Master‘s Thesis

Examining the Potential of Fish Farming to Improve the Livelihoods of Farmers in the Lake Victoria Region, Kenya

Assessing Impacts of Governmental Support

Athugun á möguleikum fiskeldis til að bæta lífskjör keniskra bænda við Viktoríuvatn -

mat á áhrifum opinbers stuðnings

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Declaration

I hereby confirm that I am the sole author of this thesis and it is a product of my own academic research.

Nora Jacobi

Abstract

In Kenya, East Africa, fish-demand is constantly growing. Fish supply, however, lags behind owing to declining natural fish stocks. Aquaculture production in Kenya is still insignificant on a global scale, not following the sector's worldwide rapid growth. However, Kenya shows great potential for aquaculture activities that are not yet fully explored. In 2009 development and commercialization of Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*) aquaculture became part of the government's Economic Stimulus Programme (ESP), aiming to stimulate economic growth by creating business opportunities and jobs, as well as to alleviate food insecurity and poverty, two major problems in Kenya. Aquaculture production increased significantly. This study uses a structured questionnaire to elucidate the impacts of governmental support on the livelihoods of small-scale aquaculture farmers in the Nyanza and Western provinces, Kenya. Foci are *(1)* farm characteristics, *(2)* support mechanisms used, *(3)* fish farm wealth, *(4)* livelihood changes and *(5)* future perspectives of aquaculture. Livelihoods of ESP supported farmers improved in terms of protein consumption through incomes from aquaculture but pond productivities are low. ESP subsidies helped fish farmers in the short-term, i.e. through income generation and increased protein accessibility, but it failed to teach farmers how to achieve self-sustainable aquaculture without the help of subsidies. One way of achieving higher pond productivities is the promotion of sustainable and integrated aquaculture-agriculture farming practices. The risk is high that if pond productivities are not increased, aquaculture practices may be discontinued in the future with negative impacts on the farmers' livelihoods.

Útdráttur

Fiskeftirspurn vex sífellt í Kenýa í Austur-Afríku. Vegna hnignandi fiskistofna gerir fiskframboð það hins vegar ekki. Í alþjóðlegum samanburði er fiskeldi í Kenýa enn óverulegt og fylgir ekki hröðum vexti greinarinnar á heimsvísu. Hins vegar eru vannýtt sóknarfæri í fiskeldisstarfsemi í Kenýa. Árið 2009 varð þróun og markaðsvæðing eldis á beitarfiski og Norður-Afríkgrana hluti af efnahagsörvunaráætlun ríkisstjórnar landsins. Markmið áætlunarinnar voru að örva hagvöxt með sköpun viðskiptatækifæra og starfa og að draga úr fæðuóöryggi og fátækt sem eru meiriháttar vandamál í Kenýa. Fiskeldisframleiðsla jókst stórum í kjölfarið. Þessi rannsókn notaðist við spurningalista til að varpa ljósi á áhrif stuðnings ríkisstjórnarinnar á lífskjör bænda sem stunda smáframleiðslu á eldisfiski í Nyanza- og Western-sýslum í Kenýa. Í brennidepli voru einkenni býla, stuðningskerfi, fjárhagur býla, breytingar á lífskjörum og framtíð fiskeldisins. Vegna tekna af fiskeldi bötnuðu lífskjör bænda sem hlotið höfðu styrki frá ríkisstjórninni þegar litið er til prótínneyslu en framleiðni tjarna þeirra er lítil. Með því að auka tekjur og bæta aðgengi að prótínum hjálpuðu styrkirnir bændunum til skemmri tíma litið en þeir kenndu bændunum ekki hvernig stunda má sjálfbært fiskeldi þegar þeir hætta að fá styrki. Ein leið til að auka framleiðni tjarna þeirra er að styðja við samþætta og sjálfbæra stundun landbúnaðar og fiskeldis. Ef framleiðni tjarnanna nær ekki að aukast er mikil hætta á að dragi úr fiskeldi í Kenýa með neikvæðum afleiðingum á lífskjör bænda.

"Fulu bende oro ngege."

"Even haplochromis (a small fish) employs tilapia (a large fish)."

(Luo Proverb)

Foreword

This thesis was written in the winter of 2012/2013, representing my final project for a Master of Resource Management degree in Coastal and Marine Management from the University of Akureyri, Iceland. In lectures the importance of aquaculture in terms of food-provision and income-creation was often a main point of discussion. Fascinated by these topics I decided to do my final project on aquaculture development in a developing country in Africa, namely Kenya. Iceland and Kenya: Two countries that could not possibly be much more different in terms of culture, climate, food and spirit! Attracted by this challenge I travelled to Kisumu in western Kenya in the summer of 2012 to conduct my research. Top-down aquaculture support, which is frequently ill-reputed, is applied in Kenya where the government is funding the farming of fish, among other things to alleviate poverty and food insecurity. I wanted to assess how successful in terms of livelihood improvement small-scale fish farming in Kenya is, most of the farmers being relatively new to aquaculture. I visited fish farms so very different to the ones observed in Iceland where aquaculture has a long and well-established history. The farmers I visited usually lived in simple farm houses, typically mud-and-wattle dwellings with grass- or reed-thatched roofs and often without electricity. Rather small amounts of fish are produced to be sold on local markets. Generally speaking, not at all comparable to the industrial cultured fish production in Iceland. This research got me engaged in a completely different aquaculture practice and opened my eyes to problems rarely seen in countries like Iceland where aquaculture is well-managed and monitored. I hope that my thesis will be of future use in helping to address problems of small-scale farmers in countries where aquaculture is not a long established tradition.

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Acronyms

ESP	Economic Stimulus Programme
FD	Fisheries Department
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für InternationaleZusammenarbeit (German Development Agency)
GNI	Gross National Income
GoK	Government of Kenya
INADES	Institut Africain pour le Développement Economique et Social
ITCZ	Inter-Tropical Convergence Zone
KES	Kenyan Shilling
KMFRI	Kenya Marine and Fisheries Research Institute
LBDA	Lake Basin Development Authority
LIFDC	Low-Income Food-Deficit Country
MoFD	Ministry of Fisheries Development
NGO	Non-Governmental Organisation
PPP	Purchasing Power Parity
USD	US Dollar

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Foremost I would like to express my sincere thankfulness to my advisor Dr. Benedict J. Colombi for his patience, motivation, knowledge and enthusiasm. His guidance and continuous support helped me in all project phases - preparation, research and finally the writing of this thesis. Besides my advisor I would like to thank the staff at the University Centre of the Westfjords in Ísafjörður, Iceland: Peter Weiss for his enthusiasm and help getting this project started, Dagný for helpful and valuable advice and suggestions, Albertína for her time and help with questionnaire development and data interpretation, and Gunna Sigga for keeping up my spirits. Furthermore I am very grateful to Dr. Tumi Tómasson for his time to read and correct my thesis, providing mewith helpful adviceand valuable literature. Special thanks also go to Dr. Patricia Manuel for her time, valuable input and last-minute help! Without help of the Deutsche Gesellschaft für Internationale Zusammenarbeit (German Development Agency) and Kenyan Ministry of Fisheries Development during project-planning and my time in Kenya it would not have been possible to conduct my research: Special thanks goes to Arnoud and Laszlo for hosting me and their helpful advice about living and researching in Kenya. Getting in touch with people able to help me find and contact respondents for my study would not have been possible without help from Arnoud, Enos, Jedida, George O., Fredrick, Sophie and George A. - thank you so much. Special thanks to Fredrick, Sophie and George A. for their help with translation, and George for driving me safely to my respondents on the crazy Kenyan roads! Many thanks also to Laila who helped me design my questionnaire. I would also like to thank all the fish farmers who agreed to participate in my field work, taking time off from their farm work to help me complete my research. None of this project would have been possible without the help and support of my amazing family and friends worldwide who I could always rely on with personal as well as with professional matters – be it via Skype or in person! Nic and Jojo, really big hugs go to you! Finally I want to thank Tómas for his time and Icelandic translations - without you I would not have started writing.

Takk fyrir.

1 Introduction

1.1 Background – Livelihoods and Aquaculture in Kenya

In the most general terms, livelihoods can be described as peoples' means to secure the necessities of life. They are highly dynamic and shaped by a variety of different factors and forces that are themselves shifting constantly. The improvement of livelihoods of people in developing countries is the mission of many public and governmental institutions, and is successful when communities experience increased well-being and reduced vulnerability through higher incomes, improved food security and the more sustainable use of natural resources (DFID, 1999).

Rural populations in Kenya - an East African Low-Income Food-Deficit Country (LIFDC) (FAO, 2013a) - are facing increasing pressure on their livelihoods through, for example, the combined impacts of HIV/AIDS, climate change and water scarcity (CIA, 2013). Aquaculture of low-trophic level fish species is one way to improve livelihoods in developing countries (FAO, 2012). Russell, Grötz, Kriesemer and Pemsl (2008) for example described fish farming households as being among the more livelihood-secure households of their studied communities in Malawi. Aquaculture development has hence been stimulated in numerous countries in order to improve livelihoods with varying success rates.

Kenya has great potential for pond-based aquaculture of Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*). However, in 2008 this potential was by no means fully explored (Mbugua, 2008a) despite about 30 years of various aquaculture extension services (Ngugi & Manyala, 2004).

Support for aquaculture development in Kenya comes from the Government of Kenya (GoK) but also from the industry, the private sector and a number of Non-Governmental Organisations (NGOs) (Rothuis, van Duijn, van Rijsingen, van der Pijl & Rurangwa, 2011). In 2009 the development of Nile tilapia and African catfish aquaculture became part of the GoK's Economic Stimulus Programme (ESP), in order to commercialize this sub-sector of Kenya's economy (Manyala, 2011), improve the nutritional situation of the farmers and create employment (TISA, 2010). Fish pond construction costs as well as the costs for feeds and fingerlings are subsidised by the programme. Additionally, governmental infrastructure supporting the aquaculture sub-sector, i.e. trainings, research farms and extension officers, is in place (Hino, 2011). This program led to an increase in the number of farmers engaged in fish farming as well as to increased fish production (FAO, 2013b). On a global scale, however, Kenyan aquaculture production is still insignificant (Rothuis *et al.*, 2011).

Top-down government support policies for aquaculture development sometimes prove to be unsuccessful in terms of increasing production (Russell *et al.*, 2008). In Kenya, however, the country's increasing demand for fish connected to a rapidly increasing population (CIA, 2013) may improve the likelihood of success of government intervention.

Fish consumption patterns in Kenya used to reflect the proximity to fishing areas and cultural tradition. Traditionally the major fish consumers have been the Luo ethnic group, inhabiting areas around Lake Victoria. However, the demand for fish has increased fast because more and more people have embraced fish on their household menus and aquaculture production is widespread throughout the country (Rothuis *et al.*, 2011). The Nyanza and Western provinces, where this study took place, are poor. However, owing at least partially to aquaculture development, significant improvements in livelihoods were recorded between 2004 and 2011 (Dominion Farms, 2011). These prerequisites, i.e. the population's fondness for fish, the prevalence of aquaculture and the high poverty ratio in the area, makes the Kenyan Nyanza and Western provinces ideal for a study on livelihood changes through aquaculture in a developing country.

1.2 Research Purpose

"Even haplochromis (a small fish) employs tilapia (a large fish)."

This old Luo proverb (author unknown, from Miruka, 2001, 56; see also page ix of this document) mentions two types of fish which both inhabit Lake Victoria (Odada, Olago, Kulindwa, Ntiba & Wandiga, 2004). It is about responsiveness to humble calls, the need to listen to the voices of those who are perceived as voiceless – the poor. I found this proverb attributing to this study because it incorporates collaborations between the GoK and the rural poor through the provision of subsidies for fish farming activities. The opinions of the fish farmers – the poor - encountered in this study could help to improve the livelihoods of small-scale fish farmers.

Aquaculture has been developing rapidly over the last 30 years (FAO, 2012), but for Kenya the farming of fish still depicts a relatively new opportunity to create incomes and improve livelihoods (Fisheries Department, 2012). Since the introduction of the GoK's ESP in 2009 no study has described a livelihood-based response of the fish farmers to the program. In order to identify if the GoK's efforts in terms of boosting aquaculture development with the aim to improve livelihoods were successful, the livelihood situations of farmers who did and who did not receive governmental support for aquaculture are compared. This study thus seeks to elaborate on the potential of governmental aquaculture support to help improve livelihoods in a sub-Saharan LIFDC in terms of increased well-being and reduced vulnerability through increased income creation, changes in protein consumption and the sustainable use of natural resources on the farms.

In order to continuously improve livelihoods it is necessary to ensure that aquaculture can successfully continue after subsidies have stopped. However, earlier studies show that successes from subsidised aquaculture are often short-lived. After support is terminated, fish farming activities are often discontinued (Dey *et al.*, 2006) or production levels drop back to pre-funding levels (Brummett *et al.*, 2011), which both should be avoided. This study seeks to provide insights and offer recommendations on supporting small-scale aquaculture, even when government funding is no longer available.

1.3 Research Aims and Objectives

Aquaculture plays a role in food security and poverty alleviation worldwide through significant production of some low-value freshwater species. Especially fish producers in Asia, mainly in China, Bangladesh, Vietnam, India and Indonesia, have benefitted from the culture of low-trophic level fish like for example tilapia. The LIFDCs though, mostly in Asia and sub-Saharan Africa, remain minor in terms of their share of global aquaculture production. However, especially in many developing countries, fish is the number one animal protein source. Its contribution to the health of people as well as to economic growth is crucial (FAO, 2012).

Hence, aquaculture development has been stimulated in many ways with varying success rates in numerous countries. Building on other case studies this study examines the potential of fish farming to improve the livelihoods of farmers in the Lake Victoria region, Kenya. Objectives of this study are to shed light on *(1)* farm characteristics and demographics in the study area, *(2)* support mechanisms used by the fish farmers, *(3)* farm wealth, *(4)* livelihood changes through aquaculture and *(5)* future fish farming prospects.

1.4 Research Questions

The study objectives are framed in the context of the following guiding research questions:

(1) How effective has the Kenyan government's Economic Stimulus Programme been for chosen Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*) farmers in western Kenya to improve livelihoods in terms of improved well-being and reduced vulnerability through *(a)* increased income creation, *(b)* changes in protein consumption, and the *(c)* sustainable use of natural resources?

(2) What is the long-term potential of small-scale Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*) aquaculture in chosen farms in western Kenya *(a)* with or *(b)* without the support of the Kenyan government's Economic Stimulus Programme?

Answering these questions will shed light on the potential of governmental aquaculture support to improve the livelihoods of farmers in the Lake Victoria region of Kenya.

This study does not provide a full picture of fish farming in the study area. Instead, it explores the experiences and opinions of a small group of fish farmers more thoroughly. Also, the study involves only one group of stakeholders, the fish farmers themselves, even though aquaculture in Kenya is an activity with a multitude of different stakeholders (Rothuis *et al.*, 2011). The sample of participants is not random, it is opportunistic. The study relied on the availability and willingness of famers to participate and was constrained by logistical challenges. The work covers only a small area and in a very short period of time. Consequently, the sample displays strong attributes of homogeneity: predominantly male, and quite old farmers, with a high proportion of them operating financially 'better-off' farms.

Despite these constraints and limitations the research never-the-less presents lessons from farmers who are attempting to eke out a livelihood in small-scale aquaculture with and without government support. It illustrates some of the successes and challenges of the activity and offers insights to future aquaculture success for farmers wishing to attempt it.

1.5 Structure and Context of the Paper

The aim of this thesis is to first give information on the area under discussion and second, to employ data collected in the Lake Victoria region of Kenya (western Kenya), in the Nyanza and Western provinces, to put the situation of local fish farmers into context. Background information on the topic and a review of related literature are provided in sections two to four of this thesis. Kenya's geography, climate, politics, economy and demographics, as well as two of the country's main issues, namely poverty and food insecurity, are described in section two. The importance of fish farming in Kenya, with its declining Lake Victoria fisheries, to help alleviate poverty and food insecurity is highlighted in section three. Aquaculture extension services in Kenya, highlighting the support the sector receives through the GoK's ESP, are concentrated on in section four. Also, a historical overview of the subject is given. Research methods employed to collect and analyse the data are outlined in section five. The results of the research on aquaculture development in the Nyanza and Western provinces are presented and discussed in sections six and seven: The results of my study are presented in section six, encompassing farm characteristics and demographic information, the fish farmers' use of aquaculture support mechanisms, farm wealth, livelihood changes induced by fish farming and perspectives for aquaculture continuation in the future. These results are discussed and related to relevant earlier studies in section seven. Conclusions and recommendations are also given in this section.

2 Kenya Country Profile – With Focus on the Study Area

2.1 Geography, Climate, Politics, Economy and Demographics

The primary source of this section is the CIA (2013)'s World Factbook, which provides up-to-date data on Kenya. Another reference frequently cited throughout this thesis project report is Rothuis *et al.* (2011). The authors of this report, working out of Wageningen University in the Netherlands, present key findings and recommendations of a fact-finding mission on aquaculture business opportunities in Kenya with respect to food security. Overall, and especially for this section, this source provided very valuable information.

2.1.1 Geography of Kenya

The Republic of Kenya (capital city: Nairobi) is an East African country lying on the equator. It is bordered by Tanzania to the south, Uganda to the west, South Sudan to the north-west, Ethiopia to the north and Somalia to the north-east (Figure 2.1) and has a total area of 580,367 km^2 (CIA, 2013). In the west Kenya borders Lake Victoria, the world's second largest freshwater lake (Prado, Beare, Siwo & Oluka, 1991); in the south-east the country borders the Indian Ocean. Kenya's inland landscape is characterized by numerous hills and broad plains. The Great Rift Valley, containing Kenya's highest mountain Mt. Kenya, is the main feature of Western and Central Kenya (CIA, 2013).

Figure 2.1 Map of Kenya, East Africa (from Rothuis et al., 2011)

2.1.2 Climate of Kenya

Kenya's climate is influenced by its topography, proximity to the equator, the Indian Ocean and the Inter-Tropical Convergence Zone (ITCZ) (National Environment Management Authority, 2005). The country's climate varies by location, with elevation being the major driver for temperature differences. The climate along the Indian Ocean coastline is tropical with rainfall and high temperatures throughout the year. Further inland the climate becomes more arid. The migration of the ITCZ produces the country's seasonal rainfall resulting in two distinct rain periods: The 'long' rains from March to May and the 'short' rains from October to December. Between about 50 – 200 mm of rainfall per month are generally received in these seasons. The country also suffers water scarcity due to the uneven distribution of water resources in time and space as well as due to an increasing occurrence of extreme weather events (Rothuis *et al.*, 2011). Recurring droughts in the dry seasons and flooding during the rainy seasons are Kenya's main natural hazards (CIA, 2013). The shores of Lake Victoria display a warm, tropical climate all year round (Rothuis *et al.*, 2011). Precipitation and temperature data for Kisumu, the capital of the Nyanza province at the shores of Lake Victoria, are displayed in Figure 2.2.

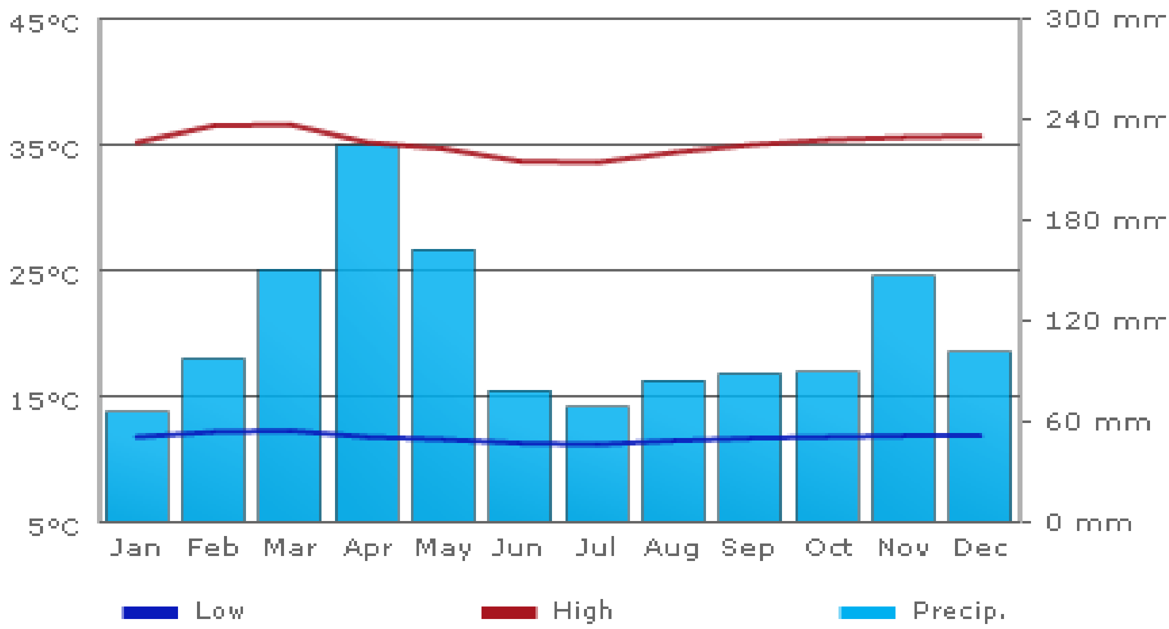


Figure 2.2 Annual climate chart of Kisumu (city), Nyanza province, Kenya, displaying average low and high temperatures (in °C) and average precipitation (in mm) (from Climate Data, n.d.)

