

- To protect the productivity and biological diversity of coastal and aquatic ecosystems through prevention of habitat destruction, pollution and over exploitation.
- To promote small scale, semi-intensive aquaculture system with simple technologies and low capital investment.
- To promote sound utilization of the ecological capacity of water based area as a means to promote diversification of income sources and diet.
- To promote effective farm and fish health management practices favouring hygienic measure and vaccines.
- To promote the involvement of the fisher communities in the planning, development and management of fisheries resources.
- To promote the availability, accessibility and exchange of fisheries information.
- To incorporate gender perspective in the development of the fisheries sector.
- To strengthen collaboration on cross-sectoral issues between the fisheries sector and other sector.
- To develop and strengthen inter-sectoral co-operation in general Fisheries Division to minimize operational conflicts.
- To pursue continuing fisheries integrated programme of effective management of coastal zone to meet the ecological and socio economic needs of the present and future generation.
- To strengthen regional and international collaboration in the sustainable exploitation, management and conservation of resources in shared water bodies and exclusive Economic Zone (EEZ).

5 CHARACTERISTICS OF FISHERIES BY MAJOR WATER BODY

5.1 Marine Fisheries

5.1.1 Natural Condition

The coastline of Tanzania stretches for approximately 800 km on the continental side and, moving from north to south, passes through the Regions of Tanga, Coast, Dar es Salaam, Lindi and Mtwara. The continental shelf is generally narrow except the areas of the Zanzibar channel and the Mafia channel, where the shelf extends for 20 to 30 miles, scattering many reefs and islands.

5.1.2 Fisheries Production

The marine fisheries in Tanzania are composed of industrial fisheries based around Dar es Salaam, and artisanal fisheries carried out by the people of coastal areas. The industrial fishing is mainly intended to export its products and is mainly based around prawn trawling. About 20 trawlers (34 to 146 GRT tons) based in Dar es Salaam carry out fishing operations. In terms of production, the industrial fisheries account for 1,300 tons (1996) and the main share of the marine fisheries production, i.e. 50,000 to 60,000 tons or more than 95 percent of the total, is landed by the coastal artisanal fisheries.

Table 1-27 Production of the Marine Fisheries

	1991	1992	1993	1994	1995	1996
Artisanal fisheries	52,380	42,183	34,226	37,286	48,762	59,508
Industrial fisheries	1,510	1,119	1,223	1,787	1,933	1,341
Total	53,891	43,302	35,449	39,073	50,695	60,849

Source: Fisheries Division, Fisheries statistics

The artisanal fisheries are carried out based around Dar es Salaam and fishing villages, scattered along all the coast. According to the frame survey carried out by the Fisheries Division in 1998, approximately 20,000 fishers are engaged in the artisanal fisheries at 210 fishing villages and landing sites located in all the coast including Dar es Salaam. There are 5,000 fishing boats, of which approximately three-quarters are dugout canoes and outrigger canoes and the remained quarter are planked construction boats. Motorized boats account for approximately 10 percent of all the artisanal fishing boats.

Dar es Salaam, having the largest consumer market in Tanzania, is the most active landing site, where about half of the total catches are landed by the fishing fleets of Dar es Salaam and fish-buying boats from Mafia, Zanzibar etc.

Table 1-28 Coastal Artisanal Fisheries

Region	Catches (tons)	Ratio (%)	Fishers	Fishing boats	Boats with outboard engine	Boats with diesel engine	Ratio of Motorised boats (%)
Tanga	6,599	11.1	4,480	969	95	2	10.0
Coast	13,564	22.8	8,042	1,714	116	16	7.7
DSM	30,403	51.1	5,250	966	213	35	25.7
Lindi	4,292	7.2	2,640	620	24	0	3.9
Mtwara	4,649	7.8	2,056	859	15	2	2.0
Total	59,507	100.0	20,625	5,157	463	55	10.0

Source: Catch = 1996 Fisheries Div., No. of fishers = Fisheries Div. 1998 Frame survey

Main fishing methods are hand line, gillnet, surrounding net, purse seine, long line, trap, fixed trap and so on. The fishing is carried out mainly in the shallow areas of coral reefs that are easily accessible from fishing villages and landing sites.

Reef fish such as Emperor, Rabbitfish and Parrotfish are caught by hand line, gill net and surrounding net, while demersal fish such as Shark and Ray, etc. are caught by bottom gill net. Reef fish alone account for almost one-third of the overall fish catch, and this indicates that shallow reef waters are used as the main fishing grounds. Approximately one-third of the total fish catch is accounted for by small pelagic fish such as Sardine, Horse mackerel and Small mackerel, a large portion of which are caught by ring-net fishing. Large pelagic fish such as Kingfish and Mackerel, etc. are caught by gill net, seine net and long line, etc. Octopus and Lobster are also caught by wading and diving in reef areas at low tide.

Catch and types of fish caught in 1996 are shown in the following Table.

Table 1-29 Production of Artisanal Fishery (1996)

Species		Production (tons)	Sub-total (tons)	Share (%)
Reef Fish	Scavenger	7,304		
	Parrotfish	3,725		
	Rabbitfish	3,816		
	Queen fish	2,263		
	Rock cods	652	17,760	29.8
Demersal fish	Flat fish	148		
	Ray	4,006		
	Shark	1,594		
	Cat fish	913		
	Cobia	51	6,661	11.2
Demersal fish total			24,421	41.0
	Octopus	605		
	Prawns	267	872	1.5
Small pelagic fish	Sardine	14,324		
	Thread fins	937		
	Mackerels	4,619		
	Half beaks	1,483	21,363	35.9
Pelagic fish	Kingfish	734		
	Tunas	801		
	Jacks	1,406		
	Silver biddies	333		
	Mullet	619		
	Milk fish	29		
	Sword fish	240	4,162	7.0
Pelagic fish total			26,397	44.4
	Others	8,639		14.5
Total		59,508		100.0

Source: Fisheries Division, Fisheries statistics

(1) Landing Sites

Fishing with hand line, gill net, ring net and trap is carried out by canoes, outrigger canoes and boats in all the coast areas. The fishing is usually carried out in shallow waters around coral reefs easily accessible from the fishing villages and landing sites. There are some regional characteristics depending on marketing situations and movement of motorized boats as follows.

In Dar es Salaam, having the largest population and consumers' demands, fishing and landing of catches are most active in the country. There are many motorized fishing boats here and the ratio of motorization is also high. Ring net fishing using fish lights is conducted by around 50 boats (roughly half of the national total), and 70 percent (10,000 tons) of the national sardine haul is landed at the fish market in Dar es Salaam. Moreover, fishing boats from other areas are landing their catches and fish-buying boats landing fish purchased from Mafia, Zanzibar and Kilwa. According to the fishery statistics of 1996, approximately half (30,000 tons) of the total catches by the marine fisheries is landed in Dar es Salaam.

In Tanga Region, hand line, gill net and trap fishing are carried out by dugout canoes and outrigger canoes same as in other regions. Ring net fishing with fishing lights is conducted by around 50 boats, which are smaller in size than those based at Dar es Salaam.

Coast Region has the continental shelf extending to the islands of Zanzibar and Mafia, and the Wami, Ruvu and Rufiji Rivers flowing into the sea. These conditions give good fishing grounds in the coastal areas, in particular the estuary areas. In the Rufiji River delta area (the largest mangrove area in Africa, 65km from north to south, 23km from east to west), prawn fishing is especially common, and a private fish-processing factory in Mafia is purchasing the prawn by boats. The good fishing season lasts from March through June. Fishing boats from Dar es Salaam, Zanzibar and Kilwa, make fishing trips to

Mafia, and fish-buying boats from Dar es Salaam purchase their catches in Mafia. A water area south of Mafia is reserved as a marine park, where many of fishing activities are restricted for conservation of marine environment.

In the southern regions of Lindi and Mtwara, their numbers of fishers and fishing boats are smallest and production is also lowest among the coastal regions. Off Kilwa in the north of Lindi Region, there are many small islands such as Songosongo and reef areas, forming good fishing grounds. In addition to the local fishing boats, some fishing boats move into these fishing grounds from Mtwara and Lindi, Dar es Salaam, Zanzibar, sometimes even from Tanga and Pemba, for fishing in a certain period. The number of such external boats increases during the dry season (June to November) when overland transportation from Dar es Salaam becomes possible.

Small mackerel and Kingfish, etc. migrate to Mtwara coastal waters during a period from October through December. It is a good fishing season for the fishers of Mtwara. A lot of fishers from Mozambique migrate to this area to conduct fishing in this period. Mtwara fishers, however, have no way to market their catches to Dar es Salaam but to consume somehow within the southern areas.

Table 1-30 Number of Fishing Gear by Region

	Gill net	Shark net	Hand line	Long line	Beach seine	Ring net	Scoop net	Trawl net	Madema	Fixed trap	Others
Tanga	631	608	2,654	24	84	53	7		1,442	14	
Coast	6,885	1,087	2,133	11,670	65	0	132	5	1,052	224	494
DSM	84	865	2,005	0	59	63	80	2	1,593	1	150
Lindi	1,012	386	855	21	72	12	38	0	423	15	45
Mtwara	515	516	1,640	9	39	0	0	0	789	0	116
Total	9,127	3,462	9,287	11,724	319	128	257	7	5,299	254	805

Source: Fishery Division, 1998 Frame survey

(2) Fish Species

Potential species of small pelagic fish are Sardines (*Clupeidae*), Anchovy (*Engraulidae*) and small species of mackerel (*Scombridae*). Because these species account for a major portion of the marine fishery catches and are much cheaper than others, they are subject to large demand and are an important element in supplying fish to the population. Other important demersal fish species are Jacks (*Carangidae*), Kingfish (*Scomberocoridae*) and Mackerel tuna (*Katsuwoidae*), etc. Bottom fish species include reef fish such as Scavengers (*Letherinidae*) and Snappers (*Lutjanidae*), and also Shark and Ray, etc.

5.1.3 Fisheries Resources

(1) Production Potential

Marine fishery resources have not been fully grasped yet. There are, however, a number of resource survey results and assessments from which it is possible to obtain a rough estimate of Tanzanian coastal waters.

The FAO/IOP workshop held in 1978 adopted the very preliminary value of 20,000 tons/year as the potential yield of small pelagic fish including areas around Zanzibar and Pemba islands, based on a biomass estimate of 43,000 tons (Venema, 1984). It is largely based on results of acoustic survey implemented by R/V Prof. Mesyatev in 1976/77.

In the resources survey implemented by the Norwegian research boat Dr. Fridtjof Nansen in 1982/83, fish biomass in the surveyed waters were estimated at 100,000 to 175,000 tons (S. A. Iversen 1984). This survey, consisting of acoustic surveys and trawling research, was carried out three times in target waters ranging in depth from 10m to 500m. These waters did not include such shallow reef areas where the fishing are currently being carried out. The main part of the biomass was observed at depth less than 200m, in particular in the areas with depth less than 50m. Fishing was not conducted in the

survey areas, and the catch potential was estimated to be between 25,000 to 40,000 tons. This indicates that the catch potential can be increased 60 to 100 percent by extending the fishing grounds beyond the shallow reef areas. Since this percentage figure is based on the annual catches 40,000 tons in 1975 to 1980, it indicates that the potential catch is between 65,000 to 80,000 tons including the catch 40,000 tons. However, fish density was generally too low to support any large scale trawling and purse seine fishing by large fishing boats. Therefore, the first step to increase the catches will be to introduce the artisanal fisheries to areas that are located beyond shallow reefs.

It is not always true that catches will increase if they go further offshore, as is frequently claimed by the fishers. As indicated in the aforementioned surveys, productivity and abundance of resources are highest in shallow reef waters where the fisheries are currently conducted, and it should be understood that fish density is lower in offshore waters. When talking about expansion of fishing grounds to offshore waters, the targeted areas for expanding the fishing grounds are to be surrounding areas of the shallow reef areas currently used and non-exploited reef areas.

(2) Fishing Grounds

Sea areas where relatively good concentrations of fish were observed during the three surveys conducted by Dr. Fridtjof Nansen in 1982/83 are as follows:

- Areas between Dar es Salaam-Bagamoyo and Zanzibar (Zanzibar channel)
- Areas around Mafia and Rufiji Delta (Mafia channel)

As a result of fishing surveys with bottom long lines, conducted by the East African Marine Fisheries Organization in 1969 to 76, high catch potentials were indicated in the north and south of Mafia Channel. These waters are already important fishing grounds and they should continue to be regarded as major fishing waters in future.

5.1.4 Fishing Gears, Methods and Boats

(1) Fishing Gears and Methods

The main fishing gears used in Tanzania are hand line, gill net, long line, ring net, surrounding net, and trap. Ring net fishing for small pelagic fish is the most productive method in terms of catch volume, while hand line fishing is the most prevailed method in terms of number of fishers engaged.

1) Ring Nets with Fish-attracting Lights

[Outline]

Ring net fishing is to catch small pelagic fish such as sardines and small mackerel, using lights to attract fish in the night. Fishing boats used for this fishing are 9 to 13m long, provided with inboard diesel engine or outboard engine and are manned by a crew of about 10 fishers. The net are approximately 150 to 200m in length and 30 to 50m in depth, and mesh size ranges from roughly 1 inch to 1/2 inch. Each fishing boat usually carries two small boats for fish-attracting lights. Pressure kerosene lamps (made in China) are used as the fish-attracting lights, and each light boat uses 4 to 6 lamps. These lamps are locally procurable and effective light sources for the fishing.

Around 128 ring net fishing boats are operated based in Dar es Salaam, Tanga and Bagamoyo. These boats catch a large proportion of sardines and mackerel, which account for about one-third of the total production of the marine artisanal fisheries. Fishing boats provided with inboard diesel engines load ice at Dar es Salaam and then sail out to waters near Mafia and Zanzibar, where they conduct fishing for two or three nights.

For outboard engine boats, it is not easy to carry out such extensive fishing trips due to their engine capacity and fuel cost. Although the initial costs for fishing boats and fishing gears are highest, this

fishing is thought to be the most efficient one for increase of the production, since small pelagic fish are targeted and the catch efficiency is relatively high.

[Possibility for Improvement]

Due to the difficulty of procuring fishing materials, there are some nets with insufficient length and depth. They may be improved by expanding and adjusting net dimensions, floating capacity and sinker weight.

2) Daytime Purse Seine

[Outline]

This purse seine fishing targets pelagic fish such as mackerel and jack etc. Approximately 20 to 30 persons work on the fishing boat, which is 9 to 12 m long and equipped with an outboard engine. The net is approximately 150 to 270 m in length and 26 m in depth, and mesh size ranges from 2 inches to 1. The net is provided with purse rings and purse lines to enclose the foot part of the net. The net is used to surround fish shoal. Since the net is too short to enclose the fish shoal, it covers only half of the intended area and many crew members dive into the water to drive the fish into the nets, while the remaining crew on board haul the purse lines and hand-line to enclose the net.

This fishing method is not yet common. In our survey, nine boats are found in Tanga, and some boats from Zanzibar working around Dar es Salaam, Bagamoyo and Mafia. The boats leave port in early morning for fishing, conducting fishing operation 3 to 4 times, searching for fish shoals, and return to their fish-landing site in the afternoon. The quantity of catches varies from sometimes no fish at all to 3 tons rarely.

