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MAIN FACTORS IN THE DEVELOPMENT OF THE FISHERIES INDUSTRY

Discussion paper*

Prepared by the
UNIDO Secretariat

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* This document has not been edited.

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TABLE OF CONTENTS

	<u>Paragraphs</u>	<u>Page</u>
Foreword	1 - 5	2
Introduction	6 - 8	3
Fishing Boats	9 - 13	3
Shore Facilities	14	5
Processing	15 - 34	6
- On-board	16 - 19	6
- Canning	20 - 21	7
- Chilling	22 - 24	7
- Freezing	25 - 27	8
- Curing	28 - 29	8
- Improved utilization of fish	30 - 32	9
- By-catch	33 - 34	9
Packaging	35 - 36	9
Quality Control	37	10
Government Strategies and Policies	38 - 48	10
Manpower Development	49 - 53	12
Trade	54 - 57	13
Environment	58 - 60	13

FOREWORD

1. UNIDO, as an industrial development organization, with its mandate to promote and accelerate the industrialization of the developing countries, is not directly involved in the exploitation of fisheries resources, fishing, aquaculture or training of fishermen but rather in all forms of industrial fish processing. Besides, the fisheries industry, particularly large-scale, depends very much on industrial inputs such as gear, boats, nets, packaging, which are manufactured by support industries.

2. The commitment to assist developing countries in fields such as, among others, shipbuilding and repair must be seen in the light of the original mandate of UNIDO to promote the industrialization of developing countries, with the importance of engineering activities to industrialization recognized from the start.

3. The Second General Conference of UNIDO, held at Lima, Peru, in 1975, specifically called for the "creation of national, regional and interregional enterprises in the field of maritime transport..." *

4. Since its inception, therefore, UNIDO has steadily increased its technical assistance activities in the fisheries industry, in particular in shipbuilding and repair. They comprise:

- Provision of advice to governments on development programmes
- Provision of technical and managerial advice to the industry, including advice on modern methods of production
- Assistance in establishing repair facilities
- Assistance in establishing industrial institutions and development of technology, including new technologies
- Carrying out techno-economic studies or technical evaluations of existing facilities
- Provision of training for personnel

5. There are also non-technical activities in which UNIDO is involved, from industrial planning (industry as a whole as well as individual sub-sectors) to the preparation of investment feasibility studies, factory establishment and general management, institution building and training. This sequence of activities represents a certain logic which if not followed may lead to wrong investments and low capacity utilization.

* See Report of the Second General Conference of the United Nations Industrial Development Organization (ID/CONF.3/31), chap. IV, para. 60(m).

Introduction

6. Fisheries supply 23 per cent of the world's protein and a livelihood for millions of people. Despite its important nutritional and social constitution, the fisheries industry was often given low priority by many governments in overall national development plans. Following the adoption of a new Convention on the ownership and use of marine resources in 1982, however, the attention of governments of both developed and developing countries focused upon the potential of the resources off their shores.

7. At the same time renewed attention has been drawn to the roles of inland water fisheries and aquaculture both as food suppliers and within the overall context of rural development. Because of over fishing and marine pollution there is little prospect of raising the natural productivity of world fisheries. Aquaculture, coupled with the exploitation of undeveloped forms of marine life, such as krill, may help bridge the protein gap.

8. The scope for developing the fisheries industry depends, however, not only on the availability of the resource but on demand as well. And while estimates of demand are carefully calculated they cannot be assessed easily. There are many kinds of edible fish that are consumed in varying proportions in different societies. While fresh fish markets handle a great variety of species, the processing industry tends to concentrate on a few. The three major processed groups are tuna, shrimp and small pelagic (sardines, herring, mackerel). In addition, a large proportion of fish is used for purposes other than direct human consumption especially in fish meal which is used for animal feed. Thus, an increase in the world's consumption of animal protein could increase the demand for fish products.

Fishing Boats

9. For most developing countries a number of profitable conditions and pre-requisites exist for establishment and development of shipbuilding.

10. In the choice of suitable materials for the construction of fishing vessels five materials can be considered as currently in use, namely, wood, fiberglass reinforced plastic (FRP), ferro-cement, steel and aluminum. No single material can be said to offer definite advantages over the others in all size ranges and each material has its advantages and disadvantages which should be considered.

