria began as a hobby in the 1940's in Lagos and Ibadan by the then expatriate Fisheries Officers. The first commercial fish farm was established in Panyam, near Jos in 1952. By 1979, nearly every State in the Federation was involved in the development of a fish farming pilot project. From then on, the recreational production of food fish was replaced by commercial food fish market.

In the commercial operation, the producer who is now a private investor rather than a government agency, performs the production, distribution and marketing functions, and with it food fish culture in Nigeria has expanded tremendously between 1981 and 1985. Regardless of the distribution mode, food fish culture in Nigeria as in other parts of the world is capital intensive. Even where inputs are at a minimum, the fixed capital expenditures are still relatively high.

Fish farming in land-locked States must have some type of impoundment constructed using either manual labour or machine labour. In addition, commercial food fish operations require relatively high operating capital expenditures especially when the system is intensive* in nature.

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* If formulated rations are fed to achieve a shc ter growing period.

Available statistics show that few potential producers have enough capital to construct ponds and that some form of credit has to be used (Esobhawan, 1986; Ezeife, 1985; Obuseh, 1986; Ofor, 1984; Williams, 1983). Capital for fish farming enterprise must be acquired through long-term financing arrangements. Also, short-term loans are frequently required to finance operating day-to-day activities. Therefore, bank officials or financial institutions should look further than an individual's character and collateral when considering whether or not to lend an individual money to begin a food fish culture operation. Every potential borrower wishes to succeed in his venture, therefore, both the creditor and the debtor want to carefully evaluate a new enterprise such as food fish production before making any commitments. It is therefore, important to define the perspective from which an economic analysis is done. This is important because human desires and needs vary greatly, and economic analysis may result in contradictory results depending on whose perspective the economic analysis is carried out.

Thus, the purpose of this study is to present a means of evaluating fish farming enterprise from an economic standpoint. The example used here is from Anambra State, Nigeria. The computation is that of a generalized situation based on average conditions. However, the farmer's perspective is used as a focal point because of his need to succeed. Therefore, any fish farmer should be liable to analyze his enterprise using his own personal data in the same manner. Prior planning in this manner would result in better decision-making.

A basic assumption for this analysis considers fish production as an integrated enterprise on an existing farm that has other crops and livestock operations as was observed in Anambra State.

METHODOLOGY

The methodology consisted of enterprise budget developed from production costs incurred by the fish farmers in Anambra State. The enterprise budget approach is chosen because it gives a general idea of whether the farmer's investment of capital and labour is worth the effort or whether there are sufficient returns in cash or in kind to justify the effort put into the farming activity. The survey results are described under two headings:

- assessment of the area for food fish production, and
- preparation of enterprise budgets for 1-, 5-, and 10-hectare ponds.

The survey was carried out between December 1984 and February 1985.

RESULTS AND DISCUSSIONS

Assessment of the Area for Food Fish Production

In establishing a freshwater fish farm, several technical factors must be considered.

a) Water Quality and Supply

Water is a pre-requisite for food fish culture. In the case of Anambra State, field survey results indicated that there are several rivers and streams that will provide the ponds with perennial water of good quality throughout the year.

It was also recorded that all the fish farm operations in Anambra State during the period the survey was carried out were all sited near a river or stream.

b) Soil

Soils with a high percentage of clay material are considered to be quite adequate for pond construction because of the clay's quality for high water retention property. Anambra State has good land areas rich in clay soils.

c) Topography

The shape of the land is important when considering the location of pond sites. Anambra is noted for her hills, albeit, private farmers who have already invested in fish farming received good advise from fisheries experts in the Federal, State and Local Government agencies. Summary of pond construction costs showed that the 24 private fish farmers in the State as of February 1985 spent a total of ₦522,300 to construct 49.56 hectares fish ponds. This gave an average estimated cost of ₦10,540 per hectare of fish pond. Costs ranged between ₦2,500 and over ₦20,000 per hectare (Table 1).

Table 1 - Pond construction costs in Anambra State based on fish farmers' responses, 1985

Cost Range (₦)	Number of Farmers (Frequency)	Percentage (% Frequency)
1,000 - 4,999.99	6	25.00
4,999.99 - 9,999.99	7	29.20
10,000 - 14,999.99	5	20.80
15,000 - 19,999.99	4	16.70
20,000 and above	2	8.30
Total	24	100.00

d) Vegetation

Clearing of heavily wooded land as well as stumping the site for pond construction can add more to the cost of constructing the fish ponds. Thus, fisheries enterprises located on relatively rolling land with good watershed is ideal. Results of the survey showed that clearing costs ranged from ₦155 to ₦3,000 per hectare (Table 2).

Table 2 - Land Clearing Costs based on fish farmers' responses in Anambra State, 1985

Cost Range (₦)	Number of Farmers (Frequency)	Percentage (Per cent Frequency)
100 - 499.99	9	37.50
500 - 999.99	11	45.80
1,000 - 1,499.99	2	8.30
1,500 - 1,999.99	1	4.20
2,000 - 2,499.99	-	-
2,500 - 2,999.99	1	4.20
3,000 and above	-	-
Total	24	100.00

Source: Field Survey, 1985

e) Fish Seed and Stocking Rate

Almost all the fish farmers interviewed in Anambra State stated that stocking rate is dependent on the quantity of fish seed supplied for the production activity. This they said was due to the irregular availability of fish seeds in the State. Hence, the quantity and quality of fish fingerlings available at the time of stocking dictates the stocking rate. There were only two fish farms in the State during the survey exercise noted for fish seed production. It was estimated that only 30,000 fingerlings were available as compared to the estimated demand for 200,000 fingerlings. Most of the farmers had plans to start producing their own fingerlings in order to remove the economic hardship created by the insufficient production of fish seeds to satisfy farmers needs.

f) Feed and Feeding

Fish farmers in Anambra State use a variety of feeds such as groundnut cake, palm kernel cake, rice bran, brewer's waste and cassava but the two most frquently used feed, fed to the fishes are palm kernel cake and rice bran.

g) Liming and Pond Fertilization

All the farmers interviewed stated that they lime and fertilize their ponds. They used organic fertilizers such as poultry waste, pig dung and compost or inorganic fertilzers (NPK). The organic fertilizers are applied at the rate of 160kg per hectare while the inorganic fertilziers are applied at the rate of 100kg per hectare per month.

h) Fish Species Cultured

Four types of fish species were named and these are: tilapia, catfish, common carp and Heterotis. The two most commonly cultured are tilapia and catfish.

i) Harvesting and Marketing

The survey results showed that most of the fish farmers harvest their fishes once or at most twice a year. The harvested fishes are sold directly to the public or accredited agents at the pond sites. They indicated that they have no problems marketing their fishes as there are more fish retailers and distributors than producers. The price range of fish sold was between ₦2.50 and ₦4.00 per kg depending on the species.

Preparation of Enterprise Budgets

An enterprise budget is a static image of a certain farm activity (Engle, 1985). It is static in the sense that it analysis the activity at a given point in time rather than over the whole productive life of the activity. Positive net returns is always an indication of profitability in an enterprise budget (Crawford and McCoy, 1977). Tables 3, 4 and 5 summarized budgets for 1-, 5- and 10- hectares of fish pond cultured using tilapia, carp and catfish in a polyculture system.

As shown by the budgets, fish farming is economically feasible in Anambra State given that capital (liquid assets), management, labour and all the necessary inputs are available at the right time. Hence, in terms of protein production, the increase in fish available for home consumption in Anambra State can contribute significatly to the stabilization in other food crop production and this can be perceived by the fish farmers as important benefits to the farmers in Anambra State in general.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

As of February 1985, there were approximately 24 active fish farmers in Anambra State, Nigeria. In addition, there was a viable State Pilot Fish Farm in operation. Total land under utilization was 52 hectares with an estimated output of 33 metric tonnes.

Most of the fish farms were sited near rivers and streams for easy assess to water supply needed for year-round fish production. The State has potentials for commercial fish farming operations.

It was reported by the farmers interviewed that the fisheries experts engaged by the Federal, State or Local Government agencies were actively involved in the State's developmental programme.

The enterprise budgets developed from the survey showed that fish farming can be a lucrative business all things being equal.

It is therefore, recommended that prospective fish farmers should as a rule carry out an economic analysis of any proposed fish farming operation before embarking on the activity. The budget can be prepared along the lines demonstrated in this study to allow the farmer interprete his own plans in financial terms. A well prepared plan will serve as checks and balance for the farmer's activities especially if it is to be a commercial enterprise.

Major constraints identified from the survey were:-

- lack of capital for interested fish farm investors in the State
- dire scarcity of fingerlings, feed and experience fish farm managers for the commercial enterprises.
- lack of infrastructural facilities for a well developed marketing activity.

Future researches should include budgeting for intergrated systems such as Chicken-Fish Production, Hog-Chicken-Fish Production, Duck-Chicken-Fish Production, to name a few.

ACKNOWLEDGEMENTS

The author wishes to acknowledge her student, Mr. T.C. Ezeifo for his help in collecting the data used in the study and the following fishery experts: Messrs Phillip Amiegheme, S.E. Sagay and Ude and all the wonderful people of Anambra State for their help and cooperation in making the study possible.

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Table 3 - Annual costs and returns for Tilapia-Carp-Catfish production for 1-hectare pond in Anambra State, 1985

Item	Total Value or Cost (₦)	Annual Depreciation (₦)
Annual Returns		
Tilapia	4,200.00	
Carp	4,725.00	
Catfish	4,550.00	
Sub-Total =	13,475.00	
Costs		
A. Fixed: Pond construction		2,681.64
B. Operating:		
Fish seed: Tilapia	400.00	
Carp	450.00	
Catfish	450.00	
Lime	30.00	
Fertilizer	24.00	
Poultry waste	15.00	
Feed: Palm kernel cake	360.00	
Rice bran	270.00	
Labour Cost:		
Fertilizing, liming	200.00	
Periodic stocking	100.00	
Pond maintenance	100.00	
Harvesting	250.00	
Transportation	200.00	
Land rentage	50.00	
Nets		40.00
Management	1,500.00	
Miscellaneous	100.00	
Interest on operating capital at 8¾%	397.16	
	7,617.80	
Annual Net Returns to Capital and Labour	5,857.20	

Table 4 - Annual Costs and returns for Tilapia-Carp-Catfish production for 5-hectares pond in Anambra State, 1985

Item	Total Value or Cost (₦)	Annual Depreciation
Annual Returns		
Tilapia	20,490.00	
Carp	21,245.00	
Catfish	21,437.50	
Sub-Total	63,172.50	
Costs		
A. Fixed: Pond construction		7,828.06
B. Operating:		
Fish seed - Tilapia	2,000.00	
Carp	2,250.00	
Catfish	2,250.00	
Lime	150.00	
Fertilizer	120.00	
Poultry waste	75.00	
Feed: Palm kernel cake	1,800.00	
Rice bran	1,350.00	
Labour Cost:		
Fertilizing, liming	450.00	
Periodic stocking	200.00	
Pond maintenance	250.00	
Harvesting	550.00	
Transportation	480.00	
Land rentage	250.00	
Nets		80.00
Management	2,400.00	
Miscellaneous	250.00	
Interest on Operating Capital at 8¾%	1,282.31	
Sub-Total	16,187.31	
Annual Net Returns to Capital and Labour	39,157.13	

Table 5 - Annual costs and returns for Tilapia-Carp-Catfish production for 10-hectares pond in Anambra State, 1985

Item	Total Value or Cost (₦)	Depreciation (₦)
Annual Returns		
Tilapia	40,950.00	
Carp	43,960.00	
Catfish	43,400.00	
Sub-Total =	128,810.00	
Costs		
A. Fixed: Pond construction		15,656.11
B. Variable:		
Fish seed: Tilapia	4,000.00	
Carp	4,500.00	
Catfish	4,500.00	
Lime	300.00	
Fertilizer	240.00	
Poultry waste	150.00	
Feed: Palm kernel	3,600.00	
Rice bran	2,700.00	
Labour Cost:		
Fertilizing, liming	650.00	
Periodic stocking	250.00	
Pond maintenance	350.00	
Harvesting	800.00	
Transportation	600.00	
Land rentage	500.00	
Nets		120.00
Management	3,600.00	
Miscellaneous	400.00	
Interest on Operating Capital at 8³/4%	2,385.25	
Sub-Total	29,645.25	
Annual Net Returns to Capital and Labour	83,008.64	

THE ECONOMIC IMPACT OF DISEASES AND PARASITIC PROBLEMS IN FRESHWATER FISH PRODUCTION

by

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ABSTRACT

Diseases and parasitic problems could constitute significant economic losses in fish production if not controlled, thus the need to continue monitoring its prevalence. Based on field studies on feral and intensively raised fish at the Kainji Lake Research Institute, some diseases and parasitic problems have been identified. These include; helminthiasis, fungi disease; protozoa which include Myxosoma sp., Myxobolus spp., Henneguya sp., Trichodina sp., Ichthopthrius sp. bacterial mainly Aeromonas sp., Pseudomonas sp., mechanical injuries; death due to unknown causes and economic assessment of myxosporidian infection. Suggestion for disease control in fish production are recommended.

INTRODUCTION

The prevalence of disease and parasites of fresh water fish under natural condition is usually low incidence because of expanse of water and reduced risk of contact between parasites and fish (Hoffman and Bauer 1971). However under intensive management the crowded condition of large population of fish would result in heavy parasitic infection, disease and loss of fish. It is important to study the parasitic and disease conditions under natural conditions because it serves as a basis to providing needed information on potential risk of disease expected under intensive management. Common parasites and diseases of fish have been studied and reported in developed countries (Hoffman 1960, 1970, 1976), but in Nigeria there is paucity of information. This paper examines the results of findings of parasites and disease of fishes from Lake Kainji and associated tributaries of River Niger and the indoor hatchery and reservoir of the Kainji Lake Research Institute, New Bussa.

MATERIALS AND METHOD

Investigations on disease and parasites of fish were conducted from 1978 to present based on samples from field and indoor hatchery. Diagnosis were based mainly on gross pathology of post-mortem findings, and isolation of organism by microscopy examination. Fishes were submitted by staff of Fisheries Division of Kainji Lake Research Institute and from field collections. Feral fish were examined from Lake Kainji, and tributaries of River Niger, and from indoor hatchery and reservoir of the Kainji Lake Research Institute (KLRI). An estimate of the economic significance of disease in a Myxobolus sp. infection in Tilapia sp. was assessed by estimated weight loss and fecundity based on Gonado-somatic ration.

RESULTS AND DISCUSSION

Table 1 gives the summary of results of pathological investigation on some fish species from Lake Kainji and tributaries of River Niger and Table II, hatchery conditions. The most prevalent problem is helminthiasis in feral conditions with the external helminths of Clinostomum tilapia tend to disfigure the skin and the gills and the yellow-whitish nodules metaceraria of Acanthocephalus sp. distortes the gut system. Based on number of fish samples examined Sarotherodon niloticus is more susceptible to helminth infection with infection rate of 52.94% compared to Sarotherodon galilaeus 29.41% and T. zilli 17.65%. When compared to pre-impoundment studies of parasites of Sarotherodon and Tilapia spp. (Ukoli 1965), there is a considerable increase in both infection rate and fauna of helminths affecting Tilapia sp.

Cases of septicemia conditions were observed both in hatchery and feral conditions. In the indoor hatchery septicemia conditions were associated with skin lacerations, ulceration and diarrhoea in fish. Escerichia coli, Enterobacter aerogenes, Aeromona anitratum, Pseudomona aeruginosa, P. flourescens, Citrobacter diversus, Staphylococcus epidemidis have been isolated. In feral condition during the beginning of rainy season mortality of fish is usually observed in Lake Kainji. Death is associated with physiochemistry of stratification and oxygen level in the Lake, and sand toxicity due to high salt content in water at beginning of the rains because the gills tend to clog with black greyish alluvial soil deposit. Similar toxicity have been observed in Panyam fish farm (personal - communication McCharm E.S.). Secondary bacteria associated with the conditions are due to Pseudomanas sp., Aeromonas sp., Staphyloccoccus spp. with characteristic signs of red sores of skin, Necrotic epithalium; and bloat. Such characteristic signs due Aeromona sp. and Pseudomona sp. infections have been reported in fish in North America (Gaines and Rogers 1975). Fungal infections were also diagnosed with prediliction for the skin and gills. It is usually observed as cotton-white blooms around the gills or creamy white spot on the skin. Microscopic examination readily reveal lactophenol stained hyphae consistent with Saprolegnia sp. Mortality due to fungal infection in the hatchery could reach 10-20%.

Protozoan infection found of economic significance in indoor hatchery were Myxosoma sp., Myxobolus spp. and Trichodina sp. They are free-living fresh water protozoan organism which becomes very intensive under changing environmental condition. Although the prevalence of protozoan is 2-5%, it is worthy of note because in countries like North America with high intensive fish culture the diseases due to protozoan infection could reach epidemic proportion (Hoffman and Bauer 1971) and generally regarded as a world-wide problem for freshwater fisheries (Hoffman 1976). Myxosporean infection has been found to be of economic significance at KLRI. It would result in staunted growth, extensive colonization of the gonads of fish followed by hypertrophy and atrophy as myxospore as released and finally loss of fecundity. Table III gives the summary of cost-benefit analysis.

While disease and parasitic conditions needs further investigations the significance of findings is the need for investors to be aware of the economic consequence of health and management in fish production. In order to achieve an accelerated fish production, investors must plans on how to handle and prevent disease outbreaks.

RECOMMENDATIONS

i. Investigation on nation-wide basis into fish parasites and disease should be pursued so as to advice farmers of disease prevalence in the area of operation.

ii. Proper health record of fish culture should be kept in farms. Information should include records on mortality disease and parasitic incidence, drug used and amount spent in any disease control. The information would be useful in planning budget for subsequent years. It would also aid investors to determine the impact of mortality on cost-benefit of fish production.

iii. Trained professionals on fish pathology should be fully assimilated as an integral part of fish production in particular intensive fish culture through regular consultation.

iv. Importation of fingerlings should be under strick surveillance to avoid importation of new strains of infection into the country.

v. Research on disease of fish, drug and vaccine trails should be encouraged.

A disease and parasite free or controlled environment is an integral part of the panacea to fishery development and production when hygiene and management is adequate.

ACKNOWLEDGEMENT

My sincere thanks to Mr. E.O. Ita, Head of Department of Fisheries, Kainji Lake Research Institute for stimulating my interest in these studies and for his encouragement. The Director, Dr. J.S.O. Ayeni for permission to present the findings.

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TABLE I - ABNORMALITIES FROM FERA FISH BASED ON GROSS PATHOLOGIC EXAMINATION

Parasitic/Disease Condition	No Cases	Organ	Host
Helminth:			
Clinostomum tilapia	35	Skin	SAN, SAG
Electrotaenia malapterurus	15	Intestine	MAL
Euclinostomum heterostomum	7	Skin	SAN
Aranthocephalus sp. metacercaria	26	Intestine	SAN, SAG
Neoascus sp.	23	Skin	SAN, SAG TZ
Acanthogyrus sp.	30	Intestine	SAN, SAG
Acanthostomum sp.	2	Intestine	BAG
Annalid:			
Hirudo sp.	2	Operculum	BAG, CL
Protozoa:			
Icthyopthrius multifillis	2	Skin	SAN
Ameoba	5	Gill, skin	
Eimeria sp	9	Intestine	SAN, SAG TZ
Costia sp	1	Skin	MAL
Hexamita sp	10	Intestine	SAN, SAG
Unidentified flagellates	3	Intestine	SAN, SAG
ABNORMALITIES:			
Staunted growth	1	Whole fish	SAN
Laceration on skin	4	Skin	SAN, SAG
Toxicity (Gill clogging)	10	Gill	SAN, SAG
Necrotic epithelium	3	Skin	SAN, SAG CL
Exophthalmia (Popeye)	2	Eye	SAN, MAL
Fungi:			
Saprolegnia sp.	10	Skin	SAN, SAG
Tumour:			
Skin papilloma	3	Skin	SAN
Mesenchyma adenoma	1	Skin, Internal Organs	CL
Traumatic neoplasma	1	Tail	MAL

TABLE II - PARASITES AND DISEASES OF CULTURED FISH AT KAINJI LAKE RESEARCH INSTITUTE HATCHERY AND RESERVOIRS

Host species	Parasitic/Disease Condition	Organs affected
SAG	Acanthogyrus sp.	Intestine
SAN	Myxosoma sarigi	Eye
SAG	Myxobolus israelensis	Spleen
SAN	Myxobolus spp.	Ovary Gill
	Myxobolus isrealensis	Spleen Ovary
SAN,SAG	Trichodina sp.	Gill
Hb	-do-	Gill
Hb	Myxobolus sp.	Pvary
	Myxidium sp.	Gall bladder
	Henneguya pseudolamellaris	Accessory Breathing Organ
SAN,SAG, CL	Saprolegnia sp.	Skin oparudum
CL	Ameoba sp.	Skin gill
SAN, SAG	Eimeria oocyst	Gut system
Hb, CL	Hexamita	Following
	Unidentified ciliates	Diarrhoea
SAN	Benign tumour	Skin
SAN	Lymphomatosis (Virus)	-
SAN	Lamproglenia momodi	Gill
	Ergasilus sp.	"
	Argulus africanus	"

SAN, S. niloticus, SAG, S. galilaeus; Hb, Heterobranchus bidorsalis

CL. Clarias spp., BAG, Bagrus sp; MAL. Malaptururi.

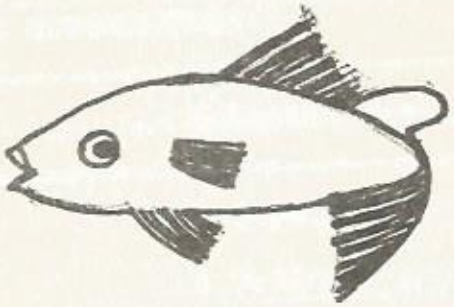
... INFECTION IN SAROTHERODON sp. AND ITS ECONOMIC CONSEQUENCE

arameters	Infected fish	Uninfected fish
Whole weight at maturity	4.1-78.4gm	1.2-2kg
Standard length	5.1-12cm	4.19-49.7cm
Gonado-somatic ratio male	0-.012	0.54-12.1
Female	0-.048	8.1-53.20
Estimate in 10,000 fish at production cost ₦3/kg	₦121-2352[c]	₦36,000[a]-60,000[b]
Labour for removal of condemned fish at 0.5k/fish	₦500[e]	
Drug and chemical treatment to arrest situation 44 gallon of 10% ammonia solution at ₦10 per 2.5 litre	₦792[f]	
Approximate expected losses excluding dummy risk	₦37168-58940[d]	
100% infection loss	₦37168-58940	
10% infection loss	₦3716.8-5894	

d = (a-c .....+e+f) a=(₦3x1.2kg x 10^4), c=(₦3x4.1-78-.4gmx 10^4)

Akintunde 1976.

