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P A P E R VI

FISHERIES INDUSTRIES

The FAO Contribution to this Symposium includes in addition to the one mentioned above six other papers entitled:

- I: The Economic Significance and Contribution of Industries based on Renewable Natural Resources and the Policies and Institutions Required for their Development.
- II: Some Essential Requisites for Industrial Development of Renewable Natural Resources.
- III: Food and Food Products Industries.
- IV: Industries Processing Agricultural Products other than Food.
- V: Development of Forest Industries.
- VII: FAO's Relations with Industry through the Freedom from Hunger Campaign.

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FISHERIES INDUSTRIES

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FISHERIES INDUSTRIES

Introduction

1. The problems associated with industrial development in fisheries differ in a number of ways from other industries based on renewable natural resources.
2. Fisheries involves exploitation of a raw material source which cannot be seen with the naked eye and thus cannot be as easily quantified as is possible with trees, livestock, or field crops.
3. The catching of fish is a hunting effort in comparison to the harvesting of a land crop. Except for fish stocks whose habitat are in rivers, lakes and territorial marine waters, the resource is available to any nation having the skill, capital, and ingenuity to exploit it. However, fish stocks are not inexhaustible and can be seriously depleted unless proper management practices are applied. This aspect of common property in respect of fishery resources on the high seas, which play an increasingly important role for the world's present and future fish supply, complicates the task of ensuring that their exploitation is in accordance with sound biological and economic criteria. An example of what may happen in the absence of adequate and sufficiently early control measures, is provided by the exploitation of the Antarctic whale stocks, both as regards the present biological state of this resource and the economic situation facing the important industry which was built upon it.
4. The raw material is highly perishable. The catching of fish must be closely coordinated with facilities for prompt handling, preservation and distribution into the hands of the consumer or to processors who will subject the raw material to treatment to further extend its storage life.
5. Modern fishing has become an increasingly technical operation which utilizes highly sophisticated equipment and requires that fishermen be much more skilled than in the past. Also, a modern fishery industry requires substantial capital investment in equipment and facilities to produce the raw material and for utilization.
6. In many areas of the world fishing is still looked upon as a lowly occupation. Relatively large segments of populations are engaged in fishing using equipment of a very primitive nature. These fisheries often are largely a subsistence activity which, in most cases, are very inefficient and of low productivity. While the output of such fisheries can be considerably increased by improving boats and introducing simple but more effective fishing gear and methods, it is difficult to effect major development from such a base.
7. Governments sometimes associate the desire to improve the conditions of a very extensive subsistence fishing population with the objective of developing a productive and viable fishing industry. As a consequence, considerable sums of money can be spent without obtaining the anticipated result. When consideration is being given to the potential role of fisheries in industrial development, it is advisable to differentiate between what may be a necessary and desirable social objective and what is necessary to utilize available fisheries resources to maximum economic advantage in an industrial sense.

Growth of Fisheries Industries

8. The world fish catch has increased by about three-quarters during the past decade and now amounts to approximately 50 million tons annually. Since much of the increase has been due to landings of a lower-value fish for industrial purposes, such as the the manufacture of fish meal and fish oil, the expansion in terms of provisional

FAO price-weighted indices is somewhat less (about 42 percent). Nevertheless, this increase is much greater than the rise in agricultural production or in the output of most individual agricultural products. In the same period productions of agricultural and forest products increased 31 percent and 19 percent respectively. Present knowledge of the production potential of the world's oceans and inland waters, although still limited, indicates that a catch much greater than present levels could be attained and sustained if the world fish stocks were fully exploited and in a rational manner.

9. More than half of the rise in fish production in recent years has come from the fisheries of developing countries. The largest rise in production and consequent increase in industrial development was in the fisheries of Latin America, where the combined catches of Peru and Chile have risen to over 10 million tons in 1964 from less than half a million tons in 1954. This was due chiefly to exploitation of the very abundant stocks of anchoveta off the Pacific Coast of South America.

10. Progress in fisheries development and production in Africa during the past decade has followed somewhat the same quantitative pattern as world fisheries, although its relative position has decreased slightly. Production increased from 1.66 million tons in 1954 to 2.81 million tons in 1963, and to 3.0 million tons in 1964. Between 1954 and 1959, Africa consistently contributed 6.0 to 6.4 percent of the world catch. However since 1959 the relative contribution has decreased to 5.6 percent. Although data on value of the catch to the producer cover only about three-fourths of the reported African catch, these data suggest a current value in local currencies approaching the equivalent of US \$200,000,000.

