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Market analysis of Aquaculture in Kenya

November, 2013





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M.N.J. Turenhout[1], E. Rurangwa[1] and A.P.van Duijn[1]

[1] Wageningen UR

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Contents

Summary

Growing demand for aquaculture

- The population growth rate in Kenya is increasing due to improved life expectancy and a drop in infant mortality. The population growth rate in 2013 was estimated at 2.27%.
- The high growth rate put more pressure on the protein sources in Kenya. For animal proteins, Kenya's climate is particularly suitable for aquaculture practices. Especially tilapia and catfish are interesting farm species.
- The Kenyan government started a Fish Farming Economic Stimulus Programme (FFESP) in 2009 for aquaculture. FFESP accelerated an exponential increase of fish production in farms.
- Growing demands for fish due to GDP growth, increasing product varieties and awareness for fish as protein source among younger generations, combined with declining capture fisheries give a new impetus to aquaculture.
- Increasing regional integration in East Africa and rapidly improving regional infrastructure is creating an easier access to other markets in the region.

Increasing market

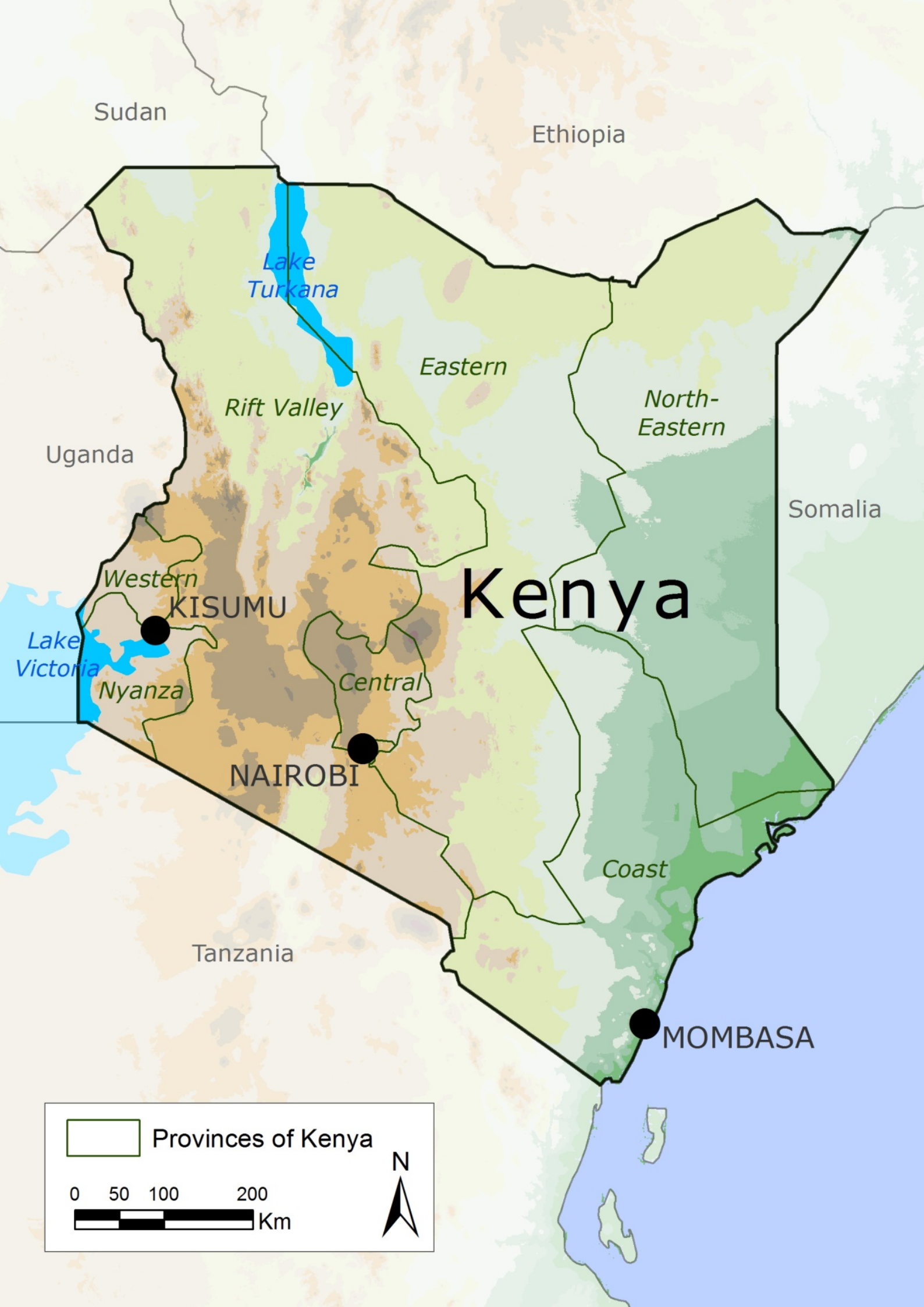
- In almost all market segments the demand for fish is increasing. However, for most fish products this increase is not expected to be exponential.
- Demand for plate-sized fish is expected to grow gradually.
- A faster growth is expected in those rural and urban areas where there is a high potential for small tilapia (<100 grams) for low-income groups. In upper level segments there is a trend of increasing the variation of fish products.
- In the upper level segments there is a trend towards increasing the diversity of fish.

Weak supply chain

- There are numerous challenges that limit the growth of the aquaculture sector.
- A lack of knowledge how to farm fish and realise good feed and seed is one such challenge.
- There is little supply of feed and the quality is generally low. Protein content is around 27%. Fraud in fish feed is common, whereby protein contents are often below assumed percentages.
- For seed, there is shortage of good quality fingerlings. The government authorised 146 hatcheries for producing fingerlings. Only a small amount of these hatcheries are active. The fingerlings supplied are most of the time accompanied with inbreeds.
- Most Kenyan farms are extensive and semi-intensive ponds, with only a few intensive farms.

Opportunities for FTA

- Investing in farm improvements and knowledge will improve aquaculture production in Kenya
- There's not enough (good quality) fish feed for fish production nowadays. Feed producers are working on good fish feed, but there's still supply shortage.
- The quality and availability of (good) seed need to improve. Less inbreed and mixed sex are preferred.
- Investments in awareness, aquaculture farms, feed and seed can bring the aquaculture sector to a next level.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1 Introduction

1.1 Background

Due to a sharp growth in population, rapid urbanisation, rising incomes and changes in food habits East Africa faces a growing demand for animal protein. This results in increasing demand for sustainably produced, safe, nutritious and protein-rich food products. At present, local actors are unable to meet this demand. This results in nutritional deficiency, inconsistent supply and excessively high prices for a substantial part of the population.

Compared to livestock, farmed fish are efficient livestock in terms of water usage, feed conversion and greenhouse gas emissions. This healthy source of animal protein offers substantial opportunities to improve food security, when produced in a sustainable manner.

At present, several major challenges inhibit production increase within the aquaculture value chain: (1) lack of economies of scale and the absence of critical mass; (2) insufficient access to high-quality inputs such as stocking material, fertiliser, feed and water; (3) poor farm management; (4) poor animal health management; (5) lack of an integrated value chain (including raw materials, inputs, primary production, processing, cold storage and distribution to (retail) markets); (6) lack of local finance, costly debt funding, high transaction costs, commercial risks; and (7) a challenging business environment (e.g. corruption, formalities, duties) for commercial to small-scale subsistence farmers.

FoodTechAfrica (FTA) is a public-private initiative combining the strengths of Dutch agro-food companies (mainly SMEs), knowledge institutes, governmental agencies and their East-African counterparts to improve food security in East Africa through the establishment of a fully integrated aquaculture value chain. FTA will demonstrate the effectiveness and efficiency of a fully integrated aquaculture value chain in dealing with the challenges mentioned above. In order to do this several activities need to be undertaken, the first of which is this market study.

1.2 Objective

This market study will provide FTA project partners with sufficient information to become familiar with the Kenyan fish market; the regional availability of feed ingredients; and the characteristics of fish production systems in preparation of the impact tour.

1.3 Approach

This market study was conducted on two levels:

- A desk study to acquire relevant information and data about the recent market situation in East Africa and Kenya based on public databases and reports.
- A field mission in Kenya including interviews with key informants and fish market study around Nairobi and Kisumu.

This document is the result of an intensive collaboration between Lattice and Wageningen UR.

1.4 Structure

Chapter 2 provides general background information on Kenya and more specific information about fish protein consumption and availability. Chapter 3 describes the fish market and important market characteristics and segments for fish in Kenya. Kenya's aquaculture growth potentials, production systems and their main characteristics are mentioned in Chapter 4. Chapter 5 focuses on potential

constraints to fish farming: feed, seed, transport and import regulation. In Chapter 6 the governmental institutions and supporting organisations in Kenya are discussed. This report ends with observed aquaculture challenges for FTA partners in Chapter 7.

2 Fish protein consumption and availability in Kenya

This chapter provides a short introduction to Kenya including protein consumption and fish availability. By using the consumption values and fish availability values in Kenya, development scenarios are measured. Additional background information about Kenya can be found in the Wageningen UR report *Business opportunities for aquaculture in Kenya* (Rothuis et al., 2011).

2.1 Country profile

Kenya lies on the equator with the Indian Ocean to the South-East, Tanzania to the South, Uganda to the West, South-Sudan to the North-West, Ethiopia to the North and Somalia to the North-East. Kenya is part of the East African Community (EAC). The EAC is a regional intergovernmental organisation of the Republics of Burundi, Kenya, Rwanda, the United Republic of Tanzania, and the Republic of Uganda, with its headquarters in Arusha (Tanzania). Table 1 provides the most important country facts from Kenya. Appendix 1 provides country facts from the surrounding EAC countries and Ethiopia. The capital and largest city in Kenya is Nairobi. Other important cities in the Kenya are Mombasa in the East, Kisumu and Eldoret in the West and Nakuru in the middle of Kenya. The geography of Kenya is diverse. Kenya has a coastline on the Indian Ocean, which contains swamps of East African mangroves. Inland are broad plains and numerous hills. Central and Western Kenya is characterised by the Kenyan Rift Valley, home to two of Africa's highest mountains, Mount Kenya and Mount Elgon.[1]

Table 1
Country facts

Population in 2013	44,037,656 (July 2013 est.).
Population growth rate in 2013	2.27% (2013 est.) (1.095% in the World)
Median age 2013	Total: 18.9 years (29.4 years in the World)
Capital	Nairobi, 3,375 thousand inhabitants (2009)
Major Languages	English (official), Kiswahili (official), numerous indigenous languages
Land Area	580,367km^2
Arable land	9.48%
GDP in 2012	USD77.14bn (est.) (purchasing power parity)
GDP - per capita (PPP)	USD1,800 (est.) (Ethiopia: 1,200, Uganda: 1,400, Tanzania: 1,600, World: 12,600)
GDP - real growth rate (est.)	4.7% in 2012, 4.4% in 2011, 5.8% in 2010
GDP - composition by sector in 2012	Agriculture 24%, Industry 15%, services 61% (est.)
Currency	Kenyan shilling (KES); €1 = KES117; USD1 = KES87 (26 August 2013)
Literacy (age of 15 can read and write)	Total population: 87.4% (2010 est.)
Population below poverty line	50% (2000 est.)
Inflation (est.)	9.4% in 2012; 14% in 2011
Exports - commodities	Tea, horticultural products, coffee, petroleum products, fish, cement
Export - partners in 2012	Uganda 10.5%; Tanzania 10.2%; Netherlands 7.1%; UK 6.7%; US 5.8%; Egypt 5.2%
Main imports	machinery and transportation equipment, petroleum products, motor vehicles, iron and steel, resins and plastics
Imports - partners in 2012	India 20.7%, China 15.3%, UAE 9.5%, Saudi Arabia 6.7%

Source: CIA (2013).

[1] http://en.wikipedia.org/wiki/Geography_of_Kenya

Kenya regained independence in 1963 after nearly eighty years of British occupation and colonial rule. The republic is a multiparty democracy, ruled by a “grand coalition” of parties. With little oil or natural gas and few mineral sources, most of the foreign currency Kenya needs for vital imports is earned from coffee and tea exports, and tourism. The Kenyan society consists of a huge, impoverished underclass, a small but growing middle class and a tiny, rich elite. Corruption is a big problem in the country and affects every aspect of the economy.

Less than 20% of the land in Kenya is suitable for cultivation purposes (mostly West and Central Kenya; see Appendix 2). The rest of Kenya contains arid or semi-arid land. Eight per cent of Kenya is used for crop and feed production. Most of the production (75%) is carried out by small producers cultivating no more than 2 hectares of land using limited technologies. Eighty per cent of the Kenyan work force is engaged in agriculture and or food processing (Chauvin et al., 2012). High population growth increases the need for food and infrastructure development in Kenya. This increase is putting pressure on the arable land and livestock in the high potential areas. A growing population and an increased GDP per capita present a greater demand for (animal) proteins. Productivity per acre needs to increase and costs reductions need to be realised in the value chain in order to fulfil this demand.

Aquaculture is characterised by low levels of production and provided less than 1% of the country’s protein needs over the past decade (Nyonje et al., 2011). Nevertheless, there’s a growing potential for this kind of farming. On the one hand this is due to good climate conditions and availability of water sources. On the other hand this is due to a growing market (through population growth and GDP growth), an increased government attention and decreasing fish stocks in local lakes as Lake Victoria and Lake Naivasha. An overview of the main water resources is provided in Appendix 2.

2.2 Protein consumption

Figure 1 shows the average total protein intake for Eastern Africa and Kenya projected against the world consumption between 2007 and 2009. In this period the world average animal protein intake was 39% of total protein intake (31 grams per capita per day). The animal protein intake in Eastern Africa is only 19% of total protein intake (10 grams per capita per day). This is a consequence of the poor constituting the largest share of the total population in Africa and their diets being largely starch and vegetable-based. Kenya’s animal protein consumption is higher than the East African average. The animal protein intake is 29% of total protein intake (17.2 grams per capita per day). Fish and seafood in Eastern Africa and Kenya provide only a small part of the total protein intake. Where the average world fish and seafood protein intake is around 16.5% of total animal protein intake (5.1 grams per capita per day), Eastern Africa and Kenya derive only 14.0 and 5.8% of their total animal protein intake from fish and seafood (1.4 and 1.0 grams per capita per day respectively). Measured in kilograms, the world average consumption of fish and seafood is 18.5 kg per capita per year, while the East African average is 4.6 kg of fish and seafood per capita per year and the Kenyan average is 3.4 kg of fish and seafood per capita per year.