[Possibility for Improvement]

The nets are too short and shallow for surrounding fast swimming pelagic fish, and crew's efforts, diving into the sea can not compensate for this. Catch efficiency is therefore low. Moreover, the nets observed in Tanga, have no sinkers on footropes, and numerous purse rings were attached. They may be improved by enlarging the net dimensions, attaching sinkers and reducing the number of rings.

3) Gill net

[Outline]

There are various kinds of nets. Small mesh nets (50 to 100mm) consist of bottom gill net and floating gill net, used around coral reefs and estuaries. Large mesh nets (150 to 200mm) such as shark nets are used as floating gill net in offshore waters. No nylon mono-filament nets were found through the survey.

[Possibility for Improvement]

It is thought that catch efficiency could be increased by using nylon mono-filament nets. However, due to natural environment and resource protection considerations, use of such nets is limited to experimenting and training purposes under special permission from the Director of the Fisheries Division. General use is prohibited.

4) Hand Line Fishing

[Outline]

Hand line fishing is generally conducted by dugout canoe and outrigger canoe in coral reef areas and mangrove waters. Catch size seems at around 10kg/person/day, but there is a report that per capita income is higher than that of crew working with gill net and seine net fishing (Martin Guard, IMS, 1997). It may be possible because their target fish are relatively high price reef fish and the fishing costs are very low.

[Possibility for Improvement]

It is thought that quantity of catches could be increased by improving fishing tackles and by using long-line at the same time.

5) Seine nets/Surround nets/Pull nets

[Outline]

There are some variations on this kind of nets (Swahili names are Nyavu za kuzungush, Nyavu za kuvuta, Mtand). This fishing is to catch reef fish such as Scavenger, Snapper, Rabbitfish and Parrotfish by surrounding fish with the net in shallow coral reef areas. The fishing is conducted by a group of 10 to 20 fishers with a set of nets ranging 1,000 to 2,000m in length and 3 to 5m in depth, depending on amount of nets owned by each member. This fishing method can be seen practiced in Mtwara, Kilwa, Songosongo, Mafia and Bagamoyo.

It is easier to catch reef fish than pelagic fish because they inhabit reef areas, the resources are easily affected if catching efforts become concentrated. Some fishers point out that catches have fallen compared to past levels as a result of fishing conducted over many years.

Because coral and sea grass areas are damaged when the nets are dragged on the bottom, alternative methods are being considered by Mafia Marine Park, though they are not illegal.

[Possibility for Improvement]

Nets are sometimes not long enough to surround fish. An effective means of overcoming this is to increase the number of nets. It is also effective to add on net material in the depth direction. Speeding up setting the net with motorized boats can increase catch efficiency.

6) Fish Traps

[Outline]

Traps made with bamboo come in various shapes and sizes, but common types measure approximately 1 to 2m in width and depth and are around 50 to 60cm high. In Dar es Salaam, large traps made from wire mesh are also used. Traps weighed with rocks and baited with cut fish or squid and seaweed are set in coral reef areas. Targeted fish mainly consist of Rabbitfish, Parrotfish and Warasse, etc.

7) Beach Seine

[Outline]

This net fishing gear is known as juya la kojani or kavogo in Swahili. The net is deployed in shallow waters are pulled in on the coast or reef areas and the caught fish are taken in. When the nets are dragged on the bottom, they damage the coral and seagrass areas, fishing ground environment. For this reason, this fishing method was prohibited under the fisheries law of 1994.

(2) Fishing Boats

The fishing boats used for the marine artisanal fisheries are dugout canoes, outrigger canoes and planked construction boats consisting of mashua, Dau and boat. All the types of boats are built with traditional skill in Dar es Salaam, major fishing villages and landing sites in all the coastal areas.

Estimated construction costs of different type of boats are as shown in the following table.

Table 1-31 Boat Construction Cost in Dar es Salaam

Dimensions	For material	Wages	Engine		Total	
13.5m x 4.8m	6,000,000	2,000,000	6,000,000	(inboard engine)	14,000,000	Tsh
12.0m x 4.2m	5,000,000	2,000,000	6,000,000	(inboard engine)	13,000,000	Tsh
11.1m x 2.4m	2,000,000	1,000,000	2,200,000	(outboard engine)	5,200,000	Tsh
9.9m x 3.3m	2,000,000	800,000	2,200,000	(outboard engine)	5,000,000	Tsh
9.3m x 3.0m	1,800,000	700,000	2,200,000	(outboard engine)	4,700,000	Tsh
9.0m x 2.4m	1,600,000	500,000	1,800,000	(outboard engine)	3,900,000	Tsh
6.3m x 1.8m	600,000	400,000	1,500,000	(outboard engine)	2,500,000	Tsh

Source: Information through interview of boat builders in Dar es Salaam and Kunduchi

According to the 1998 frame survey conducted by the Fisheries Division, the number of recorded fishing boats over the whole coastal area is approximately 5,000. Almost half of all fishing boats are dugout canoes (mtwunbi) and one-quarter are outrigger canoes (galau). Planked construction boats consisting of Dau, mashua and boat are few in number and account for just one-quarter of all the boats. The ratio of planked construction boats is highest in Dar es Salaam, where more than 60 percent of fishing boats are concentrated.

Table 1-32 Number of Fishing Boats by Regions

	Mtunbwi	Ngalawa	Mashua	Dau	Boat	Total
Tanga	262	452	84	137	34	969
Coast	947	466	177	72	81	1743
Dar es Salaam	195	351	30	111	278	965
Lindi	363	103	30	100	24	620
Mtwara	689	7	23	136	4	859
Total	2,456	1,379	344	556	421	5156
Share of each boat (%)	47.6	26.7	6.7	10.8	8.2	

Source: Fisheries Division, 1998 Frame survey

(3) Motorization of Fishing Boats

1) Motorization of Fishing Boats

The ratio of motorized fishing boats is around 10 percent on average over the whole coastal area. In the southern Regions of Lindi and Mtwara, only around 2 to 3 percent of fishing boats are motorized. When compared with other African coastal countries, the motorization rate in Tanzania is low.

This does not mean that there is no demand for engines in the marine artisanal fisheries in Tanzania. Engine powered mobility is required for moving to fishing grounds and landing sites and conducting rapid operations (in particular ring nets and surrounding nets). Among fishing boats that carry out net fishing, quite a few lease outboard engines from fish-buyers of Dar es Salaam and other engine owners. The lease conditions are harsh for fishers in all cases, for example, rental charges may vary between Tsh.5,000 to 20,000 or fishers may be required to pay 15 percent of sales and to sell all their catches to the engine owner.

Table 1-33 Motorized Boats in Marine Artisanal Fisheries

	Diesel engine	Outboard engine	Non-motorized	Ratio of motorized (%)
Tanga	2	95	883	9.9
Coast	13	116	1,615	7.4
Dar es Salaam	35	213	652	27.6
Lindi	0	24	596	3.9
Mtwara	2	15	842	2.0
Total	52	463	4,588	10.1

Source: Fisheries Division, 1998 Frame survey

Table 1-34 Ratio of Motorised Boats of Marine Artisanal Fishery in African Countries

	Ratio (%)	Catches (tons)	
Tanzania	10	50,000	
Mozambique	below 20	20,000-60,000	
Ghana	54	100,000	1987 Data
Senegal	90	360,000	
Guinea	47	50,000	
Gambia	32	20,000	

In spite of the low motorization rate, there are some fishing boats which are provided with inboard engines. Most of them are purse seine fishing boats with 35 to 75 HP diesel engines. They are common in Dar es Salaam, from where they sail for fishing grounds around Mafia and Zanzibar for two or three days. Inboard diesel engines are more durable and have less fuel consumption than outboard engines. They are more suitable than outboard engines to the large planked construction boats of Tanzania, which are of displacement type with heavy weight. Second-hand diesel engines were procured from Dubai for the boats and they were installed by boat carpenters on landing beaches in Dar es Salaam.

In African countries south of the Sahara, there are no examples other than Tanzania, which has artisanal fisheries with inboard engine boats, locally built. In Senegal, Ghana and Guinea, purse seine fishing are actively conducted, targeting small pelagic fish such as Sardines by coastal artisanal fishers. All of the boats used for the purse seine fishing (ring net fishing) are equipped with outboard engines. The reasons are that they are all canoe type boats, suited to beach landing and difficult to install inboard diesel engines, in addition that outboard engines are cheaper than diesel engines.

Although inboard diesel engines need large initial costs, they are suitable to the large fishing boats of Tanzania, as mentioned above. It is therefore necessary to take advantages of durability and less fuel costs by introducing diesel engines for the large fishing boats, in addition to raising motorization with outboard engines.

2) Possibility for Better Income by Motorization

As mentioned above, some fishing methods can be made possible by motorizing fishing boats. Since sailing distances and speed can be increased by using engines, motorizing of fishing boats will give advantages in terms of fishing capacity and production. However, since motorization does entail higher operating costs, careful consideration has to be made for it from viewpoint of costs for engines.

Costs for outboard engine can be estimated as shown below. Assuming selling price of fish at Tsh.800 /kg, a fish catch of 20 kg/day would be needed to pay for the fuel cost alone in case of 25HP engines. When the depreciation cost of the engine is included, they need 24kg of fish per fishing trip to offset the cost of outboard engine installation. It would be 16kg in case of 15 HP engines.

Table 1-35 Estimate of Cost on Outboard Engine per Fishing Trip (day trip)

Estimate of cost for outboard engine for one day fishing			
Horsepower	25 HP	15 HP	
Fuel oil, unit price (including LO)	627	627	Tsh/litre
Fuel Oil Consumption/day (Approx. 4 hours)	25	15	Litre/day
Cost of fuel oil	15,675	9,405	Tsh/day
Selling price in average	800	800	Tsh/kg
(A) Catches necessary to cover the cost for F.O.	20	12	kg/day
Maintenance cost for the engine (Estimating at 10% of the price of the engine)	875	725	Tsh/day
(B) Catches necessary to cover the maintenance cost	1	1	kg/day
Depreciation of the engine			
Price of the engine =	1,750,000	1,450,000	Tsh
Period of depreciation = three years	584,000	484,000	Tsh/year
Number of fishing days a year = 200 days			
Depreciation cost in a day	2,917	2,417	Tsh/day
(C) Catches necessary to cover depreciation cost	4	3	kg/day
(A)+(B)+(C)	24	16	kg/day

A data on daily catch per boat are as shown below. Comparing these figures, the aforementioned quantities to pay the costs for engines seems to be within attainable range in some of the fishing methods. In the case of seine net fishing, fish catches can be expect to increase, since the engine will make it possible to set nets much faster. Actually, there are fishers groups that gain of better income after they commenced the fishing with engines and larger nets. Although gill net and shark net fishing are not active fishing methods, catch increase can be expected by motorization, since it will increase sailing range, enabling fishers to reach better fishing grounds, and operate with larger quantity of nets.

Table 1-36 Fish Catches per Boat per Day (kg)

	Gill net	Shark net	Surrounding net	Hand line	Fish trap
Average catches/boat /day in the main centres.	13-52	22-151	7-147	6-81	12-68
Average (kg)	31	52	63	24	28

Source: Fisheries Division, 1990 Fisheries statistics

In case of hand line fishing, which is most commonly conducted in outrigger canoes, catches per day were observed 20 to 30kg at most. They need to increase catches by 50 percent or more when using 15HP engine. It would be better to utilize outrigger canoes as low cost means of production, rather than using outboard engines. Even though they are equipped with engines, the use of engines should be limited only when there is no wind or difficult to raise sails.

(4) Situation of Supply of Fishing Materials

Fishing net materials are produced and sold by Tanzania Fishnet Industries Ltd. in Dar es Salaam. In addition, there are some fishnet retail stores in Dar es Salaam and they are selling various nets made in China and Korea as well as rope and hooks. In regional areas, some stores are selling some net-twines for mending nets, but it is difficult for most of the fishers to access these outlets to purchase fishing materials.

Concerning outboard engines, when the survey was started in January 2001, there were no agents importing and selling the engines in the coastal areas. In the past, motorbike and automobile retailers in Dar es Salaam had dealt outboard engines, but they did not last for long. The reason for this is not that there was no demand, but the quantities sold were too few to maintain the business.

Nile Fishnet Motor Co., Ltd., which imports and sells outboard engines in Mwanza on Lake Victoria, opened its shop in Dar es Salaam in March 2001. The shop has stocks of outboard engines ranging from 15 to 40 HP (spare parts are stocked from Mwanza), but only few sets were sold so far. Although an outboard engine store and stock are available in Dar es Salaam, since single down payment is required, it is not easy for fishers (boat owners) to actually buy.

Concerning import of fishing equipment and materials such as nets, engines and boats, they are exempted from import duties, same as equipment and material for agriculture production.

There are no retailers of inboard diesel engines in Tanzania, and almost all the inboard diesel engines (35 to 75 HP) of the fishing boats were procured through agents from the second-hand engine market in Dubai.

One of the issues marine fisheries face, is the short supply of fishing gears and engines, due to the difficulty in procuring materials. Because fishers cannot afford to buy fishing gear and materials and are thus unable to conduct sufficient fishing operations, they are consequently unable to obtain sufficient income. Moreover, fishers and fishers' groups that are eager to promote their fishing have been unable to take action. Moreover, in terms of processing and marketing, fish processors/ vendors are unable to start fish-buying business and cannot expand their business because they do not have funds for purchasing fish or for investing in marketing equipment. There are no measures for providing financial support and assisting the activities of fishers and fish-buyers, benders.

5.1.5 Marketing

The overall flow of fish in marine coast can be largely divided into three channels, these are : i) fisheries production and marketing centered around Dar es Salaam, ii) production and marketing in northern areas such as Tanga, etc., and iii) production and marketing in southern areas such as Lindi and Mtwara, etc.

(1) Marketing Channels

1) Flow of Caught Fish to Dar es Salaam

Dar es Salaam has the largest population and consumer market in the country, and the fishing boats based in Dar es Salaam land their catches at the Banda Beach in front of the city's fish market. In addition, fish from other areas are carried in by truck and boat. Overland routes are from Kunduchi and Bagamoyo, etc. and also from Kilwa areas during the dry season (June through November). Purchase and transportation of fish by boat is carried out from Mafia, Kilwa, Tanga, Bagamoyo and Zanzibar. Mafia is the largest of these purchasing sources.

A Purchase and Transportation from Mafia

[Purchase and Transportation by Boat from Dar es Salaam]

The distance between Dar es Salaam and Mafia is approximately 80 N. miles. Boats loaded with ice boxes set out from Dar es Salaam and purchase fish from Kilindoni in Mafia. The fish buyers provide some fishing boats with fuel, engine, fishing material and even advanced money under agreements to secure fish. The amount of fish purchased in a single fishing trip is 1.5 to 3.5 tons. A single purchasing trip lasts for between 7 to 10 days depending on the type of fishery, and boats make two such trips every month. Around 10 boats make purchasing trips on a regular basis. Estimated amount purchased = approximately 600 tons/year (= 2.5 tons/boat/trip x 2 times/month x 10 boats x 12 months)

[Purchase and Transportation by Small-scale Buyers]

There is another route whereby small scale buyers purchase fish in small ice boxes and carry them from Kilindoni in Mafia to Kisij (35 N. miles) by sail boat, and then the fish are transshipped onto trucks at Kisij and carried to Dar es Salaam market. Approximately 20 buyers are engaged in such business. They purchase approximately 200kg of fish per trip and make roughly three trips per month.