SECTION 5: SYMPOSIUM ON COMMERCIAL AQUACULTURE



IJOMA FISHERIES LIMITED

- Fish Propagation
- Fish Farm and Hatchery Design and Construction
- Fish Farming and Hatchery Equipment Design and Manufacture
- Fish Farming
- Aquaculture Development and Aquatic Resources Management
- Consultancy Services

FARM: Stillwaters
Asanmajana Road
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COMMERCIAL POND FISH CULTURE

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ABSTRACT

Commercial Pond Fish Culture Practice is comparatively new in Nigeria. It is therefore very important that simple Guide Lines be provided for the establishment, development, and management of such projects. The objective of this Paper is to fulfil this urgent need. All aspects of Commercial pond fish culture have been dealt with. Fish pond operations comprise of pond preparation, stocking, rearing, and harvesting.

These have been highlighted in the text, bearing in mind that the most important principle of fish culture is the acquisition of maximum production of marketable-size pond fish from a given unit area.

INTRODUCTION

In 1984, Nigeria's fish demand was about one million metric tonnes, and production estimate was 374,000 tonnes. In 1985, total fish consumption was put at 1.95 million metric tonnes, as against domestic production of 610,000 tonnes (NIOMR, 1985). Hitherto, shortfall in fish production was augmented by importation of stock fish, salted fish, frozen fish, and canned fish.

With the present rate of population growth in Nigeria: 55,670.055 (Census 1963); and 116,189,300 (Federal Government Projections 1985), it is estimated that fish demand will exceed two million metric tonnes by 1990. Now that importation of fish has been restricted, the alternative is for Nigeria to improve upon the implementation of the accelerated fish production programmes including Aquaculture (Fish Farming/Pond Fish Culture).

Fish production in Nigeria is mainly from two Sectors; Artisanal accounts for 90 percent, and Industrial has 5 percent. Production from aquaculture Section is only 3 percent. It is evident that Aquaculture (Fish Culture in ponds, cages, pens etc.) is the least exploited for fish production in Nigeria. Continuous development of this sector is to be pursued vigourously.

In this respect, Pond Fish Culture, that is cultivation or rearing of fish in ponds for production of pond fish as distinct from Sea Fish should be given special attention. Pond Fish Culture has a lot of potentials for commercially feasible projects which can increase fish production by 656,815 metric tonnes from about 25 percent of available 1,741,509 hectares of freshwater and brackishwater swamps (NIOMR, 1984).

As a matter of fact, the following Pre-Feasibility and Feasibility Studies have confirmed that development of Commercial Pond Fish Culture is practicable and profitable in Nigeria for both brackish water and freshwater swamps:-

(i) Nigerian Government: Studies in Northern Nigeria - Panyam Fish Farm, Jos, 1953

(ii) Federal Government (FDF) UN-FAO: Studies in Niger Delta, - Buguma Fish Farm, Via Port-Harcourt, 1963

(iii) Federal Government (FDF)/AFRECO (Association of African Economy and Development, Tokyo, Japan) in Niger Delta, 1973

(iv) Federal Government (NIOMR)/UN-FAO: Studies in Niger Delta-ARAC. Buguma/Aluu, Port Harcourt, 1976

(v). Federal Government (FDF)/ASIAPHIL (Asiaphil Fish Corp. of Philippines): Studies in Nigeria - Ondo, Bendel, Rivers, Cross River, Benue States, 1979

(vi) Federal Government (NDBDA)/FISESCO (Fisheries Services and Equipment Supply Company, Limited, Lagos, with Partners ASIAPHIL (Asiaphil Fish Corp, Manila, Philippines)- Full Feasibility Studies in Niger Delta Rivers State, for (a) 3 Commercial Fish Farms of 500 hectares each, (b) 10 Community Fish Farms 20 - 100 hectares each 1981

In order to achieve the objectives of enhanced commercial pond fish culture in Nigeria, water-tight fish ponds must be constructed at suitable sites, selected species of fish must be stocked, proper pond management techniques must be practised, and efficient methods of cropping must be maintained, to obtain maximum pond fish production level per hectare per annum.

In a paper entitled "Construction of Brackishwater fish ponds In The Niger Delta" by this author, presented at the Workshop on "The Managrove Ecosystem of Niger Delta" - published by the University of Port Harcourt (1980), a vivid description of the principles of pond construction

was made with particular reference to Brackish water fish ponds. Similarly, in another Paper "Pond Construction/ Engineering" presented by this author at the Fourth Annual Conference of FISON (Fisheries Society of Nigeria), NIOMR/ ARAC, Port Harcourt (1985) explanations were made of the technicalities involved; in the construction of both fresh-water and brackish water fish ponds - indicating essential difference in constructional details.

The purpose of this Paper, therefore, is to present in a nutshell, the description of all activities involved in the establishment, development, operation and management of Commercial Pond Fish Culture, or Commercial Fish Farming in Nigeria.

BACKGROUND INFORMATION ON POND FISH CULTURE IN NIGERIA

Animal protein is a very important food item in the diet of Nigerians and it contains 40 percent fish protein. For over two decades, domestic supply of fish in Nigeria has been inadequate to meet the Country's needs. It was the demand for increased fish production; that directed the Nigerian Government's attention upon the potentialities of our natural resources.

The objective was to increase fish production through Aquaculture, by the Construction of modern water-tight fish ponds with suitable soil, in fresh water and brackish water swamps, and by the culture of suitable fish species in the ponds.

In order to implement the freshwater fish culture programme in 1953, Nigerian Government engaged the services of an Expatriate (from Europe), Dr. K.K. Zwilling to carry out investigation on the possibility of constructing modern freshwater fish ponds in the Country. A Nigerian Government Counterpart Officer, Mr. S.A. Wokoma, was seconded to the project to assist the Expert, also two Nigerian Officers Messrs A.A. Ibrahim, and J.A.E. Ojomo were attached for training.

After travelling throughout Nigeria for identification of suitable sites, the Expert established Panyam Fish Farm, at Panyam, near Jos for demonstration, experiment, training and fish production. The Expert proved that freshwater fish farming (Pond Fish Culture) was viable, and that personnel for extension services could be trained locally and Overseas.

As a follow-up, construction of freshwater fish ponds started spreading all over the Country, especially by Government departments such as Panyam Community Dam/Fish Ponds near Pankshin, Maska Dam/Fish Farm, near Zaria in the North; Agodi Fish Farm, near Ibadan in the West; Umuna Fish Farm, near Okigwe in the East.

Within the last few years, appreciable interest has been shown in freshwater fish farming/pond fish culture with commercial bias, by both private and public sectors, e.g. Aviara Fish Farm, and Fish Farms Limited, in Bendel State; Ellah Lakes Fish Farm, and the proposed Niger Delta Basin & Rural Development Authority 500 - ha. and Community Fish Farms in Rivers State; Government's Modern Fish Farms in Lagos State.

Inspite of the offset made in focussing attention on conversion of freshwater swamps into fish farms; the Federal Government being aware that many Countries increased their national fish production by means of brackish water fish farming (pond fish culture), requested the Food and Agriculture Organization of the United Nations in 1962, to carry out investigation into the possibility of reclaiming the vast area of mangrove swamps of the Niger Delta into Brackishwater fish farms for culture of fish to increase pond fish production in Nigeria. The FAO granted this request and sent an Expert to Nigeria in October, 1962.

In 1963, the FAO's Expert, Dr. T.V.R. Pillay, assisted by his Nigerian Government's Counterpart Mr. S.A. Wokoma completed the investigation under the auspices of the Federal Department of Fisheries. The Niger Delta Development Board (Federal Government) Cooperated fully with the FAO Expert, and attached Mr. B.S. Moses Fisheries Research Officer to the project. They also provided transport and accommodation etc.

The result of the investigation demonstrated the feasibility of brackish water fish culture projects and the urgent need for training extension personnel to assist in the development of brackish water pond fisheries.

Dr. T.V.R. Pillay left Nigeria in 1964, and his successor Dr. K.K. Nair, FAO Expert arrived in 1965 to continue the experiments. Construction of the Experimental Brackish water fish farm was completed in 1966 at Buguma for the purpose of; Critical studies of fish culture; experiments on fertilization and fish feeds, studies on pond construction and management techiques; and training of extension staff. In January, 1967 Messrs, S.A. Wokoma and B.S. Moses were awarded FAO/UN Fellowships. They left Nigeria for studies Overseas in Pond Engineering and Advanced Aquaculture Course. The FAO assignment was interrupted by the Nigerian Civil War in 1967, and Dr. K.K. Nair was recalled to Headquarters, Rome, Italy.

Since then, many brackish water fish farms have been established by the public and private sectors - some with commercial bias. A few of them are: NIOMR's (Federal Government) Ikoyi Fish Farm Lagos, Niger Delta Basin & Rural Development Authority's (Federal Government) Pilot Fish Farm at Buguma and Bodo, Rivers State, Rivers State Ministry of Agric's Demonstration Fish Ponds, Port Harcourt,

University of Science and Technology's Fish Ponds Port Harcourt, Tomte Multipurpose Cooperative Development Authority's proposed 500 - hectare Commercial Fish Farms at Buguma and Bodo Rivers State, (Full Feasibility Studies Completed by FISESCO/ASIAPHIL, 1981).

ESTABLISHMENT OF COMMERCIAL FISH PONDS/FARMS:

The importance of carrying out Pre-Feasibility and Feasibility Studies, before tne establishment of commercial fish ponds or fish farms, cannot be over emphasized, because of the huge investments involved. Stated below are relevant guidelines for such exercises.

A pond may be regarded as an earthen vessel for collecting and holding water. Its dikes and bottom soils must be of a type that will reduce seepage to a minimum (Wokoma-Ezenwa 1982).

In broad terms, a collection of fish ponds constitute a fish farm. Therefore fish farming or fish culture is simply the art of constructing fish ponds which can hold water stocking them with fish and making the fish grow. The ponds should be such that adequate level of water could be maintained. Fish culture may be practised on Subsistence Scale, Small Scale or Large Scale (i.e. Commercial Scale). The subsistence/small scale projects with one or few ponds in small area of about 1 to 10 hectares, are sometimes known as homestead ponds. Such ponds are generally owned by individuals or families for the purpose of providing pond fish and/or extra income. The large scale commercial fish ponds may range in size from 10 to 500 or more hectares.

Feasibility studies are generally conducted under the following guidelines or Terms of Reference:-

(i) Site Identification; and Investigation: made in accordance with regulations governing aquacultural technology;

(ii) Land Survey of Site; and production: of topographic map, in order to facilitate preparation of design plans, and specifications;

(iii) Computation of Bill of Quantities, and Costings for construction of the Commercial fish farm;

(iv) Investigation on Availability of Labour; materials, and finances required for the fish farm construction;

(v) Surveying of Availability of support facilities, that would enhance the establishment and management of pond fish culture project; portable water;

(vi) Provision of Production Description: relating to pond fish culture, cropping and post harvest management of the fish farm;

(viii) Preparation of Operational Plans: for the Commercial pond fish culture project, in respect of production distribution and marketing of pond fish in Nigeria.

COMMERCIAL POND FISH CULTURE IN NIGERIA:

Commercial Pond Fish Culutre is comparatively new in Nigeria. It was introduced during the late Sixties. Interest in this lucrative business increased with the gradual decline of the "Oil Boom" in the early years of the current decade. Apart from the huge investments being made by the Public Sector for development of Commercial Fish Culuture Projects, the Private Sector is contributing its comparatively little quota towards the same objective, by investing in small scale, and large scale (Commercial) pond fish culture projects.

In this context, the essential aquacultural techniques involved in the successful organisation and management of such business venture are outlined.

Operation Strategy: The most important principle in fish culture is the acquisition of maximum production of marketable-size pond fish from a given unit area e.g. 5 ton/ha./yr. With this aim in view, fish pond operations comprise four main activities: Pond preparation. Stocking, Rearing, and Harvesting. In the operation or management of commercial fish pond it is advisable to understand and put into practice these important principles of management:-

(i) Fish grows rapidly when there is plenty of food and slowly when food is scarce;

(ii) Within one year after stocking, a pond supports approximately the maximum weight of fish for food available;

(iii) Ponds are fertilied to produce more fish food, so as to produce more fish;

(iv) Supplementary feeds are essential for increased fish production;

(v) Proper methods of fertilization, stocking, feeding, and cropping will result in a higher production from the fish pond.

Having noted the above points, fish pond management practices are detailed under the following headings:-

Management of Dikes, and Water Supply/Drainage Mechanism
Newly constructed dikes should be protected against erosion caused by rain, wild-wind action, wave action, flood and tide. Grass and Creeping vegetation grow on dikes naturally, but should be planted if necessary. Cracks in dikes should receive immediate attention, by carrying out proper and adequate repairs. Pond bottom should be levelled to avoid any "Pot-Holes" that may hinder complex drainage of the pond. Water supply/drainage mechanism such as monks sluic gates, culverts, spillways, pipes, should be given adequate maintenance.

Management of Pond Water: Water quality control is essential in pond management practices. It entails checking of salinty, temperature, pH. Dissolved Oxygen, Turbidity etc. Fertilization of pond increases fertility which increases growth of fish.Pond water can be fertilized if fertility is low. Control of water weeds, pests, predators, mosquitoes are necessary.

Management of Pond Fish: This comprises of proper handling of fish fry/fingerlings for stocking, inducing fish growth, by making available natural and supplementary feeds, providing conducive habitat for the fish under cultivation, and adopting efficient harvesting techniques.

Pond Preparation/Activation of Environment: The fish pond environment is activated to enhance natural fish food production through adequate pond preparation and fertilization. The use of fertilizers can increase the productivity of fish ponds. Pond fish feeds on microscopic plants and animals (phytoplankton and zooplankton). These microscopic plants are present in most waters, but in very limited quantities. When the pond is fertilized, the minute plants multiply and grow rapidly thus making the colour of the pond water appear greenish or brownish. The reason for fertilizing the pond therefore is to produce more plants to produce more fish. The Activators are as follows:-

Lime: Prior to impounding water in the pond, lime (Calcium Carbonate) is applied to the moist pond bottom to kill pest, and solve the problem of acidity by raising the pH to desirable level that will enhance the effect of fertilizers. Compounds Commonly used are:

(i) Agriculture Limestone (Calcuim Carbonate)

(ii) Hydrated lime or slated lime (Calcuim hydroxide)

(iii) Calcium Oxide.

Liming Rate: 1000 kgs to 5000 kgs/hectares per annum depending on the acidity.

Method: By broad-casting or spreading on pond bottom or on water surface, if pond is filled.

Fertilization: Fertilization of fish ponds are classified as Chemical Fertilizers (Inorganic Compound) and Organic Fertilizers (Manures). Chemical fertilizers contain nutrients (NPK) which stimulate phytoplankton production in fish ponds; require about 8 - 12 periodic fertilizer application to maintain good plankton bloom - 1000 kg. to 1,500kg/ hectare per annum.

Organic Fertilizers (Manure) are usually agricultural waste e.g. chicken droppings, cattle and pig dung; these waste products decompose and release inorganic materials that stimulate the growth of phytoplankton. A few days after liming the pond, chicken droppings and/or pig and cattle manure are applied to the pond with 8 - 10 cms. depth of water) about 2,000 kg to 2,500 kg/hectare per annum. After 7-10 days, when the plankton has bloomed, the water in the pond is increased to the required level of about 100 cms depth. Then the pond is ready for stocking.

Fish Species for Commercial Pond Fish Culture In accordance with the recommendation in Pre-Feasibility and Feasibility Reports (Ref: "Introduction" of this Paper and the writer's practical experience in Nigeria the following species of fish are recommended for pond fish culture in Nigeria:-

(i) Brackish water: Tilapia (Sarotherodon nilotica, Sarotherodon malanotheron, (or T. heudeloti). Tilapia guineensis (or T. Melonepleura); Grey mullet (Mugil Cephalus) Chrysichthys spp; Elops spp; and Lutjanus spp.).

(ii) Freshwater: Common Carp (Cyprinus carpio) T. giuneensis Tilapia (Saretherodon mosambicus); Tilapia nilotica; T. Zillii S. galilaea; Clarias lazera; Heterotis spp. and predators Lates nitloticus; Hetrobranchus spp.

Fish Stocking Density: The Stocking density is the number of fish which a pond can hold and maintain without exceeding its carrying capacity. Hence the number of fish to be stocked in a pond depends on the factors stated below. It is to be noted that fish stocking is done at cooler times of the day- early morning or late afternoon and early evening. Fish Fry/ Fingerlings must be acclimatized.

Factors That Determine Stocking Rate are: Size of Fish Pond, Number of fish for stocking; Average size of fish, Availability of fish food. and weight of harvest expected. In Nigeria two types of pond fish culture are practised:

Monoculture: Culture of one species of fish in a pond.

Polyculture: Culture of two or more species of fish in a pond. Polyculture is recommended for effective use of all types of natural food present in the pond.

Examples of Specific Fish Species: Stocking Rates;

(i) Polyculture: Tilapia spp. Mugil spp. Chrysichthys spp; may be stocked in one pond in the Ratio of 10:4:1 and the stocking rate will be 10,000 No. Fry/ Fingerlings per hectare.

(ii) Monoculture: Tilapia spp - 10,000 to 15,000 fry/ fingerlings per hectare. Mugil spp. 10,000 to 20,000 fry/fingerlings per hectare. Chrysichthys spp. 7,000 to 8,000 fry/fingerlings per hectare Clarias spp: 15,000 to 20,000 fry/fingerlings per hectare.

Hatchery: In the operation of subsistence and small scale fish farms, collection of fish fry/fingerlings from the wild or purchase may be sufficient, but for Commercial Small Scale or Large Scale Fish Farms, it is imperative to build a hatchery within the project complex for production of fish seeds.

Fish Feeds, Natural and Supplementary Feeds: As stated above, fish will grow rapidly if there is plenty of food, and will grow slowly if there is scarcity of food. Pond can produce natural fish food such as Microscopic water plants, water animals and water insects.

In addition to the natural food supply from the pond system, supplementary diet may also be given to the fish in order to improve the growth e.g. wheat bran, rice bran, brewery waste, groundnut cake, palm kernel cake etc. but preferably compounded fish pellets.

Feeding Sequence: The frequency at which fish is fed, may depend on two factors: (i) The size of fish and (ii) the rate of consumption of feeds. Fish fry are fed at two to three hourly intervals; and the number of feeding is gradually reduced as the growth rate increases. Fish culturists and fish farmers feed bigger fish and brood stock once a day, six to seven days per week, for convenience.

However, experiments show that feeding twice daily induces slightly faster growth than once thrice or more times daily. For this purpose, ration is divided equally and fed morning, and evening respectively.

It is to be noted that feeding should not be done early morning or before 10a.m. in Nigeria, because the dissolved oxygen used by the fish and aquatic plants during the night has not been replaced by photosynthesis.

Calculation of Quantity of Food to be Used:

The quantity of supplementary feed to be given per day in relation to weight of fish stocked is dependent on the following factors: (i) Number of fish stocked (X)

(ii) Average weight of fish stocked (Y)

Therefore Gross Weight of fish = X x Y. It is to be noted that the percentage of quantity of feed is between 2 percent and 4 percent of the Gross Weight of total number of fish in the pond.

Hence quantity of supplementary feed will be equal to 2% of (X x Y) = 2/100 x (X x Y).

Conditions that necessitate application of supplementary feeds are:

(i) Insufficient natural food

(ii) Available food not suitable for fry consumption

(iii) Inducement of rapid growth

Feed Mill: Well formulated fish feeds must be available in adequate quantities in a commercial fish farm at all times. To this end it is advisable to establish a fish feed mill within the fish farm complex for production of fish feeds (pellets) in commercial quantities from local ingredients.

An example of a Formula for well formulated fish feed by composition contains:

75 percent wheat bran, 10 percent Ox-blood, 5 percent groundnut cake, 5 percent beans, 5 percent cassava starch, small quantity of table salt; some palm oil and vitamin premix.

Harvesting Pond Fish

As stated earlier, proper methods of fertilization stocking feeding, will yield good fishing. Proper Cropping could be carried out in several ways of which the following methods are suitable for commercial pond fish culture:

(i) Use of Gill Nets: This method allows for selection of marketable size of fish as dictated by mesh-size of the net, thereby controlling fish population in the pond;

(ii) Use of Seine Net: Total harvesting could be effected by this method, and the pond is emptied for preparation.

(iii) Use of Catching Pond: This is the cheapest method fish are made to gather in the catching pond, and are netted out.

(iv) Use of Gravity: The method of draining the pond, is suitable for brackish water fish ponds - water is let out of the pond at low ebb-tide by gravity and fishes are easily harvested.

Marketing and Distribution of Pond Fish

Pond fish marketing comprises of all business activities carried out in conveying fish from the source of production to the area of comsumption, i.e. from the producer to consumer.

A well established Commercial Pond Fish Culture Project should have adequate facilities for handling, processing, storihg, and transportation of fish. Marketing and Distribution system of the project should be well organised to avoid all complications; such as engaging the services of distributors with in-adequate finances and equipment.

In recent years, to be precise, 1975 - 85 price of pond fish has excalated very high, caused by the correspondingly astronomical increase in the cost of capital investment in fish pond construction e.g. Price of 1 kg of pond fish from ₦1 to ₦5.00 at source of production and cost of construction, 1 cub meter of earth movement from ₦2.00 to ₦4.00 used in building fish pond for production of pond fish.

