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Forum on Appropriate Industrial  
Technology for Africa

Dakar, Senegal, 6-10 November 1989

FISHERIES: CASE STUDIES OF KENYA,  
SOMALIA, ZAMBIA, GHANA AND COTE  
D'IVOIRE

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\* The views expressed in this paper are those of author and do not necessarily reflect the views of the Secretariat of UNIDO. Mention of firm names and commercial products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO). This document has not been edited.

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FORUM ON APPROPRIATE TECHNOLOGY FOR AFRICA;

Summary of Findings and Required Actions.

The recommended fisheries focus of the Forum is discussed in the light of previously identified technologies considered as being the top priorities. Among the several aspects of these priority areas, specific activities are suggested to be organised at possible lead centres for sub-regions.

The comments and suggestions given by various Agencies (IAEA, FAO, ECA and PTA) from their project operational experience are described in Part II. The need for their further inputs and participation in the Forum is indicated and suitable publications and video presentations are cited, but require formal requests.

Part III provides observations from countries visited indicating their specific interests, fishery maps and possible lead centre capabilities. For each subject required actions are outlined. These include:

Kenya - fishseed mass production 12; fish leather 13; net making 14.

Somalia - GRP boatbuilding 16.

Zambia - fishseed and fishfeed production 19-21; fish products 21; irradiation 25.

Ghana - Forum preparation 26; wood boatbuilding 28; fish processing 29; canneries 30; net making 31; irradiation 32; technology transfer institutions 33; industrial fish hatcheries 35.

Cote d'Ivoire - Food irradiation 38; mass hatcheries CRO 39.

Part IV suggests a strategic approach and follow-up actions for the Forum. It cites other technologies which need attention for the fisheries sector, like the role of women in the fishing industry and potential for developing seaweed industries as TCDC from Asia.

Part V comprises the annexes which provide lists of persons (Forum contributors) and institutions visited; significant references including some for use at the Forum; the economic groupings of African countries; a possible draft agenda, desirable overview papers, advisory notes and outlines for important papers to be presented at the Forum. These should be given to authors who were interviewed by the mission and await formal requests.

(This report is complementary to the detailed handwritten notes and informal outlines provided at UNIDO to assist in the organisation of contributions to the Forum.)

## I. INTRODUCTORY

The first UNIDO Forum on Appropriate Industrial Technologies held in India a decade ago encompassed a very wide range of disciplines. This African Forum will give special attention to three industrial sectors, namely;

- food processing and preservation
- fisheries
- agricultural machinery.

Each of these admittedly covers a wide scope and variety of technical options. Accordingly this Forum seeks to identify specific technologies which offer timely opportunities for adoption and implementation, in the medium term, through cooperation activities including joint ventures. These technologies are to be examined as processes for transfer using the concrete mechanisms and tried successful experiences of developing regions.

The Forum will therefore aim at defining and exploring these mechanisms, while illustrating a few selected activities which may be the subject of programmes or projects already executed at national or regional levels. There are several complementarities with Asian and Latin American fishery developments which are directly relevant. Further, the perspective must be emphasised as those technologies appropriate for fruitful application in preparing Africa for the years 1992 to 1995 and beyond. They should provide opportunities for accelerated development responding to the pressing needs and consistent with defined regional aims.

Significantly, most countries expressed the view that the fisheries industrial systems involve multidisciplinary complexities, which relate to several Ministries of their Governments, while interacting with various different International Agencies. However, the role of fisheries has gained greater prominence in view of the formidable and still increasing problems posed by enlarging populations, widening protein deficits, declining resources, increasing costs and unemployment. Accordingly, the management of resources, with its ecological and environmental complexities, interacts directly with economic and social aspects of profitable earnings, employment and rural development schemes. Additionally, there are aspects which relate to national circumstances (both man-made and natural) while others depend on external parameters (economic inputs as well as regional and extra-regional market forces).

It is therefore evident that for promoting industrial fishery systems interaction between Ministries and departments of Government is as necessary as collaboration between multilateral and other international agencies which deal with various aspects of the fisheries sector. Similarly, the sustained success and efficient management and development of industrial fishery operations of other regions result from such collaboration by

Government agencies and industry. In this regard then it is important that a multidisciplinary perspective be maintained in the Forum so as to involve decision-makers, managers, investors, industrial operatives, commercial traders and beneficiaries. However, to be realistic, it is suggested that a few selected programmes should be targetted among the many priorities identified in the vast and complex continent of Africa. The collaboration of all concerned is accordingly solicited in the promotion of the programmes to be suggested and endorsed by the Forum.

### 1.1. Objectives and Technical Rationale.

The recent study of the fishery industrial systems by UNIDO has placed in proper perspective these operations as an integrated series of contributory activities for fish harvesting, processing and commerce. In Africa, moreso than other developing regions, the fisheries sector is largely operated by small-scale or artisanal enterprises. Industrial fishing activities, of the larger scale which may be considered as directly relating to UNIDO, are to be found in vessel operation and processing factories in some African countries. Other industrial technologies which are required to provide all the basic elements of production have been repeatedly identified as being particularly required for African fisheries development.

Those previously identified to be of highest priority include:

- fish boat construction (wooden and plastic);
- fishing nets, gear (nets, cordage and fishing devices);
- products processing and packaging (preparation of customary national and export packs);
- industrial fish hatcheries (juveniles supplied for aquaculture and stock enhancement).

Many national enterprises and technical assistance development programmes continue to be involved in promoting those activities to satisfy evident needs, with inputs from international and bilateral agencies and investment banks. Accordingly there is considerable experience in various countries, with on-going or terminated enterprises, which provide sub-regional examples of appropriate initiatives which can be a basis for technology optimisation. Further, there have been feasibility studies and assessments for enlarged industrial activities in each of the categories cited above. However several specific opportunities seem to be evident now with new economic groupings, preferential tariff areas, structural readjustments and closer fisheries collaboration programs within the region. The joint promotion by all interested parties of specially needed fishery technologies seem therefore very timely.

It has become noticeable that for those industries some successful operations are emerging as "lead centres". Some have been formally recommended by regional groupings, others have noteworthy service/performance records, despite the recent economic difficulties which the Africa region has been experiencing. A partial list of these industries in Sub-Saharan Africa includes:

- Ghana's Boatyards - (both government and private wooden fishing vessels for West African use).
- Somalia - GRP Products (for fibreglass small craft)
- Fishing nets - Kenya, Mozambique, Tanzania, Ghana
- Fish Products - traditional low cost products (smoked, dried, salted) and chilled / frozen high value "export" products; packaging. (Many coastal countries and lake fisheries have centralized processing enterprises).
- The "Advanced technology of gamma-irradiation" treatment for foods has been tested in Ghana, Nigeria, Senegal, and Zambia.
- Industrial fish hatcheries for the mass-production of millions of juvenile fish operated privately or as state centres, of the following species:
  - Tilapia species - Kenya, Zambia, Zimbabwe.
  - Clarias sp. - Lesotho, Zambia, Central African Republic, Cote d'Ivoire, Nigeria
  - Chrysichthys - Cote d'Ivoire
  - Carps - Nigeria, Sudan, Egypt, Lesotho.

The objective of the Forum will be to select and to develop at least two programmes for industrial maximisation in these priority areas.

It should be noted that these technologies have already been perfected in some tropical Asian and Latin American countries so that the procedure and experience of their implantation in such developing regions is directly relevant. Further, several of these activities will stimulate more coordinated industrial activities which will thus better realise economies of scale when operational programmes are in place.

UNIDO, in collaboration with other bodies, can thus undertake specific feasibility studies for accelerating joint-venture industrial activities in the disciplines and geographical areas which may offer the best opportunities to satisfy already identified economic needs in Africa.

## II. ACTIVITIES OF ORGANISATIONS RE FORUM OBJECTIVES.

### 2.1. International Atomic Energy Agency (IAEA)

2.1.1. The IAEA News Feature of December, 1988 provides a factual review of worldwide developments in food irradiation, describing how it works; where it is used; results of international scientific tests; marketing and international trade.

2.1.2. In addition to the traditional methods of preserving and processing food, the technology of food irradiation has become widely accepted. The process has been approved by the WHO and FAO Codex Alimentarius Commission. In thirty five countries thirty different foods have been processed by gamma irradiation. By 1990 about 55 facilities are expected to be in operation worldwide for the irradiation processing of foods.

2.1.3. Governmental interest in the process - which uses energy of gamma rays from cobalt-60 to preserve foods - is emerging for many reasons viz. as a means to mitigate food-borne diseases; to reduce high food losses from infestation, contamination and spoilage; and to meet quality standards for products of international trade. However, in some European countries public acceptance of irradiated foods has been adversely affected by misconceptions and fears surrounding nuclear-related technologies.

2.1.4. International health and safety authorities have now endorsed the process as one capable of mitigating the very serious problems of food supply, health and nutrition facing third world countries. Practical applications of interest include:  
decontamination and disinfection  
extension of storage life  
control of pathogenic bacteria.

2.1.5. Among the foods which affectively respond to the process are fish and seafood products apart from vegetables and fruit for which it is currently used. Cote d'Ivoire and Ghana are developing plans to irradiate food products commercially. The process is already used for fish products from Thailand and for fresh and frozen fish products in Netherlands, Chile, and Bangladesh.

2.1.6. Scientific research and testing have been rigorously carried out with reassuring results, and the irradiation process is now considered to be one of the most thoroughly investigated processing techniques on record. There is increasing industry use, consumer acceptance and international trade and commerce. There have been several training seminars on good manufacturing practices, conferences to promote information exchange, international standards and codes. An international facility (IFFIT) in the Netherlands has provided training courses for more than 200 scientists from 40 countries since 1980.



2.1.7. It is recognised by IAEA, FAO and WHO that the use of irradiation alone as a preservation technique will not solve the problem of post-harvest food losses. Nevertheless, in African countries, there is considerable loss of fish, after harvesting, through insects, in storage or transportation, bacteria and rodents.

2.1.8. Some studies conducted on the economic feasibility of food irradiation in the USA estimated costs of 2 to 8 cents per kg. Installations require very considerable capital investment which can only be justified for a bulk of commercial products. Typical tropical agricultural commodities - such as cocoa, coffee, tea and spices - account for 50-90 % of the world supply. 64% of the world's shrimp and 35% of fresh vegetables derive from tropical countries.

2.1.9. IAEA lists the countries of Europe, Latin America, Asia and Africa where irradiation programmes are active or planned. In Africa these include Algeria, Egypt, Ghana, Côte d'Ivoire, Libya, Niger, Nigeria, Senegal, Sudan, Zaire and Zambia.

2.1.10. The opportunity for commercial-scale testing of fish products beyond the pilot stage may be most opportunely accomplished by the plant in Côte d'Ivoire being established for yams. Several experimental studies have been accomplished in Ghana for fish and in Zambia for onions and other vegetables.

2.1.11. The IAEA division concerned with this aspect provided the technical contacts in AGSI and FIID of FAO where the practical African problems and their general policy approach were discussed.

2.1.12. On return to IAEA subsequently it was suggested that possibly a collaborative study may be supported to permit the standardisation of dosimetry for various smoked, dried and salted fish products, so as to extend their shelf-life at ambient temperatures. The packaging and storage of products will also be investigated to control insect infestation and contamination after irradiation, under normal marketing conditions.

2.2. FOOD AND AGRICULTURE ORGANIZATION: (FAO)

2.2.1. Agriculture Services Industries.

(i) The irradiation process was supported because it provided an added safety measure of foods for national and international markets.

(ii) Priority is for highest sanitary standards in product preparation and handling in food industries.

(iii) Irradiation processes now help increase storage life of products, enlarge distribution/consumption and can provide "cleaner products" (before bacterial load of foods develop toxins for human consumption).