11. Nearly seventy per cent of the increase in African production has been accounted for from fisheries conducted in waters off the west coast. These fisheries, as along the Pacific coast of South America, are based largely on easily accessible pelagic marine species which occur in considerable abundance and are utilized mainly in industrial fish processing operations.

Some Requisites for Industrial Development in Fisheries

12. Most nations with access to the sea or possessing sizable inland waters are giving increasing attention to developing fisheries industries. Fisheries offer opportunity for increasing the availability of animal protein in the local food supply and for increasing local income. It also represents a potential source of foreign exchange earnings, and a possible base for further industrial development.

13. Although many requisites for industrial development in fisheries are common to those for other industries based on renewable natural resources, there are some aspects of fisheries which are perhaps more critical.

14. Fish stocks, with few exceptions, are not subject to individual ownership. Therefore, it is desirable that there should be an agency in government having specific responsibility for administering and supervising certain fishery activities. Further, the agency should have qualified staff and facilities sufficient to plan and implement research and survey programs, either independently or with outside assistance, to supply types of information which are essential in determining the extent to which development or expansion is justified.

15. Knowledge about the raw material source is especially important in fisheries. Unlike other industries, it is necessary to conduct a hunting operation in order to produce the raw material. Also, in most fisheries, a major proportion of the total capital investment in the industry is required for the equipment and facilities for producing the raw material. Unless there is adequate information regarding the abundance and range of the more important accessible fish stocks, their seasonal occurrence, the most productive fishing areas, the most suitable methods for catching, and the

possible yield of these stocks, it is difficult to reliably determine the extent of the fishing effort that could or should be directed to raw material production. This refers to the number, size and types of fishing vessels to be used.

16. Knowledge of market potential and characteristics also is perhaps more critical in fisheries than in most industries based on agricultural and forest products. Rigid consumer preferences, or prejudices, may constitute a serious barrier to accelerated fishery development. For example, it has been seen that new fish species, in some instances the result of extension of fishing operations to more distant waters, have met with considerable resistance, even aversion, from consumers, who are unfamiliar with such species. In one known case it took as much as three years to introduce marine fish, and make it generally accepted, in a district where the population previously had known only freshwater species.

17. Due to the high perishability of fish, the effort directed to raw material production must be quite closely correlated with market demand for fresh fish and the facilities available for immediate preservation and processing of that part of the supply which will not be consumed fresh. Thus the operations concerned with producing the raw material supply and those concerned with handling, preservation, processing and distribution are less independent of one another than is possible in many other industries. This has led to a certain amount of vertical integration in fisheries industries in the past and the trend is toward a further increase. Another advantage of vertical integration in fisheries, in addition to improved technical control, is, of course, that the producer receives a larger share of the price paid by the consumer, depending on the degree of integration forwards.

Fishing Boats and Fishing Gear

18. The fishing boat equipped with the necessary fishing gear represents the primary tool for raw material production in any fishery industry. Much of the progress that has been made in fishing in developing areas has come from introducing and adapting to local conditions boats and gear which have proven successful in more advanced fisheries. However, it can be dangerous to assume, as has been done in some cases, that boats can be successfully introduced from one part of the world to another without careful study. This includes among others, attention to such practical matters as correlating size with distance to fishing grounds, type of gear to be used, number of crew and fish carrying capacity needed, location of deck equipment, proper protection for the catch, engine power in relation to vessel size, type of gear to be used, maintenance and repair facilities, etc.

19. Since fishing boats normally represent the largest single item of capital investment in a fishery industry, the possibility of supplying these through local construction offers considerable opportunity for developing a supporting industry based on boat building. Advances being made in the development of forest product industries in the manufacture of lumber and marine type plywood in some developing areas are providing highly suitable building materials for wooden boat construction. A number of countries conscious of these possibilities are seeking to have nationals trained in the fields of naval architecture and boat building, and others already have established shipyards engaged in building fishing boats. FAO is contributing to these developments under its technical assistance activities, training courses and technical meetings on fishing boats and resultant publications.

20. The manufacture of fishing net webbing and certain other items required in the construction and/or operation of fishing vessels also offer, in lesser magnitude, opportunity for developing additional industries in support of fishing.