Restrictions on this route are ice procurement and transportation between Mafia and Kisij. There is an ice making plant run by a private fisheries company in Kilindoni, Mafia. Its ice making capacity is small (2 tons/day) and ice is not always available. Moreover, because sea transportation relies on sailboats, on days when wind conditions are poor there is a risk that ice will run out and all fish will be ruined if too much time is taken.

Estimated purchase amount = approximately 144 tons/year (= 0.2 tons/person/trip x 3 trips/ month x 20 people x 12 months)

In addition, some fish are transported by some local fishers to Dar es Salaam fish market.

B Purchase and Transportation from Kilwa

Dar es Salaam fish-buying boats purchase fish in Kilwa, for Dar es Salaam fish market. This activity is carried out in the same way as the purchase of fish from Mafia as described above, and the same operators sometimes change their fish-buying site from Mafia to Kilwa depending on fishing conditions. Buying sites in Kilwa district include the fishing village of Kilwa Kivinje, Somanga on the continental side, offshore islands of Songosongo, Njovi, Somaya, Nyumi and Ukuza, etc. Distances from Dar es Salaam are 105 N. miles to Kilwa Somanga, 110 miles to Songosongo, and 125 miles to Kilwa Kivinje. Sailing these distances in two days by outboard engine boats is considerably hard and dangerous job. There are five or six merchant boats purchasing between 3 to 4 tons per trip and making two trips per month.

Overland route: Dar es Salaam fish-buyers come to buy fish from Kilwa (Somanga, Kilwa Kivije) by truck in dry season (June to November). The transportation between Dar es Salaam and Kilwa area is closed during the rainy season.

C Transportation from Zanzibar

Zanzibar is separated from Dar es Salaam by 40 N. miles. Since the consumer market in Zanzibar is small and sale prices are two times or sometimes three times higher in the Dar es Salaam market, fish are shipped by boat from Zanzibar to Dar es Salaam fish market. There are three fish-buying boats carrying about 700 to 1,000 kg of fish per trip and making about 10 trips per month. Accordingly, it is estimated that approximately 300 tons of fish are transported in this way every year.

D Transportation from Kunduchi and Bagamoyo, etc.

Distances are about 60km and since roads are in good condition, transportation by truck is relatively easy.

In Bagamoyo, there is a fishers' cooperative association composed of 27 members (fishers and merchants). In addition to fishing, the cooperative members also purchase fish through auctions, store the fish in ice boxes and ship the fish in rented trucks or by bus. In the case of shipping by truck, about 1.7 tons of fish is shipped per time. It usually depart Bagamoyo at 03.00 a.m. and arrives at the fish market in Dar es Salaam at 06.00 am for selling the fish.

Trucks can be procured at any time for a rental fee of about Tsh.50,000 /trip and are not a problem in terms of transportation, but, ice required for fish storage and transportation is not available in Bagamoyo. They usually purchase ice in Dar es Salaam, although prices rise and buying ice is not so easy during the hot season (October through March).

2) Flow of Fish in Tanga

Main roads lead from Tanga to Dar es Salaam and major inland cities and there are frequent high-speed bus services between Tanga and these cities. Utilizing these bus services, some fish traders are marketing fresh fish (frozen fish) from Tanga, Kigombe and Pangani to inland cities such as Arusha and Morogoro. The fish traders in Tanga, Kigombe and Pangani use their own or leased freezers (about 400 litre chest type freezers) to store fish purchased, and they pack this fish in bamboo baskets,

sisal bags and vinyl sheet for shipping and transportation. Shipped quantities vary between 50 to 600kg depending on the operator.

Table 1-37 Number of Fish-Traders, Shipping Quantities and Destinations

	Number of fish traders	Quantity shipped per month	Destinations
Tanga	Approx. 10 persons	50-200kg/person/month	Arusha, Morogoro
Kigombe	Approx. 6 persons	200-600kg/person/month	Arusha, Morogoro
Pangani	1 person (* In addition, some fish-retailers are also dealing with this business)	400-600kg/person/month	Arusha, Morogoro

Concerning marketing from Kigombe and Pangani, fish is first carried to Tanga by bus or truck, and it is then reloaded onto other buses going to the final destinations. Since fish-traders are dealing only small quantities, they cannot afford to charter trucks and their most realistic option is to make use of buses. This transportation is however one of the major constraints to fish marketing, because bus connections are sometimes difficult depending on departure and arrival times.

Although they intend to expand their transaction of fish sales, they have neither enough money to purchase more fish nor fund to procure additional freezers. It is necessary for the public sector to provide fish-traders, fish-mongers and vendors with some financial assistance such as low interest loans in order to support the people and promote marketing activities.

3) Flow of Fish in Lindi and Mtwara

Major fisheries sites in Lindi Region are Kilwa District, Somanga, Kilwa Kivinje and Songosongo Islands. Fish are purchased by fish-buying boats came from Dar es Salaam and also by trucks during the dry season (June through November). These activities are the same as described in the section of marketing in Dar es Salaam.

Fish processors/traders from Mtwara and southern inland towns such as Masasi, Newalla and Nachinguea buy fish and process them by salting, drying or grilling at the landing sites. After processing, they carry the fish, taking buses to the inland areas of Mtwara Region and sell their products. These activities, however, become difficult in the rainy season.

Besides the aforementioned marketing of processed fish, there have been some efforts to transport fresh fish to the inland marketing areas. Fish-buyers and traders purchase ice made in individually owned freezers, but the quantity of such ice is very limited. Buses are used for transportation of fish in this case too.

(2) Prices

Sale prices at landing sites are determined through auctions or in bargaining conducted by fishers and buyers. Prices vary depending on landed quantities, number of buyers and their desire to purchase, species, freshness and quality of fish, etc. everyday. In fish auctioning and selling conducted in all the landing sites including Dar es Salaam, weighing by scales is not carried out at all.

Price difference between Regions: As reflection of the largest consumer demands, fish prices are highest in Dar es Salaam scavenger and snapper at the fish-landing beach, Dar es Salaam fish market were in a range of Tsh.600 to 1,000 to 1,200 /kg at the time of the survey. In production areas near Dar es Salaam (Kunduchi, Bagamoyo) where they ship fish to Dar es Salaam fish market, auction prices are set in consideration of prices at Dar es Salaam fish market.

In Mafia, Songosongo and Kilwa, since local demand is small, prices are mainly influenced by purchasing from Dar es Salaam. Prices are set based on market prices in Dar es Salaam and purchasing costs, and they are set much lower than prices in Dar es Salaam. The purchase price of fish landed by the fishing boats that have any agreements with Dar es Salaam fish-buyers are set in advance, but prices of other fish catches are basically set through auction.

The findings of interviews conducted with buyers are indicated below. Sale prices greatly vary depending on conditions of supply at Dar es Salaam fish market, however, a price difference of Tsh.300 to 400 /kg generally exists.

Table 1-38 Area Wise Purchase Prices and Sales Prices in Dar es Salaam

	Average Purchasing Price	Selling price in DSM market
Mafia	Purchase by boats from DSM=240-300 Tsh/kg Purchase by small buyer for DSM=480-800 Tsh/kg	800-1,200 Tsh/kg
Kilwa (Somanga, Kilwa kivinje)	Purchase by boats from DSM=200-250 Tsh/kg Purchase by trucks from DSM=200-330 Tsh/kg The price declines even 100 Tsh/kg in raining season.	600-800 Tsh/kg When landed a lot =400 When landed few =1,200-1,500
Songosongo	Purchase by boats from DSM=300 Tsh/kg	500-700 to 1,200 Tsh/kg

Expenses directly incurred during purchase of fish by boat are approximately Tsh.200/kg per trip in case that 1.5 tons of fish is purchased from Mafia. This rises to Tsh.200 to 320/kg in case where 2 to 4 tons is purchased and transported from Kilwa, Songosongo. Profit is not all that large and there is large risk depending on market fluctuations in Dar es Salaam. Expenses in the case of buying and purchasing 1.5 to 2.0 tons from Kilwa by truck are Tsh.200 to 230/kg, which is cheaper than in the case of purchase and transportation by boat. In either case, in the case of small pelagic fish, since prices are too cheap to even cover direct purchasing expenses, these fish are not targeted for purchase.

Purchase prices of fresh fish in Arusha and Morogoro are not much different from prices at Dar es Salaam fish-landing beach, and the price margin with beach prices in Tanga (Kigombe, Pangani) is about Tsh.300 to 400/kg as indicated below.

Table 1-39 Purchase and Sale Prices in Each Area by Species of Fish

	Purchasing price in Kigombe, Pangani	Selling price	
		In Arusha	In Morogoro
Scavenger	700	1,100	1,000-1,100
Parrotfish, Snapper	600-700	800-1,100	1,000-1,100
Grouper, Kingfish	1,000	1,600	1,500

In the case where 600 kg of fresh fish (frozen fish) is marketed from Tanga (Kigombe, Pangani) for Arusha and Morogoro, transportation and electricity for freezers are Tsh.125 to 150/kg and Tsh.67/kg respectively, and this is still enough to allow some profit to be secured even if freezer rental (Tsh.75/kg) and depreciation cost (Tsh.51/kg) are included. However, transportation and electricity costs are large and it is necessary to ship and sell at least 600kg of fish every month; otherwise it is difficult to make any profit.

In the southern districts of Lindi and Mtwara, prices are not directly affected by market conditions in Dar es Salaam, but they are determined by supply and demand conditions in the local area. Beach prices at the central landing site in Mtwara are Tsh.800 to 1,000/kg, which is about the same level as beach prices at Dar es Salaam fish market. This is indicative of high demand for fish in Mtwara City and inland areas, albeit on a small scale. Having said that, in small fishing villages dotted around areas separated from Mtwara and Lindi, access to markets is difficult due to poor road conditions and there are large disparities in sale prices. Because buyers are unable to come, fish are dried in the open air.

5.1.6 Processing

Processing of caught fish in the coastal areas mainly consists of sun drying, salt drying and cooking (deep frying and grilling).

Sun drying of anchovy: Anchovy are landed by ring net fishing in Dar es Salaam and Tanga and most of them are sun dried (marine Dagaa). There are no records of quantity of this specie, but they do not seem to be major fish in quantity and in value as well.

Improvements such as introduction of vinyl house for drying were discussed as means of preventing losses caused by rain during sun drying in Tanga. But, because marine Dagaa are sold at the same (Tsh.600 /kg) as Dagaa Mwanza being sold with large quantity and not all people necessarily prefer marine Dagaa anyway, it is not possible to add the investment and maintenance costs of rain prevention facilities on to the selling prices.

Sun drying and salt drying : Salt sun-dried fish are made in Kilwa, Somanga and in particular offshore islands. The drying is only performed as a stopgap measure at times when it is difficult to ship fresh fish. From the middle of the 1980s, purchase by boats from Dar es Salaam and overland trucks during the dry season has been carried out, and shipments and sales of fresh fish have increasing.

Because fish traders, buyers from Mtwara and other inland areas in the south are still unable to carry fresh fish, they carry and sell salt dried fish that they make themselves. However, here again, sun dried and salt dried fish are merely means of storage for transporting and marketing fish to consumer markets. People prefer fresh fish.

5.1.7 Management of Fishing Households

(1) Form of Fishing Households

Though fishers households varies depending on type of fisheries and by each fishing boat, the most common case consists of boat owners possessing fishing boat and fishing gear with crew members carrying out actual fishing work. In the case of canoe and outrigger canoe fisheries, it is common for boat owners to go fishing by themselves and take part in the fishing operation. In the case of large boats, boat owners rarely take part in fishing trips and master-fishers conduct fishing operation, commanding crew members. Some boat owners own more than one fishing boat.

A way to divide income from catches is arranged in advance between boat owner and crew members. Fishing expenses such as fuel, ice, food and expendable costs are deducted first from sales amount of the catch and the remainder is divided between the boat owner and crew. The division ratio varies depending on the fishing boat. The most common case in net fishing is 50 percent to the boat owner and 50 percent to the crew. Considering that boat, engine and fishing gear repair costs are borne by the boat owner, the 50 percent share taken by the owner is not so high.

(2) Working Conditions

Gross income from fish catches is divided according to the aforementioned way. It is usually divided up as cash after sale of fish, but sometimes the crew members divide up the caught fish between themselves and sell it off independently.

According to interviews with fishers of ring net fishing, the share for crew is divided equally to all crewmembers. In the case of hand line fishing, the share for crew is also divided equally between the crewmembers, though the catch varies depending on each crewmember.

There are some boats which have more crewmembers than needed and they work on board in turns. As a result, their working opportunities are less and income is also lower than ones of full-time crewmembers.

(3) Fishing Operation Model by Fishing Method

Based on information obtained from fishers, fishing management models in each fishing method are estimated and indicated in the Table below. Prices in Dar es Salaam and nearby landing sites are assumed here, however, regional price conditions are much harsher.

Concerning the prices of fishing boats, engines and fishing gears for the initial investment, estimated costs of newly building and procuring are used.

Night-time ring net fishing is the biggest fishing management, which requires the biggest initial cost and operation cost. Catch per fisher of this fishing is largest and operation cost per unit catch quantity is relatively cheap at Tsh.160 /kg. Since catches are largely made up of cheap sardines, it is important that costs are held to this level. When viewed in terms of supplying large quantities of cheap fish to the people, this fishing is the most important.

In case of night-time ring net fishing by boats with outboard engines, fuel expenses increase largely. Although this fishing indicates almost same level of productivity as the same fishing with inboard engine boats, as long as it is conducted in nearby waters without taking ice, it becomes difficult to carry out long fishing trips because of cost of ice besides the fuel cost.

Ring net fishing during the daytime is not established properly yet in terms of fishing technique. Catch efficiency is then low and crew incomes are the lowest among fishers and fall well below the poverty line.

As models of non-powered boat fishing, estimates were made on hand line fishing by outrigger canoe and gill net fishing by small Dau type boats. Since no fuel expenses are incurred, crew incomes are relatively good, in particular of hand line fishing, though their catches are small. Consideration should be given to utilizing non-powered fishing boats as a means of low cost production.