(iv) It is clearly established that there are no health hazards in relation to technologies of irradiated foods, thus food consumption and post-harvest losses can be improved for national or export markets.

(v) Publications are available which detail the status and arguments concerning use of the process for developing countries. WHO is a great advocate of wider use of the process.

2.2.1.2. (i) Commercial experiences show that while capital investment costs are high, operational costs over 5 or 6 years are relatively low with the cobalt system. Other systems involve low initial but high recurrent costs.

(ii) Compared to the repeater treatment (e.g. resmoking) of fish to control mold or insects, less energy inputs are involved.

(iii) Irradiation is a benign process that causes little change in taste or texture of fish.

(iv) Interesting comparisons are available in China (jute bags pre-and post-packaging irradiation) where 4 months' operation proved economically viable.

(v) If capital investment is provided for other products it would be opportune to test fish products, e.g. Côte d'Ivoire (Canadian plant), Ghana (Hungarian pilot equipment), Nigeria, Zambia, etc.

## 2.2.2. Fisheries Department - Industries Division.

2.2.2.1. Systems for industrial packaging of dried, smoked or salted low-cost fish products for rural distribution in Africa were discussed. The use of shrink-on packs for such products is well advanced in Asia. Moreover, for some frozen or chilled high-value products, such systems are now being applied through industrial African plants. The collection and standardisation of artisanal products present the main obstacle, with varied challenging problems because of scattered production, climatic variations and product type/species in African sub-regions. In general it is agreed quality standards of fish products in Africa require major improvements; it is important to avoid packaging systems that do not improve basic consumption quality and tend to be "cosmetic".

2.2.2.2. While Gamma irradiation may seem attractive, the costs and logistics of its operation in the prevailing African post-harvest appear difficult to rationalise. Tests, pre-feasibility and economic viability studies should be compared in relation to standard refrigeration, drying and storage facilities which can also have multi-purpose uses. This process may have to be applied to pre-packaged fish. However, it was felt that current systems, using large bales of bulk dried/smoked fish, have also given effective results. Admittedly, the use of insecticides involved hazards which are now recognised, but the areas of greatest need for the low-income fish consumer may not be attainable through irradiated products.

2.2.2.3. Although irradiation processing plants may be established for other food products (and thus available for fish) the fisheries officers were sceptical as to whether this technology was suitable or truly appropriate for African conditions. It was conceded however, that various high-value fish products were irradiated in Holland and some Asian countries for export markets in USA and Europe.

2.2.2.4. The fishing industry division's views were thus:

(i) Top priority focus is improved manufacturing and processing practices to obtain best quality and safe standards of traditional or factory-produced products (for third world consumption).

(ii) Packaging technology of dried/smoked/salted products already standardised in Asia and applicable under certain conditions in Africa. (Available as a descriptive booklet published by Infofish).

(iii) Packaging costs must be recognised as being both with added value and added costs. Possibly economically feasible for export high-value products (shrimp, filets, squid) and marginally perhaps for local urban sales. Cheapest possible system may be acceptable for low-price products but doubtful that small consumer packs can bear high-cost technology of gamma radiation. Market acceptance of products is very important in advanced countries.

(iv) Bulk treatment presents varied/complex logistic and difficult problems for different species and products of same fish.

(v) Issues - Questionable whether slightly prolonged storage life of products can justify cost of cheap fish for the consumer. Quantity of post-harvest losses may be only 10 - 15%, possibly overestimated at 30-50%. Is this gamma irradiation appropriate for African fish products and market conditions?

- Will it not divert policy/improvement emphasis needed from upgrading processing standards/practices?

- Is the technology "maintenance-sustainable" when applied only for fish products?

Suggestions - Currently products which seem susceptible for such packaging are: East Africa - Kapenta, Nile perch (smoked or filleted) West Africa - Sardinella (smoked, salted, dried).  
Inland Africa - Dried fish.

Prefeasibility studies should determine economics of packaging as well as irradiation.

Other opportune industrial systems were also reviewed. Boat building, net-making and the industrial mass-production of juvenile fish were discussed with specialists concerned with these disciplines. Contacts, addresses and particular suggestions were given in regard to the countries visited and the status of current activities.

#### Discussion and choice of appropriate projects:

Boatbuilding - varied designs, acceptability, construction efficiency and costs. (GRP not considered acceptable in West Africa). Wood readily available for planked craft. Wood boats (even marine plywood eventually) must be solution for marine and inland fishing in West Africa. However necessary to consider design improvements to include catch stowage, power take-off, buoyancy / non-sinkability.

(NB) Ghana boatyard experience.

GRP boats East Africa and inland fisheries - cost / life expectancy new design for improved use / catch stowage, power etc. great variation therefore concentration on specific standard designs of proven efficiency for houri, sambuk, Dhow and outrigger type as well as sesse - canoe for inland fisheries.

#### Experience of:

Somalia boatyards, Kenya, Zambia, Tanzania.  
Need for profile of industrial possibility.

#### Net Making:

Net factories in each country had proven inefficient when

they imported yarn, now necessary to extrude plastic fibres from raw materials in order to be cost / efficient production. Old net factories used machinery for knotted nets, some monofilaments gillnets and multifiliments seines, markets restricted to countries and negative cost / efficiency frustrated possible trading spread.

Profile must have clear pre-conditions to justify efficiency of factory and marketability of products in any given economic grouping.

Need to concentrate on specific size and type for wider use (must be technically approved, standard size for biological / survival / escapement considerations).

(NB) for large lakes and rivers they may be common standards for mesh size and thread. Similar gear may be selected for wider manufacture to cater to established demand - coastal and inshore marine fisheries, drag seines, gill nets, pond seines.

- cords, ropes, lines offer opportunities but need to be produced at competitive prices.

### 2.3. ECONOMIC COMMISSION FOR AFRICA

2.3.1. The SIDFA / UNIDO stated that the Ethiopian Ministry indicated that it had no interest in the fisheries aspect of the Forum; there were therefore no further national contacts. The various divisions of ECA were very helpful and expressed keen interest in further collaboration with the Forum, particularly UNIDO projects follow-up.

2.3.2. The National Resources Division Director expressed support for industrial fish hatcheries. If these can mass produce suitable juvenile fish in sufficiently vast quantities, they may contribute significantly to the re-stocking and rehabilitation of many ravaged fisheries (of river basins and lakes) affected by the severe drought years, quite apart from Formal aquaculture systems. Industrial - scale fish hatcheries should be considered for pre-feasibility studies for two subregions initially.

2.3.3. The joint division of FAO / ECA (JEFAD), had undertaken several missions for identification and formulation of investment projects in fisheries. The Natural Resources Division had a permanent officer (provided by French Bilateral aid) who had travelled extensively and written descriptive reports on several countries in the subregion which were essentially data gathering and review information, (some were provided but have little "UNIDO interest content").

2.3.4. Significant areas identified by JEFAD and suggested for action were

- (a) post-harvest losses (insects, moulds, etc.),
- (b) processing packaging and treatment systems,
- (c) production economic constraints - boatbuilding, net-making, cold storage, ice-making - cost / efficiencies.

They provided several reports of a general identification nature; specific reports on Somalia and Zambia; and travel notes on boatbuilding (Comores, Seychelles, Mauritius), seaweeds.

2.4. Preferential Trade Area: PTA, Eastern and Southern African States (Lusaka).

The officers of the Economic Commission for Africa had indicated that an essential aspect of technology development and industrial output of products in Africa, was the facilitating of tariff barriers for intra-regional trade. In this regard the regional economic groupings had significant roles to play. The large grouping of states of Eastern Africa, PTA, had their secretariat headquarters in Lusaka and had been involved in the promotion of several regional initiatives. Accordingly, it was suggested that they should be involved in the Forum.

The Director of Industry and the Director of Agriculture of Lusaka's PTA indicated that they had many projects for investment support and were seeking donors, like EEC for instance, who were shortly sending an evaluation mission to assess PTA's proposals. The various investment banks had PTA's lists of favoured proposals, which included the boatyard and fishing technology centre for Somalia. They urged UNIDO's support for their proposals and seemed willing to participate in the Forum if invited.

This should be also considered for other groupings such as OCAM, ECOWAS, etc. as to what specific inputs they may provide, as a statement or paper, for information of participants.

III COUNTRY DISCUSSIONS      FORUM PRIORITIES

APPROPRIATE TECHNOLOGY "LEAD CENTRES" FOR ACTION PROJECTS.

3.1. KENYA.

3.1.1. Industrial fish Hatchery complex

The various climatic zones of Kenya have provided the distinct ecosystems for several tilapian species with many isolated in particular lakes. Studies and the commercial production of several species have been mainly conducted as a business venture by Baobab Fishfarm (Bamburi / Mombasa), but several government stations also have stocks of different species for fishculture propagation. The innovative continuous "gallery hatchery" and raceway system developed at Baobab has been improved / applied in Zambia and other tropical countries. However in Israel, Thailand, Philippines and Taiwan, far greater mass production quantities are currently supplied from a variety of industrial plants. The major demand is for T.nilotica, T.spirulus and T.rendalli, which may total about 30 million for East Africa, but there is stated to be an annual need far more than 5 million T. nilotica for the lake Basin Authority's fish ponds, in Kenya alone. The local market and regional markets justify the need for industrial hatcheries.

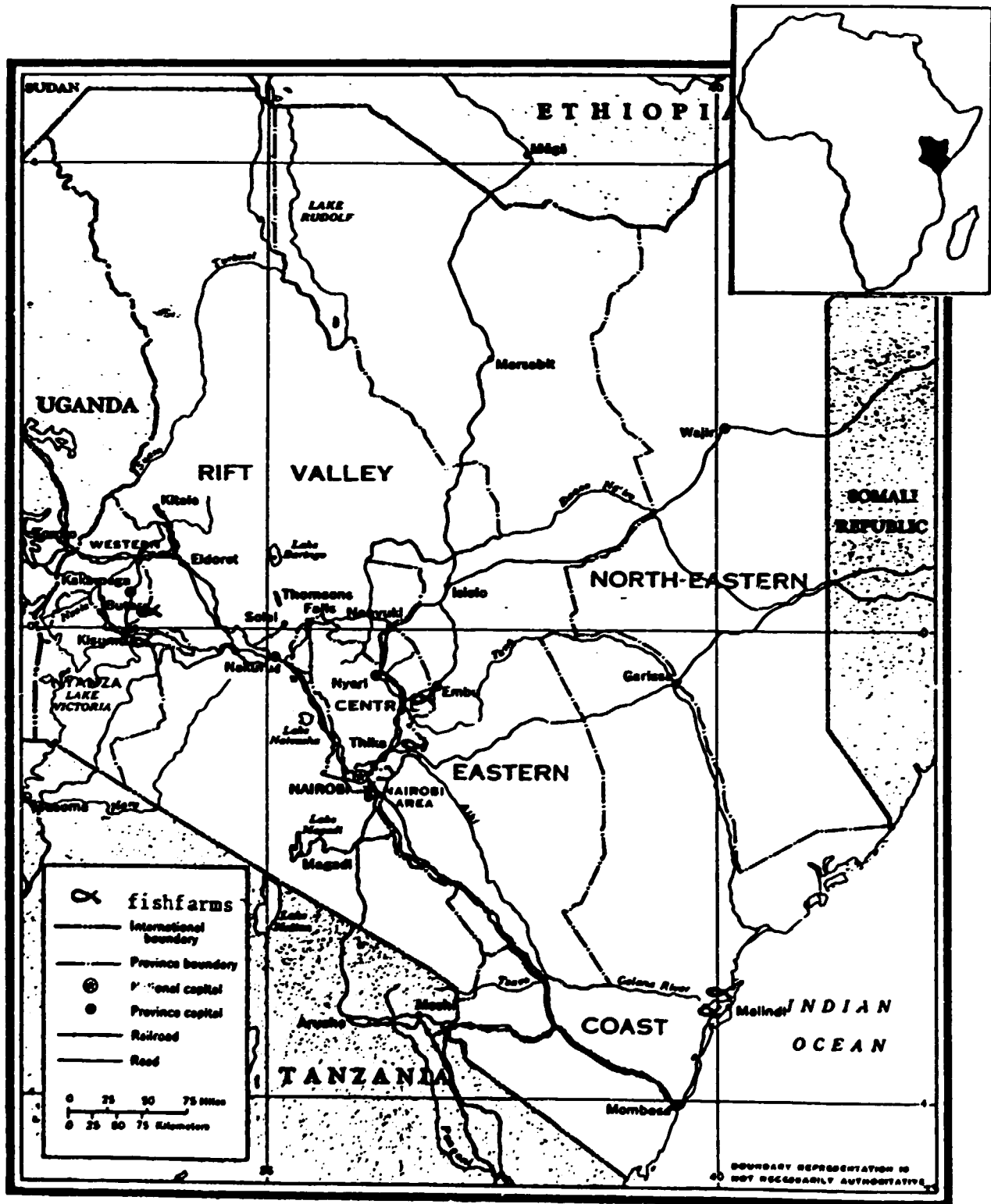
Currently production capacity of Baobab is about 0.5 million, while other supply sources are stated totally to be totally about 2 million. Their facilities produce about 1 ton of market fish per month. (11 MT per year). Hatcheries and nursery equipment for similar installation may be approximately \$100,000 US, but the major recurrent costs are energy for water recirculation systems and feeds for the growth of broodstock and juveniles. Many sugar factories in Kenya which have wastewater treatment plants discharge algal enriched waters which could be usable for such installations. In Zambia, Malawi and Zimbabwe such factories also cultivate fish for their staff canteens.