Fishing Harbours

21. As fishing operations progress from small non-powered craft to larger mechanized craft, the matter of adequate harbour facilities becomes of increasing importance. Experience has shown in a number of developing countries that establishing fishing harbours has proved to be a stimulus to fisheries development far beyond what was originally anticipated.

22. A fishing harbour permits greater centralization of fishery activities with all its inherent advantages. By concentrating the catch into major landing ports, it is possible to organize a more effective marketing system and establish more efficient marketing practices. With more boats coming to a centralized place, there is encouragement for and the possibility of establishing better service facilities, including maintenance and repair yards, fueling stations, ice supply, ship stores and fishing supplies. Similarly, the concentration of landings leads to a greater and more regular raw material supply. This permits and encourages establishing facilities for preserving and processing and the development of fish processing industries.

23. In many advanced fishery nations, governments have played a leading role in the planning and provision of central fish landing and marketing facilities, realizing that here lies very often the bottleneck to further development. The cost of providing suitable facilities at a large number of small fishing centres would, in most instances, be out of all proportion to the volume and value of the fish being handled. The provision of basic landing and marketing facilities, including a modern wholesale fish market, is made possible by the concentration of the trade in such volume that the cost can reasonably be recovered at acceptable levels of price.

24. In most advanced fisheries, such facilities are usually looked upon as social capital, the function of which is to stimulate fishery development. They do not, therefore, as a rule, bear profit directly for the entrepreneur, but are always required as the basis of economic development. Their socio-economic functions and the high capital cost involved is perhaps the main reason why governments in many countries have found it necessary and appropriate to assume responsibility for the planning, financing, construction and, to a large extent, administration or supervision of administration of such facilities. If this were done by private industry, one might, in view of the very considerable capital requirements involved, be faced with serious waste of capital through unnecessary competition, or, on the other hand, a situation of monopoly through lack of competition. The latter condition perpetuates certain unattractive practices of traditional fish marketing systems through which the fisherman becomes completely dependent on the owner of facilities required to land and market the fish. The usual arrangement is that the necessary ground in suitable fish landing areas and primary facilities, such as landing facilities, market halls, etc., are provided by the government which, again, provides the incentive and indeed the necessary basis for private industry to move in and establish all the secondary facilities and services, including processing, required for the efficient balancing of supply and demand.

25. An interesting example in Africa of the significance of providing central harbour facilities for fishery development is perhaps afforded by Ghana, who since the Fishing Port at Tema Harbour was constructed, has acquired a modern deepsea fishing fleet of considerable proportions, which again has permitted the establishment of modern processing facilities within the harbour area.

Handling and Preserving the Catch

26. Due to the rapidity with which fish spoils, especially in tropical climates, it is necessary that the catch either be consumed fresh within a period of hours or be subjected to some method of preservation which retards spoilage. This creates a need for facilities for preserving and handling the catch if a fishery industry is to reach

any appreciable stage of development. The type of facilities and services may vary depending on the use to be made of the raw material.

27. For a modern, progressive food fish industry, the use of ice during handling and distribution is in most cases indispensable. In addition to space for preserving and handling the catch, it is obvious that provision should be made for chilled storage of iced wet fish. The supply of good quality fish to industrialized processing plants requires fishing boats or carrier vessels either with chilling facilities or which are fast enough to deliver fish to the plants in the freshest state possible.

28. The application of ice for the preservation of fish in the tropics is not more difficult than in moderate climates. Ice may have an even greater effect on the retardation of spoilage of fish caught in tropical waters if it is used in sufficient quantity. It is quite evident that a greater amount of ice is required at higher ambient temperatures. Ice and iced fish should be protected as much as possible during transport against the direct influence of the sun and the warm air.

29. Ice can be produced as block ice, flake ice, tube ice and in other physical form. Each type has its advantages under certain conditions. Block ice is preferable if ice has to be transported under unfavourable conditions prior to use, since the smaller exposed surface area minimizes loss due to melting. Block ice, however, must be cracked for icing fish. Small ice, such as flake, tube or snow ice, is more convenient for markets or for re-icing of fish during transport. Flake, tube and even snow ice can be used successfully for icing fish aboard vessels if proper procedures are used.

30. The requirements for ice in handling and preserving the catch as "wet fish" in a developing fishery can provide the stimulus for either the introduction or the expansion of an ice manufacturing industry at fishing ports.