Economics of Pond Fish Culture (Input and Output):

The Economics of managing a modern Commercial Pond Fish Culture Project, can be illustrated with conservative Estimates of 10 - Hectare commercial Fish Farm, Constructed in the freshwater swamps of the Rivers State:-

Economics of Operation Estimates:

10 - HECTARE COMMERCIAL POND FISH CULTURE PROJECT

A. CAPITAL EXPENDITURE

Construction of Commercial Fish Farm for Pond Fish Culture:-

BILL OF QUANTITIES

10 - Hectare Fish Ponds

BILL NO. 1

EARTH - WORK: SITE CLEARING, DIKE CANAL AND POND CONSTRUCTION

Item	Description	QTY	Unit	Rate	Total
1-1	Land Clearing Clearing bushes, grasses other vegetation felling all trees, stumping, up-rooting total roots grubbing. Burning cleared materials or deposit where directed	11	Ha.	2000.00	22,000.00

Item	Description	QTY	Unit	Rate	Total
1-2	Perimeter Feeder Canal Dike	10,000	M3	₦3.50	
1-3	" Dike	7,500	M3	₦3.50	
1-4	" Drainage Canal Dike	1,500	M3	₦3.50	
1-5	Secondary Drainage Canal Dike	4,000	M3	₦3.50	
1-66	Secondary Dike	6,000	M3	₦3.50	
	Provide, spread, shape and compact soil, layers of 0.15m earthfill at sub-base (total of times 1-2 to 1-6	29,000	M3	₦3.50	101,500.00
1-7	Trench and Canal (Excavation)	1,000	M3	₦1.00	1,000.00
1-8	Inlet/Outlet Water Channel (Exca. disposal)	2,000	M3	₦2.00	4,000.00
1-9	BILL NO 1 GRAND TOTAL				128,500.00
	BILL NO 2				
	CIVIL WORK: FOUNDATION STRUCTURE MONK, TOWER				
2-1	MONKS, TOWERS				
	Foundation	160	M3	₦2.00	320.00
	A Excavation	160	M3	₦2.00	320.00
	B Backfill: Backfilling by layers of 150mm compacted at each layer up to required elevation	56	M3	₦2.00	112.00
	C Hardcore: 150mm thick under monk slabs and cut off walls	200	M2	10.00	2,000.00
	D Blending 100mm thick concrete 1:2:4 aggregate min diam. 19mm	200	M2	25.00	5,000.00
	Structure:				
	A In-situ concrete 1.2 aggregate min diam 19mm	100	M3	150.00	15.000.00
	B Mild steel Re-inforcement rods	2,500	kg	1.50	3,750.00
	C Sawn Form Work	700	M2	12.00	8,400.00
	D Asbestos pipes jointed with cement morter (1.4) Inlet pipes 30cm. diam	10	Set	200.00	2,000.00
	E Reinforced concrete culvert 450mm X 1000mm	10	Set	250.00	2,500.00
	BILL NO. 2 GRAND TOTAL				39,082.00

Item	Description	QTY	Unit	Rate	Total
	BILL NO 3				
	Construction of Infrasture, provision of facilities and equipment				32,418.00
	Hence Capital Expenditure:				
	GRAND TOTAL BILL NO. 1 & BILL NO. 2 + BILL NO. 3				200,000.00

B. RECURRENT EXPENDITURE PER ANNUM

(i)	Fish Fry/Fingerlings collection and/or purchase and stocking 100,000 at 10 kobo	10,000.00
(ii)	Cost of Agric Lime and fertilizers: 25 metric tonnes at ₦200/ton average	5,000.00
(iii)	Salaries and Wages at ₦835.00/month	10,000.00
(iv)	Transport, maintenance & incidental expenses	5,000.00
(v)	Cost of supplementary feeds or feed ingredients 20 tonnes at ₦500.00	10,000.00
		40,000.00

C. ESTIMATED REVENUE PER ANNUM

Pond fish production from 8 hectares production ponds at 3 ton/ha./annum	24 tonnes
Sale of pond fish, 24 metric tonnes (24,000 kgs) at average rate of ₦4.00/kg	96,000.00

N.B: For Intensive cultivation, 4 - 5 ton/ha./An. could be achieved.

DISCUSSION

It was the demand for increased fish production that directed the Nigerian Government's attention to the potentialities of the natural resources. The objective was to increase fish production through Aquaculture (including pond fish culture). This necessiated the commissioning of several feasibility studies that aimed at increasing fish production through the development of fish culture and fish farming in the Country.

Results of the studies proved that fish culture was feasible in Nigeria, and that increased fish production could be achieved by the construction of water-tight fish ponds, and subsequent culture of fish in the ponds to produce pond fish. Consequently, modern fish ponds were constructed and pond fish culture at subsistence/ small scale levels were established successfully;

Commercial Pond Fish Culture is comparatively new in Nigeria because the level of production is gradually, developing into commercial ventures. It is interesting to note that recently, both public and private sectors are increasing their investments in this lucrative business especially now that the era of the "Oil Boom" is over!

It would pay a lot of dividend if this trend of development continues, so as to counter the serious shortfall in domestic fish production. There is still much to be done. In order to achieve this goal, perhaps in the next two decades, it would be absolutely necessary to adopt the lines of action stated hereunder:

Federal and State Governments as well as Commercial Establishments and Cooperative Societies, should pursue vigorously the establishment of large-scale fish farms which could be commercialised.

Federal Department of Fisheries, State Governments and River Basin Authorities should set up demonstration Commercial Fish Farms, hatcharies, seed-multiplication centers, fish feed mill, for servicing community fish farms to be operated on commercial basis.

Following the practice in Asian Countries, River Basin Authorities should construct small-scale and large scale fish farms, and hire them out or sell them on subsidized rates to interested individuals. Communities or Companies for pond fish production.

Basin Authorities, Rural Development Authorities and State Governments should establish Community Commercial Fish Farms in each local Government Area. The local people should be trained in simple pond construction, operation and management.

Universities, Polytechnics, Fisheries Institutions, Fisheries Societies, should increase their training facilities for aquaculture research and extension personnel; so that commercial pond fish culture projects would be adequately staffed and research results readily available for the industry. Also Nigerians should take advantage of the Post-Graduate Aquaculture Courses offered at the NIOMR/ARAC of FAO/UN, ALUU, PORT HARCOURT.

ACKNOWLEDGEMENT

I wish to thank the National Executive Council of Fisheries Society of Nigeria (FISON), and E.O. ITA, Esqr; Chairman, Local Organising Committee (LOC), FISON' 86 Conference for giving me the unique opportunity of presenting this Paper at, the Symposium during the Fifth Annual Conference of FISON.

I also like to express my gratitude to the Niger Delta Basin and Rural Development Staff Mr.' Ichechukwu Wonsirim who assisted me in typing the manuscript of this paper.

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A REVIEW OF RECENT ADVANCES IN COMMERCIAL TILAPIA CULTURE

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ABSTRACT

The paper introduces the tilapias as important culture fishes; their classification, breeding habits and general ecology. The versatility and plasticity of their reproduction and growth are major advantages as well as draw backs in their use as culture species. The culture of tilapias in ponds, cages, pens and raceways are described and a comparison of extensive and intensive cultivation is made.

The major factors in commercial cultivation of tilapias such as feeds, hatchery/fry production and disease control are discussed. Recommendation is made for the consideration of tilapia as the equivalent of the common carp in tropical African fish culture in either monoculture or in polyculture with other fish species.

INTRODUCTION

The tilapias are particularly well-suited to aquaculture in that they are principally primary consumers or detritivores, they are hardy and have wide tolerance limits to most potentially limiting environmental variables such as temperature and oxygen and they will spawn readily in ponds to produce large numbers of fry for stocking.

Indeed tilapias are well-known - even notorious in fish culture circles for the facility with which they reproduce. Moreover, it is the plasticity of their reproductive, growth and developmental processes which are the main advantages and also major draw-backs in the use of tilapias for culture; at the same time these processes also hold the key to the future of tilapia farming through selective breeding to true domestication.

BREEDING METHODS AND CLASSIFICATION:

Tilapias are not particularly fecund fish but the relatively large egg and yolk supply combined with a high degree of parental care ensures a high survival rate amongst the fry.

Parental care, however, comes in a number of forms which have recently been reviewed (Ruwet et al 1976; Phillipart and Ruwet 1982) in the light of recent suggestions regarding the systematics of the group (Trewavas 1983).

There are three approaches to parental care in tilapias which are important for their culture.

(i) Guarders: Guarders or substratum spawners where the male builds a nest of several holes within a vigorously guarded territory. A female is attracted; the eggs are layed and fertilized in the holes and then guarded throughout the incubation period and early development. Monogamy is practised by the guarders.

(ii) Mouth Brooders: The male builds a saucer-shaped nest, within a spawning arena, to which a female is attracted. She lays a batch of eggs which are promptly fertilized by the male and then taken into an oral broodpouch in the mouth of the female. The female may then deposit a second batch of eggs to a neighbouring male in the spawning arena. There is, thus, no pair bond, as in the 'guarders', and both polyandry and polygamy can occur. Thus the eggs in the mouth of the female could have been fertilised by several males.

PATERNAL OR BIPARENTAL BROODERS:

It is either the male or either sex which mouth-broods the eggs in this group. This is very similar to maternal brooding but these types do not adopt the arena spawning. Consequently, although mating and fertilization still only take a short time, mating appears to be monogamous.

The evolutionary implications of these three mechanisms are that the possible genetic variation resulting from the promiscuous arena spawning maternal brooders is potentially much greater than that of either the guarders or the paternal/bi-parental brooders. It may, thererore, be no accident that of the ninety (90) or so species of tilapia recognised, thirty (30) are guarders, eighteen (18) are paternal/bi-parental brooders and forty-two (42) are maternal brooders. Of the three methods guarding is the most primitive.

ZOOGEOGRAPHIC DISTRIBUTION OF TILAPIAS:

The guarders are now referred to as Tilapia species (Trewavas 1973) while the maternal brooders are Oreochromis species; and biparental brooders are classified as Sarotherodon species (Trewavas 1982 ; 1983). These generally fall into relatively uniform geographic groups in that Tilapia species are confined to West Africa with the exceptions of T. zillii and T. rendalli which have extended their ranges into central and East Africa; whilst Oreochromis is distributed over central and East Africa and one or two rivers of the Levant. The Sarotherodon species, apart from the more widely distributed S. galilaeus are restricted again to West Africa.

Distribution of a few species of tilapias is now widespread in the tropical world due to their introduction for culture (Welcomme 1981, Balayut 1983).

NATURAL HABITAT OF TILAPIAS AND THEIR ADAPTABILITY

Although tilapias originated in rivers they are preadapted to lakes where seasonal variations in the tropics are limited. Tilapias contribute a high proportion of the ichthyomass in man-made lakes such as 35% in Lake Kariba, 57% in Lake Volta (Petr 1967) compared with only 4% in the Rufiji River in Tanzania (Payne and Collinson 1981) and 3% in the Zambesi (Petr 1987). The higher phytoplankton production in lakes must be a contributory factor to the success of microphagous and planktivorous Oreochromis and Sarotherodon species. Never the less, the availability of nesting sites is critical hence in the early years of post impoundment of Lake Kainji tilapias contribution to the fish catch and biomass was low because of the large seasonal draw down which coincided with the spawning seasons of the S. galilaeus and O. niloticus in the Lake, (Ita, 1973). However, it seems that the tilapias in Lake Kainji have adapted to the hydrology of the Lake as rotenone sample estimates in later years in the littoral areas of Lake Kainji showed the tilapias contributing 43% of the ichthyomas (Ita, 1984, Sagua, unpubl.).

The tilapias show great variability and adaptability in their growth and reproductive strategies within their normal environment. Under adverse conditions they can spawn at very small sizes. For example O. niloticus in Lake Albert spawn at 28cm while in isolated lagoons of Bahuka they begin at 10cm - a real bane of fish culture. They also can spawn at a younger age (Iles 1972). Precocious spawning is most valuable in rivers which are prone to leaving seasonal pools as the flood receeds as was observed for S. galilaeus in the River Sokoto (Iles and Holden 1969). Such habit is undesirable in tilapia culture because this can lead to rapid over population and reduced growth of the cultured fish.

In tilapia the smaller fish produce proportionally more eggs than the larger fish - a direct consequence of the unusual relationship between fecundity (F) and body length (L)

whereby $F = @ L^2$ instead of the

usual $F = @ L^3$ (@ = constant) (Babiker and Ibrahim 1979; Welcomme 1967).

It means that it may be more efficient to keep smaller rather than larger fish as brood stock in contrast to most cultured fishes.

COMMERCIAL CULTURE OF TILAPIA

Selection of Tilapia Species for Culture: For commercially successful culture of tilapia the selection of suitable species for cultivation is of paramount importance. The cultivation of tilapia in Africa has been largely based on specimens taken from the wild. There is reason to believe that considerable inbreeding and inter-specific breeding has led to a variety of progeny which are hybrid species in our waters. Selective breeding programme for genetic improvement and experimental screening of the productive capability of different breeds needs to be embarked upon in Africa. At the present the potentials of the tilapia species in Africa are not tested and research on this is taking place mainly outside Africa (e.g. USA; Stirling University, UK).

A red tilapia has been bred in Florida USA, from a cross of O. mossambius and O. niloticus. It has a pink rather than black peritoneum giving it a delightful pinkish colour. It has a high gale value and preferred to the darker tilapia.

In Israel an all male hybrid has been obtained from a cross of male O. aureus and female O. niloticus. The hybrid is however fertile and therefore its commercial cultivation on large scale must depend on a hatchery that will continuously supply hybrid seed. For a successful hybrid production the specific identify of the two species must not be in doubt. This is why there is urgent need to determine and preserve pure genetic stocks of our tilapias a basis of any genetic improvement work. At the moment the techniques for such identification involve electrophoretic methods combined with detailed taxonomy, since morphological separation of some of the mixed strains and species is very difficult.

Some desirable characteristics to breed for include, fast growth rate, large adult size, efficient food conversion ratio, ease of reproduction in hatcheries, adaptability to a range of environment e.g. brackish and freshwater.

Development of monosex hybrids with suitable growth qualities from hatcheries is likely to become important.

On the whole the Oreochromis species are favoured as species for commercial culture.

HATCHERY TECHNIQUES FOR TILAPIA CULTURE

Cage Hatcheries: The idea of tilapia hatchery in cages came from the use of hapas. Applying the arena spawning behavioural nature of Oreochromis sp. the cage is designed so as to separate the breeders from the fry produced. An inner coarse net separates the brood fish from the fry in the patterns shown in the figures (1) or (2). The fry are harvested by means of a scoop net.

Size of cage may be 100m³ or less with depth of 0.5m. breeder stocking density is 20/m³. Sex ratio of breeders is 3-7 females : 1 male. Fry production rate (4mm) average 650 fry/m²/month but over 1000 fry/m²/month is possible. Spawning frequency can be improved by increasing feeding intensity and quality of food.

Problem

Clogging of fine mesh net with silt, algae. Floating objects e.g. aquatic weeds.

Tank hatcheries: Tilapia tank hatcheries are best made of circular shape from cement blocks, poured concrete, corrugated iron or steel and fibre glass. The size of tank ranges from 1m to 10m or more in diameter depending on the quantity of fry needed. Depth of tank is usually about 1.5m, but if greater than 1.5m then for cement block tanks extra reinforcement is necessary.

In iron or steel tanks the inner walls need protective lining with plastic or butyl liner. Steel and fibre tanks though more expensive are very durable (can last 20 - 40 years) and can be moved to a new location unlike concrete or cement block tanks which are cheaper but immoveable and have higher maintenance costs and shorter (5 - 10 years) life span.

Construction of tanks should provide for an arena for spawning separated from an outer ring where the fry collect. The figure (3) is an example of a concrete tank in use at the Boabab Fish Farm in Mombassa, Kenya where a viable tilapia culture using raceways for production is profitably operated. Costs estimates of 8m diameter fibre glass tank is £900.00, while for steel £2800 and corrugated iron £1500 in the U.K. in 1985.

Advantages of tank hatcheries over cage/hapa and pond culture are ease of control of water quality, feed and the number of fry. It is also easier to harvest the fry and to maintain a pure brood stock which is essential in genetic improvement work.

In small indoor tank hatcheries use of recycled water aerated and filtered through biological filters enables a high efficiency of fry production in a minimum space. A constant head of water is maintained in the rearing plastic or fibre glass tanks by means of a stand-pipe; the fry is protected by an outer pipe from being flushed away.

Problems

Sedimentation of tanks and Ammonia pollution. Velocity of water needed to maintain self cleaning of tanks (7-8 body lengths/sec for small fish or 4-5 body lengths/sec for larger fish) can be withstood well by tilapia. Rearing tanks should not have depth lower than 0.7m as shape of the fish is affected at lower water depth.

Pond Hatchery

Tilapia can breed easily in a normal fish breeding pond where females and males are kept. The ratio of females to males should be about 5:1. It is easier to collect fry if one end of the pond is shallow and the arena area is provided as shown in the cross section drawing shown (Fig. 4).

Table 1 - Fry production rates from various methods and authors

Ponds	10 fry/m²/month	(Rothbard et al 1982)
	Fingerlings 4-8/m²/month	Coche, 1982)
Hapa (Cages)	200 fry/m²/month	(Guerrero & Garcia, 1983)
Tanks	688 fry/m²/month	(Snow et al, 1983)
	1024 fry/m²/month	(Coche, 1982)
	1688 fry/m²/month	(Uchida & King, 1962)
Tank (Hapa)	3000 fry/m²/month	(McAndrews (Unpubl.))

Artificial Incubation of Tilapia Eggs

Fertilized eggs from known parents are removed from the brood pouch of the female and incubated in a container with water swirling around enough to keep the eggs rolling up and down. Optimum water temperature for incubation is 28°C.

High quality fry are produced through aritificial incubation. Compared to parental incubation the artificial incubated eggs released fry in 12-16 days while the wild stock brooding the eggs released in 13-21 days. The earlier released fry have a head start growth advantage over the late released fry. The growth difference observed by Kahn (pers. comm.) in Stirling University for O. mossambicus ranged from 50% to 120%. Water quality must be very good especially with regards to eliminating ammonia and maintaining a pH of 6-7 in the incubation tanks.

Artificial incubation is very useful in genetic improvement studies where fry of uniform size and age are required for experiments.

Improving Quality of Fry Production

Sex-Reversed all-Male Fingerlings

It is essential to obtain fry of a uniform size and age for application of hormone treatment to obtain sex reversed all-male fingerlings.

To obtain these sex reversed fingerlings feed the fry on food pellets to which MT (17 - & methyltestosterone) a male steroid hormone has been added at 40 ppm. This is obtained by addition of 16 ml of a stock solution of 2.5 mg/ml in Ethan 1 of MT to 1 kg of the feed. The size of pellets to feed tilapia fry should be about 1000 microns. The fry must be fed the hormone treated food within the first 10 days of life until about 40 days. There is evidence that hormone treated fry have a higher weight gain than controls over 40 days.

Also the hormone is completely eliminated from the fish within 200 to 300 hours after cessation of feeding with the hormone food.

MT is supplied by Sigma Chemical Co. Missouri, USA for about $10.00 per 10 gm bottle.

Tilapia Feeds and Feeding

In nature *Oreochromis* spp. and *Sarotherodon* spp. are mainly omnivorous as adults while the fry feed on zooplankton or phytoplankton. *S. galilaeus* feeds exclusively on phytoplankton. *O. niloticus* feed predominantly on phytoplankton and can utilise blue-green algae. *O. spirulus* is an omnivorous grazier. *O. mossambicus* feeds mainly on plankton, vegetation and bottom algae.

The *Tilapia* spp e.g. *T. melanopleura* and *T. zillii* are herbivores with preference for higher plants and are used for weed control.

T. rendalli adults feed exclusively on higher plants while juveniles take zooplankton and phytoplankton (Jauncey and Ross, 1982).

Clearly an understanding of the natural feeding habits and diets of tilapia can be used in their culture to prepare nutritionally balanced diets for intensive culture systems or for boosting zooplankton/phytoplankton production in extensive culture systems.

Nutrient Requirements of Tilapias

Table 2 Summary of the major nutrient requirements of tilapia (From Jauncey and Ross, 1982)

Nutrient	First feeding to 0.5g	0.5-10g	10-35g	35g to market size	Brood-stock
Crude protein	50%	35-40%	30-35%	25-30%	30%
Crude lipid	10%	10%	6-10%	6%	8%
Digestible carbohydrate	25%	25%	25%	25%	25%
Fibre	8%	8%	8-10%	8-10%	8-10%

From the above data carbohydrate and fibre requirements remain fairly constant while protein and lipid requirements are higher in the smaller fishes.

Vitamin/Minerals

The feed should also contain vitamin and mineral supplements as recommended in Jauncey and Ross(1982).

Feed Formulation for Tilapia Feeds

Feed formulation is the method of combination of raw materials available to satisfy the pre-established nutrient requirements of the cultured fish. It should be noted that the fact that a nutrient is chemically present in a given feedstuff does not necessarily mean that it is biologically available. In formulating feed we need to balance protein level, check energy level and the levels of essential amino acids and essential fatty acids.

The principle of "least cost", "best buy" is applicable here, but above all raw materials locally available should be used as much as possible.

Example:

Protein sources

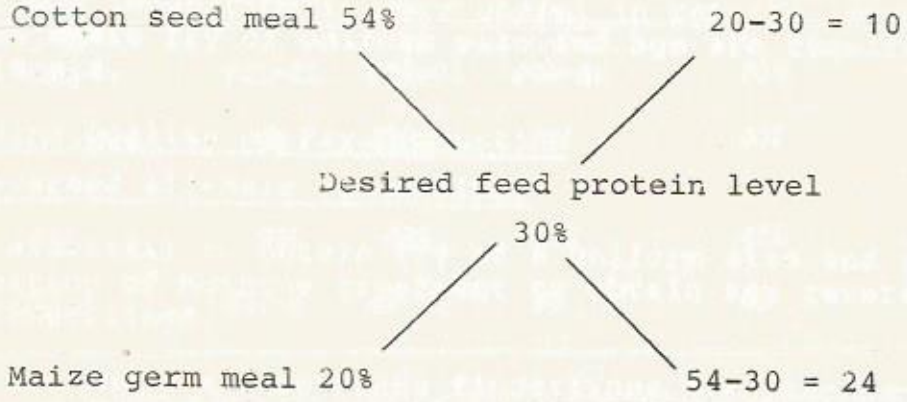
Cotton seed meal (54%) and groundnut meal (44%) protein content.

Energy Sources

Rice bran or polishings contains 2700 kcal DE/kg.

Maize contains 4300 kcal DE/kg.

Supposing it is desired to formulate a 30% protein tilapia feed from cotton seed meal (54% protein) and maize germ meal (20% protein) a square is constructed thus:



The protein level of feed is subtracted from that of each feedstuff and the answers are added, disregarding positive or negative signs (i.e. 10 + 24 = 34).

To obtain 30% protein tilapia feed we need:

$\frac{10}{34}$ x 100 = 29.41% of cotton seed meal

and $\frac{24}{34}$ x 100 = 70.59% of maize germ meal

By similar procedure other components can be calculated .

Linear Programming

The best method of diet formulation is to use purpose written computer programme. The computer works out the complete analysis and costs of the available feedstuffs and the required nutrient profile of the feed. Programmes such as these can be purchased.

Parasites and diseases of Tilapia

In extensive and semi-intensive tilapia cultures diseases have not been a problem, but under intensive cultivation with high stocking density and intensive feeding diseases could become a problem.

Parasites groups seen on tilapia

These include protozoans - flagellates, ciliates and sporozoans e.g. Myxosoma cerebralis causing whirling disease. Metazoans include helminths, - monogenetic and digenetic flukes, Nematodes and leeches.

Among the crustacean parasites are Branchiurans, Copepods (e.g. Argulus, Ergasilus, Lernea) and isopods the later are increasingly becoming important.