It therefore seemed that appropriate operational hatcheries may conveniently be located in association with a sugar factory complex using the Baobab system. Details of investment, production costs will need to be the subject of a specific pre-feasibility study. However there seem to be a number of favourable elements: Interest has been expressed by the Mumias and other sugar companies in extensive aquaculture; Baobab will be interested to consider overseas joint-venture partners; the demand for selected performance species of aquaculture for the Africa region is estimated to be over 500 million annually; the development of fish feeds (and livestock feeds) may be most favourable in Kenya or Zimbabwe.



# KENYA

LOCATION OF MAIN FISHCULTURE ACTIVITIES



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Crustacean juvenile species also offer attractive demand in Africa. These notably include freshwater prawns (Macrobrachium sp.) Crayfish (Astacus sp.) and brackishwater coastal shrimp, in particular Penaeus monodon .

Kenya has a particularly favourable opportunity for the last mentioned since their UNDP pilot project for shrimp culture established the technical feasibility of shrimp culture in sea catchment ponds for salt production. The major constraints were the availability of an adequate supply of juvenile shrimp and the controlled production of brine shrimp (Artemia sp.) which became established in the salt evaporation pond complexes.

Again shrimp hatchery production on an industrial basis may interest j-v partners to supply needed quantities for coastal shrimp culture throughout tropical coastland of Africa. This is particularly attractive where salt evaporation operations have established large catchment ponds which can be concurrently used for extensive shrimp culture, provided stocks of juvenile shrimp are available. The salt industries along the coast of E. Africa can benefit appreciably from the extensive culture systems which will be practicable when abundant quantities of larval shrimp are available.

It would seem appropriate in the near future to support a pre-feasibility study to examine the practicality of industrial hatcheries. Such hatcheries will be able to utilise the 14 species of Tilapias held by Boabab Fish Farms, and develop industrial mass production systems in association with Kenyan sugar factories. The resources and technical management experience of both organisations afford a very favourable opportunity for further intensification of their systems, in collaboration with inputs from commercial hatcheries overseas. The technical expertise developed by the University of Kenya at Nairobi in tilapia reproduction, as well as the current programmes of the Kenya Marine Fisheries Institute are also relevant. These can therefore significantly contribute to an effective group for the collection and industrial breeding of the various indigenous species in different climatic zones or ecosystems of Kenya. It was also indicated that there is an increasing demand for several ornamental aquarium fish from Africa. Their mass breeding, as part of such hatchery facilities, can provide an important hard-currency earning output.

There are therefore many positive conditions and circumstances that seem timely for such developments. Additionally, KMFRI has gained further experience with shrimp and Artemia cultures which are also linked with hatchery operations.

### 3.1.2. Fish products processing:

A review conference in 1988 indicated that production of Nile perch from Lake Victoria now exceeds 200,000 MT/year. The fish are filleted and smoked (artisanally and industrially), sundried, and fried. Various by-products, e.g. swimbladders, fish leather from skins and silage, show promising indications. The scattered production units and dislocated processing plants in Nairobi, and Mombasa which developed on an adhoc basis by entrepreneur exporters, are to be replaced by a central processing facility at Kisumu to be established by LBDA. Such an aggregation of supplies, would permit the development of appropriate industrial operations for the preparation of the various value-added products already prepared on a pilot scale. In particular the high value of good fishleather products can be a keen incentive for such concentration of processing while permitting economic quantities for the use of offal for silage fishmeal and other by-products.

Economic assessments give favourable indications of the production of cool-smoked, packaged frozen or chilled fillets for export. Similarly the leather made from the skin is a very attractive speciality product, if available in adequate quantities, (This has already been made into shoes, purses, etc. by the tannery of KIRDI Bata shoes of Kenya etc.).

Nile perch occurs in various river systems of Africa and, though their form, fat-content and taste reportedly are very variable, the establishment of efficient processing systems can be repeated in several lake and river fisheries of Africa. This however will only be technically and economically feasible if there is an adequate volume of product for industrial efficiency. The implications of this for improvement of the fish processing industry are significant. For instance there is a suitable facility, established at Mwanza in Tanzania, that can process southern lake resources.

Traditionally, smaller fish species are preferred by lake dwelling populations throughout lake fisheries of eastern Africa. These small fish generally called "N'Dagaa" or "Kapenta" include several species, which are sundried and packaged for rural marketing. Sanitary packaging is needed so as to provide increased shelf-life for rural distribution in difficult climatic and transport conditions. Fish processing plants, such as Sopelac, freeze their Kapenta in consumer packs of small plastic bags. However, this is mainly for urban markets where cold storage is available, prior to retail sale to middle-income buyers.

Shrink-on packaging systems and pouches for such low-cost products may be possibly made economic through combined plant-processing with the Nile perch higher value products for export.

Again, the total quantities of small fish produced from the lake now amount to 15,000 MT annually, but need to be centralised for economic processing/packaging. There are also social and political aspects to be resolved since this is an international lake fished by three countries. The situation may also change when normal commercial fishing operations are re-established along Uganda's part of the lake.

The impact and cost/benefits of these two groups of fish products need to be assessed in a pre-feasibility study with a view to determine

- practicality in lake Victoria
- replicability in other areas e.g. L. Tanganyika
- Joint-venture enterprise participation for export products both for regional and extra-regional markets.

### 3.1.3. Net Making Industry:

Kenya fishnet industries produce about 3 tons of finished nylon nets monthly, but they make them in 8 varieties of denier thread and over 12 mesh sizes for gill nets. Drag seines for dagaa and pond seines are also manufactured. However production costs are evidently too high for fishermen. Other net factories exist in Tanzania, Zaire and previously in Uganda. The economic rationalisation of production may be an important study to be considered by the PTA, since both the viability of enterprises and the regulation of mesh sizes for fishery management need to be harmonized. FAO/UNDP and bilateral donors are supporting fishery development projects on Lake Victoria. These projects may include certain economic development aspects of significance for the Forum and possible follow-up action.

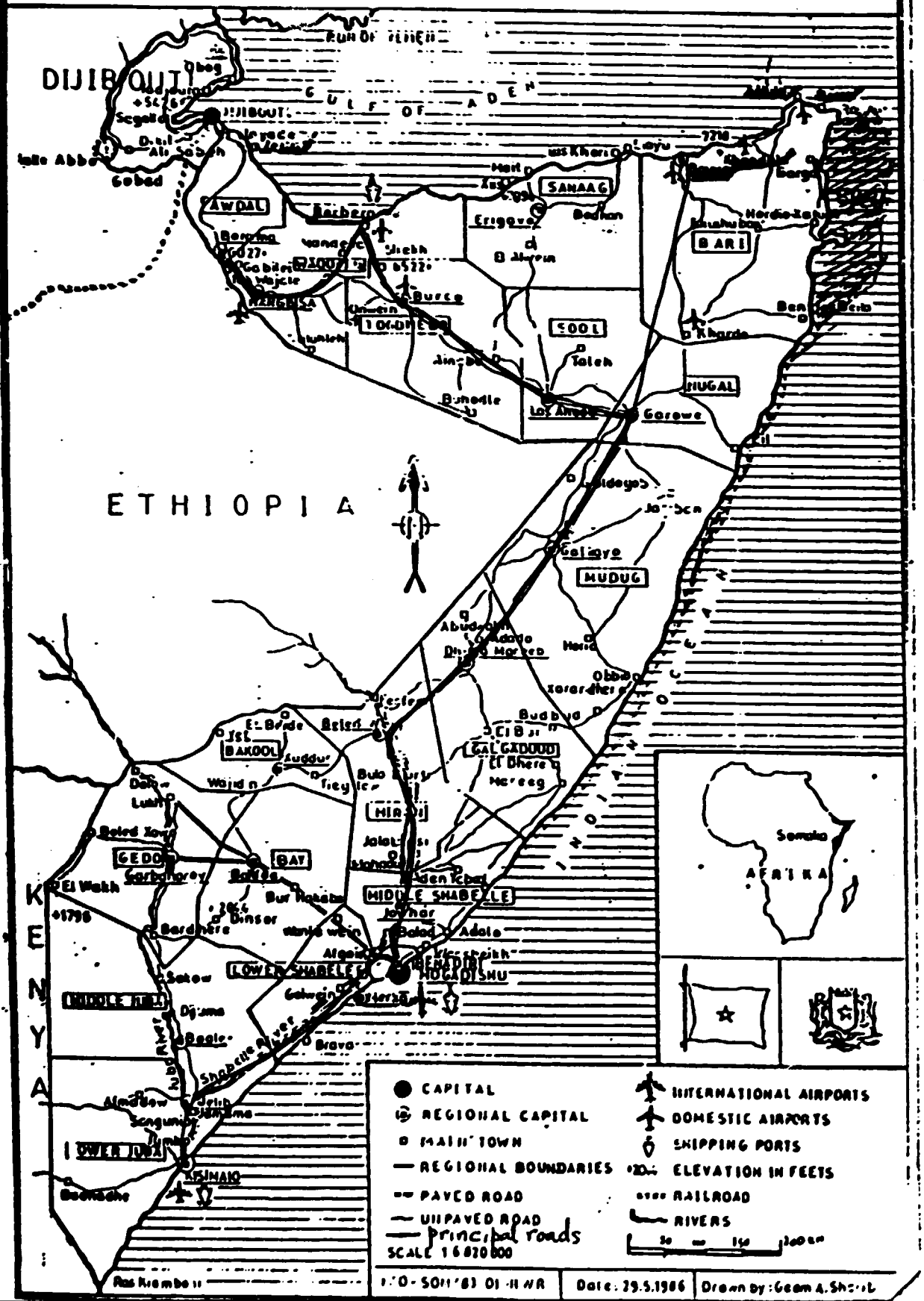
### 3.1.4. Boatbuilding - GRP plastic fishing craft

Two small production plants have made sesse canoes, pleasure craft and other fishing vessels for Kenya markets. It is understood that several craft have been supplied to Kenya from the Somalia GRP-Boatyard. Accordingly there seems a favourable opportunity for PTA/reciprocal trade development in this sector.