Fish Processing Industries

31. Fish which are not to be consumed fresh may be preserved or processed by one or more of several methods, depending on the conditions pertaining. The principal methods are freezing and frozen storage, canning and curing. The latter includes such processing techniques as salting, drying, smoking and fermentation of some combination, as for example salting and drying. Also fish which can be caught in sufficiently large quantity at very low cost, and waste and trimmings from food fish processing, are used to manufacture fish meal and fish oil.

32. Latest FAO statistics (1963) on the disposition of the world catch of fish indicate that 35.3 percent of the catch is consumed fresh, 10.1 percent is preserved by freezing and frozen storage, 17.9 percent is preserved by curing, 8.6 percent is processed by canning, 25.9 percent is used in the manufacture of fish meal and fish oil and 2.2 percent is used in other ways.

33. Statistics on the disposition of the catch of fish taken in African fisheries are as yet fragmentary. These data indicate that a very small proportion of the total catch, perhaps not over 1 to 2 percent, is now frozen. About 6 to 7 percent is reported to be used in canning, and at least 30 percent or more is taken for manufacture into fish meal and fish oil. The remainder of the catch, about 60 percent, including that of the countries not having highly industrialized fish processing operations, is consumed fresh or is preserved by curing. Estimates made on the disposition of the catch taken by 14 West African states indicate that the proportion of the catch that is consumed fresh to fish preserved by curing is about one to two. This would suggest that about 20 percent of the total catch is consumed fresh and about 40 percent is preserved by traditional methods of curing.

34. In planning the development of fish utilization in African countries, the extreme perishability of fish indicates the need for a careful balancing of supply and demand in time and space in view of the climatic conditions; the general economic development including power supply, storage and transport facilities; and the availability of markets for the various products. While traditional processing can be undertaken economically on a periodic basis, industrial processing cannot, due to the necessity for a regular supply of raw material, the high cost of capital equipment and the need to keep higher paid, specialized technical personnel continuously employed. It is essential to determine at what stage activities can be concentrated in order to justify the provision of facilities for centralized landings, large scale processing and quick distribution over large distances, since the conditions which have led to the development of modern fish processing industries generally do not prevail where fisheries are little developed.

Fish Curing

35. The processing methods traditionally used in Africa can be classified as curing. Curing methods have their place in all fisheries of the world and offer possibilities to produce a wide variation of products ranging from simple salted and sun dried fish to delicacies such as smoked salmon and caviar which shows that these methods can be applied to a wide range of species. Inexpensive equipment can be used which can be manufactured locally and easily operated.

36. There are, however, limitations to the use of curing methods connected with climatic conditions prevailing during processing and distribution. Unsalted dried products and smoked fish are difficult to protect against beetle infestation during storage and transport. In areas where cured products are not already known, marketing problems arise in respect of consumer acceptance. In certain areas of Africa, such as the arid and semi-arid zones south of the Sahara, dried unsalted fish is in general use and the consumer refuses salted dried fish. On the other hand, the brown colour due to fat oxidation is accepted while in areas where salted dried fish is in demand only light coloured products are readily acceptable. In spite of all, however, it seems that this preference either for salted or unsalted fish is not so deeply rooted that no change would be possible.

37. The importance and usefulness of curing methods in developing countries is not always recognized and these methods often do not have their appropriate place in development programs. In the efforts to provide fish as a source of valuable protein to populations with low purchasing power, improvements under prevalent conditions should be initiated, especially in areas where the traditional curing methods cannot be replaced in the near future. Moreover, new arrangements for the use of improved methods and equipment suitable for curing in bulk should be made. Products can be improved and, depending on the stage of development of the curing industry, adapted according to the changing taste of the consumer. Such arrangements would gradually pave the way to industrialized processing using mechanized equipment.

Fish Freezing

38. Freezing is at present the only method which can preserve the fresh fish characteristics during long storage. In addition it offers, if applied on a large scale, the following advantages common to industrialized processing:

- Consistent quality
- Products variety
- Possibility to stabilize supply and price
- Hygienic packaging and distribution
- Standardization of product type
- Extension of range of retail outlets

Providing an incentive for individual
manufacturers to use modern advertising

39. These obvious advantages of freezing over chilling make the widespread interest in developing countries towards establishing fish freezing plants and frozen storage facilities understandable. On the other hand, the initial capital investment is high and the costs of storage and distribution are substantial if fish is properly stored in a cold chain. It is, therefore, essential to determine not only the cost and type of any particular processing equipment and method, but also the type and cost of facilities and services required after the stage of landing and processing, in order to bring the products to their final destination, that is the consumer, in a satisfactory state. Thus, the possibilities of marketing frozen fish are directly related to the capacity and geographical range of cold storage distribution facilities, including transport, both at the wholesale and retail stages, and, to some extent, also to the number of consumers possessing a refrigerator in their homes. If no such chain exists, one will have to consider very carefully the economic implications of establishing such a chain based on frozen fish distribution alone. Usually the cost is too high and the possibility of frozen fish distribution is, therefore, to a large extent, determined by the stage of development in other frozen food lines.