2.1.3 Kenyan Politics

The Republic of Kenya is a presidential republic, with a multi-party system and the president being both the head of government and state (Rothuis *et al.*, 2011). Formerly Kenya was British East Africa. On December 12th, 1963 Kenya became independent from the United Kingdom. The Republic of Kenya is politically divided into seven provinces and Nairobi area (Figure 2.1). In August 2010 the constitution designated 47 yet-to-be-defined counties as first order administrative units (CIA, 2013). The Nyanza province comprises the Homa Bay, Migori, Kisii, Nyamira, Kisumu and Siaya counties; the Western province comprises the Busia, Bungoma, Kakamega and Vihiga counties (Figure 2.3)

(CRA, 2011). Data for this study were collected in the Homa Bay, Kisumu and Vihiga counties.

Figure 2.3 Counties of the Nyanza (Homa Bay, Migori, Kisii, Nyamira, Kisumu, Siaya) and Western (Busia, Bungoma, Kakamega, Vihiga) provinces in the west of Kenya (modified from CRA, 2011)

2.1.4 Kenyan Economy

Kenya's economy is considered one of Africa's most developed (Rothuis *et al.*, 2011). Kenya's Gross Domestic Product (GDP) is composed as follows: agriculture (24%), industry (15%) and services (61%) (CIA, 2013). In 2011 the Gross National Income (GNI) per capita (Atlas method, current USD (US Dollar)) was USD 820; GDP per capita (current USD) was USD 808 in the same year. Real GDP growth rate increased from 1.5% in 2008 (World Databank, 2013) to 5.1% in 2012 (CIA, 2013). Economic growth in Kenya, however, is restrained by an unstable macroeconomic environment characterized by exchange rate depreciation, high energy costs and inflation. Also, in the first half of 2011 Kenya experienced limited rainfall which negatively affected food production.

Overall, however, Kenya's economy has gradually emerged from economic slowdown and political instability. Reforms in public finance management have continued, but progress has been slow. Economic freedom has been held back by extensive corruption and weak protection of property rights (Rothuis *et al.*, 2011).

In this thesis project report KES (Kenyan Shilling) are converted into USD using the appropriate exchange rates to enable direct comparisons. The official exchange rates of KES per USD used are displayed in Table 2.1.

Table 2.1 Official exchange rates of KES per USD (period average) (from World Databank, 2013)

2012	**2011**	**2009**	**2004**
84.53	88.81	77.40	79.17

2.1.5 Demographics

Kenya is a multi-ethnic country with a rapidly increasing population of around 44 million (2013 est.). Forty per cent of Kenyans are unemployed (2008 est.) (CIA, 2013); youth unemployment constitutes 70% of total unemployment (AfDB, OECD, UNDP & UNECA, 2012). Kenya's adult literacy rate (people aged 15 and older that can read and write) is 87.4% (world: 84.1%) (CIA, 2013). Kenya's population, agricultural activity and infrastructure are heavily concentrated in the country's southern half (CRA, 2011) near Lake Victoria the population density was over 100 per km^2 in 2004 (Odada *et al.*, 2004). Kisumu city is the largest city in the region with approximately 388,000 inhabitants in 2009. By contrast, Kenya's northern half is only sparsely populated and characterized by fragmentary infrastructure (CRA, 2011). Demographic information on Kenya as a whole, and for the three counties of this study, is displayed in Tables 2.2 and 2.3. These two demographic snapshots aim to elaborate on data introduced in this paragraph, and illustrate poverty and food insecurity issues in Kenya (e.g. through the rapidly increasing population and high prevalence of HIV/AIDS) as well as problems during this study´s data collection (i.e. the presence of various ethnic groups, languages and religions). Since aquaculture is a rural activity, the degree of urbanisation is also displayed.

Table 2.2 Selected demographic data of Kenya (adapted from CIA, 2013)

Factor	
Population	44,037,656 total (July 2013 est.)
Population growth rate	2.4% (2012 est.)
Languages	English (official), Kiswahili (official), numerous indigenous
Ethnic groups	22% Kikuyu, 14% Luhya, 13% Luo, 12% Kalenjin, 11% Kamba, 6% Kisii, 6% Meru, 15% other African, 1% non-African
Religion	45% Protestants, 33% Roman Catholic, 10% Muslim, 10% indigenous beliefs
Urbanization	22% 4.2% annual rate of change (2010 - 2015 est.)
Health	6.3% HIV positive Prevalence of malaria and typhoid

*Table 2.3 Selected demographic data for the Kisumu, Homa Bay and Vihiga counties, western Kenya; *2009 census data (from CRA, 2011)*

	Kisumu	**Homa Bay**	**Vihiga**
Population*	968,909	958,791	554,622
Surface area (km^2)	2,086	2,586	531
Population density (people/km^2)*	465	371	1,045
Share of urban population (%)*	52.4	14.3	31.4

2.2 Poverty and Food Insecurity in Kenya

2.2.1 Definitions

Poverty – Definition

Bellù (2005, 2) states that “Poverty is the lack of, or the inability to achieve, a socially acceptable standard of living”, which is “deemed to constitute a socially acceptable standard of living by a given society at a given time”. Hence, there is no absolute definition of poverty. Sometimes, absolute poverty lines are identified by a uniform and simple indicator. People who live below the international poverty lines are living on less than 1.25 USD/day (Purchasing Power Parity, PPP), or less than 2 USD/day (PPP) (World Databank, 2013). It needs to be made very clear, however, that poverty is not only about incomes and expenditures; it is also comprises ideas of human well-being, social opportunities, economic conditions and a healthy natural environment (WorldFish Center, 2005).

Food insecurity – Definition

Food insecurity is the lack of secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active, healthy life. Because food constitutes a major part of expenditures for the poorest households, food prices can directly affect food security (FAO, 2008). Typically, one has to consider four dimensions when discussing food security (from FAO, 2008):

(1) *Availability of food* which is determined by a country's importation capacity, domestic production and the existence of food aids and food stocks.

(2) *Access to food* which depends on purchasing power of households, levels of poverty, the availability of market and transport infrastructure and food distribution systems as well as food prices.

(3) *Stability* of food access and supply may be influenced by weather, human-induced disasters, price fluctuations as well as a variety of economic and political factors.

(4) *Food utilization* must be safe and healthy and hence depends on feeding and care, access to clean water, food quality and safety as well as sanitation and health.

2.2.2 Food Insecurity and Poverty – Situation in Kenya

In 2005 the percentage of Kenyans living below the international poverty lines of 1.25 USD/day (PPP) and 2 USD/day (PPP) was 43.4% and 67.2%, respectively (most recent figures available at the time of writing this thesis) (World Databank, 2013). In 2011 about 75% of the country's poor lived in pastoral areas; 3.75 million of these people were food insecure. Malnutrition of children may be as high as 30% in some parts of the country (Rothuis *et al.*, 2011). Factors driving Kenya's poverty and food insecurity are water scarcity during droughts, land subdivision and tenure, environmental deterioration (Ministry of Foreign Affairs of Denmark, 2006), volatile food prices and social inequality (Rothuis *et al.*, 2011). The data presented in Table 2.4 aim to develop an understanding of poverty in the Kisumu, Homa Bay and Vihiga counties before fish farming became popular. Even though no absolute poverty line was applied by CRA (2011), the data still give an idea about the situation since the lack of education and literacy, the lack of electricity, improved water and sanitation, and stunting are possible poverty indicators.

*Table 2.4 Selected poverty and food security related data for the Kisumu, Homa Bay and Vihiga counties, Kenya; *2005/2006 data; **2009 census data (from CRA, 2011)*

	Kisumu	Homa Bay	Vihiga
Poverty rate (%) *	47.8	44.1	41.8
Primary education (%) **	62.0	65.6	71.2
Secondary education (%) **	13.0	11.8	12.7
Improved water (% households) **	60.1	38.6	76.4
Improved sanitation (% households) **	87.4	61.4	99.1
Electricity (% households) **	18.3	3.3	7.0
Adequate height for age (%) *	76.4	53.7	62.2
Can read and write, 10-14 years (%) *	65.8	73.3	70.2

3 Rationale for Aquaculture in Kenya

3.1 Status of Kenyan Capture Fisheries

Kenya has a 536 km long stretch of Indian Ocean coastline, multiple freshwater bodies (CIA, 2013) and a long fishing history with the Luhyia, Luo and Abasuba ethnic groups actively fishing for more than five centuries (EPZA, 2005). In 2011, capture fisheries directly employed 62,232 fishermen. The Kenyan capture fisheries sector comprises mainly artisanal practices; offshore marine waters are exploited by vessels from Distant-Water Fishing Nations. Kenya's capture fisheries hence mainly depend on freshwater inland capture fisheries (Figure 3.1). In 2011 80% of Kenya's capture fisheries were comprised by Lake Victoria's harvest of approximately 133,800 tonnes (Fisheries Department, 2012). Lake Victoria (Figure 3.2), one of the East African Great Lakes, is the world´s second largest freshwater lake. Its surface area is 68,800 km^2, with only 6% in Kenya (Prado *et al.*, 1991).

However, Kenya's capture fisheries are at risk: Overfishing of marine fish resources is reported in some areas. Also, increasing fishing efforts on Lake Victoria(Fisheries Department, 2012) combined with multiple environmental problems like pollution, water hyacinth infestation, anoxia and alien species introduction (Odada *et al.*, 2004) led to a declining trend in catches for most fish species (apart from catfish (*Clarias spp.)* and omena (*Rastrienobola argentea*)) since the early 2000s. This could be an indicator for reduced fish stocks in the lake directly threatening food security and income for livelihoods of lakeside communities. The country's aquaculture sector could be a means to create employment and reduce pressure on capture fisheries (Fisheries Department, 2012).

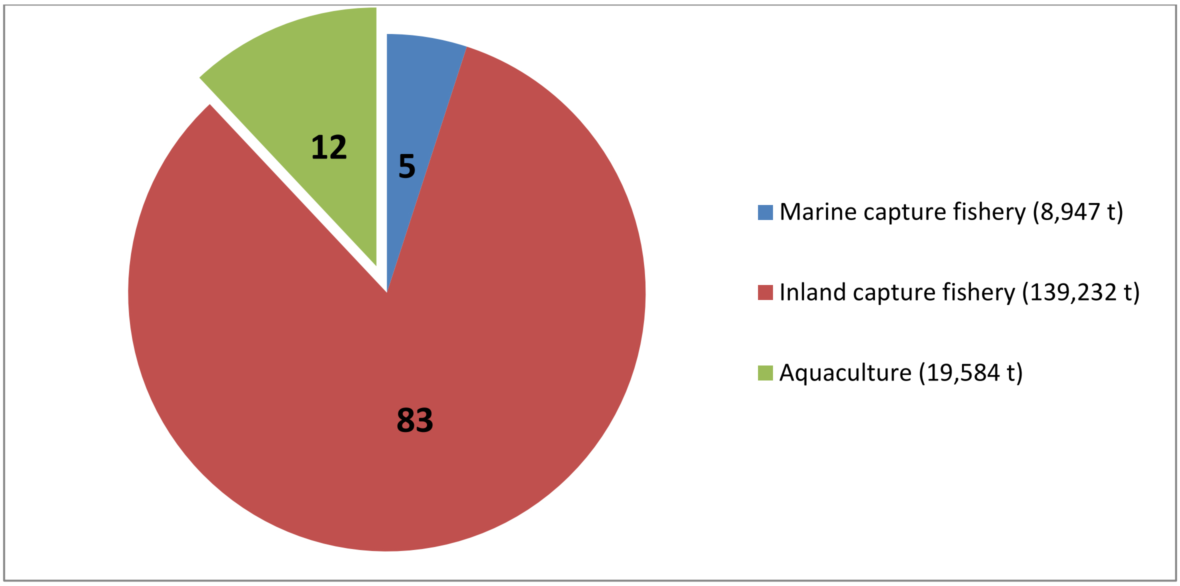


Figure 3.1 Kenya's fisheries and aquaculture production (in tonnes and %) in 2011(data from Fisheries Department, 2012)

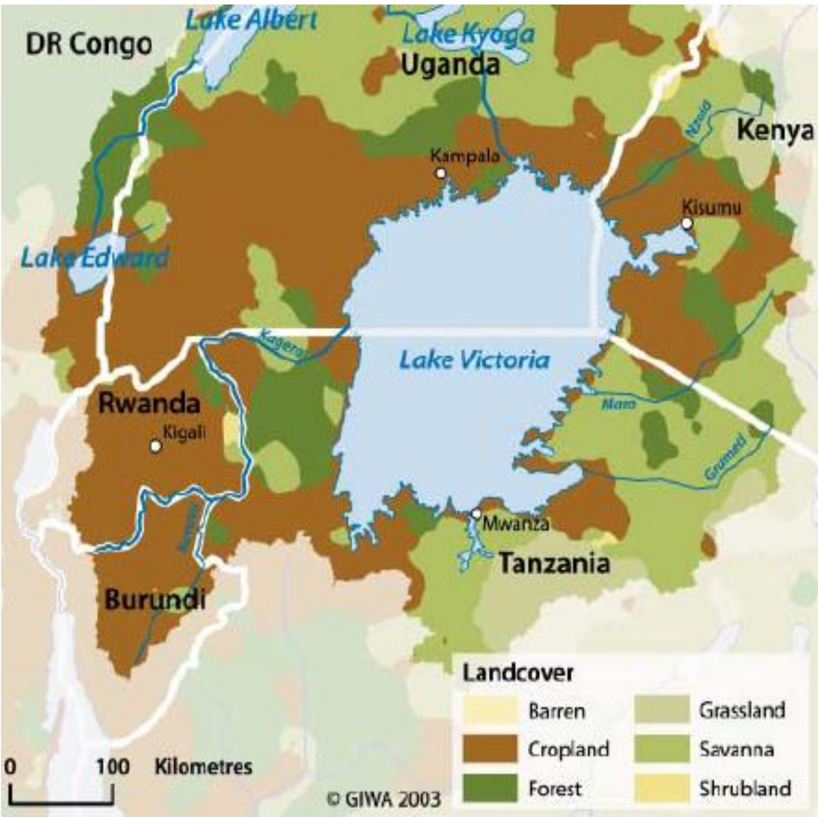


Figure 3.2 Map of Lake Victoria, Africa (from Odada et al., 2004)

3.2 Aquaculture Development in Kenya

Aquaculture is one of the fastest growing animal food-producing sectors worldwide: Its contribution to world food fish production was 47% in 2010. Because of fast population growth the world will require at least another 23 million tonnes of food fish by 2030. This demand will need to be met with aquaculture since many of the world fisheries are at or close to their limit. Many developing countries, especially in Asia, are major aquaculture producers (FAO, 2012) but there is little aquaculture tradition in most African countries (Brummett & Williams, 2000).

Fish farming in Kenya developed from the introduction of sport fishing in the 1890s. Static water pond culture of carp, tilapia species and catfish developed in the early 1920s as a control mechanism for snails, aquatic weeds, mosquitoes and leeches. Small-scale aquaculture started in the 1940s (Kaliba, Ngugi, Mackambo & Quagrainie, 2007) but only expanded in the 1960s through the 'Eat More Fish' campaign of the GoK (Rothuis *et al.*, 2011). Since then declines in aquaculture activity were recorded regularly due to low-level extension services and a lack of quality fingerlings (Ngugi & Manyala, 2004). Mariculture, i.e. marine aquaculture, was introduced in the late 1970s but never flourished (Rothuis *et al.,* 2011).

Generally, the reasons for slow aquaculture development in Kenya have been *(1)* lack of a tradition of fish and water husbandry (Brummett & Williams, 2000), *(2)* numerous political, social and economic constraints that restrict investment and delay expansion, *(3)* lack of information on fish farming technology and culture practices (Fisheries Department, 2012) and *(4)* unknown investment return-rates (Ngugi & Manyala, 2004).

Kenya has a high potential for aquaculture, however, offering prospects of better incomes and food supply for its rural population. Diverse aquaculture species, such as tilapia, trout, catfish, common and Chinese carps, shrimp and freshwater prawns (Rothuis *et al.,* 2011) can be supported due to varied geographic and climatic regions and diverse water resources ranging from marine and brackish waters to warm and cold fresh water resources. The region around Lake Victoria is endowed with high potential due to various water sources such as rivers, wetlands, lakes, water reservoirs and springs. Also, the region has clay/loamy soil suitable for pond construction, as well as high temperatures for year-round production and fast fish growth. Markets are also available in the area (Alal, 2012). The two main species cultured in Kenya, Nile tilapia and African catfish (Fisheries Department, 2012), are introduced in the following two paragraphs.

3.2.1 Nile Tilapia (Oreochromis niloticus)

Nile tilapia (Figure 3.3) makes up the bulk of Kenya's aquaculture fish production (Fisheries Department, 2012). The species has a long aquaculture history, being cultured in Egypt for some 2,500 years (Brummett & Williams, 2000). It is usually produced in semi-intensive static ponds. Tilapias grow best in waters with a temperature between 20 and 35°C. This fish species can grow up to 500 g in weight in eight months provided adequate food supply and controlled breeding. Cultured tilapias accept a wide range of diet forms such as pellets, flakes and mashed feeds (Guerrero, 1980) and feed well on a variety of feeds such as formulated feeds from cereal bran and fishmeal, but also garden wastes and greens. The major drawback of tilapia culture is their capacity to over breed, which may result in a large population of undersized fish in the ponds (Ngugi, Bowman & Omolo, 2007).

Figure 3.3 Nile tilapia (Oreochromis niloticus), one of the fish species cultured in western Kenya (from Ngugi et al., 2007)

3.2.2 African Catfish (Clarias gariepinus)

African catfish (Figure 3.4) is the second most commonly produced fish in Kenyan aquaculture (Fisheries Department, 2012). It is usually produced in semi-intensive static ponds. The optimal water temperature for the culture of African catfish is 30°C. These fish usually reach maturity at two years of age, weighing 200 – 500 g. After eight to ten days they can start feeding on a formulated diet consisting of cereal bran and fishmeal. Additionally, catfish also feed on garden waste and greens. The main drawback of catfish aquaculture is the high mortality of fry, especially in the first two weeks after egg hatching (Ngugi *et al.*, 2007).

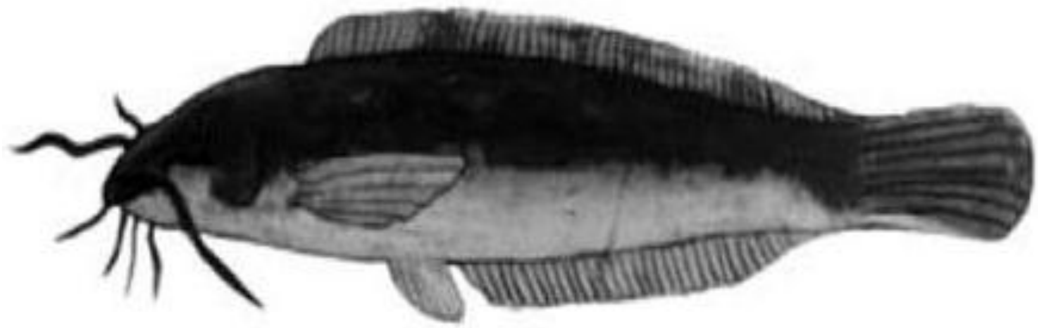


Figure 3.4 African catfish (Clarias gariepinus), one of the fish species cultured in western Kenya (from Ngugi et al., 2007)

3.3 Fish and Food Security

3.3.1 General

Fish, often the cheapest source of animal protein (Yosef, 2009), contributes to livelihoods through its nutritional importance and through its role in trade. Fish is especially important in LIFDCs, comprising 24% of animal proteins consumed in 2009, despite lower levels of total fish consumption compared to developed countries (FAO, 2012): With five kg/capita/year fish consumption is low in Kenya (Rothuis *et al*., 2011), compared to the world average of 18.4 kg/capita/year in 2009 (FAO, 2012). Fishery exports earned Kenya KES 3,597 million (USD 40.5 million) in 2011 (Fisheries Department, 2012).