11. The use of laminated wooden boat building technology is an innovative and promising type of industry in developing countries. In many countries in fact there is a long tradition of producing wooden boats for a number of

activities like trade, household, transport and fisheries. Skills for the construction of vessels exist among a considerable group of craftsmen along rivers or lakes and in coastal areas. In a number of developing countries due to environmental constraints or to lack of forest resources the availability of wood is limited. This results in higher prices and further restrictions in terms of quality and quantity of timber resources. This asks for the production of better boats with less materials. The application of laminated wood and marine plywood in boat building has many advantages compared to traditional boat building techniques. Laminated boats, built according to modern designs, use up to 40% less wood, save on fuel consumption and last much longer.

12. The increasing scarcity and cost of timber however shows the introduction of ferrocement and FRP as viable alternative boatbuilding materials. FRP, however, which was almost the ideal material 30 years ago, after the oil prices were raised became very expensive. Furthermore, many countries have made rigorous rules for workshop ventilation and heating thereby further increasing production costs.

13. Ferrocement, which has been very popular the last years, is labour-intensive and therefore not competitive in countries with high labour costs. Considerable savings in operational maintenance costs can be expected with FRP and ferrocement when compared with wood. The most important factor in the choice of a construction material, is local availability of the raw material and experience and facilities for its use in the construction of vessels. Where one particular material can combine local availability, manpower skilled in its use, established shipyards which are accustomed to building in the material, and the cost of construction is competitive (or nearly so) with the cheapest alternative, then this material should be chosen, unless a deliberate decision has been made to experiment with alternatives. In the latter case, if a new material is involved, it should be accepted that prototype construction is likely to prove considerably more expensive than vessels built in an established yard, and some time and experiment will probably be necessary to gain acceptance by the local fishermen.

Shore Facilities

14. Fishing ports have also very indispensable functions as base of fishing activities such as the handling of catch, preparation for the fishing operation and distribution of fish, including marketing transaction, storing and processing. When a fishing port is constructed facilities relevant to fisheries such as cold storage, ice plant or freezing plant along with shipyard and fishing material shops inevitably open up as integral parts of the fishing port. These facilities naturally generate employment opportunities hence contribute to the development of the local economy. The

development of the fishing port, however, should be planned and carried out carefully taking into account the magnitude and foreseeable development of fisheries as an industry. As fish and shellfish are highly perishable, it is most important that they are handled and transported as quickly and as clean as possible to consumers. For this purpose, adequate supply of ice, after handling and during transport and the development of an easy approach to the landing places and frozen transport facilities to the terminal markets or consuming countries are more urgent prerequisites than expanding the port itself.

Processing

15. Because fish is a highly perishable commodity, it is estimated that up to 10 million metric tons are lost a year due to improper handling, processing and marketing. Of this, 5 million tons are estimated to be lost as by-catch, 3 million tons due to insect infestation and the remainder as a result of other spoilage.* Processing has therefore become a dominant factor in the fisheries industry aiming at continuous improvement in efficiency and quality.

On-board

16. To avoid losses the first handling and preservation operations must be carried out on board. For example, distant water trawlers used to load crushed block ice immediately before sailing to the fishing grounds, where the fish caught was gutted and then stowed in bulk or placed on shelves surrounded by ice. Later, some fish was iced on boxes at sea, which gave a better quality of fish on landing. However, this method was not very practical until aluminum and later, plastic boxes became available to replace wooden boxes for fish storage. Current practice ashore is to use disposable boxes made of plastic foam.

17. Two other methods of chilling have become popular in recent years. Both depend on stowing the catch in cooled sea water and both present advantages for the stowage of small, delicate fish. The fish are buoyed up in the water and are thus not subjected to crushing as is commonly the case when they are stowed in ice. Cooling is also relatively rapid. The fish is generally boxed and carried in ice once on shore if it is to be marketed as fresh fish, although methods of chilling in tanks which can be landed and carried straight to the factory have been devised. Usually, fish is pumped ashore.

18. At one time, fish preparation operations such as gutting, heading and

* Fishery-Sector Policy Paper. The World Bank, December 1982.

filleting were carried out entirely by hand. Virtually all such operations can now be done by machines which can be taken to sea as well as used on shore. This enables fish preparation to be done very quickly. At sea, it can be done before there is any risk of spoilage. The machines are not cheap, however. They require electric power and sometimes large amounts of potable water. On the other hand, they are efficient and reliable.

19. Weighing fish in a moving ship at sea has until very recently been a problem, and packers have found it necessary to over-pack in order to avoid the risk of packing underweight. Special scales for use at sea have now been devised allowing accurate weighing of the product.