40. The application of a freezing process before storage at low temperature is an established and recommended practice. The freezing temperature for fish is in general -35 to -40°C . The fish should remain in the freezer until it is cooled at the thermal centre to -15°C or lower. The freezing rate is, within a certain range, of little influence on quality, but the freezing of fish at too slow a rate by simply placing it in a cold store or by partial freezing will result in deterioration of quality. If quality is of limited concern, and the main need is just to prevent spoilage, any freezing practice may be applied, but such a procedure should not be considered a generally recommendable one.

41. Storage time and storage temperature are, in addition to the fresh quality of the fish before freezing, the most important factors in ensuring good quality at the retail market. The generally accepted maximum temperature for the storage of frozen fish is -18°C but there is evidence that in the tropics even -20°C is insufficient as a maximum basic storage temperature. Different storage times require different storage temperatures.

Fish Canning

42. Canned products, on the other hand, as opposed to frozen products, need no special marketing facilities; their keeping qualities, when they are fully sterilized, are almost unlimited, and they can be marketed anywhere by anyone under any conditions. Such products have, therefore, immediate access to a wide range of existing transport and intermediate storage facilities at low cost through all stages of the trade, including all types of retail outlets, which, of course, greatly enhance their immediate marketing potential compared with products for which specialized and expensive marketing facilities are required.

43. Canning also offers a comparatively wide scope in adapting products to specific consumer preferences in respect of texture, tastes and flavours or in disguising inherent raw material characteristics which may be unfamiliar or unpopular. This, of course, greatly facilitates the introduction and marketing of the product, and it also offers a better opportunity of utilizing species which would have met with consumer resistance had they been marketed with their natural characteristics.

44. A generally known handicap is, however, the high cost of tin plate required for the containers, especially in countries where tin plate is not produced. In

developing countries where the average level of income may be quite low the cost of the container, which may be considerably greater than that of the contents, can quite easily offset the low cost of storage, distribution and marketing.

45. Pre-investment studies should be made on the application of canning under the current economic situation in the country and on the fish available. Regularity of supply and good quality raw material are of special importance. The capacity of the plant and the number of months during which it can be utilized each year must be decided and information on the quantity and regularity of supply, species suitable for canning etc. must be available.

46. Not all species of fish are equally suitable for canning nor for the same type of canned product. Fish products development is, therefore, one of the prime requirements before decisions concerning the establishment of a cannery are made. Developing or finding markets for the products is of equal importance.

47. The market for canned fish in world trade involves relatively few species and types of products. Most of these products have a long history of acceptance and have become quite firmly standardized in the minds of the consumer. Unless it is possible to duplicate these products both with respect to raw material and method of packing, canned fish offered for export is very likely to encounter very limited market interest.

48. In Africa, for the time being, only a few countries have a fish canning industry of sizable proportions. Significantly, the important canning industry in Morocco was developed on the basis of a type of sardine, which is well known and appreciated on the world market as a canned product, either in oil or tomato. In 1963, the export of this product amounted to 30.6 thousand tons valued at U.S. \$16.6 million. Other canning in quantity has been based on pilchard, which is also a principal raw material for the manufacture of fish meal and fish oil and available in quantity along the south-west coast. Canned pilchard is a relatively low-priced product, the bulk of the export going to developing countries in Africa and the Far East. Exports rose steadily until 1961, reaching 66.6 thousand tons valued at US \$21.5 million, but declined over the following two years to about one-third of the 1961 record, both as regards volume and value.

49. For local consumption, processing operations and products specifications or standards may be established, according to local conditions and requirements. The basic rules of maintaining highest nutritive value, food hygiene and plant sanitation should be followed. The type of product must conform to local tastes.