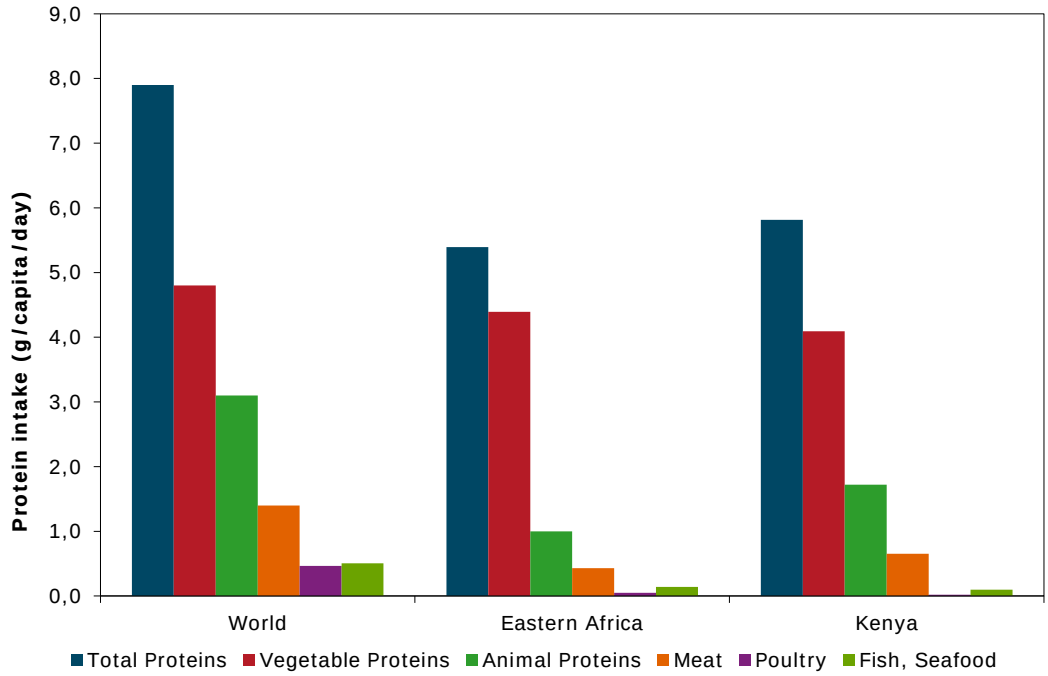


Figure 1 *Average protein intake (2007-2009) per gram per capita per day*
Source: FAOSTAT (2013).

In 2009 the average monthly household expenditure in Nairobi was KES14,000 (around USD160) for low-, KES25,231 (around USD290) for middle- and KES140,828 (around USD1,620) for the high-income groups. In the same year the average food expenditure was 29% of total household income (28% in 2003). The proportion of income spent on food decreases with rising income. In 2009 low-income groups spent around KES6,876 (49%) per household on food per month, while high-income groups spent around KES21,934 (16%) on food per month. Middle-income groups spent around KES10,256 (41%) per household on food per month (Kamau, M. et al., 2011).

Staples, fruits & vegetables are the most important food products for all income groups (Kamau et al., 2011). However, the share of total food expenditure spent on staples, fruits & vegetables decreases with income. Low-income groups spent 53% of their total food expenditures on staples, fruit & vegetables, while middle- and high-income groups spent respectively 49% and 45% of their total food expenditure on these food products. Contrary to the share of total food expenditure spent on staples, fruits & vegetables, the share of total food expenditure spent on animal proteins increases with income. The share of total food expenditure spent on dairy products increased from 13% for low-income to respectively 14% and 17% for middle- and high-income groups. The share of total food expenditure spent on meats and eggs (including fish) increased from 15% for low-income to respectively 20% and 23% for middle- and high-income groups.

2.3 Fish production

From Figure 2 it appears that inland capture fisheries delivers the highest production (159,000 tonnes in 2011), followed by aquaculture (20,000 tonnes in 2011) and marine capture fisheries (8,000 tonnes in 2011). In the figure, FAO data (2000-2008) and data from the Kenyan ministry of fisheries (2009-2011) are used. The differences between the FAO data and ministry data are negligible.

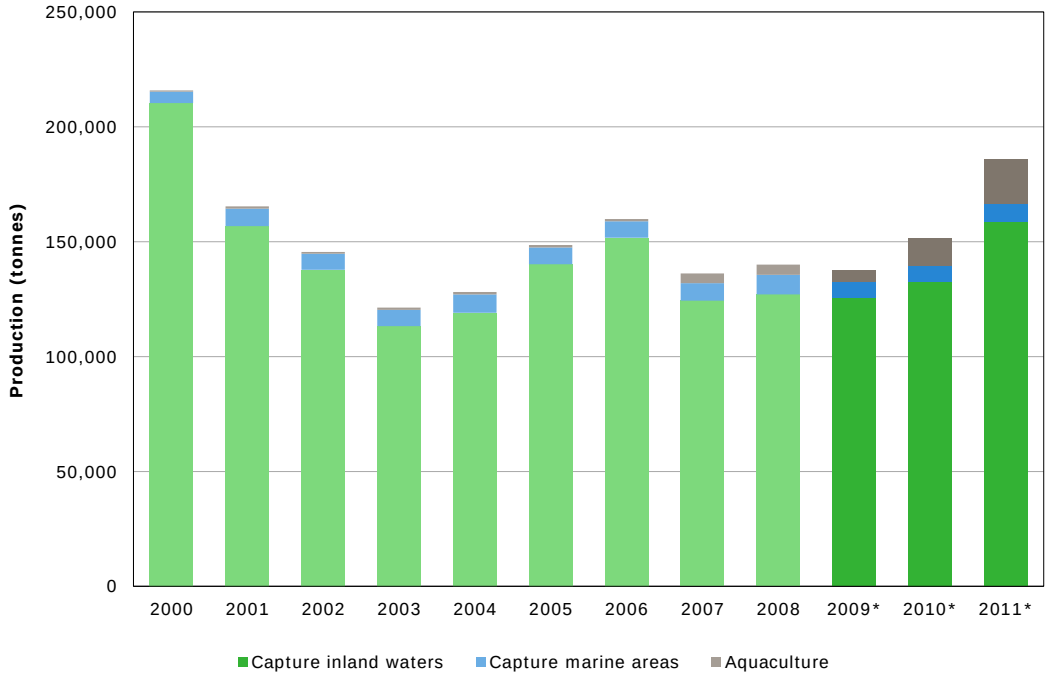


Figure 2 *Fisheries and Aquaculture production in Kenya (tonnes). 2009-2011 data come from the Kenyan ministry of fisheries*
Source: FAO (2013) and *ministry of fisheries* (2012).*

The inland capture fisheries subsector is host to over 50,000 fishermen, where almost all are artisanal (ministry of fisheries, 2012). Inland capture fisheries is supported by three main fish stocks. These are Nile perch (*Lates nilotucus*), Omena (*Rastrineobola argentea*) and Nile tilapia (*Oreochromis niloticus*). Nile perch contributes to about 30% of the total catch from the lake fishery in 2011 (ministry of fisheries, 2012). 80% of total Nile perch production is sent directly to fish establishments for processing and export to overseas markets (Georgsson and Thorkelsson, 2009). Omena (a sardine-like fish) and tilapia contribute to respectively a 46% and 16% share of the total catch from lake fishery in 2011 (ministry of fisheries, 2012). Omena and tilapia serve the local lake regions and domestic markets. In 2011 tilapia capture production in 2011 was around 25,000 tonnes. Catfish catches are relatively low (around 6,000 tonnes in 2011). Total capture production is rising since 2009 (Figure 2), but decreased again in 2012 (ministry of fisheries, 2013).

The marine subsector is host to nearly 12,000 fishers, out of which 95% are artisanal. Fishing is carried out in the near shore areas using simple boats and is heavily dependent on the monsoon wind patterns. Over the last 20 years, the annual catch has fluctuated between 4,000 and 10,000 tonnes with some areas reporting overfishing. Lobsters, prawns, crabs, octopus and squid are the main marine commercial species, but contribute only 4% of total fish landings (Rothuis et al., 2011).

The aquaculture subsector is host to around 49,000 fish farmers. As can be seen in Figure 3, aquaculture production amounted to about 22,000 tonnes in 2012. This is 23 times greater than the production in 2006. In 2011 Kenya ranked third in Africa as far as aquaculture production was concerned (22,000 tonnes). Only Egypt (987,000 tonnes) and Nigeria (221,000 tonnes) produced more than Kenya. According to FAO (2012) Uganda ranks third with a total production of 86,000 tonnes in 2011. However, several sources have reported Ugandan figures to be a gross overestimation. Actual figures are estimated at or below 8,000 tonnes.

Aquaculture in Kenya can be divided into three categories (Mbugua, 2008):

- Warm freshwater aquaculture dominated by the production of various species of tilapia and the African catfish (*Clarias gariepinus*) mainly under mixed sex semi-intensive systems using earthen ponds;
- Cold freshwater aquaculture production of rainbow (*Oncorhynchus mykiss*) trout under intensive systems using raceways and tanks; and
- Marine aquaculture (Indian Ocean).

Figure 3 provides an overview of the total aquaculture production in Kenya by species. Since 2007 there is a substantial increase in fish farming activity. This can be attributed to the government investments in improving aquaculture in the country (see FFESP in Chapter 5). In 2011 74% of aquaculture production in Kenya consisted of tilapia. In the same year catfish accounted for 19% of aquaculture production.

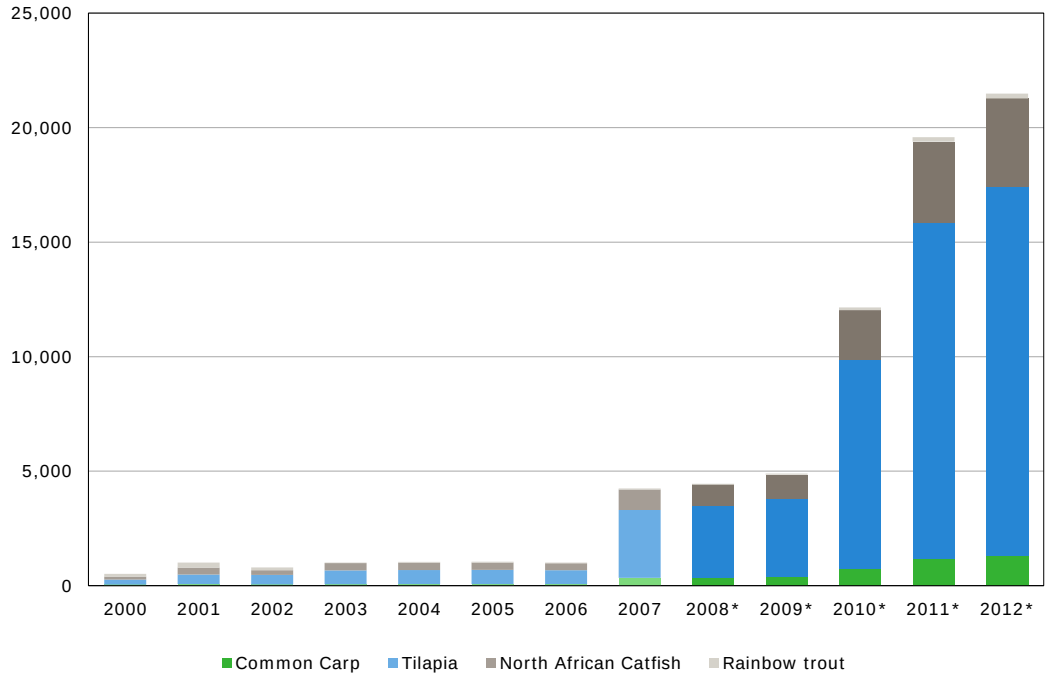


Figure 3 *Aquaculture production in Kenya (tonnes). 2008-2012 data come from the Kenyan ministry of fisheries*
Source: FAO (2013) and *ministry of fisheries* (2013).*

Figure 4 shows the average price for different aquaculture products in Kenya between 2000 and 2011. FAO data (2000-2007) and data from the Kenyan ministry of fisheries (2008-2012) are used. The differences between the FAO data and ministry data are negligible Prices for farmed carp, catfish and tilapia have been relatively stable since 2007 (around USD1,00 per kg for carp and USD2,50-3,00 per kg for tilapia and USD2,30-2,80 per kg for catfish). During the same period, prices for farmed trout fluctuated between USD6,00 and USD8,00 per kg. It is likely that the demand for farmed fish will increase due to population growth, growth of GDP and declining fresh water and marine fish stocks. If no or limited new fish sources are available these circumstances are expected to put increased upward pressure on future fish prices.

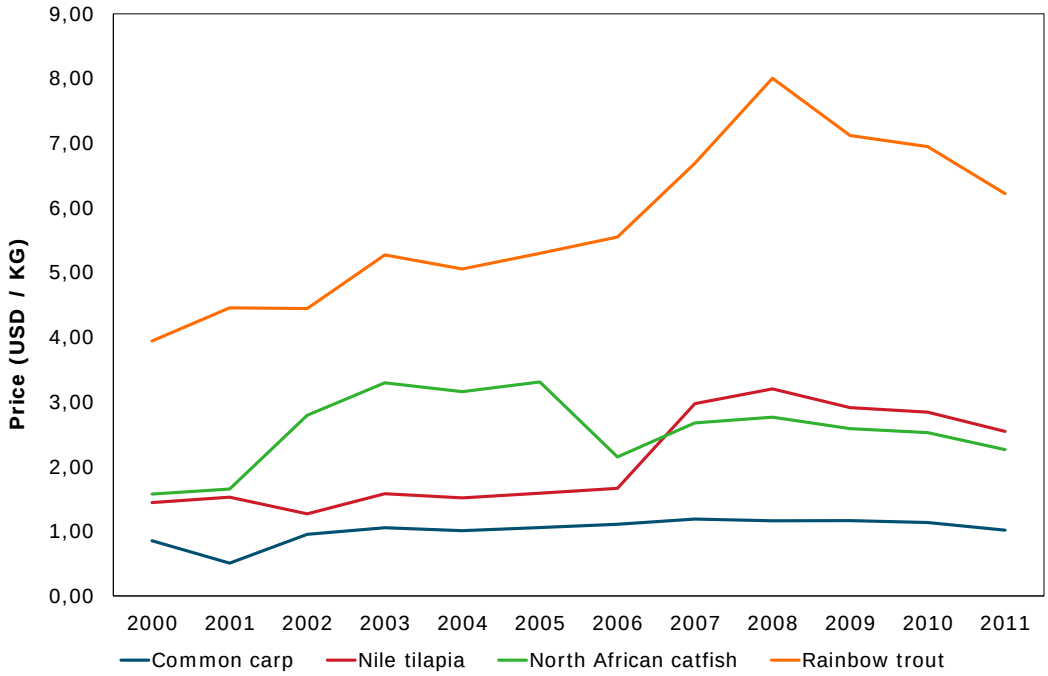


Figure 4 *Average price for aquaculture products in Kenya (USD per kg)*
Source: FAO (2013).

2.4 Fish exports

Table 2 shows that the most important fish export products in Kenya are Nile perch and tuna loins. In the year 2011 Nile perch fillets accounted for about 41% of total exports. Tuna loins, processed and trans-shipped through the port of Mombasa, accounted for 51%. Octopus contributed for 7% of the total export quantity. The Nile perch fillets were mostly exported to Israel (40.1% or 3,327 tonnes), the Netherlands (22.2% or 1,841 tonnes), Portugal (9.5% or 787 tonnes) and Germany (8.3% or 687 tonnes). Products were most of the time sold as frozen fillets (51.2 %), followed by fresh (37.5%) and frozen headless&gutted Nile perch (7.4%).

Compared to 2007, the Nile perch export decreased by 37%. This can partially be explained by the diminishing competitive position of Nile perch in the international market. In the year 2011 the total export value was USD52m. Traditionally, the largest share of Nile perch exports was destined for the EU and Israel. However, in recent years exports to the EU came down rapidly. According to Mbugua (2008) and USAID (2008) Nile perch exports suffer from three causes:

1. competition in the EU market from cheap Vietnamese pangasius;
2. a reducing supply from Lake Victoria;
3. the trend that Nile perch is more exported from Tanzania and Uganda; and
4. import bans and Illegal Unregulated and Unreported (IUU) fishing regulations from the EU authorities.