Canning

20. Frozen fish continues to be produced in large quantities in the developed countries but there is a definite shift of canning activities from developed to developing countries where labour costs are lower. So much lower are their operating costs that some developing countries are able to purchase supplies for Europe or North America and sell the processed product back to those regions.

21. Energy costs which may appear small in comparison to total costs or turnover have been estimated to be 3% of the canned fish value. Reducing energy costs in canning operations may therefore now offer potential for increasing profitability. The possibilities for variations of canned products are many. This fact is reflected in the standard canning plant which has a capacity high enough to test consumer preferences without too much involvement in sophisticated equipment.

Chilling

22. Temperature plays an important role and the lower the temperature the lower the pace of bacterial activity. Refrigeration is used at two main temperature levels throughout the industry, namely, 0 to 5 degrees centigrade for chilling and -20 to -30 degrees centigrade for freezing. The effect of temperature is so important in deteriorative processes of fish that one of the most effective methods of preservation is cooling or chilling. Nevertheless, the velocity of lipid auto-oxidation is not affected by this method.

23. Preservation with ice is the obvious approach to chilling since ice is normally available at fishing ports. The ice can be taken to sea and mixed with fish. Chilled fish is a growth area in markets of several developed countries as consumer demand for fish increases. In fact, one key factor identified as influencing the chilled fish market in the 1990s consists in the consumer perception that chilled foods are close-to-fresh and because of this

are less likely to be adulterated with additives and preservatives. The consumer demand for chilled, fresh and additive and preservative free fish has led to the growth of modified atmosphere packaging (MAP) to improve product image and quality, reduce wastage and extend the shelf life of products.

24. In spite of the fact that fish and fish products have a good safety record and only a small number of hazards can be associated either with fish or with contamination of fish, recent concern over the safety of the chill chain focused attention on the necessity of temperature monitoring throughout the chain from manufacture to consumer storage in domestic refrigerators.

Freezing

25. The developed countries have a much higher use of freezing to preserve the catch while developing countries concentrate on curing which requires very little capital investment. Freezing plants, as canning factories, in developing countries are mostly geared to satisfy the export markets.

26. Freezing and frozen storage of fish, depending on the fat content of the species, can give a storage life of more than one year if properly carried out. Some deterioration during freezing in frozen storage is however inevitable and in order to obtain satisfactory results emphasis must, among other things, be placed on the state of the raw material. Fish for freezing must be of good quality otherwise the result will be unacceptable.

27. It is normally recognized that freezing should be carried out as quickly as possible but there are no clear definitions of how quickly fish and fish products should be frozen. Besides the equipment used, the size of the product and packaging material are dominant factors influencing the freezing time.

Curing

28. Artisanally cured fish forms the bulk of processed fish in the developing countries. The raw material is cleaned, salted, sun-dried and smoked but a substantial amount is lost by spoilage during the process. Fly, bacteria and beetle infestation are the main causes of spoilage. As with fresh fish handling, the remedies are simple and relatively low cost. Proper drying racks, fly screens, plastic solar dryers, good salt, clean water and hygienic premises would eliminate most of the spoilage.

29. Flavour is a key factor in cured fish products in relation to the acceptability of salt to the consumer.

Improved utilization of fish

30. In order to complement existing resources to meet growing value added products markets greater use will have to be made of species not currently harvested because of their inaccessibility. These species can be processed in "surimi" based products such as artificial crab legs and scallops and headed shrimp as well as ready-to-cook/ready-to-eat products.

31. Other efforts at improved utilization have involved the design of machines to produce uniform fillet-like portions from small pieces of fish flesh, improved methods for separating crab from shell by crushing and enzymatic treatment and the manufacture of products from or using minced fish flesh

32. Improvements in utilization practices include also better utilization of small pelagic species, an area which has a great potential linked with the perceived health benefits of fish as these species contain the highest concentration of the omega-3 marine lipids which have been shown to be effective in lowering cholesterol levels in blood.

By-catch

33. The recovery and utilization of the large quantities of heterogeneous fish species that are at present being wasted, the by-catch, can be aimed at existing and potential markets of food for direct consumption in the form of reconstituted products, livestock feeds and industrial by-products. Being selective harvesting methods not yet widely adopted, by-catch has to be handled by the crew of the fishing vessel. Preservation at sea in chilled sea-water has proven to be a most suitable preservation method while processing on board, involving expensive technology, has not yet been optimized.