Effect of parasites include:

- reduction in growth rate
- poor food conversion efficiency
- increased cost in treatment/control
- reduced carcas value
- castration and pre-spawning mortality.

Examples

White spot disease "ich" ichthyopntarus - a ciliate. This is an important killer of hatchery fry controlled by liming.

Ciehladogyrus- attached to gills of tilapia causing damage but does not kill the fish.

Gyrodactylus - found on skin of fish and can kill tilapia rapidly.

Bacterial diseases

(i) Flexibacter columnaris (saddle back) - diseases occur where a damage or lesion occurs to the skin at temperatures above 30°C. Control by reducing water temperature below 30°C.

(ii) Flexibacter psychrophila - This loves cold water and affects the ventral fins or tail of the fish.

(iii) Flexibacter spp - Causes gill rot disease in young small tilapia. Treatment by washing the affected gills with detergent.

(iv) Enterobacterial - Diseases caused by Yerisiwa muckerii, Edwardsiella tarda. These cause haemorrhages killing fish and causing an awful nasty foul smell when the fish is cut open even when still alive.

(v) Treatment - Drain pond and lime and let the pond dry before refilling.

Proteus rettgari - introduced to fish pond through chicken manure. Caused loss of over 200 tonnes of silver carp in Israel.

Aeromonas hydrophila - commonly found in tilapia ponds. Attacks of this organisms comes after the fish has been weakened by a virus attack. The abdomen is swollen and red spots on the mouth.

Control - drain the pond and lime it and let it dry up.

Streptococcus faecalis - associated with poor handling and human faeces or manure pollution.

Botulism - is very common in tilapia caused by Clostridium botulinum which is in the mud of the pond.

Virus caused diseases

Lymphocystis - an irodovirus.

Use of antibiotics not recommended. Strict quarantine laws should be enacted, and enforced to prevent importation of fish pests and diseases.

Recommendations on Tilapia

The tilapias are the best studied tropical culturable fishes and they have the best prospect of becoming the equivalent of the carp in Africa.

To achieve success it is recommended that pure genetic resources of the various tilapia species be kept in genetic banks in Africa from which breeding work can be done to develop highly suitable strains as parent stocks for hatchery work. The research Institutes and universities should do this.

The future of tilapia in fish culture depends on efficient hatcheries to produce good quality fry and fingerlings plus a good feed base for intensive cultures.

The high proliferation of tilapia could also be utilised to produce small fishes for fish meal production.

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SUMMARY OF CAGE AND PEN CULTURE OF TILAPIAS

(a) Comparison of Cage and Pen Cultures

TYPE OF ENCLOSURE	SIZE (M^2)	SHAPE	CAPITAL COSTS	TYPE OF CULTURE	COMMENTS
FIXED CAGE	$1-10^2$	Square	LOW	EXT/SEMI-INT/ INT	Production flexible, however not suitable for exposed or deep water site (8m).
FLOATING CAGE	$1-10^3$	SQUARE/CIRC/ RECTANGULAR	MEDIUM	EXT/SEMI-INT/ INT	Production flexible Comparatively strong
PEN	10^3-10^5	VARIABLE	MEDIUM-HIGH	EXT/SEMI-INT/ INT	Inflexible production However not suitable for deep water sites (8m) Hard substrates is a problem. Good growth

(b) Comparison of extensive, semi - intensive and intensive cultures

METHODS OF CULTURE	STOCKING DENSITY (M^3)	FEED	SITE	PRODUCTION kg/m^3/month	COMMENTS
EXTENSIVE	4-10	natural	lentic	Less than 2	Experiences suggest difficulty to maintain production due to over-exploitation of site
SEMI-INTENSIVE	10-50 +	less protein (10%) plant & agricultural by products	lentic/ lotics	Less than 4	Most popular method Addition of some food usually increase production unless phytoplankton bloom conditions prevail
INTENSIVE	50-200 +	high protein (20%) artisanal or commercial	lentic	5 - 15	Rare. Advisable where growing season is short or where water resources scarce. Need high retail price to make profit

COMMERCIAL POND FISH CULTURE USING WASTE WATER

by

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ABSTRACT

Waste water from some National Electric Power Authority (NEPA) housing units was fed to a 0.4 ha pond which was stocked with 2,200 Sarotherodon galilaeus fingerlings with a mean weight of about 36.0gm and 1000 Cyprinus carpio fingerlings with a mean weight of 10gm. This yielded after 10 months over 2300 kg of harvestable fish plus over 20,000 Sarotherodon galilaeus fingerlings. The growth rate of Cyprinus carpio was not very encouraging possibly because of the type of plankton that colonised the pond. The Sarotherodon galilaeus became stunted because of over population as there were no carnivores to control their excessive breeding. The physico-chemical parameters were favourable for the growth of fish food organisms.

INTRODUCTION

Organic wastes are extensively used in many regions of the world to replace part of, or all supplementary feeding in fish ponds. Cow manure and sewage from small towns have been demonstrated to be commercially useful bases for natural fish foods. This has resulted in large increases in fish yield per unit area of pond as well as sharp decrease in feed conversion coefficient. Schroeder (1973, 1974) showed through his study of 35 commercial fish ponds with fish stocking densities ranging from 1 to 5 tons/ha that the amount of natural food in the ponds was the most important parameter in determining the efficiency at which supplementary feed was utilized by the fish for growth. This led to the discovery of fluid cow manure which contains urine and faeces as a successful but inexpensive nutrient for increasing the productivity of natural fish food organisms in ponds.

Human sewage has also been shown as other types of organic manures to have significantly increased fish growth in ponds but aesthetic considerations often limit its use. However, holding the fish in clean water ponds for several weeks at the end of the growing season has proved to be a pragmatic

method for providing fish acceptable for market (Schroeder and Hepher, 1976). This flush-out period has been shown to remove residual objectionable odours and pathogens. Human wastes from a town of 5000 people has been used as a fertilizer and feed directly into a 4 hectare reservoir fish pond and this yielded 2,800 kg/ha/6 months. Similarly human wastes from a population of 500 people fed into fish ponds of 3 ha in area with supplementary feeds at daily rates of 3 - 4% of the biomass but without chemical fertilization, yielded 8600 kg/ha/8 months with a feed conversion coefficient of 1:1. But adjacent non-sewage ponds receiving chemical fertilization and similar supplementary feeds yielded 4700 kg/ha/8 months with feed conversion coefficient of 1:2. Fish growth therefore as stated by Huet (1982) depends greatly on the quality of the water used in the pond and the quality of water depends upon where it comes from and what kind of soil it travels over. Lake Laguna, Philippines a very productive lake with a surface area of 900 km² and average depth of 3 meters, has about 5000 ha of fish pens, where milk fish is commercially cultured. This lake is fed by domestic and industrial effluents from the capital city, Manila with a population of over 6 million people. In Kano State, Jakara Dam Reservoir into which flows River Jakara which passes through Kano metropolis collecting all the refuse wastes, sewage and industrial waste has been declared a chemically polluted reservoir. This reservoir has been shown to be dominated by Tilapia species which form 97.04% by weight of the total catch while Clarias species formed only 2.96%. These Tilapia species are stunted as a result of over population as majority of them are caught by 63.5mm gill net. Similarly, the I.I.T.A. Ibadan 70 ha reservoir which is also a circulatory waste water is dominated by Tilapia species but with the recent introduction of Lates niloticus to control the population of Tilapia it is very common to catch Tilapia species weighing average weight of 500 gm and above.

In the light of the above facts, a polyculture trial of Sarotherodon galilaeus and Cyprinus carpio was undertaken in one of the waste waters in New Bussa to determine:-

(i) The physico - chemical parameters of such a eutrophic water body.

(ii) The growth and survival of these two fish species in the waste water.

(iii) The yield and fingerling production of the fish species after one year culture period.

Materials and Methods

The study was carried out at the NEPA sewage pond situated at the back of the State Ministry of Agriculture and Natural Resources, New Bussa. The sewage pond with a surface area of 0.4 hectare , average depth of 1.0 meter and a 30 cm diameter inlet pipe and 15 cm outlet pipe to let out excess

water during heavy down-pour, was built in 1965 primarily for the collection of waste waters from some parts of the NEPA quarters with a population of about 2,000 people.

The sewage pond was stocked on 1st July, 1985 with 2,200 tilapias mostly Sarotherodon galilaeus fingerlings with a mean weight of 36.0gm and 1,000 fingerlings of Cyprinus carpio with a mean weight of 10gms. The gut content of C. carpio was analysed using point and gravimetric methods. Monthly sampling was undertaken to monitor the growth rate of the stocked fish. Biweekly samplings for physico-chemical parameters such as temperature (air and water) hydrogen ion concentration (pH) dissolved oxygen concentration, nitrates and phosphates were taken at the inlet, outlet and main body of the pond according to the techniques described by Golterman (1980), A.P.H.A. (1980) and Hach (1980).

Results and Discussion

Fish harvest at the waste water started in May, 1986. So far about 1580 kg of marketable size S. galilaeus with a mean weight of 51.3 gm have been harvested along with 173.8 kg of fingerlings which have been processed into fish meal. This harvest also includes 825 kg of Cyprinus carpio fingerlings with a mean weight of 50.3 gm and which was divided roughly into four size groups of 9.5 - 12.5, 12.6 - 15.5, 15.6 - 18.5 and 18.6 to 21.5 cm. In addition an estimated 20,000 S. galilaeus fingerlings were produced during the ten month period.

The Cyprinus carpio fingerlings in the waste water were noted to have shown a slow growth rate due to the nature of the food available to them. The phytoplankton of this waste water is over 80% Scenedesmus and this has been shown not to be easily digested by C. carpio. This must have invariably accounted for the slow growth rate of the C. carpio fingerlings. The occurrence of the various food items in the stomach of different size groups as shown in Table 1 could be summarized under eight basic food items with detritus constituting 20.21%, insect larvae 18.16%. phytoplankton 12.21%, zooplankton 9.85%, aquatic vegetation 9.23%, seed shell 7.38%, ants 5.54% and unidentified algae 2.77%. Insect larvae formed the dominant food item and this is in line with the work of Swingle (1957), Huet (1972) and Crivelli (1981) who seem to agree that the principal constituent food of Cyprinus carpio fingerlings is insect larvae. It is oberved from Table 1 that the rate at which each size group feeds on planktonic organisms increases as the size of the fish increases. This agrees with Huet (1982) who documented that older carps feed predominantly on 75% planktonic organisms.

The mean values of the physico-chemical parameters analysed for the four sampling stations from October, 1985 to April, 1986 are shown in Table 2. From this, it is observed that increase in water temperature coincides with decrease in the

dissolved oxygen content. This agrees with the observations of Huet (1972). The pH value was high in all the sampling stations. There was high photosynthetic activity in the water body (15.70 mg. 0_2/lit/day) thus leading to high pH value. This agrees with the observation of Boyd (1979) that the photosynthesis of aquatic plants removes carbon dioxide from water during the day and causes a rise in pH. Schroeder (1975) also observed that sewage treatment ponds stocked with fish have higher average dissolved oxgen concentrations and pH than similar ponds without fish. The production of nitrogen in eutrophic water is high especially when there is plankton bloom and concentrations of organic nitrogen might exceed 2 or 3 mg/l (Boyd, 1979). The result obtained for available nitrate ranged from 3.6 to 4.1 mg/l. This agrees with Boyd (1979) who observed that human wastes and domestic detergent wastes lead to high values of phosphate content and low values of nitrogen content especially where the results in Table 2 indicate that highest phosphate value corresponds with lowest nitrate value.

CONCLUSION

The physico-chemical parameters of the NEPA waste water in New Bussa were found to be favourable for the growth of fish food organisms for increased fish production. Stocking such eutrophic water with only non-carnivorous and planktonic fish species especially Tilapia species, could lead to stunting as the Tilapia could breed prolificly. However, the waste water could be used specifically for the supply of Tilapia fingerlings for stocking other ponds and water bodies. Otherwise, few voracious feeders could be added to effectively control the prolific nature of Tilapia. The effectiveness of sewage pond has been shown tc be actually improved by stocking it with fish.

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Table 1. Percentage Occerrence of Food items in Stomachs of *Cyprinus carpio*

	9.5 - 12.5	12.6 - 15.5	15.6 - 18.5	18.6 - 21.5	Mean % of Food Eaten
Insect larvae	26,07	14.21	24.70	22.22	21.80
Diatoms	8.70	4.74	5.88	3.70	5.76
Cyclops	8.70	3.68	2.35	3.70	4.61
Brachionus	-	1.58	-	-	0.40
Clostorium	8.70	7.37	7.06	14.82	9.49
Scenedesmus	8.70	4.21	4.71	-	4.41
Unidentified algae	-	2.11	4.71	3.70	2.63
Aquatic vegetation	-	10.53	7.06	14.82	8.10
Ants	4.35	5.79	5.88	3.70	4.93
Detritus and Mud	13.04	23.68	17.65	11.11	16.37
Seed shell	-	8.42	4.71	14.32	6.99
Unidentified food items	8.70	8.42	11.76	7.41	9.07
Incidental food items (sand and scales of fish)	13.04	5.26	3.53	-	5.46

The percentage of each kind of food for each size group of fish in vertical columns add to 100

Table 2. Mean values of the physico-chemical parameters analysed for the four sampling stations during the study period

Parameters	Sampling Stations			
	Inlet	Mid-Pond 2	Mid-Pond 1	Outlet
Water Temperature (°C)	29.4	25.8	26.9	26.9
Dissolved Oxgen (mg/l)	4.6	7.3	7.2	7.1
Hydrogen Ion Concentration (pH)	7.9	8.4	8.4	8.4
Nitrates (No_3 - N)	3.60	4.10	4.0	3.68
Phosphates (PO_4-P)	1.00	0.80	0.95	0.72

SOME EXPERIMENTS ON COMMERCIAL POND FISH CULTURE IN THE TIDAL MANGROVE AREA OF THE NIGER DELTA OF NIGERA

by

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ABSTRACT

A Pilot project was initiated by Shell Petroleum Development Company of Nigeria Limited in 1981 with specific aims and objectives. Site selection, survey, pond construction method and fish production with regards to experiences gathered and gained, problems and solutions so far obtained are discussed. Trial of fresh water fish species to check their adaptability to brackish water ponds were carried out and the exciting results of the growth rate of these species when compared with the traditional local brackish water species selected for culture are reported. Extension Programme so far carried out is briefly described.

INTRODUCTION

SHELL, the pioneer and major oil production company in Nigeria operates in three main zones namely upland, swamp and offshore. Shell realises that the main occupation of the people living in the upland zone is subsistence farming whereas those in the swamp or riverine area are basically artisanal fishermen. In order to raise the standard of living of the people living within its areas of operation Shell in 1965 started involving itself in agricultural projects in the upland zone through qualified Extension Advisers who provide free technical advice and provision of improved varieties of crops to help the farmers, help themselves. Meanwhile nothing in the form of agriculture was being done by the company to assist the villagers dwelling in the vast swampy zone. Within this zone is situated the tidal mangrove swamp and the evergreen thick forest of the Niger Delta. Shell, realising that South East Asian countries like the Philippines, Malaysia, Indonesia, Taiwan, etc. with tidal mangrove swamps have developed high skill and level of fish farming, and also realising that Nigeria is blessed with over one million hectares of tidal mangrove swamp which is a great potential to produce much of her needed fish protein, decided to establish a Pilot Fish Farm at Ogbe-Ijoh village near Warri in Bendel State of Nigeria in 1981/82 at an initial capital cost of ₦.5 million.

Much work had not been done by the Government in this area and so data were not available to help Shell. The project is basically for research and development of fish culture in the tidal mangrove swamp of Nigeria with the desire to share experiences gained with local, State and Federal Agencies and Higher Educational Institutions, mangrove swamp communities, persons or corporations whose interest and responsibility are concerned with fish farming in the mangrove areas. Shell's goal is to create avenues for jobs, income and food within the mangrove area by producing improved fish species.

The water in the mangrove swamp is naturally brackish but the Shell Fish Farm, Ogbe-Ijoh , is within an area which is annually affected by the influence of the River Niger high flood from September to November which reduces the salinity of the water to near zero. This knowledge has prompted fresh water species to be introduced into the Farm with exciting results. Ponds are stocked after filling them with fresh water from Ogbe-Ijoh creek. Fresh water fish species so stocked gradually adapt themselves to changes in salinity when the water becomes brackish during the dry season.

This presentation is based mainly on experience gained from the Shell Fish Farm as from September, 1981 - August, 1986 through trials and demonstration of biological and commercial feasibility of fish culture in the tidal mangrove swamp. Our main interest is centred around the Niger Delta basin and any other areas of the tidal mangrove swamp where the water becomes fresh during the flood season and gradually brackish during the dry season. In such a situation as at Ogbe-Ijoh fresh water as well as brackish water fish species could be cultured with great commercial advantages.

SITE SELECTION

For a site to be considered suitable, the following factors are critically examined:

1. Water quality,
2. Vegetation,
3. Soil,
4. Topography,
5. Tides, tidal range and land elevation, and
6. Climate.

Other factors are accessibility, seed stocks, labour, capital and market.

WATER QUALITY

Some recommended water quality standards usually considered for suitability of a site are as follows:-

Parameter	Standard	Ogbe-Ijoh Creek Water
pH	6.5 - 9.0	6.7 - 6.9
Total Alkalinity	20 - 150 mg $CaCO_3/l$	28 - 40 mg $CaCO_3/l$
Temperature	24 - 32°C	25 - 31°C
Salinity	0-5 ppt (fresh water spp.)	0.025-2.709ppt
	5-26 ppt (brackish water spp)	
	26-32 ppt (salt water spp)	
	0-32 ppt (euryhaline spp)	
Turbidity	50 NTU maximum wet season, green water colour preferable	
Polluta nts oil and grease	0.0mg/l preferable up to 2.0mg/l maximum. Avoid sites near oil pipes, rigs and flowstations	
Heavy metal	Avoid sites near industry.	

VEGETATION

Site with medium to low/sparse mangrove trees is preferred. High mangrove trees, tall trees, raffia palms, thorn trees are unsuitable because they are difficult to clear, cut and pack. Moreover their numerous roots make it hard to construct dikes.

Recommendations on vegetation for selecting a site are presented below:-

Type and Density of Vegetation	Recommendation
No vegetation	Ideal, area limited
Short sparse mangrove	Desirable, area unlimited
Short dense mangrove	Suitable
Large, high mangrove	Unsuitable, avoid
Raffia palms, thorn trees and other trees	Unsuitable, avoid.

SOIL

Clayey soil is preferred for building of dikes because it is impervious to seepage which is one of the greatest problems that could be encountered. The recommendations on soil for selection of site for fish farms are given below;-

Types of Soils	Recommendation
Clay	Ideal
Sandy clay	Ideal
Clay with few mangrove roots	Desirable
Clay with many mangrove roots	Suitable
Loamy or sandy soil with little clay	Unsuitable, avoid
Soft soil of any type	Unsuitable, avoid

It is important to examine the soil profile down to a depth of 1.0 meter with the use of soil auger, or a digger or with a spade to be sure of the subsoil. The top could be clay yet below could be sandy.

Figure 1 - Soil Profile at Shell Farm

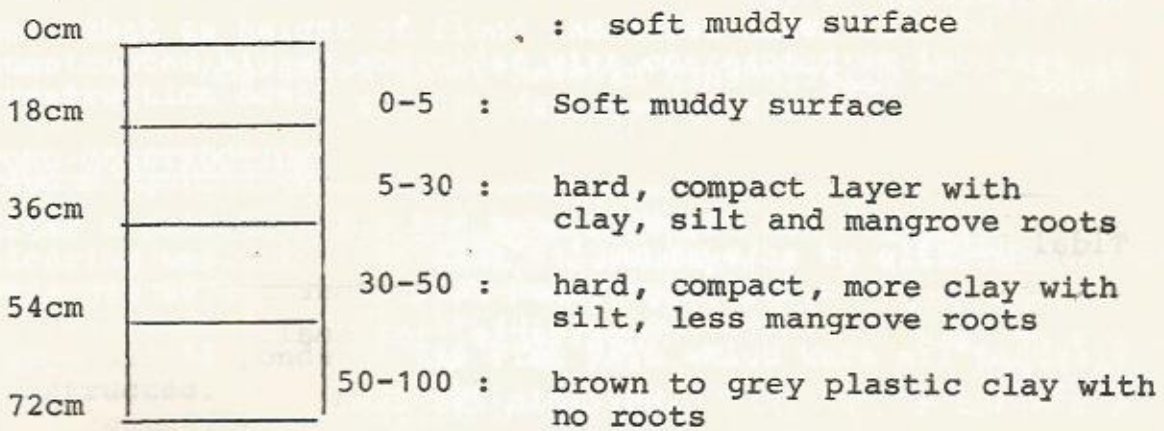


Fig. 1

TOPOGRAPHY

The slope of the land should be gentle, 0.5% or less to facilitate drainage. Land should not be ridged or rolling or divided by creeks. When water begins to flood the site the lowest and drainage points will be covered first and the highest points last. A knowledge of this will enable one to locate the gates.

TIDES, TIDAL RANGE AND LAND ELEVATION

In Nigeria the coastal water has a cycle of 2 high tides and 2 low tides per day. During the new and full moon the high tides are highest whereas low tides are lowest because the gravitational forces of the moon and the sun are pulling the ocean waters in the same direction. The lowest high tides and highest low tides occur during the first and third quarters of the moon when the gravitational forces of the sun and moon are pulling at right angle to each other. The result is that the high tides and low tides from day to day are not the same but are constantly increasing and decreasing. A knowledge of this is utilized to top off or fill ponds to maximum depth and to effectively drain ponds for harvest during the new and full moon periods.

The interval between a consecutive high and low tide is six hours 12½ minutes which means that it takes 24 hours 50 minutes to have the 4 tides (2 high and 2 low) each day. Every day therefore, the tide will advance 50 minutes. For instance, if low tide was 8.00 a.m. on Monday it will be 8.50a.m. on Tuesday. Times of tides can therefore be predicted.

Tidal Range is the vertical distance or the difference between average high tide and the average low tide. It is an important factor in determining whether a site is suitable or not. Table 1 below shows the relationship between tidal range and suitability for fish culture in Indonesia. (Yamashita and Sutardjo, 1977).

Table 1 - Relationship between tidal range and suitability for fish culture

Tidal Range	Comments
1.0 or less	Unsuitable, too small
1.0 - 1.5 m	Suitable for fish
1.5 - 2.0 m	Suitable for salt water shrimp
2.0 - 2.5 m	Unsuitable, too large

Tidal range at Shell Fish Farm is 116 cm and is suitable. Tidal range should be high enough to accommodate an adequate depth of pond water, excavation of drainage canals/ditches, secondary gates, main gates and sufficient drainage of ponds for harvesting.