The problems of Kenyan fishery exports to the EU reached its top with to EU bans on fishery products from Kenya in 2003-2004 and renewed issues relating to IUU fishing regulations since 2009. Currently, most tilapia and catfish are sold in the domestic market.

Table 2

Export fish and fisheries products Kenya (tonnes).

	2007	2008	2009	2010	2011
Nile perch Fillets	13,101	12,422	9,712	10,293	8,297
Fish maws	383	565	623	546	45
Fish skins	273	192	23	-	-
Lobsters	29	47	23	4	23
Live Lobsters	-	8	-	13	22
Prawns	134	68	-	-	-
Octopus	479	487	530	690	903
Cuttle fish	-	1	-	-	2
Sword fish	175	159	44	153	9
Squids	-	-	-	-	1
Dried salted fish	-	-	-	-	80
Bech-der-mer	-	-	-	16	11
Sharks	-	462	135	-	55
Shark fins	215	34	-	15	5
Big eye	-	14	-	-	-
Marine shells	-	-	-	172	113
Fish oil	-	2	-	-	-
Crabs	23	45	24	43	23
Mackerels	-	-	-	15	-
Sardines	-	-	-	36	-
Sea weed	-	-	-	2	-
Dried whole Haplochromis					23
Tuna Loins	16,564	15,069	7,392	9,207	9,821
Total	**31,376**	**29,575**	**18,506**	**21,205**	**19,433**

Source: Ministry of fisheries (2013).

2.5 Fish imports

In 2011, Kenya imported 2,664 metric tons of fish and fishery products worth around USD2m. The most important import products in 2011 were frozen mackerel (60.2% or 1,605 tonnes), sardines (19.9% or 529 tonnes) and tilapia (4.9% or 131 tonnes). Imports originated mostly from Asian countries, notably India, Pakistan, Japan and Korea, but all tilapia was imported from China. Important to note is that while the import volumes in 2011 are 7 times smaller than the export volumes, the import value (USD2m) is almost 26 times smaller than the value of the export value (USD52m). This confirms the observation that Kenyan consumers mostly consume unprocessed fish products which have a much lower value than high value processed products that are mainly destined for exports.

Table 3

Import fish and fisheries products Kenya (tonnes).

	2007	2008	2009	2010	2011
Nile perch Fillets	36	-	-	-	-
Frozen Salmon	14	-	20	54	57
Tilapia	-	-	23	91	131
Frozen Tuna	2	-	-	31	107
Frozen Herrings	-	611	96	22	-
Aquirium fish	-	-	-	-	1
Dried salted fish	-	-	4	-	-
Rock cods	-	28	28	-	-
Sardines	-	430	545	485	529
Frozen Mackerels	-	971	1,898	1,749	1,605
Frozen marine fish	-	-	-	81	-
Fish meals	-	-	40	-	-
Sea food	1	-	-	-	-
Dory	-	-	6	-	-
Frozen red fish	-	59	-	-	-
Frozen Creaker	-	37	-	-	-
Frozen Lizard fish	-	27	561	54	-
Canned fish	-	14	-	-	-
Frozen Pacific Saury	-	-	25	-	-
Frozen Pangasius fillets	-	-	23	73	36
Frozen whole fish	-	-	80	-	-
Frozen Billest Tuna	-	-	24	-	-
Frozen Kahawai	-	-	-	259	114
Frozen Koheru	-	-	-	27	-
Coycan	-	-	-	3	-
Dried Sharks	-	-	1	158	81
Frozen Sharks					
Tinforera	-	-	4	-	-
Haplochromis	-	-	-	15	-
Barracuda	-	-	-	27	-
Dolphin fish	-	-	-	21	-
Others	-	13	-	-	3
Total	**53**	**2,190**	**3,378**	**3,150**	**2,664**

Source: Ministry of fisheries (2013).

2.6 Fish availability

Almost the entire supply of fish available for consumption in Kenya is produced locally. Figure 2 showed that the total production of fishery products was around 187,000 tonnes in 2011. Table 2 shows that in 2011 19,000 tonnes of seafood products were exported and an additional 3,000 tonnes of seafood products were imported (see table 3). This means that in 2011 around 171,000 tonnes of seafood were consumed domestically in 2011. With a population around 42m in Kenya for 2011 an average fish consumption of 4 kg per capita per year was consumed in that year.

2.7 Competition and development scenarios

In Kenya, there's almost no competition in the fish market between domestic and imported fish products. The market for domestic fish is protected by high import duties (25%) for imported fish products in Kenya. Only high-end butcheries and some retailers sell imported fish products (see Chapter 3). As marine and inland capture fisheries production continue to decline due to overfishing, increase in invasive weeds (e.g. water hyacinth), and environmental pollution of water bodies (Kabahenda and Hüsken, 2009) the supply of fish is declining. An increase in the supply of fish is not expected from capture fisheries and thus has to come either from imports or aquaculture. As import duties are high and local circumstances for aquaculture development are good (see Chapter 4) aquaculture has the potential to develop domestically. If the abovementioned per capita fish consumption is 4 kg per capita per year and the population growth rate is 2,26%, the additional production volume required in order to maintain the present level of fish consumption can be

estimated for different years for different consumption averages. Table 4 shows the expected scenarios for increasing consumption per capita per year. These scenarios give an idea about the growth potential for aquaculture in Kenya.

Table 4

Additional annual production required to maintain consumption at 4 kg, 5 kg and 7 kg per capita by 2013, 2018 and 2023

		Additional annual production (tonnes)		
	Population (million)	**4 kg/cap/yr**	**5 kg/cap/yr**	**7 kg/cap/yr**
2013	44.0	0		
2018	49.4	21,246	70,649	169,455
2023	55.3	44,717	99,987	210,529

Source: CIA (2013).

To maintain the current level of fish consumption in 2018 total annual production has to increase by approximately 21,000 tonnes. This means that each year aquaculture needs to increase with around 4,200 tonnes. In 2018 aquaculture production will be almost two times the production in 2012 (see Figure 3). To increase the consumption per capita to 7 kg per capita per year, total production in 2023 has to be approximately 211,000 tonnes. To reach this amount of fish with aquaculture, production should be 10 times as high as the production in 2012. To increase fish production to the expected scenario quantities, investments in aquaculture seems to be essential.


DO NOT PAY
or CHAPATI WITH
KACHUMBARI
AT THE COUNTER

3 The Kenyan fish markets and market segments

This chapter highlights the Kenyan fish market including the main outlets, fish distribution, main factors influencing fish consumption and fish prices, based on the markets in Nairobi and Kisumu. Important segments for tilapia and catfish will be discussed based on the main markets for fish. Finally, an indication of the growth potential in the market segments will be provided.

3.1 Fish marketing

Figure 5 illustrates fish marketing in Kenya. The marketing chain for the lake capture fisheries is long and complex. It involves several marketing agents who carry fish from the landing points to the processing facilities and village and/or city markets.

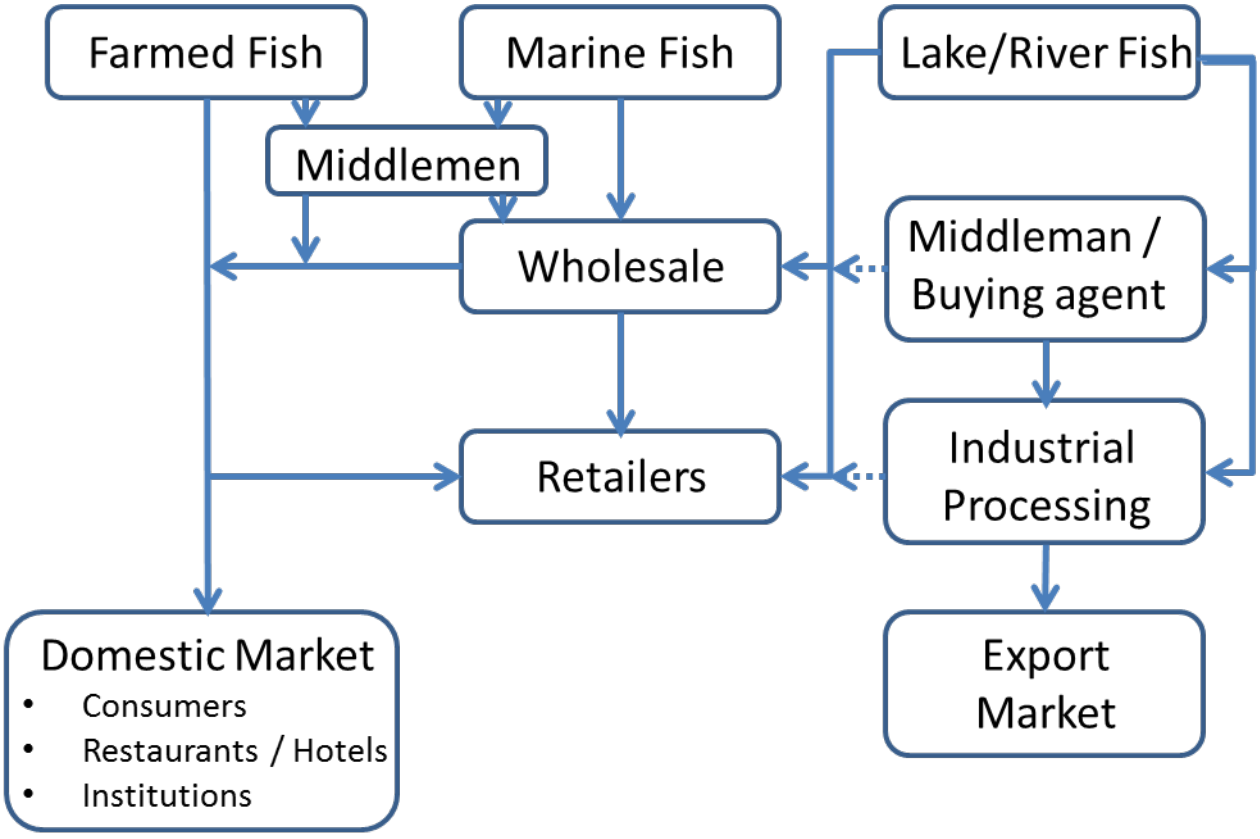


Figure 5 *Fish marketing in Kenya*
Source: Quagrainie et al. (2009).

On the domestic market catfish and tilapia are the most popular fish species. Only small quantities of Nile perch that do not meet the export quality standards are sold for local consumption.
The fish for the domestic market is mainly distributed by road. Most of the time, the fish is transported in twined baskets on ice, but also in refrigerated trucks. Road transport to Nairobi from Kisumu, the main place where most of the caught fish comes from, takes around 7 to 12 hours, depending on traffic conditions. Aquaculture products come from all constituencies in Kenya. While most of the consumed fish comes from capture fisheries, only a small amount of the available consumption fish

comes from fish farms. These fish are most of the time sold at farm gate directly to consumers or to institutions (e.g. schools and hospitals), restaurants, hotels, retailers and middlemen.
In Kenya the main fish distributer to retail and wholesale is Alpha Fine Foods. Alpha Fine Foods has 150 employees and 14 refrigerated trucks. They supply supermarkets, high-end butcheries, hotels, restaurants and schools. Most of the fish they are distributing are from Lake Victoria, but they also distribute farmed fish. The main fish products they are selling are frozen tilapia, Nile perch and Red snapper. At the moment Alpha Fine Foods is working on convenient and value added fish products. Examples of their new products are fish balls, fish fingers and breaded fish. About 100-120 tonnes of frozen fish were distributed by Alpha Fine Foods last year. This is only a small part of the estimated consumption of 171,000 tonnes of fish per year from Section 2.6. 70 to 80% of the fish from Alpha Fine Foods are distributed in the domestic market. The rest of the fish was exported to the other Eastern African countries. The distribution of fish by Alpha Fine Foods is growing with 5-10% a year.

Alpha Fine Foods Limited	Head Office
Minaz Kurji	Road A, Off Enterprise Road
+254-(0)722-511893	P.O. Box 10338-00100, Nairobi
minaz@alphafinefoods.com	Tel: +254-20-651251
www.alphafinefoods.com	Fax: +254-20-534486

Farmers Choice, another distributor of fish, imports nowadays 5 tonnes of frozen tilapia fillets per week from China. They sell this mainly to hotels (60%), but also to institutions (e.g. airports) and retail (e.g. Nakumat).

3.2 Main fish market

This section provides a short description of the main markets for fish in Kenya. Detailed information about tilapia and catfish in the main markets will be provided in Section 3.4.

3.2.1 Local markets

The local market can be divided into the larger city markets (like City market and Gikomba market in Nairobi and the big Municipal fish market in Kisumu) and local district markets. The larger city markets are specialised in selling animal food products. The local district markets sell all kind of food products, but also other products like textile and music CDs. Most households in Kenya buy their food at these local district markets. The availability of fish in the local markets depends on the size of the market and familiarity with fish. Markets in traditional fish production areas provide more fish products than markets in non-traditional fish production areas. Fish are sold per piece or per kilogram. Kilogram prices for fish products vary between KES120 per kg of Omena to KES800 per kg of fish fillets.

Local market at Kisumu. Photo made by Mike Turenhout (2013).

3.2.2 Restaurants and Hotels

Fish can be found on the menu in restaurants and hotels. The fish variety and preparation style depends on the restaurant or hotel standards. Different kind of fish meals are offered for prices varying between KES500 for fried tilapia and more than KES1,200 for a more expensive fish dishes.

3.2.3 Retail market

Only large retailers have fish products in their assortment. One of the bigger supermarkets in Kenya is Tuskys. Tuskys has 42 supermarkets through the country. Besides domestic fish species, imported fish like herring and calamares are sold in this market. Fish are most of the time sold by kilogram and vary between KES500 per kg for whole fish and KES1,200 per kg for frozen tilapia fillets.

3.2.4 Butcheries

Butcheries in Kenya prepare and sell fresh and/or frozen cuts of animal products. The larger high-end butcheries are selling different kind of fish. Beside domestic fish species, a high variety of imported fish like tuna, mackerel, prawns, scallops, herring and salmon are sold in these butcheries. Very little or no fish products are sold at the small regular butcheries. Prices vary between from KES500 per kg for frozen whole tilapia to KES1,900 per kg frozen trout gilled & gutted.

3.2.5 Institutions

In Kenya, institutions like schools, colleges and hospitals provide animal products to their clients. The government of Kenya has subsidised some public institutions to start a fishpond to produce fish for their own consumption. In this way institutions become more familiar with fish as an animal protein source. Institutions also buy fish from middlemen or directly at the farm gate. These institutions buy the fish for between KES400-500 per kg for 300-500 grams of whole fish.

3.3 Characteristics influencing the fish consumption

The four main characteristics which are influencing the fish consumption in Kenya are:

1. Traditional versus non-traditional fish production areas
2. Rural versus urban areas
3. Low- versus high-income households
4. Younger versus older generation

These characteristics are important factors determining the sales successes in the different market segments.

3.3.1 Traditional versus non-traditional fish production areas

Fish consumption depends heavily on where people are living. In areas around big lakes (e.g. Victoria, lake Navasha and lake Nakuru), rivers and seacoasts people are familiar with fish products. For example, fish contributes about 50% of total animal protein to the diets of people in the Lake Victoria Basin (Bartley et al., 2004), where the average animal protein intake percentage for fish in Kenya is around 6% (FAOSTAT, 2013). People from the traditional fish production areas know what fish looks like and how to prepare it. In the non-traditional fish production areas people are less familiar with fish as a result of which fish consumption is much lower.

