

**REVIEW ON THE STATUS OF FISHERY RESOURCE  
DEVELOPMENT AND UTILIZATION IN ETHIOPIA****Nega Mekonnen<sup>1\*</sup> and Shibabaw Bejano<sup>1</sup>**<sup>1</sup>Department of Animal Science, Assosa University, P.O.Box 18, Assosa, Ethiopia.

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**ABSTRACT**

Ethiopia is a country with the largest livestock populations in the Africa. The livestock sector accounts for over 26 percent of agricultural GDP, 8 percent of export earnings and can produce over 51,500 t of fish per annum. However, their exploitation and consequently their contributions to food security and growth in the

country are minimal. Ethiopia's many lakes, rivers, and reservoirs and its approximately 960 kilometers of Red Sea coastline are fertile fishing grounds. However, fishing contributed less than 1 percent of GDP in 1987. The ten-year plan in 1983/84 estimated that the country had the potential to produce more than 92,000 tons of fish (66,000 tons from the Red Sea and the remaining 26,000 tons from lakes and rivers). But actual production in 1983/84 was estimated at 600 to 1, 200 tones. Artisanal freshwater fishery is one of the most important economic activities in Ethiopia. Improvements in fishery sector would contribute to poverty alleviation and environmental sustainability in Ethiopia.

**KEYWORD:** Ethiopia, fish, fishery, production.**INTRODUCTION**

The reported annual yield from global inland capture fisheries in 2008 was over 10 million tons, although real catches are probably considerably higher than this. It is estimated that the inland fisheries of Africa produce 2.1 million tons of fish, which represents 24% of the total global production from inland waters.<sup>[1]</sup> In comparison to marine fisheries, inland fisheries production is relatively small, representing only 6% of global production. In Africa, marine

fisheries production (4.7 million tons) is also much larger compared to inland fisheries (2.1 million tons) but in a smaller scale than at the global level.

Ethiopia is a land locked country depending only on inland water resources for the supply of fish as a low cost protein source. The inland water body of Ethiopia is estimated to encompass about 7,400 km<sup>2</sup> of lake area and a total river length of about 7,000 km. As many other countries challenged in the world, population rise urbanization, agricultural development, industrialization and other water resource development activities have resulted in a decrease in the species diversity of freshwater fish species.<sup>[2]</sup> Fishing contributed less than 1 percent of the gross domestic product in 1987. A study reported that 15,389 tons were caught in 2001, only 30% of an estimated potential of 51,481 tons.<sup>[3]</sup>

Fisheries production is also under-exploited while current demand exceeds supply by about four-fold. One of the big and immediate challenges of our country is addressing the problems of food security and poverty. Currently, about 45% of the total population is living under poverty and the level of impoverishment is worse in rural areas, where 85% of the total inhabitants dwell.<sup>[4]</sup>

### **Fish Production and Supply Potential of Major Ethiopian Water Bodies**

Following Eritrea's secession from Ethiopia in 1993 and the consequent loss of its coastline, Ethiopia has only inland freshwater capture fisheries. It has no significant aquaculture development. The inland capture fishery comprises: Rift Valley lakes (for example, lakes Chamo, Abaya and Ziway and the northern part of Lake Turkana) and Lake Tana, which although shallow, is the largest lake in Ethiopia; rivers; and small water bodies (reservoirs, natural ponds). There is fishing on all these water bodies, but commercial production (i.e. serving markets other than the local communities) is concentrated on the five lakes, with Chamo, Ziway and Tana particularly dominant.

The main species are Nile tilapia, representing 60% of the catch<sup>[5,6]</sup>; Nile perch (favored but increasingly scarce), barbus (two species) and catfish. There are seasonal variations in the availability of different types of fish, but as there are some differences between the lakes, traders can smooth out supply to some extent. There are 180 different species of fish in Ethiopia and 30 of those are native to the country.<sup>[7]</sup> For the sake of convenience, the country's water bodies are classified into four systems: lakes, reservoirs, rivers and small water bodies. The lakes and rivers support highly diverse aquatic life, ranging from giant

mammals like the African Hippopotamus, to microscopic fauna and flora. Table 1 shows that the major lakes in Ethiopia with their altitude, mean depth, area, production potential and their catch per year.

**Table 1: Major Lakes and fish production potentials.**

Water Bodies	Altitude (m)	Mean depth (m)	Area (Km)	Fishery potential (tone /year)	Catch (tone /year)
Tana	1829	8	3,500	10,000	1,454
Ardibo and Lugo	670	37	51	400	330
Ziway	1848	2.5	434	2,941	2,454
Langano	1585	12	225	240	151
Abijata	1578	7.6	205	2,000	500
Shalla	1558	87	250	1,300	10
Awassa	1708	11	97	611	853
Abaya	1285	7	1070	600	412
Chamo	1282	6	551	4,500	4,359
Turkana (1.3 % of the total area)	365	33	94	750	75
Sub-total			6,477	23,342	10,598

Source:<sup>[5]</sup>

The major reservoirs and small water body's area, potential for fishery and catch tons per year showed in the table. 2 table and table 3 respectively.