Fish Protein Concentrates

50. Although still in the development stage, the production of fish protein concentrates offers the possibility of providing at a relatively low cost a protein rich food of high nutritive value and long shelf life. The advantage of these products is that they can easily be packed and can be transported easier than dried fish. They can be protected more easily against spoilage and beetle infestation than dried fish. Non-deodorized and non-defatted products suitable to be used as condiments can be produced in a simple, satisfactory and inexpensive way. Defatted and deodorized products require more complicated processing methods and should be produced from inexpensive fish species in order to keep the cost of the product low. The development of simplified processes for industrial production is under continuous investigation by technologists and process engineers.

51. At present, the manufacture of fish protein concentrates on a commercial scale is handicapped by lack of market, although the need for such products exists in many developing areas. Market development has lagged due to lack of suitable and sufficient quantities of product for introductory programs and the fact that food

industries are also relatively undeveloped in these areas. Fish protein concentrate as a rule does not lend itself to sale as such and might better be incorporated into staple or widely used foods. So far national or internationally operating agencies have not shown enthusiasm or interest in developing food products in which fish protein concentrates are an ingredient. A plant designed to produce a good-quality fish protein concentrate on a commercial basis has recently been completed in Morocco. The plant is starting now its industrial functioning. Difficulties in finding adequate outlets for the product have to be overcome. Thus much work needs to be done to find ways for incorporating fish protein concentrate into the local diet in various areas, and to create sufficient consumer acceptance. If this can be accomplished, a basis will be established for the development of a new type of industry using fish as a raw material.

Manufacture of Fish Meal and Fish Oil

52. The most rapid expansion in fish processing industries during recent years has occurred in the manufacture of fish meal and fish oil. At the present time, over one-fourth of the world catch of fish as such, plus the trimmings and waste from processing fish by freezing, canning and curing are being converted into these products. Fish meal is utilized almost exclusively as a source of high quality protein in animal feeding and the fish oil is utilized for a number of industrial and food purposes.

53. A primary requirement for developing an industrial operation based on the manufacture of fish meal and fish oil is to have a plentiful and very low cost source of raw material. This means that unless trimmings and waste from food fish processing are to be used only species of fish which occur in great abundance and are readily accessible to highly productive types of gear can be considered. Due to the usually much higher price which can be paid for food fish it is only under very unusual circumstances that establishing a fish meal plant could contribute to sustaining food fish prices during periods of temporary overproduction.

54. As indicated earlier, approximately 30 percent of the African fish catch presently is being utilized in the manufacture of fish meal and fish oil. The products are largely sold in export and represent an important source of foreign exchange income from fisheries in Africa, amounting to over 40 million dollars in 1963. The extent to which fishery industries based in the manufacture of fish meal and fish oil can be increased in Africa will be determined by whether marine resource research and experimental and exploratory fishing will demonstrate the occurrence of additional stocks of fish which can be caught in sufficient abundance and at a low cost.

Present Status of African Fisheries

55. At the present time about 75 percent of the fish catch in Africa is taken in marine fisheries and about 25 percent from inland waters. Of the marine fisheries, the Mediterranean, Red Sea and east coast fisheries account for only about 15 percent and west coast fisheries for about 85 percent.

Marine Fisheries

56. There are wide differences in the potential yield as well as in the state of development of these fisheries. But according to present knowledge of the availability and size of the natural resources, it seems probable that, even if fishing methods, equipment and distribution facilities were greatly improved in parts of the Mediterranean, the northern part of the Red Sea and parts of the east coast, catches could only be increased to a modest extent.

57. The narrowness of the continental shelf and coral formations of the African

east coast handicap greatly the development of demersal fisheries. There is, however, undoubtedly some scope for improvement of the present small-scale operations and also for larger pelagic operations in certain eastward areas. This applies also to the offshore islands of Madagascar, the Mascarene Islands, the Seychelles, Comores and other groups. Japanese and Taiwanese tuna vessels are operating between the Seychelles, Madagascar and the African mainland; another Japanese group is operating mainly in the area of the Maldives and Seychelles archipelagoes. These fisheries bring foreign currency to the countries in which they are based. Foreign enterprise has entered shrimp fishing in Madagascar, operating off the west coast of the island with modern ships, and tuna fishing is developing in the western part of the Arabian Sea and off Somalia.