Table 1-40 Fishing Operation Model by Fishing Method

Fishing method	Ring net with lights	Ring net with lights	Ring net in daytime	Surrounding net	Gill net	Gill net	Hand line
Engine	Diesel eng.	Outboard eng.	Outboard eng.	Outboard eng.	Outboard eng.	No engine	No engine
Number of crew	(10)	(10)	(25)	(15)	(3)	(3)	(3)
Days/fishing trip	3-4 days	One night	One day	One day	One day	One day	One day
No. of fishing trip/month	4trips	15trips	15trips	15trips	20trips	20trips	20trips
Operation cost	1,265,200	943,500	1,007,467	360,000	360,000	30,000	50,000
Fuel oil	420,000	567,000	816,000	360,000	330,000	0	0
Ice	480,000	0	0	0	0	0	0
Provisions	200,000	150,000	0	0	30,000	30,000	20,000
Bait, others	165,200	226,500	191,467	0	0	0	30,000
Catches (kg)/month	8,000	6,000	4,000	1,500	1,000	300	400
Main species	Small pelagic fish	Small pelagic fish	Jacks, Mackerel	Reef fish	Demersal fish	Demersal fish	Reef fish
Av. selling price (Tsh/kg)	290	290	500	700	700	700	700
Sales	2,320,000	1,740,000	2,000,000	1,050,000	700,000	210,000	280,000
Levy for fish landing 5%	116,000	87,000	100,000	52,500	35,000	10,500	14,000
Gross profit (Share)	938,800	709,500	892,533	637,500	305,000	169,500	216,000
For Owner	469,400	354,750	446,267	318,750	152,500	84,750	43,200
For expenses for boats	0	0	0	0	0	0	0
For Crew	469,400	354,750	446,267	318,750	152,500	84,750	172,800
Av. income/crew	46,940	35,475	17,851	21,250	50,833	28,250	57,600
Maintenance/repair expense	115,583	73,167	71,667	32,083	30,833	11,667	2,500
Owner's income	353,817	281,583	374,600	286,667	121,667	73,083	40,700
Depreciation	233,333	201,389	188,611	95,278	92,778	33,333	6,667
(Initial investment)							
Boat	3,500,000	3,000,000	2,800,000	2,100,000	1,800,000	1,000,000	300,000
Engine	6,000,000	2,200,000	2,200,000	1,800,000	1,800,000	0	-
Fishing gears	6,000,000	5,000,000	5,000,000	1,000,000	1,200,000	900,000	20,000
Ice box	600,000	400,000	-	-	-	-	-
Total of investment	16,100,000	10,600,000	10,000,000	4,900,000	4,800,000	1,900,000	320,000
Catches/person/month (kg)	800	600	160	100	333	100	133
Operation cost/kg Tsh.	158	157	252	240	360	100	125
Income/person	46,940	35,475	17,851	21,250	50,833	28,250	57,600
Owner's net profit	120,483	80,194	185,989	191,389	28,889	39,750	34,033
Owner's net profit/Sales (%)	5.2	4.6	9.3	18.2	4.1	18.9	12.2
Owner's share/operation cost (%)	28.0	29.8	37.2	79.6	33.8	243.6	81.4
Investment/Owner's share		3.8	3.1	2.2	1.4	3.3	2.2

Source: Estimate by JICA Master Plan Study Team

5.2 Fisheries in Lake Victoria

5.2.1 Natural Condition

Although it is situated directly below the equator, the temperature at the lake is not so high at 20 to 25 degrees centigrade throughout the year, as it is located on the relatively high land, the lake surface being 1,134 metres above the sea level. The annual precipitation is 1,034 millimetres⁷ (1999), about two thirds of that in Tokyo. However, the rain falls not evenly over the year but intensively in two

⁷ Tanzania Meteorological Agency, Mwanza

periods of March to April and November to December, on which 75 percent of the annual precipitation is concentrated. During these two rainy seasons, it is considered that the nutrients is replenished by the rain water that falls on the land, flows on the land surface, absorbing the nutritive elements from the surface soil, and flows into the lake in large quantity. On the other hand, the wind blows from the southeast in the morning and predominantly from the north-northwest in the afternoon throughout the year (See the Attached Figure 31). Paying attention to the wind from the southeast in the morning that affects the operation on the lake, it can be seen that the wind blows harder from May to September (See the Attached Figure 32). The lake water is stirred and mixed up during this period, when the whole water mass from the lake surface to the bottom is mixed uniformly. In other periods, the layer of discontinuity is formed around the 30 to 40 metres depth, stratifying the lake water.

5.2.2 Fisheries Production

Commercial artisanal fishery in the Lake Victoria aims at three kinds of fish, namely Nile perch, Dagaa and Tilapia. According to the fishery statistics for the fiscal year 1996, Nile perch occupies 75 percent of the total quantity of the fish caught, making this fish the most important target for fishing. This is followed next by Dagaa with the share of 12.2 percent and then by Tilapia with 11.4 percent. However, the reliability of the statistical data is often questioned.

Table 1-41 Composition of Fish Caught

Unit: ton

SPECIES	CATCH	COMPOSITION
Tilapia	18,180	11.4%
Bagrus	192	0.1%
Clarias	454	0.3%
Alestes	40	0.0%
Nile perch	120,326	75.6%
Dagaa	19,392	12.2%
Protoprerus	227	0.1%
Others	388	0.2%
TOTAL	159,199	100%

Source: Fisheries Statistics 1996

The latest statistics from the Fisheries Division (1996), the Nile perch production is recorded as 120,326 tons. However, calculating 29,104 tons of the fillet produced in 1996, together with 35 percent of yield recovery rate and 20 percent of reject rate, total production comes only up to 103,946 tons. On the other hand, FAO announces the figure of 151,615 tons as for Nile perch production. Despite datum for the exporting volume being accurate, other figures accompanies to the production figure may probably be paid less attention which resulted in rather low estimated figure for the production. One way or the other, the Nile perch production is the first half of 100,000 tons and even though the number of boats and fishing gears are increasing (Frame survey), production itself is estimated not to have grown much because of bans of Nile perch products in EU.

(1) Landing Sites

There are 602 landing sites on the lake, 15,491 fishing boats in operation and 56,258 fishers, according to the Frame survey of the year 2000 edition. These figures have rapidly increased due to the boom in Nile perch fishing, indicating a 33 percent increase in the number of landing sites, 103 percent increase in fishing boats and 74 percent increase in fishers, in comparison to the data in the previous Frame survey of 1998. Since the artisanal fishery, in the Lake Victoria when combined, is large in its scale, and there are big differences in fishing forms for different target fish, fishing practice, distribution and processing will be described in detail for each kind of fish.

(2) History of the Fisheries

At the Lake Victoria, full-scale fishery was initiated in the beginning of the 20th century. The main fish targeted then were Tilapia (*Oreochromis esculent*), which were dried in the sun and transported to the consuming region, since the preservation facilities were not satisfactory then. In 1950s after the Second World War, fishing nets made of synthetic fiber and outboard engines, produced at the factories in large quantity, started to be introduced, resulting in a big jump in the catch of the existing Tilapia thereafter. However, it was only until 1980s that they had been playing the main role in the fishery in the Lake Victoria, which was taken over by Nile perches, said to have been transplanted in 1950s to 1960s. It is said that Nile perch did not originally live in the Lake Victoria, but were transplanted from the Lake Albert of neighbouring Uganda. As they are highly prolific carnivorous

fish, they rapidly became the dominant species in the ecosystem. They began to be netted by local fishers in the beginning of 1980s, and it did not take more than 10 years for the first frozen Nile perch fillet to be exported from Kenya (1987). Thereafter up to the beginning of 1990s, many processing plants of Nile perch fillet started to be constructed and put into operation in Kenya, which extensively bought a large quantity of these fish in unprocessed state from Tanzania and Uganda, as it owned only a small portion of the lake surface to begin with. Nevertheless, the Tanzanian government, fearing an outflow of economic resources, banned export of unprocessed Nile perch, requiring the processing plants to be built locally. Since 1992 Kenyan-owned plants began to be constructed in the neighbourhood of Mwanza and put into operation to start exporting Nile perch fillet made in Tanzania.

Apart from Nile perches, the Tilapia (*Oreochromis niloticus*) of other species, now important as the target for commercial fishery, have been transplanted to the Lake Victoria. They are in competitive relation with the Tilapia of existing species (*O. esculent*) in the same living circumstances from which they gradually drove away the existing species because of their biological superiority. Also from the effect of being eaten by Nile perches, the Tilapia of existing kind have rapidly decreased in number, now barely surviving in the satellite lakes of the Lake Victoria. In this connection, before the advent of Nile perch fishing, Haplochromis fishing funded by Dutch capital was operated in 1970s. Haplochromis, small pelagic fish of Cichlid family, had been caught in large quantities as the raw material for the fish meal plants of Dutch capital and further eaten by Nile perch, decrease rapidly. There are Dagaa (*Restrineobola argentea*), occupying the same position as the Haplochromis in the lake's ecosystem, that are the important target of the current commercial fishery. Since Dagaa is not originally a name for a specific species, but for small fish in broad sense, they are called Dagaa Mwanza in Tanzania to differentiate from Dagaa caught in the Lake Tanganyika, valued higher in the consumer market. Although Dagaa are eaten by Nile perch as Haplochromis are, they managed to escape the tragedy of Haplochromis, because they live in the area a little different from that of Nile perch and rapidly reproduce themselves at younger age and smaller size. It is said that Dagaa fishing began when beach seine fishing, using fish-attraction light was introduced from Kenya in 1960s. Since Dagaa have the habit of approaching the lake surface to eat plankton rising up toward the surface layer during the night time, the method was adopted to gather them with the fish-attraction light during moonless night to catch many of them at a time. In 1970s, Dagaa caught and dried in the sun, or dried Dagaa, finally secured a regular position in the market. As new fishing methods such as scoop net and lift net were introduced in 1980s from Lake Tanganyika where Dagaa fishing is more advanced than in the Lake Victoria, the quantity of Dagaa caught in the Lake Victoria has attained stable growth (Peter Gibbons).

5.2.3 Fisheries Resources

While the volume of resources is not fully researched, as full-scale resource survey has not been conducted up to this date, the second phase of the resource survey project financed by EU (LVFRP: Lake Victoria Fisheries Research Project) is now underway with the scheduled duration of five years and the research results is expected to be released in November, 2001. In this research, the biomass of three commercially important fish, namely Nile perch, Dagaa and Tilapia, are surveyed, combining different methods of research, such as trawl fishing, scientific echo-sounder, gill net fishing and survey of catch at the landing sites. According to the interim report released in December, 2000, the biomass of Nile perch is said to be 649,000 tons and pelagic fish resources like Dagaa and others 600,000 tons, both for the entire lake. It looks to be difficult, to our regret, to estimate the biomass of Tilapia, because they do not live in the zone where the trawl can be dragged.

Nile perch resources in Tanzanian zone is supposed to be 330,000 tons from the simple calculation for the dimension of Tanzanian occupied zone, assuming that this kind of fish live uniformly all over the lake. As this figure indicates, the biomass, the TAC (Total Allowable Catch) can be said to be realistically a half of it. Dagaa resources are calculated similarly from the dimension to be about 300,000 tons, suggesting that there still is a lot of room for more catch, according to a Dutch Dagaa researcher dispatched to TAFIRI.

5.2.4 Fisheries Condition of Major Three Species

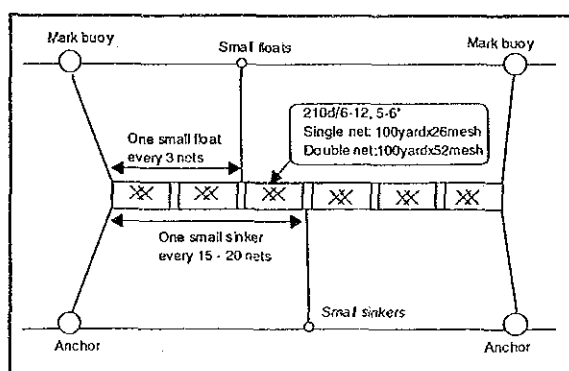
(1) Nile perch Fisheries

A Fishing Gears and Boats

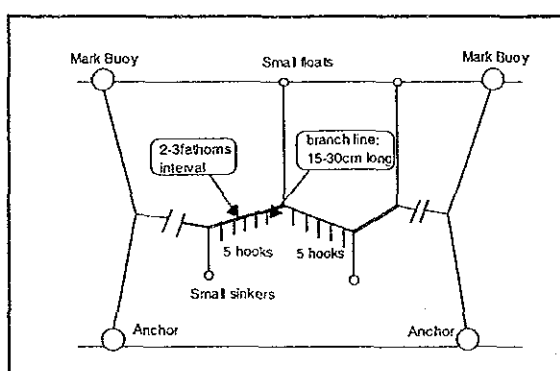
a Fishing Gears

Broadly classified, there are two fishing methods, namely gill net and long line. Trawl fishing, once practiced, was prohibited by the Fisheries Regulation of 1994, blamed as affecting the resources and fishing ground severely. The twine of 12 to 15 ply is most used for the gill net, of which the raw material is nylon multi-filament of 210d/6 to 15. The most common mesh is of 5 to 6 inches, since the one of less than 5 inches was prohibited by the Fisheries Regulation of 1994. The size of a piece composing the gill net is 100 yards long by 26 meshes, the specification of the one imported from China, regarded as the *de facto* standard. Fishers with more fund buy more pieces of this net to use. The price of a piece of the net is Tsh.10,000 to 12,000. While a boat uses 33 pieces of the net in simple average (Frame survey, 2000), this data includes the gill nets for Tilapia, smaller in number, resulting in an estimate that a boat specialized in Nile perch fishing should own more pieces of the gill net. If 30 pieces of the net with 5-inch mesh are combined in a single file, one entire net is to be 1,620 metres long and 2.6 metres wide, assuming the hanging ratio to be 0.6. Since Nile perch live in the middle layer to bottom layer, making it hard to pinpoint their swimming zone at a specific layer, fishers with ample fund add one more set of net to increase the depth, resulting in the expanded net of 52 meshes, 5.2 metres long, so as to cover a wider swimming zone. The gill net fishing is operated once a day, generally setting the net in the evening to lift up early in the next morning, by a crew of 3 to 4 men, who keeps vigil, sitting up all night after the net setting for fear of robbery of the fishing gears.

There are two types of the long line, the one using the nylon mono-filament, thought to be more popular, and the other the cord rope. The fishhook is the No. 10 to 11 Kirby sea hook made by a Norwegian company, Mastad. The space between two branch lines is 3 metres, while their length is very short, about 10 centimetres, causing concern that fish may notice them, although they are all the more easy to handle. *Haplochromis* are most commonly used as the baits, though they are now collected by hand-lining one by one or buying for Tsh.10 a piece to cover the shortage, as there is no efficient way to catch the bait fish in large quantity due to the prohibition of catching them by beach seine under the fishing regulation of 1994. While the number of hooks for the long line per boat is 780 on average (Frame survey, 2000), many hooks are said to be without bait, since it is hard to collect this much baits by hand lining and purchase. Besides *Haplochromis*, fry of *Clarias* (belonging to the family of catfish) are liked because of high fishing efficiency and bought at a high price of Tsh.50 a piece, although they are not used frequently, as it is difficult to procure them in significant quantity.



Nile perch gill net



Nile perch longline

Figure 1-7 Specifications of Nile perch Gill Net

Figure 1-8 Specifications of Nile perch Long Line

b Fishing Boat

There are two kinds of fishing boats, the one not equipped with an outboard engine, called double ender type and the other with an outboard engine, called transom stern type (See the photo below). The size of a transom stern type boat is 7 to 8 metres and double ender type boat 5 to 7 metres, as the length of a boat is usually expressed in the length of keel. While it is not known where the boat design originated, it appears that the boat type and construction method matching the Tanzanian circumstances were independently developed, as the design is apparently different from the ones of Uganda and Kenya seen near the borders with them respectively. The boats of Kenyan and Ugandan types, similar to each other in many parts, are slim on the whole and of linear design with less number of relatively large transverse frames put in to maintain their strength (See the photo below). Each of the wooden board composing the outer wall is large, suggesting that forest resources are still relatively rich.