**Table 2: Potential for fishery and catch tons per year of major reservoirs and dams of Ethiopia.**

Reservoir (Dam)	Area (Km)	Fishery potential (tone/year)	Catch (tone/year)
Koka	255	1,194	625
Fincha-Amerti	250	1,330	333
Beseka	39	205	41
Denbi	72	383	77
Melkawakena	82	434	109
Aba-Samuel	44	234	59
Alwero dam	74	394	79
Hashengie	20	106	21
Small Abya	12	66	13
Wedecha	10	53	11
Sub-total	857	4,399	1,366

Source.<sup>[7]</sup>

**Table 3: Small water bodies.**

Water body	Area(Km)	Fisher potential (tone /year)	Catch (tone/year)
Southern region (Cheleloka Swamp)	100	423	21
Gambella (Swamps and Flood plains)	125	529	132
Small reservoir and ponds	50	1,000	150
Sub-total	275	1,952	303

Source.<sup>[7]</sup>**Table 4: Summary of Ethiopian water bodies and their fisheries potential per ton per year.**

Water bodies type	Extent	Fishery potential (tone/year)	Catch (tone/year)
Major lakes	6,477 km <sup>2</sup>	23,342	10,598
Major reservoirs and dams	857 km <sup>2</sup>	4,399	1,366
Small water bodies	275 km <sup>2</sup>	1,952	303
Rivers	7,185 km <sup>2</sup>	21,788	3,121
Total		51,481	15,389

Source.<sup>[7]</sup>

The total area of the lakes and reservoirs stands at about 7000 to 8000 km<sup>2</sup> and the important rivers stretch over 7000 km in the country.<sup>[8]</sup> In addition, minor water bodies such as crater lakes and reservoirs make up about 400 km<sup>2</sup>.<sup>[9]</sup>

### The Role of fisheries in Ethiopia

Ethiopia's fishery sector contribution to the Gross Domestic Product (GDP) is 0.02 percent. Sustainable fisheries management is crucial to food security, poverty alleviation and economic growth. Fisheries are thus acknowledged as an important strategy in the drive for poverty reduction. They help to promote greater economic development in Ethiopia. In 2010 Ethiopia realized about USD 14 000 000 from its capture fishery while a total of 40 000 livelihoods were positively impacted upon by the fishery sector in the same year.

**Trade:-**the Ethiopian cross-border fish trade is currently not properly documented. The country imports significant amounts of fish from neighboring countries though some of these imports end up being exported to Sudan through the porous border with neighboring South Sudan. Fish plays a vital role in domestic trade as well as in import and export market.

**Food security:** - Though there is a strong consumer preference for beef, fish is regarded as an important component of a nutritionally rich diet. However, fish consumption patterns vary according to availability. More fish is consumed in areas where the product is more available, such as in the vicinity of the Great Rift Valley lakes. Fisheries are regarded as an important sector in the effort to increase animal protein consumption and achieve food security for the growing population. Two important national documents, the Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) and the Rural Development Policy, highlight the importance of the sector to food and nutrition security. National fish demand is somewhat seasonal, as religious observances exert strong influence on fish consumption patterns. During Lent, for example, Christians, especially of the Coptic Orthodox Church, who are required to refrain from eating meat, milk and eggs, resort to fish as a substitute. The domestic fish demand is significantly robust during two short periods of the year when the Orthodox Church encourages fish consumption. These periods are the fasting seasons in February and April, and two weeks in August, totaling about 80 days. Large quantities of fish are consumed at periods of religious fasting in the cities, around major fish production areas such as the Great Rift Valley lakes, and major towns, particularly in Zeway, Arba Minch, Bahir Dar and the capital Addis Ababa.

**Employment:** A considerable workforce is employed, both directly and indirectly, by Ethiopia's capture fisheries which also help in sustaining local communities. Whereas 4 052 persons were employed directly by the sector in 2010, a total of 9 148 others benefited from indirect employment offered by the sector.

**Rural development:** The rural areas of Ethiopia where substantial fishing takes place benefit from the economic activities of the fishers and their related operations. This is especially so around the Great Rift Valley and areas surrounding the lakes, reservoirs, rivers and other small water bodies with major fishing activities. In those areas, much more than in the urban and peri-urban centers, fisheries are increasingly recognized as an alternative means of addressing the problems of food security and poverty, consistently with the rural development objectives of the sector. Employment opportunities, both primary and secondary, are enhanced with the availability of fishery resources in the rural areas. And while the national mean *per capita* fish consumption is only 200 g, the consumption in the rural production centers of Awassa, Sodo, Gambella close to River Boro, etcetera, is as much as 10 kg/capita/year. There is a national awareness that rural areas and the agricultural sector,

which support more than 80 percent of the total population, are the basis for bringing about rapid and equitable economic growth and development in the country. Until recently Ethiopia had a solid fish potential estimated at over 80 000 t/year, of which about 50 000 t/year from marine waters. Despite substantial water resources and crucial need for food supply, fish production however has stagnated under 5,000 t/year due mainly to the lack of tradition in fishing and related activities. Commercial fishing is a rather new practice in the Rift Valley Lakes which started in the fifties, while riverine fisheries are still mainly exploited on a subsistence basis.