LAND ELEVATION

Height of land may be so high that it may not be flooded or only low depth of it may be flooded during high tides. Water will be too shallow for fish culture and land would require excavation with an increase in cost and increase in acidity problem. It should be avoided.

Some lands may be too low. Whereas water depth would be ideal but drainage for harvest will be a problem unless transfer pump is used with an increase in cost. Such areas should be avoided.

CLIMATIC CONDITIONS

Areas liable to high flooding during rainy season as in Ogbe-Ijoh as from September, to November, each year should be selected with care. Recommendations concerning flooding are as follows:-

HEIGHT OF FLOOD STAGE

Above Normal Highest Tides		Recommendations
No flooding	:	Ideal
50cm or less	:	Suitable
More than 50cm	:	Unsuitable, avoid.

Note that as height of flood increases dikes must be constructed higher and wider with corresponding increase in construction cost.

POND CONSTRUCTION

After a suitable site had been surveyed and acquired, manual clearing was done. It took 113 man-days/ha to clear short mangrove at the Shell Fish Farm, Ogbe-Ijoh.

There are 18 ponds at the Fish Farm which were all manually constructed.

It is possible to use mechanised method to construct the dikes like at Mosheshe Fish Farm near Warri in 1985, with the use of swamp boggy excavator.

A specially constructed soil digger was designed at the Farm to dig and cut the peaty soil into equal and regular blocks. The blocks were piled in a special way to build the dikes according to the layout of the ponds. The sluice gates were located at the lowest section of the land.

There are 4 Nursery ponds,

2 fingerlings ponds,

4 production ponds, and

8 utility ponds at the Shell Fish Farm

Other facilities at the Fish Farm include fish hatchery, wet laboratory, a Pelleting Mill and two aluminium livewell tanks for fish distribution. Total area of the 18 ponds is 8.0 hectares. Average cost of building an hectare pond from clearing, stumping, packing, surveying/layout design, dike/ sluice gates construction was ₦8,644.00. The detailed analysis of cost is given below:-

Cost of building a single One Hectare Pond

Clearing, stumping and packing = 246 mandays/ha. at ₦6.00/manday	=	₦1,476.00
Survey	=	500.00
Dike construction (manual) 1320m³ at ₦5.00/m³ = (20 men x 2.0m³/manday x 27 days for 400 linear meters of dike)	=	₦5,400.00
Wooden sluice gate construction: 1 @ ₦200.00	=	200.00
Grass planting, 47 mandays @ ₦6.00	=	282.00
10% Contractor's fee	=	786.00
Total cost	=	8,644.00

SEEPAGE PROBLEM

Soil used in building the dikes contained succulent mangrove tree roots. After about one year the roots started to decompose forming hollows and holes in the soil blocks piled together to form the dike. The hollow became the source of seepage which overtook the entire ponds in 1983/84. It was a great confusion that brought a great setback as most of the stocked fish species with all the treated water were lost and the Farm was in a ruined stage.

SOLUTION

Since seepage was almost along all the dikes its control was difficult until the use of concrete slab to line the interior side of the dike was developed. Concrete slab stopped the seepage.

With extra cost of ₦10,170.00 per hectare, length of dike of the 1 hectare pond is 405m. See detailed analysis below:-

Size of concrete slab: 405m x 76cm x 10cm

Cost analysis based on current prices of materials used:

225 bags of cement @ ₦12.00 (1.8m/bag)	=	₦2,700.00
12 tipper loads of sharp white sand @ ₦50.00/load (34.4m/tipper load)	=	600.00
11 bush tipper loads of 3/4" granite @ ₦400.00/load (37.8m/load)	=	4,400.00
3½ rolls of BRC iron rods @ ₦185.0/roll	=	648.00
Labour of transferring materials to dikes	=	800.00
Slab construction 116 mandays @ ₦7.00/ manday (3.5m/manday)	=	812.00
Wood/nails	=	200.00
Total		10,170.00

Dike repairs with concrete slab were effected in 1985/86. Total cost for permanent dike construction, i.e. piling of soil blocks and lining of the interior side of dike with concrete slab will be ₦8,644.00 plus

$$\frac{10{,}170.00}{} = ₦18{,}817.00/ha$$

Alternative method yet to be tested is the building of a clay core trench at the centre of the dike. Since clay is impervious it could check and control seepage unless some organisms could borrow holes along the dike to create seepage points which, however, could be easily checked. An estimated cost of building one hectare pond with clay core trench dike is about ₦14,364.00.

In 1985 a private farmer in Warri used a mechanised method to build his ponds. The dikes were properly rammed with the machine. Half hectare pond (100 x 50m) was constructed at an average of 3 days at about ₦500.00/hour. Seepage has not been experienced yet but we are still watching.

One of the greatest advantages in tidal mangrove fish farming is that the high tides act as natural pump by filling the ponds with water so that bore hole is not needed.

FISH PRODUCTION

Initially several available local species of fish were stocked in 1982. Out of these the followings were selected for culture:

1. Chrysichthys spp (silver catfish mixed
2. Tilapia guineensis
3. Mugil spp. (mullet)
4. Citharinus spp. (Moon fish)
5. Hemichromis fasciatus (Predator)

As fish feed wast available , ponds were fertilized with dry poultry manure at the rate of 200kg/ha/week with bi-weekly application of NPK 15.15.15 fertilizer at the rate of 100kg/ha/mo. When growth rate of fish had not been fully tested, seepage started to occur in 1983 and it finally disorganised the programme. When poultry manure were no more readily available as many poultry farmers folded up due to high cost of mash, we decided to integrate poultry with fish so that the birds could provide fresh untreated poultry manure as food for the fish.

Although it was encouraging yet the seepage still affected the fish production in the pond with the poultry unit. True utilization of the birds (layers) was not realized until 1985 and 1986 after the seepage had been checked. There are three poultry units now in 3 production ponds. Growth rate of all species of fish in these 3 ponds was encouraging. See Tables 2 - 5 below for details.

In 1983 two production ponds (1 ha.) each were stocked with Chrysichthys spp from the wild with Hemichromis fasciatus a predator to check Tilapia reproduction and pond 'A' fed with fresh poultry manure from 400 layers fed with 50kg of mash/day to produce 16kg of manure/day with application of NPK 15:15:15 fertilizer every 2 weeks.

In April, 1985, a production pond was stocked with mainly T. guineensis grow out assembled from various ponds and fed with fresh poultry manure and wasted layers mash from 300 layers in a pen built over the pond with perforated floor to allow faeces to drop directly into pond water. Birds (layers) moved freely in the pen.

In October, 1985, when water was fresh, 3 fresh water species from the upland were introduced and stocked with the local Tilapia guineensis, Chrysichthys spp. and Citharinus. The fresh water species were Clarias lazera, Heterotis niloticus and Channa obscura all from the wild. They were fed with fresh poultry manure form 300 layers in a similar pen as above

supplemented with wet spent grain from a beer brewery at 5% body weight of fish when fresh manure alone could not support the fish. In each case birds were fed with 37.5kg of layers mash per day and each was capable of producing about 40 grams of faeces/day. 300 layers would produce 12kg of fresh poultry manure plus wasted feeds for fish to feed on together with the brewery spent grain. Bi-weekly application of NPK 15.15.15 fertilizer was no more necessary after six weeks of stocking because adequate level of green water colour was maintained.

By comparing the growth rate of local species being cultured since 1982 with fresh water species introduced in October, 1985 it became clear that the newly introduced species were ideal for culture in the Niger Delta tidal mangrove zone. Arrangement to induce Clarias lazera to spawn in our hatchery is already completed. Mass propagation of Clarias lazera and Heterotis niloticus is our next programme while we also try again to induce Chrysicthys nigrodigitatus to spawn in the pond as we successfully did in 1983 by providing and arranging 6" PVC pipes out into about 18" long along the dikes in a nursery pond. Fed on dry poultry manure the C. nigrogitatus attained an average weight of 500 g in 12 months.

Production of Tilapia guineensis fingerling is quite encouraging. We have enough broodstock and the farm is capable of producing over 400,000 T. guineensis fingerlings annually. They are available to the public at subsidized rate of 10k per fingerling weighing 10 grams.

Sarotherodon melanotheron though not stocked is always present in large number during harvest. It is like weeds competing with desired crops in the Farm for food, oxygen, space, etc. The average weight of adult fish is only 90.8g which is not attractive enough for market women.

We plan to utilize it as fish meal to improve poultry feed and proposed fish feed pelleting. Where it is not required the pond will be dried up to eliminate them since the seepage has been controlled.

Poultry Units

Each of three pens was stocked with 300 layers. Total number of laying chickens was 900 and fed 4½ bags of layers/mash a day to produce about 40 grams of fresh manure/bird/day (ROESTAMI DJAJADIREDJA, ZULKILFI JAN GKARU AND MOCHAMAD JUNUS, 1980).

Extension Services

Free technical advice is provided by the Fisheries staff to third parties. Fingerling are distributed to fish farmers at subsidized rates. Free training courses are offerred to fish farmers and Fisheries Officers interested in tidal mangrove swamp fish farming.

Inputs and outputs analysis are shown in Tables 6-8. Production data for Tilapia guineensis, Clarias lazera and Heterotis niloticus in Table 6 below are based on the information gathered from actual cropping data presented in Tables 4 and 5.

Much problem encountered at the Pilot Fish Farm Project has exposed us to more experiences in the tidal mangrove swamp fish farming. With the seepage problem solved more attention will be given to efficient way of utilizing fresh poultry manure in raising fish. Already we are encouraged with the growth of fish in ponds fed with fresh poultry manure supplemented with wet brewery waste and application of inorganic manure.

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Table 2 - Fish fed with dry poultry manure with application of NPK 15.15.15 fertilizer every 2 weeks during the seepage period of 1983. Pond A

Fish spp.	Av. Wt. At Stocking	Culture Period	Av. Wt. At Harvest	Stocking Rate
T. guineensis	25g	10 months	64.4g	5000
Chrysichthys spp.	44.5g	-do-	145.6g	1000
T. aurea	43.3g	"	227g	100
Citharinus spp.	225g	"	854g	20

Table 3 - Fish fed with fresh poultry manure with bi-weekly application of NPK 15.15.15 fertilizer during the seepage period of 1983/1984 - Pond B

Fish spp.	Av. Wt. At Stocking	Culture Period	Av. Wt. At Harvest	No. of Fish Stocked
T. guineensis	50g	10 months	165g	5000
Chrysichthys spp.	35g	-do-	331g	1000
Citharinus spp.	30g	"	227g	200
Mugil spp.	30	"	229g	400

Table 4 - Fish fed with fresh poultry manure from 300 layers supplemented with wet brewery spent grain at 5% body weight of fish with initial application of NPK 15.15.15 fertilizer after seepage control in 1985. Pond A 1 ha.

Fish spp.	No. of Fish Stocked	Av. Wt. At Stocking	Culture Period	Av. Wt. At Harvest
T. guineensis	5000	50g	5 months	230g
Chrysichthys spp	2000	45g	5 months	185g

Table 5 - Fish fed with fresh poultry manure from 300 layers/ wasted mash supplemented with wet brewery spent grain at 5% body weight of fish in October, 1985 - May 1986. POND B 1 ha. after seepage control.

Local Fish Stocked	Introduced SPP. Stocked	No. of Fish Stocked	Av. Wt. At Stocking	Culture Period	Av. Wt. At Harvest
T. guineensis	=	5000	75.6g	8 months	277g
Chrysichthys spp.	=	2000	40.4g	-do-	152g
Citharinus+	=	800	30g	"	240g
-	Clarias lazera*	210	30.3g	"	731g
-	Heterotis niloticus*	850	90.8g	"	908g
-	Channa obscura*	400	26.2g	"	363.2g

\+ Captured from the wild by trapping them in ponds

* Fresh water species introduced for trial from the wild

If all imputs are supplied now that the seepage is under control, our projected production figures are presented in Table 6 below:-

Table 6 - Fish : Polyculture 6 months culture period in Production Pond

Species Stocked	Stocking Rate/ha.	Yield in kg/ha.	Selling Rate/kg	Income
Tilapia guineensis	5000	1000	₦5.00	₦5,000.00
Chrysichthys (mixed)	1000	180	6.00	1,080.00
Clarias lazera	4000	2500	7.00	17,000.00
Heterotis niloticus	2000	1600	5.00	8,000.00
T. guineensis fingerlings	-	(8,000 in number)	15k each	1,500.00
	12000	5,280kg		34,580.00

Annual production = 5,280kg x 2 = 10,560kg

Gross Annual Income/ha. = ₦34,580.00 x 2 = 69,160.00

Gross Total Annual Income from 4 ha. production ponds =₦276,640.00

Annual T. guineensis fingerling from 3 earthen ponds

(500m², 800m² and 900m²) = 300,000 @ 15k = ₦45,000.00

Total Income: = ₦321,640.00

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Table 7 - Chickens (Layers)

No. of birds	Av. Egg production per day (55%) in crates of 30 eggs/ crate	Selling Rate/Crate	Daily Income
900	490 eggs, 16.3 crates	₦7.00	₦114.10

Annual egg production = ₦114.10 x 30 x 12 = ₦41,076.00

Sales of old layers (less 3.3% mortality) (870 x ₦10.00) = 8,700.00

₦49,776.00

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SUMMARY OF INCOME

1. Fish Income : ₦321,640.00
2. Poultry Income : 47,776.00

369,416.00

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Table 8 - Cost of Production - Fish/Poultry:

Annual operating budget fish/poultry = ₦105,600.00

Staff cost = 57,500.00

Total = 153,100.00

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Note: Poultry Section

a) Poultry mash 4½ daily @ ₦18.00
1 year = 30 x 12 x 4½ x ₦18.00 = ₦29,160.00

b) Drugs = 1,200.00

c) Labour: 2 Attendants @ ₦1,602/annum = 3,204.00

d) Miscellaneous = 1,000.00

e) 900 point of lay birds @ ₦12.00 = 10,800.00

= 45,364.00

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FISH SECTION

Fish/Poultry - Poultry cost

= ₦105,600.00 - ₦45,364.00 = ₦60,236.00

SUMMARY OF OPERATING COST

1. Fisheries	=	₦60,236.00
2. Poultry	=	45,364.00
3. Staffing	=	57,500.00
Total	=	₦153,100.00

SUMMARY

Gross Total Annual Income	=	369,416.00
Gross Total Annual Operating cost	=	153,100.00
Net Profit	=	₦216,316.00

COMMERCIAL CAGE FISH CULTURE

by

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INTRODUCTION

Fish Cage Culture is the art of growing fish from seed to marketable size in cages. There is no controversy about the feasibility of growing fish in a confined environment as growing fish in fish ponds is a well-known aquaculture practice in this Country. The difference between cage and pond is that they are different types of agents of confinements, otherwise, the principle is the same.

This paper, therefore, is not faced with the problem of rationalising the growing of fish in cage. The object here is only to show the reasonableness of committing hard-earned money in cage fish farming with a profit motive in view. In other words, to what extent can it be an attractive venture to the enterpreneur; to what extent can the nation rely on large-scale cage fish culture for the solution of her fish supply situation?

The use of cages to rear fish in inland waters is an increasingly popular method of fish culture involving relatively low initial costs and simple technology and management methods 1. Fish cage culture can be considered as an advanced type of aquaculture; its productivity is 10 to 20 times higher than that of pond culture for comparable inputs and area 2. The robust confidence of this paper has been partially derived from these two excerpts.

The FAO has organised series of seminars and workshops on cage fish culture with a view to promoting the concept in the tropical countries where it thrives well in warm waters and with tropical species. Above all, this paper will derive extensively from the empirical experiences of Companies, Organisations and Research Centres engaged in Cage Fish Culture in Nigeria and elsewhere with encouraging results. This has to be so because usually in many cases theoretical possibilities differ from the actual.

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1. FAO/UNO Fisheries Technical Paper 255. (Abstract)

2. Green Revolution Programme of The Federal Department of Fisheries - An Occasional Paper GRP/P.2.

With competing demands on land space, water-based fish culturing technique is bound to lead to a reduction of pressure on land resources. Increased attention is therefore being focussed on fish cage culture in many parts of the world. Scientific Fisheries Development is de-emphasising catches as a means of fish supply as it is a depletion of natural resources and cage culture is one of the veritable alternatives.

ORIGIN

The origin of cage culture, like other types of aquaculture, is traced to Southeast Asia, Kampuchea, to be precise, where fishermen in and around the Great Lake region would keep Clarias spp. and other commercial fishes in bamboo cages and baskets until ready to be transported to market. This dates back to about 1910. From there it spread to Vietnam, Thailand, the Philippines and other Indo-Chinese Countries.

Back in Nigeria cage culture, in an informal manner, can also be seen from a hindsight. From time, local fishermen have been used to holding stock of fish for market in baskets and cages made of bamboos, ribs of raffia palm fronds and canes and immersed in water for preservation. It was soon observed that after some days some shed weight while others died due to starvation. The need therefore arose to feed the fish using fruits of oil and rafia palms and remnants of food from the kitchen. With time, they showed signs of fattening or at least maintained their weight for a good market value.

This time-worn practice is still current among our local fishermen while the practice in Asia metamorphosed into a national policy on increased fish production.

MODERN CAGE CULTURE METHODS

A growing emphasis on fish culturing using cages received an impetus as it spread to many countries particularly in Europe, Asia, Africa and America undergoing modernisation in its trail. Cages of various types of structures and materials are now in use.

The rustic wooden and bamboo cages buoyed with empty drums are being replaced with industrial materials considered more durable. In all but a few areas, new materials such as nylon, plastic, polythene and steel mesh which, although much more expensive, have superceded wood and bamboo. These cages are buoyed with sleek floats of metal, plastic or styrofoam. Cages can be floated on walkway floating logs uch as astonia and corkwood.

There are also non-floating cages staked to the base of the river or sunk in water but these are not only difficult to manage but are easily destroyed by floods, so they are unpopular.

For fishculture in saline water plastic, glassfibre and rubber materials which are rustless are ideal. Cage culture can therefore be carried out both in fresh water and saline water.

THE PROJECT CONCEPT

Cage culture project therefore involves the culture of culturable species in cages. Like pond culture, it is a type of enclosure culture and involves holding organisms captive within an enclosed space while maintaining a free exchange of water and feeding the organisms intensively with rich artificial feed to attain an accelerated growth rate. The cages are of varying sizes and are arranged in modules (a unit module consists of 6 - 10 cages). In each module the cages are arranged in a staggered manner to ensure that each cage receives fresh water without interruption. For purpose of security and scenery the cages are enclosed within floating logs which are linked together by means of planks. These logs also serve as walkways to facilitate feeding and harvesting of fish. In the absence of walkway logs, the staggered cages are linked together by marine ropes or chains and moored to the shore or anchored to the bed of the river at intervals. Feeding and harvesting are done from dug-out canoes.

The abundance of aquatic systems in Nigeria which are in most parts serene and unutilised either in whole or in part makes cage fish farming a very viable proposition. These systems include rivers, lakes, bays, streams and dams. Surveys conducted by the Federal Government reveal an abundance of water bodies that can be put into productive use for cage fish farming. The maritime states apart, many of our inland states have lakes and dams which are even more ideal for cage culture as they are free from plying commercial water crafts.

The success of commercial cage fish culture is predicated on a number of factors:-

(i) Durability of cage material.

(ii) Adequate security.

(iii) Site selection.

(iv) Feed and feeding.

(v) Availability of fish seed or fingerlings.

(vi) Post-implementation management.

Cage Material

In order to attract meaningful investment in cage culture, the durability of the cage material is certainly of serious consideration. Otherwise investment will be risky. In this regard the experiences of practised hands will be pertinent. In an effort to reduce initial capital outlay, we may run into devastitating losses. Some people are apt to quote the practice in the Philippines in particular where, inspite of the many advantages of using other more durable materials bamboo is still the most commonly used construction material for cage frames due principally to its comparatively low price and easy availability. Their conditions and experiences in sub-tropical waters may not be the same as ours. In our local situation where destructive muskrats and other carnivorous aquatic creatures abound in our water, the use of bamboo cages seems precarious. A typical cage site environment presents a picture of carnivores locking around ceaselessly not only to eat the flow-off feed from the cage but are attracted by abundant fish concentration in the cage. There is infact a mass migration of these creatures to such sites. Their task is to try hard to destroy the cage. From within, with a build-up of conserved energy, adult fish in cage exhibits a militant attitude of aggressive revolt against captivity. This two-pronged potential danger from within and without is a serious threat to cages of ephemeral materials. In 1983 the Niger Delta River Basin Rural Development Authority in Port Harcourt invited some Filipino experts to install and manage cage fish farms. Importing their own practice from a sub-tropical country these experts set up bamboo cage fish farms. The failure of the experiment is still fresh in our memories; the bamboo cages gave way and fish found their way back into the wild.

Easily available are welded metal mesh materials which are certainly more durable and have a longer life span. The mesh size should be such that there is a free flow of water through the cage, but small enough not to allow in fry from the environment. Cage culture is predicated on the advantages of growing fish in its natural environment where there is sufficient oxygenation in a free flowing water. Meshed materials of 1/4" to ½" size are ideal. The arguement against metal is its low resistance to rust and corrossion. Indeed metal materials even when galvanised can show signs of rust and depreciation in a matter of months. On the other hand an adequate marine treatment with rust-oleum or tar over red oxide will hold back rust and corrossion for many years.

Security System

The cage is enclosed in all sides with a lockable top leaving a trap hole from where the fish is fed and at times observed. The top cover is perforated to further ensure sufficient light and ventilation. Each module of installed cages is linked together so that it is not easy to float the cages

away under the restricted freedom available to the intruder.

Security is further reinforced by the use of the services of security guards at night while the farm attendants provide security in the day. Sociologically, cage farms located in riverine village setting have a good chance of being free from poaching and vandalism even without being policed at night.

Prospective investors have instinctively expressed the fear of loss of stock to predators. Admittedly, cage farms seem to act as a magnet to a wide range of both obligate and facultative fish-eating vertebrates particularly in the tropical waters. Common among these are Gymnarchus niloticus Crocodiles, snakes, muskrats. Many of them migrate into an area where a fish farm has been established attracted by the concentration of fish and also by the flow-off of feed from the cages. This fear calls for the use of durable materials for cage construction. It is against this background that bamboo and cane materials are suspect in providing the desired security.

Site Selection

A good survey needs to be carried out before deciding on cage farm site. The following factors will govern the choice of site.

(i) Areas affected by toxic industrial, domestic or agricultural pollution should be avoided.

(ii) There must be sufficient exchange of water through the cage to provide sufficient oxygenation, and wash away waste products and uneaten food. Water velocity must be between 10 - 150cm per second but not too strong to cause unnecessary loss of feed or dislocation of the cage from position.