Africa’s fish consumption is expected to increase by over 20% by 2030 (Robison, 2011) but fish supply is often hampered by declining capture fisheries (e.g. in Lake Victoria), impacting on health and nutrition of the poor (The World Bank, 2007). Aquaculture is one way to ameliorate the situation, by supplying food fish and creating incomes to the local population from market sales: According to KMFRI (2012), the mean price for tilapia on Kenyan markets and beaches (Lake Victoria shores) in June 2012 was 290 KES/kg (3.43

USD/kg) and 191 KES/kg (2.26 USD/kg), respectively. Kenya's marketing potential for fish is high with the GoK actively promoting its consumption for health reasons (EPZA, 2005).

3.3.2 Aquaculture for Food Security

Aquaculture is divided into small-scale rural and large-scale commercial activities. It can contribute to food security and poverty alleviation both directly by providing food fish, and indirectly by job- and income-creation (Table 3.1). For small-scale rural aquaculture these contributions are, however, rather small (Hishamunda, Cai & Leung, 2009; Brummett & Williams, 2000). Small-scale aquaculture is further divided into subsistence (least commercialized form, production mainly for home-consumption) and artisanal farming (slightly more commercialized, also production for local markets). It is most often integrated with agriculture: Nutrient-inputs for fish farms in inland areas are likely to originate from the farm and prospective fish farmers often already farm livestock and/or crops. . This allows each element in a rural farm set up to benefit from each other. Usually an extensive or semi-intensive low-cost production technology appropriate to the available resource-base is applied (FAO, 1997). This integrated approach of aquaculture development is usually more environmentally and socially sustainable than the rapid and indiscriminate expansion of commercial aquaculture, which has often led to environmental degradation and social disruption. Economic problems may be alleviated in the short-term, but the intervention is probably unsustainable in the long-term (Brummett & Williams, 2000).

Before 2007 aquaculture in Kenya was mainly a subsistence activity. Realizing the above-stated potentials of fish farming the GoK started subsidizing aquaculture commercialization (see section 4). However, in 2011 fish farming was mainly practiced by smallholders producing around three tonnes/ha; the number of intensive commercial farms and aquaculture employment creation in Kenya was still limited. The contribution of intensive fish production systems is expected to contribute far more significantly in the future (Rothuis *et al.*, 2011).

Table 3.1 The different roles of aquaculture in Africa (adapted from Brummett & Williams, 2000)

	Small-scale rural aquaculture	Large-scale commercial aquaculture
Fish feed used	Unprocessed agricultural by-products	Prepared diets
Species cultured	Low value, easily grown and reproduced	High value
Investment	Land, water, labour	Measured in cash only
Fish use	Local barter economy, Home consumption	Local luxury markets, Export
Intention	Food security, Poverty alleviation, Improved rural environment, Greater farm output, Greater farm stability	Job provision, Foreign exchange earning/saving, Creation of wealth for investors

4 Extension Services and Support Mechanisms for Aquaculture in Kenya

4.1 Aquaculture Extension in Kenya

The information in this section relies to a large extent on an FAO report by Ngugi and Manyala (2004). This document is the only report presenting information about aquaculture extension services in Kenya in a holistic manner, and describing aquaculture development in the country since its beginning.

One of the GoK's major development aims is to introduce/improve alternative, sustainable, low-cost family and community initiatives with the perspective of *(1)* increasing protein availability for domestic use, *(2)* generating income and *(3)* reducing poverty. One such initiative is to boost protein production from the fisheries and aquaculture sub-sectors (Ngugi & Manyala, 2004). Government agents and other stakeholders, especially in rural and semi-urban communities, have campaigned a lot for the promotion of aquaculture since the early 2000s (Manyala, 2011).

4.1.1 Public Sector and Institutional Linkages

The Kenyan Fisheries Department (FD) in the Ministry of Fisheries Development (MoFD) assures that fisheries programmes meet the needs of the Kenyan public and the industry by interacting closely with stakeholders. It is responsible for the administration of fisheries and aquaculture including enforcement of fisheries regulations, collecting and reporting statistics, licensing, fish quality assurance and control of imports and exports. Regional development authorities, like the Lake Basin Development Authority (LBDA), have direct charge over definite areas, complementing the FD rather than overlapping with its responsibilities. The degree to which the FD can fulfil its responsibilities depends to a great extent on available manpower and research from Kenya Marine and Fisheries Research Institute (KMFRI) and Kenya Agricultural Research Institute. The FD works closely with multiple international development agencies, NGOs and individuals in order to promote aquaculture in the country. The LBDA was established in 1979 with its headquarters in Kisumu (city). The KMFRI is dedicated to scientific research in the sectors of aquaculture, marine and inland fisheries as well as related basic research on aquatic ecology and fish biology. They also engage in transfer and dissemination of research findings to farmers. The Department of Fisheries at Moi University (Eldoret, Rift Valley province) was founded in 1990. Its objectives are oriented to community outreach and include education and training and are otherwise similar to those of KMFRI (Ngugi & Manyala, 2004).

4.1.2 Non-Governmental Organisations

The following NGOs are either interested in or actively associated with aquaculture extension in different parts of Kenya: INADES (Institut Africain pour le Développement Economique et Social), Catholic Church, Action Aid, Africa Now, Intermediate Technology Development Group, Netwas International, World Vision and Plan International. Among the most prominent NGOs involved in aquaculture extension services in Kenya is the US Peace Corps (the first organization to transfer fish farming technology to the grass root level). As of 2004 most NGOs had reduced their participation in aquaculture extension services (Ngugi & Manyala, 2004).

4.2 History of Aquaculture Extension in Kenya

Small-scale aquaculture in Kenya expanded in the 1960s during the GoK´s ´Eat more Fish´ campaign. Extension services, however, were thinly spread and farmers failed to reap the benefits (Ngugi & Manyala, 2004). The GoK’s efforts still resulted in the rapid spread of rural Nile tilapia ponds in western Kenya. However, most of them were small and neglected or abandoned in the 1970s due to poor yields, the lack of technical expertise and quality fingerlings and low-level extension services (Okechi, 2004). The need for effective and sustained extension services to support and improve the productivity of rural fish ponds in Kenya became clear (Ngugi & Manyala, 2004).

In the 1980s the GoK was able to engage various donors and NGOs aiming to rehabilitate several thousand rural fish ponds that had been abandoned. One region given particular attention was western Kenya because of its high aquaculture potential and its already existing organized extension structure under the LBDA. Pond constructions, involving women, development issues and training activities were also taken care of. Success was scarce though: Ten thousand ponds existed in Kenya's central and western regions in 1989, but only 967 were actively managed. Their total annual production was only around 65 tonnes (Ngugi & Manyala, 2004); compared to around 1,000 tonnes/year countrywide (FAO, 2013b).

In the 1990s further aquaculture extension programmes were undertaken by the Department of Fisheries at Moi University in order to carry out on-farm trials in Kenya's central and western regions. This brought together FD extension officers, farmers and academic researchers striving to commercialize small-scale fish farming. This programme resulted in higher tilapia and catfish yields through improved management approaches. However, countrywide cultured fish production lingered at around 1,000 tonnes/year until 2007 (Figure 4.1). Only a few donors were supporting aquaculture extension in Kenya, and government support was insufficient. Staff salaries consumed a large portion of the operating budgets and a big share of project funding was taken by expatriate consultants (Ngugi & Manyala, 2004).

The only institution which had attempted to provide a revolving credit facility for fish farmers in Kenya in 2004 was LBDA, targeting mainly individuals and groups already involved in small-scale aquaculture, fish feed or fingerling production. Even though private sector aquaculture development in Kenya had mainly been in the form of agriculturally integrated small-scale rural projects, a number of investors had ventured into more commercial fish farming practices in the early 2000s (Ngugi & Manyala, 2004).

In 2007 the GoK attempted to stimulate aquaculture through the development of high quality fingerlings and feeds, and the introduction of training programmes (Mbugua, 2008b) making Kenya a noteworthy aquaculture producer in East Africa (FAO, 2012): Fish production increased exponentially, reaching more than 4,000 tonnes (Figure 4.1). This growth can be explained by increasing commercialization of aquaculture by government policies (Rothuis *et al.*, 2011). However, the lack of proper pond management and coherent government policies were still hampering a further increase of aquaculture production (Mbugua, 2008b). According to Mbugua (2008a) aquaculture needs to be treated and operated as an enterprise with only one aim to further boost production: The creation of economic gains for investors. This is where the GoK's ESP comes into play.

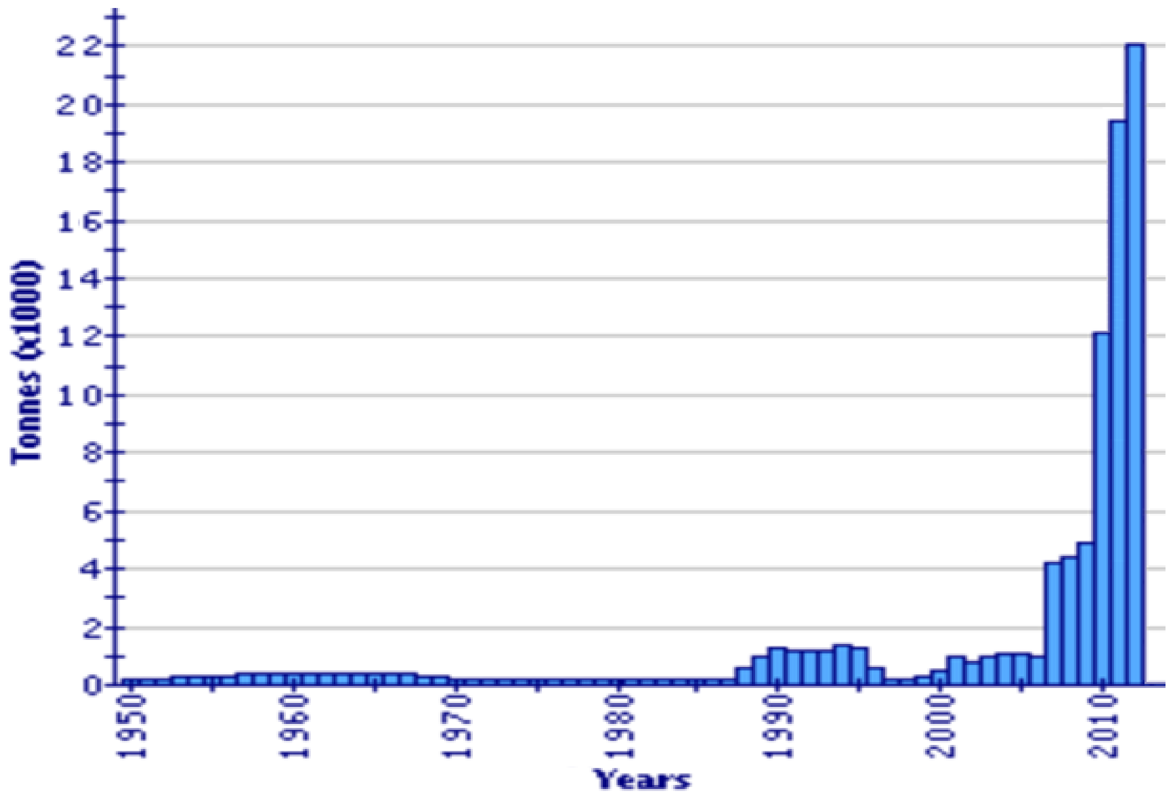


Figure 4.1 Reported aquaculture production in Kenya (in tonnes x1000) between 1950 and 2012 (modified from FAO, 2013b:1950 – 2010 data from FAO, 2013b; 2011 data from Fisheries Department, 2012; 2012 data from Otieno, 2012)

4.3 The Economic Stimulus Programme of the Kenyan Government

4.3.1 Project Description

The Kenyan economy showed a relatively fast growth between 2003 and 2007. However, government corruption scandals and political unrest, resulting in post-election violence in 2008, made numerous investment and business projects collapse. Also, prolonged drought during that time made food prices increase further, often beyond the means of a large proportion of Kenyans. Economic restoration to its former status was made a priority by the GoK (TISA, 2010).

The ESP is a GoK programme coordinated by the Ministry of Finance. It was introduced through the 2009/2010 budget and aims to stimulate the growth of Kenya's economy through rapid creation of business opportunities and jobs. KES 22 billion (USD 284 million) were committed to the programme. Large investments were undertaken in key sectors of the economy, namely education, health and sanitation, food production, environment, local government, industrialisation and fisheries/aquaculture. Aquaculture is identified as a key pillar in the production sector (TISA, 2010). Rothuis *et al.* (2011) state that observed economic growth can be attributed, at least partially, to this programme.

However, many initiatives such as the ESP were doomed to failure due to corruption, poor project planning or failure to involve citizens in local development. By the end of 2010, several ESP projects that were supposed to have been funded had either not commenced or were incomplete as a result of slow implementation and poor planning. Citizens' involvement in ESP projects is not adequately provided for by the ESP governance structure. Hence, there is low community involvement and awareness in the ESP funded projects. The poor information flow on the progress of the ESP projects also leads to only a few people knowing about the existence of the full fund. Many people are not fully aware of the assigned projects and objectives of the programme. Also reported is consistent confusion between different sources of funding and that projects are misplaced and therefore do not meet the priorities of particular regions (TISA, 2010).

4.3.2 The Economic Stimulus Programme and Aquaculture

Description of Implementation

Aquaculture commercialization was incorporated into the ESP by the MoFD in 2009 (Manyala, 2011) in order to improve nutrition, alleviate poverty and create over 120,000 employment opportunities (TISA, 2010). It promotes Nile tilapia and African catfish culture in western, eastern and central Kenya, parts of Rift Valley and the coastal regions (Fisheries Department, 2012). However, both species are not farmed in all counties (MoFD, email, September 26th, 2012). Fish pond construction costs as well as the costs for feeds and fingerlings are subsidised by the programme. Additionally, governmental infrastructure supporting the aquaculture sub-sector, i.e. training, research farms and extension officers, is in place (Hino, 2011).

In Phase 1, starting in 2009, the construction of 28,000 fish ponds (Hino, 2011) at 300 m^2 each (Rothuis *et al.,* 2011) was funded, i.e. 200 fish ponds in 140 constituencies at a total cost of KES 1,120 million (USD 14.5 million) (TISA, 2010). Each of these ponds is expected to produce at least 270 kg of fish/year (Muiruri, 2010). Phase 2 of the project started in late 2010 with an additional USD 37.5 million investment to increase the number of fish ponds countrywide to 48,000 (Hino, 2011). As of November 2012 the GoK had invested KES 5,600 million (USD 66.2 million) in aquaculture development over the previous three financial years (Alal, 2012). GoK subsidies on pond construction ended in 2011, feed subsidies were gradually decreased from 100% in 2010 to 25% in 2012 (Rothuis *et al.,* 2011).

Kenyan Aquaculture Production since 2009

Cultured fish production in Kenya increased exponentially with the availability of ESP support (Figure 4.1): During the year 2009 a total of 4,895 tonnes of cultured fish was harvested. In 2010 a 12,153 tonnes yield of cultured fish was reported. In 2011 19,584 tonnes of farmed fish were produced in approximately 46,000 ponds, creating employment for almost 49,000 farmers. Farmed fish comprised 12% of fish production in the same year (Figure 3.1), creating about KES 4,223 million (USD 48 million) for the farmers (Fisheries Department, 2012). Aquaculture production in 2012 reached 22,000 tonnes (Otieno, 2012). In 2010 Kenya was Africa’s number four aquaculture producer, with 0.94% share of Africa’s farmed fish production (FAO, 2012). On a global scale, however, aquaculture production in Kenya is still insignificant (Rothuis *et al.*, 2011). Fish farmers are active in all Kenyan provinces, apart from the North Eastern province and Nairobi area (Manyala, 2011). In 2011 the bulk of cultured fish production came from Nile tilapia, followed by African catfish, Common carp and Rainbow trout (Figure 4.2) (Fisheries Department, 2012). Other farmed species include Koi carp, Black bass and Gold fish, but these only contribute insignificantly to the total (Manyala, 2011).

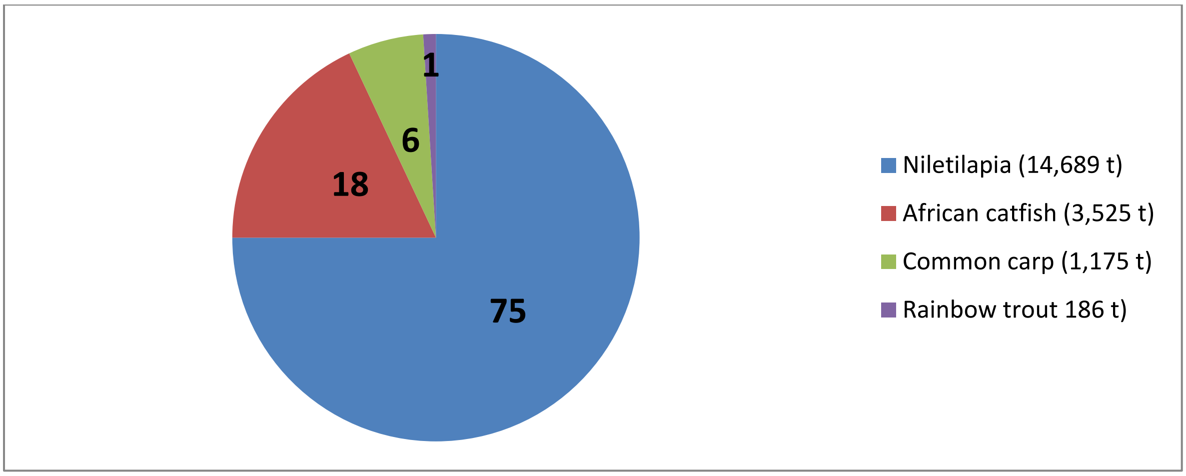


Figure 4.2 Aquaculture production in Kenya (in % and tonnes) by species in 2011 (data from Fisheries Department, 2012)

Tables 4.1 and 4.2 present an overview of the aquaculture situation in the Vihiga, Homa Bay and Kisumu counties. Comparing available pond numbers, number of ponds stocked and harvested gives an idea about the success of ESP-supported aquaculture in the three counties.

Table 4.1 Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) aquaculture statistics for Vihiga county and Kenya's Western province in total as of 31st of December, 2011 (from MoFD, email, September 26th, 2012)

	Vihiga County	**Western Province (Total)**
No. of Fish Farmers	1,667	11,684
No. of Fish Ponds	2,065	13,159
Area of Ponds (m^2)	619,500	2,817,025
No. of Ponds Stocked	400 (sic)	5,744
Area of Ponds Stocked (m^2)	120,000	1,653,400
No. of Ponds Harvested	513 (sic)	3,614
Area of Ponds Harvested (m^2)	153,900	1,058,050

Table 4.2 Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) aquaculture statistics for the Homa Bay and Kisumu counties, and Kenya's Nyanza province in total as of 31st of December, 2011 (from MoFD, email, September 26th, 2012)

	Homa Bay County	**Kisumu County**	**Nyanza Province (Total)**
No. of farmers	614	977	**10,429**
No. of ponds	621	1,038	**11,587**
Area of ponds (m^2)	66,300	303,316 (sic)	**3,087,244**
No. of ponds stocked	621	993	**6,902**
Area of ponds stocked (m^2)	66,300	316,171 (sic)	**1,731,954**
No. of ponds harvested	94	216	**3,257**
Area of ponds harvested (m^2)	28,200	135,765	**901,364**

Constraints

Despite all observed successes of the programme the following constraints for aquaculture development in Kenya were noted in 2011 (from Fisheries Department, 2012):

(1) Lack of readily available and affordable quality fingerlings

(2) Lack of adequate good quality and affordable fish feeds

(3) Inefficient aquaculture production technologies

(4) Competition for water use

(5) Inadequate market information/lack thereof

(6) Lack of good credit facilities for fish farmers

(7) Lacking security and safety of fish ponds posed by thieves and predators

(8) Limited land size

(9) Suboptimal extension personnel staffing levels

(10) Inadequate transport facilities

Future Outlook

Tying in with the work done by the ESP, the MoFD is partnering with Israel and Germany to further boost aquaculture production in Kenya and make it the key income generation for smallholder farms. The programme includes professional fish farming training. This trilateral tilapia value chain programme runs for two years (August 2012 – June 2014) and aims to eradicate poverty by creating alternative livelihoods (i.e. aquaculture) for communities around Lake Victoria and to thereby enhance sustainable protection of the lake's environment (Israel Diplomatic Network, 2012).