From the end of the eighties, the former Government had placed emphasis on the development of the fishery sector with a view to reach food self-sufficiency, with the support of projects. At present, in conjunction with a growth in the number of fishermen due to unemployment in other sectors and liberalization of the economy, fishing activities are substantially developing. The contribution of fisheries to GDP is very small, and would remain so even if the maximum economic yields were actually extracted. Based on annual production estimated at 5,500 t from lakes and reservoirs, the value of fish landed in Ethiopia is about Br5.5million (\$US1.1million) at producers' prices averaging Br1/kg. In comparison, the total contribution of forestry, fishing and hunting was estimated at Br0.29billion for 1988/89. The total number of fishermen, including those from riverine fisheries, is about 2,250 which would show an increase in fishing employment by roughly 50% over the last four years. Furthermore, 220 persons are employed by the Fish Production and Marketing Corporation (FPMC), while a smaller number of licensed and unlicensed private traders are directly employed in fisheries. In production areas where informal marketing has developed, the sector provides a livelihood for a significant part of the population.<sup>[10]</sup>

### **Problems related to Fish Production and supply of major Ethiopian water bodies**

The demand for fish has been on the increase in the last decade as a result most of the Ethiopian lakes are over exploited. Several national reports indicate that fisheries production of the major lakes of Ethiopia is declining in an alarming rate (Ministry of Agriculture annual report, 2008).<sup>[11]</sup> The fisheries for some of the lakes have already reached the level of none rewarding to the fishermen due to very small size of the catch. The production of small sized fish (Nile perch in Lakes Abaya and Chamo and Nile tilapia in Lake Ziway) probably lead to extinction of species in these lakes as the result of pre-mature harvesting. In Ethiopia and many other sub-Saharan countries, fisheries from natural water bodies have failed to meet the

ever growing demand for fish.<sup>[2]</sup> Moreover, as a result of high population growth in the country there is high competition to be engaged in fisheries activities around the lake region. Thus, as the experience of different countries in the world shows, aquaculture if developed in a sustainable way is the best alternative to tackle this kind of problems.<sup>[12,13]</sup>

As indicated on different findings of FAO, among LDCs of the world, Ethiopia is listed at last by its fisheries contribution to GDP 0.05% with no aquaculture production, fish contribution to total animal proteins 0.67%, fish contribution to total proteins 0.1% and per capita supply of fish per year 0.1kg. Like for most of Africa, Ethiopia is riddled with poverty, economic stagnation and environmentally unsustainable practices, all of which pose serious constraints to fisheries development. However, ample opportunities exist for the sector to help reverse national development challenges by making a significant contribution to poverty alleviation, economic growth, better nutrition and ecological improvement.

As indicated on EFASA,<sup>[14]</sup> Ethiopia is endowed with resources (land, water & fish species), the contribution of the fishery sector to the country's GDP is still minimal. Several factors can be mentioned of which important ones are: Lack of recognition (fishery was and is still under livestock), Absence of universities dealing fisheries and aquaculture (till recently) & hence lack of trained personnel, Poor coordination among stakeholders, Poor enforcement of decrees, High turnover of the fishery staffs into other sectors and Weak extension services and linkage.

Despite the challenges of the sector there are also good opportunities which can be used for the development of the fishery production and utilization in general. Some of these are: government policies and development strategies (irrigation, hydropower development etc.), suitable agro ecologies, water bodies (surface & ground), diversity of fish species, higher learning institutions dealing on fisheries and aquaculture (e.g. Addis Ababa, Bahir Dar, Ambo and Hawassa universities) and increasing public awareness.<sup>[14]</sup>

### **The status of aquaculture in developing countries including Ethiopia**

The definition and history of aquaculture: Aquaculture is defined as the farming of aquatic organisms including fish, mollusks, crustaceans and aquatic plants. Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms which are

harvested by an individual or corporate body which has owned them throughout their rearing period contribute to aquaculture, while aquatic organisms which are exploited by the public as a common property resource, with or without appropriate licenses, are the harvest of fisheries.