34. The part of by-catch not suitable for human consumption can be used in fishmeal or fish-silage production. Comparative financial analyses is however necessary to determine the cost-benefit of processing different by-catch species and mixtures for specific target markets.

Packaging

35. Consumer demand for fresh, conveniently packaged food has led recently to increased interest in the use of modified atmosphere packaging (MAP) of fishery products. The possible benefits of extending the shelf life of chilled fresh fish by their storage in an atmosphere other than air has long been known but it is only in the last decade that packaging systems have been developed which make this technology commercially feasible. However, modified

atmosphere packaging is expensive, currently about twice the cost of vacuum packing. Only the highest quality fish should be therefore used for modified atmosphere packs in order to gain the most benefit from any extension of storage life.

36. The general conclusion is that for white fish and shellfish an extension of shelf life, perhaps as much as double, can be expected but for products such as salmon and fatty fish, MAP shows no advantage.

Quality Control

37. Fish undergoes irreversible changes soon after harvest, resulting in much quality loss. Laboratory tests for quality control and assessment are numerous and can be categorized as mandatory or voluntary. The methods for assessing quality can be broadly categorized as (a) physical and sensory, used as first step for quality of assessment of colour, texture and smell; (b) microbiological, focusing on bacteria causing human diseases or spoilage of the fish itself and originating from pollution or contamination during processing and handling; (c) chemical, to measure proteins, lipids and amines.

Government Strategies and Policies

38. So far the degree of government involvement in fisheries and the funding of fisheries development by financial institutions has been rather limited except in countries where the fishing industry has traditionally occupied an important position. In many countries fishing has been regarded merely as a way of supplementing the diet of communities living by the sea but nowadays more and more governments are realizing the importance of fishing and fish processing for the achievement of one or more of the following objectives: increase employment, higher incomes, improved protein content of the population's diet, generation and saving of foreign exchange and in some cases even the conservation of national resources.

39. Government assistance to fisheries through the provision of finance, resource management measures and labour legislation has taken place in both small-scale and large scale fishery industries.

40. In the context of the extension of national economic zones to the 200-mile limit under the Law of the Sea, many governments have granted financial aid to their fishing fleets in order to help the industry to develop its operations. Certain countries, whose fishing industry has had to cope with the adverse effects of the extension of national economic zones by other countries have provided financial incentives to encourage modernization of fishing fleets. In many countries as well, governments have been active in encouraging small-scale fishery industries, their processing techniques as

well as their fish storage and handling methods.

41. Management of fishery resources falls within the broader framework of general development policy and is characterised by a large number of uncertainty and risks. The aim should be to make the best possible use of the resources available to the country, i.e., to catch as much fish as possible using the most efficient methods. Government action may include promoting appropriate technical innovations improving the skill of fishery industry technicians and managers by training, reducing losses from spoilage.
42. A national fishery development strategy should include, among other, (a) the formulation of legislation regarding entry in the fishing sector aimed at prevent overfishing, regulate market supplies or in some cases to give preference to particular groups of fishermen for socio-economic reasons; (b) the introduction of more efficient fishing boats taking into consideration the costs and benefits associated with such figures; (c) the planning for the development and improvement of the infrastructure including roads to landing sites, cold storage, harbours.
43. Financial aid for the purchase of equipment can consist in the provision of credit for the purchase of boats, gear and processing equipment. Banks tend to be reluctant to lend money to the fishery industry sector because they expect the recovery rate to be low.
44. In many countries, governments facilitate the marketing of fish and fish products through, for example, the ownership and management of such facilities as ice plants or cold storage.
45. Special support to the sector in the form of relief from tax and import duty burdens exists in most countries and continues to be accepted as an integral part of fishery policy.
46. Fishing ports are the basis for fishing activities and the government should be responsible for their planning, instruction and administration. Construction of fish markets, ice plants, cold store rooms should also be undertaken, at least at the initial stages of development, by government funds or under other financial assistance.
47. Active part in the development of the fishery industry can be taken by governments either by encouraging or by restricting various activities so as to ensure that the fishery resources are rationally utilized. Promotion can be done by encouraging both offshore and onshore fishing and the use of fishery products for both domestic and export purposes. At the same time regulations can be used to control fishing efforts and restrictions may be necessary for post-harvest activities.