(iii) Site for aquaculture generally must exhibit pH ranges of between 6.8 and 8.0 which are most suitable for optimum growth of fish and the water medium must ensure that dissolved oxygen concentration is at least between 2 - 5 mg/l This is the range acceptable by most freshwater fishes.

(iv) The site must be located in areas protected from strong wind action and water current caused by floods or run-off.

(v) It is necessary that cage farms should be sited where there is no extensive human action and away from the routes of water crafts. Nigeria is blessed with an abundance of water bodies which are in most parts very serene and entirely unutilised.

Feed and Feeding

The basis of the concept is to save fish the task of scavenging for food, concentrate them and feed them intensively inorder to achieve an accelerated growth rate. The operative thing here is feed and feeding. Unlike pond or pen situation where fish held captive can feed on natural food in form of plankton and detrital production, these are not available to fish in cages more than the little quantity clogging around the cage and which of course are cleaned off to allow a free flow of water. Experience has however shown that a natural situation for development of algae in the feeding tray can be created. The use of rich artificial feed is a sine qua non for the success of cage culture. The protein content of such feed must be high enough and balanced with sufficient energy for effective protein conversion. The idea is to be able to grow fish to reasonable market size between four and five months. Cost of feed will certainly raise the operating cost but the effect of good feeding is geometric in output and will certainly not exceed 15 - 20% of the farm gate value of the fish. The commercial fish farmer must rely on a balanced artificial feed inorder that the advantage of the concept can be fully realised. A good feeding rate to suit the size and age of fish should be worked out beginning from about 5% of body weight to 2% in adult stage. Intensive feeding also means that fish should be fed two or three times daily.

Fish Seed

Common to all aquaculture practices is the need for easy availability of fingerlings in sufficient quantities to stock the farm. Some companies in Nigeria now engage in fish seed multiplication. The only problem is to know where to find them and which brings into focus the need for both aquaculturists and nursery operators to publicise their activities. Attention should also be focussed on producing fish fry from good quality and fast-growing broodstock. The use of slow-growing fry for production puts the farmer's business in jeopardy. Hybridised stock is most ideal for culturing in cage. Female stock are less ideal as reproduction affects their food conversion effeciency adversely. Cages can be effectively used in fry production particularly Tilapia.

Post-Implementation Management

The management technique involved in cage culture project, though simple, demands a great deal of conscientiousness as this will determine the profit level. Attendants should be up and doing and must ensure that the cage is observed regularly to detect mortality and the presence of predators (although rare). Cleaning of cage walls should be regular. Feeding must be done regularly in accordance with the planned rate and regime. Any mortality must be traceable to its cause and which should be immediately attended to. For

example, mortality due to pollution calls for the possible relocation of the module or modules until things become normal. Unlike pond culture, fish should be carefully observed for biological problems. The fish is expected to grow. Regular weighing should determine this and anything otherwise should call for an immediate attention. Normally, weight differential is inevitable but marked weight differential should be traced to its cause such as under-feeding with the result that the more active ones monopolise the available feed; they grow fast while the weaker ones suffer starvation.

The Farm Manager should be available to monitor the activities of the Attendants. Attendants should be equipped with a diving kit for intensive observation of the cage and fish in water and to protect himself against predators in a large cage farm. A kit will include a mask, snokel, swim suit, divers-knife, gun and fins.

CULTURABLE SPECIES IN CAGES

Experience has shown that species which respond to the use of artificial feed are preferable for culturing. Other factors that must be considered along with the above are:

(i) Market acceptance.

(ii) Easy availability of fish seed.

(iii) Ability to perform well under high density stocking.

(iv) Good growth-rate and diseases resistance.

(v) Easy handling.

Based on the above factors, Clarias, Tilapia, Silver cat-fish, Common Carp and Synodontis spp. are recommended for cage culture. While for all the above species a sufficient free board must be maintained, for Tilapia in particular, the freeboard should not be less than 1 foot to allow sufficient ventilation and light.

Heterobranchus has a very high growth-rate in cages. When grown on a large scale it will lead to a very high profit-ability of the farm. It performs very well on artificial feed in cages. Its market value is high. Nursery operators who engage in multiplying this fish could have a commercial field day. The Silver catfish which thrives better in clean environment is also another good species for cage culture.

STOCKING LEVEL

In the Asian countries, stocking level of fish in cages is very high indeed and this is to increase the profitability of the venture. Fish chosen for culturing must therefore be able to perform well under high density stocking.

However, care must be taken not to over-stock as this could lead to mortality and staunted growth. It must be understood that a marginal increase in the stocking level means a corresponding increase in variable costs of feed and fingerlings and vice-versa. The extent to which very high density stocking increases profitability must not be exaggerated therefore. At the same time, the cage should not be understocked. Stocking level will be related to waterflow through the cage in maintaining food and oxygen and size of fish and cage. Academic postulates on stocking levels have not proved exact. Appropriate stocking levels should therefore be on trial and error basis.

ADVANTAGES OF CAGE CULTURE

Mobilisation period before the take-off of operations in cage culture is very short; take off is almost immediate as soon as the cage is purchased. This will affect amortisation period of capital to the advantage of the cage farmer. Capital outlay is low and elastic.

This country is blessed with abundant reservoirs of water that can be utilised to produce abundant fish for the nation nor is the environmental impact of cage culture farms noticeable.

While considerable fish kills are experienced in pond culture due to pollution, collapse of oxygen, changes in temperature and flooding etc. Cage culture employing natural water systems in well located areas with adequate water renewal and stable temperature increases survival and growth rates. It is true to say that while mortality rate can be as high as 20% in pond culture, it could be less than 5% in cage culture.

The maximum utilisation of balanced feed and feeding technique and other management techniques portrays cage culture as a very serious-minded culture system leading to an early realisation of objective, namely, accelerated growth, quick turnover and early amortisation of capital.

Equally serious in pond culture is the problem of cover recovering stock. Some species of mudfish family dig far into the mud in the base and in the wall of "chikoko" dykes with the result that usually, more than 30% of stock are not recovered in a harvesting operation. In cage culture, harvesting is completed, infact the cage can be "turned out" to recover the very last fish.

ESTIMATED COSTS/RETURNS

Capital Expenditure (two-yearly stocking)

		₦
a)	30 floating cages (Mifcol brand) with 30 feeding trays, (4'x4'x4' @ ₦1000/Cage	30,000.00
b)	12,000 fingerlings of Heterobranchus 400/cage at 80k/x2 per fingerling	19,000.00
c)	4 tonnes of Mifcol feed at ₦1700/ton x 2	13,600.00
d)	1 dug-out canoe	100.00
e)	1 weighing scale	60.00
f)	1 dip scoop net	30.00
g)	2 plastic basins	20.00
	Sub-Total	63,010.00

Personnel Costs

a)	2 Guards at ₦1440 each per annum	2,880.00
b)	1 Fisherman/Attendant per annum	1,440.00
c)	1 Supervisor ₦2400/per annum	2,400.00
	Sub-Total	6,720.00
	ESTIMATED TOTAL EXPENDITURE	69,730.00

*Cost of feed is related to its quality which could be variable. This rate works out at 0.50k per fish. Feed for cage culture should be of high protein content.

ESTIMATED OUTPUT

(Two-yearly harvest)

12,000 x 2: 24,000 less 5% mortality: 22,800

1kg/per fish/per six-monthly harvest

₦8/per kg of fish:

$\frac{22,800}{1} \times \frac{8}{1}$: ₦182,400.00

Annual profit (₦182,400 - ₦69,730 = ₦112,670.00

One Hundred and Twelve Thousand, six hundred and seventy naira.

SUMMARY

With increasing emphasis on aquaculture as an alternative to dwindling artisanal fishing and scarce foreign exchange for fish import, cage fish culture from the foregoing, is a more profitable aquaculture practice than pond culture. It appears one of the most viable business ventures for business men and women and with minimum risks. It is a highly recommendable project.

The Federal Government should be commended for the interest it has shown in the promotion of Cage Fish concept.

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SHOPPERS' GUIDE:

Available Items

Tilapia Hybrid (fingerlings).

Clarias lazera (fingerlings).

Rust-Oleum.

Diving Kit (mask, snokel, fins, diving knife and gun, diving suit).

Mifcol Fish Cage.

Mifcol Complete Fish Feed.

Contact: Midland Industrial Fisheries Limited,
9, Ogbeide - Ihama Avenue,
Off Joromi Road, Ekenwan Road,
Benin City.

Postal Address: P. O. Box 1967,
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COMMERCIAL AQUACULTURE IN NIGERIA: A VERTICALLY INTEGRATED APPROACH IN THE COMMERCIAL FRESHWATER FARMING OF TILAPIA IN FLOATING BAMBOO NET-HAPAS AND CAGES SYSTEMS

by

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ABSTRACT

Tilapia once termed "poor man's" fish, still remains as the highly-priced food fish in many developing countries. The good attributes of this fish prompt its use in intensive aquaculture vertically integrated systems (VIS) which embrace broodstock development, hatchery/nursery and growout phase. Based on the series of studies carried out at Kainji Lake Research Institute using Oreochromis (Tilapia niloticus) in floating bamboo hapas/cages, the recommended intensive modular systems were estimated to be capable of producing 4 million Tilapia fingerlings and 729 tons fish (Market-size) annually. Cost-benefit analysis showed the venture to have high prospects. It is recommended that priority be given to Tilapia cage culture at the national level in order to contribute immensely towards increased fish production.

INTRODUCTION

Aquaculture is a very old and highly productive management practice with a history of at least 4000 years (about 42 years in the case of Nigeria). In aquaculture, a great variety of animals and plants are cultured, and considering the scale of production, some can be called industrial enterprises, while small scale fish farming is of special importance to villagers and farmers. In Nigeria, commercial aquaculture both at small and large scale is yet to become popular. Some of the major constraints that can be attributed to this situation of relatively little support and attention for aquaculture in Nigeria were identified by Otubusin, (1983).

In Nigeria, pond culture of fish is by far the commonest known aquaculture system. Other more highly production systems like cage, enclosure, pen, raceway are either in the experimental stage or not practised at all. In this pond culture system, Tilapia is the most commonly cultured fish species in spite of its prolific characteristic which results in production of a large volume of small-sized fish attracting

little market value. Despite this prolific characteristic, Tilapia still remains as the highly - priced food fish in many African countries (where it is endemic). It is also popular in Asia and successfully marketed in countries such as the Philippines, England, Belgium, the U.S.A. and Mexico.

Even though Tilapia was formerly rated as "poor man's" fish especially for the developing countries, it is fast realising its true value as a fine, firm-fleshed quality product. Since this fish species breeds easily even in net-hapas (Otubusin and Opeloye, 1985), feeds very low in the food chain, grows fast, can be confined at a high density and can be manipulated genetically for improved productivity, it is considered that Tilapia can be named Nigeria "national fish" especially for the commercial cage culture system. In order to permanently combat the well-known constraint of inadequate supply of high quality and quantity fingerlings (Tilapia), it is proposed in this paper that a vertically-integrated approach be followed for the commercial farming of Tilapia in the floating hapas/cages system.

The Vertically-Integrated Approach

The vertically-integrated floating bamboo net-cages/hapas culture system technology being practised at the Kainji Lake Research Institute involves a complete manipulation of all stages of the life of the species (Tilapia) for the purpose of increasing production. These stages are: broodstock development, hatchery, nursery, and grow out phase. The Tilapia breeders spawn in the floating hatchery hapas; the fry are transferred to the nursery hapas till fingerling-size and the fingerlings are finally cultured to marketable (table) size in net-cages; all in a series of modules of hapas and cages (Figs. 1 and 2).

A series of studies using Oreochromis (=Tilapia) niloticus in broodstock development, breeding (hatchery and nursery) and farming to table size was carried out at Kigera III reservoir and Shagunu Bay, along the western portion of Lake Kainji in order to arrive at this vertically integrated Tilapia cage culture system. (Otubusin and Opeloye, 1984 and 1985). In this system, there is a continuous flow of stock viz: brooders -> fry -> fingerlings -> marketable size -> brooders, applying the intensive modular aquaculture systems method.

Operational Aspects

These aspects will elaborate on the different phases operated in the Tilapia vertically-integrated system (TVIS). A slightly eutrophic water is ideal for TVIS in order to drastically cut down on cost of fish feed.

lake. A total fish yield of 729 tons is expected from the 50 grow-out modules annually (i.e. 14.58 tohs/module/year or 3.645 tons/cage/year) (Table 1).

INVESTMENT PROSPECTS

Table 1 shows the cost benefit analysis of operating the vertically integrated Tilapia production in floating hapas/ cages system. The total loan (input) required is ₦1,195,810 in the first year of operation with a return on investment (after company tax deduction) of 13.7%. This is quite low because only one cropping of the grow-out phase will be possible in the first year of operation. Subsequent years will give higher return on investment. This system was estimated to be capable of producing about 15 tons of market-size Tilapia per week. The personnel needs of this TVIS include one (1) Farm Manager, one (1) Fisheries Superintendent and five (5) daily paid labourers. Casual labour will be taken when needed especially during harvesting. This system is designed in such a way that the hatchery/ nursery will supply fingerlings to the grow out phase, while high quality breeders can be sorted out from the grow out phase for stocking the hatchery hapas. From Table 1, there will be a surplus of 800,000 fingerlings. These can be sold out as additional revenue. So also spent breeders can also be a source of additional revenue.

DISCUSSION

Raising fish in cages has already been identified as possible alternative towards increasing fish production. Tilapia, endemic in Nigeria and many parts of Africa has been widely cultured in several aquaculture systems including cages. It has tolerance for an extremely wide range of water conditions, grows and breeds rapidly. These qualities have led to the proposal of using Tilapia in a vertically-integrated system for maximum utilization of resources (modules of hapas and cages, the stock of fish, labour etc).

The investment prospects from this culture system using Tilapia is quite high. The market for fresh fish in Nigeria is really high but the supply runs far short of the demand. Establishment of large scale vertically-integrated Tilapia systems will in fact be the beginning of the hitherto neglected Tilapia industry towards increased fish production, foreign exchange conservation, fish export promotion and overall integrated rural development.

CONCLUSION

Tilapia have been likened to chickens because the latter unlike other major animal food commodities, can be mass produced from eggs, intensively farmed in tiers in three dimensional "batteries" and can convert plant products into animal protein at a very efficient and economical 2: 1 ratio

(Maclean, 1984). Tilapias, like chickens, are a source of low-priced animal protein. Both (Tilapia and chickens) can be farmed highly profitably in a variety of situations from backyard enterprises to high-technology systems (e.g. TVIS). The potential for genetic improvement in Tilapias is enhanced by their ease of hybridization. Tilapia yields of 600-800 tons/hectare/year are now attainable as a result of early genetic research coupled with intensive farming technology. This yield is comparable to 729 tons/50 modules (1800m² total surface area)/year estimated as obtainable from the grow-out phase of the TVIS. But a higher yield of 10 times or more is actually possible in cages stocking these hybrid Tilapia seeds. Maclean (1984) opined that given the growing popularity of tilapia, it is now feasible to project that even using present research results, annual world aquacultural production of these fish (Tilapias) can attain 2,000,000 tons. It is recommended that priority be given to this project (Tilapia cage culture) at the national level in order to contribute immensely towards increased fish production.

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		AMOUNT/(₦)/YEAR				
I	HATCHERY/NURSERY					
	i 50 modules of 16 unit hapas (hatchery)	45,000	–	–	–	–
	ii 50 modules of 16 unit hapas (nursery)	45,000	–	–	–	–
	iii Tilapia breeders (220/module) 3 sets ₦1.00/breeder	33,000	33,000	33,000	33,000	33,000
	iv Feed (from industrial & Agric waste s)	10,000	10,000	10,000	10,000	10,000
	v Maintenance & Repairs	4,500	4,500	4,500	4,500	4,500
	vi 20% depreciation on infrastructure	18,000	18,000	18,000	18,000	18,000
	vii Miscellaneous	15,550	15,550	15,550	15,550	15,550
	Total for hatchery/nursery	171,050	81,050	81.050	81,050	81.050
II	GROW-OUT PHASE					
	i 50 modules of 4 unit cages/module	175,000	–	–	–	–
	ii Fish seeds (3.2 million, 2 crops) 10k each	320,000	320,000	320,000	320,000	320,000
	iii Fish feed (364.5 tons)	364,500	364,500	364,500	364,500	364,500
	iv Maintenance and Repairs	12,500	12,500	12,500	12,500	12,500
	v 20% depreciation on infrastructure	35,000	35,000	35,000	35,000	35,000
	vi Miscellaneous	90,700	90,700	90,700	90,700	90,700
	Total for Grow Out Phase	997,700	822,700	822,700	822,700	822,700
III	GENERAL					
	i Staff Salary	19,200	19,200	20,700	20,700	22,200
	ii Casual labour	5,400	5,400	5,000	5,400	5,000
	iii Miscellaneous	2,460	2,460	2,610	2,610	2,760
	Total for Grow Out Phase	27,060	27,060	28,710	28,710	30,360
IV	TOTAL COST OF OPERATION (I + II + III)	1,195,810	930,810	932,460	932.460	934,110
V	REVENUE					
	i Sale of 4.0million fingerlings at 10k each	400,000	400,000	400.000	400,000	400,000
	ii Sale of table size fish 729 tons at ₦300/ton	1,093,500	2,187,000	2,187,000	2,187,000	2,187,000
	iii Total Revenue	1,493,500	2,587,000	2,587,000	2,587,000	2,587,000
	iv Total operational cost	1,195,810	1,195,810	1,195,810	1,195,810	1,195,810
	v Gross Profit	297,690	1,391,190	1,391,190	1,391,190	1,391,190
	vi Less 45% Company Tax	163,730	765,155	765,155	765,155	765,155
	Return on Investment	13.7%	64.0%	64.0%	64.0%	64.0%

* Based on the following:

1. Production period:- 10 months for hatchery/nursery
   :- 5 months (2 crop/year) Growout.

2. Expected life span of hapas and cages 5 years

3. Stocking density :- 12 Breeders/hapa and 1,000 fry/hapa and 62.5% survival from fry to fingerlings

:- 300 fish/m^3, 300g/fish at harvest and 90% survival from fingerlings to table size.

4. Only 22.5m^3 of the cage volume used

5. 8000 fingerlings actually stocked/cage/crop to allow for stocking mortality

6. Part of miscellaneous expenses is for scoop nets, buckets, antipoaching equipments etc.

7. One crop from growout phase during year 1, but 2 crops in subsequent years.

A DESIGN FOR COMMERCIAL PRODUCTION OF CATFISH (Clarias lazera) IN MULTIPLE CAGES

by

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INTRODUCTION

Cage fish culture is defined as the rearing of fish stocks, generally from juvenile to market size, in a totally enclosed water volume through which a free water circulation is maintained (Coche, 1982). Together with raceway and tank culture, fish culture in cages constitutes an intensive rearing system that is perfectly adaptable to commercialization. Of the intensive systems mentioned, however, it has the least initial capital cost. The cages are normally constructed with locally available materials and can be set up in most water bodies without any special arrangement as would be necessary for tanks or raceways. Ita, et. al. (1985) prepared a checklist of inland water bodies in Nigeria. Most of these water bodies are not put into any economic use and can be utilized for cage culture, thus reducing the pressure on land resources. Land-based aquaculture is limited to the availability of land near sources of adequate and suitable water supply. In cage culture, there is optimum utilization of artificial food for growth, reduced fish handling and mortalities, and complete harvest of fairly uniform product.

The history of cage culuture can be traced to Southeast Asia, where, according to Beveridge (1984), it originated as a traditional method used by fishermen to keep commercial fishes in bamboo cages and baskets until ready for transport to market. In captivity, the fishes were fed kitchen scraps and were found to grow well. The practice was on for years in Kampuchea and Vietnam (Beveridge 1984). Cage culture has since moved from the era of a holding device for fishermen's catches to a highly efficient method of growing fish to marketable size. Chan (1977) described the design and construction of floating marine fish cage in Hong Kong. Sodikin (1977) and Teng, et. al. (1977) did so for Indonesia and Malaysia.

Cages and enclosures of different designs have been developed in recent years and successfully used Salmons (Oncorhynchus, Salmo), trout (Salmo spp), channel catfish (Ictalurus) and yellowtail are the most commonly used species for modern cage culture (FAO, 1976). A production rate as high as 173kg/m³ has been reported for Channel catfish in the United States of America (Collins, 1972). Cage culture trials have been carried out in Egypt (Ishak, 1979), Tanzania (Ibrahim 1976), Ivory Coast (Coche 1977, 1979) and Kainji Lake (Konikoff, 1975; Ita, 1976). In all the cases, the conclusion was that this system was potentially suitable for intensive culture of fish especially the tilapia.

The use of the catfish (Clarias lazera) in cage culture does not appear to have been so well investigated. As cage culture is becoming more and more important in awareness and as Clarias lazera is a choice species that can be used in this culture method, it is necessary that relevant practical information be made available.

The dual purpose of this paper is first, to report on preliminary study on the appropriate economical feeding rate which would enhance the growth of catfih (Clarias lazera) in cages, and secondly, the paper serves to introduce a design of a practical floating platform that can be used for culture of fish in multiple cages. Feed cost is the single highest annual production cost in cage culture averaging over 55% (FAO, 1976). Feeding rate therefore should be at the economic level. Balarin and Hatton (1979) reported Moriarty and Moriarty (1973) as having developed a formula for the feeding rate which they successfully used to feed Sarotherodon niloticus in cages in Lake George, Uganda. No such relationships have been evolved for cage culture of Clarias lazerá.

MATERIALS AND METHODS

The Floating Platform

The study was carried out at the Lyi-ojoo Lake, Nike a few kilometers from the Anambra State Capital, Enugu. A floating fish farm has been established there by the State Ministry of Agriculture using platform and cages described in this study.

Figure I shows the design of the platform which is made of wooden planks mounted on sealed empty oil drums which provide the floatation. The planks are hardwood with the normal dimensions of 1" x 1ft x 12ft. They are arranged as shown in the figure, such that 20 cages can be carried at a time as well as four working men. Attachment of each drum to the platform is achieved by means of three 3" belts which have been welded on to the drum and passed through holes drilled at the required positions of the wood and then tightened with fitting nuts. The details of the calculations that gave the

number of drums required to float the platform such that the cages will have 0.25m above water, are shown in Appendix I. The calculations show that 18 drums are required. However, it was observed from experience that after a short time, the middle portion of the platform would sag. This was corrected by fixing a row of six extra drums in the middle as shown in figure I. Three extra pieces of planks measuring 6ft. (1.83m) for each ~~of~~ two and 7ft (2.14m) for the third piece were needed for this. The platform including the drums were coated with bituminous black paint, for protection.