Nile tilapia has been farmed for centuries; depictions on an Egyptian tomb (dated at 4000 years) display the fish in ornamental ponds. The culture of the tilapia genus on a global scale, primarily *Oreochromis mossambicus*, began in the 1940s. However, it was not until the 1960s that *Oreochromis niloticus* was exported worldwide.<sup>[15]</sup> Aquaculture was heralded as the perfect protein production technique for developing countries during the 1960s and 1970s. Aid organizations promoted aquaculture as a means of improving food security with low grain to feed conversion rates, and minimal environmental impacts.<sup>[16]</sup> This global popularity has led to a number of important developments in culture techniques. Initially, tilapia was allowed to breed freely. However, farmers and scientists observed that this led to the production of smaller fish. In the 1960s, attempts were made to produce male monosex populations through hybridization between different tilapia species. This proved problematic and gradually females reappeared in the progeny.<sup>[17]</sup> Major technological developments in the 1970s allowed for the successful production of all-male populations through the use of sex-reversing hormones which resulted in higher returns from tilapia farming. Following this, and further research into culture processes, the industry boomed.<sup>[15]</sup>

Aquaculture is the fastest growing food production system worldwide. In the times when majority of the other food production systems are showing decline or almost stagnation in production, aquaculture has been growing at a rate of approximately 9 percent per annum since 1985. It is now widely recognized that the world's aquatic resources are limited. More than 70% of the global fisheries have already been exploited to the point of extinction or have been exploited beyond capacity due to over exploitation and pollution. It is therefore the right strategy to concentrate on aquaculture to increase farmed fish production, which has been achieved successfully as evident from the statistics.<sup>[18]</sup>

Since the mid-1990s, aquaculture has been the engine driving growth in total fish production as global capture production has leveled off. Its contribution to world total fish production climbed steadily from 20.9 percent in 1995 to 32.4 percent in 2005 and 40.3 percent in 2010. Its contribution to world food fish production for human consumption was 47 percent in 2010 compared with only 9 percent in 1980<sup>[15]</sup> According to the report of<sup>[15]</sup> Asia accounted for 89

percent of world aquaculture production by volume in 2010, up from 87.7 percent in 2000.<sup>[19]</sup> acknowledged that the important role of fisheries and aquaculture for food and nutrition security in the least developed countries (LDCs) in terms of caloric intake, protein and fat availability as well as providing for a wide range of essential vitamins and minerals. Most LDCs rely on fish as a critical source for their per capita daily protein intake. For example, in 2003, the average percentage of fish in the total protein consumption for Asian and Pacific LDCs was about 17 percent, with a mean value of fish available for annual consumption of close to 35 kg per capita.<sup>[15]</sup> The contribution of fish to the food basket among sub-Saharan LDCs was significant as well, with an annual average of 9.4 kg per capita apparent consumption of fish. Individual country per capita consumption of fish as a percentage of total animal protein ranged from zero to 54 percent among the LDCs. As stated, Maldives, Solomon Islands, Sierra Leone, Kiribati, Bangladesh and the Gambia are among the countries with the highest values of nutritional dependence on fisheries.<sup>[15]</sup>

### **Constraints of aquaculture development in Ethiopia and developing countries**

Global aquaculture is now the fastest growing food production sub-sector in many countries and it is expected that this trend will continue despite several constraints, which may become more challenging in the future.<sup>[20]</sup> According to Hussein.<sup>[21]</sup> a national data on various aspects of aquaculture including total production is yet not available. Limited research activities are underway. The aquaculture capabilities of several other species present in the freshwater rivers and reservoirs are yet to be explored. Different types of institutions such as the Ministry of Agriculture and Rural Development and Environmental Protection Agency promote and regulate aquaculture development. Aquaculture is not part of existing irrigation, farming and water harvesting schemes in the country. A lot of work remains to be undertaken in promoting aquaculture. Few Universities and ATVET Colleges offer courses in aquaculture as a part of the fisheries graduate program, but none offers aquaculture as a full graduate program in their curricula to produce more skilled and specialized workers locally. In line with the above idea<sup>[22]</sup> has identified the following points has the bottle neck effect for the development of aquaculture in Ethiopia. Lack of inexpensive and efficient locally available fish feeds, lack of locally selected and certified fish seeds, the problem of land ownership policies in the country, over-reliance on capture fisheries, lack of licensed fish seed multiplication centers and lack of institutional capacity in the area of training, research and technology transfer. To transform the rate of aquaculture development in Ethiopia, as

proposed by,<sup>[22]</sup> the country will need a multi-sectoral approach and well-coordinated collaborative efforts from all different stakeholders. In many developing countries there is significant scope for enhancing contributions of aquaculture to food supplies and poverty alleviation.<sup>[23]</sup> However, according to<sup>[23]</sup> aquaculture in developing countries face significant challenges which including among others.