On the other hand, the boats of Tanzanian type are of the bulging design with the hull in bow-like form predominantly at the central part with small horizontal frames put in closely, 30 centimetres apart from each other, to provide strength to the hull. The wooden boards used in the outer wall are 9 inches each in width, as the standard size of the sawn boards are of that size, requiring more numbers of boards used in comparison to those for Ugandan type boats. In other words, the characteristic of a Tanzanian type boat is that all its components are small, requiring more time and labour as they have to be assembled minutely and correctly. The most expensive kind of the wood used is hard wood, called Mwininga, higher in price as it has better durability. While the price of a boat amounts to about Tsh.800,000, in the case where all the materials used are Mwininga, that of the one made of soft wood can be contained to a half or one third thereof.



Figure 1-9 Three Types of Fishing Boats are Observed in Lake Victoria; Transom Stern Type (left) and Double Ender Type (centre), Ugandan Type (right)

B Distribution (Export)

Nile perch is not so liked among people living on the lakeshore. One of the reasons is that it is rather new and unfamiliar to most consumers with the history of less than 20 years since it was regularly circulated on the market and also because of their greasy taste which is not welcomed. Such being the case, almost all Nile perch caught there are sent to the fish processing plants to be exported after processed into fillet. The fish rejected by plant buyers at landing sites are delivered to the local market after dried in the sun or smoke processed.

Buying agents under contracts with factories are exclusively dealing with the distribution of Nile perches for processing into fillet. These agents come to the landing sites by trucks and boats for cargo collection, loaded with ice for purchasing them. At the landing sites, under the strict hygienic guidance of EU, fish freezer boxes of each plant for temporary storage and platforms for weighing are arranged on the shore, paying meticulous attention for the fish to be clear of the ground. While the purchasing price on the shore fluctuates between Tsh.300 to 700, the average price through the year is estimated to be around Tsh.500.

The Nile perch export first appeared in the statistics in 1993 and the current level of export quantity is 29, 104 tons (2000, Fisheries Division), roughly divided 50 / 50 into fresh and frozen fillet.

Fresh fillets are exported from Mwanza Airport directly to the consumer markets in Europe by air. Belgium and the Netherlands are the two largest consumer markets where they are welcomed as alternatives for the cods that have been traditionally liked by the people in these countries. Although the Mwanza Airport has a runway of 3,300 metres, there are no long distance regular flight services from Europe, since the sightseeing demands are not high. Accordingly, the chartered flights using the cargo carriers of the ex-Soviet air force that became available as a result of the end of the cold war structures are the main means of transportation.

As frozen fillets have no such limitations of market range as the fresh ones have, they have various destinations such as the Netherlands, Greece, Japan and Spain. Some 40 percent of the products are transported in the refrigerating containers loaded on cargo trains to Dar es Salaam, where they are trans-shipped to reefers. The remaining 60 percent are transported by road in the refrigerating containers pulled by trailers to Mombasa of Kenya, where they are trans-shipped to reefers. Since the road network between Mwanza and Dar es Salaam is not well developed, the products are never transported to Dar es Salaam by road (Quality Control Unit, Fisheries Division, Mwanza, 2000).

In the year 2000, Tanzania alone exported 2,608 tons to Japan. Including Kenya and Uganda, the three countries, exported a total of about 7,000 tons (See the Table below). While they might be sold sometimes labelled as white sea bass to consumers, they are mainly sold as raw materials of whitefish fries for the restaurant industries. The CIF import prices in Japan somewhat vary but are around US\$ 3 per kilogram.

Table 1-42 Japanese Import of Nile perch

Country	1998		1999		2000	
	Quantity (kg)	Value (,000 yen)	Quantity (kg)	Value (,000 yen)	Quantity (kg)	Value (,000 yen)
Kenya	1,255,583	508,115	1,826,042	672,792	2,125,997	607,560
Uganda	1,033,332	431,628	2,303,495	830,976	2,461,362	705,323
Tanzania	3,258,232	14,250,851	4,526,940	16,312,151	2,608,586	809,050

Source: Japan Tariff Association

Assuming that the purchase price of the Nile perch at a plant on the shore of Lake Victoria is Tsh.700/kg (US\$ 0.80/kg), the price of the fillet per kilogram is calculated to be US\$ 2.3, using simply the weight ratio between materials and products (yield ratio of 35 percent). The expenses at the plant such as personnel expenses and refrigerating costs, profit and transportation cost to Japan should be added to this figure to reach the final price of US\$ 3 per kilogram, resulting in an estimation that it is fairly difficult to squeeze out a profit unless the cost is considerable curtailed. On the other hand, in the European markets, assuming that the prices are similar to those of cods which are traded at US\$ 5 to 6 per kilogram, the circumstances seem to provide a considerable room for the profit.

C Processing

Table 1-43 Use of By-products of Nile perch Fillet

Raw fish (whole parts)	<ul style="list-style-type: none"> • Sent to the consumer market such as Dar Es Salaam as fresh fish. • After salted and dried, exported to Congo (former Zaire). (Kayabo).
Fish offals	<ul style="list-style-type: none"> • Consumed locally as foods. • Extraction of edible oil.
Fish maw	Exported to China as high class food materials. Unit price of dried one is 10,000 ~ Tsh.20,000/kg.
Fish chips	Small fragments of fish meat produced in the process of trimming the fillet. Salted, dried and exported to Democratic Republic of the Congo.
Belly flap	Same, rib part of fillet.
Punk (head part)	Distributed intact or after frying to the local market or surrounding areas.
Fish frame	Dried in the sun and ground to produce fish meal.
Chest	The throat part of the fish distributed intact or after frying to the local market or surrounding areas.

Almost all kayabo and chips are processed in the market of Kirumba and exported, of which the pricing process is shown in the following figure. It may not be called a highly profitable business, as the profit accounts for less than 10 percent of the commodity price. Moreover, the dependence on the plants for procurement of raw fish may leave room for future uncertainty in securing raw materials.

Although there are two places near Mwanza to process fish frames, punks, and final residual materials from the factories, both places are far from the city and poor in social infrastructures. The fact is that they were gradually evacuated by the municipal authorities from the places near the city to the inconvenient locations due to reek and flies.

As a matter of course, the working condition for those working there is awfully poor without any access road, water service or shelter from rain and wind of any kind whatsoever.

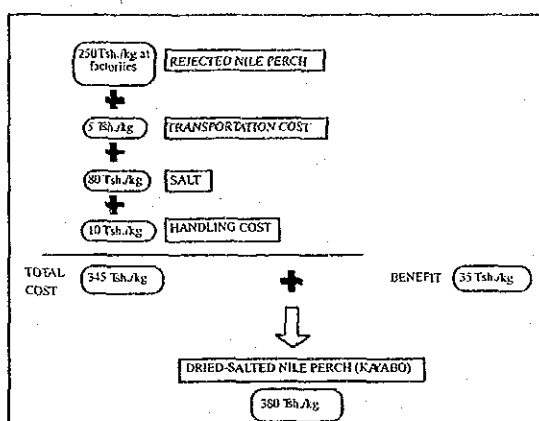
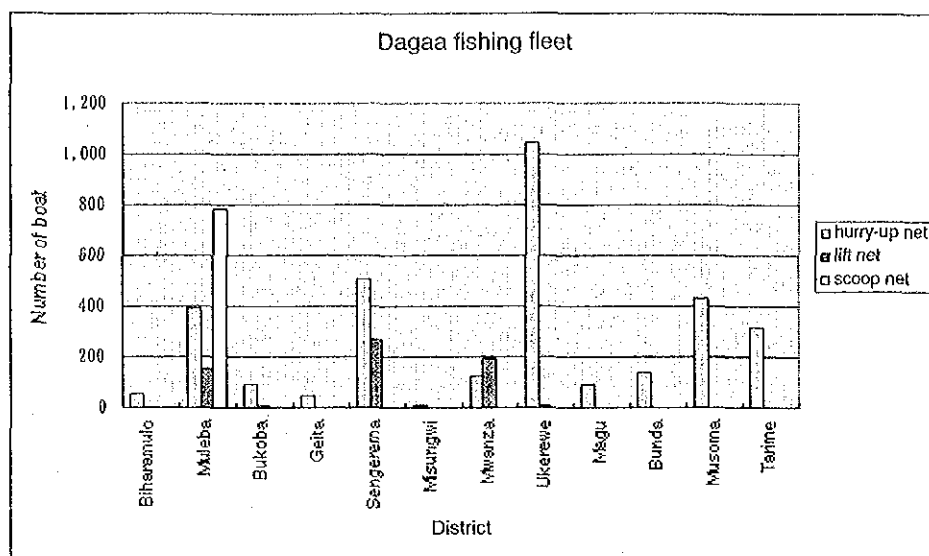


Figure 1-10 Price Structure of Kayabo in Kirumba Market

(2) Dagaa Fisheries

A Fishing Boats and Fishing Gears

At present, there are three fishing methods to catch Dagaa. The first is the seine net called Hurry-up net, the second the four-armed hand net called Lift net and the third called Scoop net. Since these methods have their own characteristics, the area where each method is used also has the characteristics in its extension respectively. (See the Figure 1-10)



Source: Fishing Division, The Lake Victoria Frame Survey 2000

Figure 1-11 Distribution of Dagaa Fishing Boats by Prefectures and Fishing Methods

The Hurry-up net is most widely used among these three methods. This method, original of Lake Victoria, is to attract Dagaa by the kerosene lamp floated on the water and catch them by the net placed in such a way as surrounding the lamp. It is not used in Lake Tanganyika where Dagaa fishing was originated. The boats are operated independently by engine or manually and one boat is usually operated by four fishers.

The technique of the lift net, original of Lake Tanganyika, was devised by the fishers who had moved from Kigoma, the centre of Dagaa fishing in the Lake Tanganyika. A large square is formed by connecting two boats with connecting bars and a kerosene lamps is lit to attract fish above the previously sunken four-armed hand net, each 20 metres wide to catch all the fish at a time by pulling up the net. Since two boats run in parallel to the fishing ground, usually only one of them is equipped with an outboard engine (8 to 25HP). At least four fishers are needed on board, because each man is to be engaged in pulling up one of the four corners of the square-shaped net.

The scoop net, the simplest of the three methods to operate, is used in Muleba district. Same as in the above-mentioned two methods, the kerosene lamp is lit to attract Dagaa for a fisher standing astern on the boat to simply scoop fish with a large insect catching net. This method is used at the places relatively close to the lakeshores. In other words, the fact that they can fish near the lakeshores with simple gear means that the fishing grounds are that rich. One double ender type boat of 7m long without a engine is used to operate. The bottom of the boat is made of tin plates instead of wooden boards to reduce the cost of the boat. It is believed that the tin plate bottom was introduced to minimize damages to the bottom when pulling up the boat on the gravel shores that are common in the Muleba district, although a thin tin plate as the bottom of the boat presents a great concern on the security of the boat. Unlike the above-mentioned two methods, this one requires only two fishers.

B Distribution

There are various estimated data and published data of the production volume of the dried Dagaa. According to the latest fishery statistics released by the Fishery Division, the volume of Dagaa caught was 19,392 tons. Assuming the weight ratio of dried Dagaa to be 40 percent (Gibbon, 1997) and processing and distribution losses to be negligible, the production of dried Dagaa is estimated to be 7,757 tons. On the other hand, the Master Plan Study estimates the annual production volume to be

52,200 tons, judging from the number of Dagaa fishing boats and the average volume caught per boat⁸ based on the Frame Survey 2000, resulting in a difference of as large as seven times. There also exists a record in the Kirumba market in Mwanza where nearly 90 percent of the dried Dagaa is distributed that the distribution volume amounted to 10,393 tons. As you can see in the distribution figure of Dagaa by districts shown above, Dagaa fishing is most popularly operated in the prefectures of Ukerewe, Sengerema and Muleba. In these areas, the purchasing prices

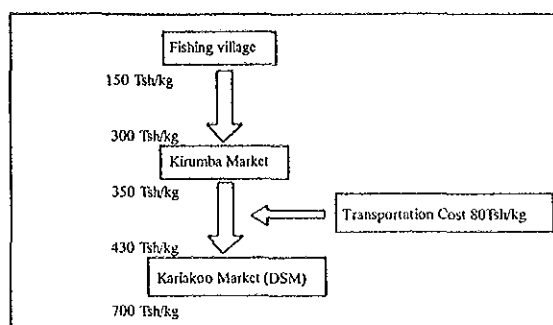


Figure 1-12 Price Structure of Dried Dagaa

slightly vary according to the distance from the Kirumba market. The average price is Tsh.6,000 for a bag containing 40 kilograms each. But in Ukerewe district where the transportation costs are less due to a shorter distance to the market, the price is Tsh.10,000. The products are purchased by trading ships and brought into the Kirumba market, where they are distributed by other traders to respective districts. How the prices are fixed during the distribution processes is shown in the figure.

According to the distribution statistics of the year 2000, 441 tons were exported to Dar es Salaam by rail and TRC and 356 tons to the Democratic Republic of the Congo (ex-Zaire)(The Kirumba Fish Market Office). And considerable volume of Dagaa is distributed additionally to various places in Tanzania by trucks.

C Processing

The only method to process Dagaa is to dry in the sun. The drying racks that are used in Kigoma are not used and the fish are simply spread over the sand to be dried. Where there are some large rocks nearby, the fish are also dried on them, because it is understood to be more sanitary than dried on the sand and faster to be dried. But on the islands of Muleba where neither sand nor rocks exists, they dry fish on grasses brought in from the mainland. The most serious pending question at present is how to dry fish in rainy seasons.

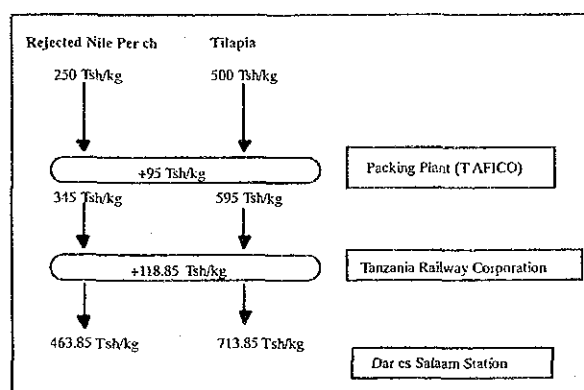


Figure 1-13 Price Structure of Fresh Fish Marketing

(3) Tilapia Fisheries

A Fishing Boat and Fishing Gears

Fishers solely engaged in Tilapia fishing are not many. Since Tilapia fishing does not require a large amount of capital, it is considered subordinate to the Nile perch fishing or a side job for the cotton growing farmers. Most of the Tilapia fishing uses double ender type boats without engines and the main fishing methods are gill net fishing, long line and rod fishing. On a rod fishing boat, usually two fishers are on board, each of them handling five rods on average.