3.3.2 Rural versus urban areas

Fish consumption also differs between urban and rural areas. In urban areas there's a high variety in markets as high-end supermarkets and butcheries, local district markets and restaurants, where you can find fish for consumption. In rural areas there are only one or two potential fish markets like the local market and local restaurants. Furthermore, in urban areas the population diversity is high including expats and tourists. Finally, the urban population in Kenya is growing at a rate of 4% and accounted for about 22% of the total population in 2008 and 24% of the population in 2011 (Lead et al., 2009; CIA, 2013). At the same time the rural population is decreasing.

3.3.3 Low- versus high-income households

Disposable income is an important factor for fish consumption. As mentioned earlier Kenyan society consists of a huge, impoverished underclass, a small but growing middle class and a tiny, rich elite. Most of the fish is only affordable for the middle- and high-income groups because of their relatively high prices. Beside the rich elite, tourists and expats also belong to the high-income group. High-income groups are mostly located in Kenyan cities.

3.3.4 Younger versus older generation

In Kenya there is a difference in fish consumption between generations. The younger generations grow up with fish consumption as part of their eating habits due to their increased awareness of fish as protein source. From a young age onward fish is available for this group. The older generation Kenyans, who are not from traditional fish producing areas, did not grow up with fish as protein source. As a result they are not familiar with consuming fish and continue to prefer meat. According to the Kenyan age pyramid in Figure 6, the median age lies around 18.9 years. Where older generations are decreasing, high birth rates (around 30 per 1,000 a year) help realising the new generations familiar with fish in their eating habits who will regularly prefer fish over meat.

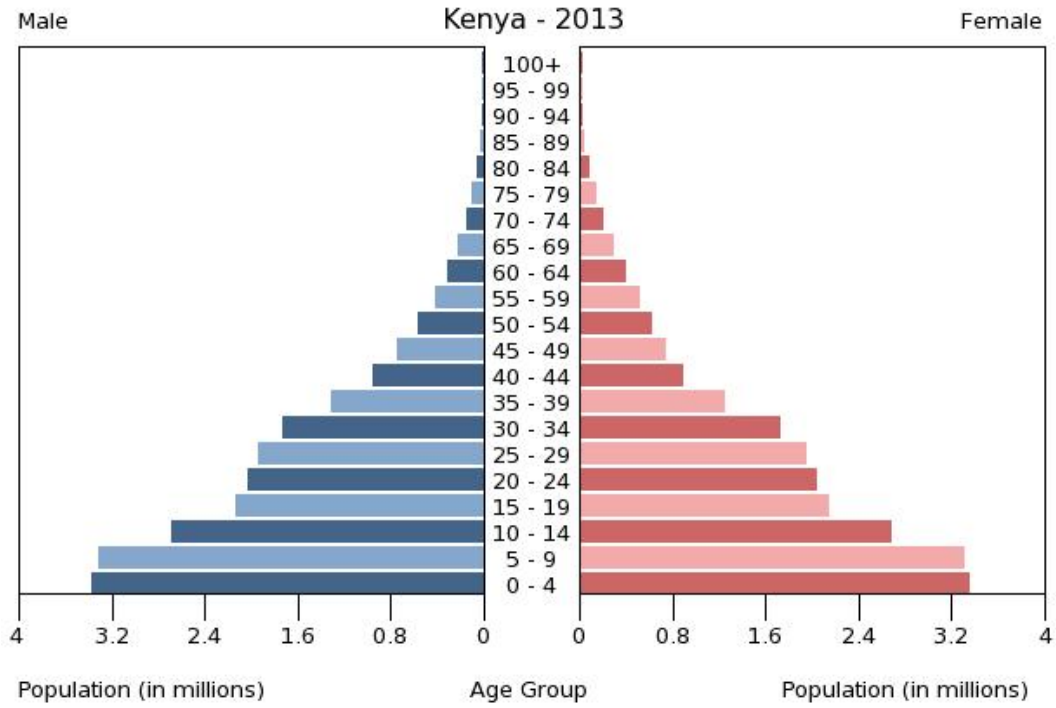


Figure 6 *Age pyramid of Kenya*
Source: CIA, 2013.

3.4 Market segments

Important segments for tilapia and catfish will be discussed based on the main markets for fish that were described earlier. Per market channel segments are distinguished. Finally, the main requirements and an indication of the growth potential of the market segments will be provided.

3.4.1 Local Markets

Large city markets					
	Product	**Size (in gr.)**	**Price (in KES/kg)**	**Channel**	**Consumers**
Tilapia	Whole fresh	>350	310-350	Hotels/restaurants/ retail/butcheries	Expats/high and upper middle income
	Fresh fillets[2]	~80-100	780-800	Hotels/restaurants/ retail/butcheries	Expats/high and upper middle income
Catfish	Whole fresh	>500	300-340	Hotels/restaurants/ retail/butcheries	Expats/high and upper middle income

Large city markets
In almost each of Kenya's 47 counties there is a large city market. These large city markets first of all act as wholesalers selling fish to different market channels. Fish is also sold directly to end consumers. These end-consumers are mainly high- and upper-middle-income customers. Most fish sold on these markets is wild caught. This fish is delivered to the different sellers at the city market by agents who buy the fish from fishermen near Lake Victoria.

[2] Tilapia fillets are estimated 45-50% of a whole fish (2 pieces).

In the large city markets tilapia are sold as fresh whole fish or fresh fillets. Filleting is done on location. The fresh whole tilapia and fresh fillets go mainly to restaurants and retail, but also to high-income groups and expats, who want to prepare the fish at home. Tilapia sold on the bigger city markets weigh above 350 grams. Retail markets and restaurants prefer to sell plate sized fish. Depending on which big city market the fish is bought, fresh whole tilapia are sold for KES310 to 350 per kg. Fresh tilapia fillets are sold around KES800 per kg. Market sellers can provide discounts to regular buyers. The waste products after filleting the tilapia are sold to low- and middle-income groups to make soup (head and skeleton for around KES50 per kg), to feed producers for feed production (skin for around KES250 per tonnes of fish) or to Chinese importers for suture threat (fish maws for around KES1,500 per kg). At the moment the city market fish prices increase by KES10-20 per year. The market demand is large enough for the market to absorb tilapia at these higher prices.

Catfish is only sold on a small scale on the large city markets. Only whole fresh catfish between 500-700 grams were found.

Large City market in Nairobi. Picture made by Mike Turenhout (2013).

Local district Markets				
	Product	**Size (in gr.)**	**Price (in KES/kg)**	**Buyers**
Tilapia	Fried whole	200	200	Middle income/low income
		600	450	Middle income/low income
	Fried piece	50-100	50-100 per piece	Low income
	Smoked whole	200	200	Middle income/low income
		600	450	Middle income/low income
	Sun-dried whole	200	200	Middle income/low income
		600	450	Middle income/low income
	Fresh whole	250	150	Middle income/low income
		600	350	Middle income/low income
	Fresh piece	<100	20-40 per piece	Mostly rural low income
Catfish	Smoked whole	200-250	200-250	West Kenyan people/middle income/low income
	Fried whole	700	500	West Kenyan people/middle income/low income
	Fried piece	100	50-100 per piece	West Kenyan people/middle income/low income
	Fresh whole	700	350	West Kenyan people/middle income /low income

Local district markets

Local district markets can be found in every district. They do not act as wholesalers like large city markets. They target middle- and low-income groups. Fish sold on these markets is both wild caught and farmed. On local markets around traditional production areas the supply of tilapia and catfish is much bigger than in other areas. In Nairobi no or only a few stands on the local district markets are selling fish. On the local district market in the traditional production area of Kisumu, 15% of the markets consist of stands and eateries for fish. Beside tilapia and catfish you can also find Omena and undersized Nile perch on these markets. The fish is bought from the larger city markets, middleman or directly from the fishermen/farmers.

Tilapia are sold mostly fried, smoked and dried, but also fresh. Tilapia from the local district markets are sold in different size categories and per piece. Most of the time 3 to 4 different size categories are mentioned. Size categories are not measured but estimated. The sellers don't have the instruments to base the categories on exact weights or sizes. The small size is around 200 grams, where the biggest sizes are around 600 grams. For fried tilapia prices range from KES150-450 per piece for respectively sizes between 200 and around 600 gram. Smoked and dried tilapia are also sold per piece for around the same prices as the fried tilapia. Fried tilapia are chopped into smaller pieces (50-100 grams a piece) to reduce the price of tilapia. As a result, tilapia is also available for low-income groups (KES50-100 per piece). For this low-income group also <100 grams whole fresh tilapia are sold. Because of the small size of the fish people can also consume the fish bones after cooking/frying.

The local district markets are the main markets for the sale of catfish as almost all available catfish are sold on these markets. Catfish are eaten by people who are already familiar with this fish (most of the time people from West Kenya). Also in the bigger cities like Nairobi, it are mainly the West-Kenyans who buy the catfish. Kenyan consumers like neither the head of a catfish nor the name. That's why farmers prefer selling the fish as Clarias. Catfish is sold mainly as a smoked and fried product, but also fresh in markets around big lakes and rivers (like Kisumu). The smoked catfish, folded in a circle, are relatively small (about 200-250 grams) and called odol. The price for an odol is between KES200-250. Fried catfish (500-700 grams) are most of the time sold by piece (5-7 pieces per fish). The head is removed. A piece of catfish is around KES50-100.

3.4.2 Retail Market

Upper level retail markets				
	Product	**Size (in gr.)**	**Price (KES/kg.)**	**Buyers**
Tilapia	Whole fresh	>500-1,000	500	High income/expats/tourists
	Fresh fillets	~80-100	650	High income/expats/tourists
	Frozen fillets	~80-100	1,075-1,150	High income/expats/tourists
	Breaded fillets		910	High income/expats/tourists
	Fried whole	~300-500	900	High income/expats/tourists
Catfish	N/A		-	-

Upper level retail markets

Upper level retail markets can be found in the bigger cities in Kenya. Upper level retail markets target high-end customers who prefer a high variety of fish products including imported products. Imported fish are competing with domestic fish at upper level markets. Examples of upper level retail markets are Nakumatt and Tuskys.

Tilapia are mainly offered fresh whole, fresh filleted and frozen filleted. Sizes vary between 500 grams and 1 kg. Also breaded fillets and fried whole tilapia are available in this market. Prices for fresh whole tilapia are around KES500 per kg for above mentioned sizes. Fresh fillets are sold for around KES650 per kg. On several occasion we found that these tilapia fillets were in fact Nile perch fillets. Also frozen fillets are offered between KES1,075 and KES1,150 per kg.
Catfish is not sold in upper level retail markets.

Middle class retail markets				
	Product	**Size (in gr.)**	**Price (KES/kg.)**	**Buyers**
Tilapia	Whole fresh	>300	500	Middle income/high income
	Frozen fillets	~80-100	1,075	Middle income/high income
Catfish	N/A		-	-

Middle class retail markets
Middle class retail markets are less expensive than the upper level retail markets. They target high and middle income customers. Where imported fish are competing with domestic fish at upper level markets, there is less competition with domestic fish in middle class markets.

Tilapia are sold as whole fresh or as frozen fillets. Middle class retail markets sell mainly fresh whole fish between 250-300 grams and frozen fillets from Alpha fine foods.
Catfish is not sold in middle class retail markets.

Lower level retail market				
	Product	**Size (in gr.)**	**Price (KES/kg.)**	**Buyers**
Tilapia	N/A	-	-	Middle income
Catfish	N/A	-	-	Middle income

Lower level retail markets
Lower level retail markets are small and regularly in poor conditions. This market target middle income customers. In most of the lower level retail markets only meat and poultry are available. However, around traditional production areas small amounts of fried and whole fresh tilapia can be found. Nevertheless fish like tilapia are potentially interesting.

3.4.3 Restaurants and hotels

High-end restaurants and hotels				
	Product	**Size (in gr.)**	**Price (in KES)**	**Buyers**
Tilapia	Complete meal with fillets or whole fish, vegetables and rice/potatoes	>300 (for whole)	~900-1,200 per meal	Tourists/expats/high income
Catfish	Complete meal with most of the time fillets vegetables and rice/potatoes	>300 (for fillet)	~900-1,200 per meal	Tourists/expats/high income

High-end restaurants and hotels
High-end restaurants and hotels can be found in the bigger cities in Kenya. They target tourists, expats and high-income Kenyans that make frequent use of these establishments. In the high-end restaurants domestic fish also competes with imported fish products. Whole fish is mostly bought at a large city market. Fillets are mostly bought from importers like Alpha Fine Foods and Farmer's Choice. These fillets are imported from China because they are uniform in size, which enables restaurants and hotels to offer uniform portions.

In high-end restaurants and hotels tilapia are most of the time presented as whole plate-sized fish (>300 grams) or fillets. For hotel and restaurant visitors it is an advantage if a variety of dishes are provided on the menu. Prices around KES900-1,200 per dish are normal for these markets. Tilapia are bought from the local markets or directly from farm gate or fish landing site. Farm gate prices are around KES210-500 per kg and capture fishery prices around KES280-500.

Catfish is also offered in high-end restaurants and hotels. However, the availability of catfish is minimal. Catfish fillets of around 300 grams are served in different dishes around KES900-1,200.

Local restaurants and hotels				
	Product	**Size (in gr.)**	**Price (in KES)**	**Buyers**
Tilapia	Fried	300-400	~550-650	Middle income/expats/tourists
	Stewed	300-400	~550-650	Middle income/expats/tourists
Catfish	Fried	300-400	~500-600	Middle income/expats/tourists in traditional fish production areas

Local restaurants and hotels

Local restaurants and hotels can be found throughout Kenya. They target tourists, expats and middle income Kenyans. While imported fish is competing with domestic fish in high-end restaurants and hotels, this does not occur in local restaurants and hotels. Local restaurants and hotels buy their fish from the larger city markets, from middlemen or directly from fishermen/farmers.

In local restaurants and hotels mainly two types of tilapia dishes are sold, namely fried tilapia and stewed tilapia. The sizes of this tilapia are around table size (300-400 grams) and consumed mainly by middle income consumers, but also expats and tourists. The average prices for fried as well as stewed tilapia is KES550-650.

Catfish was only found in local restaurants and hotels in traditional production areas. In Kisumu fried 300-400 grams catfish was offered in restaurants for around KES500-600.

Stewed tilapia. Photo made by Mike Turenhout (2013).

Food stall				
	Product	**Size (in gr.)**	**Price (in KES)**	**Buyers**
Tilapia	Fried whole	200	200	Middle income/low income
		600	450	Middle income/low income
	Smoked whole	200	200	Middle income/low income
		600	450	Middle income/low income
	Sun-dried whole	200	200	Middle income/low income
		600	450	Middle income/low income
Catfish	Fried	700	500	West Kenyan people/middle income/low income.
	Smoked	200-250	200-250	West Kenyan people/middle income/low income.

Along the many roads there are small food stalls selling fish. These food stalls cater for the same clients as the local district markets and sell identical products.

3.4.4 Butcheries

High-end butcheries				
	Product	**Size (in gr.)**	**Price (in KES)**	**Buyers**
Tilapia	Frozen whole	>500	~600	Expats/high income
	Frozen fillets	~80-100	~980	Expats/high income
	Fresh whole	>500	~700	Expats/high income
	Fresh filleted	~80-100	~800	Expats/high income
Catfish	Frozen whole	500-700 grams	~650	Expats/high income

High-end butcheries
High-end butcheries can be found in the bigger cities of Kenya. High-end butcheries sell fresh and/or frozen cuts of animal products. Besides meat, poultry and eggs they also sell fish. Most important costumers for high-end butcheries are expats and high incomes. In the high-end butcheries domestic fish need to compete with the meat and poultry, but also with a high range of imported fish products. High-end butcheries buy their fish from the large city markets or directly form fishermen.