**A. Capital:** Evidence abound of some form of aquaculture practices in China as far back as 2000 BC spreading gradually to European and Asian countries from about 475 BC and finally to Africa with a slow rate of adoption due to its capital intensive nature. In most developing countries, capital is not easy to obtain from banks and only few individuals who are rich can actually embark on fish farming development without external fund. Capital is required to write a good feasibility report, land clearing, pond construction, and procurement of feed and acquisition of equipment and materials as well as establishment of hatcheries for fingerling production among others. Sufficient fund is also required to hire personnel with the right type of training.

**B. Poor Planning:** As management and planning of aquaculture in each country is crucial for development of the sector, planning and coordination capabilities need to be strengthened considerably. A thorough review of existing arrangements would seem advisable in various countries. In some cases it remains to be established which ministry will be vested with final authority to oversee aquacultural matters. Planning involves systematic gathering of data and step by step analysis of such data in order to arrive at the desired objective. Planning for aquaculture whatever level of production should involve essentially: justification of the projects, objectives, definition of aims, business environment, and budget for capital and recurrent expenditures, production strategies and management among others. In most cases these steps are neither considered nor adhered to, thereby, resulting in the failure of many projects in developing countries.

**C. Government Policy:** All things being equal, it is the state of development, policies and status of agricultural development that will determine the future of fish farming in developing countries. The role of government policy for the success or failure of agricultural/aquaculture performance is quite crucial. Even though such a policy could differ among different countries, there are countries with successful performance. However, it is generally accepted that many countries in sub-Saharan Africa lack appropriate policy (as part of the national economic or agricultural policy) that leads to viable aquaculture development. Constraints

such as poor infrastructure development, inadequate extension services that have to be provided for various classes of target groups, lack of appropriate research in the field of aquaculture, insufficient training and allocation of man-power remain the major handicaps for development of aquaculture in Africa. All of these need appropriate government sustainable policy for their development. The slow rate of adoption of aquaculture practices in developing countries can also be attributed to inconsistency in government policies. Successive administration after change of government has its priorities, plan and objectives. In most cases fisheries are rarely given its rightful place, while aquaculture to them is a waste of time and capital. In a number of countries fisheries still remains an appendage of agriculture, livestock or forestry while fisheries officers who are expected to develop aquaculture report to and take instructions from the directors of these already well-established sectors. Not much can be expected from this type of policy.

**D. Lack of Manpower:** Manpower availability at national and regional levels is still low. Manpower could be categorized as senior aqua culturists, aquaculture technicians as well as extension workers. Various literatures have indicated that low-level of knowledge on theoretical and practical aspects of aquaculture practices among different groups of the society seem to be a major bottleneck of development. Such groups include farmers, processors, investors, consumers as well as traders of aqua cultural products. Unfortunately, government's efforts have not been adequately directed at this area.

**E. Insufficient Research & Extension:** Extension programs can further involve development of pilot demonstration projects by governments. This also includes an extension delivery system which provides the necessary fingerlings or breeders at normal prices for farmers. Preparation and distribution of various training manuals, posters, etc. together with the training program also needs attention. On the other hand, the collaboration between the production sector (extension services) and aquaculture research is generally limited researchers aren't involved in the identification of development policies. Most research findings unfortunately are kept the on shelves in research institutions and not at the reach of end users.<sup>[21]</sup> Therefore a major future task is to increase participation of producers and relevant public authorities in the allocation and management of aquatic resources and land uses. Capacity building through provision of training, extension, and advanced education to fish producers continues to be crucial for successful development of the sector.

### **Fish management policy of Ethiopia**

Management system combines a set of regulatory scheme within a particular resource to achieve a management outcome.<sup>[24]</sup> The effectiveness of this regulatory measures depends on the support gained from the resource user group<sup>[25]</sup> and the way they themselves define their problem, their involvement in the decision-making process, in installing and enforcing the regulation.<sup>[26]</sup> Hence, management principals have to include human responses and motivation as part of the system to be studied and managed.<sup>[27]</sup> Particularly, their attitudes and perceptions towards management, compliance and enforcement as these are vital to the effectiveness of any regulatory effort.<sup>[28]</sup> The traditional fishery of Ethiopian fishery is undeveloped due to low level of economy, lack of fisheries' legislation implementation, ineffective administration set-up and lack of expertise. Based on these facts, Ethiopian fisheries might not seem to manage. But some stocks (Nile perch & Tilapia) on some lakes (Chamo & Awassa) show signs of over-fishing and Tilapia of lake Ziway are probably at full exploitation. Currently there is fishery management legislation enforced at the Federal level, proclamation No.315/2003 in 2011. It provides broad guidelines relating to resource conservation, food safety and aquaculture. This document puts considerable emphasis on regulation, permits and the role of the fishery inspector. It is intended that the regional administrations should then use this as the broad framework within which their own proclamations are developed.