⁸ The monthly average production of Dagaa fishing boat by fishing methods was estimated in the following manner. 25 bags of 40kg for the hurry-up net fishing of 18-day operation to produce 1,000kg of dried dagaa (LVEMP mid-term report), 50 bags for the lift net of 18-day operation to produce 2,000kg (by hearing survey) and 15 bags for the scoop net fishing to produce 600kg (by hearing)

B Distribution and Processing

Being different from such high priced type of fish with high marketability as Nile perch and Dagaa, Tilapia tends to be consumed locally. There is no established distribution networks and most fish are consumed in the neighbouring villages and towns. Tilapia is much liked by the lakeshore inhabitants. According to a consumption survey (sub-contracted) result, the percentages of those who listed Tilapia as the fish that they liked best to eat was 71 percent in Mara region, 74 percent in Mwanza region and 22 percent even in Dar es Salaam from where the lake is very far away. The distribution forms are: where the consumer markets are close, they are distributed fresh; where they are far away or it takes days to reach the markets, they are distributed sun-dried or smoked. When distributed fresh, no ice is used and most of the fish are transported packed in the gunny bags. Some brokers who go to the Mwanza market to purchase and distribute them to Dar es Salaam keep temporary insulated box in the fishing villages. Some of them use ice for temporary storing or during the distributing process. According to the Year 2000 statistics, it is recorded that the volume of the lake fish (Nile perch and Tilapia) sent to Dar es Salaam from Mwanza was 526 tons transported by TRC and 794 tons by air (ATC: Air Tanzania Corporation). Although the correct ratio of the volumes between these two types of fish is not available, the volume of Tilapia supplied to Dar es Salaam is deemed to be 7,456 tons, assuming, through hearing from the related people, that the ratio is 80 percent for Tilapia and 20 percent for Nile perch. Since the transportation takes 36 hours by rail under the ordinary cargo, the products are pre-frozen at three places in Mwanza city by private freezers and packers. However, it is easily imagined that the outer wedges of the packed products could melt during the 36 hours of normal cargo transportation and the freshness of the products could be lowered. The process of pricing the products to be sent to Dar es Salaam is shown in the figure.

5.2.5 Management of Fishing Households

The test calculations of the profit and loss of fishing households according to the above-mentioned fish types and fishing methods are shown in the Table 1-31. It shows that a Nile perch gill net fishing boat with outboard engine produces highest return on fishing. Not only the boat owner but also the fishers are rewarded with plenty of cash incomes. This mainly owes to the outboard engines after all. While the competition among fishing boats operating near the lakeshore fishing grounds is getting fierce, it is far more beneficial to be able to extend the fishing grounds to the areas far from the lakeshores. At the same time, the cost of the outboard engines such as depreciation, maintenance, fuels for the outboard engines occupies a higher share in the total cost. In particular, the fuel cost in Mwanza is higher by 8 percent than in Dar es Salaam. In local villages, it is higher by more than 10 percent. While gill net fishing boats and long line fishing boats have problems that the extension of the fishing grounds is limited, the long line fishing boats have an additional problem that it is very difficult to secure *Haplochromis* for baits in large quantity.

For the case of Dagaa fishing, we envisaged four types of household fishery. First, in the case of the most technically established lift net fishing, the net profit base is very close to that of the Nile perch fishing using boats without outboard engines because of the unexpectedly high cost bearing of the outboard engines and fuels for them. In the case of the hurry-up net fishing, the fishing fields are already over-crowded. Although fishers wish to go out farther, it cannot contribute to increasing profit as a result, because the cost bearing of the outboard engines and their fuels are high. Interestingly, the income of employed fishers on the scoop net fishing boats is higher than that of those on the other fishing boats, because only two fishers including the owner of the boat are needed on board. But this fishing method is only limited in the Muleba district and care must be taken in applying it to other areas. In the case of Dagaa fishing in general, the operation frequency that can be increased is limited, since Dagaa fishing days are based on the age of the moon. Therefore, as is the case in Geita district, it is possible to increase profitability by introducing compound fishing, that is, to be engaged in the Nile perch fishing in the daytime during the period of moonlit nights.

Table 1-44 Monthly Fishing Operation Analysis by Different Types of Fishing Methods

Item	Specification	NP gill net	NP gill net	NP longline	Hurry-up	Hurry-up	Lift net	Scoop net	Pole-line
Fishing boat	7m-long, stern type	300,000			150,000		300,000		
	7m-long, double-ender		150,000	150,000		100,000			100,000
	7m-long, metal-bottom							70,000	
Engine	Yamaha 9.9Hp	1,200,000							
	Yamaha 8Hp				1,100,000		1,100,000		
Gear	210d/9, 6", single 30 sets		360,000						
	210d/9, 6", double 30 sets	720,000							
	Longline 500 hooks			13,500					
	Lift net						160,000		
	Hurry-up net				120,000	120,000			
	Scoop net							10,000	
	Kerosene lamp				39,000	39,000	52,000	39,000	
	Pole and line								2,000
Total of capital investment		2,220,000	510,000	163,500	1,409,000	259,000	1,612,000	119,000	102,000
Fuel of engine	700Tsh/litre	175,000			126,000		126,000		
Kerosene for dagaa lamp	1 litre/lump/trip, 500Tsh/l				27,000	27,000	36,000	30,000	
Food	200Tsh/head	15,000	15,000	15,000	14,400	14,400	14,400	8,000	
Maintenance cost	3% of capital investment	66,600	15,300	4,905	42,270	7,770	48,360	3,570	3,060
Depreciation	Engine in 5 years	20,000			18,333				
	Gears in 3 years	20,000	10,000	375	4,417	4,417	5,889	1,361	
Total of operation cost		296,600	40,300	20,280	232,420	53,587	230,649	42,931	3,060
Fish sales	Nile perch 500Tsh/kg	525,000	157,500	130,000					
	Dagaa 6000Tsh/sac-40kg				300,000	150,000	384,000	90,000	
	Tilapia 300Tsh/kg								37,500
Total income		525,000	157,500	130,000	300,000	150,000	384,000	90,000	37,500
Net income		228,400	117,200	109,720	67,580	96,413	153,351	47,069	34,440
Net income of owner	Half of net income	114,200	58,600	54,860	33,790	48,207	76,676	23,534	17,220
Number of crew		3	3	3	4	4	4	2	2
Salary of each crew member	Equally divided	38,067	19,533	18,287	8,448	12,052	19,169	23,534	17,220

Remarks:

Estimation of fuel consumption: 10 litres x 25 days (Nile perch), 10 litres x 18 days (Hurry-up and Lift net)

Estimation of kerosene consumption: 3 lumps x 1 litre x 18 days (Hurry up), 4 lumps x 1 litre x 18 days (Lift net), 3 lumps x 1 litre x 20 days (scoop net)

Estimation of food: 3 crews x 25 days (Nile perch), 4 crews x 18 days (Hurry-up&Lift net) and 2 crews x 20 days (Scoop net)

Estimation of Nile perch catch: Catch rate per net (0.7 for motorised and 0.42 for non-motorised) x number of net x 25 days and Catch rate per hook (0.026) x number of hook x 25 days

Estimation of Dried dagaa: Monthly production of is estimated as 50 sac for motorised hurry-up, 25 sac for non-motorised hurry-up, 64 sac for Lift net and 15 sac for scoop net

Estimation of Tilapia catch: Daily catch 5kg x 25 days

5.3 Fisheries in Lake Tanganyika

5.3.1 Natural Condition

Lake Tanganyika is shared by four countries: Burundi, the Democratic Republic of Congo, Tanzania and Zambia. The lake covers an area of 32,945km² of which 13,510km² is in Tanzania. It has a maximum depth of about 1,470m and contains 18,880km³ of water. By water volume, it is the second largest lake in the world after Lake Baikal. By water area, it is second largest of African lakes after Lake Victoria and the fifth largest lake in the world.

5.3.2 Fisheries Production

The fisheries statistics survey shows that the catch of Dagaa is 40,179 tons, and the catch of Migebuga is 800 tons out of total fish catch at Lake Tanganyika (66,469).

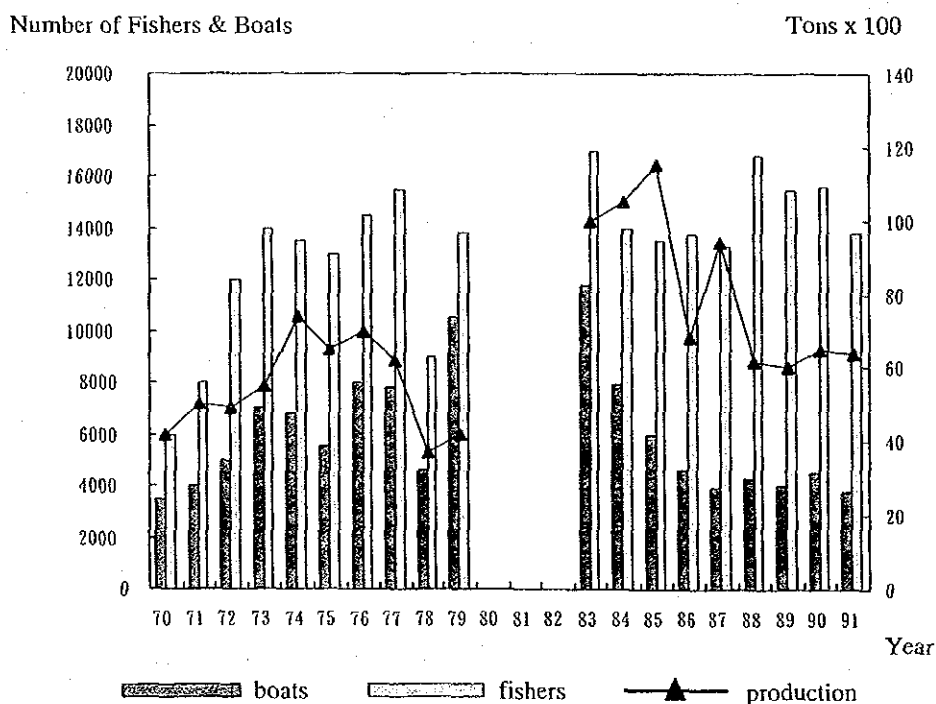
The lowest annual catch during 26 years from 1966 to 1991 was 15,000 tons in 1966, and the biggest catch during the same period was more than 110,000 tons in 1985. Because the average annual catch of the 26 years was 57,000 tons, and the average between 1983 and 1991, during which period, the catch increased, was 81,000 tons, the volume of resources that can be caught is estimated to be within the range of 40,000 to 100,000 tons. Looking at the trend of catch by species between 1971 and 1991, the average annual catch of Dagaa was 45,000 tons, and the biggest was 80,000 tons in 1985. The annual average in eight years from 1984 to 1991, during which period, the catch grew, was 50,000 tons. The average annual catch in Migebuga was 10,000 tons, and the biggest was 25,000 tons in 1987. The annual average of seven years from 1985 to 1991, during which period, the catch increased, was 18,000 tons.

Table 1-45 Result of Frame Survey in 1995 and Statistics Survey 1998

	Kigoma Region		Rukwa Region		Total	
	1995	1998	1995	1998	1995	1998
Landing site	-	88	-	60	208	148
Fishers	7,644	5,594	4,868	3,056	12,510	8,650
Boats	1,952	1,213	1,542	1,191	3,494	2,404
Gill net	1,948	1,353	969	34,022	2,917	35,375
Beach seine	216	0	280	0	496	0
Dagaa seine	13	-	26	-	39	-
Lift net	690	599	398	417	1,088	1,016
Scoop net	252	78	19	2	271	80
Seine	3	-	1	-	4	-
Apollo lift net	2	-	2	-	4	-
Hooks	1,945	590	4802	47,181	6,747	47,771
Out board engine	351	443	136	546	487	989
In board engine	3	-	4	-	7	-

Source : The frame surveys, 1989 to 1998, are compared with data

According to the 1998 frame survey, there were 989 outboard engine, most of which are believed to be used for Dagaa fishing. The number of lift nets was 1,016. In Rukwa Region, lift nets are often used on even small canoes that were not equipped with outboard engine, there is consistency between the number of the nets and the number of fishing boats. Because the ratio of the number of outboard engine and the number of fishing boats is 1:2 in the case of Dagaa fishing, about 2,000 boats are estimated to be engaged in Dagaa fishing which figure differs from the survey data.



Source: Fisheries Division, MNRT

Figure 1-14 Change in Numbers of Fishers and Boats (1970 to 1991)

(1) Landing Sites

According to the frame survey in 1995, there are 27 and 38 fishing villages in Kigoma and Rukwa Regions, respectively, and there are 208 landing sites included the fishing villages. However, according to the frame survey in 1998, the number of landing sites decreased to 148.

Although landing sites are located on the lakefront along the whole lake, they are mostly located near river mouths or sand beaches between reef zones. Landing sites contrary to so-called fishing port, have no infrastructure facility for fishing, including wharf, jetty, slip way, ice production facility, fuel supply facility and radio stations. Fishers land their fishing boats directly on the sand beach to load fishing gears and materials and unload their catch.

At fishing sites such as Katonga in Kigoma where there are too many boats to land all of them on the shore, fishers cast anchor inside the bay to moor their boats on the lake. In such cases, one of the boats which conducts lift net fishing and which is not equipped with outboard engine is moored on the lake. Huts to house fishing gears and materials including nets, outboard engine, fish attraction lamps and fish boxes usually stand in line on the beach of landing sites, facing the lake. Behind the huts, fishers' houses, shops and tea houses and huts to store dried fish stand at random in accordance with the condition of the land in the area.

Many boat owners who mainly use landing sites near Kigoma, capital of Kigoma Region, do not live in fishing villages or landing sites, but live in Kigoma. Many fishing crew do not live in their fishing sites either, just like boat owners. However, in local fishing villages and landing sites remote from Kigoma, both boat owners and their fishing crew members live there as members of community. Although most of them usually were born and raised there, it is not rare to find fishers who moved there. Depending on their relatives to find a job, they moved.

There was a total of 8,650 people registered as fishers in Kigoma and Rukwa Regions (5,594 and 3,056, respectively). According to LTR research, 90 percent of fishers have field and cultivate for home consumption. A large number of fishers in Rukwa Region in the southern part where a rice cultivation zone is located behind Kirando are engaged both in farming and fishing. However, fishers living on islands near Kipiri live solely on fishing, from which they earn most of their cash income. All fishers in Lake Tanganyika are men, and no women are engaged in fishing. Some fishing boat owners have Tanzanian citizenship, although they are not Tanzanian nationals.

(2) Fish Species

Lake Tanganyika is oldest lake in the Western Rift Valley with over 200 endemic species. But target fishes for small scale artisanal fishery are only a few species. The percentage of Dagaa and Migebuga in the fish catch of the whole lake is over 80 percent. Nonji and Sangara of the genus *Lates* are caught on a small scale.

5.3.3 Fisheries Resources

Resources control measures in Lake Tanganyika are limited to the ban of some fishing gears and fishing methods. There is no regulation for a closed fishing season or marine park or issuance of licenses to use fishing boats or fishing gears. Because the mesh size of the beach seine (Kokoro) is extremely small less than 5 mm and fishing is near the shore where the young of fish grow, it is apparent that it has a huge adverse effect on fisheries resources and thus the method is prohibited. Fishers understand the issue and they observe the prohibition of beach seine relatively well.