Tilapia are sold as whole fresh and fresh filleted, but also as whole frozen and frozen filleted. The tilapia need to be >500 grams. Also at High-end butcheries there's a presumption that the sold fresh tilapia fillets were in fact Nile perch fillets. Catfish is only found incidentally in this market whole frozen (KES650 per kg). Sizes are around 500-700 grams.

Regular butcheries				
	Product	**Size**	**Price**	**Buyers**
Tilapia	N/A	-	-	Middle income/low income
Catfish	N/A	-	-	Middle income/low income

Regular butcheries
Regular butcheries can be found throughout Kenya. Regular butcheries cater for middle income and low-income customers. Most of the time they only sell meat, poultry and eggs. In these butcheries fish is not yet a standard product.

3.4.5 Trends for tilapia and catfish

Several trends can be identified for tilapia in the market segments that were discussed in Section 3.4.

- In almost all segments the demand for fish is increasing. However, for most segments this increase is not expected to be exponential. The main reason for this is that the majority of fish is currently being sold to high- and middle-income groups. This may not completely satisfy their demand, but as a consequence it is not expected that the demand of these groups will grow exponentially. This could be different for low-income groups. More people become familiar with fish consumption because of the growing awareness of fish as protein source. This awareness is growing because of the increased availability of fish (products) in the Kenyan markets. In the larger city markets refrigerators are available to store unsold fish products. Most of the time these are idle. This indicates that most of the time the fish demand on the bigger city markets is higher than the fish supply. In restaurants fish consumption is growing. While five years ago fish was only known in traditional fish areas, nowadays it's popular in most parts of Kenya thanks to the introduction of aquaculture via FFESP; Retail markets regularly increase their fish prices to prevent empty shelves. Finally, the number of middle class retail markets selling fish is increasing.
- Demand for plate-sized fish is expected to grow gradually. A faster growth is expected in those rural and urban areas where there is a high potential for small tilapia (<100 grams) for low-income groups. Fish of this size are affordable for low-income groups. At the moment the demand for this size of fish is growing exponentially and is already larger than the market for the bigger plate-sized tilapia.

- In the upper level segments there is a trend for increasing the diversity of fish. The high-end restaurants and hotels are offering more fish dishes for their customers. By providing a higher diversity in fish dishes, tilapia and catfish can improve their competiveness with the high variety of meat dishes. Also the upper level retail markets are increasing their fish variation in the shelves. By offering more value added fish products fish can be more compatible with the huge supply of meat.
- In the short term it is not expected that fish will be sold in the lower level retail markets and regular butcheries.
- In the Kenyan market catfish is not as popular as tilapia. At the present there is 10-15 times more tilapia on the market than catfish. There's no indication that the consumption gap between tilapia and catfish is decreasing. Catfish is not a popular as tilapia due to a lack of promotion. From interviews it appears that if promoted well, catfish has a market potential as large as tilapia.

4 Aquaculture growth potential

This chapter covers the growth potential for aquaculture in Kenya. Potentials, production systems and main characteristics of these production systems in aquaculture are discussed.

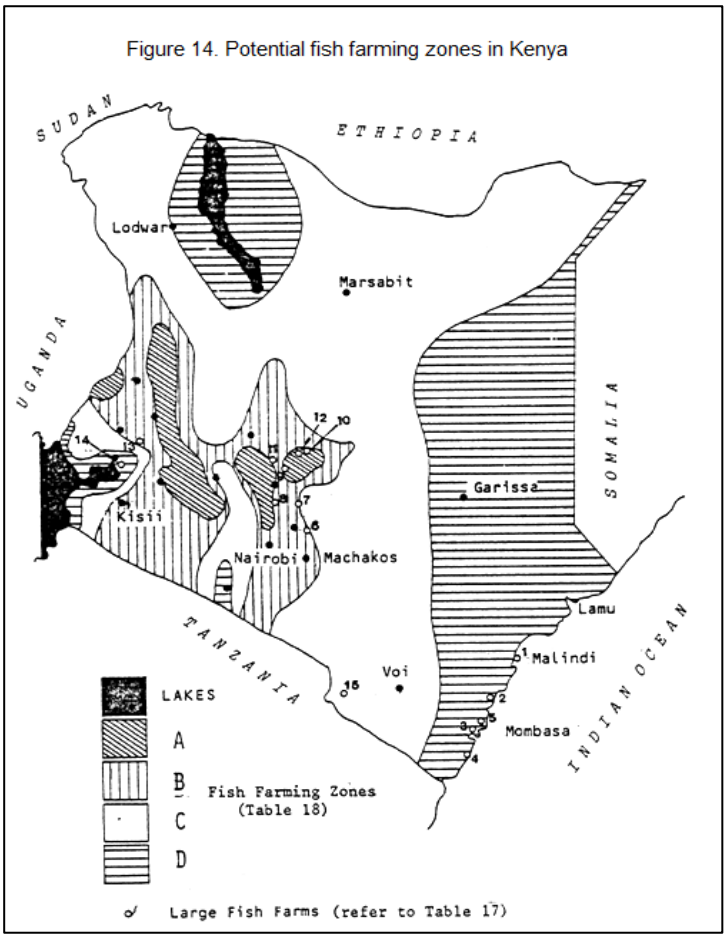
4.1 Potential

Kenya is endowed with climatic and geographic conditions favourable for a variety of aquaculture investments. Both cold water and warm water, freshwater and marine water aquaculture can be developed depending on the location. In 1982 the FAO conducted a study about the possibilities for aquaculture development in Kenya. Some of the results of this study are presented in Table 5 and Map 1. Both table and chart indicate which species can be cultured in different areas of Kenya. As these fish species are still being cultured it may be assumed that the suitability of each zone has not changed over the years.

Table 5
Kenya provinces and suitability for aquaculture

Zone	% of total	Common mean air temp. range	Fish species
A - Highlands	3.2%	5-22 °C	Trout
B - Central Province and Rift Valley	11.6%	10-26 °C	Trout Common carp Tilapia
C - Plains and Northern Province	51.9%	15-30 °C	Common carp Tilapia Catfish
D - Coastal and Lakeshore Belts	33.3%	22-34 °C	Common carp Chinese carps Catfish Freshwater prawns Shrimp

Source: FAO (1982).



Map 1 *Potential fish farming zones in Kenya (corresponding to Table 5)*

Estimates by the fisheries ministry indicate that Kenya has about 1.4bn hectares suitable for fish farming. From these, the country could generate USD10bn (KES750bn) from the sale of fish. In 2009 the Kenyan Government started a Fish Farming Economic Stimulus Programme (FFESP) to alleviate poverty and create food and employment for rural populations. Before the Government started the FFESP, there were only a few aquaculture farms in Kenya. In 2002, there were only 4,742 fish farmers with 8,026 fish ponds in the country. The total of 722 ha of aquaculture surface realised 4,220 tonnes of farmed fish (2% national fish production). The FFESP changed Kenya in three years' time into an important fish producing and fish eating Nation in Africa. The FFESP was implemented in high aquaculture potential areas, because of the need for water resources as springs, wetlands, rivers, water reservoirs and temporary water bodies. The chosen areas were Western Kenya, Nyanza, parts of Rift Valley, Easter, Central Kenya and coast regions.

The FFESP activities included construction of fish ponds and dams in fresh water areas, construction of hatcheries, production of fingerlings, stock of the ponds with fingerlings, fish seed and feed production, fish harvesting and marketing, participants trainings of fish farming and best fish business practices.

The FFESP project triggered subsidised farmers to expand their farms and new farmers to dig their own ponds for aquaculture. However, many subsidised farmers have quitted after the project. Table 6 shows the impact of FFESP on the aquaculture farms in Kenya. Not all farms are registered in Kenya. The numbers may be higher than given.

Table 6

Impact of the FFESP on the aquaculture farms in Kenya

	2002	2012
Aquaculture Area	722Ha	14,076Ha
Aquaculture Production	4,220 tonnes	19,337 tonnes
National fish production	2%	9%
Fish ponds	8,026	46,824 in 160 constituencies

Source: Directorate of Aquaculture Kenya (2013).

From all countries in Kenya the Western province has seen the highest adoption rates and new ponds built since the implementation of the FFESP. This may be because this province lies in the Lake Victoria Basin and the people have always had a strong fish culture- eating and fishing.

4.2 Production systems

Aquaculture production systems in Kenya are classified in three levels of management:

- Extensive systems with very little or no inputs in natural and man-made water bodies contribute to about 10% of the total aquaculture production (Ngugi and Manyala, 2009). They are mostly cages.
- Semi-intensive systems contribute to the bulk of aquaculture production (70%). Ponds are fertilised (inorganic and organic fertilisers) to enhance natural productivity and fish are supplementary fed using cereal bran and other local feedstuffs. Tilapia and catfish are produced in monoculture (or in polyculture to control the prolific breeding of tilapia) in earthen ponds or in cages.
- Intensive systems are few but are projected to increase in the future and to contribute far more significantly to the production (Ngugi and Manyala, 2009; Rothuis et al., 2011). Intensive practices involve the use of various types of tanks, and sometimes cages, as holding units. Systems are stocked at high densities and complemented by exogenous feeding, aeration, and water filtration and reuse in the case of Recirculating Aquaculture Systems (RAS). Production of intensive systems ranges from 1 to 80 tonnes/ha/year (Rothuis et al., 2011).

Almost all aquaculture in Kenya is extensive or semi-extensive. Intensive aquaculture is rare due to high costs and knowledge needed. Because of the increased riparian land prices around cities and major towns farmers are warming up to intensive RAS farms. For most of the farms a water source is necessary to supply the farms with water. That's why you can find most of the farms around lakes and rivers.

Earthen Fish ponds in Kisumu. Photo made by Mike Turenhout (2013).

Table 7 shows the national distribution of fish culture systems in Kenya for 2009. The area covered is also mentioned in this table. There's no data available about other aquaculture systems as RAS and cages. This indicates that there's enough room for development in the Aquaculture sector (Munguti et al., 2003).

Table 7

Number of farmers in the main aquaculture provinces

Province	No. of Farmers	Ponds		Dams		Tanks		TOTAL	
		No.	Area	No.	Area	No.	Area	No.	Area
Coast	184	434	58,698	-	-	9	180	434	58,698
Eastern	538	752	423,628	20	113,018	3	118	775	536,764
Nyanza	1,360	2,070	453,423	15	41,220	1	27	2,086	494,670
R. Valley	1,242	1,531	761,856	129	3,385,298	65	4,015	1,725	4,151,169
Western	1,665	2,720	549,486	-	-	-	-	2,720	549,486
Total	**6,328**	**9,116**	**2,753,696**	**331**	**5,473,346**	**161**	**23,085**	**9,608**	**8,250,127**

Source: Munguti et al. (2013).

Most of the aquaculture farms are monoculture tilapia farms (75%), followed by polyculture catfish and tilapia farms. trout takes about 5% of the total production and the remaining 5% consists of catfish monoculture.

4.3 Main characteristics production systems

The main used aquaculture production systems in Kenya are water impoundments, ponds, tanks and cages. Characteristics of the main used production systems are explained below, followed by information about water consumption, energy consumption, cost price of produced fish and sustainability issues for some production systems.

4.3.1 Productions systems

Water impoundments

Natural water bodies (lakes, rivers) and man-made water impoundments (dams and reservoirs) are stocked with fish with little or no input as feed or fertilisers. The production of these systems is low, relying on natural productivity of the culture environment and is estimated between 0.5 and 1.5 tonnes/ha/year (Rothuis et al., 2011). A hundred and twenty-four (124) reservoirs with an area of 744,000 m^2 were used to farm fish in 2011 (Ministry of Fisheries Development, 2011). Main cultured species are tilapia, catfish and carp.

Ponds

The Kenyan Ministry of Fisheries Development started in 2009 a countrywide programme to build small-scale fish ponds as well as developing hatcheries (AquaCRSP, 2010).

Ponds of different sizes are found in Kenya depending on purpose. They are in most cases earthen ponds and in some areas plastic liners are used to reduce the seepage. Family ponds are smaller with sizes ranging from 300 to 3,000 m^2 in small farms (Ngugi et al., 2007). Most ponds have a rectangular shape, with a water depth between 0.80 to 1.2 m. (40 to 70 cm at the shallow end). Inlet and outlet canals are made of PVC pipes, and in some cases concrete monks are used for the water level control and drainage at harvest.

In semi-intensive ponds with fertilisation and feeding, tilapia fingerlings of 10-20 g, preferably males, are stocked at a density of 1 to 4 fingerlings/m^2 depending on the level of management and cultured for a full production cycle (6 to 8 months) (Ngugi et al., 2007). When catfish are stocked in polyculture with tilapia to control their reproduction, 10% as catfish are added.

Catfish fingerlings to be reared till the market size, are stocked at about 2 to 10 per m^2. For a 6- to 9-month growing period, these rates produce fish of about 500 g and 200-250 g, respectively, depending on water temperatures (Ngugi et al., 2007).

The productivity of semi-intensive ponds ranges between 1 and 3.5 tonnes/ha/year (AquaCRSP, 2010) and between 1.5 and 2 tonnes/h/year in polyculture systems of tilapia, catfish and carp (Ngugi and Mayala, 2009 in Rothuis *et al.*, 2011). Some pond farms integrate fish production with small animal production to fertilise the ponds using the wastes from animals.

Tanks

Flow Through Systems (FTS)

Flow Through Systems are mainly used for the intensive farming of rainbow trout. Fish are kept in raceways made of a channel or tank with a continuous flow of water (Rothuis et al., 2011). For linear raceways, a minimum velocity of incoming water is set at 0.015m/s.

FTS using borehole water is also used to produce tilapia fingerlings at Suleiman Masoud farm in Mtwapa (Rothuis et al., 2011).

The grow-out phase at Jambo Fish is done in a flow through system. Fish are kept in concrete tanks in which fresh water is introduced every day to maintain a perfect water quality. The Feed Conversion Ratio (FCR) of about 0.9 is obtained using high quality imported feeds (Skretting feeds). Life catfish are sold at a size between 800-1,200 grams (Jambo Fish Farm website).

Recirculation Aquaculture Systems (RAS)

During the 3-year incentive (2009-2012) period of the FFESP, three hatcheries using the RAS technology were constructed by private sector players to intensify aquaculture production levels countrywide (Anonymous). They are located at:

- Kiambaa (Jambo Fish Farm),
- Juja (Samaki Tu Fish Farm) and,
- Kisumu Rural (Thinqubator Fish Farm).

Recirculation Aquaculture System. Photo made by Mike Turenhout (2013).

Jambo Fish recirculation systems are constructed using polyester, stainless steel, PVC, polypropylene, etc. The system is equipped with mechanical and biological filtration. The different sections of the hatchery consist of small individual recirculation systems (incubator/hatching system, fingerling, juvenile and brood stock section) enabling the control of both the quality and temperature of water.

Jambo Fish uses borehole water and collects rain water to minimise the introduction of diseases (Jambo Fish Farm website). The farm is specialised in the production of Natural (without hormones) Male tilapia and African catfish. The farm is promoting fish production in greenhouses in integration with crop production recycling wastewater from fish production.