4.4 Literature Review

4.4.1 Livelihoods and Aquaculture

Aquaculture is one way to provide communities with improved nutrition through the provision of valuable fish protein (e.g. FAO, 2012). In their study in Malawi, Dey *et al.* (2006) for example established that in households with fish ponds home-produced fish was consumed more frequently than in households without fish ponds. This trend is, however, not always observed: Thompson, Roos, Sultana and Thilsted (2002) showed that 32% of the surveyed households in Bangladesh never consumed the fish they produced. Another study in Bangladesh also observed that fish from the fish farmers´ own ponds only contribute 1-11% of fish consumed at household level and that fish bought from local markets were the single most important source of fish consumed locally for both, households with and without fish ponds (Kawarazuka & Bene, 2010). The production of ´cash crops´, not ´food crops´ seems to be, according to Kawarazuka and Bene (2010) the general perception of many smallholder fish farms.

Through employment and income generation from aquaculture, and subsequent higher purchasing power, fish farming households often manage to improve their diets through increased food accessibility. Dey *et al.* (2006)´s study in Malawi for example found that the income of households owning fish ponds was 1.5 times higher than that of households without fish ponds. Furthermore, it seems particularly successful to combine aquaculture with other activities: Profits of fish farmers who combined aquaculture with rice farming almost doubled (Kawarazuka & Bene, 2010; Aiga *et al*., 2009).

Certain food products, e.g. meat and fish, are possibly bought more frequently because of a better income situation of the farmers through aquaculture. Several recent studies highlight this trend: Household incomes from aquaculture increase the consumption of staple foods (Jahan, Ahmed & Belton, 2010) and foods from animal sources (Dey *et al.,* 2006; Alderman, 1986), increasing the total energy intake of the fish farming households (Kawarazuka & Bene, 2010). Another reason for often observed increases in meat consumption could be that farmers, through incomes from aquaculture, have more money to keep livestock on their farms for home consumption: Neiland, Jaffry, Ladu, Sarch and Madakan (2000) for example show in a study in north-east Nigeria that increased income (from fishing, however) was used as input for farming resulting in the fishing households to have a higher farm-productivity. The increased availability of farmed produce was not, however, definite evidence for better or greater amounts of food intake: Von Braun, Bouis, Kumar and Pandya-Lorch (1992) established that additional incomes may be spent on foods of low nutritional value or on non-food items.

Overall, the need for food of the poor would, without income increase initiated by fish farming, possibly never be translated into an effective demand for food. Food availability is increased either immediately through the selling of fish on the domestic markets or later with food imports through foreign exchange earned through aquaculture. Hishamunda and Ridler (2006) show this aspect in their case study in Zimbabwe, where commercial tilapia farms provide jobs and incomes to farmers in an impoverished region.

Aquaculture also creates employment for underprivileged groups, e.g. women and young people (Hino, 2011; Jagger & Pender, 2001). Women and children are mainly involved in pond management activities such as feeding, fertilization, predator control. Women also take care of value-adding post-production techniques. However fish ponds are mainly owned by men. In Kenya women predominate in the fish processing and marketing sectors (Hino, 2011). Jagger and Pender (2001) suggest that women should be more actively integrated into extension practices. The importance of women participation I aquaculture is stressed by Weeratunge, Snyder and Sze (2010): Gender disparities not only affect the livelihoods of women themselves, but also livelihoods of the entire household and community. According to these authors the aquaculture sector “might well turn out to be a female sphere” (Weeratunge *et al.,* 2010, 405) if gleaning and post-harvesting are accounted for.

In order for aquaculture to improve livelihoods in the long-term, integrated agriculture-aquaculture practices may be the way forward. Dey *et al.* (2006) for example established that low soil fertility and water availability, the two major constraints to crop production on small-scale farms in Malawi, were at least partially overcome by the role of fish ponds in nutrient recycling and water storage. Overall farm-output for home-consumption and income creation may hence be increased. Also, organic farm by-products and wastes, like manure, greens and garden/kitchen waste, are used in integrated systems (Dey *et al.*, 2006).

Aquaculture has also been shown to indirectly improve livelihoods. As a valuable alternative for fish production it presents an important environmental role helping to conserve threatened wild fish species. The importance of this is evident, Bene, Steel, Luadia and Gordon (2009, 115) for example describe fish from small-scale fisheries in Congo as "bank in the water" for local communities.

However, it needs to be noted that especially in developing countries record keeping in aquaculture is often not adequately practiced. Okechi (2004) reports this as a constraint to aquaculture related research in Kenya.

4.4.2 Subsidies and Extension Services in Aquaculture Development

Over the years, several donor organizations have supported aquaculture development worldwide to initiate livelihood improvements. Success rates, however, varied greatly. Looking at these past successes and failures of support activities for aquaculture sheds light on the necessary for *(a)* successfully increasing aquaculture production to improve rural livelihoods and *(b)* avoiding discontinuation of fish farming or drop-backs to pre-funding levels after support is stopped.

A commonly accepted fact is that aquaculture support always needs to be applied with great knowledge of local conditions so as to not have negative environmental and social consequences (Hishamunda & Ridler, 2006; Brummett & Williams, 2000; Coche, Haight & Vincke, 1994): If prevailing regional economic conditions, social systems, natural resource constraints and indigenous knowledge bases are not taken into account sufficiently, impacts of any support mechanism applied are likely to be negligible in the long-term. Brummett and Williams (2000) for example show that mass-applications of aquaculture technologies in Africa are impossible due to the continent's wide spectrum of aquaculture systems arising from variable social, environmental and economic conditions. Another example is capture fisheries in the Senegal River basin, making aquaculture uncompetitive (Hishamunda & Ridler, 2006). Coche *et al.* (1994) described the (unsuccessful) promotion of fish farming in non-fish-eating communities in Kenya. Complex research to gain understanding of local conditions always needs to be undertaken. Failure to do so could lead to farms not being able to evolve into more productive systems, as well as to reluctance among assistance bodies to fund further aquaculture work.

Another important point is that only profitable aquaculture practices can be sustained without continuous subsidies (Brummett *et al.*, 2011; Hishamunda & Ridler, 2006; Pillay, 1997; Coche *et al.*, 1994). Hence, it is crucial to prepare fish farmers to be self-sufficient before aquaculture support is ending (Pillay, 1997). This economic reality, however, is often ignored by donors. In sub-Saharan Africa in the 1970s, for example, less than ten out of 54 surveyed small-scale farms were found to be self-sustainable after international donors had departed (Coche *et al.*, 1994). Self-sustainability of fish farms can only be achieved in regions with an existing infrastructural basis for fish farming, such as access to markets, administration services and institutional help (Ahmed, 2009). If aquaculture development is promoted without these services, successes can usually only be recorded when support is still available to the farmers.

A commonly observed malpractice is that donor-funding often takes place without regard to market conditions (Hishamunda & Ridler, 2006). This includes the impracticality of selling cultured fish on (existing) markets (Hishamunda & Ridler, 2006; Coche *et al.*, 1994; see above) as well as the non-availability or inaccessibility of markets, stated as a constraint for aquaculture development in Africa by Brummett and Williams (2000): Improved availability of storage and cooling facilities and better access to the markets through improved road infrastructure can increase the fish farmers’ incomes by improving the marketing of the fish. However, according to Alal (2012) market availability is not a problem in Kenya´s Lake Victoria region. In their case study of fish farming in Central Cameroon Brummett *et al.* (2011) assessed the effects of a five-year participatory aquaculture extension programme and found that during the programme period fish pond productivity, the number of active fish farmers and net returns from aquaculture overall increased. However, success was more significant in areas with good market access. Within three years of termination of extension support farmers with bad market access had returned to pre-extension production levels. Market access is hence necessary for long-term successes in aquaculture.

Dey *et al.* (2006) showed in their case study in Malawi that farmers who adopted supported fish farming technologies were i.a. recorded to have higher household incomes and a higher consumption of meat and fish than farmers who did not adopt these technologies. However, in the long-term the support showed only little success because farmers usually discontinued fish production as soon as subsidies came to an end (Dey *et al.,* 2006). Brummet *et al.* (2011) recorded drop-backs to pre- funding levels of fish production after subsidies had stopped. In a case study in Bangladesh Ahmed (2009) showed that fish production efficiency, and hence the chance of self-sustainability, were increased through extension services and farmer trainings: Both methods are relatively low-cost and can help reducing risks in aquaculture as well as improve profitability. If self-sustainability cannot be achieved, investments evidently need to be made to ensure the continuous (and costly) availability of quality technical assistance to achieve long-term success of aquaculture. Another way to financially help fish farmers is loan-availability. Loan may help fish farmers to recuperate from shocks, as well as a starting capital for an aquaculture business. Quagrainie, Ngugi and Amisah (2010) found in their study about small-scale fish farmers in Kenya that the level of credit use in fish farming is very low even though the GoK encourages aquaculture development by offering credit facilities through the government agricultural finance institution, Agriculture Finance Corporation.

Failure of (donor-funded) aquaculture development may also be introduced simply by using wrong indicators of success: Hishamunda and Ridler (2006) showed that the plain amount of fish produced was not sufficient to indicate aquaculture success; production costs need to be incorporated as well.

Generally, classical top-down approaches of aquaculture support seem to have a lower success rate than participatory approaches (Dey *et al.,* 2006; Brummett & Williams, 2000; ALCOM, 1994). The most promising approach of aquaculture development in Africa, according to Brummett and Williams (2000), is an evolutionary pathway. When aquaculture is a component of broader, integrated rural development initiatives it is more likely to be sustained. More and more long-term support is provided by leadership that comes from local initiatives rather than being imposed from outside by development agencies (Brummett & Williams, 2000; ALCOM, 1994). Through this practice both the needs of rural communities and rural budgets can be met eventually. Successful aquaculture industries in Norway, Scotland, Israel, South Africa and the USA have followed such pathways: From the beginning, small-scale fish producers worked closely with universities and/or government researchers to improve output and markets over time. Government policies and assistance followed in most cases. As the fish farmers, over time, gain a greater understanding of the functioning and potential of certain aquaculture techniques, they will become increasingly able to guide further evolution towards greater productivity and profitability (Brummett & Williams, 2000). ALCOM (1994) found that farmers who started aquaculture on their own or through local initiatives, rather than being imposed from outside, may also be more aware of the importance of trainings to improve their fish farming business in order to be successful.

5 Research Methodology

5.1 Conducting Interviews

5.1.1 Questionnaire Development

Following my interest in food security, poverty alleviation and aquaculture in developing countries I started an online search for a suitable topic for my thesis project in December 2011. I found a project on tilapia aquaculture in Kenya through the German Development Agency (GIZ, Deutsche Gesellschaft für Internationale Zusammenarbeit). It followed a period of consulting the available literature on alleviating food insecurity and poverty through fish farming in general, as well as on aquaculture development in Kenya. My literature search was mainly done through online databases and using documents sent to me by a GIZ employee. Through discussions with GIZ and MoFD employees, as well as through knowledge gained by consulting the available literature, I came up with my research questions and a timeframe for the project.

After consulting Bernard (2006) I decided on conducting formal, face-to-face interviews, using a structured survey questionnaire. All respondents answered the same set of questions. The rationale is that in structured interviews, and especially in those using questionnaires, the input that triggers peoples´ responses is controlled, so that outputs can be reliably compared (Bernard, 2006). Appendix A presents the study questionnaire. The interviews followed the structure of the questionnaire and were divided into five sections: *(1)* General information – Farm characteristics and demographics, *(2)* support mechanisms used, *(3)* farm wealth, *(4)* livelihood changes and *(5)* future perspectives. However, I also recorded information volunteered by the farmers, as suggested by Marshall and Rossman (2011), since it is the respondents' – not the researchers' – perspective that is needed. I recorded the information (writing down the comments) during the interview and later incorporated them into my sorting of the data and analysis of results.

I started designing the questionnaire in March 2012 and used both quantitative and fixed-choice and open-ended short-answer questions. This approach is suggested by Bernard

(2006) to create insight and understanding of the topic. After consulting the literature on past studies I came up with 37 questions for my questionnaire. I organized them into a logical sequence, leading the conversation from rather simple (e.g. number of ponds) to more complex questions (e.g. future perspectives). Bernard (2006) recommends this order to gain the trust of the respondents and also to get the conversation 'flowing' before the subjects become more difficult.

I developed my questionnaire by consulting the literature and discussing the questions with GIZ and MoFD employees. The questionnaire went through several versions before it was ready to be taken to the field. Following the example of Ahmed (2009) I checked my questionnaire for weaknesses by doing a few test runs after arriving in Kenya: I asked fish farmers to answer the questions, attentively trying to find ambiguities. The results of these test-runs were not incorporated into the results of this study. I noticed that I had to simplify and especially shorten my questionnaire. Changes were incorporated into the questionnaire before testing it again. I conducted five such test-runs. With the resulting set of questions I conducted 60 interviews of qualitative nature, only applying small changes occasionally. These changes mainly concerned the use of different wordings to clarify poor understandings.

My questionnaire was later used as a basis for the GIZ's project 'Analysis of a Baseline Data Collection Conducted within the framework of the Trilateral Cooperation between the Republic of Kenya, the State of Israel and the Federal Republic of Germany to improve the Tilapia value chain in the north-western region of Kenya' (Manyala, in press) to achieve their objective of protecting Lake Victoria's environment and eradicating poverty by creating alternative livelihoods for communities living adjacent to the lake. The results of this quantitative research project were not available at the time of writing this thesis project report, and could hence not be incorporated.

5.1.2 Interviews

I conducted the interviews between August 31st, 2012 and September 24th, 2012. Each interview lasted for 30 to 45 minutes. Even though Bernard (2006) recommends using a voice recorder in all structured and semi-structured interviews, except where people disapprove, I decided to not use voice recording devices to avoid reluctance of the interviewees. Most questions were multiple-choice style; other questions only required very short answers. I trusted myself to capture the information given while interviewing. The actual act of filling in the questionnaire, i.e. the writing, was always done by the interviewer, never by the interviewees.

My questionnaire did contain a section where the participants were asked to provide their name and phone number in case of ambiguities when working with the data. After reassuring them I would keep their identities anonymous, all of the participants agreed to provide me with this information. Once a potential respondent was willing to participate in the study, I provided him/her with a cover letter, briefly describing the background of my study (Appendix B). Most of the interviews were conducted by myself, 21 interviews, however, were carried out by others (one GIZ employee and three extension officers), mainly due to my inability to speak the local languages. I also captured contact information of the other interviewers in case of ambiguities when working with the data.

The respondents of this study lived in, or close to, small villages in the Lake Victoria area. They usually inhabited simple farm houses, usually mud-and-wattle dwellings with grass- or reed-thatched roofs and often without electricity. They typically had agriculture, livestock and/or fishing related occupations as well as a number of fish ponds for tilapia and/or catfish culture nearby the house. Typical fish farms visited during my research are shown in Figure 5.1.

Most of the interviews were conducted in the homes of respondents. One, however, occurred in a bar and about 20 interviews were conducted in community centres. During interviews in community centres I met a large number of farmers (around ten, twice) in one day, interviews were still conducted individually though. During these days one GIZ employee as well as three extension officers helped me conduct the interviews. I consulted Bernard (2006) regarding protocols with multiple interviewers and subsequently trained them in detail on how to conduct the interviews. Additionally I monitored the other interviewers on a regular basis.

If the interview was conducted on a farm, I usually received a tour of the farm. Usually I got to see a feeding demonstration during which I could observe fish activity and size, and water colour (Figure 5.2). This gave me some idea about farm husbandry and success. The respondent’s family as well as the people I was travelling with on that particular day were usually present during the interviews.

Figure 5.1 Typical fish ponds at two Nile tilapia (Oreochromis niloticus) and/or African catfish (Clarias gariepinus) farms visited during my research in August and September 2012 in western Kenya, Nyanza (Kisumu and Homa Bay counties) and Western (Vihiga county) provinces

Figure 5.2 Visible fish during a feeding demonstration on a farm in western Kenya in August/September 2012, also visible is some organic fertilizer in the pond

5.1.3 Limitations

The main limitation was my inability to speak the local languages and hence being dependent on interpreters and/or additional interviewers, surely introducing bias. It rained and monitored the other interviewers to keep bias minimal as suggested by Bernard (2006). Some respondents may have been uncomfortable, or even unwilling, to share certain information, hence affecting the quality of the data. Marshall and Rossman (2011) note that it is possible to introduce bias through the phrasing of questions and/or the interpretation of given answers. Especially since this was my first time conducting interview-style research this may have affected data quality. I made an effort to minimize the negative impact of these limitations by watching the respondents´ reactions closely and, if necessary probing for more complete data as recommended by Bernard (2006). Not all respondents were able to answer all questions. However, due to my rather small sample I did not exclude incomplete questionnaires. Due to time-constraints data collection for this study was only possible through structured questionnaire interviews. The incorporation of other approaches, such as Participatory Rural Appraisal (allowing wider community participation) and/or interviews with key informants, both conducted by Ahmed (2009), would have given more diverse data.

5.2 The Study Area

Respondents in this study hailed from villages in the Homa Bay and Kisumu counties (Nyanza province), and the Vihiga county (Western province). The Homa Bay and Kisumu counties directly border Lake Victoria, Vihiga county lies about 10 - 40 km away from the lake's shoreline (Figure 5.3) (Google Maps, 2013). The percentage of paved and good/fair roads in the study area varies between 4.8 and 16.6%, and between 38.0 and 60.4%, respectively (CRA, 2011). Access to the farms was often difficult and only possible with a 4x4 jeep due to difficult driving conditions. The area around Lake Victoria is characterized by both small-scale and commercial agriculture, as well as fishing activities of communities close to the lake (Kipkembo *et al.*, 2010).

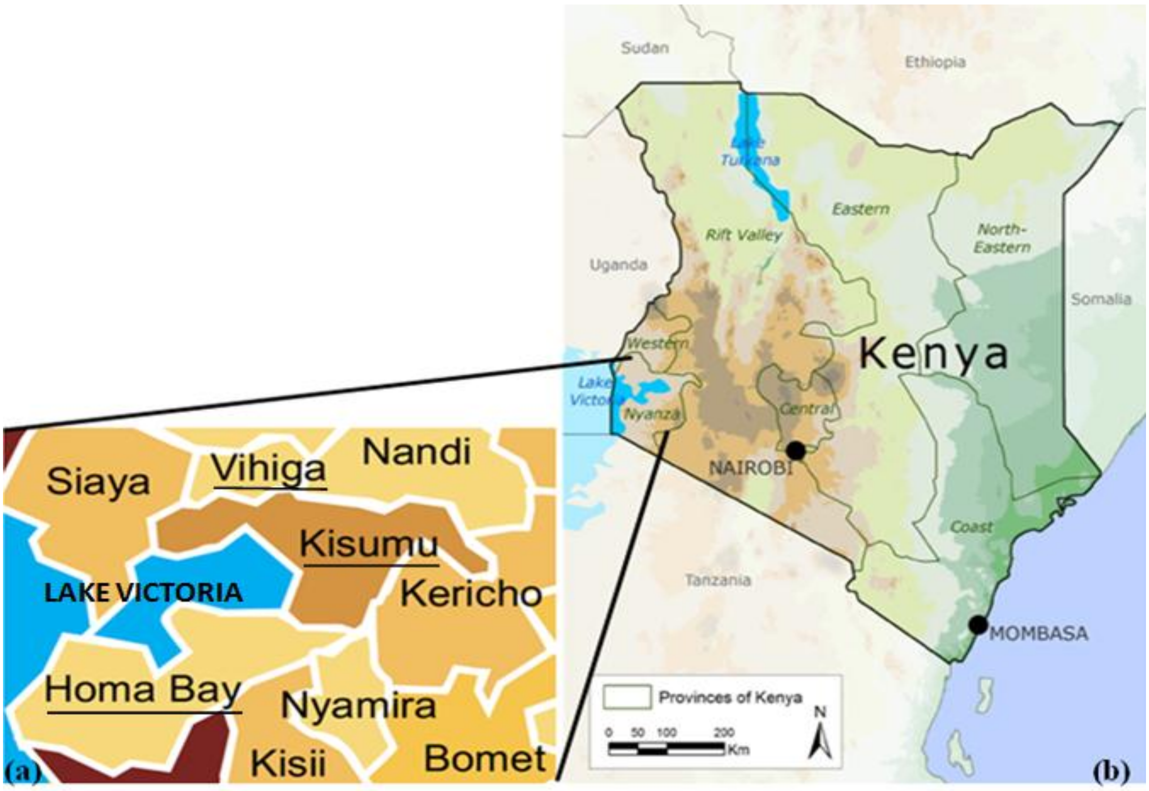


Figure 5.3 Thearea of data collection: Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province) of Kenya, East Africa (from CRA, 2011 (a) and Rothuis et al., 2011 (b))

5.3 Selection of the Respondent Group

I strove to interview farmers who had adopted tilapia and/or catfish pond aquaculture from a variety of locations. I selected small-scale, usually family-owned, fish farms from the

Nyanza and Western provinces. The questionnaires (Appendix A) were mostly answered by the fish farm owners, but sometimes by family members working on the farms as I was seeking to speak to the person with the broadest knowledge about fish farming on the particular farm.