# SOMALIA

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## MAIN TOWNS AND REGIONAL BOUNDARIES



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### 3.2. SOMALIA.

#### 3.2.1. Boatbuilding - GRP smallcraft factory.

Established in 1976 under the ministry of Fisheries with assistance from Sweden, this boatbuilding facility has been a parastatal corporation since 1982 and run as a strictly commercial operation since 1985. It now produces several types of GRP craft: houris (4-5m.) 6.4; 8.5 and 10 m. fishboats to replace dhows or sambuks, as well as GRP water tanks and fuel containers. About 2/3 of its business comprises fishing craft and 1/3 containers which provides the cashflow satisfying continuous needs. The company is affiliated to the Swedish company Krona-Marine AB, managed by them and with financial inputs from the Government of Somalia. It is said to be making a small profit, as a commercially run enterprise, since 1987.

The company provides vessel hulls, Saab engines and all the needed hardware spares and supplies, after-sale service and maintenance. However, because of the widespread use of their craft and the radical change in preventive maintenance required by the vessel owners, (whose experience is with dugout houris), there has been evident need for basic vocational training for users, coupled with other fishing technologies. Such a vocational training centre (associated with the boatyard and other industrial fishing activities) has been recommended and endorsed by PTA in 1986. The need and objectives are still valid and are clearly evident in the fishing industry in Eastern Africa.

From their accumulated experience over 13 years, the management considers that it would be logical and feasible for East-African countries to operate small factory units for GRP inshore craft of a few designs. Such enterprise may involve capital outlay of about \$250,000.00 inclusive of supplies and basic equipment (for moulds, sawing, grinding, compressed air, etc.) and expatriate supervisor. This approach would be practical for most fishing areas (e.g. major lakes and rivers) where there is a need for minimum number of approximately 150 craft. However the major constraint will be the procurement of *regular* supplies (polyester, fittings, hardware etc.) needed for the construction and maintenance of craft. A nearby source of polyester from a Saudi-Finnish company can now supply GRP needs. This company would be in a position to provide such services provided hard currency funding through banks can be arranged with PTA countries prepayments.

The boatyard already supplies a regional market, i.e. craft to Tanzania, Mozambique, Kenya, Cape Verde, Muscat/Oman and Angola. It has now established (1988) a smaller subsidiary plant in Mozambique which now produces 7 m. and 8 m. craft. Because of the many justifiable reasons for this technology for fishing craft construction in E. Africa, support for this regional training centre is clearly logical. It seems appropriate for several multilateral agencies (i.e. ILO, UNIDO, FAO) but may also be most

appropriate for EEC/ACP and ADB inputs. It could provide services which are complementary to activities planned by other agencies regarding the training in maritime disciplines, but its focus is at the vocational hands-on technician level.

Various UNDP/FAO assisted projects (NEC fish, Regional Fishermen's Cooperatives, etc.), as well as bilateral programmes have stressed the need for training of operatives. A specific study of NEC fish (Oct. 1988) has evaluated the economic and operational feasibility of fishing craft of different designs using varied fishing gear/systems. They recommend the 8.5 and 10 metre vessels as being most suitable for Somalian fishery needs.

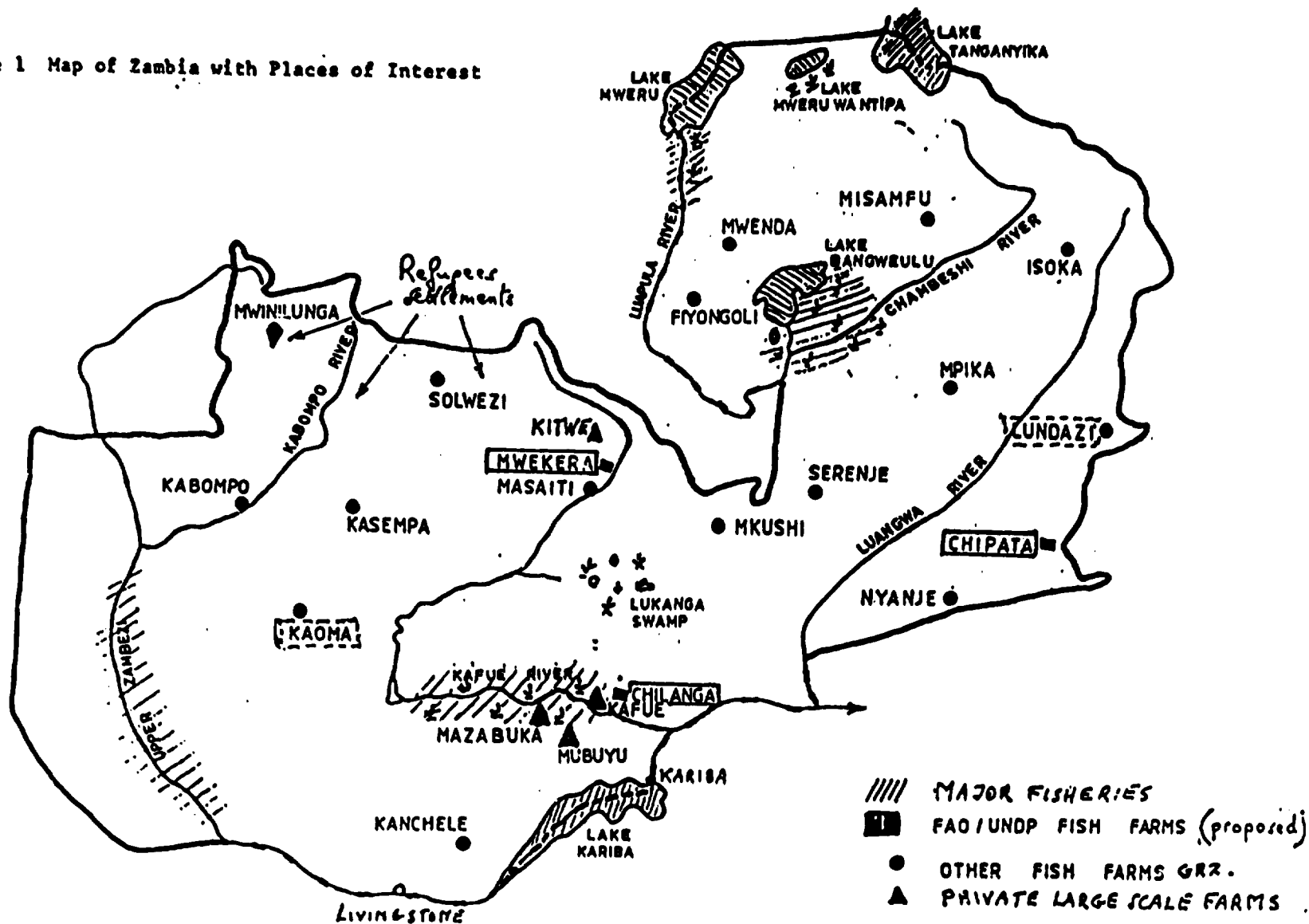
### 3.2.2. Other Project Areas.

The reciprocal activity with activities in other lead centres may be most effectively pursued in regard to fish leather processing through the various processing centres operated by current projects. Initially, the most readily available quantities may derive from sharkskin. The development of this product may be coordinated with the UNIDO regional tannery improvement project and the fish leather proposal which are in the pipeline. These projects are evidently to be centred in Kenya in association with KIRDI.

### 3.2.3. Next Steps:

At the final meeting with DGOF and Deputy R.R. of UNDP it was agreed that government's priority for the Forum would be the promotion of the boatbuilding and fish technology training centre. This required clearance procedures on their part, through the Planning Ministry, and formal submission to Donor Agencies for support in following up the endorsement of PTA.

Figure 1 Map of Zambia with Places of Interest



The boundaries shown on this map do not imply official endorsement or acceptance by the United Nations Industrial Development Organization



### 3.3. ZAMBIA

**General:** Initial discussions were held with the fisheries advisor to the ministry, the director of fisheries and senior staff and the CTA of the Fish culture project. They indicated the specific areas which have been given priority in the Fourth Development Plan and which fell within the particular focus of the Forum.

Of these they agreed that if the demand for juvenile fish could be met by industrial hatcheries this would contribute greatly to the resource rehabilitation of small water bodies and fill the gap in needed supplies for aquaculture. Additionally they stressed as problem areas: post-harvest losses of Kapenta fish; cold storage needs; industrial packaging at production centres; joint-venture opportunities with various fishery parastatals like fishing craft manufacture and net-making.

The programme of visits arranged permitted further discussions with principals of those enterprises to a large extent. However visits were not possible to the boatyard or net-making parastatal enterprise because of communication difficulties and the absence of their principals. The major constraints for these enterprises were stated to be: high foreign exchange costs of imported supplies (resulting in high-priced products and diminished markets); obsolete equipment and low productivity.

Accordingly, the activities which seemed most immediately suited for the technology development focus of the Forum were industrial fish hatcheries and fish products processing. Further discussions were therefore held with those enterprises. However future follow-ups re boatbuilding and net-making could be later developed.

Near the end of the visit the Director of Fisheries invited the consultant to address the annual meeting of senior officers of the department when they reviewed all projects, goals and prospects of priority programmes being developed, and budget allocations. The opportunity was taken to describe the purpose and focus of the Forum and obtain opinions as to their likely application, constraints and impact in Zambia. In general the staff concurred with the focus of the Forum. Particular interest was expressed in mass hatchery production and fish leather, but the urgent needs for supplies of gear, craft and control of fish storage losses were stressed by various staff members from different areas of Zambia. It was felt that if private hatcheries can, at low cost, provide mass supplies from select broodstock, this could have most immediate impact on rural fish supplies from small water bodies.

### 3.3.1. Industrial Fish Hatcheries

The Fourth 5-year Development Plan of Zambia gives emphasis to rehabilitation of mainland fish production and promoting large scale aquaculture. Programmes involve stocking of dams, mining pools and lakes where prolonged drought have reduced fish stocks, as well as formal aquaculture. The aquaculture target of 2000 MT per year will require about 25 million fish fingerlings annually (if it is assumed that 100 gram fish can be marketable in 6 months) Restocking dams at the rate of 5,000 fish per Ha must cater for some 360 such dams totalling approximately 1800 Ha thus requiring 90 million fingerlings. A stated aim of INDECO and ZCCM include the use of old mining pools for fishing. Open cast mining pools provide another 1000 Ha, while the enhancement of drought-ravaged lakes like Bangweula and Mweru-Wantipa could conceivably require another 300 million fry!

The main species needed are Tilapias and Clarias catfish together with other fast-growing species and particular types for controlling snails, insects weeds etc. The current production of these from government stations is stated to be less than 200,000 fingerlings per year while main private enterprises produce perhaps more than 2 million. Accordingly the demand is vastly unsatisfied and there is a favourable opportunity for effective joint-venture private upgrading of hatchery production to satisfy national demands. Further the neighboring countries have similar deficits in fingerling supplies, therefore the successful establishment of prototype industrial fish hatcheries, such as operate in Asia, can cater also to needs of SADECC countries with considerable expansion prospects. Additionally there are potential aquarium fish supplies for export earnings.

The potential partners in this field who had several years of experience in successful commercial fish culture operations are the Nakambala Sugar factory at Mazabuka, Kafue Fisheries Ltd. of Turner Asbestos Products and possibly Mubuyu fish farms near Mazabuka. Other enterprises, like Kitwe Electric Coy., also have industrial fish culture production experience and may be involved subsequently. Visits were therefore made to the first two enterprises.