When launching into water, the platform is placed such that the side shown as right elevation (Fig.1) is farthest from the shore while the opposite end with double line of planks is nearest the shore. Depending on the shoreline and how far out there is deep enough water, an approach ramp can be attached to the platform. This is in the form of three lines of planks attached to the drums. The length of this approach ramp depends on the distance it has to cover so that the platform is placed where the hanging cages would have good clearance from the water bed. The floating platform is anchored by means of nylon ropes tied to either trees or pipes that are fixed securely on shore.

The cages used in this study were made of 1" angle iron frames and clicken wire mesh sides. The mesh was 1" (25mm) and each cage was 1m x 1m x 1.25m with a bottom made of perforated galvanised sheet and a top of galvanised mosquito proof in a wooden frame. This top is hinged on one side so that the cage can be opened completely or locked with a staple. At the four corners of the cage and at the 0.25m mark from the top, are fixed four loops made of iron rods for use as handles to aid in lifting the cage out of water. To attach the cage to the platform are four springs (each 10cm long) that hook on from holes in the top rim of the cage to spring hooks fixed in the wood of the platform. Water level comes up to the 1m. mark of the cage so that a volume of $1m^3$ is inside water. The cage, like the platform, is coated with bituminous black paint. For this study, the hanging cages were 1.3m clear from the bottom of the lake.

Feeding Rate Study

Clarias lazera fingerlings of 50g. range were collected from the wild and stocked in six cages at the rate of 50 fish per cage. They were fed on NIOMR pellets (of 33% crude protein) at varying ratio levels of 3%, 6% and 9% of fish body weight. The daily ration was applied in two feedings. Two cages were used for one feeding rate and the results averaged for each rate. The fish in each cage were sampled for weight after 28 days by weighing ten randomly selected fish. The estimated fish biomass was then used to adjust the amount of feed applied.

At the end of the experimental period of 55 days, the final measurements were used to compute the following parameters:

(i) Specific Growth Rate $= \frac{\log_e W_2 - \log_e W_1 \times 100\%}{d}$

Where W_1 = wt(g) at stocking

W_2 = wt(g) at end of experiment

d = culture period (days)

(ii) Food Conversion Ratio (FCR) = $\frac{\text{Amt. of feed applied(g)}}{\text{Increase in fish wt(g)}}$

(iii) Protein Efficiency Ratio = $\frac{\text{Increase in fish wt(g)}}{\text{g. crude protein fed}}$

Statistical tests of significance were carried out using Duncan's Multiple Range Tests. The temperature and pH of the surface water of the lake were measured with a mercury thermometer and a digital pH meter, respectively. Working from the platform, the water was collected in plastic bottles and the readings taken within 5 minutes of collection. This exercise was done once a week and the mean values for the period were 25°C ± 1.0 for the temperature and 6.90 ± 0.75 for the pH.

RESULTS

Table 1 shows the results obtained in the study. Survival of the fish at the end of the study period was high with the least value of 98.2% recorded for 6% feeding rate. The specific growth rate (SGR) was highest for the 6% feeding rate and lowest for the 9% rate. The values, however, were not significantly different. The food conversion ratio (FCR) increased as the feeding rate increased. The FCR for 9% feeding rate was significantly different from the rest. The change between the 3% and 6% rates, however, was not significant. The protein efficiency ratio (PER) decreased as the feeding rate increased. There was a significant change between the PER for 3% and 9% rates, but the change between 3% and 6% or between 6% and 9% was not significant.

The relationship between the FCR, SGR and the three ration levels is shown in Fig. 2. From this figure, it can be seen that the optimum ration level under the conditions of this experiment was 6.6%.

Table 1 - Growth of Clarias lazera fingerlings fed at three feeding levels

Daily Feeding Rate % of fish biomass	3%	6%	9%
Initial Average Weight(g)	50.1	38.9	50.1
Final Average Weight(g)	110.9	105.5	101.0
Culture Period (days)	55	54	55
Number Stocked	50	55	50
Number Recovered	50	54	50
% Survival	100	98.2	100
Quantity of feed applied(g)	5,880	10,125	14,940
* Specific Growth Rate SGR) %	1.44^{a}	1.85^{a}	1.27^{a}
* Food Conversion Ratio (FCR)	1.93^{b}	2.76^{b}	5.87
* Protein Efficiency Ratio (PER)	1.57^{c}	1.10^{cd}	0.52^{d}

* Figures with the same subscript are not significant (P = 0.05).

DISCUSSION

Daily Ration Level

There is hardly any available published work on the culture of Clarias lazera in cages. However, the effects observed in this study correspond to the effects on SGR, FCR and PER observed in other species with changing ration levels. Working with Carp fingerlings of about 52g and in circular tanks, Ejike and Ofojekwu (1983) made similar observations using three ration levels of 1%, 2% and 3% body weight. The growth rate was highest near the optimum ration level and declined to both sides of it. The PER decreased with ration size while the ratio of conversion of food to flesh improved in value with lower ration level. Stetfen (1981) in a review of protein utilization by rainbow trout (Salmo gairdneri) and carp (Cyprinus carpio), calculated the data from Huisman (1976) and showed the same trends - the growth rate was highest near the optimum ration level, the FCR increased and PER decreased with ration size. However, Jauncey (1982) in a review of carp nutrition, used the data from Jauncey (1979) to show that at a given temperature, the SGR increased as the ration size increased even up to 9% body weight. He noted, though, that increasing the feeding level resulted in proportionately smaller increases in SGR which suggested that a maximum was being approached. Other authors sited by him had observed that for both sockeye salmon and carp, increasing the feeding rate at any one temperature increased growth up to an asymptote beyond which it remained constant.

The observations made on the SGR, FCR and PER as the ration size increased should be expected from the definition of those parameters. At the low feeding level, there is not enough food for growth and the FCR will naturally be determined as a low quantity. The PER at this low ration level will show high utilization of the little amount of protein present, at least for maintenance. As the ration size is increased, more food is available for growth, the FCR increases in value and PER decreases. Beyond the optimum ration level, there is high induced metabolic rate and consequent reduction in the amount of energy available for growth (Jauncey, 1982). Also, as the meal size increases, the absorption efficiency decreases (NAS, 1983) with the overall effect of less nutrients being available for growth metabolism. Thus the SGR and PER decrease. At the optimum level of the ration, the fish is growing at the rate at which food is being converted to flesh. This then is the economic level of feeding, and in this study the optimum feeding level has been found to be 6.6% body weight given the experimental conditions.

The best feeding rate in cage culture is usually higher than in ponds. This is because, apart from food losses through the cage, the system is by nature intensive and the fish depends almost solely on artificial feeds rather than the natural food in the environment. Phillips et. al. (1983) showed with data from various authors that the FCR

for ponds are generally lower than for cages. For tilapia, Jauncey and Ross (1982), citing Macintosh, (1982) and Macintosh and De Silva. (1982), states that at 28°C, the 50g fish will not accept more than 3% of the body weight. In cages, however, Coche (1979) reports that for tilapia of less than 40g the best feeding rate was 6% of the body weight, and for fish above this size the daily ration should not exceed 4% of the biomass in order to obtain a reasonable conversion rate. Coche (1982) reports the recommendations of other authors for tilapia in cages. For fish of 50g size he reports as follows:

a) Melard and Philippart (1980) recommends 6% reducing to 4.5% for fish in the range 40g-100g.

b) Guerrero (1980) recommends 5% for fish less than 50g. and 4% for fish in the range 50g-100g.

The above recommendations for cages were higher than the 3% for ponds with fish of the same size.

Equivalent data are not available for Clarias lazera in cages, but for pond culture Viveen, et. al. (1986) recommends feeding at 3% body weight for fish in the size range 24g - 55g. Also, NAS (1983) recommends the same 3% of body weight for daily feeding of channel catfish at temperature range of 21°C. Judging from the observations discussed above for tilapia in both cage and pond culture, the value of 6.6% body weight as obtained for Clarias lazera in this study, appears reasonable when compared with the 3% recommended for the species in pond culture.

Commercial Use of the Floating Platform

Published data on cage production of Clarias lazera are not available, unlike the tilapias where a fair amount of information has been published. To assess the usefulness of the platform and cages used in this project for commercial purposes, the production data as known for tilapia can be used. Balarin and Haller (1982) summarized the stocking and production programme for tilapia in cages as follows:

> fingerlings of 20 - 40g stocked with initial biomass of 20kg/m³ reach harvestable size (200g) with annual production rate of 200 - 300kg/m³ and FCR of 2-2.5. Locally, tilapia fingerlings cost one kobo per gramme. Thus 20kg. will be ₦200.00. Shang (1981) showed that the cost of feed per unit of fish production (C_f) can be given by:
>
> $$C_f = R P_f$$
>
> where R = Food Conversion Ratio (FCR) and P_f = unit price of feed.

NIOMR pellets were purchased at about ₦900/tonne. ₦100/tonne should be added for transportation, etc. This brings the price to ₦1000/tonne or ₦1/kg. With FCR of 2.5, the feed cost per unit of fish production becomes ₦2.5/kg. of fish produced. Then for annual production of 200kg/m^3, the feed cost becomes ₦500/m^3.

The materials used for the construction of the platform are as follows:

Material		Quantity
a)	planks (1" x 1' x 12') hard wood	36
b)	sealed drums	24
c)	3 bolts and nuts with washers	114
d)	spring hooks	80
e)	springs (30cm)	19
f)	bituminous black paint	40 gallons

The cost of the above materials and labour for the construction and installation of one platform came to ₦3,000.00 The cost of materials and construction of one cage was ₦350.00, so that for 20 cages the cost was ₦7,000.00. Thus the total capital cost of one Platform with 20 cages was ₦10,000.00. Like other agricultural projects, the bigger the size of the farm, the more economical the venture. It is suggested here that for a good size, a floating fish farm should have at least 10 platforms with 200 cages. This will be at a cost of ₦100,000. The unit of production is one cage or 1m^3. The capital cost per unit of production, therefore, is ₦500/m^3.

The labour required for the maintenance of the farm is put at 4 men earning a total of ₦9,600 per annum. Thus labour cost per unit of production is ₦48/m^3. Assuming loan repayment and other expenditure to be 10% of Capital cost, this comes to ₦50/m^3 per annum.

The best commercial fish farm in Anambra State, is in Anambra Local Government Area and it produces tilapia and other species. Sales are to wholesale buyers who then re-sell in the market. The farm gate price of tilapia in this fish farm is ₦5/kg. The official price list as at July, 1986 issued by the Anambra State Ministry of Trade and Cooperatives shows the market price of fresh fish to be ₦10,kg on the average. Using the figure of ₦5/kg a production of 200kg/m^3/yr will give ₦1,000/m^3/yr.

sing the above considerations, the annual revenue and costs er unit of production(m^3) for the floating fish farm with) platform and 200 cages, are given thus:

. Annual Production Revenue:

roduct	Quantity	Unit Price	Revenue
'ish (Tilapia)	200kg/m^3	₦5.00/kg	₦1,000/m^3

3. Annual Operating Costs

Item of Expenditure	Quantity	Unit Price	Cost	% Total
Fingerlings	20kg/m^3	₦0.01/g	₦200/m^3	25.00
Labour	4 workers	₦2400/annum	₦48/m^3	6.00
Feed	FCR=2.5	₦1.00/kg	₦500/m^3	62.50
Other expenditure (loan repayment, etc)	10% of Capital		₦50/m^3	6.25
Total			₦798/m^3	
		Approx	₦800.00	

C. Economic Indicators

i) Profit/m^3 = ₦1,000 - ₦800 = ₦200/m^3/annum

ii) Return on investment = $\frac{₦200}{₦500}$ x 100 = 40%

iii) Payback period = $\frac{₦500}{₦200}$/annum = 2.5 years.

The indicated payback period is 2.5 years. The materials used for this study can last up to a minimum period of 5 years with little maintenance e.g. repainting of the cages every year. To increase the profit margin, the cages can be made with cheaper materials like wooden frames. Furthermore, the above economic considerations have been done with tilapia which constitute one of the cheapest types of fish in the country. Using a better priced fish species will increase the profit margin. It is therefore suggested that the floating platform described in this paper can be used for commercial fish production in cages.

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Appendix I

Calculations To Get The Number of Drums Required For A Floating Platform

Data Given

i) Drums: diameter = 0.55m, thus radius (r) = 0.275m length of drum = 0.881m wt. of empty drum = 40kg. No. drums required to achieve desired.

ii) Persons (human workers): ave. wt. = 80kg

Maximum of 4 persons at a time i.e.

maximum wt. of human workers = 320kg

iii) Cage No. cages = 20

Each cage made of angle iron (two lengths of 20ft. each. One lenth weights 10kg)

Wt. of each cage = 20kg + 3kg = 23kg

(where 3kg is a tolerant wt. for weld joints)

Then total wt. of cages = 20 cages x 23kg

= 460kg.

Each cage attached to platform such that 0.25m will be above water.

(iv) Platform 34 No. planks (hard wood) 1" x 12" x 12ft

i.e. 1 cu. ft.

£t 33lb/cu.ft., each plank weighs 33lb.

34 planks will weigh 34 x 33lb

= 1122lb

= 510kg.

Calculations

a) To get volume of water displaced per drum:

i) Area of submerged section of drum:

i.e. area of sector CDBA:

AO = (0.275 - 0.249)m = 0.026m

From triangle AOB,

Cor angle AOB = $\frac{0.026}{0.275}$ (i.e. $\frac{AO}{OB}$)

= 0.09455

angle AOB = 84.58 degrees.

Then angle COB = 2 x angle AOB = 169.15 degrees

Area of sector COB x = $\frac{\text{angle COB}}{360}$ x TI x x^2

= 0.112m^2

Now AB^2 = OB^2 - AO^2 = 0.074949m^2

thus AB = 0.274m

CB = 2 x AB = 0.518m

Area of triangle CBO = ½(CB) x AO = 7.124 x 10^3 m^2

Area of sector CB x = Area of sector COBy - Area of triangle CBO = 0.105m^2

X - sectional area of drum i.e. area CDBX = Ti x R^2

= 0.238m^2

Area of sector CDBA = Area CDBX - Area CBX

$= \underline{0.133m^2}$

ii) Volume of submerged section of drum = Area CDBA x length of drum = $117m^3$

iii) An object displaces its own volume in water

∴ volume of water displaced per drum = $117m^3 = 11700\ cm^3$ (c.c.)

b) To get weight of water displaced per drum:

1 cc of water at 4°C weighs 1g. (p.001kg)

∴ 117000cc of water at 4°C weigh 117kg.

c) Weight of water displaced by n drums will therefore be 117n kg.

d) From the principle:

$W_{t.}$ of fluid displaced = downward force.

Total downward force = wt. of water displaced by n drums.

∴ wt. of platform + wt. of drums + wt. of human workers + wt. of cages = wt. of water displaced by n drums.

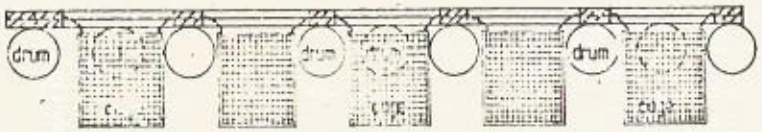
Thus 510kg + 40n kg + 320kg + 460kg = 117n kg

$77n = 1290$

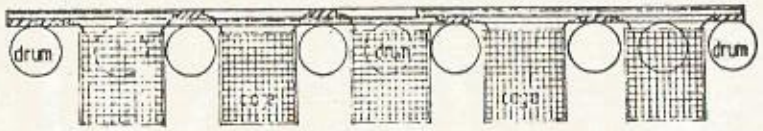
$n = 17$ drums.

To allow for margin of safety and also for symmetry, the number of drums required will be 17 + 1 = 18 drums.

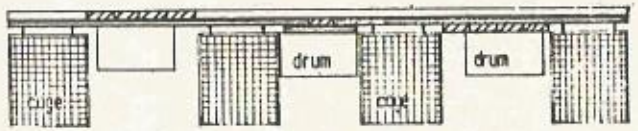
Courtesy of Engr. J. E. Amadi
Engineering Division,
Ministry of Agriculture,
Enugu.



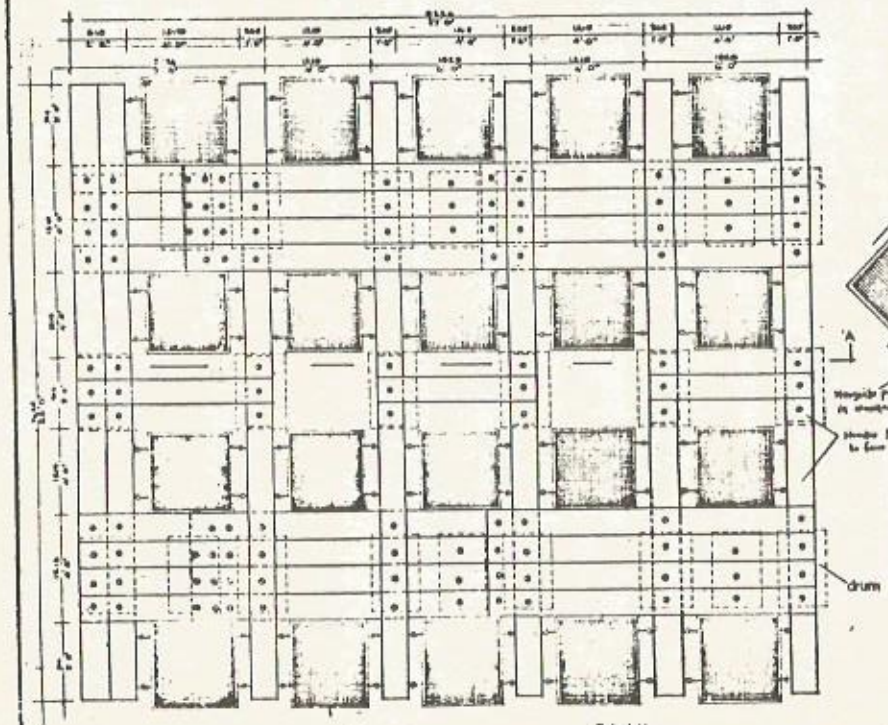
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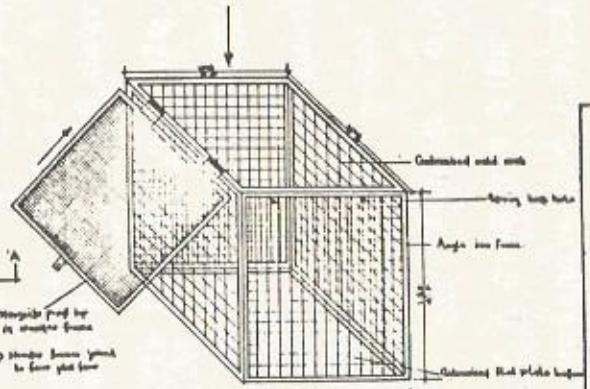
FRONT ELEVATION



RIGHT SIDE ELEVATION



PLAN



A FISH CAGE

MINISTRY OF AGRICULTURE
ENGINEERING DIVISION
ENUGU

FLOATING PLATFORM
FOR FISH CAGES

scale

DESIGNED	C C EMENELU
DRAWN	VICTOR S OKEKE
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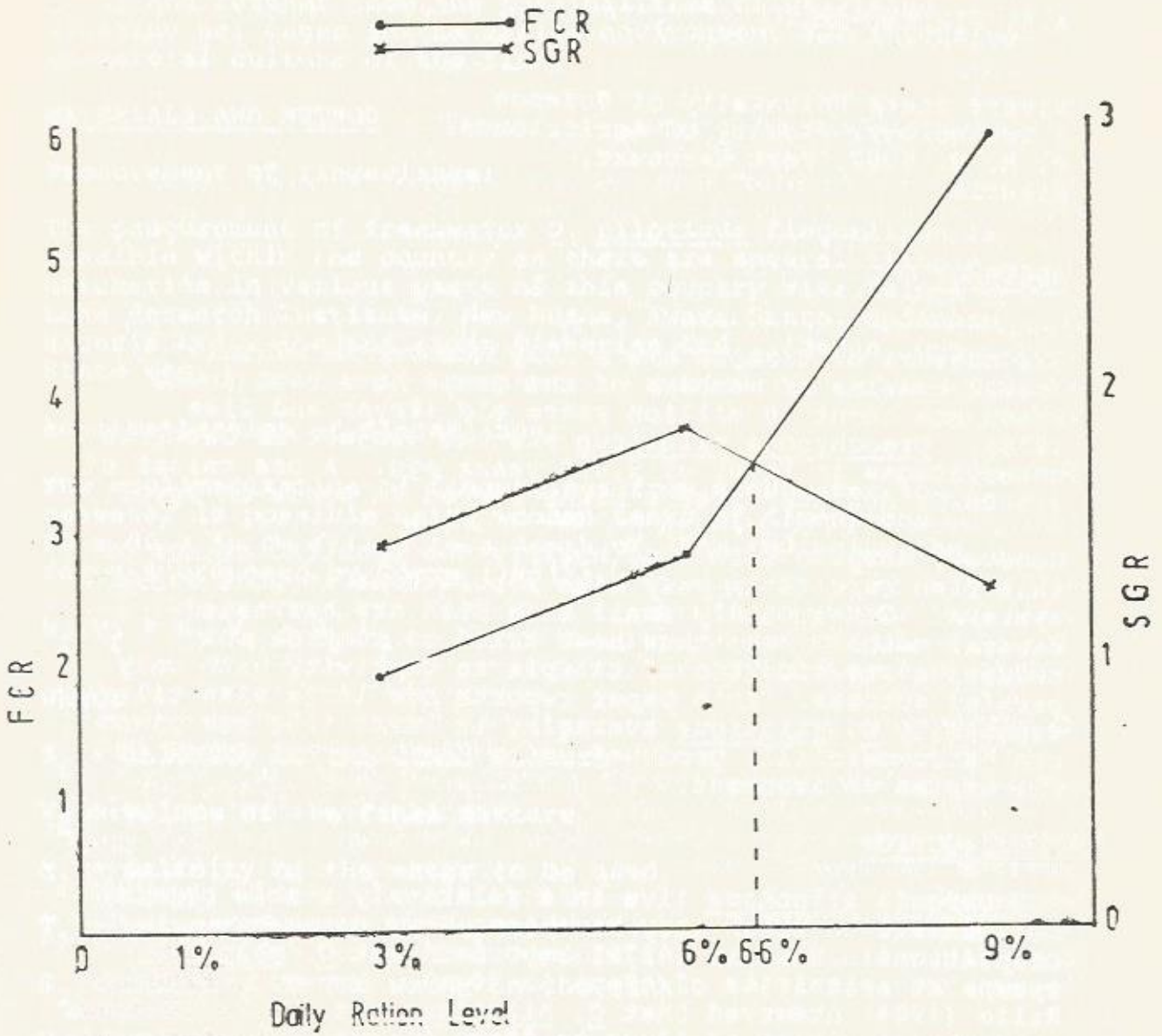


Fig 2. Relationship between FCR , SGR and the ration levels.