48. To conclude, four major development areas should be given top priority by governments in the promotion of the fishery industry as follows: (a) fishing efforts, that call for research, training, financing and regulation; (b) landing infrastructure facilities, the location of which should benefit the largest number of people and should be able to adequately handle anticipated increases in fish catch (c) processing facilities that should be equal to the requirements of modern processing methods and should be in harmony with the operations of the port facilities (d) distribution that requires adequate roads and rail network systems for moving the products efficiently from producers to consumers and export harbours, hence ensuring adequate delivery sources.

Manpower Development

49. In the area of training there is a constructive role for governments to play. Priority should be given to upgrading the skills of fish plant managers and supervisors through vocational, technical and marketing training. Every effort should be made to ensure that educational programmes for management have a practical orientation and high performance standards.

50. Fisheries training institutions can be fully effective, however, only when a country has a resource base adequate to support increase and more efficient exploitation by its own fleet markets that can absorb increased production at remunerative prices, resulting in job opportunities for those who receive training and a pool of properly motivated personnel from which to draw trainees.

51. Experience has shown that a national training institution designed to meet specific national training needs can make a bigger contribution than a regional training institution, which cannot accommodate all the different needs of the countries in the region. Indeed, in the latter case, an existing national institution can accommodate training needs from neighbouring countries for specific courses under a TCDC arrangement.

52. The new methods of fish handling, preservation and processing (such as by freezing at sea) require appropriate training often provided by fishery institutions in the form of short courses. Some ships now carry fish-processing machinery such as washers, gutters and filleters which fishermen usually learn to use on the job, though most manufacturers will provide training if requested. In addition, there are many books on fishing gear and related topics and manufacturers operating instructions are generally good. Where illiterate fishermen start to use equipment an extension service can be invaluable in training them to operate it properly.

53. Until now, however, extension services have focused almost entirely on

agriculture. As a result no channel exists for transmitting to fishermen information about the availability of financing, government regulations, new technology and the like.

Trade

54. Although imbalances between supply and demand are likely to occur from time to time, the world trade of fishery products, for their high nutritional value, high protein and low fat content, will probably continue to expand during the present decade though at a slower overall rate than in recent years.

55. Exporters should follow market conditions closely to take advantage of any new developments and opportunities that may arise, for example, in terms of changing patterns of demand for value-added products. To penetrate new markets and to increase exports of value-added products continuous product development, product adaptation and quality and packaging improvements are needed in most developing countries. One example of product development is the incorporation of weeat fish mince into noodles. Noodles are popular food in Asian countries. Various types of noodles are available and made from wheat, flours and rice. These products are often consumed in place of rice and cooked in a variety of ways. The addition of sources rich in protein to noodles has been the aim of research work and now fish meat incorporated into noodles increases their protein value.

56. Eating habits vary greatly in different countries. Annual consumption per head of fish and fish products ranges from 10 kg in the Federal Republic of Germany to 75 kg in Japan. Changing life-styles, both in Asia and in Europe, are resulting in changing eating and buying habits. More women are now working outside the home and thus learning to appreciate the convenience of ready-to-use or prepared food, usually in frozen packs.

57. In import markets more and more specific requirements are formulated as to quality, form, shape, temperature, packaging, etc. which have to be met before the product will be permitted on the country's market. A number of important factors are therefore to be considered prior to exporting fish products such as (a) inspection, (b) grading, (c) temperature, (d) net weight, (e) packaging material, (f) labelling, (g) extraneous substances, (h) freshness, (i) size.

Environment

58. Though most developing countries had not previously given much thought to environmental considerations, awareness of the ecological consequences of development is growing rapidly.

59. Planning of fishery industry cannot be done in isolation. Environmental concerns require in fact a cross-sectoral approach. For example, the quality of water may be affected by irrigation infrastructure or pollution from industries. As a result, where industries or agricultural activities are located near water, attention should be paid to the danger of pollution and to measures that can be taken to minimize its effect. The world regional seas, most notably the Mediterranean, the Baltic, the Caribbean and the North Sea, have all been hard hit by pollution. Being enclosed or semi-enclosed and often having slow rates of water renewal, regional seas, in fact, do not have the same cleansing capacity as the open oceans.

60. On the other hand, worldwide the fish-processing industry generates itself an enormous amount of waste. From an environmental viewpoint the dumping of these wastes does not usually cause difficulties of major consequences. The dumping of seafood wastes is not, in fact, a serious environmental problem because the wastes are not toxic, are highly biodegradable and are generally dumped into water bodies which have an adequate capacity for assimilating them.*

* Environmental assessment and management of the fish-processing industry, Sectoral Studies Series No. 20, UNIDO-PPD-15, 12 December 1986.