58. Although trawl fishing off the East African coast is generally limited by the narrowness of the continental shelf and the abundance of coral formations, the number of medium-size vessels fishing off the Indian Ocean coasts of South Africa and Mozambique is increasing. Successful tuna fishing, trawl net and trap fishing experiments have been made in the waters of Zanzibar, and on the Kenyan coast with the aid of FAO experts showing that there is scope for local fisheries development. In this area, Mediterranean-type purse seine vessels have started fishing on a small scale with lights for deeper level pelagic fishes to supply African markets. Spiny lobster (langouste) fishing is being developed around Zanzibar and Dar-es-Salaam.

59. In the African countries bordering the southern part of the Red Sea, improvement in fishing gear and methods could be effected with beneficial results; but the northern half, according to information available, seems likely to be less productive. A modern trawl fishery is developing off the Eritrean coast, and the possibility of establishing other Ethiopian trawling and surface fisheries (which might extend also outside the Bab el Nandeb) is being studied.

60. Some Mediterranean resources of fish may still be under-utilized, especially towards the west, and there would appear to be scope for further developing the fisheries of Tunisia, Algeria and Morocco.

61. The west coast of Africa has larger natural fish potentialities than its east coast. Large-scale wind driven oceanic circulations create powerful east-west surface currents to the north and south of the equator which in turn influence near-coastal divergencies in the sub-tropics. These divergencies appear at the surface as currents flowing parallel to the coasts equatorwards, lifting nutrient-rich, cool depth-water masses to the surface (upwellings) and diverge from the coast gradually into the North and South Equatorial Streams. These nutrients form the basis of a primary production of organic life which develops under the influence of light, and this in turn supplies the food for large quantities of pelagic fish.

62. Waters of the Benguela current along the southwest coast of Africa support large stocks of pelagic fish such as sardine (pilchard), maasbanker (horse-mackerel), mackerel and anchovy. Countries contiguous to these waters have been able to take advantage of their proximity to the rich fishing grounds to establish highly developed fishing, fish processing and fish reduction industries. As these rich waters are adjacent to land deserts or poorly populated areas, the bulk of the catches are not needed for local human consumption and are, therefore, utilized either in canning, freezing or manufacture of fish meal and fish oil for export.

63. In addition to the pelagic stocks referred to above, there are also intensive demersal species found on the Continental Shelf and close inshore out to the 20 fathom contour are excellent spiny lobster grounds. The largest catch of spiny lobster (langouste) in the world is taken in this area. More recently, a tuna fishery, using the Japanese longline technique, has begun to develop.

64. Other countries, such as U.S.S.R., Spain and Japan for example have become

interested in the fishery resources of the South East Atlantic and the number of long-distant fishing craft making their appearance in these waters is increasing; vessels from the U.S.S.R. have concentrated mainly on pilchards and maasbankers, while the Spanish have concentrated mainly on hake, and the South African trawlers fish for the demersal species. The catches of fishermen from countries other than those bordering on these waters at present amount to about ten percent of the fish taken from the South East Atlantic, and this might be increased significantly in the near future as other countries with long-distance fisheries step up their operations in the fish-rich waters off South-West Africa.

65. Further north, in the Gulf of Guinea, surface waters appear to be somewhat poorer. However, high-seas pelagic tuna occur in many parts of the Gulf, and land-based storage and reloading points for frozen tuna have been built along the Gulf coast from the mouth of the Congo to Cape Verde and on the island of St. Helena, by foreign companies but often in collaboration with African enterprises. Tuna fishing is gradually increasing and processed catches are being transhipped abroad.

66. As a result of periodic upwellings near the coast, large stocks of sardine-like fishes (sardinella) appear for short seasons near enough to the surface to support major traditional fisheries, for instance in Ghana and Ivory Coast. Under the guidance of FAO, successful attempts have been made using lights to concentrate these fish to economically catchable shoals in the "off-season" (when they are more scattered in deeper water). The "Guinea Trawling Survey" of the Commission for Technical Co-operation in Africa South of the Sahara (CCTA), now the Scientific Commission for Technicians and Research for the Organization for African Unity (SCTR/OAU), has also observed other pelagic fish, in large quantities, in deeper water. U.N. Special Fund Projects in Ghana, Ivory Coast, Senegal and Sierra Leone are being developed with FAO assistance for the study of these pelagic fish stocks with a view to better exploitation. It is probable that these studies can lead to an extension of the present short fishing season over a larger period of the year and to an overall increase in catches. FAO experts working in Nigeria also have assisted in demonstrating the availability and methods of catching shrimp in commercial quantities in Nigerian coastal waters and a modern shrimp industry has been started, even though as yet on a relatively small scale. Japanese and U.S.S.R. factory trawlers have started large-scale operations in the deeper grounds off Ghana and the Ivory Coast and are landing there and in Nigeria sizable quantities of frozen sardinella and miscellaneous species for local consumption. Modernization of local fishing fleets and techniques and improvement of skills will be a prerequisite for the development of African participation in this type of operation.