#### 3.3.1.1 Nakambala Sugar Company of Zambia, Mazabuka

##### Current Operations: (General)

Main thrust is the production of 150,000 MT / Sugar per year with 1000 field workers and about 70 factory and administration staff. Their production of fish is about 30 to 50 MT / year but average about 35 MT. Presently with their own production of feed

and a hatchery producing 500,000 fingerlings / year they cover expenses breaking even, but without charging all costs (water, electricity, etc.). About 17 staff workers are concerned with fishculture. Diversification activities from sugar have not been economical in general, but fish production systems have been maintained, since it supplies fish to their workers and have public relation benefits with limited losses. Keen interest was expressed in the possibility of operating industrial hatchery for export earnings.

Constraints: Foreign exchange constraints limit further imports, current dollar earnings from sugar are mainly from Zaire and PTA sales do not help the company's forex requirements for replacing equipment, supplies etc. The industrial hatchery operation must then aim to also earn forex so as to pay for imported equipment and inputs.

Technical difficulties are mainly lower water temperatures from April to November, which limit growth rates, breeding and thus production during these months. T. nilotica does not grow well during that period but are claimed to yield better than T. andersoni (the native species recommended for its performance by FAO projects). Broodstock of nilotica has been imported from U.K.'s Sterling University, (which obtained their stocks from Kenya!). Food conversion for carps and nilotica was stated to be satisfactory.

Transport problems occur at critical periods when national grain storage of maize or other food products require all available trucks. This is foreseen as a limitation for feed production if this became necessary for large scale culture of broodstock and juveniles. Feed storage which attracts rodents *can* present some problems.

#### Fishculture operations:

The management considers that these operate at "break-even with costs" though precise costing of electricity, water usage and all personnel management inputs are not included. Production of 35 MT of fish nets about 40 to 50,000 Kwacha with current prices of 15 to 17.5 K / Kg (= \$1.50 to 1.75 / Kg) for tilapia and carp. (This price is intended for the staff and bears no relation to current market value in Lusaka or to the changes in forex value of the Kwacha). It was felt that current facilities can provide a maximum of 50 MT per year. They also provide unstated quantities of fingerlings for stocking farmers' dams.

During the 9-month breeding season 10,000 fry per week are produced, held in open raceways up to 3 gram weight then transferred to closed circulation systems for growth to market size of approximately 150 grams tilapia. Mirror carps average 300-400 grams. Food conversion rate for their local formulated feed pellets is said to be 1.4 to 2.1 for tilapia and 2.2 for carps.

At water temperatures of 18 to 19 degrees C, T. nilotica cease spawning. The possibility of solar heated panels or other cost-efficient systems for raising the water temperatures by 4 to 6degrees C. could be explored. Use of waste-water from the factory, heat-exchangers etc. may also improve growth and spawning performance. The performance comparison of indigenous T. andersonii needs formal testing. Production of indigenous species for the aquarium ornamental fish trade also offer good export prospects.

Supervisory and operational staff have acquired experience on the job. Further training in specialised techniques and for technical analysis of fishculture performance is needed.

Potential: Current operations have concentrated on a standard fail-safe system which produces tilapia and carp for staff canteen needs. These operations are not at their maximum potential since a greater through-put can be realised if certain facilities (e.g. broodstock ponds, carp spawning systems and nursery raceways) were operated on a more intensive basis. Feeds supplied suffice for the purpose but are not optimum. The waste-water from the factory is not used for the fishculture complex.

Subject to a more detailed feasibility analysis the potential production of the current facilities could probably be improved by 50%. The enlarged development of industrial hatchery production systems could be complementary to the current operations. This could be phased to produce from 5 million initially towards 50 million fingerlings annually.

Joint-venture development of such an industrial system will initially have the prospect of a national demand for fish seed of between 50 to 100 million per year with the potential for sub-regional supplies to SADCC countries. Particular considerations are necessary for feeds, water controls, and foreign exchange earnings.

### 3.3.1.2. Kafue Fisheries Limited

Started in 1981 as a pilot 5-acre fishfarm this enterprise now comprises 23 Ha of production ponds integrated with pig raising and producing annually 70 tons of fish and 2,000 hogs for market consumption. Earnings are stated to be \$340,000.00 per year through weekly sales of fish and pigs. The fish used are T. andersonii which were originally gathered from wild stocks of the adjacent Kafue river. The culture system is similar to the integrated pig-cum-fish raising practised in China. Growth of juvenile fish are stimulated by the pig manure discharged into ponds with some supplemental feeding for hatchery tank systems. Their annual production requirements of fish fry amount to nearly one million. They have continuous weekly sales of marketable fish which are 6 to 8 months old, 100 to 200 grams, i.e. about 10,000 fish per week.

Kafue Fisheries is quite interested in a joint-venture partnership which could be a complement to the current food production activities, serve as a catalyst to increased efficiency earnings and capacity, with favourable operating conditions. They have adequate space, water and power supplies, but an additional complex would need to be built with buildings, housing etc. for the hatchery facilities and supervisory staff. This could be accommodated adjacent to the present farm on the banks of the Kafue River.

This enterprise seems appropriate for investment promotion together with or as an alternative to Nakambala Sugar Company. The principals of the company, which is a subsidiary of a multinational, were receptive to considering joint-venture partners for mass hatchery production.

### 3.3.1.3. Fish processing and products:

The majority of fish consumed in Zambia derives from the lakes and rivers and is transported by truck for consumption in urban and industrial centres. While the industry is serviced by a number of cold storage plants with refrigerated vans there are many areas where landings and processing have no facilities, at scattered points for the small scale artisanal fishery. At such places small species like Kapenta are sundried and bulk packed in sacks while larger species are smoked and stacked in baskets or sacks for transport to markets. Though there are cold storage plants at many of the major fish production lakes, limited access to them and other factors result in their handling and freezing only a small portion of the catch. It is stated that, with such frozen distribution to markets, losses between capture and

consumption may account for about 10 to 15% in the best circumstances. Other operational problems affect their efficiency regarding supply quantities, machinery maintenance and costs. However the demand for this output of fish far exceeds their production. Additionally, inflationary costs of transport and spares for the cold chain, create spiralling added costs for the consumer. Zambia has a deficit of fish supplies of about 20,000 MT since foreign exchange has reduced imports.

The artisanal and small-scale operations present a greater post-harvest loss problem of processing, storage and transport, but the sale price of their product is less. While at fishing camps and villages there are drying racks and some smoking facilities, post-harvest losses through spoilage, insect infestation etc. are stated to amount to 35% or greater. Access roads, equipment and supply services have been the subject of major investment programmes to relieve these problems. The Msumbu area of Lake Tanganyika is cited as typical of such problems. Cost-efficient systems for processing packaging and storage remain major problems for this type of fishery. The increasing costs of production coupled with the post-harvest losses are recognised problems in the fishery plan.

In brief: 1) The greatest challenge and opportunity for increased fish consumption from artisanal production systems in the lakes of eastern and southern Africa depend on better processing, packaging and storage systems to provide low-cost fish supplies.

2) Freezing and cold storage plants and refrigerated transport, in general, need new equipment, greater production quantities for through-put cost-efficiency, and preparation of value-added products for profitability. However, their high operational cost and maintenance requirements in forex for spares, fuel, etc. are critical factors affecting market prices.

Many of the larger fish plants (like SOPELAC) are parastatal companies and are seeking joint-venture for upgraded operations. The opportunity seems favourable for preparing value-added fish products (fillets, specialty packs and fish leather) and will depend on increased supplies. This may be another appropriate enterprise for investment promotion.

As regards the products of artisanal fish processing, the most promising opportunity was indicated to be the development of shrink-on packaging of well processed products which are prepared at a central packing plant. It is acknowledged that the dried and smoked fish is the most popular low-cost rural consumption product where avoidance of wastes can have considerable impact on supplies.

National Council for Scientific Research:

Their food technology and isotopes research unit comprising food irradiation scientists, microbiologists and support technicians have processed various foods in their cobalt-60, gamma irradiation plant. They have previously worked on onions and other vegetables and fruit with a view to increased shelf-life of fruit and to control premature sprouting of onions. They have a small Bulgarian irradiation unit for samples up to 1 Kg as well as a 4-ton multi-purpose batch irradiation pilot plant built by Group CEA, ORIS Industrial, France. This pilot plant has been installed since 1987. NCSR has the capability of determining effective treatment for packaged fish products for safe storage at ambient temperatures under the varied climatic zones of Zambia, (which are typical and representative of adjacent countries).

Discussions with Prof. Siamwanza indicated his agreement in principle for such studies on fish, if supported by UNIDO or IAEA. However the food technology group, though expressing interest, indicated that their programme commitments did not include fish. While agreeing that they had the staff and capability to do the study, they felt that the major problem was one of logistics in collecting and packaging fish (whether Kapenta or smoked larger types).

Subsequently B.E. Chishya accompanied the mission on a visit to Siavonga on Lake Kariba where Kapenta was being caught and processed. Though the limitations of their landing and processing facilities were evident, the impact of the problem of storage and losses could not be well illustrated because of the period of the visit and movement of supplies.

Shelf-life comparison of processed Kapenta and other fish products treated by irradiation with normally processed products could be investigated when stored at ambient temperatures. This pilot study can be of significance for fish consumption and supplies for SADCC countries where substantial post-harvest losses occur. The UNDPRR indicated that if such a study were formally requested by the Planning Ministry, funds may be available through UNDP IPF. It should be noted that a similar study is likely to be done in Ghana for W. African fish products and storage conditions.

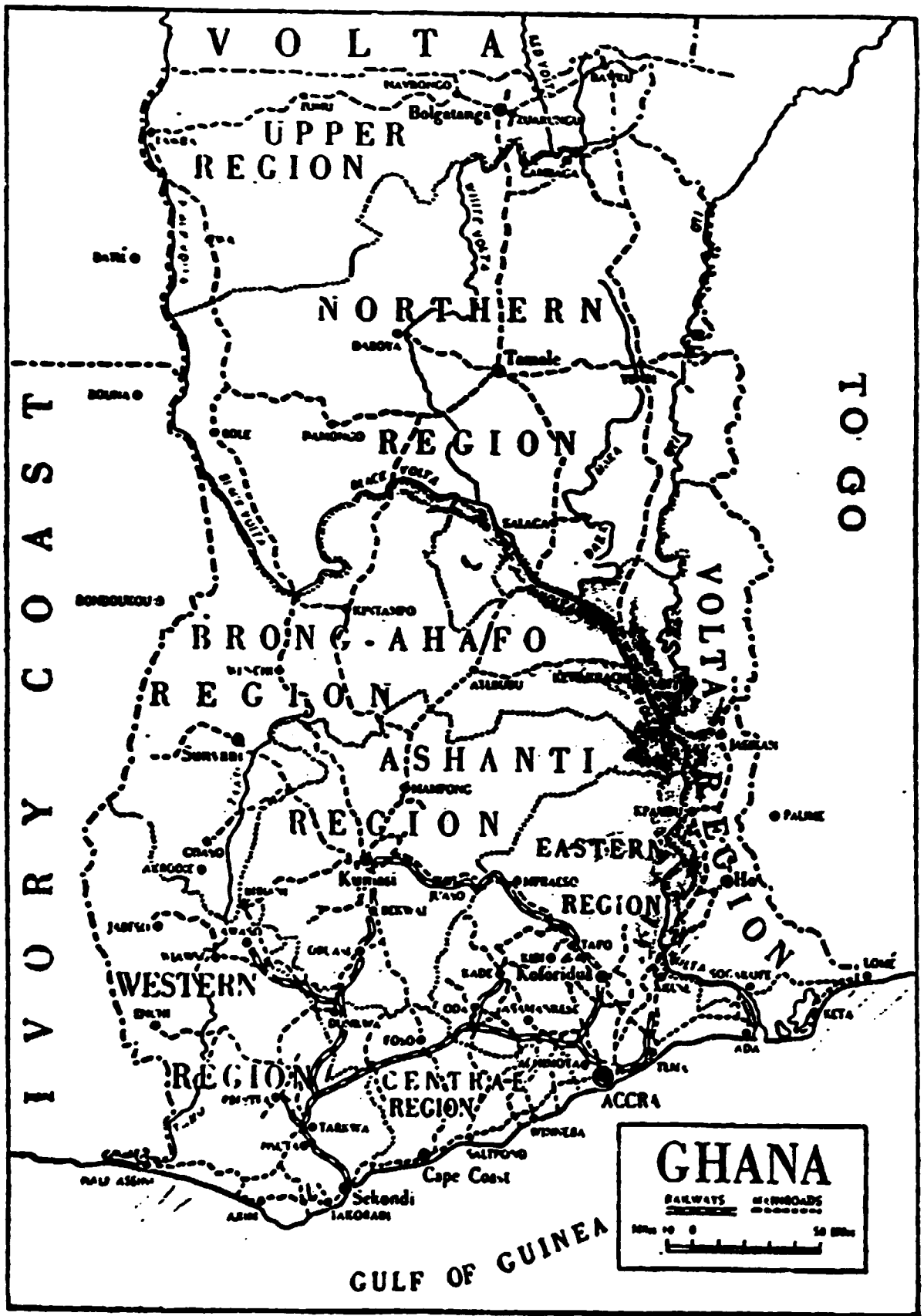
Other focal points of the Forum:

Fishing craft manufacture and the supply of fishing gear are major constraints in Zambia. Both activities are conducted by parastatal companies of INDECO viz. Kafue Boatyards and Nkwazi Net manufacturing company.

It has been generally indicated that their main operating problems were raw material procurement, foreign exchange, competitive equipment obtained from neighboring countries and the general low production quantities. Again it was said that joint-venture investors would be of interest.

Both these industrial enterprises could be further assisted through collaboration with other similar activities in PTA countries. Evidently the procurement of supplies for the Mogadischu boatyard has developed to the degree where they offer their services as a procurement agency to provide supplies needed by smaller boatyards in other countries. Similarly the study of the specific supply and operational problems of Kenya's fishnet factory in Kisumu may help indicate significant policy decisions for such small industries in PTA countries. Perhaps these approaches can be facilitated by SIDFA as follow-up to the Forum.





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### 3.4. GHANA:

General: A programme of visits and discussions was arranged by the JPO at various government departments and private enterprises. The site visits to Kpandu, Tema and Kumasi University were undertaken, but observations at artisanal fish smoking villages could not be accomplished.

It should be noted that, quite apart from fisheries, Ghana has given much emphasis recently to appropriate technologies and the development of small industry technologies. Accordingly, the aptness of their approach regarding mechanisms and successful experiences may be usefully compared with other countries and regions.

Since Ghana was the host of the Forum, it was considered useful to see exemplary activities which may be visited by Forum participants in addition to discussing possible institutions and specialist contributions to the proceedings of the Forum. Accordingly, discussions with the Department of Fisheries, Ministry of Industry, Food Research Institute, Boatyards, Universities and Atomic Energy Research Centre took place.

#### 3.4.1. Boatbuilding: (West African lead centre).

The importance of a boatbuilding industry for the fisheries of West Africa has been well recognised. The majority of small craft that harvest the inshore or coastal fishery resources are dugout canoes. There are probably more than 30,000 in operation in sea and inland waters. Apart

from their limited operational range and gear capabilities during favourable weather, their construction is wasteful in the use of timber. Such forest resources of large trees are rapidly diminishing and the huge trees that are needed to make the large canoes have become very scarce. Therefore many different planked fishing craft have been designed and tested to replace the canoe. These aim to have more seaworthiness, operating range, fishing versatility and carrying capacity or payload.

Ghana Boatyards Corporation has been the first shipyard in West Africa for planked fishboat construction, enlarging from its initial operations at Sekondi to the present site when Tema port facilities were built. It constructs multi-purpose 45 and 65 foot fish vessels, while Sekondi builds the smaller craft, using Ghana hardwoods like Kusia and Odum. Despite its proud history of achievements the yard has experienced economic difficulties, sorely needs replacement machinery, and suffers from forex procurement constraints re engines and fittings for vessels.

Its operational experience has provided professional training for the technicians who now manage 3 private boatyards, at Tema, Elmina and Winnebah, which have also built vessels for neighbouring countries. Ghana Boatyards has produced over 300 fishing and other vessels of varying designs for Ghana, Nigeria, Sierra Leone and other West African countries. They have also supplied vessels for users in Britain, Europe and elsewhere, since the renowned durability of the West African hardwoods provide very satisfactory seagoing usage for such craft.

Currently they accept overseas orders, where the engines, deck machinery and major equipment are supplied by the purchaser, and thus require no forex procurement by GBC. They are also eager to consider joint-venture partnership for their expansion and are being assessed as part of International Bank financing for industrial rehabilitation.

A workshop in Ghana on small-scale boatbuilding and boat repair technology for selected West African countries was organised in late 1987 by Engineering Industries Branch D10 of UNIDO. Seven countries participated and reviewed the many technical difficulties encountered in the industry, ranging from qualified technicians, managerial skills, modern equipment and adequate resources to the provision of competitive and efficient services.

An Association of Shipbuilders and Repairers of West and Central African countries was established with a secretariat in Douala, Cameroon. It aimed to strengthen regional self-reliance for maintenance of maritime smallcraft, while promoting collaboration and appropriate policies in order to assist economic vessel construction, as well as standardisation of design and equipment. The workshop requested UNIDO to sponsor follow-up action to foster cooperation among countries, to upgrade and strengthen this industrial section. Participants illustrated the current importance and increasing future needs. Particular emphasis was given to the challenge of replacing the dugout canoe with a suitable, efficient and affordable craft. It was felt by Ghana Boatyards that this Forum may conveniently foster those aims as concrete follow-up actions.

While this workshop did not focus exclusively on fishboats, most of the discussants emphasised the importance of such local vessels for exploiting marine resources. Apart from river and lake transport, the dominant numbers of fishing craft were considered to be the most productive full-time vessels used by coastal and riparian communities.

The upgrading of this industrial technology will therefore have significant spin-off benefits with much social and economic impact, while effectively utilising timber resources. The workshop's report is available as UNIDO 10.69 (Spec) of 5 February, 1988.

### 3.4.2. Fish Processing Systems.

From its inception, the Food Research Institute has been involved in fish processing studies, with a view to improving the traditional fish products. Such investigations have examined smoking kilns and products, as well as drying and salting of various fish products.

Since the main fish preservation system in W. Africa is smoking, much effort has been concentrated on smoking ovens or kilns. Currently the "Chorkor" oven seems to be considered as the accepted standard. Many variants of this hot-smoking or barbecue oven have been devised in several countries of W. Africa. Tests have been conducted on their fuel efficiency, fish capacity, construction material (earth, brick, metal drums, corrugated zinc, etc.) and operating costs. However, upgrading of processing systems for the horizon of year 2000 must consider the current developments in tropical S.E. Asia, and aim for greater efficiency.

The improvement of traditional fish products in W. African countries is the subject of on-going EEC, FAO, UNICEF and bilateral assistance projects. However, limited efforts seem to be concentrating on the packaging of traditionally prepared fish products. Public health regulations have had their impact on many other marketed food products, which are publicly displayed in the open stands of urban and rural markets. Thus, loaves of bread are required to be packed in plastic bags.

Many other food products are similarly packaged to avoid contamination from flies, dust, etc. However, in W. Africa generally this is not the case for fish products in public markets.

It is recognised that the bulk of fish consumed is processed by small units at artisanal family level and not at industrial complexes. However, if there is to be any organised packaging system it may need to be done at centralised locations of cooperatives or community fishing centres, for cost-efficiency as well as safe hygienic standards

Canneries:

There are 3 Ghanaian canneries involved with products. A study of their operational constraints has been undertaken by the FIS team during their visit. Further aspects concerned the possible manufacture of standard cans from sheet aluminium by the ALU Works, which had begun a feasibility study of a can fabrication system to expand their aluminium products. They projected the initial annual manufacture of 60 million cans for fruit juices, as well as fish products.

This enterprise, which is largely a privately financed subsidiary of FATA - New Hunter Engineering SDA of Milan, is negotiating further development with the assistance of Italian Government loan/grant. When this enterprise develops, the prospects for locally canned fish products may be broadened.

Net-making factories:

Ghana, like many other W. African countries, has established fishnet factories to supply local fisheries. There is such a diverse set of mesh sizes and thread denier that it has been practically impossible to supply all needs. However, this is stated to be a major handicap particularly for mechanised vessels. It is implied that much of the artisanal netting supplies are somehow provided, even by barter trading across borders.

It has been indicated also that an EEC/Ghana Agricultural Development Bank line-of-credit operation for gear supplies has been functional. The operation is being assisted by MacAlister Elliot and Partners of Lymington, Hampshire, UK (See J. Weeks FIS/MEPS).

Plastic floats for fishnets are also extruded at a factory in Tema. These floats are suitable for surface and shallow-water fishing gear but, evidently, not for deepwater trawls.

### 3.4.3. Irradiation of Fish Products - GAEC.

The food technology unit of Ghana Atomic Energy Commission at Kwabenya has conducted various investigative studies on the shelf-life and consumable state of smoked tuna and herrings after irradiation with varied dosages of cobalt 60. These studies demonstrated the potential for safe prolonged storage at ambient temperatures with products packed in different materials. Their experiments, though conducted with small samples, indicated promising possibilities for commercial application.

The food technology unit has had considerable experience with irradiated products such as cocoa, maize, beans, etc. with some experience with fruit and vegetables. They will shortly have a pilot pre-commercial facility (provided by IAEA) which is under construction, to be finished by end of 1989. They will then have a capability of dealing with batches of products of up to 4 tons per treatment. Meanwhile they are eager to offer their services in collaboration with Côte d'Ivoire, Nigeria or other industrial processing facilities.

Their capability and past experience enables them to do technical analysis of laboratory irradiated fish samples. They can monitor the microbiology, texture analysis, acceptable quality, packaging control, as well as the organoleptic taste-panel evaluation of the product type, as far as its consumption acceptability.

**NOTE:** They are agreed to undertake a study which will assess the effect of dosages of irradiation on different fish products (smoked/dried, sun-dried, dry-salted) and species with different fat and moisture content. The effective storage and consumability of products can be studied at ambient temperatures for various parts of Ghana (25 to 35 degrees C.); at normal humidities (15% to 95%); in full daylight or in enclosed dark conditions. This investigation can be designed to indicate, more precisely, the treatments, packaging and storage conditions which can most effectively be industrially applied. This can determine the optimum system for prolonging shelf-life for the distribution and

marketing of traditional fish products under normal West African rural conditions.

Such a study, if supported by IAEA, will be of considerable significance for the industrial irradiation plants planned for W. Africa (Cote d'Ivoire, Nigeria, Ghana). Subsequently it was discussed with Prodexi in Côte d'Ivoire and they agreed to collaborate fully with GAEC in the conduct of such a study using their facilities when available. This was further discussed with IAEA officials who agreed in principle.