5.3.1 Defining the Stakeholders of this Study

Different stakeholders play a role in the Kenyan aquaculture sub-sector (Figure 5.4). These are input suppliers (feeds and technical materials), hatcheries, artisanal processors, local markets, value chain supporters such as credit providers and government agencies, and of course the fish farmers themselves. Also included should be industrial processors and export markets, even though these did not play a role in Kenyan aquaculture at the time of the study. However, if cultured fish production increases in the country, these two groups may become important (Rothuis *et al.*, 2011). In this study the focus was only on one stakeholder-group, the rural fish farmers.

I ultimately identified and interviewed three groups of fish farmers (n=60). In Group A (n=28) are farmers who started fish farming with the ESP (in 2009 or later). These farmers had no experience with fish farming before their ponds were built. In Group B (n=24) are fish farmers who had started aquaculture without the support of the ESP but later received some kind of support through the programme (e.g. inputs, the construction of further ponds, enlargement of existing ponds). Group C (n=8) comprises farmers who have never received any kind of ESP support.

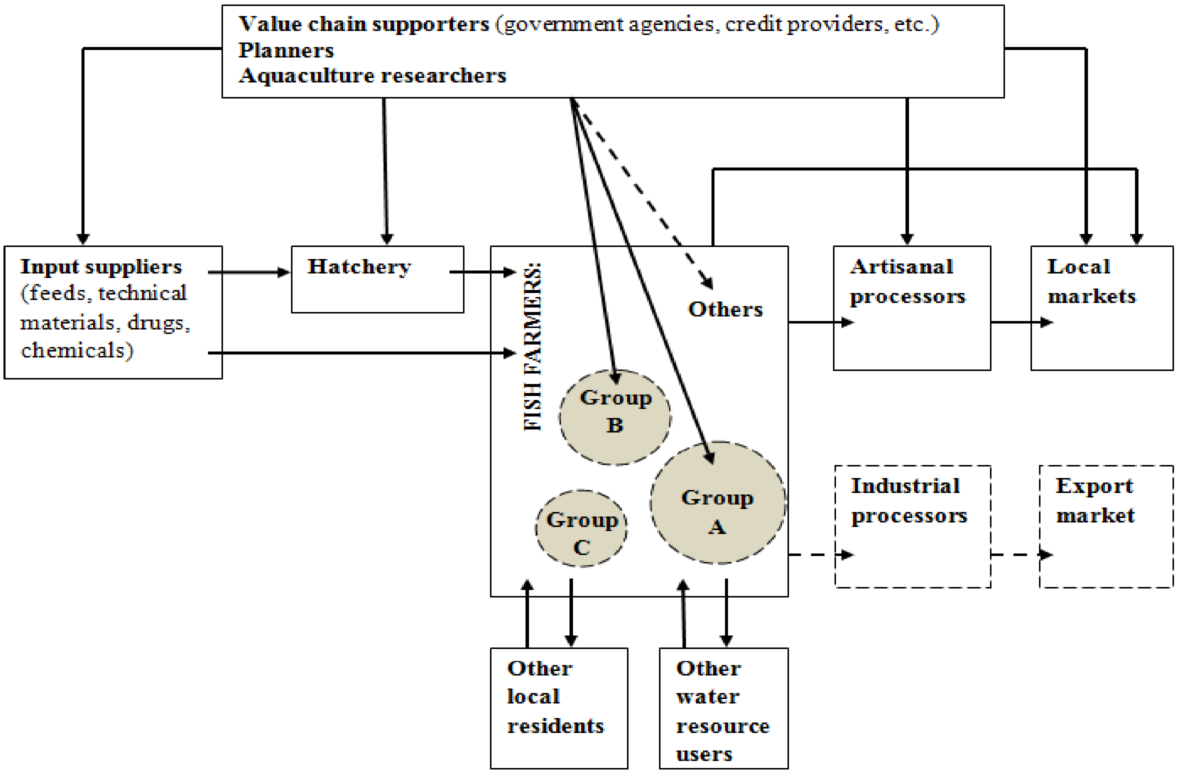


Figure 5.4 Aquaculture stakeholders in Kenya. The three interviewed groups are shaded in grey. Group A (n=28): started aquaculture with the Economic Stimulus Programme (ESP); Group B (n=24): started aquaculture before the ESP and later received some ESP support; Group C (n=8): never received ESP support; 'Others' are for example farmers of different fish species or farmers who have different sources of funding (modified from Rothuis et al., 2011).

Bernard (2006) suggests carrying out the ´snowball´ sampling method, suitable for studying hard-to-find populations: I contacted three aquaculture extension officers at the MoFD in Kisumu city who pointed out suitable fish farmers for my study. I interviewed these individuals and asked them to suggest other farmers suitable for my research. Generally I spoke to any fish farmer available and willing to participate that met my criteria, i.e. operating a small-scale subsistence or artisanal tilapia and/or catfish farm, either receiving ESP support not. These non-probability sampling methods were chosen according to Bernard (2006) because of the labour-intensity of the research. The resulting bias was documented.

5.3.2 Farmers' Characteristics

Sixty respondents, mainly farm owners (90%), or in some cases family members working on the farm (8%) were interviewed since I sought to speak to the person with the widest range of knowledge about the fish farming activities. Two per cent of the respondents did not state his/her connection to the farm. Most of the farmers interviewed were male, from Homa Bay county, and with primary education (highest level of education) (Figure 5.5). The average age of the fish farmers was 50.3 years, ranging from 17 to 76 years. Thirty-eight per cent were 60 years or older; only 7% were 25 years old or younger. Their average household size was 7.6 people, ranging from two to 17. Average extended family (i.e. family who do not live in the household but depend on the farmers´ incomes) were 4.3 people, ranging from zero to 20. Aquaculture was started between 2009 and 2012 by 78.3% of the farmers, only 21.7% started before 2009. The land used for aquaculture was either the fish farmers´ own (81.7%), or rented (18.3%).

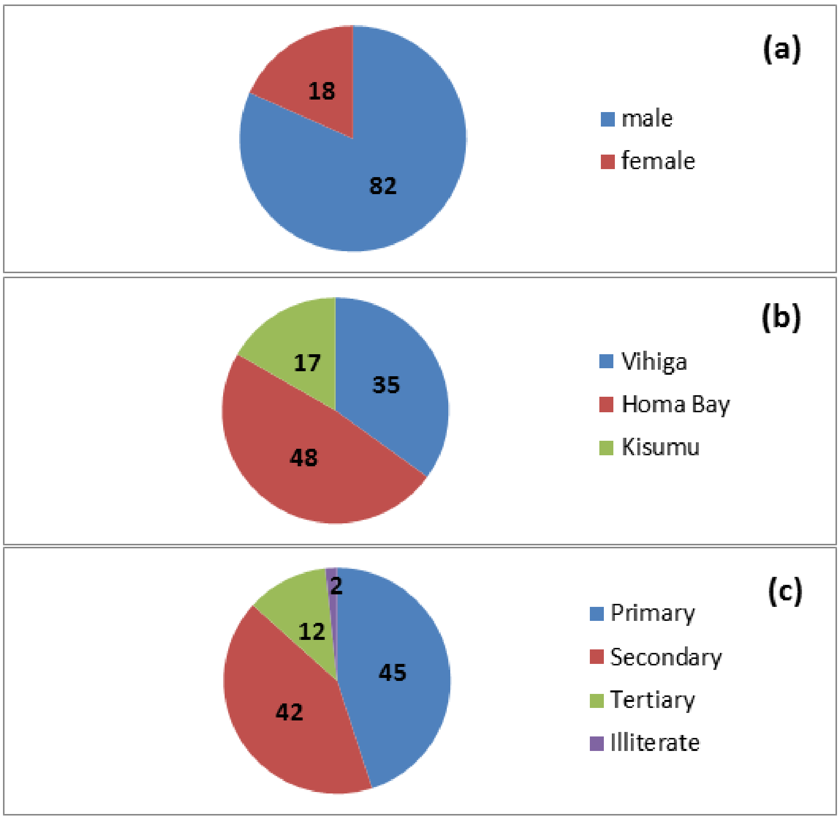


Figure 5.5 Gender (a), county (b) and highest level of education (c) divisions of the interviewed farmers farming Nile tilapia (Oreochromis niloticus) and/or African catfish (Clarias gariepinus) of this study conducted in western Kenya (Nyanza and Western provinces) in August and September 2012

5.3.3 Limitations

Marshall and Rossman (2011) note that research cannot be designed without certain limitations; never, for example, can all relevant stakeholders be interviewed in depth. The main limitation of this study is the fact that I was only able to interview one group of stakeholders, i.e. the fish farmers. Furthermore, my research was limited to fish farmers who spoke English. Even though English is an official language in Kenya (CIA, 2013), Kiswahili and various indigenous languages are prevalent in the villages. Not only was the respondents' ability to speak English crucial, decisive was also their contentment to discuss their farming activities and livelihood situation. Another restraining factor was that English is not my first language either. Without doubt misunderstandings were evoked by the conversation of two parties, of which one at least was a non-native English speaker. I tried to avoid such misunderstandings as much as possible by speaking slowly and re-wording my questions as well as giving the respondents time to read the questions. On the other hand, the fact that I am not a native English speaker may have reassured some participants.

A few times I was confronted with farmers not able to speak English. The aquaculture extension officers, at least one of which usually travelled with me, helped me by interpreting and translating. This, however, may have put their point of view across to me rather than the opinion of the fish farmers. I was not able to avoid this.

My respondent pool was also limited to respondents comfortable discussing personal and political issues with a foreigner. Some individuals may have been uncomfortable sharing their opinion as well as certain personal information with someone who has a completely different background and colour. I felt that the issue of skin colour played a critical role in the willingness, and possibly also honesty, in answering certain questions. Some farmers may have tried to impress me. From discussions with the aquaculture extension officers from the MoFD I learned that fish farmers in the area are accustomed to discussing their activities with NGO personnel, and hence know which answers are 'good' and 'bad' ones to give. However, apart from taking note of possible bias (Bernard, 2006) I was not able to avoid these issues. In some cases, however, there may have been potential benefits by my status as a foreigner. I most likely did not represent a political 'threat' and hence fish farmers may have answered my questions more honestly.

The 'snowball' method is known to generate a relatively homogenous data sample (Bernard, 2006). My inability to choose respondents randomly may have resulted in the disadvantage of only getting to interview fish farmers that are comparatively 'well-off'.

Many of the farmers were elderly and male, often receiving a pension or having a regular business generating income. I cannot shake off the feeling that the extension officers may have been ashamed of showing me farms in bad conditions. However, I made efforts to alleviate this bias as much as possible by trying to interview farmers from different areas. Thanks to the MoFD I had access to transport and was able to interview fish farmers up to a two hours´ drive away from Kisumu.

My intent was to find around 20 farmers in each of the three groups. However, it was especially difficult to find fish farmers who had never received any ESP support (Group C). Nonetheless, I decided to include the eight farmers in this group in my research because I consider this group extremely important for evaluating the outcomes of the study. Even though every effort was made to present a reliable set of outcomes, comparisons between the three groups of fish farmers are complicated due to the considerable difference in sample sizes.

5.4 Data Transcription and Analysis

5.4.1 Data Transcription

Data noted down on the survey questionnaires during the interviews were transcribed into Microsoft Excel (2007) between September and December 2012. During this step some data were numerically coded (e.g. 1 = yes; 2 = no; 0 = no response) in order to ease data management and lucidity, as suggested by Bernard (2006).

5.4.2 Data Analysis

I analysed and discussed the data using the characterization of livelihood improvements used by DFID (1999); i.e. that livelihood improvements happen when communities experience increased well-being and reduced vulnerability through higher incomes, improved food security and the more sustainable use of natural resources.

For analysis some of the data were pooled into categories: Manure, cow dung, chicken droppings and compost, for example, were pooled as organic fertilizers. This step was necessary for open-ended short answer questions. The construction of visual displays like graphs and tables, recommended by Bernard (2006) for all qualitative and quantitative analysis, helped me to understand the data and communicate detected patterns to the readers.

In order to assess any aquaculture related activities incorporating time spans (i.e. fish grow-out period, expenditures and income over a year) correctly, it was necessary to know the period of time between stocking of the pond with fingerlings and re-stocking for the next grow-out cycle. This period includes the time that the fish pond is actually occupied with fish, plus approximately one month of fallow period between fish harvest and re-stocking (fish farmers, personal communications, August and September 2012). The average length of one such cycle is 7.9 months, ranging between six and 12 months. The farmers were asked to provide information about their incomes and expenditures for one such cycle and the size of their last fish harvest. From these figures monthly figures were calculated and ultimately extrapolated to give yearly figures.

5.4.3 Limitations

Employing a full Sustainable Livelihoods Framework (using poverty reduction, well-being and capabilities, livelihood adaption, vulnerability and resilience, and natural resource base sustainability as indicators to assess sustainable livelihoods) to analyse the data, as done by Ahmed (2009), would have given a broader and more in-depth insight into livelihood improvements of the studied households. However, due to time-constraints only certain aspects were investigated, namely incomes, food security and the sustainable use of natural resources.

The use of voice recording would possibly have increased my credibility, as well as made data transcription and analysis easier. However, I suspect that under the interviewing circumstances a voice recording device might just have introduced tenseness amongst the respondents, which would have negatively impacted the answers given. Hence, I believe that the use of multiple choice questions as well as a few very short open answer questions eliminated the need for voice recording.

6 Results

6.1 Fish Farming Characteristics

6.1.1 General

The majority of the respondents (61.7%) were members in a fish farming group. The water used for fish farming was most often groundwater (45%), followed by lake- and well water (18.3%, each). Fifteen per cent of respondents stated riverine water sources (no response: 3.3%). Many farmers mentioned that for them aquaculture represents a ´risky´ activity of income creation in terms of harvest losses due to water non-availability and fish diseases (fish farmers, personal communications, August and September, 2012). General fish farming characteristics, according to the type of support received by the farmers, are displayed in Table 6.1. Farmers owned an average of 2.6 ponds, ranging from one to 13 (average pond area: 355.6 m^2), i.e. 936.4 m^2 pond area per farm. Farmers in Group C not only had most ponds on their farms, they also employed most labourers. The main species farmed by all groups was tilapia, mostly in monoculture systems. The often more rewarding polyculture of tilapia and catfish (Ngugi *et al.,* 2007) was mainly practiced by Group C, followed by Group B. A similar tendency was observed with the use of polysex fingerlings: Mainly farmers in Group C used this comparatively cheaper alternative of fingerling acquisition, followed by Group B. Several farmers doubted the efficiency of monosex fingerlings, observing fish reproduction in the ponds even though hatcheries claimed to sell monosex fingerlings (fish farmers, personal communications, August and September, 2012). The re-use of pond water, e.g. for watering vegetables, was mostly practiced by Group B, followed by Group C. The main fertilizers used were of organic nature, i.e. compost and various kinds of manure. The chemical fertilizer Di-Ammonium Phosphate was mainly used by Group A, rarely on its own though. Record-keeping was widely practiced, mainly in Group C, followed by Group A. Overall, farmers in Groups B and C did best in terms of cost-effective and environmentally sustainable farming practices: Group C through their lead in the use of polysex fingerlings and polyculture systems; Group B through their lead in water-reutilization and the use of organic fertilizers.

Table 6.1 Fish farm characteristics of the different groups of farmers farming Nile tilapia (Oreochromis niloticus) and/or African catfish (Clarias gariepinus) in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province). Group A: started aquaculture with the Economic Stimulus Programme (ESP); Group B: started aquaculture before the ESP and later received some ESP support; Group C: never received ESP support

		Group A (n=28)	**Group B (n=24)**	**Group C (n=8)**	**All (n=60)**
#ponds	Average	2.4	2.7	3.25	2.6
# paid employees on the farm	Average	1.3	0.9	1.8	1.2
% farmers farming...	Only tilapia	89.3	79.2	62.5	81.7
	Only catfish	0	0	12.5	1.7
	Both	10.7	20.8	25	16.7
% farmers practicing...	Monoculture	92.9	91.7	75	90
	Polyculture	7.1	8.3	12.5	8.3
	Both	0	0	12.5	1.7
% farmers using...	Monosex	64.3	45.8	25	51.7
	Polysex	28.6	41.7	62.5	38.3
	Both	7.1	12.5	12.5	10
Re-use of water (% of farmers)	Yes	21.4	50	37.5	35
	No	60.7	50	37.5	53.3
	No response	17.9	0	25	11.7
Fertilizer used (% of farmers)	Organic	67.9	87.5	75	76.7
	Chemical	3.6	0	0	1.7
	Both	17.9	12.5	12.5	15
	None	7.1	0	0	3.3
	No response	3.6	0	12.5	3.3
Records kept (% of farmers)	Yes	82.1	58.3	87.5	73.3
	No	17.9	37.5	12.5	25
	No response	0	4.2	0	1.7

6.1.2 Access to Aquaculture Related Necessities

Easy access to fingerlings, fish feeds, fertilizers, pond construction help, training facilities and markets are crucial for success of aquaculture practices. Travel times in the study area can be prolonged due to bad road conditions which may have negative impacts on, for example, fingerling quality. The average distances that fish farmers had to cover in order to access certain aquaculture related necessities are displayed in Table 6.2. Fertilizers were mainly obtained locally, greater distances had to be covered to access fingerlings and fish feed. Public transport, such as motorcycle taxis, was used by most farmers (81.7%) to access aquaculture related necessities. Only 1.7% of respondents owned a motorized vehicle, 8.3% relied on biking and walking (no response: 8.3%).

Table 6.2 Distances (in km) to be covered by Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) farmers in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province) in order to get access to certain aquaculture related necessities

Aquaculture related necessity	Average distance from farm (km)	Range (km)
Access to fingerlings (n= 57)	11.9	0 – 60
Access to fertilizers (n=58)	4.4	0 – 60
Access to fish feed (n=56)	10.3	0 – 60
Help for pond construction (n=52)	5.3	0 – 60
Training facility (n=51)	9.9	0 – 60
Closest market (n=56)	5.3	0 - 60

6.1.3 Fish Feed

In an open question the respondents were asked to list the types of fish feeds they used. Between the 60 farmers, a total of 137 answers were given. These were grouped into six different categories (Table 6.3). Specific fish feeds in each category, if the farmers stated any, are also displayed in this table. The frequency of different categories of fish feed used by different groups of farmers is shown in Figure 6.1. The bulk of fish feed was made up of various formulated feeds, followed by freshwater animals, cereal, garden/kitchen waste, manure and fruit/vegetables. Farmers in Group A were the main users of (expensive) formulated feeds. Farmers in this group also were the main users of cereal and manure. Farmers in Group C, on the other hand, were the mainly users of cheaper and locally available garden/kitchen waste, freshwater animals and fruit/vegetables. Fifteen per cent of farmers exclusively fed formulated feeds; 8.3% did not use these feeds at all. The majority of farmers (73.3%) fed their fish on a mixture of formulated and other feeds (no response: 3.3%).