Although not all of the regional proclamations have been finalized, the proclamation for Amhara and Oromia Region was developed in 2011 and 2012 respectively. It covers the same areas as the national policy, but has an additional objective relating to the creation of employment opportunities in fishing communities. It also states that information, including research findings, should be made available to the fishing communities. As with the National Proclamation it relies heavily on regulatory measures ('command and control') and the role of the fishery inspector. There is no mention of co-management, though one of the stated objectives (to prevent and control over-exploitation of the fisheries resource) would seem to leave open this option. At both national and regional level, the proclamations reflect concern that fish products should conform to prescribed standards.<sup>[29]</sup>

There are no guarantees that we can continue along our present trends of catching fish from the wild. Fish, the last wild food man has, are not going to keep up for many reasons including climate change and population increase. Since this Federal and Regional fishery

management proclamation is not active, another way of fishery management which is called fishery co-management was developed for most of lakes and reservoirs in 2013. The following fisheries management measures, which could be implemented using a co-management approach, are proposed.

- A) Licensing:** a certain number of fishermen and fishing gears according to biological limits.
- B) Closed season:** (June –July) to prevent fishing during one of the tilapia breeding seasons.
- C) Mesh size limitation:** of minimum 10cm stretched mesh for gillnets and 8cm for beach seine.
- D) Progressive reduction:** in number of beach seines by 50% in 2yrs leading to total eradication.
- E) Prevention:** of beach seining in certain areas by placing obstacles in the near shore areas and planting of inshore vegetation.
- F) Closed areas:** - to prevent fishing in designated areas where fish are known to breed generally, what are the options for sustainability in fishery production for food security, particularly in Ethiopia?

According to Professor Brook Lemma's recommendations 2014, some adaptation alternatives setting the environment is: Delineate fish sanctuaries, such as protection of breeding grounds, The fishery sector should engage in land use planning with other stakeholders in the watershed to make water use sustainable, Free access to fresh waters, as in Ethiopia, should be regulated (know at least who does what)., Restock freshwater systems; work done at Lake Tana, Ethiopia, Create value addition at each market chain, Cutback on external nutrient load and eutrophication, Capture free nutrients, Cutback on pollution from aquaculture practices and others, Use ephemeral waters (e.g. new dams) with fast growing and flexibly feeding fishes, and also Harnessing flood waters for irrigation and fish farming. Fish farming maximized and made environmentally friendly by integrating different production.

## **Fish harvesting, preparation and consumption in Ethiopia**

### **Fish harvesting techniques and equipment**

In Ethiopian fishery fishing techniques are overwhelmingly artisan, with very few motorized boats (limited to a very small number on Lake Tana and on some of the southern lakes). Gill nets are the most common, but there is also some use of beach seines, cast nets and line-fishing (the latter for Nile perch).<sup>[5]</sup> Ethiopian fishery is entirely artisanal. Most of fishing vessels, whose number is about 600, are made of papyrus or scirpus and are not motorized

with the exception of about 30 boats on Lake Tana. In the Rift Valley, canoes tend to be gradually replaced in some of the lakes by wooden punts with oars (4m x 1.7m x 0.55m). Fishermen mostly use one-man rafts, whose carrying capacity is extremely limited. However, the vessels give fishermen access to the entire surface of the Rift Valley lakes, at minimum cost, a punt costing Br450 with a life of 3 to 5 years while a raft costs about Br30 and lasts for 3 months.

On Lake Tana, the Ethiopian Orthodox Church/Development and Inter-Church Aid Department (EOC/DICAD) project has introduced 25 metal boats with outboard and inboard motors. All the motorized boats have been provided to fishermen almost free of charge. The technology allows fishermen to operate on the entire surface of the lake, but producers cannot afford its high running costs when compared with economic conditions.

Gillnets are by far the most popular gear used, with the largest mesh sizes on Lakes Abaya and Chamo (up to 32 cm), where fish is bigger. Gillnets are mostly operated with rafts on the exception of Lake Awassa where fishermen use wooden rowing boats. Beach seines of about 150-200 m long are used on Lakes Langanu and Ziway (in Ziway during fasting periods only). The cost of one 150m beach seine in Ziway is about Br2,800. Taking into account its relatively high cost a large number of fishermen is engaged as crew members. Castnets are also used by traditional fishermen on Lake Tana, while hook and lines and long lines are operated for catching Nile perch on Lake Chamo. In the near future, the LFDP (Phase 2) is expected to conduct exploratory commercial fishing operations with a view to identifying improved vessels and gear.

Some repair and maintenance facilities have been provided on Lake Tana by the EOC/DICAD project which has organised a net manufacturing unit with trained women. In the Rift Valley, the LFDP (Phase 2) operates a boat-building yard at Ziway and is also expected to construct workshops and net-making/repair facilities. Apart from Lakes Ziway, Abaya, and Tana/Bahirdahr where the FPMC hold basic jetties, there is a general lack of landing facilities on Ethiopian fisheries. Only two landing points, under the control of the FPMC, are equipped with electricity and fresh water supplies for fish handling and preservation. The main installations are at Ziway (chill store, ice) and Arba Minch (freezing, cold store), with more limited facilities at Bahir Dar (cold store). Until recently, the majority of fishermen used to be organized into fishermen's association (Service Cooperative), in line with the previous policy of the Government. The Ministry of Agriculture (MOA) has granted

commercial fishing rights only to fishermen's associations, each of which has to pay a royalty in return for the privilege of exploiting a given water body.