In some reports is mentioned the importance to be careful in the use of the small mesh size of gill net. However, the use of this type of net is yet to be regulated. Lake Tanganyika is shared by four countries; they need to have a consensus about the control of resources and fisheries management in the lake and they need to cooperate with each other to manage the lake based on scientific data. However, luckily or unluckily, in the case of Tanzania, most fishers conduct fishing on a small scale and there is still a lot of room for development.

Especially, in the cases of fishing of Dagaa and Migebuga that are important commercial fish, the former is caught in accordance with the lunar cycle and no Dagaa fishing is conducted during the full moon period, which can be said that resources are controlled half-voluntarily. The Migebuga fishing is conducted as an addition to Dagaa fishing and the hand line is used for it during daytime, it hardly leads to excessive fishing and consequently to the exhaustion of resources, which are caused by corporate-type large-scale trawling and dragnet fishing.

(1) Production Potential

Because there have been only a few surveys on fisheries resources in Lake Tanganyika, and they describe resources of the whole lake, it is difficult to determine how much fisheries resources Tanzania has. However, it is possible to estimate the resources Tanzania has using the ratio between the shores length and lakes surface and those figures of the whole lakes. Johannesson and his group conducted a survey in 1975 and reported that there was 2.8 million tons of fish biomass in the whole lake according to an acoustic survey.

According to a report released by the fisheries agency in 1991, the fisheries resources in the whole Lake Tanganyika is estimated to be 380,000 to 480,000 tons. Because Tanzania occupies about 45 percent of the lake surface, Tanzania has potential resources of 170,000 to 220,000 tons. According to a report released by the fisheries agency in 2000, there is potential resources of 300,000 tons. Because the catch in 1995 was about 54,000 tons, only approximately one sixth of the resources was used. Judging from the data, Lake Tanganyika has big potential fisheries resources, and thus there is a lot to be developed. Judging from previous catch records, 80,000 tons can be sustainably harvested every year.

(2) Fishing Grounds

Dagaa fishing using lift nets is conducted mainly in the northern part of the lake. The fishing ground is about 0.5 to 1 hour offshore during the high fishing season of February to March. However, it moves to the area about 2 to 3 hours off shore in July and August when the catch decreases. The maturity stage of gonad (GSI) of Dagaa (*S.tanganicae*) increases every four months, three times a year, in March to April, June to July and November to December. The fish is caught in relatively early stage of maturation in Kigoma, according to LTR report (GCP/RAF/271/FIN-TD/53).

The theory is that the eggs are spawn near the centre of the lake, moves close to the shore as they develop, and matures at the length of about 8 cm in about 8.5 months. Although the new year class enters in the dry season from June to November, which is the same as the time when the fishing ground moves far away from the shore. Another type of Dagaa (*L. Miodon*) that is caught with the lift net between the area around Kigoma and Mahare are mostly matured.

5.3.4 Fishing Gears, Methods and Boats

(1) Fishing Gears and Methods

Main fishing methods adopted in Lake Tanganyika are lift net, gill net, longline, and handline fishing. Scoop net and traps are hardly used. The following Table 1-46 shows fishing methods and kinds of fish caught with each type of method.

Table 1-46 Fishing Method, Gear and Target Species in Lake Tanganyika

Fishing method	Fishing gear	Target species
Lift net	Dagaa net	Dagaa, Migebuga
Gill net	Bottom gill net	Nonji, Nile perch, Kuhe
Long line	Bottom long line	Crarias, Baglus
Hand line	Vertical hand line	Migebuga, Nonij

Source: Interview survey by JICA Master Plan Study Team

1) Lift Net

Design of a lift net, there are three kinds of lift net that are used today. They differ in size of the opening part and the depth--64m x 18m, 72m x 20m and 80m x 24m. Nets that have prevailed and are now used are the ones that were improved as part of FAO projects. Compared to the former type of net before the improvement, because the opening part of the currently used net opens wider when it is pulled out of the water, it is more efficient. Because the side formation of net is more vertical than that of the former version, water drains better when the net is pulled out of the water, which put less resistance and thus contributes to the reduction in labour force.

The young of fish can easily escape from the net, which consequently contributes to the protection of resources. Two kinds of nets with the size of opening part and depth of 64m x 18m and 72m x 20m are used in general. Used tires, rocks and steel pipes are used as weight. Dagaa fishing is conducted in such a form that two fishing boats (one of which is equipped with outboard engine) form catamaran. It is conducted at night with the use of the fish attraction lamps. Planked boats are used. They are usually about 10 metres in length, 1.6 metre in width and about 90 centimetres in depth, equipped with one outboard engine of 25 to 75 HP.

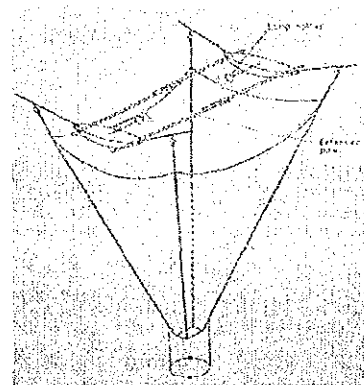


Figure 1-15 Lift Net

Most common outboard engine is that of 45HP. Before departure, fuel for outboard engine (50 litres) and kerosene for pressure lamps (20 litres) are obtained, lamp wicks are adjusted and the chimney is polished. Twelve pressure lamps, fish boxes, fishing nets, four props for forming catamaran and four more props for supporting lift nets are loaded on to the fishing boats. The boats leave the shore before the sunset and head for a fishing ground, with one of them with outboard engine pulling the other one.

Fishing nets, fish boxes and pressure lamps are loaded on the boat equipped with outboard engine, and props for forming catamaran and supporting lift nets, fish boxes and pressure lamps are loaded on the other boat. Fishers decide the fishing ground based on the running time from the departure and their inspiration. They do not form catamaran soon after reaching the fishing ground. Instead, they put on two lamps of each boat and spend about one hour checking how much Dagaa and Migebuga and other fish that are predatory fish of Dagaa are gathering. During that time, the boats are drifting, leaving them to the water current and wind. If they do not find a school of fish or there is little possibility of finding one, they move to another point. When they find a school of fish, the boats form catamaran, and they throw the net into the water, light all the lamps and wait for several hours until sufficient amount of fish gather. During that time, the boats are drifting, leaving them to the weather condition. Around the time they pull the nets out of the water, they leave only the lamps inside the boats on, and put off those outside the boats and gather them to store. Only manpower is used to pulling out the nets. After the catch, the boats head for a landing site around dawn.

2) Gill Net

The gill net fishing method is mainly used by fishers for home consumption. Depending on their financial situation, fishers use a net of five to ten pieces. One piece is basically 50m x 27m meshes. Although the mesh size of the net depends on fishers' preference, it is usually within the range of 50 to 100mm. Although the mesh size of the gill net is often all the same, some fishers combine different size of mesh for one net. They do so, believing that there is an increased opportunity of catching different kinds of fish at one time. Fishers usually set the net at evening and pull it out of the water in the following morning. They usually use a canoe. One fisher can operate a canoe, but there is another crew member on board in many cases. Plastic or wood pieces are used as a buoy and rocks are used as sinker.

3) Longline Fishing Method

The longline used in Lake Tanganyika is the bottom longline. Because of the geographic feature of the lake that it becomes sharply deep from the shore, the method is not used far from the shore. Nylon twine of 1380R-tex or 2 to 4mm polyethylene rope is used for the main line. Nylon twine with the length of 30 to 60cm and 0.5 to 1mm in diameter is used for the branch line. A hook is attached about every 50cm. Bugs (locally called chambo), Dagaa and juvenile *Chiclids* are used as bait. Wood pieces are used as a buoy and rocks are used as sinker. One buoy is usually set so fishers can tell where they set the line. A buoy is set every 5m of the main line to keep buoyancy so the hooks will not touch the bottom.

4) Hand Line Fishing Method

There are two types of hand line fishing methods. One is called Kachinga and is carried out during daytime and the other is called Busyupa and is conducted as an additional operation to the night time Lift net fishing. The method can be described as one to use the vertical longline. The target fish of the Kachinga is Migebuga. Lates such as Nonji and Sangara, which are the predatory fish of Dagaa are the target of the Busyupa. Nylon filament with the diameter of 0.6mm is used for the main line which is about 150 to 200m in length. No hooks are attached for the first 100m from the surface of the water in both types of fishing. Although nylon filament with the diameter of 0.6mm is used for the branch line, just same as the main line, the length of the branch line is only 15 to 20cm and the distance between hooks is 20cm. About 60 to 70 hooks are attached to one line for the Busyupa. The number of the hooks is smaller than that for the Kachinga. Bait is not attached to the hook in the case of Kachinga. Fishers throw the line directly to the water and catch fish that are hooked by moving up and down the line. In the Busyupa, bait that is similar to the one used in the longline fishing is used. In order to avoid the line twining with the lift net, it is conducted about 100 metres away from the net. Thus, a yacht-like buoy with a sail made of a plastic bag is put on the water, from which the line is put into the water.

5) Traps

Traps found in Lake Tanganyika are all basket. There are three shapes of basket-rectangular parallelepiped, cylinder and tube. Wire mesh or bamboo and reeds are used for traps. The traps made of wire mesh are the shape of parallelepiped (45 x 45 x 80cm) or cylinder (45 x 60cm.) A "one way door" is attached inside the traps and there is a door of the square shape with 15cm sides at the top to put in and take out bait and take out fish trapped inside. These types of traps is placed at deeper place than bamboo traps, and used to catch big fish. Tube-type traps made of bamboo and reeds are about the size of 30 x 80cm, and are used at the shallow bottom of the lake and rivers. The traps used to be used only in Rukwa Region, not around the shore in Kigoma Region. However, as the lift net prevailed, trapping method is becoming a forgotten fishing one.

(2) Fishing Boats

Fishing boats used in Lake Tanganyika can be divided into two types, dugout canoes (Ngalawa) and planked boat (Mitunbwi). The latter is used for Dagaa fishing that requires lift nets and is the main fishing. For Migebuga fishing, canoes are used relatively frequently. The life of the dugout canoe differs greatly depending on which types of wood-hardwood or softwood-is used. There are several kinds of trees including a tree named *Bombax rhodognaphalon* is used as hardwood and a canoe made of the wood lasts five to seven years. However, dugout canoes made of softwood including *Ficus sycamorus* last only about one year. Raw lumber of trees at about estimated age of 50 to 80 is used for dugout canoes. Although the size of the canoe depends on the size and shape of raw lumber, it is usually 4 to 6m in length and about 60 to 80cm in width. They are not equipped with outboard engine or outriggers. The canoes found in Lake Tanganyika are relatively well formed and sails can be set up in some cases. Costs to build a canoe differ from place to place. It costs more in areas around Kigoma where it is hard to obtain raw lumber. It costs about. Tsh.15,000 to 30,000, including materials, wages and other expenses, to build a canoe out of softwood, and Tsh.60,000 to 80,000 to build one out of hardwood. A least expensive canoe made of hardwood costs more than two most expensive canoes

made of softwood. Of the construction costs, materials and wages for craftsmen are about the same. Delivery costs is also included in the costs. Craftsmen live in main fishing villages of landing sites. They do not use chain saws and electric tools, but build canoes with extremely basic tools necessary to cut wood, including chisels and hammers. Planked boats used as fishing boats also differ in size. Smallest ones can be about four metres long, similar to a canoe, and a longest one can be about 10m long. The boats are also used as a means of transportation. They are large with the length of about 8 to 20m. They transport materials and people, including marine products, not only in waters of Tanzania but between Tanzania and Burundi. It costs about Tsh.300,000 to build an eight-metre-long planked boat, which is the most popular type as fishing boat. It takes about two months, when three to four craftsmen are involved in the construction. A planked boat can be used at least for 10 years.

5.3.5 Marketing

The distribution routes of fish caught in Lake Tanganyika are as follows in general. By the kind of fish, Dagaa is processed soon after they are landed and Migebuga is either smoked or consumed fresh. Large fish such as Nonji is consumed fresh around the landing sites. Small fish including Chiclid is consumed fresh or smoked and consumed in the local area. Chiclid for ornamental purpose is gathered from the place they are caught to Kigoma and then transported to Dar es Salaam to be exported mainly to Europe. Fish other than ornamental one is caught by artisanal.

Fish caught in inland waters can be preserved for a long time after they are smoked or sun dried. There is little distribution of fresh fish not because there is no custom of eating fresh fish but cause of the cold chain is not developed. Thus, there is a limitation of the improvement of the distribution of fish products without the improvement of social infrastructure including road system and electricity. Considering the little prevalence of freezer-refrigerators in ordinary households, it is understandable that consumers prefer to get dried fish because it is difficult for them to keep fish fresh without a refrigerator.

(1) Prices of Fish Products

Amount of catch, kind of fish, freshness and quality and brokers and distributors influence fish prices. Dagaa prices mainly depend on the day's catch. The prices are decided by auction between the master fisher of a boat and buyers at the edge of the boat. Although many buyers process the fish by themselves, some processors also work as brokers. The prices at the beach differ greatly according to the catch, at about Tsh.1,500 to 1,800 per kilogram in the low season in the dry season and about Tsh.300 to 600 per kilogram when the catch is big during the rainy season. Because a catch in the rainy season can be 10 times bigger than a catch in the dry season, the gap of the catch between the two seasons is not such a big issue for fishers for their income. When a catch is extremely small, some fishers buy fish from other fishers on the lake. Fishers who know each other sometimes loan fish they catch. On the other hand, when a catch is big, fishers sometimes sell part of the catch in the black market. Because boat owners are not on board in general, some master fishers embezzle part of a catch, which has become a problem. To avoid such an incident, boat owners try to avoid employing fishers whose identification is not clearly known. Although each fishing boat has a certain buyers, who are processors and brokers, they also sell to others. Prices are decided without negotiations when a buyer purchases in large quantities regularly.

(2) Characteristics of the Distribution of Dagaa

There are about 90 broker-exporters who export Dagaa caught in Lake Tanganyika, according to the government. Most of them concentrate in Kigoma. The Democratic Republic of the Congo is by far the biggest importer of Dagaa, and a little amount of the fish goes to Kenya, Zambia and Burundi. A total of 630 tons of Dagaa was exported to the Democratic Republic of the Congo in 1999, which worth 500,000 dollars. A total of 1,800 tons of Dagaa was consumed domestically. Some buyers from the Democratic Republic of the Congo come to other landing sites than Kigoma and the quantity they purchase is not included in the statistics.

The main distribution route of Dagaa via Kigoma is that it is gathered in Kigoma by boat, truck and bus on a regular route, and then it is transported by the Tanzania railway to Dar es Salaam, during which it is unloaded at every station, where it is transported to each consumption site by bus or truck. Eighty-seven percent of Dagaa that is shipped out of Kigoma reaches Dar es Salaam, followed by Tabora at 4.2 percent. Dagaa exported to the Democratic Republic of the Congo is carried to the beach near the place where the Liemba, a cargo-passenger boat, is moored by the plank boat. The fish is then loaded on the boat to be carried to Zambia, from which it is transported to The Democratic Republic of the Congo by land. Dagaa is for ordinary people in Tanzania. It is the source of animal protein even low-income earners can buy. The fish can be found at kiosks even in a very remote area, however, most of it is from Lake Victoria. The destination of most Dagaa that is shipped out of Kigoma by rail is Dar es Salaam. This shows that the city has a big population and is a big consumption area of the fish. However, it is also true that Dagaa from Kigoma is tastier than that from Lake Victoria, resulting in higher prices and quality than that from Lake Victoria, and thus most of Dagaa from Kigoma is consumed in Dar es Salaam where many wealthy people live.