#### 3.4.4. Technology Transfer Institutions:

Ghana has given much emphasis to development of small industries and transfer of industrial technologies for small enterprises. Accordingly, there has been established in 1972 a Technology Consultancy Centre (TCC) as a unit of the University of Science and Technology at Kumasi, as well as (1980) Intermediate Technology Transfer Unit (ITTU). This ITTU at Suame, is located in what is described as "Ghana's largest informal industrial area" and concentrates on metallurgy and carpentry. Subsequently (1987) the Ministry of Industries and Technology established Ghana Regional Appropriate Technology Industrial Service (GRATIS) to set up an ITTU in each region of Ghana.

These ITTU's deal with food processing, agriculture, fish farming, ceramics, beekeeping, soapmaking and textile weaving. They aim to provide training in the manufacture and operation of simple machinery and systems for the above-mentioned activities. Their activities have received high profile attention of Government support and attracted considerable technical assistance inputs from various international agencies (EEC, FAO, CIDA, UNICEF, USAID, GTZ, IFS, SKAT, UNESCO), as well as local banks and volunteer NGO services.



Though their technologies are focussed on small enterprise, they are clearly advocated as "appropriate technologies" for local conditions and will therefore be most relevant for the Forum. Particularly significant may be the comparison of how these Ghanaian mechanisms for technology transfer have been established, with the experiences of other regions. This refers specifically to the first part of the Agenda of the Forum.

The activities of TCC in Ghana have been directly linked and interacting with several appropriate technology organisations overseas. For instance, German Appropriate Technology Exchange of GTZ has helped the TCC Fish Seed and Feed pilot project. Appropriate Technology for Development (APT) of Gloucestershire, UK, have helped engineering workshops. Swiss Centre for Appropriate Technology (SKAT) and UNDP Fund for Women (UNIFEM) also support specific projects. These various inputs from local and foreign sponsors have generated considerable and widespread national activities and earnings.

#### 3.4.5. Industrial Fish Hatcheries:

Ghana had launched a major national campaign for the promotion of fishculture in ponds and stocking of small dams for on-site fish production. The campaign was frustrated largely because of limited supply of juvenile fish. Many special efforts were made for "fishseed production units", but basically there was an inadequacy of select broodstock of the recommended species to propagate the required quantities of fishseed. Private fish farmers have undertaken to supply these needs, but it is stated that the species and growth performance of fishseed is generally uncertain. TCC in Kumasi, Universities and the Institute of Aquatic Biology have become involved in modernised hatchery systems, but none of these undertakings is currently functioning as hoped. The Fishery Department indicated that their efforts concentrated on extension advice since they could not satisfy the fishseed requirements.

In keeping with the recognised potential of cultivating Tilapia nilotica and other indigenous species like Distichodus, Labeo, demand for fry by artificial breeding of these fish is estimated as at least 20 million annually. It

is stated that private enterprises (such as Pacific Farms at Ashiaman, Mankoadze-Winnebah Farms and others in Kumasi and Upper Ghana) provide unknown quantities of fishseed. Clearly the operation of industrial hatcheries to provide the requirements offer considerable opportunity.

The Institute of Aquatic Biology is establishing a fish farm and hatchery complex at Akasombo below the large dam. They currently operate 34 earthen ponds, plan to have 60 and are constructing the hatchery raceways and pools. The Director, Dr. M.A. Odei, indicated that their objectives were research oriented, but eventually they hoped to provide select broodstock, with known growth performance, for supply to fish farmers. They are encountering some construction and operational problems and expect shortly to appoint a practical fish farm manager. The current activities are supervised by a research officer, Mr. Ofori.

The installations are adjacent to the Volta River flowing from the Akosombo dam, from which their water supplies are obtained. Problems include predation by hawks and difficulties to eliminate wild undesirable fish in the earth ponds. However, this aquaculture complex has good potential for establishing mass hatchery production of fishseed from select and isolated broodstock. The remaining ponds to be constructed may be usefully designed for such purpose, maintaining in segregation the different species available from Volta Lake. Similarly, the completion of the hatchery complex can fulfill both an investigative and production function as they standardise the performance of fishseed from select broodstock. Fishfeeds seemed to be an unresolved problem.

"Kpong Farms" is part of an agricultural joint-venture with Acres International and the Volta River Authority Kpong hydro-electric project. They comprised initially 100 Ha of irrigated land and gravity fed system for rice cultivation. Currently private farmers cultivate over 200 acres in the Akuse-Kpong area with management inputs from the enterprise. Among their pilot schemes has been fishculture development of the tertiary wastewater ponds of the village. Their promising yields when integrated with poultry and livestock indicated a need for more professional inputs in aquaculture systems.

Kpong Farms has adequate controlled supplies of water, equipment and management services which are opportune for developing fishfarming. The establishment of a joint-venture fish hatchery enterprise was of interest to the Executive Engineer, who indicated that a proper feasibility study

is stated that private enterprises (such as Pacific Farms at Ashiaman, Mankoadze-Winnebah Farms and others in Kumasi and Upper Ghana) provide unknown quantities of fishseed. Clearly the operation of industrial hatcheries to provide the requirements offer considerable opportunity.

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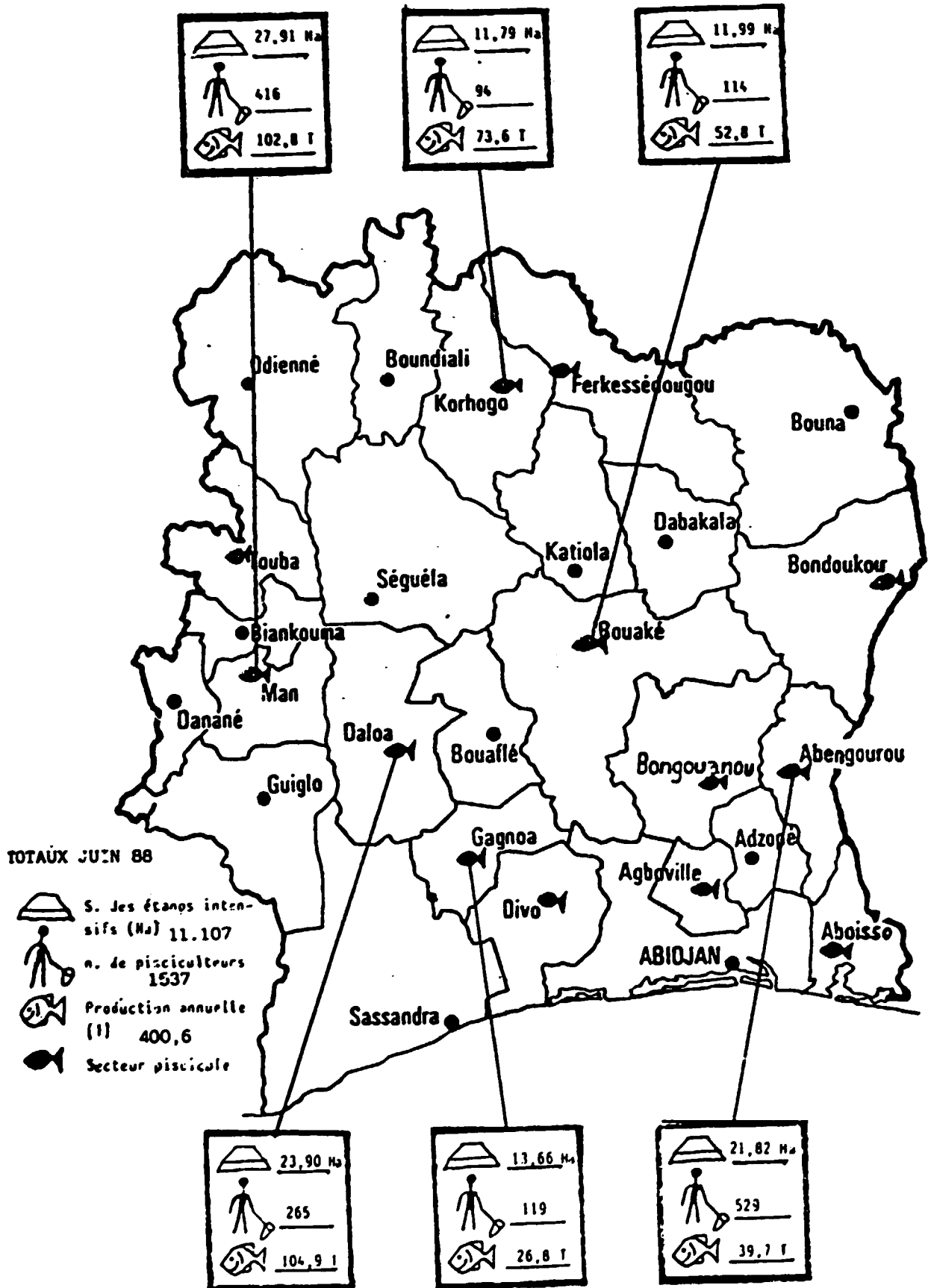
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Kpong Farms has adequate controlled supplies of water, equipment and management services which are opportune for developing fishfarming. The establishment of a joint-venture fish hatchery enterprise was of interest to the Executive Engineer, who indicated that a proper feasibility study should be undertaken. This should examine how their facilities and services can be profitably developed through partnership with professional industrial fishculture. (This matter was brought to the attention of the industry investment promotion division).

Superficie des étangs intensifs, nombre de pisciculteurs et production annuelle par Division au 30 Juin 1988

COTE D'IVOIRE.



The boundaries shown on this map do not imply official endorsement or acceptance by the United Nations Industrial Development Organization.

### 3.5. COTE D'IVOIRE.

#### 3.5.1. Fish products and food preservation:

Prodexi-Conservation S.A. is a commercial company, jointly established by the Government with Ivorian and French funding, for the purpose of irradiation and storage of clean packaged foods. Their installation will be completed and operational in July/August, 1989. Initially they will treat yams, pineapples, mangoes and other fruit from national cooperatives, on a contractual basis. By using cobalt 60 gamma irradiation they have shown that the safe storage life of these foods can be extended by avoiding sprouting, spoilage and insect infestation. Accordingly, the market availability and price can be stabilised throughout the year. Additionally, the foreign exports of various fruit can be increased.

3.5.1.1. Prodexi was introduced to the consultant through the Food Preservation Division of IAEA, who indicated in August that this project was underway. Subsequently, during his UNDP fishery mission in October, 1988 efforts were made to see them, but the contact was further explored in December by the JPO of UNIDO in Abidjan. Their interest was then indicated. There is keen interest by IAEA in this commercial application of cobalt irradiation for food processing in Africa. Thus apart from providing contacts for the Canadian manufacturers of the Prodexi plant (NORDION International, Inc.), they briefed the consultant on the status of other food irradiation facilities in Africa. As a result, the consultant had the opportunity of observing the physical facilities and laboratory equipment available and used in Zambia, Ghana and Ivory Coast. Prodexi will be the first commercial facility to be established in Sub-Sahara Africa. Zambia's pilot plant has been used for various food products but not fish. Ghana's have been the only experiments with local fish products in African market conditions.

3.5.1.2. The President Directeur General of Prodexi indicated that their aim was initially to process 35,000 tons of yam yearly, moving towards the total national production of 2.3 million tons, of which 40% was lost through spoilage. Subsequently, when working at full capacity and 3 shifts, they could accept various other foods for which the treatment has been standardised. While some initial tests have been made for them with fresh fish (by Gammaster B.V. of Wageningen in Holland), they are very interested in further collaboration through IAEA, with Ghana Atomic Energy to carry out preparatory tests on irradiated smoked fish products under

normal local storage conditions. Once organised, they consider that they will eventually be in a position to process packaged smoked fish products and even meat products.

3.5.1.3. They had estimated that the costs of irradiation should not exceed 10 cfa per kg. They anticipated that despite variation in supplies, they could contribute to market stability through the storage arrangements with cooperatives. This will progressively contribute towards national food self-sufficiency by the year 2000.