### **Fish preparation and handling systems**

Fish has always been consumed in the lake regions of Ethiopia but has now become a bigger part of the cuisine as more liberal Orthodox Christians eat fish during the fasting (vegan) days. With just three days left of the Easter fast, fish restaurants are nearing the end of their two-month busy season. Fish eaten in the larger cities of Ethiopia, away from the lakes, is mainly tilapia and small amounts of Nile perch. But rockfish, carp and catfish are eaten in the fishing towns.

As mentioned by<sup>[10]</sup> Ethiopian consumers have preference for whole fresh fish. As a result, the bulk of the fish harvest from the lakes is sold fresh. However, frozen filets are increasingly being marketed in lakeside towns as well as in the capital city, Addis Ababa. Although most fish traders do not have access to basic cold chains with ice and insulated containers, a few basic fish handling and preservation institutions which are equipped with electricity and freshwater supplies are available in the Ethiopian fisheries.

The main facilities are the chill store and ice at Ziway, freezing and cold store at Arba Minch, and a cold store at Bahir Dar area on Lake Tana. As a result of the general shortage of basic cold chains, fresh fish storage usually lasts only up to two days. Consequently, fish marketers concentrate their trade during religious fasting periods when there is more demand. Smoking is not a traditional method of fish utilization in Ethiopia, and drying is carried out only on some remote fishing locations. “Kuanta”, which is a dried fish product, is largely available around Arba Minch. The product is obtained by filleting the fish, cutting them into large strips and hanging them up on strings to dry for two to three days, after which they are packed in sacks for storage on the floor for up to a month without substantial quality deterioration. But while “kuanta” is not popular further north of the country, seasonal processing takes place in the area of Lake Ziway during religious fasting periods.

Drying is increasingly becoming a method which is frequently used to preserve excess catches, with dried fish being more available in large consumption centers such as Addis Ababa, as well as being targeted at the expatriate market. And in addition to the traditional fish preservation methods, the Ethiopian Meat Concentrates, a subsidiary of the government-owned Ethiopian Meat Corporation (EMC) has carried out fish canning, with a varied degree

of success. Whereas fresh fish handling hardly incurs post-harvest losses during religious fasting periods when demand is high and transactions rarely exceed 24 hours, at normal times, traders face major storage problems as a result of shortage of basic cold chains, thus resulting in significant losses. Because “kuanta” is generally prepared in poor hygienic conditions and insufficiently dried and stored on bare ground, it often incurs significant quality degradation.

There are several variations of fish commonly eaten in Ethiopia. “*Koroso*” is deep fried fish cut in a checkerboard style so that it can be eaten without cutlery. It is served with lime and a spicy *cochcochadipping* sauce. This is the most common preparation of fish and the favorite of many of our guests on our food tour. “*Asalebleb*” is lightly cooked fish in a flavorful sauce. The spices used in the sauce vary throughout Ethiopia. *Asalebleb* is usually only found in fishing towns where the fish is very fresh. “*Asa Goulash*” is deep fried fish served in a spicy sauce with tomato and onions and eaten with injera. It has no resemblance to goulash whatsoever but this is the name used throughout the country. “*TereAsa*” is raw fish served only at a fish market or early in the day (when the fresh fish comes in) in a nearby restaurant. It is usually served with lime and a spicy dipping sauce. The most common fish to eat raw is carp. “*Asashorba*” is fish soup. This is perhaps the dish that varies the most throughout Ethiopia. Fish properly preserved, prepared and presented in the right form is popular in most households, particularly in big towns. The appeal of an otherwise tasteless diet is greatly improved, and much use is made of fish and shellfish as soups and condiments, especially when smoked or dried. Among some religious groups, such as the Coptic Orthodox Church in Ethiopia, fish plays an important role in fasting days when the eating of meat Products is forbidden. The fish consumption per head per year of the country is very low (LFDP, 1998). However the rapid growth of population and the progressive shortage of livestock products had changed the situation to a growing demand of fish.<sup>[30,31]</sup>

### **Demand for fish meat**

The demand for fish is higher than supply especially, in Ethiopian fasting season and if it not fasting season supply is higher. This is because of religious influences on consumption patterns; the demand for fish is only seasonal. During lent, Christians who abstain from eating meat, milk, and eggs consume fish, since fish is the substitute of meat.<sup>[32]</sup> Fish as a source of human food has a long history in Ethiopia. People consume large amount of fish in fasting days, in big cities, around production areas and towns, especially in Ziway, Arba

Minch, Bahir Dar and Addis Ababa. Outside these areas, however, the domestic market for fish is small.