Cages

Cage farming is not well developed in Kenya. Efforts to develop cage farming have been hampered by the lack of appropriate feeds, the lack of quality fingerlings, the presence of predators, the theft, the lack of proper materials for cage construction, the competing price of wild caught fish, the lack of national aquaculture policy and public concern of long-term environmental and ecological sustainability of cage-farming (Charro-Karisa et al., 2009). Under the EU funded BOMOSA cage culture project, pilot studies on cage-farming of tilapia have been conducted in Kenyan waters of Lake Victoria and in satellite dams within the Lake Victoria catchment area.

In Harambe dam (Nyanza region), male tilapias were stocked in cages of 0.64 m^3 at an average stocking weight of 20 grams at a density of 203 fish m^3. At harvest, the fish had an average of 285 grams bodyweight after 7 months of growth. Survival was above 90%. Some cage farmers do not feed their fish properly and stock them at lower densities of 100 fingerlings per m^3 leading to yields between 14-16 kg per m^3 at 150-200 g body weight in 4-6 months.

Hapas

Hapas, a fine-mesh net-cage, are used during the nursing of tilapia and catfish fry in ponds until they are old enough to be released into the open pond.

4.3.2 Water consumption

In Kenyan highlands, temperature can be cold for the farming of warm water fish species, namely tilapia and catfish. In some areas of the country water can also be scarce depending on climatic conditions. In these areas, RAS can be suitable farming systems to control water temperature and water quality. Furthermore RAS use less water compared to other production systems. Extensive fish ponds consume around 45 m^3 of water per kg of fresh weight fish produced. In super-intensive recirculation system for catfish fed a high protein diet, water consumption is only 0.5 m^3 of water per kg of fresh weight fish produced (Verdegem et al., 2006). A major proportion of the water consumption in pond aquaculture is due to surface evaporation and seepage.

4.3.3 Energy consumption

The lack of energy is a handicap for many farm operations in Sub Saharan African countries including Kenya. The high cost, inaccessibility in rural farming areas, regular outages are the main constraints. Energy is needed for water pumping, recirculation and aeration in hatcheries and RAS based farms. Commercial fish farms possess electric generators which are expensive to operate and increase the production costs. Solar energy has been suggested for water pumping in hatcheries. Green houses integrating aquaculture are also tested in a pilot stage near Nairobi. Three companies have teamed up to promote greenhouse fish farming: Fleuren & Nooijen, Jambo Fish and Charles Gerald Kenya (a greenhouse company). By rearing fish in tanks, placed inside a greenhouse, the temperature of the water can be regulated to enhance growth (New Agriculturist, 2012).

4.3.4 Cost price of produced fish per system

Most fish farms do not make records of production. The cost price of products is therefore difficult to estimate unless production data and costs can be obtained from surveys and calculated from studies investigating a given type of production system. According to Jambo Fish it costs KES200 (USD2.30) to grow 1 kg of cat fish, which is sold about KES300 (USD3.5) in the market. Jambo Fish is providing fingerlings to farmers for KES10 (USD0.12) each (New Agriculturist, 2012).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5 Potential constraints for aquaculture development

Aquaculture success is dependent on different boundary conditions. In this chapter conditions as feed, seed and transport facilities, are discussed. This chapter ends with some information about import regulation in Kenya.

5.1 Feed

Feed use and availability

In Kenya there is a high demand for good quality fish feed. There are only a few feed manufacturers who can provide basic fish feed. The government has provided different aquaculture clusters (group of farmers) a miller in order to counteract the feed problem. These cluster groups can buy their own key ingredients and create their own fish feed.

The quality of the available fish feed in Kenya is low. Approximately 50% of the commercial animal feed does not meet the Kenya Bureau of Standards' (KEBS) standard for crude ash (mineral content) (+- 50%) and approximately one third of the animal feed does not meet the KEBS standard for crude protein (+- 30%) (BLGG 2013). Fraud in key feed ingredients is a common phenomenon. The key ingredients are mixed with fake ingredients as sawdust and sand to press the supply costs. Beside the fraud, poor training of the feed manufacturers, failure to use laboratories for nutritional analysis as well as a weak legal and institutional framework to enforce quality assurance are responsible for the insufficient feed in Kenya. The Government has realised a KEBS standard for tilapia fish feed and is finalising the standard for catfish feed at the moment. In this way they hope to stimulate fish feed producers to guarantee good quality fish feed. However, the manufacturers have the experience that there's a minimal control on (fish) feed.

The use of animal by-products is interesting for creating high protein feeds. Important animal products already used in Kenya are Fresh Water Shrimps (*Caridina nilotica*), Omena fish (*Rastrianeobola argentae*), meat and bones from slaughterers and Nile tilapia (*Oreochromis niloticus*) trash (mostly imported regionally). The crude protein content for Fresh water shrimps for example is 635 grams per kg and for Omena fish 551 grams per kg (Munguti et al., 2012). For plant based proteins sunflower (*Helianthus annuus*) and cotton (*Gossypium spp*) seed cakes provide the best option (259 grams per kg and 388 grams per kg respectively).

Munguti et al. (2012) presented a checklist of commonly utilised feed ingredients in Kenya, Tanzania and Rwanda in his article (Table 8). Most of the feeds were found in all countries except a few that were unique to one or two countries. 'Na' in the table means that the feedstuff may be sourced off farm, off field or the household at no defined costs.

Table 8

Checklist commonly utilised feed ingredients in Kenya, Tanzania and Rwanda.

Ingredients	Country					
	Kenya		Rwanda		Tanzania	
	Occurence	Cost USD	Occurence	Cost USD	Occurence	Cost USD
Fish Meal (*Rastineobola argentea*)	x	0.76			x	0.4
Shrimp Meal (*Caridina nilotica*)	x	0.5			x	0.4
Cow (*Bos taures*) blood meal	x	0	x	0.35	x	
Cow (*Bos taures*) offal			x	0.88		
Cow (*Bos taures*) bone meal	x	0.63				
Cassava (*Manihot esculenta*) leaves	x	N/A		N/A	x	N/A
Cassava (*Manihot esculenta*) flour					x	0.07
Premix	x				x	
Soya bean (*Glycine max*) flour	x	0.7				
Rice (*Oryza sativa*) bran	x	0.08	x	0.09		0.09
Rice (*Oryza sativa*) polishings	x	0.16				
Maize (*Zea mays*) bran	x	0.25	x	0.44	x	0.14
Wheat (*Triticum aestivum*) bran	x	0.08	x	0.53		0
Wheat (*Triticum aestivum*) pollard	x	0.15				
Maize (*Zea mays*) corn glutten	x	0.78				
Arrow root (*Maranta arundinacea*) leaves	x	N/A	x	N/A	x	N/A
Sweet Potato (*Ipomoea batatus*) leaves	x	N/A	x	N/A	x	N/A
Banana (*Musa paradisiaca*) leaves			x	N/A		
Papaya (*Carica papaya*) leaves	x	N/A	x	N/A	x	N/A
Mchicha (*Amaranthus blitum*)	x	N/A	x	N/A	x	N/A
Gallant soldier (*Galisonga parviflora*)	x	N/A				
Avocado (*Persea americana*)	x	N/A	x	N/A	x	N/A
Lucerne (*Chamaecytisus palmensis*)	x	N/A	x	N/A	x	N/A
Sunflower (*Helianthus annuus*) seed cake	x	0.19			x	0.12
Peanut (*Arachis hypogaea*) cake			x	0.15		
Cotton (*Gossypium spp*) seed cake	x	0.23			x	1.72
Cabbage (*Brassica oleracea*)		N/A	x	0.09	x	0.4
Concentrate			x	0.35		
Kitchen wastes			x	N/A		

Source: Munguti *et al.* (2012).

In Table 9 the main sources of raw materials in feed manufacturing are given. These data from a feed millers' survey in 2009 show that the main import countries for key feed ingredients for Kenya are the region's countries Tanzania and Uganda.

Table 9

Source key feed ingredients Kenya

Raw Material	Source		Source of Imports
	Local (%)	Import (%)	
Maize grain	98	2	Uganda, Tanzania
Maize bran	92	8	Uganda, Tanzania
Maize germ	90	10	Uganda, Tanzania
Maize germ cake	97	3	Uganda, Tanzania
Wheat grain	100	0.4	Not Indicated
Wheat bran	94	5.5	Uganda, Rwanda
Wheat pollard	92	8	Uganda, Tanzania Rwanda
Rice polishing	54	46	Uganda, Tanzania
Rice bran	94	6	Uganda, Tanzania
Soy bean meal	61	39	Uganda, India, Europe
Full fat soybean	100	0	-
Cotton seed meal	17	83	Uganda, Tanzania
Cotton seed cake	67	33	Uganda, Tanzania
Sunflower seed cake	65.5	34	UG, TZ
Copra cake	20	80	UG, TZ
Fish meal	51	49	UG and TZ
Omena	41	59	UG and TZ
Meat and bone meal	87	13	Not Indicated
Blood meal	100	0	-
Bone meal	100	0.4	Not Indicated
Limestone	100	0.1	Europe
Dicalcium phosphate	43	57	Europe, Israel, Belgium, S. Africa, India, China,
Common salt	100	0.1	Russia
Poultry mineral vitamin premix	67	33	Europe, Asia, Brazil, S. Africa, Israel
Molasses	68	32	TZ

Source: KENFAP (2012).

In Kenya, many key ingredients, such as soy bean meal and cow bone meal, are originally by-products. The following, not yet used by products, are maybe useful due to large presence:

- Water hyacinth: water hyacinth is Africa's most invasive water weed. Lake Victoria's ecosystem has been severely affected by the invasion of this weed, which in turn has had a negative effect on local livelihoods. There's plenty of this by-product available.
- Horticulture products: in and around Kenya there are many horticulture farms. By-products from seed breeding or flower cultivation may be interesting by products.

Feed suppliers

The (FFESP) from the government approved 15 Kenyan fish feed manufacturers until 2012. The approved feed suppliers are given in Table 10. However, the manufactured fish feed in Kenya is under-developed. Most of the time only finisher feed is available (26 to 28% crude protein). Some farmers get their fish feed from outside Kenya. Suppliers from Uganda, Norway and the Netherlands were mentioned during the fieldtrip. Other farmers produce their own feed using a small miller (see picture below).

Table 10

Governmental approved fish feed farms in Kenya

Company Name	Address	Region/Location	Director/contact
Sigma Feeds Limited Company	P.O Box 18138 Nairobi	Isinya / Namanga Road, Kajaido	Shah Kirtesh Tel: 0733600895
Uga Fish Feeds Kenya Limited	P.O Box 31833 - 00600 Nairobi	Industrial Area, off enterprise road	Dr. E. Onyango Tel: 020 - 2634081
Economy Farm Products Kenya Ltd	P. O. Box 64983 -00620 Nairobi	Nanyuki Rd. Industrial Area, Nairobi	John Gathongo Tel:+ 254 - 00202013366
Maisha Bora Fish Feeds Limited	P.O. Box 60803 - 00200 Nairobi	Kikuyu, Nairobi	Gilbert Gathuo Tel: 020 - 2511824
Thoyu Feed Limited	P.O. Box 4491- 20100 NAKURU	Sungura road Industrial Area	Priscilla Nduta Tel: +245728427898
Kwality Fish Feeds Limited	P.O Box 71-00200- Nairobi	Off Ruiru Kiambu Road	Peter Cotti Tel: +254721274386
Cottage Feed Industries			
Othaya Fish Feeders S.H.G	P.O Box 82 Othaya	Othaya	Moses Ndungu Tel: 0726849170
Chumara Fish Feeds	P.O Box 353 Chuka	Chuka	John Marangu Tel 0735628971
Bidii Fish Farmers S. H. G	P.O Box 215 Luanda	Luanda- Emuhaya	George Ambuli Tel 0723117706
Osifeeds Ltd	P.O Box 134-00606 Nairobi	Kajiado	Susan Kisoso 0720751859
Zibag Fish producers & Processors	P.O Box 1333, Nyahururu	Nyandarua	DFO Nyahururu Tel 0721622474
Hesao Integrated Fish Farming Organisation	P.O Box 3844 Kisumu	Nyalenda B	Richard Okongo Tel: 0722 620169

Source: Munguti *et al.* (2013).

Small miller for producing fish feed. Photo made by Mike Turenhout (2013).

Table 11 gives fish feed compositions (given as quantitative ingredient declaration) and prices from different feed suppliers. The average Protein content is between 26 and 29%. A single producer also provide high protein (>35%) fish feed for fingerlings. Most of the ingredients are imported regionally. The additives are bought mostly outside Africa. To prevent fraud, processors buy the original products (no powders) and mill themselves to guarantee quality. For the feed in Table 11, the costs of the fish feed key ingredients are KES27 to KES35 per kg. The consumer fish feeds are sold between KES40 and KES85 per kg.

Table 11

Fish feed composition and prices from different feed suppliers in Kenya

Feed Supplier	Ingredients (QUID)	Key product costs (KES per kg)	Commercial price (KES per kg)	Month production
Feed nr 1	mais, filler, soya, omena, additives	35	KES75-85	1,500 kg (during FFESP 8,000 kg) (Pellets)
Feed nr 2	rice bran, cotton seed cake, maize germ, fresh water shrimps, maize meal, omena, limestone, soya meal, additives	28	KES 0	2,000 kg (Mash)
Feed nr 3	rice bran, cotton seed cake, omena powder, additives	-	-	Private purposes (Pallets)
Feed nr 4	rice bran, fresh water shrimps, Wheat pollard, cassava flour, additives	30	KES70	600-800 kg (Pallets)
Feed nr 5	wheat pollard, cotton seed cake, fresh water shrimps, rice bran, additives	27	KES44	Not known

5.2 Fingerlings

In Kenya there are 146 authorised hatcheries. Only 20 of them are producing on a regular scheme. Fifty-five per cent of these hatcheries produce only tilapia fingerlings, 40% produce both tilapia and catfish. In the rest of the hatcheries only catfish fingerlings are grown (Table 12). By hatching and monosexing in hatcheries, millions of potential fish are realised for aquaculture. Hatcheries try to realise over 95% males during the monosex treatment with (methyl)testosterone. However, this percentage is not always realised. There are also farms which do no monosexing. This is because there is lack of knowledge how to do the monosexing or a dislike of using the (methyl)testosterone hormones. Some companies do realise new bloodlines on regular level and use microscopes to control the fry quality, where most of the hatcheries do not. Inbreeding is a huge problem in these hatcheries.