COMMERCIAL MARICULTURE OF Oreochromis niloticus USING NET CAGES

by

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ABSTRACT

The culture of tilapia has a long history in Africa. Fossil remains of members of the genus have been found which are about 18 million years old (Fryer and Iles, 1972). Oreochromis niloticus was the subject of detailed observations in Egypt of 5,000 years ago. A bas relief of 2,500B.C. depicts tilapia being reared in ponds in Egypt.

However, despite this long history the prolific nature of this fish results in very high populations in pond culture systems. Consequently small size fish are harvested. Several methods have thus been tried to control the excessive reproduction of tilapia in captivity with only partial success. This paper reports how large size tilapia especially O. niloticus averaging at least 150g per piece can be commercially produced using floating net cages in the marine environment.

INTRODUCTION

Oreochromis niloticus live in a relatively stable physical environment to which they have long made necessary adaptations. Balarin (1979) reported that O. niloticus spawns at salinities of 17ppt to 29ppt. However, Fineman-Kalio (1984) observed that O. niloticus was unable to spawn at high salinities of 30ppt to 50ppt in brackishwater ponds. He further reported production figures averaging 2.5 tons/ha with sizes of 125g-140g per piece after 120 days of culture with supplemental feeding. Corre (1981) reported spawning of O. niloticus at salinity of 14ppt 45 days after stocking while Biona (1981) observed nest building of O. niloticus during the 45th day of culture at salinities ranging from 18-28ppt but no actual spawning was reported. Also Chervinski and Yashov (1971) stated that tilapia species when exposed to high salinities are unable to reach sexual maturity due to a stop in their gonadosomatic index. These findings show that one effective method of controlling

reproduction of O. niloticus is to transfer it from freshwater to saline water. The resultant effect being growth to large size because energy hitherto expended for reproduction is utilised for growth.

Thus this paper will describe the various processes to achieve a successful transfer from freshwater to saline water and further show the possibilities of utilising floating net cages in the marine environment for intensive commercial culture of the fish.

MATERIALS AND METHOD

Procurement of fingerlings:

The procurement of freshwater O. niloticus fingerlings is possible within the country as there are several tilapia hatcheries in various parts of this country viz: Kainji Lake Research Institute, New Bussa, Kwara State; Sydenham Nigeria Ltd., Ibadan; Ijoma Fisheries Ltd., Ibadan, Oyo State etc.

Acclimatization of fingerlings:

The acclimatization of fingerlings from freshwater to seawater is possible using wooden tanks of dimensions 90 x 80 x 40 cm filled to a depth of 25cm and using the formula proposed by Corre (1981):

$$S_f V_f = S_1 V_1 + S_2 V_2$$

where

S_f = salinity of the final mixture

V_f = volume of the final mixture

S_1 = salinity of the water to be used

V_1 = volume of water to be used

S_2 = salinity of the water in the tank

V_2 = volume of the water in the tank.

Each of the tanks should be stocked with 500 fingerlings during the acclimatization process. The salinity should be adjusted at 5ppt per day, 2ppt in the morning and 3ppt in the afternoon at 9a.m and 3p.m respectively. This will ensure a gradual transfer and ensure a 100% survival. When fish have been acclimatized to a salinity of 30-35 ppt they should be allowed to remain in this medium for at least on week before transfer to the net cages in the sea. In order to raise salinity in the hatchery the ordinary salt purchased from the local market could be used to raise salinity where actual seawater is not available. Fish should be fed a 30% protein supplemental feed at 5% body

weight during the period of acclimatization.

Cages:

At the end of the acclimatization period fish fingerlings should be transported in oxygenated plastic bags to net cages (4 x 3 x 2.75)m i.e. 33m³ in size. Cages should be floated in units of four, referred to as one module. For a commercial venture such as proposed 50 modules will be required.

Net Material and mesh size:

The net cage made of polyethylene netting is preferable although galvanized wire mesh could also be used to keep the fish in the floating cages. However, galvanized wire needs frequent replacement besides it is bulky. Each module should be floated by 8 tar-coated metal drums. The mesh size should be 0.64cm (fish below 5cm), 1.27cm (fish between 15-20cm) and 2.5 to 3.8cm (fish above 21cm). The expected life span of the fish cage is 3 years using net material.

Project Site:

Cages should be installed in sites where salinity is at least 30ppt with dissolved oxygen at 3 cc/litre minimum. The velocity of the water current should be about 20-50cm/sec. with wave height averaging 1 meter. Water temperature should be in the range of 27-32°C. A minimum depth of 4 meters is required for an ideal site.

Stocking density:

A stocking density of 350 fingerlings/m³ is proposed for this intensive culture system. Elsewhere in the Philippines stocking densities of 250-1,000/m³ have been tried with good results (Guerrero, 1979). At the proposed stocking density each cage will contain 12,705 fingerlings which includes a 10% increase to offset loss due to mortality during culture. Each fingerling should weigh about 5g before stocking to ensure good survival.

Management:

Personnel

The project will require 1 manager with a achelor's degree in Fisheries to manage the business, 2 university diploma holders, one in Fisheries and the other in Marketing and 2 casual labourers for routine jobs.

Supplementary feeding:

A 30% protein supplemental feed is recommended for this venture. The feed should be formulated with locally available feed ingredients such as brewery waste, Ox blood, soyabean cake, beans, garri, fish meal, fish offals from canneries, palm oil, vitamin-mineral mix etc. Production of fish feed could be through the establishment of a private feed meal or by arrangement with existing livestock fed mills within the country or in consultation with fish nutritionists in research institutes and universities e.g. Kainji Lake Research Institute (KLRI), Kwara State; Institute of Oceanography and Marine Research (NIOMR), Lagos; Department of Fisheries, Rivers State University of Science & Technology, Port-Harcourt.

Cropping:

Two crops will be made each year with a one month between for preparation before stocking viz; net mending, repair of floats, procurement and acclimatization of fingerlings, purchase of feeds etc.

Investment potentials:

Table 1 shows a simple cost and returns analysis of the commercial mariculture of freshwater O. niloticus in net cages. A profit margin of ₦438,474.30 will be realised after all taxes have been deducted during the first crop, with an initial investment of ₦924,100. An ROI of 48% during the first cropping is good indicator that the project will be viable if embarked upon. There is no doubt the profit margin will be on the increase during the second and succeeding croppings when there will be no additional cost of construction of net cages. The coast of the Delta special area is some 258km long and there are approximately 8,300 square kilometers of coastal waters within the given limits which are open to exploitation (Scott, 1966). In this area are enclosed numerous saline bays such as Forcados, Ramos, Dodo, Penington, Kulama, Sombrero, New Calabar, Bonny which are all potential sites suitable for installation of net cages for the commercial cage culture of freshwater O. niloticus.

DISCUSSION

Tilapia is known all over the world as one of the promising candidates for aquaculture. Its high fecundity and prolific reproduction ensures a dependable supply of fish seed for a continuous cultivation. However, it is fast becoming a menace in ponds owing to its tendency to overpopulate the ponds, resulting into staunted growth due to depletion of food. Several methods still being tried to control or minimise its prolific reproduction with the aim of increasing its individual target size include monosex culture through manual sexing and sex reversal by use of hormones (Guerrero, 1979) and use of predators (Fortes, 1980). Under the Nigerian context, the

aforementioned methods are not only laborious but also require some special technology that require importation of some raw material, from outisde the country. The proposed control by salinity is very simple, promising and inexpensive. The response to artificial feeding by O. niloticus is an added advantage that makes possible the attainment of the proposed minimum size of 150g in 150 days.

A production of 1.7325 tons per 33m³ cage is expected in this proposal. A production of 1.32 tons was reported for cages of similar size after only two months of culture in Lake Laguna, Philippines (Guerrero, 1978). Infact it is possible for fish to attain sizes of 200g during 150 days of culture with inhibited reproduction.

CONCLUSION

The culture of freshwater O. niloticus in saline waters using net cages has great promise in controlling reproduction of this fish, which is a factor limiting growth to large size. The high fish production using floating net cages will go a long way in narrowing the gap between supply and demand of fish in Nigeria currently having an estimated deficit of well over 1.65 million metric tonnes annually.

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Table 1 - Simple Cost And Returns Analysis For One Crop During First Year Of Production

Item No.	Description	Material Cost	Labour Cost	Others	Total Cost
1.	Construction of 200 units of (4 x 3 x 2.75)m rectangular net cages	87,500.00	10,000.00	2,500.00	100,000.00
2.	O. niloticus fingerlings 2,541,000 @ 20k per fingerling				508,200.00
3.	Fish feed for 5 months 592 tons @ ₦500/ton at 5% fish biomass				296,000.00
4.	Personnel:				
	1 Farm Manager				6,000.00
	2 Fisheries Assistants				6,000.00
	2 Casual Labourers				2,400.00
5.	Miscellaneous - Security, Maintenance etc.				5,500.00
	Total Production Cost				924,100.00
6.	Revenue				
	Sale of large tilapia 150g/PC i.e. 1.7325 ton/cage for 200 cages 346.50 tonnes @ ₦5/kg				1,732,500.00
	Gross Profit				926,600.00
	Less Interest on Loan @ 14%				129,374.00
	Net Profit before Tax				797,226.00
	Less Company Tax @ 45%				358,751.70
	Net Profit				438,474.30
7.	Return on Investment				47.74%

INVESTMENT POTENTIALS IN SHELLFISH CULTURE IN NIGERIA

by

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ABSTRACT

The shellfish are a major but cheap protein source for human consumption as well as source of income for coastal towns and villages of the Niger Delta in Rivers State, Cross River, and Lagos States.

A research into the nutritive value of some of these marine shellfish viz: bivalves (Oyster - Crassostrea gasar and Cockle-Anadara senilis); Gastropods (Periwinkle - Tympanotonus fuscatus, Obtuse periwinkle - Semifusus morio and the giant whelk - Thais callifera) and Mangrove crabs (Green crab - Goniopsis pelli, Ghost crab - Cardisoma ormatum, and common blue crab-Callinectes latimanus) was carried out to compare their quality and cost with beef, chicken meat, pork and egg in order to identify those most suitable for commercial culture.

Results show that all shellfish had at least 16% crude protein except blue crab (13.38%). All shellfish had higher protein content than egg (13.36%). Cockle with protein content 25.47% compared favourably with beef (29.60%). Beef, chicken meat and pork cost ₦11.50, ₦9.00 and ₦8.00 per kilo respectively while oyster, periwinkle and the common blue crab cost ₦3.50, ₦3.00, and ₦1.50 per kilo respectively. Oysters and Cockles are recommended for commercial culture based on the findings of this research.

INTRODUCTION

The most expensive single component in the human diet is protein. Conventional animal protein sources in the diet such as beef, chicken meat, pork, egg and fish are becoming very expensive owing to high cost of production.

The second national development plan report (1970-75) stated that the staple food crops of Nigeria consist of roots, tubers, pulses and cereals. Available results from limited nutrition surveys conducted in various parts of the country indicate that

the average caloric intake of Nigerians is about 2,200 kcals per capita/day. This is far below the average intake of 3,200 kcals per day recommended by FAO and recorded for some industrialised countries. The report further stated that nutritionally the available protein in the Nigerian diet is also inadequate at the indicated level of 62g per day per capita compared with the minimum requirement of about 77g. Moreover, yields of the protein nutrient crops like pulses and nuts are still very low, apart from large losses occurring in quantity both in transit and storage. Of greater concern, however, is the small protein proportion in the Nigerian diet that comes from animal sources. It was further recommended that 35g out of the required minimum of 77g of reference protein should be obtained from animal products. But only 7g out the 35g available in Nigerian diets come from animal sources. This means that only about one fifth of the minimum animal protein requirements is presently supplied from animal produced in the country. The situation is not different if not worsened today by the present economic crunch in the country.

Afinowi (1975a) estimated the quantity of fish required in Nigeria as 869,000 tons, where as the quantity then produced from all sources was 663,000 tons leaving a deficit of 206,000 tons. Of this deficit, a little over 106,000 tons was met by imports. Judging from the trend of events from 1975 to 1985, the deficit value must have escalated more seriously within the decade. Awachie (1976) reported that maximum sustainable yield of fish from all sources was 484,000 metric tonnes while the demand for human consumption alone for the target years 1975, 1980, and 1985 were 380,000 tons, 574,000 tons, and 1,229,000 metric tons respectively quite distressing indeed.

It would therefore not be improper if supplementary source of protein other than from plants and conventional animal sources including fish be recommended. Nigeria is blessed with quite a lot of marine shellfish with potential for culture. A study of their nutritional value is invaluable to determine species best for commercial production, hence this study.

MATERIALS AND METHODS

The nutritive value of some marine shellfish viz: bivalves (oyster-*Crassostrea gasar*, and cockle-*Anadara senilis*); Gastropods (periwinkle - *Tympanotonus fuscatus*, obtuse periwinkle - *Semifusus morio*, the giant whelk - *Thais callifera*) and mangrove crabs (Green crabs - *Goniopsis pelli*, ghost crab - *Cardisoma ormatum* and blue crab-*Callinectes latimanus*) were compared with beef, chicken meat, pork and egg.

The sample were purchased at a local market in Port-Harcourt and analysed for crude protein, crude fat, ash and moisture in their cooked state. Smoked and dried oyster, cockle and crabs were further analysed. All analyses were done according to methods described by AOAC (1970). Based on prevailing market prices the amounts and cost of each product required to supply 77g protein requirement in the Nigerian diet were also calculated.

RESULTS

A summary of the results obtained from the study are shown in Tables 1,2, and 3. The approximate chemical composition of the marine shellfish are compared with livestock products The highest moisture content of 81.18% was obtained for T. fuscatus while the least was obtained for beef (57.76%). Crude protein was highest in Beef (29.60%) although 13.36% for egg was lower than values obtained for all marine shellfish. Furthermore, shellfish had a low fat content while as was high in mangrove crabs with Cardisoma ormatum having highest mineral ash content of 20.70%.

Table 2 shows the effect of smoking and drying on the chemical composition of some of the shellfish studied. Moisture content was generally low but protein content was very high. As high as 52.41% protein was obtained in smoked and dried cockle, A. senilis.

The contribution made by these food items to the protein needs of humans and their relative costs are shown in table 3. The marine shellfish were found cheaper than the livestock products. It costs ₦0.71 to supply reference protein in human diet using the crab, G. pelli, while it will cost ₦2.30 using egg which is the cheapest of the livestock products.

DISCUSSION

Marine shellfish, whose culture have so far been neglected in this country, are no doubt an invaluable additional protein source in the human diet. The high protein content of smoked and dried oysters and cockles is notable. A production of 20 tons/ha have been reported in Japan (Bardach, 1972) using raft culture method, for C. gigas which is also the species identified in Nigeria. In the Philippines, over 4,000 ha of bottom in Manila bay alone are devoted to oyster culture of clams- cockles of Anadara spp. is already practiced in Japan, China and Philippines. In Taiwan, two of Japanese species of cockles A. granosa an Sinovacula constricta which are cultured commercially, contributed 60,989 and 11,047kg respectively in 1965 while the principally cultured clam in Taiwan, the blood clam, Meretrix mertrix, yielded 1,252,432kg in 1965 (Bardach, 197

There are well over 6,049 square kilometers of brackishwater swamps with creeks, estuaries, and intertidal swamps, (Scott, 1966), presently unexploited for aquaculture purposes but with suitable sites for culture of marine shellfish. Afinowi (1975b) reported on the biology of A. senilis and C. gasar and also identified potential areas for possible cultivation. The cost of production are expectedly low since inputs are minimal and their culture technology such as bottom culture in parks, raft culture, tray culture, and long line culture are easy to adapt to local conditions in Nigeria. Hitherto production and supply of marine products have been dependent on harvests from the wild by local fishermen. There is no doubt that if commercialised the venture will be profitable bearing in mind the low production costs and ready market.

SUMMARY AND CONCLUSION

The above study suggests that marine shellfish could contribute significantly to our mitritional needs in this country. They are cheaper protein source than conventional sources such as beef, chicken meat, pork, egg, and even fish and are acceptable to consumers. Their generally low fat content could render them useful in cases of obesity in our society. The above factors coupled with an abundant natural seed supply are good indicators that marine shellfish culture especially oysters and cockles have good prospects for investment in Nigeria.

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Table 1 - Approximate Chemical Composition Of Cooked Livestock and Shellfish Products

Samples	Moisture %	Crude Protein %	Crude fat %	Ash %
Beef	57.76	29.60	10.36	1.40
Chicken meat	64.60	28.01	6.01	1.19
Pork	57.03	29.01	12.13	1.25
Egg	74.01	13.36	10.60	2.15
T. fuscatus (Periwinkle)	77.22	16.44	0.87	0.90
C. gasar (Oyster)	73.65	17.92	3.29	1.74
S. morio (Obtuse Periwinkle)	67.87	21.13	2.00	2.93
T. callifera (Whelk)	68.42	25.03	2.27	1.96
A. senilis (Cockle)	67.83	25.47	2.07	0.73
C. ornatum (Green crab)	60.08	15.77	1.95	20.76
G. Pelli (Ghost crab)	63.09	17.32	1.07	18.32
C. latimanus (Blue crab)	72.61	13.38	1.34	10.39

Table 2 - Approximate Chemical Composition of smoked and dried marine shellfish

Samples	Moisture %	Crude Protein %	Crude fat %	Ash %
C. gasar	14.90	45.20	10.19	6.88
A. Senilis	15.53	52.41	3.84	7.56
C. ornatum	24.39	26.72	1.73	40.91

Table 3 - Amount of Shellfish and Livestock Products Required To Supply Reference Protein in Adult Humans Vs Cost

	Amount to supply 77g reference protein for adults (g)	Cost per 100g ₦	Cost for requirement of 77g ₦
Beef	260.14	1.15	2.99
Chicken meat	274.90	0.90	2.47
Pork	265.43	0.80	2.12
Egg	575.06	0.40	2.30
T. fuscatus	468.37	0.30	1.41
C. gasar	429.69	0.35	1.50
S. morio	364.41	0.30	1.09
A. senilis	302.32	0.40	1.21
T. callifera	325.86	0.41	1.34
C. ornatum	488.27	0.15	0.73
G. Pelli	444.57	0.16	0.71
C. latimanus	575.49	0.15	0.86
C. gasar (smoked & dried)	170.35	0.55	0.94
A. Senilis " "	146.92	0.40	0.59
C. ornatum " "	288.17	0.43	1.24

Appendix Table 1 - Formulae for Calculations

1. Protein/100g = % protein of samples

2. Amount of sample to supply reference protein

$$= \frac{100 \times \text{Reference Protein}}{\text{Amount of Protein in Sample (\% protein)}}$$

3. Cost of Sample to Supply Reference Protein ₦ :

$$= \frac{\text{cost of sample 100g} \times \text{wt. of sample supplying ref. protein}}{100}$$

SECTION 6: APPENDICES

COMMUNIQUE ISSUED AT THE END OF THE
FISHERIES SOCIETY OF NIGERIA (FISON)
HELD AT THE UNIVERSITY OF ILORIN
FROM 22ND - 25TH SEPTEMBER, 1986

At its 5th annual conference held at the University of Ilorin on 22nd - 25th September, 1986 the Fisheries Society of Nigeria (FISON) deliberated on papers presented on the theme, "Investment Opportunities in Fisheries". The conference noted with concern, the sharp decline in domestic fish production in recent years, the efforts of government towards self-sufficiency in fish production and called for greater efforts in attaining this goal. The shift in government policy to discourage public sector involvement in production was noted as a step in the right direction.

2. Arising from papers presented, the conference deliberated and observed as follows:

i) That the deficit between the domestic fish production and demand is so large, as such, it might be premature to place a total ban on importation of frozen fish at this time. Therefore FISON is of the view that corporate bodies which have invested in local production should be accorded priority in considering the applications for frozen fish importation.

ii) That among the constraints militating against domestic fish production are lack of fishing nets and accessories, marine engines and spare-parts, fish pond construction and rearing machineries and equipment as well as fish feed. FISON therefore calls for continued encouragement of the private sector for the production of these essential inputs.

iii) That the dearth of high level skilled manpower such as skippers, engineers, fish farming specialists, fish breeders and fish-feed technologists is a great handicap towards boosting domestic production. The Conference recommends that the government and the private sector should pool resources together to intensify the training of these specialised categories of man-power.

iv) That given the finite nature of the Nigerian marine resources, government should seek more fishing rights agreements

with countries having more abundant resources, with low population pressure on such resources. FISON calls on investors to make full use of the agreements already initialled

v) That levies, taxes and the removal of petroleum subsidies by government made production cost higher and therefore contributed to the present high cost of fish. The conference calls for a review of the policy.

vi) That government should allocate a considerable percentage of credit facility available to the agriculture sector to the Fisheries sub-sector.

vii) That efforts have been recently made by investors to go into fish processing. The conference advises such investors to consult appropriate Fisheries agencies to ensure guided investment and local sourcing of raw materials. Similarly FISON suggests that the financing institutions should seek technical information from public Fisheries Agencies on fishing ventures so as to avoid misallocation of resources.

viii) That investors should consider supporting small-scale fish producers by supplying essential inputs, while guaranteeing a reasonable price for the products which are turned over to the enterpreneurs to feed the existing processing plants.

ix) That fish-farming should be patronized particularly by the private sector as it holds the key to significant increases in domestic production, given the 12 million hectares available in the Niger Delta alone.

x) That there is the need for functional hatcheries producing high yielding varieties of fish seed as against the present collection of fish seed from the wild.

xi) That the research institutes and Universities should emphasize research into the technology of low cost, efficient feeds and nutrient requirements of Nigerian culturable fish species based on local raw materials.

xii) That government plays a catalytic role in fish production and urges the Directorate of Food Roads and Rural Infrastructure to consider supporting fish farming by constructing rural community fish ponds for rural communities to operate and also in production of fish seed to operators.

xiii) That the Agricultural Development Projects (ADPs) should urgently prioritise Fisheries components in all of the 19 States and Abuja Federal Capital.

xiv) That investment opportunities adopting the integrated approach to fish farming is promising in Nigeria.

3. Based on the foregoing observations, FISON wishes to draw the attention of the private sector to the investment opportunities which abound in the following proven areas:-

a) Fishing the Nigerian off-shore pelagic resources and also in the waters of foreign countries with which Federal Government has signed fishing rights agreements,

b) Establishment of hatcheries for high quality fish seed, fish feed mills, fish meal processing plants and commercial fish farms, and

c) Production of fishing crafts etc.

APPENDIX

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