(3) Characteristics of the Distribution of Migebuga

Migebuga is caught mainly in Lake Tanganyika off southern Rukwa Region. The fish is smoked at the landing site and then brought to the nearest beach where the Liemba is moored at a suitable time. The Liemba is a cargo-passenger boat that makes one round trip a week between Kigoma and Mpurungu in Zambia. Migebuga that is loaded at each stopping point of the boat is reloaded on to a large planked boat near Karago before Kigoma to be transported to Burundi. Migebuga observed during this survey was loaded on the Liemba near Kirando. About 1,000 bags, each containing about 15kg of Migebuga, were loaded. Supposing that the fish is exported to Burundi throughout a year in such a condition, about 780 tons (1,000 bags x 15 kg x 52 weeks) of Migebuga is estimated to be exported to Burundi every year.

5.3.6 Processing

(1) Sun-dried Dagaa

The main processing method for Dagaa is sun dry. It can be dried in two to three days during the dry season. It sometimes takes five days during the rainy season. The fish is generally dried on the ground facing the landing site. However, they are not placed directly on the ground, small rocks cover the ground which is enclosed by a simple fence to prevent animals from entering to eat the fish and to separate one's fish from others'. In this way, there is special space for drying Dagaa. Although most of Dagaa is dried soon after it is landed, a small number of processors soak the fish in salt water for several tens of minutes before drying it. They soak the fish in salt water because colour of the fish can be preserved well, the drying time is shortened, and it is better in quality than simply sun-dried Dagaa (mainly its appearance becomes better.) They do so especially because it can be sold at higher prices. This type of dried Dagaa is sealed in polyethylene bags each containing 100 to 500g and shipped to consumption sites. Although some processors own their drying place, most small-scale processors rent the space from land owners on a daily basis.

(2) Smoked Migebuga

Most of Migebuga is smoked. In Rukwa Region where most of the fish is caught, "cooking stove" type smoking equipment on which metal mesh is placed to put the fish to be smoked on it is not commonly found. Instead, relatively large smoking equipment where a pole is crossed to the earth wall and doughnut-shape Migebuga whose tail is caught in the mouth is hanged through the pole is used. This smoking method is found for smoking relatively long fish such as catfish and lungfish. Because fish is smoked through the poles, it is considered that space can be used more efficiently than the method of placing fish horizontally on the metal mesh. However, the fish smoked through the poles takes more space when packaged for transportation, which means it is not so efficient. However, because less damage is done during transportation than the fish that are dried horizontally, the method is said to be better in keeping the product value.

(3) Other Smoking

Small fish including Chiclid that is consumed at home and within the fisheries community is sun dried for about 30 minutes after the intestine is removed and before it is smoked for a short period of time. Although the method is called smoking, there is no enclosure around the fish. The wire mesh is placed on assembled rocks and charcoal or firewood is used to smoke the fish for a short period of time. Thus the method is rather close to fireside cooking at low temperature.

In areas north of Kigoma, an improved version of smoking equipment FAO tried to spread can be found. However, some processors built their own smoking facility by themselves in Katonga near Kigoma. The oven is about 12m in width, 1.5 m in depth and about 0.8m in height. Four separate ovens are placed in line. The bottom of the oven is not dug, which is different from the type demonstrated as an FAO project in 1990. Seven smoking shelves for placing fish on it compose one set. Hardwood is used for the frame and wire net is used. Smoking requires about five to six pieces of wood that are about one metre long with a diameter of about 10cm. A wire net used for the equipment costs. Tsh.1,000 per metre and the hardwood is sold at about. Tsh.400 per piece.

5.4 Fisheries in Lake Nyasa

5.4.1 Natural Condition

Lake Nyasa is one of the Great Lakes of East Africa and is the southernmost of the Western Rift Valley lakes of Africa. It has a surface area of about 28,000km² and is shared between Malawi, Tanzania and Mozambique.

5.4.2 Fisheries Production

According to a statistical survey conducted in 1996, a total of 5,708 fishers with 2,353 fishing boats (most of which are dugout canoes) caught about 20,000 tons of fish in Lake Nyasa. Of the total catch, Ruvuma Region occupied the biggest quantity, accounting about 70 percent of it. The production was worth. Tsh.3.18 billion. Supposing the Tsh.-U.S.dollar exchange rate is Tsh.876.62 a dollar, it was worth about 3.63 million dollars. As the Table 1-47 below shows, the gill net fishing is the main fishing method in the lake. Most commonly used net has small size mesh at about 2.5 to 3 inches. There were only two outboard engines, according to the statistics. All the boats used for fishing are dugout canoes and paddles are used to move from one place to another, which shows that fishing method in the lake is extremely primitive. Although sails that are used in the coastal area by Arabs were introduced in fishing in Lake Tanganyika, they are not used in Lake Nyasa. It seems that fishers do not have an idea of using sails. However, the weather condition may be a reason why they do not use sails because the condition in the lake deteriorates extremely rapidly during the rainy season. In any case, there is room for developing resources by using power-driven boats. However, because most of the fish caught in the lake is Chiclid, Dagaa etc. a reliable resources survey needs to be conducted before increasing pressure to catch more fish.

Table 1-47 Lake Nyasa Fisheries Statistics Survey in 1996

	Mbeya Region	Iringa Region	Ruvuma Region	Total
Fishers	709	1050	3949	5709
Boats	374	407	1572	2353
Production (tons)	2,142.7	3601.39	13931.84	19675.93
Production (T'sh.1000)	532,645.92	496,465.74	2,147,147.19	3,176,258.8
Gill net Total	1,601	2,229	9,727	13,557
Beach seine	13	0	91	104
Dagaa seine	0	0	305	305
Scoop net	0	0	107	107
Seine	199	0	408	607
Trap	0	1,964	0	1,964
Hooks	1,189	23,301	42,003	66,493
Out board engine	0	0	2	2
In board engine	0	0	0	0

Source: Fisheries Division

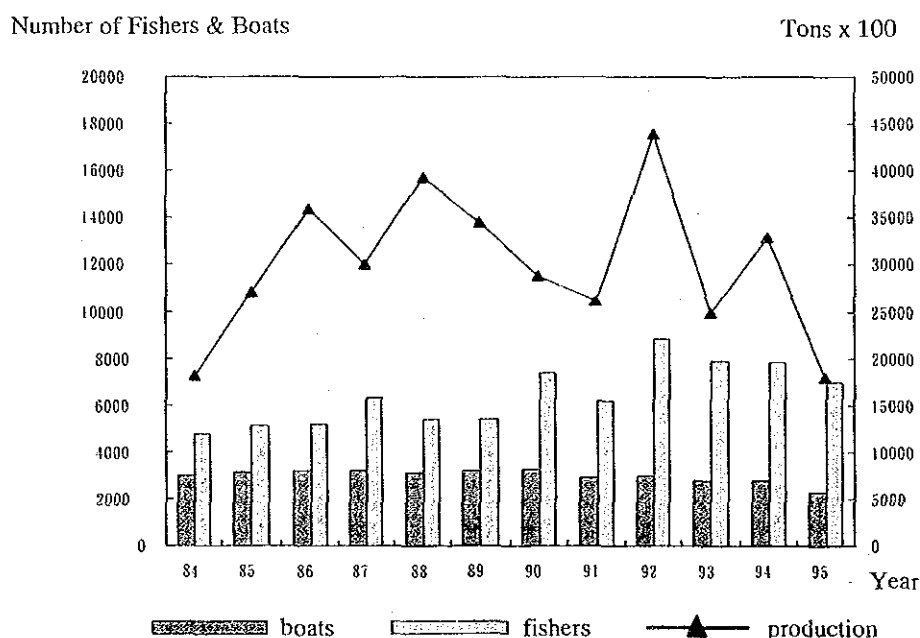


Figure 1-16 Change in Production, and Numbers of Fishers and Boats

(1) Landing Sites

Lake Nyasa is long from north to south. The north-eastern shore is occupied by Tanzania, the south-eastern shore is occupied by Mozambique and the western shore is occupied by Malawi, Tanzania occupies about 40 percent of the eastern shore. As mentioned above, three Regions face the shore, with Mbeya in which Kyela is located, Iringa and Ruvuma lining from north to south. About half of fishers in the lake live in Ruvuma Region.

According to a frame survey conducted in 1998, there are a total of 104 landing sites-- 10 fishing villages and landing sites in Mbeya Region, six in Iringa Region and 88 in Ruvuma Region. Although the landing sites are located throughout the shore, most of them concentrate in Ruvuma Region in the south, and many are located near river mouths or sand beaches between reef zones. Landing sites are different from so-called fishing port, without infrastructure facility for fishing, including wharf, jetty, slipway, ice production facility, fuel supply facility and radio communication stations.

Fishers land their canoes directly on to the sand beach to load fishing gears and materials and unload their catch. Different from landing sites of Lake Tanganyika, no huts to store fishing gears and materials such as nets, outboard engines, fish attraction lamps and fish boxes stand in line facing the lake. Fishers store the gears in their own house. Because there is no large town along the lake, most fishers live in fishing villages and landing sites.

Lake Nyasa faces three Regions, Mbeya, Iringa and Ruvuma. According to a fisheries statistical survey conducted in 1996, 913 people in Mbeya Region, 2,867 in Iringa Region and 4,481 in Ruvuma Region, totalling 8,261 are registered as fishers. Many fishers in Lake Nyasa are also engaged in farming. Some are engaged in farming just for home consumption but others even grow rice. Some completely quit fishing to be fully engaged in farming during the dry season when catch decreases and during the rice harvesting season.

All the fishers in Lake Nyasa are men, same as Lake Tanganyika. Some areas of the lake yield very little fish, leading some fishers in the lake to move to Lake Mtera seeking a better fishing ground.

(2) Fish Species

Lake Nyasa is one of the Western Rift Valley Lakes and with over 300 species is an important water body in terms of bio-diversity. Especially, a large number of beautiful brilliant colourful Chilids inhabits Lake Nyasa, a variety unique to the lake, making the lake a treasure box for fish lovers all over the world. These Chilids are caught for food in local area. Mbasa which is unique to this area is large for lake fish with the length of 50cm when it matures. It has a high market value.

5.4.3 Fisheries Resources

Fishing regulations to protect fisheries resources are not sufficient. Existing regulations are fish preserves at river mouths in Kyela district in Mbeya Region and the prohibition of beach seine, which applies throughout the country. There are voices from local fishers that they cannot utilize all the fish even they catch fish, consumption sites are far from landing sites and the transportation system is *extremely inconvenient*. *Considering such voices and the fact that primitive fishing methods are used*, there seem to be resources yet to be developed.

As Mbasa swims up river to spawn eggs, it is meaningful to study the possibility of releasing seedlings for propagation. Chilid which is consumed locally is exported for an ornamental purpose to Germany and other European countries, the United States and Japan.

In recent years, people are concerned about maintaining biodiversity for environmental conservation. Because Chilid is the main fish fishers catch for consumption, which is slower in reproduction and resources recovery than Dagaa that can be caught in large volume, an increase in pressure to promote the catch of the fish has to be dealt with carefully.

Due to the nature of the depth profile of the lake, the fishing on the Tanzania has limited shelf and falls rapidly to 200 to 300m. This feature has limited the artisanal fishers to fishing in the near shores due to the limitation of their fishing gears and equipment. This has led to increase pressure on the near shore resources and there are evidence of over fishing in these areas.

5.4.4 Fishing Gears, Methods and Boats

Fishing boats used in fishing villages are dugout canoes with the length of about four metres. They are not equipped with outboard engine or sails, and paddles are the source of driving power. It costs about Tsh.80,000 to 90,000 to build a canoe, including costs for materials, craftsmen and transportation. Materials occupy about forty percent of the total costs. Wood used for a dugout canoe is hardwood (Sembemera, Musifi, Muraira, Samderere) or softwood (Mukuyu). Canoes made of hardwood lasts longer than soft wood one. Canoes made of softwood lasts only about a year, whereas those made of hardwood last about five to seven years.

Gill net and seine fishing are the main fishing methods. The gill net is used to catch Nberere, Kitoga, Mbasa, Mbagare. The seine is used to catch Dagaa. Fish attraction lamps for night time are used. Three canoes form a team (two large canoes, each carrying two fishers and one small canoe carrying one fisher). The fishing ground is about 2 to 3 hours away from the shore. The beach seine fishing is also conducted to catch Mantura, Bagege and tilapia, although it is illegal. Gill nets with three plies with the mesh size of four inches are most prevalent, and one of such a net costs about Tsh.30,000 to 40,000. A whole set of nets for Dagaa fishing is about Tsh.3 million (12 rolls).

The income from fishing is divided into two between the canoe owner and crew members after necessary expenses are subtracted. The high fishing season is from July to November. Although fish is sold fresh in general, surplus fish is sun dried or smoked. Because of strong wind from north from January to June, and the lake becomes stormy, it is difficult to fish there. The fishing seasons are from January to June for Mbasa and from August to October for Dagaa. Fishers are mainly engaged in farming from July to December. Prices of main fish in July are as follows: one Mbasa weighing two to four kilograms: Tsh.1,000 to 2,500; one Nberere: Tsh.200 to 500; Dagaa: Tsh.250 to 500 per kilogram.

5.5 Fisheries in Other Small Water Bodies

5.5.1 General Situation

In Tanzania, there exist lakes, dams, and rivers where fishing industry is prosperous, although smaller in scale compared with the four main water bodies mentioned above. According to fisheries statistic in 1996, fishery production of these small water bodies is 17,205t, which accounts for about 5.3 percent of all production. The fishing in these small water bodies has the following features:

- Fishery using fishing boats which are not motorized.
- A small-scale production using gill nets with small meshes (3 inches).
- Comparatively small-size local fish kinds are the main of the fish catch.
- Geographically, the small water bodies exist in inland, playing the role of fish supply to the inland distant from the supply from the four main water bodies.
- It is easy to be over fishing in the small water bodies, and although monitoring is important, talented people of fishery management and budgets run short in local administration because of a small production volume.

Table 1-48 Small Water Bodies in Tanzania

Water body name	Location	Area (1,000km ²)	Remarks
Lake Rukwa	Rukuwa	2.85	
Lake Manzi	Mbezzi	0.04	
Lake Burundi	Mbwenkum	0.05	
Lake Manyara	Rift	0.52	
Lake Natron	Rift	0.91	
Kibasira swamp	Rufiji	4.0	
Malagarasi swamp		1.8	
Bahi swamp		-	
Rufiji floodplain	Rufiji	-	
Nymba ya Mundu Dam	Pangani	0.1-0.18	1945
Mtera reservoir	Rufiji	0.58	1980
Kidatu reservoir	Rufiji	0.01	1974
Hombolo reservoir	Wami	0.02	