Table 12

Active authorised Fingerling suppliers in Kenya

Organisation	Species Available	Location and Contacts
NARDTC, Sagana-GoK	Catfish and Nile tilapia	Ms. M. Opiyo; 0721782665 Isaac Wanee; 0733958133
Dominion Integrated Farm	Nile tilapia	Susan Odimo; 0714197965 info@domfarms.com
Jewlet Enterprises Limited	Nile tilapia	Enos Were; 0722958524 Jewlet farms@rocketmail.com, Kendu Bay
Kisii Fish Farm (MoFD)	Nile tilapia	Mr. Muga; 0733448048
Rongo Fish Farm (LBDA, MRD)	Nile tilapia	Mr. Luke Olando; 0733455421
Sangoro Aquaculture Research Station (KMFRI, MoFD)	Catfish	Ms. P. Boera 0724879048 Jacob Abwao; 0729256849
Kegati (KMFRI, MoFD)	Nile tilapia	Elijah Kembenya; 0720592917 ekembenya@yahoo.com
Mwea Aquafish, Mwea	Nile tilapia, catfish	Anthony Mwangi; 0726165127
Kamiti Fish & Integrated Farm, Kamiti Nairobi	Nile tilapia, catfish	Susan Njeri; 0722599995
Thogoni Aquaculture Farm, Machakos	Nile tilapia, catfish	Hellen; 0725053279; Titus; 0725769326
Bamburi Nature Trail. Mombasa	Nile tilapia	Sabine Baer; 0722719281 sabine.baer@bamburi.lafarge.com
Susu Green Aqua Farm	Nile tilapia	Titus Ngao Nzomo susugreenaquafarm@yahoo.com
Mabro Fish Farm	Nile tilapia, catfish	Rose Onyango; mabrose11@yahoo.de; 0720191180; 0720191181,Bondo
Hyrax Fish Farm	Nile tilapia	Joe Mwangi; 0722418939 jmwangimax@yahoo.com Nakuru
Green Algae Highland Fish Farm	Nile tilapia, catfish	William Kiama; 0722899904 afridozers@yahoo.com; Kirinyaga West
Jambo Fish Kenya	Catfish, Nile tilapia	Suzan; 0703698699; jambofishkenya@gmail.com
Omega Farm	Nile tilapia	Hensey Tel; 0724874661; Bonnie; 0721307033; Baringo Center El Kokwe; admin@islandcamp.co.ke
Betilex Aqua & Integrated Farm, Kiambu	Nile tilapia, catfish	Elizabeth Njeri Ngugi; 0722703784
Seka Fish Farm, Rachuonyo	Nile tilapia	Phoebe Asiyo; 0724970015 phoebeasiyo@gmail.com
Thoyu Feed Limited, Nakuru	Nile tilapia	Benson Maingi; 0728427898 maingibenson13@yahoo.com

Source: Farm Africa (2013).

Fingerlings are sold for KES4 to KES12 per piece. Markets seem to be regional, where buyers sometime prefer more expensive local fingerlings, than cheaper fingerlings from far away. The fingerlings are most of the time transported by local transport to the aquaculture farms. At the moment there is a high demand for (good) fingerlings in Kenya. Half 2013 the Kenyan government made a stocktaking of the number of stocked and required fingerlings for the FFESP programme. Table 13 shows that at that moment still 9,156,000m fingerlings were required for the government programme.

Table 13

Overview of stocked and required fingerlings for the governmental FFESP programme

Province	No. of constituencies	No. of ponds	No of ponds stocked	No. of fingerlings required for target ponds	No. of fingerlings stocked	Gap on fingerlings requirements
Central	29	8,700	7,458	8,700,000	7,458,000	1,242,000
Coast	15	4,200	1,405	4,200,000	1,405,000	2,795,000
Eastern	29	8,400	5,440	8,400,000	5,440,000	2,960,000
Nyanza	31	9,300	8,462	9,300,000	8,462,000	838,000
Rift Valley	32	9,415	8,301	9,415,000	8,301,000	1,114,000
Western	24	7,200	7,134	7,200,000	7,134,000	66,000
Nairobi	2	600	459	600,000	459,000	141,000
Total	**162**	**47,815**	**38,659**	**47,815,000**	**38,659,000**	**9,156,000**

Source: e-mail from Susan Otieno (2013).

5.3 Main transport facilities in East Africa with a focus on Kenya

Fish for domestic consumption is transported in different ways compared to fish that is exported within the East African Community (EAC) or to markets in the Middle-East or Europe. In this section the main transport facilities in Kenya and main import regulations for the EAC are described.

Roads

The length of the trunk network is more than adequate. Even if Kenya's road density indicators look relatively low by some standards, the trunk network provides basic regional and national connectivity, linking the capital to the coast, to international border crossings, and to provincial capitals in the interior (AICD 2010).

Before independency the port city Kisumu served as a trading hub for East Africa. Transport infrastructure connected Kisumu to the rest of Kenya and East African countries. Kisumu is served by four highways and has railways to other East African countries like Uganda and Tanzania. The facilities are under-invested and should be improved. In and around Nairobi road congestion is a major issue. The government is investing in better roads. At the moment they pay the Chinese to construct better roads in Kenya. This construction will improve the transport by truck within Kenya and around East Africa.. Transit and export cargo destined for regional markets mostly move by road and cross the border in the most important border posts Malaba (to Uganda) and Namanga (to Tanzania). The main roads in Kenya are provided in Appendix 2.

The Netherlands Embassy in Kampala co-finances the Uganda programme of Trade Mark East Africa. Trade Mark facilitates (intra-)regional trade through one-stop border posts and harmonisation of trade regulations. Trade mark helps by making laws compliant with the requirements of the East African common market thereby improving the mobility of goods and services across countries in the EAC.

Rail

Railways throughout Kenya are old and underutilized. Owing to deterioration of the infrastructure, freight traffic on the rail corridor has declined to less than 1m tonnes per year and handles less than 6% of the cargo passing through the northern corridor that links Kenya, Uganda, Rwanda, Burundi, the Democratic Republic of Congo, parts of Tanzania, Southern Sudan, and Ethiopia (AICD 2010). The Kenyan rail corridor can become of strategic importance to the region. Linking the port of Mombasa to Nairobi and continuing onward into Uganda, it is a key conduit for bulk freight, easing pressure and providing additional capacity along the northern corridor. However, the rails are built too close to each other (old British railroad system) to transport many heavy cargoes. In recent years foreigners tried to improve the railways, but were thwarted by Kenyan truckers who were afraid of losing their jobs. Within the EAC there are plans for a railway line that will connect Kenyan coastal city of Mombasa with Kampala Uganda all the way to Kigali in Rwanda (see East African Community).

Ports

Mombasa is one of the largest and busiest ports in Africa. With almost 0.5m TEUs (20-foot equivalent units) and 3.7m tonnes of cargo handled each year, Mombasa is the second-largest port in Sub-Saharan Africa after Durban in terms of tonnage and containers handled. With Dar Es Salaam, it is one of the key trading centres for East Africa. The port is also a natural transhipment centre for East Africa, with 27,288 TEUs of inbound transhipment and approximately the same amount outbound per year. However, Mombasa is straining to maintain that role because of significant capacity constraints. In terms of performance indicators, Mombasa fares relatively well compared with other ports in eastern and southern Africa. However, its container crane productivity, at 10 containers per hour, is far behind Dar Es Salaam (20) and Durban (15) (AICD 2010).

One of Kisumu's key strengths from an investment perspective includes its location on Lake Victoria (Kenya) as a gateway to the land-locked countries of East Africa. However, at this time there are few commercial enterprises taking advantage of lake transport from the Kisumu port. Recently the VEKA Group received support from the Dutch government to construct a shipyard near Jinja (Uganda) to construct container ships with a capacity of 90 containers. The intention is that these vessels will transport cargo across Lake Victoria between Kisumu, Port Bell (Kampala, Uganda) and Mwanza (Tanzania).

Air

Kenya is a regional leader in air transportation. Kenya Airways is one of Africa's top three international carriers, with an extensive network across the continent and a safety record up to international standards. The success of the company is in large measure due to an innovative public-private partnership with a strategic investor - KLM - which has a minority stake in the company but is nonetheless fully responsible for management. Linked to the ascendancy of the national airline, Jomo Kenyatta International Airport in Nairobi has become one of the three main international gateways in Sub-Saharan Africa. Beyond its role as an international hub, Kenya has a domestic air transport market that is the fourth-largest in Sub-Saharan Africa (following South Africa, Nigeria, and Mozambique) (AICD 2010). In total, Kenya has 230 airports, including 21 that are paved[3].

East African Community

Rwanda, Uganda and Kenya tripartite partnership that has been branded as the 'coalition of the willing' are pushing for more intensive cooperation to ensure sufficient provision of financing for infrastructure development. The three countries want to push for more financing mobilization from private public agreements and also by inviting investors to actively invest in proposed infrastructure projects in Kenya, Rwanda and Uganda. They are pushing ahead without Burundi and Tanzania in formulating infrastructure projects funding as soon as possible, launch joint tourist VISA and facilitate movement of people using national identity cards within their countries. Among the high profile projects offered are the standard gauge railway line that will connect Kenyan coastal city of Mombasa with Kampala Uganda all the way to Kigali in Rwanda with the rest of the region's other existing rail networks[4]. To counter grand infrastructure plans by Kenya, Uganda and Rwanda. Tanzania has decided to seek closer economic ties with Burundi and Democratic Republic of Congo (DRC). This may reshape the political-economic map of the region, even as the Tanzania says it remains committed to the East African Community[5]. Increasing regional integration in East Africa is creating a need for more cross-border infrastructure projects and that is why South Sudan, Africa's newest state is keen to join the EAC[6].

[3] http://www.nationsencyclopedia.com/economies/Africa/Kenya-INFRASTRUCTURE-POWER-AND-COMMUNICATIONS.html
[4] http://www.contadorharrison.com/coalition-of-the-willing-continues-to-isolate-tanzania-and-burundi/
[5] http://www.theeastafrican.co.ke/news/Is-this-the-beginning-of-the-end-for-EAC/-/2558/2057530/-/liwgn0z/-/index.html
[6] http://www.contadorharrison.com/coalition-of-the-willing-continues-to-isolate-tanzania-and-burundi/

5.4 Import regulations

Importing in the East African Region

Import regulations keep changing every year in the Eastern Region. The potential changes will be implemented at the beginning of the new book year in July.

The Kenyan government levies a tax of 2.25% on every import coming into the country. This levy is called IDF (G.O.K- Government of Kenya Levy) and a newly introduced levy of 1.5% on every import to fund the construction of a railway line from the port of Mombasa to the border post of Malaba. The extra product import duties can be found on the website: www.kra.go.ke. If investors want to start a business in Kenya they can write a letter to the government. For dutiable inputs for investments, the investor can seek waiver of import duties from the government. The Kenyan declaration officer can help investors writing the right letter to the government. Below contact details from a declaration company in Nairobi are given. The declaration officer will also help by clearing goods into Kenya.

Alexandria Freight Forwarders LTD.	Head Office	Mombasa Branch:
Benjamin M. Musyimi +254-(0)722-607612 alexandria@africaonline.co.ke www.alexandriafreight.com	Hazina Towers, 7th Floor, Wing A Monrovia Street. P.O. Box 21896-00400, Nairobi Tel: +254-20-2243542/3/4 Fax: +254-20-2214993	Cannon Towers II, 1st Floor Moi Avenue P.O. Box 81330, Mombasa Tel: +254-41-2228046

Between East African Countries there is the East Africa Community (EAC). EAC is a regional inter-governmental organisation of the Republics of Kenya, Burundi, Rwanda, Uganda and the United Republic of Tanzania, that operates as a Common Market under a Common Market Protocol signed in July 2010 which provides for:

- Free movement of persons
- Free movement of workers
- Right of establishment
- Right of residence
- Schedule on the movement of services
- Schedule on the movement of capital

The countries operate a common customs procedure which provides for a Common External Tariff (CET) on imports from third countries and duty-free trade between the member states (Keninvest, 2012).


MINISTRY OF FISHERIES DEV.
FISHERIES DEPARTMENT
P. O. BOX 58187 NAIROBI.
TEL: 3742320 / 3742349 / 3743579.

6 Government institutions and supporting organisations

This chapter provides an overview of the relevant government institutions, the government policy with regard to aquaculture, other supporting organisations in Kenya and a number of relevant international organisations and bilateral donors.

6.1 Governmental institutions

There are several departments of the Kenyan government involved in the management and promotion of the fisheries and aquaculture sector.

Department of Fisheries Development
Until 2000, when Kenya was confronted with three consecutive EU bans on fishery products from Kenya, the Ministry of Health and the fisheries department therein together with the Kenyan bureau of standards were the authorities responsible for managing the fisheries sector. However, after the EU concluded that these authorities were not competent enough to safeguard food safety standards. The former ministry of Agriculture and Rural Development became responsible for the fisheries department and published 'The Fisheries (Fish Quality Assurance) Regulations, 2000' (Legal Notice No. 100), which created a single competent authority with powers to monitor and regulate all aspects of fish handling and processing. The department had the responsibility to oversee the implementation of these regulations. The regulations were revised in 2007 and are renamed 'The Fisheries (Safety of Fish, Fishery products and Fish Feed) Regulations, 2007', which came into force on September 21, 2007 as Legal Notice No. 170. The Department was elevated to a fully-fledged ministry on April 13, 2008. This is the current Ministry of Fisheries Development[7]. This ministry has been appointed by the EU as the competent authority for giving EU licenses for processing establishments and for managing capture fisheries as well as aquaculture development and regulation.

Directorate of Aquaculture
Under the supervision of the Ministry of Fisheries Development the Directorate for Aquaculture facilitates extension services for the sector. The main objective of the Directorate of Aquaculture is to promote and facilitate development of sustainable commercial aquaculture in Kenya. The directorate provides a range of services, including:

1. Information on:
   - General aquaculture development in the country
   - Aquaculture investment in the country
   - Aquaculture management practices
   - Aquaculture produce processing and marketing
2. Assistance in planning for aquaculture investment to investors
3. Assistance for investors in aquaculture site and species selection
4. Assistance for investors in farm management issues

To be able to provide these services, the Ministry has trained and posted aquaculture extension officers (Fisheries officers, Assistant Fisheries Officers, Fisheries Assistants and Fish Scouts) to regions with aquaculture potential. Furthermore, the ministry developed aquaculture demonstration farms in regions with aquaculture potential to provide knowledge to fish farmers and developed fish seed production facilities. Extension officers are expected to provide the link between fish farming information and aquaculture investors. The services are available throughout the country at the fishery centres. Besides these activities, the directorate for aquaculture also manages a number of fish farms that are used as show models for local farmers.

[7] http://www.fisheries.go.ke

The Kenya Marine and Fisheries Research Institute [8] and the Fisheries Department
The Kenya Marine and Fisheries Research Institute (KMFRI) and the Fisheries department are the two technical arms of the Ministry of Fisheries Development. The Department of Fisheries is a technical department of the ministry whose mandate is to provide for the exploration, exploitation, utilisation, management, development and conservation of fisheries resources, and undertake research in marine and fresh water fisheries. KMFRI is a state corporation that was established by an Act of Parliament (Science and Technology Act, Cap 250 of the Laws of Kenya) in 1979 and run by a Board of Management. The research mandate of KMFRI is defined by article No. 4 of the Science and Technology Act of 1979, Cap 250. The Institute is empowered to carry out research in Marine and Freshwater fisheries, Aquatic biology, Aquaculture, Environmental Chemistry, Ecological, Geological and Hydrological studies, as well as Chemical and Physical Oceanography.

KMFRI has adopted a multidisciplinary programme approach of which fisheries and aquaculture are core programmes. The aquaculture research and development programme is responsible for investigating new and adoptive culture species and techniques for enhanced fish. Similarly, the programme undertakes studies on for example integrated aquaculture production in irrigation systems, appropriate seed (fingerlings) production, feed formulation and production, hatchery development and operations techniques or genetic and hormonal manipulation for increased fish production in aquaculture systems.

Export Processing Zone Authority (EPZA)[9]
Investor reports note the Export Processing Zone Authority (EPZA) as the one stop shop for investors who are interested to export fisheries products. The EPZA was established in 1990, by the Export Processing Zone Act CAP 517, Laws of Kenya. The Authority's mandate is to promote and facilitate export oriented investments and to develop an enabling environment for such investments. The EPZA is a State Corporation, under the Ministry of Trade and Industry. The authority provides information on all the Kenyan industrial sectors and investment opportunities. It also offers help to exporters and international buyers for attaining all necessary licenses and other requirements for exports. Contrary to the Ministry of Fisheries Development this authority works not at the level of primary production but only at the level of exports and investments.