67. The upwellings of the Canary current in the north west carry rich stocks of pelagic fish (sardine at the Moroccan coast, sardinella farther south), which support the important Moroccan sardine canning industry. The limiting factor for the development of the Moroccan industry has been partially economic, i.e. the size of the market for tinned sardines. An increase in sardine landings might be feasible, if accompanied by rationalization of the sardine processing industry and modernization of the fleet and fishing techniques.

68. Morocco is also trying to diversify into tuna fishing and processing, since promising tuna stocks occur within the reach of the Canary Current. Japanese tuna vessels are already operating in these waters. French, Spanish and other West European tuna vessels, however, concentrate on near-land tuna in the Senegal area disregarding the high-seas pelagic tuna stocks they pass by on their way to and from the fishing grounds.

69. Demersal fish stocks appear to be richer on the continental shelf of Spanish Sahara, Mauritania and North Senegal, than in the Gulf of Guinea, and have been attracting interest in international waters from non-African countries, such as Italy, Greece, Spain, Portugal, Israel, Japan, U.S.S.R., Poland and possibly others.

With heavy exploitation of stocks by large-scale trawlers, freezer trawlers and factory ships, catches are decreasing continuously, and some ships (Japanese) have left the areas, while others are looking for new fishing grounds in the vicinity.

Inland Fisheries

70. Despite a large development potential, African inland fishery resources are in most cases not being fully utilized. Although often aware of the nutritional and economic advantages of inland resources as a source of protein in remote protein-deficient areas, African countries have been handicapped in developing them by lack of trained government administrators to guide development, lack of skills and modern equipment among the fishing personnel, poor communications to potential consuming areas, and inadequate marketing facilities.

71. Modern inland fisheries have been developed on some of the major East African lakes (Lakes Tanganyika, Albert, Kyoga, Edward, George, and Mweru): landings from most of these lakes can probably be further increased. Some of the other great African lakes are obviously under-exploited (Lake Victoria and Lake Rudolf). FAO experts are aiding fisheries development in several countries. A U.N. Special Fund Project for the development of Lake Victoria and neighbouring major lakes is scheduled to be operational soon. FAO experts are working to improve the extremely backward fisheries on Lake Chad. Fisheries development is possible also in man-made lakes. At Lake Kariba, a Special Fund Fisheries Development Project started operation in 1963. Further projects are in process of development for Lake Kainji and Lake Nasser. Also considerable work has been done to establish fresh water fish culture in some Central and East African countries and FAO is now providing assistance in investigating the possibilities of large scale commercial fish culture in both fresh and brackish waters.

72. Fisheries in rivers and their flood-inundation areas are important in certain parts of Africa as, for instance, on the Niger (Mali, Niger, Nigeria), in the Shari-Logone lowlands of the Chad Basin, and in the Congo system. Landings could probably be increased considerably by improving the equipment and skill of the fishing populations and in certain areas by improving distribution facilities. An FAO expert presently is working in Mali to improve handling, storage, and transporting of traditionally-processed river fish.

Conclusion

73. Encouraging fisheries developments are taking place in many African countries where governments and private business are pioneering the introduction of modern equipment and methods, with or without assistance of bilateral aid agencies and/or FAO. For example, Ghana and Nigeria have recently acquired vessels for distant water fishing. In most cases, however, there is a need for comprehensive development planning in many fields. This is more and more being recognized and requests for expert assistance in over-all fishery development planning are increasing.

74. If development possibilities are to be realistically assessed, more fishery investigation and research will be needed throughout Africa. Much has yet to be learned about the extent of the resources that can be economically exploited. This will involve an expansion of biological research, including the scientific prospecting for fish in waters as yet little explored. Additional experimental fishing is necessary to help choose suitable harvesting methods and, where overfishing is already becoming a problem, research is needed to provide the basis for regulation and conservation. These activities should be integrated with technological and economic studies required for the improvement of processing and marketing methods and fishing practices.

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