Table 6.3 Fish feed categories, and fish feeds specifically stated in each category by Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) farmers in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province)

Feed Category	Feed Types Specifically Stated
Formulated Feed	Floating pellets, sinking pellets, mash
Garden/Kitchen Waste	(Banana) leaves, grass
Cereal	Maize flour, rice and wheat bran, maize, rice
Freshwater Animals	Omena, shrimp
Manure	Chicken waste
Fruit/Vegetables	Avocadoes, yams, Soya beans, cabbage

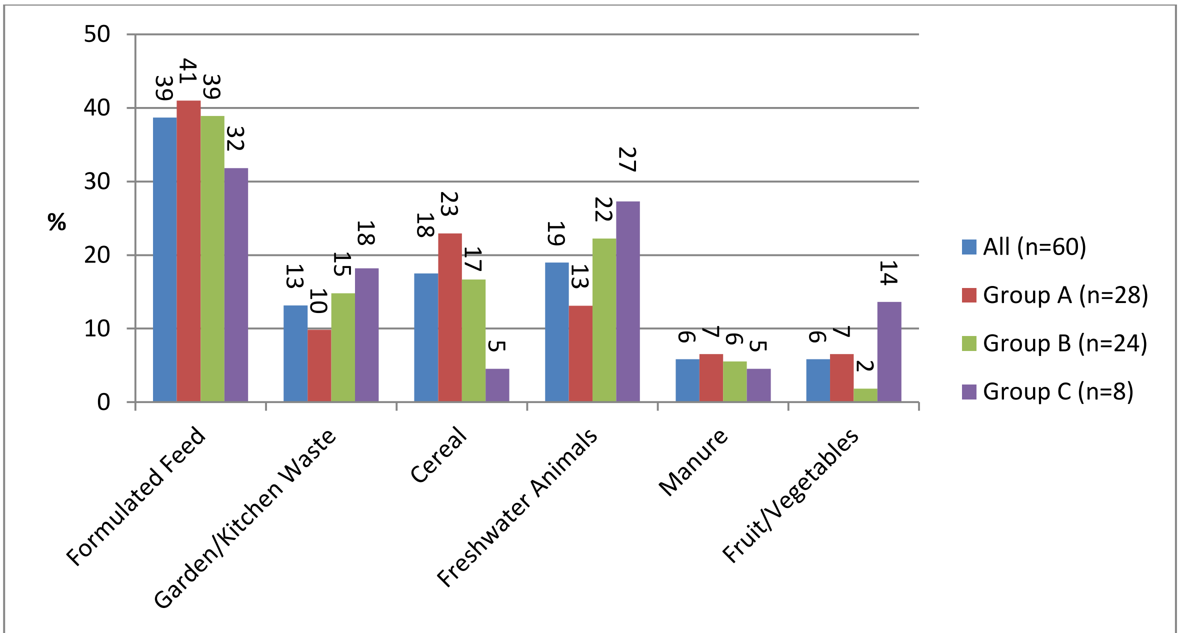


Figure 6.1 Frequency of different categories of fish feeds used by farmers in Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province). Group A: started aquaculture with the Economic Stimulus Programme (ESP); Group B: started aquaculture before the ESP and later received some ESP support; Group C: never received ESP support. Species cultured: Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus)

6.1.4 Problems on the Fish Farms

The major problems concerning fish farming were grouped into six categories (Table 6.4). Specific problems in each category, if any were stated, are also displayed in this table. Farmers grouped by their major fish farming related problem are displayed in Figure 6.2. Overall, finance was the major problem encountered, especially by farmers in Group C, followed by Group A. The second most encountered problems for Groups A and C were predators and security, respectively. Lack of training (knowledge) and marketing related problems only played a marginal role. Water availability is crucial for fish farming. Twenty per cent of farmers stated problems with flooding, and 18.3% stated the non-availability of water during droughts as a problem. The majority of farmers (61.7%) had never encountered water-related problems on their farms.

Table 6.4 Specific problems stated in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province), concerning Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) farming

Problem Category	**Specific Problems stated**
Finance	Feed price, fuel price, fingerling price
Management	Seepage, feed availability/quality, fingerling supply and high mortality
Marketing	Low fish price, market access
Predators	Birds, monitor lizards
Knowledge	Lack of trainings/education
Security	Thieves

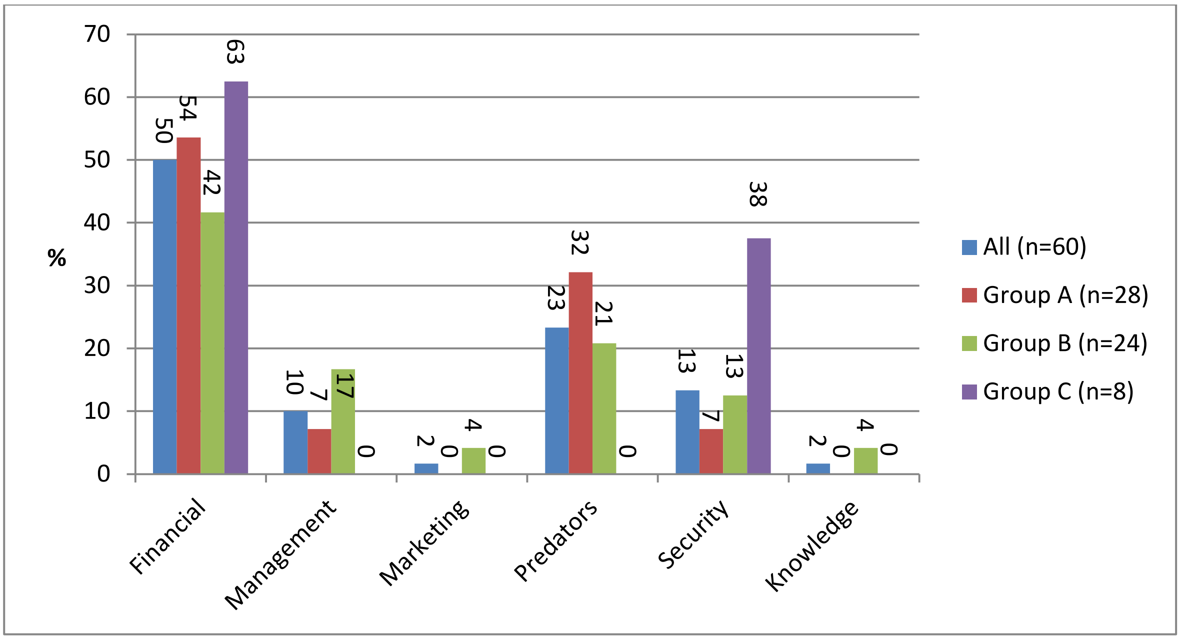


Figure 6.2 Farmers in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province) grouped by their major fish farming related problem. Group A: started aquaculture with the Economic Stimulus Programme (ESP); Group B: started aquaculture before the ESP and later received some ESP support; Group C: never received ESP support. Species cultured: Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus).

6.2 Support Mechanisms Used

Fifty-eight per cent of farmers from Groups A and B got information about ESP support from extension officers; 23% received information from other farmers. The media and promotional activities were stated by 5.8% and 1.9%, respectively (no response: 11.5%). Farmers in Group C stated unsuccessful application (37.5%) and unawareness about the project (25%) as reasons for not receiving the support (no response: 37.5%).

Farmers in Group B were less likely to receive ESP supported ponds, feeds and fingerlings than farmers in Group A. However, it is important to notice that almost twice as many farmers in Group B attended trainings than in Group A (Table 6.5). In total, only 11.7% of farmers ever applied for a loan. Of these, 71.4% received the loan. 'Fear' was stated by many farmers as a reason for not applying for loans (fish farmers, personal communications, August and September 2012).

Table 6.5 Support received by the Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) farmers in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province) through the Kenyan government's Economic Stimulus Programme (ESP). Group A: started aquaculture with the ESP; Group B: started aquaculture before the ESP and later received some ESP support

Support Type	Criterion	Group A (n=28)	Group B (n=24)
Ponds	% of farmers receiving ESP pond(s)	100	16.7
	% of ESP ponds of total ponds	67.2	10.9
Trainings	% of farmers who received ESP training	32.1	62.5
Feed	% of farmers who received ESP fish feed	96.4	70.8
Fingerlings	% of farmers who received ESP fingerlings	92.9	66.7

6.3 Farm Wealth

6.3.1 Pond Productivity

The size of the last fish harvest and pond productivities are shown in Table 6.6. Remarkable is that out of all groups, Group A - by far - showed the lowest fish production. Group B was doing best production-wise.

Table 6.6 Productivity of Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) ponds in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province). Group A: started aquaculture with the Economic Stimulus Programme (ESP); Group B: started aquaculture before the ESP and later received some ESP support; Group C: never received ESP support

	All (n=54)	Group A(n=27)	Group B (n=21)	Group C (n=6)
Average last harvest (kg/farm)	310.4	239.9	408.2	285.3
Pond productivity at last harvest (kg/m^2)	0.30	0.20	0.47	0.32
Calculated productivity (kg/m^2/year)	0.45	0.30	0.71	0.49
Estimated productivity (kg/300m^2/year)	135	90	213	147
Estimated productivity (kg/ha/year)	4,500	3,000	7,100	4,900

6.3.2 Use of Fish Harvest

The harvested fish were sold on the market, consumed at home and/or given away (to relatives and neighbours, and payment-in-kind). Overall and also in all groups the fish was mainly sold on the market. Home consumption and given away were only marginally represented (Figure 6.3).

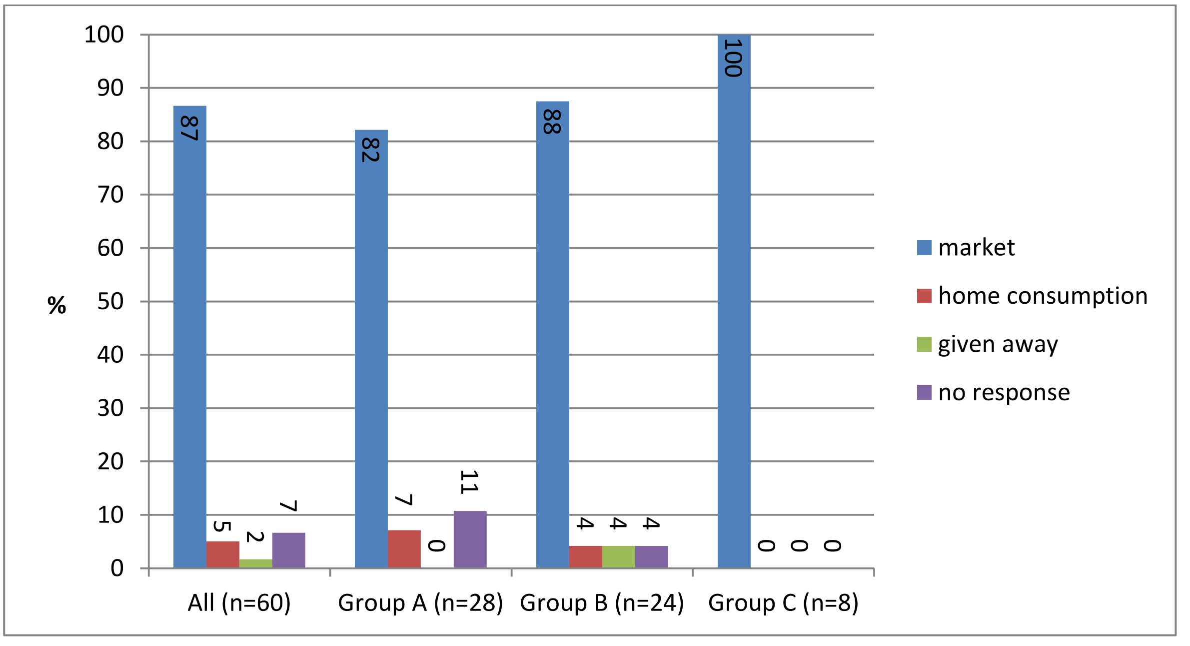


Figure 6.3 The main use of Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) harvests of farmers in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province). Group A: started aquaculture with the Economic Stimulus Programme (ESP); Group B: started aquaculture before the ESP and later received some ESP support; Group C: never received ESP support

6.3.3 Use of Household Income

The main uses of the fish farmers' incomes (from aquaculture and other sources) are displayed in Figure 6.4. Overall, the incomes were mainly invested in aquaculture. This is also visible in Groups A and C. Only in Group B the farmers spent most of their incomes on paying schooling fees. Out all groups, Group B farmers also spent most on personal use and Group A spent least on aquaculture.

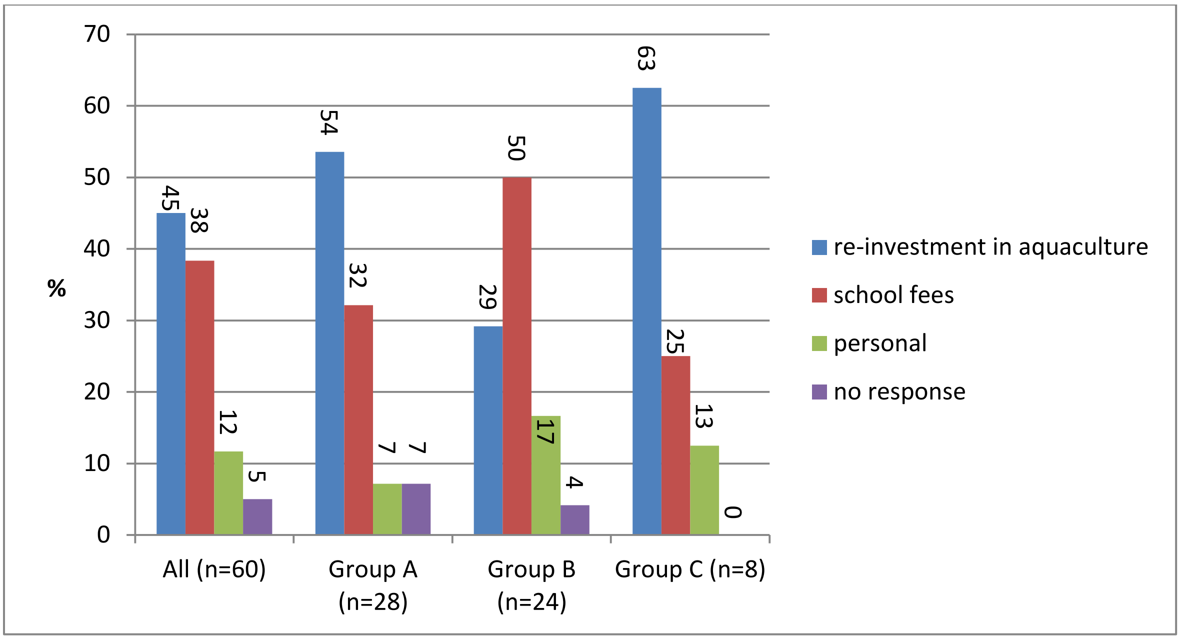


Figure 6.4 The main use of the total household income of Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) farmers in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province). Group A: started aquaculture with the Economic Stimulus Programme (ESP); Group B: started aquaculture before the ESP and later received some ESP support; Group C: never received ESP support

6.3.4 Aquaculture and Income Creation

The price of tilapia on the market was low, and fish farmers had trouble producing large-sized fish for non-local sales. Several fish farmers stated that they harvested fish of about 150 g each, receiving KES 100 (USD 1.18) for four pieces on the market (i.e. 167 KES/kg, or 1.98 USD/kg). Also, many farmers stated that Kenyans prefer wild fish to cultured fish due to bad perceptions of cultured fish that people have. Selling farmed fish on the markets was hence often hampered (fish farmers, personal communications, August and September 2012). Every respondent had at least one more source of income, additional to aquaculture (Figure 6.5). Overall aquaculture was the most important factor out of five in about 40% of cases. Out of all groups, farmers in Group C relied most heavily on aquaculture as their primary source of income; farmers in Group B depended least on aquaculture. Farmers in this group also relied heavily on fishing and salaries/pensions. Salaries and pensions were generally important in income creation. Incomes from agriculture came from tea, fruit (e.g. bananas, papayas) and vegetables (e.g. beans).

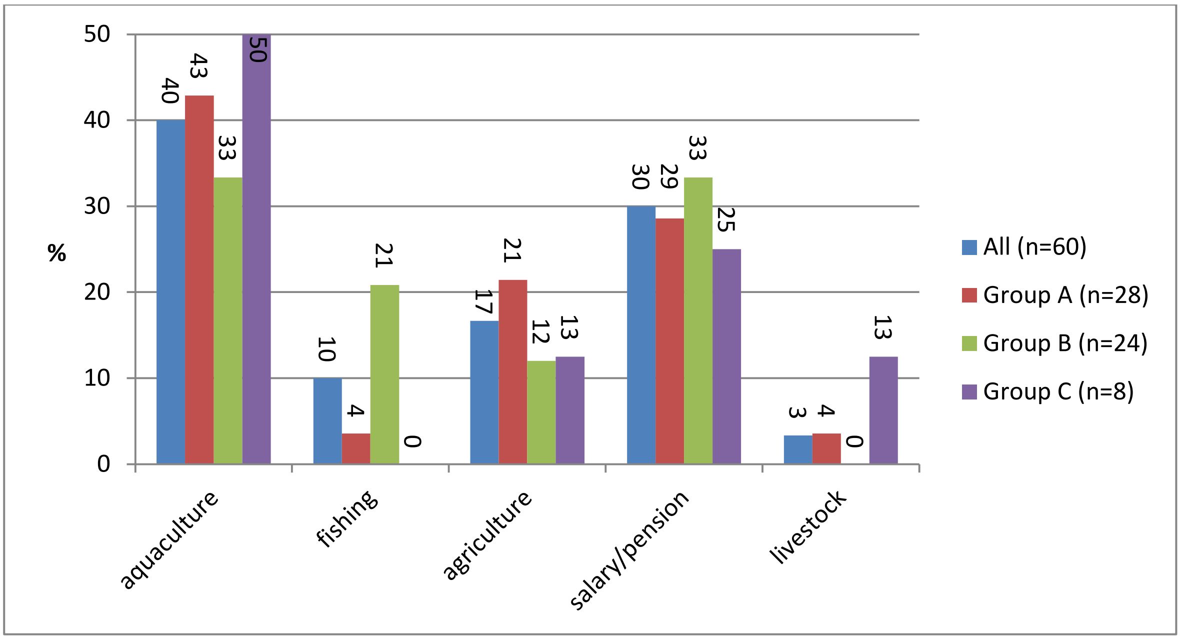


Figure 6.5 The most important source of income as stated by Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) farmers in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province). Group A: started aquaculture with the Economic Stimulus Programme (ESP); Group B: started aquaculture before the ESP and later received some ESP support; Group C: never received ESP support

6.3.5 Aquaculture Expenditures

The main aquaculture related expenditures are displayed in Figure 6.6. Fish feed clearly was the main expenditure overall and for all three groups. Out of all groups, Group A spent least on pond construction, fish feeds and fingerlings. This group, however, spent comparatively much on labour and maintenance (i.e. fuel price, farm security enforcement). For Group C fingerlings and maintenance expenditures did not play a major role.

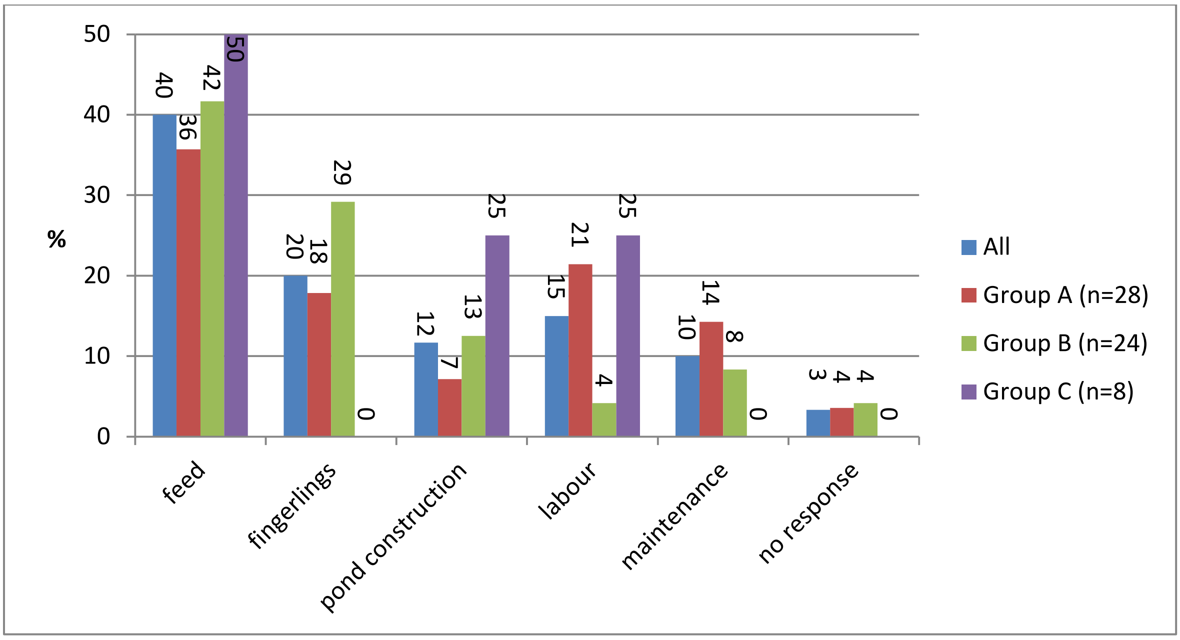


Figure 6.6 The main aquaculture related expenditures stated by Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) farmers in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province)). Group A: started aquaculture with the Economic Stimulus Programme (ESP); Group B: started aquaculture before the ESP and later received some ESP support; Group C: never received ESP support

6.3.6 Aquaculture Profits and Self-Sufficiency

The sum of the three main aquaculture related expenditures over the previous 12 months and the income from aquaculture, also over the previous 12 months, were used to calculate the percentage of self-supportive aquaculture (i.e. aquaculture income > aquaculture expenditures) (Table 6.7). The average annual income from aquaculture was highest in Group A, and lowest in Group C. Aquaculture expenditures were highest in Group C, and lowest in Group B. The annual profit from aquaculture was highest for Group A; Groups B and C only recorded losses. Alarmingly few farms were self-sufficient in terms of aquaculture. Most self-sufficient farms were found in Group A, least in Group C.