Fresh fish is produced in the Great Rift Valley lakes and in some other northern parts of the country. Price wise, too, fish is relatively expensive compared with the local prices of vegetables and grains on a unit weight basis, but it is frequently less costly than alternative animal protein sources. With increased marketing efforts and increase in supply, the demand for the fish product could be tremendously increased from the current level. Even if the available stocks of these fishery waters will be fully exploited in the near future, both current and future demand for fish by the population cannot be met. For instance, total demand for fish in 2003 is about 67 thousand tons, which is envisaged to grow nearly to 95 thousand tons in 2015 and 118 thousand tons in 2025. To fill this gap, therefore, new alternative fish supply sources must be found.<sup>[33]</sup>

### **Fish consumption practices and trends in Ethiopia**

In Ethiopia fish consumption and marketing is mostly limited to areas near water bodies (lakes) except for bigger cities like Addis Ababa where there is big demand.<sup>[20]</sup> The result of this study showed two basic roots of fish delivery to consumers. The primary root involves exclusive marketing of fish to Addis Ababa town. This is the major root of delivery for Nile perch and tilapia fish. The former is sold as a fillet while the later as gutted whole fish. In this root fishes are transported first to a temporary store present in Dilla town and then distributed to hotels and restaurants present in Addis Ababa. According to the information obtained from producers and middleman there is high market demand for fillets of Nile perch and price at landing site is higher for this fish (40birr/kg) and tilapia also receives considerable demand. The second root involves delivery of fish to the local market by the producers themselves. Catfish and Silver catfish are most commonly presented to the local market as a whole fish and dried stripe. All the production is consumed within Ethiopia since fish export activities are nowadays inexistent. In the recent past, the FPMC tried to develop fish export to Middle East markets, with a maximum of 57t exported in 1989/90 to Saudi Arabia. Fish imports are mainly composed of canned fish and represent about 100 t/year. Estimated fish consumption in a small radius around waterbodies (Awassa, Arba Minch, Gambella) can be placed at approximately 10kg/year per caput. Fish eating habits in Ethiopia have been mainly influenced by the Orthodox Church which encourages the eating of fish during 80 days of fasting.<sup>[10]</sup> In Ethiopia fish consumption is also heavily weighted towards fasting days

(Wednesdays and Fridays) and fasting periods (55 days in March/April, 15 days in August, as well as other Periods which may be less widely observed).<sup>[34,35]</sup>

Fish is one of the known aquatic animals used for human consumption as food. Aquatic animals in general do contain a high level of protein (17-29%) with an amino-acid profile, similar to that of the meat of land animals. The flesh of a fish is also readily digestible and immediately utilizable by the human body, which makes it suitable for complementing the high carbohydrate diets. Compared with land animals (with some exceptions, such as shellfish), aquatic animals have a high percentage of edible flesh, and there is little wastage.

Aquatic animals are a source of minerals such as calcium, iron and phosphorus as well as trace elements and vitamins. Marine species are particularly rich in iodine. The fatty acid content is high in poly unsaturated and particularly those which are attributed to reduce blood cholesterol. There are also some indications that certain fatty acids in fish may provide protection against renal disease. Increasing the per capita consumption of fish and shellfish in any country can benefit health standards.

## 1. CONCLUSION

Ethiopia's fisheries are entirely fresh water, in its many lakes, rivers and reservoirs, as it has no marine coastline. The total area of the lakes and reservoirs stands at about 7000 to 8000 km<sup>2</sup> and the important rivers stretch over 7000 km in the country. In addition, minor water bodies such as crater lakes and reservoirs make up about 400 km<sup>2</sup>.

Although per capita consumption of fish is very low in Ethiopia, there is steady growth in demand reflecting population increase, rising incomes and a shift in preferences. The main areas of consumption are Addis Ababa and towns close to the main production areas. Fish consumption is strongly linked to the fasting traditions of the Ethiopian Orthodox church: most people consider that fish can be eaten on days when meat is not allowed (Wednesdays, Fridays and during the fasting months).

In communities where fish farming is not practiced, e.g. Ethiopia, aquaculture creates new jobs, contributes to food security and protects wild fish. Adopting fish production systems to current climate changes help billions of people around the world to secure their protein supply. This is particularly true in Africa.

Fisheries management in Ethiopia would have great contribution to the economy. This is because fisheries provide employment, food & income and it makes possible evaluation of overexploitation of the fisheries. Since fishery production is overexploited due to inappropriate fishing practice the potential of fish was underdeveloped and the management rule and regulation at federal level and regional level to control the devastation was very poor. This shows that the government attention for fish management was very poor.

In another ways the new upcoming lake management system co-management system which consists of end users, policy makers and all stake holders is promising for sustainable lake management.

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