6.2 Trade and other associations

Aquaculture Association of Kenya (AAK)
AAK is an association formed by farmers during the ESP programme from the government. The main goal of this association is trying to find markets for their farmed fish. Most of the members of the association are small-scale farmers.

Commercial Aquaculture Society of Kenya (CASK)
CASK is set up by private investors to fight aquaculture challenges as a team. This society is composed of commercial fish farmers and their stakeholders. At the moment CASK has 35-40 members. The chairman of CASK is Otieno Okello: +254-712047940.

Kenya Fish Processors and Exporters Association (AFIPEK)[10]
AFIPEK represents the industrial fish processors and exporters. The level of their influence is not completely clear but most of the processors and exporters are a member of the association.

[8] http://www.kmfri.co.ke
[9] http://www.epzakenya.com
[10] http://afipek.org

Association of Kenya Feed Manufacturers (AKEFEMA)
AKEFEMA represents cattle, pig, chicken and fish feed manufacturers of the Kenyan industry. Also their role and level of influence is not completely clear. Only about one third (32 out of 82) of the total number of manufacturers is a member of the association and it is not clear how many fish feed manufacturers are part of this group.

The Commercial Aquaculture Producers of Africa (CAPA)[11]
The association of the Commercial Aquaculture Producers of Africa (CAPA), has been formed as the representative body for leading freshwater fish farmers on the continent. CAPA and its members are setting the standard for sustainable aquaculture in the freshwaters of Africa.

6.3 Company Registration

The Kenya Investment Authority can help with company registration in Kenya. In order to register your company, you will need to;

- Reserve a company name and get it approved Registrar of Companies
- Prepare the Memorandum of Association and Articles of Association.
- Complete various forms including Statement of Nominal Capital, Particulars of Directors and Shareholders, Situation of Registered Office and Certificate of a Lawyer involved in the Formation of the Company,
- Stamp the Memorandum of Association and Articles of Association and the Statement of Nominal Capital at the Lands Office together with payment of stamp duty on Nominal Capital.
- File all the forms together with one stamped copy of the Memorandum of Association and Articles of Association with the Registrar of Companies.

You will then be issued with a Certificate of Incorporation by the Registrar of Companies. For public companies, in addition to the Certificate of Incorporation, the Registrar will issue a Trading Certificate.

For help and more information about registering your company or other business questions you can contact the Kenya Investment Authority head office:

Kenya Investment Authority	Head Office
info@investmentkenya.ke www.investmentkenya.com	Kenya Railways Headquarters, Block D, 4th Floor Workshop Road, off Haile Selasie Avenue P.O. Box 55704- 00200 City Square, Nairobi. Tel: (+254) (20) 2221401 - 4, Mobile: (+254) (722) 205424 Mobile: (+254) (733) 601184 Fax: (+254) (20) 22243862

[11] http://www.capafish.org


MTN

7 Encountered challenges for Food Tech Africa

Aquaculture in Kenya faces many challenges. The most important challenges, with relevance to FTA, that were encountered during the fieldtrip are pointed out below:

Aquaculture market and distribution

- There's lack of and/or inadequate accurate market information for use by fish farmers. As a result fish are harvested too early and/or sold too cheap.
- There's inadequate facilitation in terms of transport, storage and distribution for fish products. As a consequence it is difficult for retailers to buy farmed fish in high quantities.
- For most of the Kenyan inhabitants fish is a relatively new source of protein. As a result people have limited experience in fish preparation. This slows down the popularisation of fish proteins as a food source.
- People in Kenya (Nairobi) have limited awareness of the Unique Selling Points (USPs) of fish products. For example Omega-3 fatty acids, which reduce the risk of dying of heart disease.
- Fish is relatively expensive and the availability of fish in different price categories is limited. Even chopped into smaller pieces to reduce the price, fish is still more expensive than meat.

Aquaculture farms

- Most Kenyan fish farmers have limited knowledge of good farming practices. Fish farmers don't know how to handle fingerlings in a farm, how to feed the fish, how to control water and how to harvest. This influences farmers' changes of success.
- Fish farms are often plagued by predation. Snakes, birds, frogs and other animals increase the mortality rates. Beside predation, theft of fish is also an issue in badly protected areas.
- The government promotes clustering of farms to share knowledge. This clustering is not properly supervised. As a result sharing knowledge between farmers is still very limited
- Water quality in pons is poor due to bad water management. Most of the farmers don't invest in simple water tests to check the water quality.
- Due to a lack of knowledge aquaculture production systems are inefficient in Kenya.
- Water scarcity due to other competing uses like industry, domestic and agriculture is sometimes a problem. As a consequence for most of the aquaculture in Kenya a water source is needed to fill a fish pond.
- Because of limited land size, some willing individuals cannot start a fish pond.

Aquaculture feed

- In Kenya there's lack of affordable good quality fish feed.
- Good quality feed (mostly imported) is very expensive. Because of poverty, cheap, bad quality fish feed is preferred above the more expensive good quality feed.
- Fraud in delivering the agreed feed product is a big challenge. Ingredients are mixed with low value products as sand, sawdust etc.

In Kenya the government is working on laws and standards that guarantee feed quality of farmed fish. These laws and standards are not yet covering all species.

Aquaculture seed

- There is lack of readily available and affordable quality fish seed (fingerlings). Producing good quality fingerlings is a challenge. Inbreed fingerlings are found on a regular basis.

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Appendix 1 Country facts EAC countries and Ethiopia

The tables below provide country facts for Ethiopia and the EAC countries Tanzania, Uganda, Rwanda and Burundi.

Ethiopia	
Population in 2013	93,877,025 (July 2013 est.)
Population growth rate in 2013	2.9% (2013 est.) (1.095% in the World)
Median age 2013	Total: 17.5 years (29.4 years in the World)
Capital	Addis Ababa, 2,863 thousand inhabitants (2009)
Major Languages	English (official), Arabic (official), numerous indigenous languages
Land Area	1,104,300km^2
Arable land	13.19%
GDP in 2012	USD105bn (purchasing power parity)
GDP - per capita (PPP)	USD1,200 (2012 est.)
GDP - real growth rate (est.)	7% in 2012, 7.5% in 2011, 8% in 2010
GDP - composition by sector in 2012	Agriculture: 46.4%,Industry: 10.7%, Services: 43% (est.)
Literacy (age of 15 can read and write)	Total population: 29.2% (09/10 est.)
Population below poverty line	29.2% (09/10 est.)
Inflation (est.)	23.4% in 2012; 33.2% in 2011

Tanzania	
Population in 2013	48,261,942 (July 2013 est.)
Population growth rate in 2013	2.82% (2013 est.) (1.095% in the World)
Median age 2013	Total: 17.3 years (29.4 years in the World)
Capital	Dar es Salaam, 3,207 thousand inhabitants (2009)
Major Languages	Kiswahili or Swahili (official), English (official), Arabic, numerous indigenous languages
Land Area	947,300km^2
Arable land	12.25%
GDP in 2012	USD75.07bn (purchasing power parity)
GDP - per capita (PPP)	USD1,600 (2012 est.)
GDP - real growth rate (est.)	6.9% in 2012, 6.4% in 2011, 7% in 2010
GDP - composition by sector in 2012	Agriculture: 27.7%,Industry: 25.1%, Services: 47.2% (est.)
Literacy (age of 15 can read and write)	Total population: 67.8% (2010 est.)
Population below poverty line	36% (2002 est.)
Inflation (est.)	16.1% in 2012; 12.7% in 2011

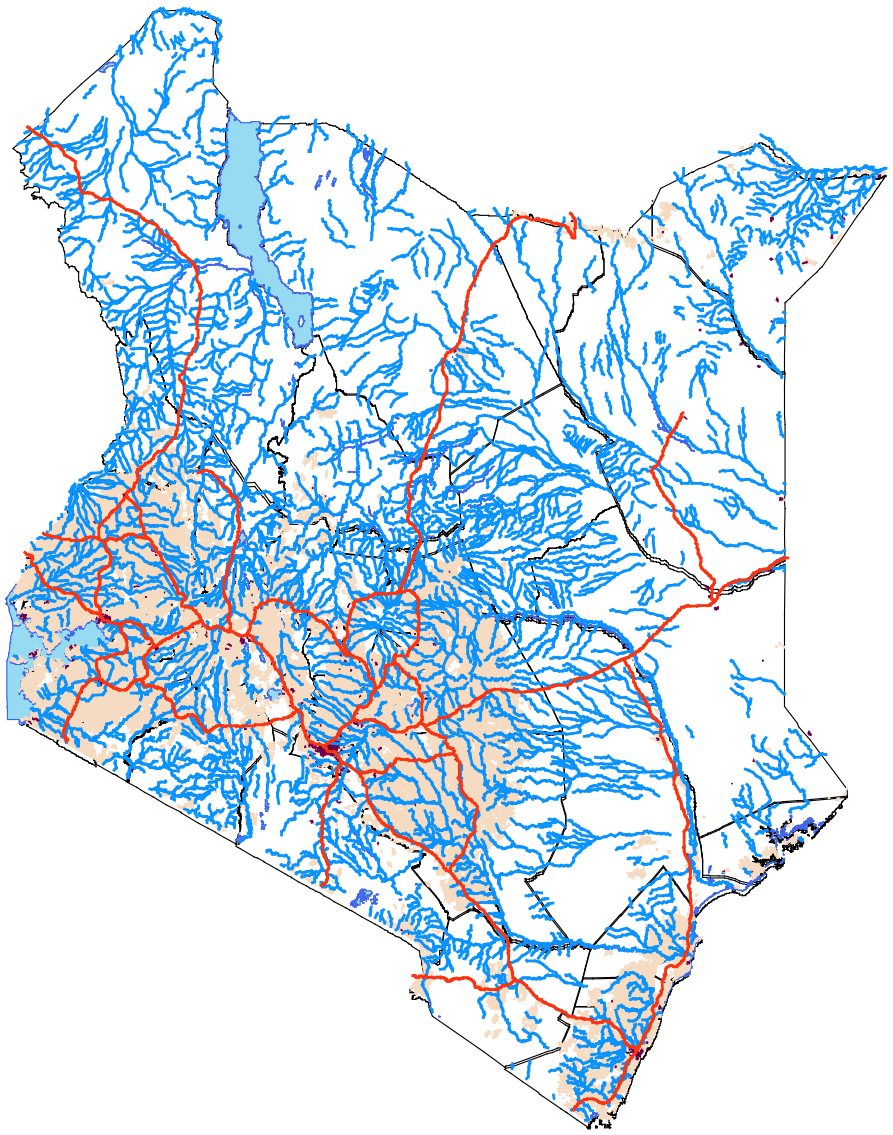
Uganda	
Population in 2013	34,758,809 (July 2013 est.)
Population growth rate in 2013	3.32% (2013 est.) (1.095% in the World)
Median age 2013	Total: 15.5 years (29.4 years in the World)
Capital	Kampala, 1,535 thousand inhabitants (2009)
Major Languages	English (official national language), Ganda or Luganda, other Niger-Congo languages
Land Area	241,038km^2
Arable land	27.94%
GDP in 2012	USD51.27bn (purchasing power parity)
GDP - per capita (PPP)	USD1,400 (2012 est.)
GDP - real growth rate (est.)	2.6% in 2012, 6.7% in 2011, 5.6% in 2010
GDP - composition by sector in 2012	Agriculture: 24.2%,Industry: 26.5%, Services: 49.3% (est.)
Literacy (age of 15 can read and write)	Total population: 73.2% (2010 est.)
Population below poverty line	24.5% (2002 est.)
Inflation (est.)	14.0% in 2012; 18.7% in 2011

Rwanda	
Population in 2013	12,012,589 (July 2013 est.)
Population growth rate in 2013	2.7% (2013 est.) (1.095% in the World)
Median age 2013	Total: 18.7 years (29.4 years in the World)
Capital	Kigali, 909 thousand inhabitants (2009)
Major Languages	Kinyarwanda (official), French (official), English (official), Kiswahili
Land Area	26,338 km^2
Arable land	46.32%
GDP in 2012	USD15.74bn (purchasing power parity)
GDP - per capita (PPP)	USD1,500 (2012 est.)
GDP - real growth rate (est.)	7.7% in 2012, 8.3% in 2011, 7.2% in 2010
GDP - composition by sector in 2012	Agriculture: 33.3%,Industry: 13.9%, Services: 52.9% (est.)
Literacy (age of 15 can read and write)	Total population: 71.1% (2010 est.)
Population below poverty line	44.9% (2011 est.)
Inflation (est.)	6.3% in 2012; 5.7% in 2011

Burundi	
Population in 2013	10,888,321 (July 2013 est.)
Population growth rate in 2013	3.08% (2013 est.) (1.095% in the World)
Median age 2013	Total: 16.9 years (29.4 years in the World)
Capital	Bujumburu, 605 thousand inhabitants (2011)
Major Languages	Kirundi (official), French (official), Swahili
Land Area	27,830 km^2
Arable land	33.06%
GDP in 2012	USD5.58bn (purchasing power parity)
GDP - per capita (PPP)	USD600 (2012 est.)
GDP - real growth rate (est.)	4.0% in 2012, 4.2% in 2011, 3.8% in 2010
GDP - composition by sector in 2012	Agriculture: 35.2%,Industry: 18.6%, Services: 46.2% (est.)
Literacy (age of 15 can read and write)	Total population: 67.2% (2010 est.)
Population below poverty line	68.0% (2002 est.)
Inflation (est.)	18.0% in 2012; 9.7% in 2011

Appendix 2 Kenya's Major Roads, Rivers and Crops intensity

Map 2 provides an overview of the major roads (red lines), rivers (blue Lines), lakes (light blue spots), crop intensities (beige areas), urban areas (red spots) and national/regional boundaries (black).



Map 2 *Kenya's major roads, rivers and crops intensity*
Source: World Resources Institute GIS data, 2013.

Wageningen UR
Droevendaalsesteeg 4
6708 PB Wageningen
The Netherlands
T +31 (0)317 48 01 00
www.wageningenUR.nl/en

LEI 13-086
IMARES C182/13

The mission of Wageningen UR (University & Research centre) is ‘To explore the potential of nature to improve the quality of life’. Within Wageningen UR, nine specialised research institutes of the DLO Foundation have joined forces with Wageningen University to help answer the most important questions in the domain of healthy food and living environment. With approximately 30 locations, 6,000 members of staff and 9,000 students, Wageningen UR is one of the leading organisations in its domain worldwide. The integral approach to problems and the cooperation between the various disciplines are at the heart of the unique Wageningen Approach.

Contact persons FoodTechAfrica

Wouter van Vliet (wouter.van.vliet@larive.nl)
Sjors Groeneveld (sjors.groeneveld@larive.nl)

Larive International BV
Sparrenheuvel 2
3708 JE Zeist
P.O. Box 870
3700 AW Zeist
The Netherlands

Tel.: +31 30 6933221
Fax: +31 30 6932908

Contact persons Wageningen UR

Arie Pieter van Duijn (arie.vanduijn@wur.nl)
Arjo Rothuis (arjo.rothuis@wur.nl)

Wageningen UR (University & Research centre)
Hollandseweg 1
6706 KN Wageningen
Postbus 8130
6700 EW Wageningen
The Netherlands

FoodTechAfrica

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