Table 6.7 Average annual aquaculture incomes, expenditures and profits, and portion of farms where aquaculture is self-supportive (i.e. aquaculture income > aquaculture expenditures) in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province). Group A: started aquaculture with the Economic Stimulus Programme (ESP); Group B: started aquaculture before the ESP and later received some ESP support; Group C: never received ESP support. Farmed species: Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus)

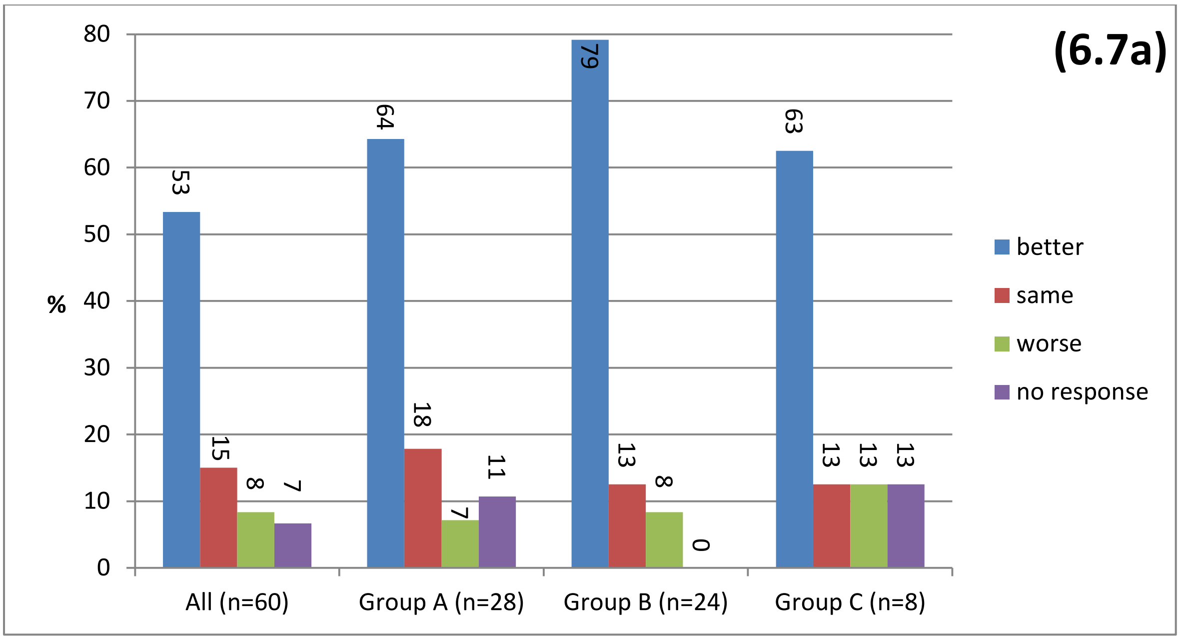
	Average aquaculture income/farm/year in KES (USD)	**Average aquaculture expenditures/farm/year in KES (USD)**	**Average net aquaculture profit/farm/year in KES (USD)**	**Self-supportive aquaculture**
All (n=60)	81,109 (960)	66,645 (788)	14,463 (171)	45.0%
Group A (n=28)	112,731 (1,334)	75,946 (898)	36,785 (435)	46.4%
Group B (n=24)	44,885 (531)	45,402 (537)	-517 (-6)	45.8%
Group C (n=8)	79,104 (936)	97,824 (1,157)	-18,720 (-221)	37.5%

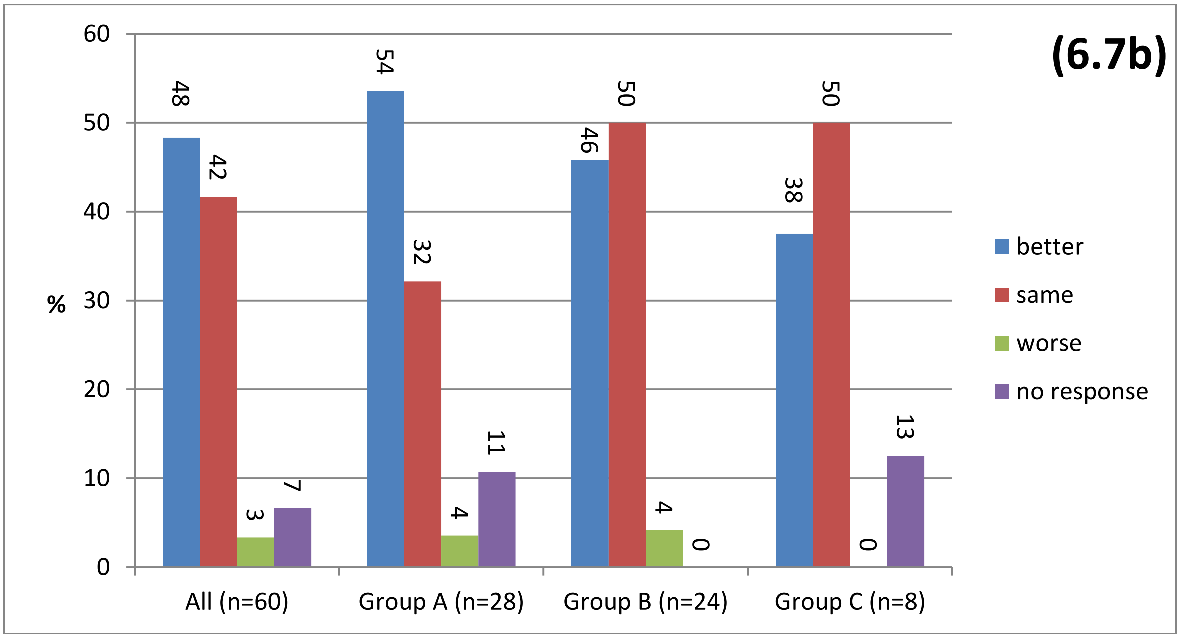
Fifty-five per cent of respondents stated that aquaculture was an additional business (i.e. no former activity was dropped in order to take up fish farming); 36.7% stopped one or more former income-creating activities when starting to farm fish (no response: 8.3%). Former income-creating activities done by the farmers were mainly of agricultural nature, a few respondents stated fishing and various salaries. However, fish farmers who replaced a former activity with aquaculture were usually worse-off (59.1%) than before the start of fish farming (no response: 13.6%).

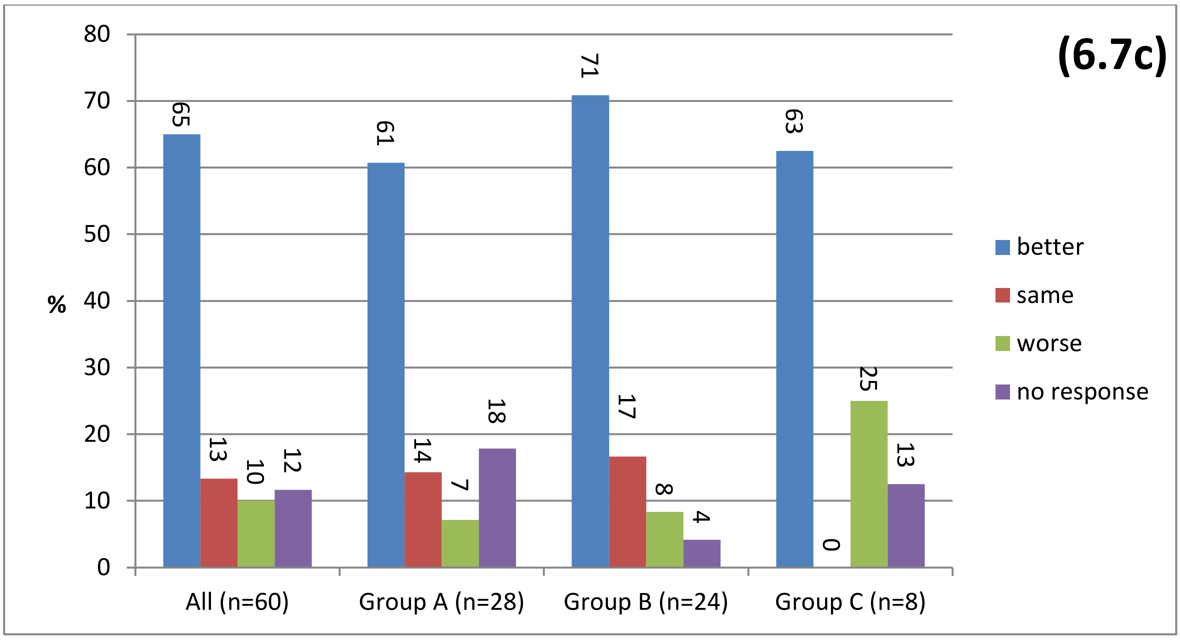
6.4 Livelihood Changes

6.4.1 Changes in Diet Diversity, Healthcare, Payment of Schooling Fees and Household Possessions

Overall, livelihood situations of the farmers in terms of diet diversity, household assets and the ability to take care of their health and pay schooling fees improved with the commence of fish farming (Figure 6.7). Farmers who stated better situations mostly belonged to Groups A (most improvement in healthcare and household assets) and B (most improvement in diet diversity and schooling fees). Farmers who stated worse circumstances mainly belonged to Group C (in terms of diet diversity, schooling fees and household assets). Worse situations in terms of healthcare were stated by farmers in Groups A and B.







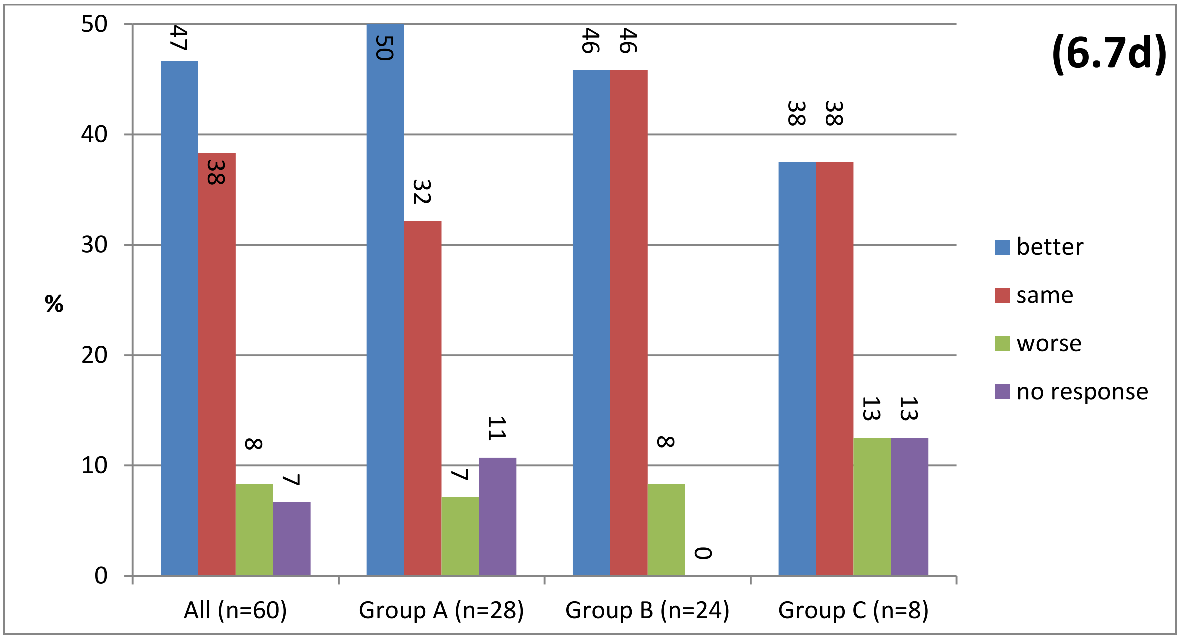


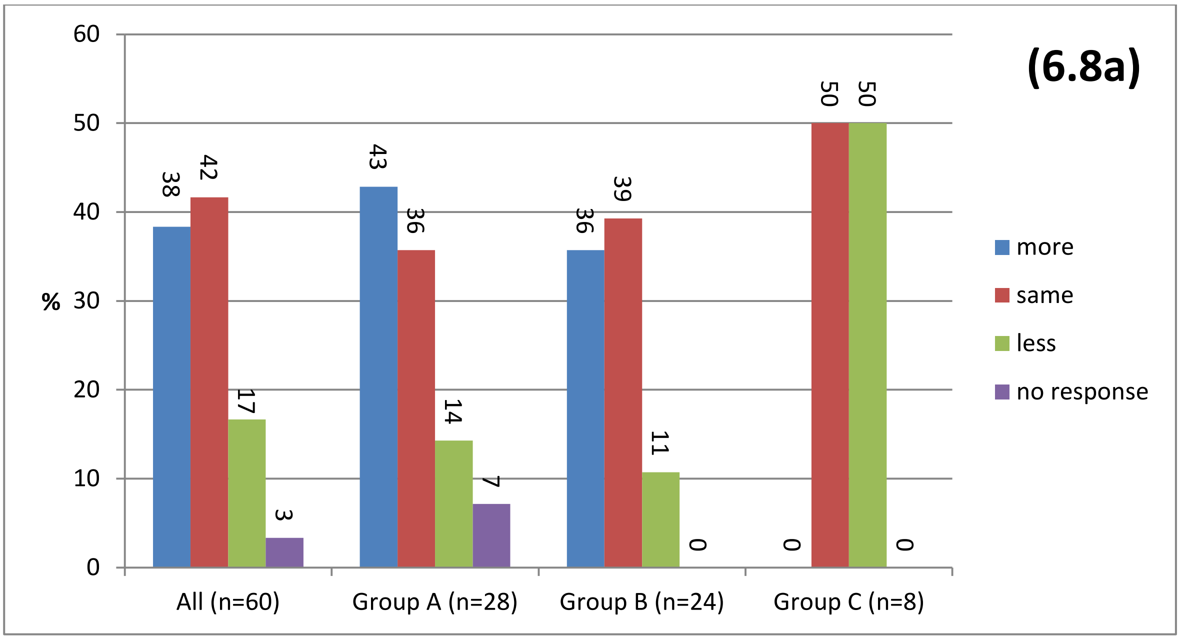
Figure 6.7 Changes in four different livelihood aspects of Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) farmers in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province) since starting aquaculture: (6.7a) Diet diversity, (6.7b) healthcare, (6.7c) ability to pay schooling fees and (6.7d) amount of household assets owned. Group A: started aquaculture with the Economic Stimulus Programme (ESP); Group B: started aquaculture before the ESP and later received some ESP support; Group C: never received ESP support

6.4.2 Changes in Protein Consumption

Protein consumption is a valuable indicator for livelihood situations (FAO, 2012). In this study the respondents were firstly asked to indicate their weekly consumption of certain types of animal proteins (i.e. meat, fish from the market and omena – local sardines that may be bought on the market and are included in this study because they represent a cheap source of animal protein (Ardjosoediro & Neven, 2008)) and plant proteins (i.e. beans) before the start of fish culture (Table 6.8). Fish from the market and meat were consumed less frequently than omena and beans. Secondly, the fish farmers indicated if, after starting aquaculture, they consumed more, less or the same amount of these proteins (Figure 6.8). The consumptions of omena and beans show similar patterns: Overall most farmers stated to still consume these proteins at the same frequency than before starting to farm fish. Most farmers that stated a less frequent consumption of these cheaper proteins belonged to Group C. Most households eating more meat belonged to Group A; overall the consumption of the same amount of meat was stated most frequently. However, a lot of farmers also said their families' meat consumption had increased. Farmers in Group C, again, ate less meat than before the start of aquaculture; no farmers in this group stated that they ate more meat. A similar pattern was observed about purchased fish consumption: The majority of farmers in Group C stated a lower consumption compared to the situation before the start of aquaculture. Overall, a slight majority of farmers stated that they consumed purchased fish less frequently.

Table 6.8 Average consumption frequency (times per week) of four different types of protein consumed by Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) farmers in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province)before aquaculture was started

Protein source	**Average consumption (times/week) pre-aquaculture**
Meat (n=57)	1.2
Fish from the market (n=56)	1.5
Omena (n=56)	2.9
Beans (n=52)	2.2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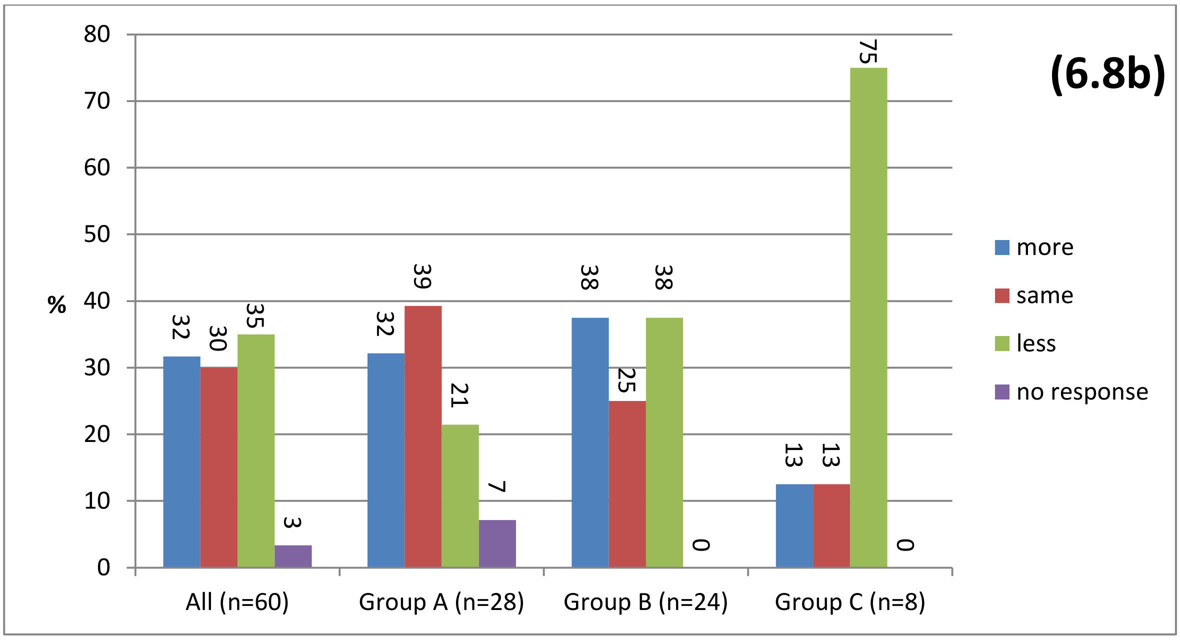
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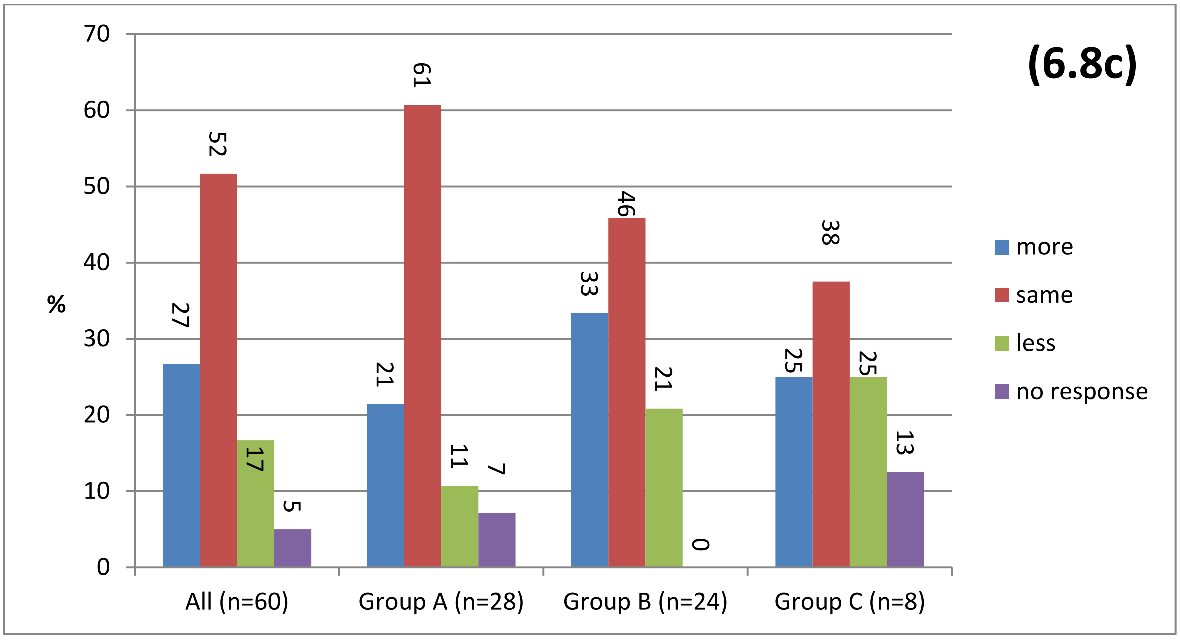