3.5.1.4. The irradiation of food products to avoid post-harvest losses has been a matter of considerable interest to the African Development Bank. Other countries have made enquiries and this development of Prodexi will be closely followed. Because the process is continuously used for various export products (fish, meats, fruit) in Holland and has been approved by the Joint Committee of WHO, FAO and IAEA, with Codex Alimentarius standards, it is also of interest to UNDP. The Planning Directorate of the Government (DGGTx) evidently expressed support in principle for the extension of the process to cover fish products. The main difficulty foreseen is the collection of products from the scattered fish-smoking centres, in standardised packs and of uniform quality. Consequently, this pioneer development in Ivory Coast, for food products in general, should be viewed with careful attention. This is especially because there have been public misconceptions and much sensitivity expressed regarding this process in developed countries, despite explicit statements based on valid exhaustive research studies.

3.5.1.5. Since the consultant was accompanied to the Prodexi complex by an officer of INFOPECHE, a special precautionary visit was made to their project manager. It was requested that no premature publicity be given in the monthly journal INFOPECHE to this initiative, without the prior clearance of the Prodexi.

It was further suggested that the Joint FAO/WHO/IAEA Committee's statement on food irradiation, with regard to fish products, should preferably be given prior publication. Any imprudent intimation of the initiatives being undertaken by the commercial or research enterprises in Africa may create problems through public misconceptions. This will also be most relevant for press releases at the Forum on this subject.

3.5.1.6. The commercial secretary of the Canadian Embassy indicated that the manufacturers of the plant equipment from Ontario were solicitously following developments and may be interested in participating with exhibits at the Forum. He stressed the need for prudent publicity because of the confusion with toxic nuclear radiation, which has been spread by ill-informed opponents of the gamma irradiation process. Similar concerns were also voiced by the UNDP RR, though he indicated much interest in this development.

3.5.2. Mass hatchery production of fishseed:

The Government of Cote d'Ivoire has been a strong African advocate of fishculture for supplying interior populations with fresh fish. For over 30 years there have been Ivorian research and development institutes dealing with aquaculture and enhancement of fish stocks in reservoir dams and coastal lagoons. Consequently, they have many private aquaculture activities. From 1977 UNDP has supported 3 successive projects for rural subsistence aquaculture development which now extends over the entire country. Several private enterprises (small and large) have been started for fish production by intensive aquaculture systems. There is much public enthusiasm to undertake commercial aquaculture. However, the main constraint has been the gross inadequacy of supplies of select juvenile fish.

The UNDP review mission's report indicated that the aquaculture programme achieved less than 30% of the project's target production figure of tilapia fingerlings and less than 5% of the target quantities for catfish. Meanwhile, the annual national demand for such fishseed production is estimated to be above 10 times the targets for the next five years. Consequently, there is clearly an opportunity for private enterprise to contribute towards satisfying these needs.

The major government institutions which are involved in developmental research in fish breeding activities have been established by ORSTOM and CTFT, and are now run as national enterprises, viz. CRO at Jacqueville, Grand Lahou and IDESSA at Bouaké. These two installations produce catfish and Tilapia nilotica from select broodstock. CRO has established a commercial-scale enterprise at Jacqueville which is capable of producing about 5 to 10 million catfish for brackishwater lagoon culture systems. They have not yet adapted this capability for the mass production of the freshwater species Clarias lazercia which is in great demand for African aquaculture.

In discussion at CRO with the Director, the aquaculturist and the fishfeed technologist, much interest was shown in the idea of industrial supplies for regional needs. They estimated that the current annual need for Chrysichthys and Heterobranchus can perhaps be easily tripled in their present production systems. Their capability in controlling the spawning of their broodstock meant that they could readily increase the through-put of their facilities and supply large quantities of fingerlings for stocking waterbodies. The production cost of fingerlings was influenced by high feed costs. This must therefore be an integral part of an industrial mass hatchery system, i.e. the cost-efficient manufacture of suitable fishfeed from agricultural waste products. Pilot feed plants already produce promising products.

CRO was consequently receptive to further examining the possibility of joint-venture investment to produce fishseed for national and regional needs. They consider that this should be the subject of further correspondence with UNIDO's investment promotion division, and they would assist in providing further data for a detailed feasibility study. They are keen to participate in the Forum and to provide a paper on "Experience and Perspectives for Industrial Hatchery Catfish Production to supply Needs for Ivorian and Francophone African Countries".

### 3.5.3. United Nations Development Programme:

The UNDP Representative indicated his interest in the developments that may follow the Forum's recommendations, particularly with regard to projects that may have future inputs from IPF contributions. The aspect of food irradiation may be most important, but perhaps planked craft that are to be built at San Pedro, as well as industrial hatcheries and fish leather may be of possible interest for the African Project Development Facility.



#### 4. SUGGESTED FOCUS OF TECHNOLOGIES.

The foregoing account provides the highlights and rationale of discussions and observations at 3 International Agencies, the Economic Commission for Africa and the technical departments of the 5 countries visited. It is evident that within the broad categories of the Forum there are many significant aspects which have been given priority attention. Among these some appear to be more favourably positioned for achieving results and even "profitable breakthroughs" in the medium term.

Accordingly, it would seem opportune for the Forum to focus particularly on those aspects. Even though some of these technologies present considerable difficulties in their application, it may be that their discussion at this Forum may serve to catalyse and promote fruitful attention. Such complex technologies, which present different levels of development, but are recognised as being essential for the fishing industry, for instance, may include certain aspects of boat building, gear manufacture, packaging of traditional processed products. However, the successful operational systems in these disciplines which can be identified in tropical Asia may, in their transfer to Africa, provide the partnership.

Other technologies may seem more attractive for "fast track" development. In this regard the UNIDO Trust Fund for industrial cooperation may be able to assist in assessment studies, negotiations and help further technical assistance.

In addition to these suggestions it became apparent that certain overview papers and documents could be most usefully made available for participants. These would also enable a more focussed review of technologies judged to be appropriate for African application. Further, since documentation may not easily arrive well in advance of the Forum, it may be strategically wise to permit a break, in the form of a field trip, to institutions on Day 2, after the formal opening and introductory sessions. In this way the participants can read the background papers and also relate, from practical Ghana observations and field comparisons, with their own national experience of that technology.

Such desirable overview papers are suggested as Annex 5 II. Documents which should be available to participants are specially marked in the references listed in Annex 4.

The role of Women in the Fisheries industrial system has been suggested as an additional topic for focussed discussion by the Forum. It is recognised that their role in the sanitary processing and marketing of fish products is critically important in Asia. Their dominant role in this sector clearly provides opportunities for improved technologies in Africa. (See UNIDO document V.87-85205 which illustrates the situation in Senegal).

It is also observed that Asian women have developed a particularly useful capability in the operation of industrial fish hatcheries and fingerling nurseries. Their skillful handling of delicate eggs and juvenile fish have established an important niche in their contribution in this enlarging industrial activity. TCDC transfer may be thus effectively pursued.

Seaweed Production and Processing is another industrial technology which has been introduced sporadically along the coast of suitable areas in Africa. Many coastal regions possess valuable natural stocks of red seaweeds which may be used as raw materials for agar and carrageenan industrial products. The successful industrial seafarming and processing of these seaweeds in Philippines and Indonesian fishing communities indicate several benefits that accrue to such areas. The further development of several African pilot enterprises should be considered and their promotion in suitable areas where shoal and lagoon areas or nutrient upwelling provide favourable sites. This may be of particular application along coasts of Sudan, Somalia, Tanzania, Madagascar, as well as off Guinea and Angola, apart from island states.

The recommendations of the UNIDO expert working group on marine algae may be considered for practical follow-up action (See UNIDO document V.87-83894).

## 5. Conclusions:

The findings of UNIDO's 1978 technical meeting on applying appropriate technologies for developing countries are still relevant and perhaps should be reiterated:

"Fish provides less than 0.2 per cent of world food energy requirements but accounts for about 20 per cent of the animal protein in the human diet. Improvements in fish preservation would make available larger quantities of a valuable source of protein. Smoking, drying, salting and canning are the best known techniques. Analysis of alternative techniques has led to the conclusion that smoke drying is the most appropriate technique for fish preservation for distant inland markets. Canning has been ruled out as being energy intensive. It is further argued that smoke drying also provides greater employment opportunities and has lower investment costs.

"To promote decentralization, it has been suggested that even where conditions permit large-scale fisheries with geographically concentrated landings, the catch could be turned over to a cluster of small smoke-drying and salting enterprises adjacent to the fishing harbour, rather than to a large cannery. It should be noted, however, that when fish is to be preserved or processed for export, more sophisticated technologies than smoke drying are indicated.

"When examining alternative technologies for food processing industries, one should also examine the benefits of recycling the residues and the measures that should be adopted for their exploitation.

"Certain policy issues are indicated: Small-scale drying and smoking should be encouraged as being more labour intensive and less costly. Processing for exports would call for more sophisticated techniques.

"The policy measures call for extensive development and promotion of technologies for much wider application of appropriate techniques, already known and used, and conscious efforts to reduce energy consumption.

"An important policy consideration would be to take positive measures to develop and popularize indigenous products that would meet the requirements of most of the population. An issue to be considered is the nature of the disincentives needed to discourage the use of inappropriate techniques and products designed to cater to non-essential demands. It is important that there be a predominance of national ownership of the capital invested.

"To strengthen national technological capability, a continuous search of alternative technologies and their appraisal and maintenance of inventories of up-to-date knowledge of a range of imported and domestic technologies is suggested."

The new imperative for state-of-the art technologies is to cater for export products which are acceptable for international trade, and competitively capable of foreign exchange earnings, by the developing country.

The suggested technologies on which the discussion may focus should aim at the general formulation of follow-up projects. This should seek to benefit from the technical views of participants as to the practicality of their implementation, indicating problems or special opportunities to be considered, without going into too great details.

Since some projects are virtually in the pipeline for implementation (e.g. fish irradiation, fish leather, fishboats) perhaps specialised Forum working groups can promote these. However, others that are difficult but desirable priorities for action (such as, packaging, industrial hatcheries, fishing gear) should have particular attention from working groups.

The Forum may also seek to establish technical corresponding working groups, which can interact on a continuing basis after the Forum, for the exchange of information and to promote development in some specific technology. They may serve as a "think tank" for investment promotion and in liaison for TCDC.

The specific actions which are suggested in each section have been brought together as a summary which is placed at the front of this report.

Annex 1

References

The following are of direct relevance to Forum's agenda:

1. Industrial Development strategies for Fisheries Systems - Vol 1  
Sectoral Studies Series N.32 (E.F.S.) UNIDO/FAO.
2. Appropriate Industrial Technology for Food Storage and Processing.  
Monographs on Appropriate Industrial Technology No 7 UNIDO/ID/232/7.
3. Consultation on the Fisheries Industry Gdansk 1987. The Integration  
of Women in the Fisheries Industries System UNIDO/PPD 34
4. Expert Group Meeting on Industrial Growing and Processing of Marine  
Algae, Riga 1986 UNIDO/IPCT 23
5. Food Irradiation Processing 24p IAEA 1984.
6. Food Irradiation Processing International Symposium on Food Irradiation  
Processing Wahington DC 4 8 March 1985 Proceedings 553p IAEA/FAO
7. Packaging Trends in Frozen Food Consuma Magazine (Singapore) by  
L Bjorkengren
8. Radiation Processing of Fisheries Products Food Technology (USA) by  
George G Giddings.
9. Report on the Project Seminar on Improved Utilization of Nile Perch  
Kisumu Kenya 28 31 March 1988 FAO/GCP/KEN/055/NET
10. Optimization of Filleting Methods for Nile Perch by J.W M Gouda  
FAO/FI/GCP/KEN/055/NET