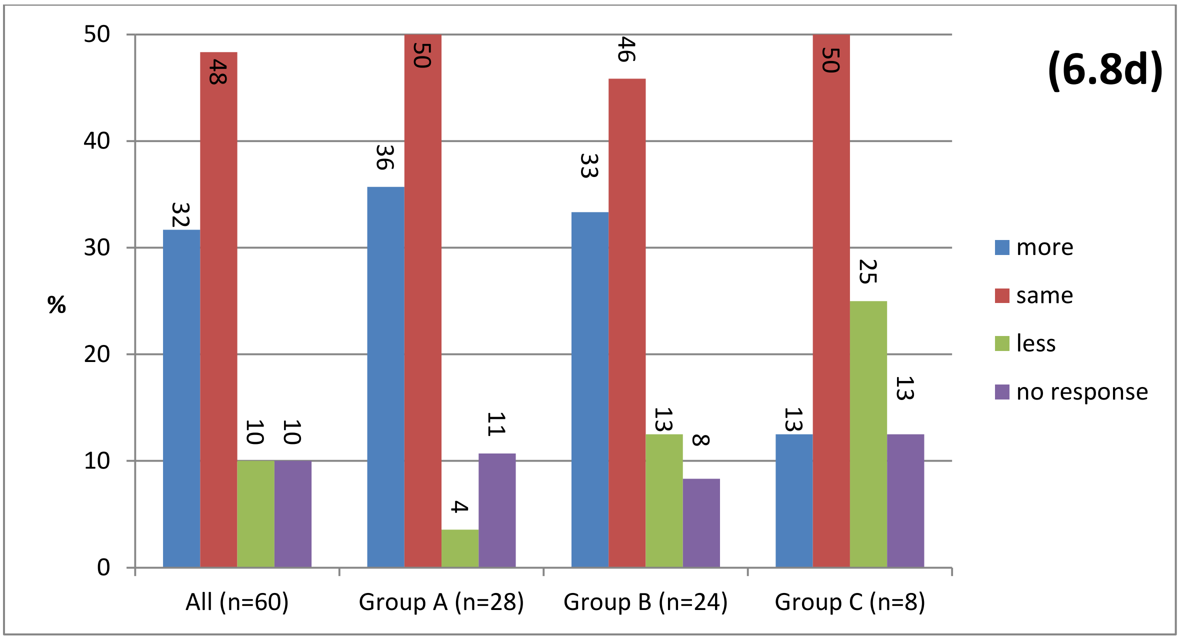

Figure 6.8 Changes in the consumption frequency of four different types of protein of Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) farmers in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province) since starting aquaculture: (6.8a) meat, (6.8b) fish bought on the market, (6.8c) omena and (6.8d) beans. Group A: started aquaculture with the Economic Stimulus Programme (ESP); Group B: started aquaculture before the ESP and later received some ESP support; Group C: never received ESP support

6.5 Future Perspectives

6.5.1 Future Plans and Funding

The majority of fish farmers were planning on expanding their aquaculture enterprises (Table 6.9). None of the farmers indicated they would discontinue or reduce their aquaculture. Some of the fish farmers (personal communications, August and September 2012) stated land availability problems as a reason for not being able to expand aquaculture. The majority of respondents (56.7%) stated the fish farm's profits as their main future aquaculture funding source. Loan application was named by 18.3% of respondents; 11.7% stated to rely on some sort of subsidies. The remaining 13.3% of farmers did not know how to finance their aquaculture enterprise in the future.

Table 6.9 Future plans of Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) farmers in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province), concerning their aquaculture enterprise. Group A: started aquaculture with the Economic Stimulus Programme (ESP); Group B: started aquaculture before the ESP and later received some ESP support; Group C: never received ESP support

	All (n=60)	**Group A (n=28)**	**Group B (n=24)**	**Group C(n=8)**
Continuation	26.7%	35.7%	20.8%	0%
Expansion	73.3%	64.3%	79.2%	100%

6.5.2 Future Support Needed

The main support needed, in all groups, was financial support. Other needs comprised training and management/infrastructure (i.e. better access to fish feed and markets, improved security, better road-infrastructure, better availability storage and cooling facilities as well as better communication between fish farmers through cooperatives) (Figure 6.9). Most need for training was mentioned by Group B, followed by Group C. Out of all groups, farmers in Group A stated the need for most management/infrastructure related support.

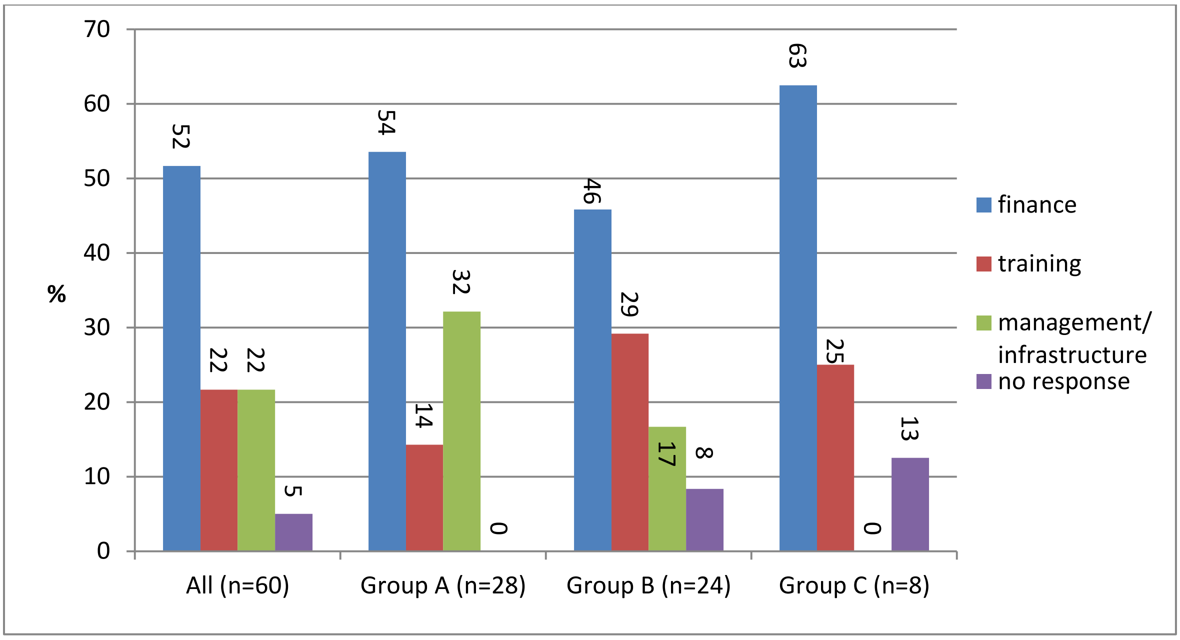

Figure 6.9 Type of support needed by Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) farmers in Kenya's Kisumu county, Homa Bay county (Nyanza province) and Vihiga county (Western province), in order to continue fish farming in the future. Group A: started aquaculture with the Economic Stimulus Programme (ESP); Group B: started aquaculture before the ESP and later received some ESP support; Group C: never received ESP support

7 Discussion

7.1 Livelihoods and Aquaculture

According to DFID (1999) livelihood improvements can be recorded when communities experience increased well-being and reduced vulnerability through *(a)* higher incomes, *(b)* improved food security and *(c)* the more sustainable use of natural resources. However, it needs to be noted that the application of a more holistic research approach, e.g. Participatory Rural Appraisal, as suggested by Ahmed (2009), may have changed the results of this study.

7.1.1 Income Creation and Aquaculture

Overall aquaculture played an important role in income creation in all the surveyed households. However, the income from other income-creating activities (e.g. agriculture) was needed to sustain fish farming: On less than half of the surveyed farms, in all groups, aquaculture was self-supportive. Similar observations about the particular successfulness of combining agriculture and aquaculture were made by Kawarazuka and Bene (2010), as well as by Aiga *et al.*, (2009). Only very few self-supportive aquaculture farms after donor-departure were also reported by Coche *et al.* (1994), initiating the thought that the situation in Kenya's Lake Victoria region may get worse, since ESP support was, at least partially, only available until 2012. The overall high importance of salaries and pensions in income creation may have to do with the rather old group of fish farmers interviewed in this study. Farmers with no support relied most on aquaculture as their primary source of income: Possibly they may have had to drop, or reduce, other income creating activities in order to start fish farming. This is supported by the fact that farmers with no support only had small, or no, shares in fishing, agriculture and business salaries. ESP support may have enabled farmers in Group A to keep up fishing, agriculture, livestock farming and regular businesses. Farmers in Group B depended least on aquaculture as their primary source of income, but practiced agriculture and had the highest shares in fishing and businesses to compensate. Their experience with fish farming may have taught them about the riskiness of aquaculture in the Lake Victoria region with its prevalent flooding and droughts.

Drought risks are increased in the study area due to the fish farmers' sole dependence on natural water sources. Later received ESP support possibly eased Group B's financial situation enabling them to go strong on other income creating activities.

Overall, pond productivity in the study area correlated well with the average amount produced (3 tonnes/ha) on small-scale fish farms in Kenya given by Rothuis *et al*. (2011). It was, in fact, often even higher. However, ponds of farmers surveyed in this study did not fulfil the expectations of the GoK's ESP; i.e. 270 kg/300m^2/year (Muiruri, 2010).

Interesting to see is that Group A was the only group making profits from aquaculture, even though Group A´s productivity was the lowest out of all groups. A possible explanation for this profit is that it builds upon ESP support received by the farmers. However, because ESP subsidies have been reduced over the years, farmers in Group A also needed to buy own aquaculture inputs. The comparatively high aquaculture expenditures in this Group may have to do with the fact that farmers habitually used more expensive inputs because these were usually supplied by the ESP. Due to lacking aquaculture experience farmers in Group A may not have known about lower cost alternatives.

The financial losses in aquaculture recorded by Groups B and C, even though these groups showed higher productivities than Group A, can possibly be explained by reduced, or no, funding in these Groups: Expenditures were highest in Group C (no funding); incomes were however higher than in Group B. Farmers in Group B also went very strong on other income creating activities, possibly reducing money and time available for aquaculture. Expenditures in Group B were lowest which can possibly be explained by their long experience with aquaculture, making them learn about cost-effective farming techniques (see section 7.1.3). The later received subsidies possibly alleviated their financial situation. For Group C long aquaculture experience and knowledge about cost-effective farming practices was not able to compensate for the non-availability of subsidies; expenditures in this group are highest out of all. Contributing to this may be the fact that farmers in Group C also employ most labourers.

Overall, it is important to note though that the actual profitability of aquaculture is likely to be even worse for all groups since only the three most important aquaculture expenditures were used to calculate aquaculture profits. Also, even though record-keeping was widely practiced by fish farmers in the study area caution needs to be exercised, especially with results regarding incomes and expenditures.

Even though local markets in the study area were available, market access may was often recorded to be difficult due to bad road conditions and the fact that most farmers did not have their own transport. Public transport is costly, possibly hindering farmers from selling the fish on the markets to increase their profits. The importance of not only market availability, but also accessibility, for increasing aquaculture profitability was stressed by Brummett *et al.* (2011), and Brummett and Williams (2000). Other problems that may hamper market sales of cultured fish in the study area are the consumers' poverty and bad perception of cultured fish, both observed in the study area. Poverty of fish consumers was also identified by Brummett and Williams (2000) as a constraint for market sales of cultured fish.

This study shows that, on a regional scale, some employment was indeed created through aquaculture. However, small-scale aquaculture often does not create full-time employment all-year-round. Respondents stated frequently that casual labourers were employed mainly during pond construction and harvest. Also, most labourers were not only working in aquaculture, but carried out work in other sections of the farm as well. Important to note is that for some farmers of this study aquaculture seemed to represent mainly a recreational activity; not feasible as a full-time activity, but great on the side, especially if it is subsidised.

7.1.2 Food Security

Changes in protein consumption and overall diet diversity, as perceived by the respondents, are looked at in this section. Before the start of aquaculture the main proteins consumed were low-cost proteins like beans and omena. Higher cost options, like purchased fish and meat were consumed less frequently by all farmers.

After starting aquaculture, fish from the farm´s own ponds were rarely used for home-consumption, which contradicts with Dey *et al.* (2006)'s observation that fish farming households frequently consumed home-farmed fish. Almost all fish produced in the households in this study was sold on the market. Indirectly, however, the consumption of animal protein increased for many farmers in Groups A and B: Fish from the market and meat were, after the start of aquaculture, consumed more frequently in many of the farmers' households. A possible explanation for this observation in Group A may be the profit from aquaculture, increasing their food accessibility, which was also observed by Hishamunda & Ridler (2006). Another reason for Group A's increase in meat consumption could be that farmers now have more money to keep livestock on their farm for home consumption. Neiland *et al.* (2000)'s study supported this finding. The increased consumption of purchased fish and meat by Group B cannot be explained by profits made from fish farming. However, out of all groups, farmers in Group B spent most of their total household income (from aquaculture and other sources) on personal items, which include food. Respondents in this study harvested their fish once or twice per year to sell the fish on the market. Large amounts of fish cannot be kept at home for home-consumption due to the often reported lack of storage and cooling facilities. If farmers wanted to produce fish for home-consumption only, continuous harvest methods would have to be applied. Aquaculture in the study area hence produced 'cash crops', not 'food crops'. Protein consumption of farmers in Groups A and B may have improved, but indirectly through the generation of income. However, it is possible that the farmers who stated a lower consumption of purchased fish than before the start of aquaculture replaced the consumption of previously purchased fish with fish from the own ponds.

An exception in protein consumption was made by Group C. Even though all the fish harvested is sold on the market, meat consumption showed no increase, and purchased fish consumption increased least compared to the other groups. Farmers in this Group only record financial losses from their aquaculture and may hence not have money available to spend on animal protein.

Beans and omena kept their high importance as protein sources in the surveyed households, and were often also consumed more than before the acquisition of fish ponds. Both are traditional and low-cost foods in Kenya.

Overall diet diversity increased for all farmers since starting aquaculture; mainly, however, for Group B. Most farmers stating worse diet diversities since starting aquaculture were from Group C. Possible explanations are that Group C records serious financial losses with their aquaculture. Also, farmers in this group did not use any of the harvested fish for home-consumption to increase their diet diversities. Groups A and B, on the other hand, stated at least some minor home-consumption of harvested fish which may have helped to make these households´ diets more diverse. Diet diversities possibly also increased through food items bought with the income generated.

Caution, however, needs to be exercised when looking at findings stated in this section: Some farmers may not have answered these rather personal questions honestly, be it because of embarrassment and/or the expectation that stating improvements in nutrition through aquaculture may make extension personnel continue fish farming subsidies (extension officers, personal communications, August and September 2012).

Overall, the findings of this study compare well with Kawarazuka and Bene (2010) and Thompson *et al.* (2002), indicating that farmed fish is often mainly used as a cash crop, not a food crop. Incomes are then used to buy staple foods (Jahan *et al.,* 2010) as well as non-staple foods (Dey *et al.,* 2006), which was both observed in this study. However, further research is needed in order to assess the actual nutritional situation of the fish farmers since the sole increased availability of food items does not equal better nutrition.

7.1.3 Sustainable Use of Natural Resources

One way to increase the farms' profits, and hence support livelihoods, is the integration of fish farming in other traditional farming activities, as shown by Dey *et al.* (2006). Since Nile tilapia and African catfish feed well on a variety of different feeds, these species are ideal for an integrated aquaculture approach. This study shows that farmers indeed used a variety of different feeds for the fish. The utilization of on-farm and locally produced material like banana leaves, maize and protein-rich omena, makes sense as these ingredients are cost-effective and readily available. However, most farmers (especially farmers that received ESP support) chiefly used formulated feeds such as pellets and mash. These are expensive and often not locally available; making feeds the most frequently stated aquaculture related expenditure. Also, great distances usually had to be covered in order to buy these feeds, adding to the total aquaculture expenses. Farmers who did not receive aquaculture funding rely to a greater extent on cheaper and locally available feeds. In order to secure fast and secure fish growth to achieve high market prices, the use of high-protein feeds is preferred. In the study area these were comprised of locally available freshwater animals from Lake Victoria and formulated feeds. Farmers in Groups B and C used locally available high-protein feeds more often than farmers in Group A, and at the same time showed higher pond productivities. Hence, good fish growth does not seem to depend solely on the use of formulated feeds.

Pond fertilizers used in the study area were mainly on-farm and locally produced materials, not adding to expenditures related to aquaculture. These cheap and readily available agricultural by-products and farm waste products would otherwise be of less (or no) importance on the farms. However, again farmers in Group A were the main users of more expensive chemical fertilizers. Especially when aquaculture support is terminated, this could lower aquaculture profits.

Another way of integrating fish farming into agriculture is the re-use of pond water (e.g. for watering crops). This, however, was not widely practiced. Especially in the dry seasons this could help to improve crop farming and should therefore be encouraged. Higher crop yields could increase the farmers' incomes and/or nutrition which would, in turn, better their livelihoods as shown by Dey *et al.* (2006). Especially farmers in Group A did not often practice pond water re-use. Farmers in Groups B and C used this practice more, possibly due to their longer experience with fish farming.

The farming of both, tilapia and catfish (also in polyculture systems), gives the benefit of having another fish species to sell on the market and may hence increase the farmers' incomes to improve their livelihoods. Overall, however, this was not widely practiced and should be encouraged for above stated reasons. Mainly farmers in Groups B and C were aware of the benefits of farming both species, also in polyculture, possibly due to their longer experience with fish farming compared to Group A.

The use of polysex fingerlings would initiate the production of own fingerlings in years to come, lowering aquaculture expenditures (also travel expenses since monosex fingerlings are not usually obtained locally) and increasing aquaculture profits that could be used to improve livelihoods. Farmers in Group C were the main users of polysex fingerlings, possibly due to the cost-effectiveness of this option. Supportive is the fact that fingerlings were not part of main aquaculture related expenditures in Group C. Farmers in Group B, possibly habitually, used a high portion of polysex fingerlings. Fingerlings however still contributed to aquaculture related expenditures in this group. Farmers in Group A (possibly habitually) chiefly used only-male monosex fingerlings, perhaps because these were subsidised by the ESP. Monosex fingerlings increase and accelerate pond production and are hence convenient to use for commercial aquaculture, but are also very costly.

Overall, fish farmers in Groups B and C did best in cost-effective and environmentally sustainable farming practices. This can possibly be accounted to the longer aquaculture experience of these farmers: Over time, they gained a good understanding of the functioning and potential of certain aquaculture techniques, and will possibly guide further evolution towards greater productivity and profitability. It is also possible that farmers in Group B worked with researchers to improve fish farming techniques before GoK support followed. Farmers in Group A, possibly due to lacking aquaculture experience, only had limited knowledge about cost-effective and environmentally sustainable farming practices. However, even though their pond productivity was lowest from all groups, these farmers were the only ones to record profits from aquaculture in this study. This is likely to be the case because farmers in this group still benefitted from the ESP support which is supported by the fact that out of all groups farmers in Group A spent least on pond construction, fish feeds and fingerlings; and overall invested least money into aquaculture. However, farmers in Group A still invested a major amount of their total household incomes (from aquaculture and other sources) in aquaculture. This may be the case because farmers in this group have lacking aquaculture experience and may buy inputs (formerly) supported by the ESP, which are usually of a more expensive nature than locally produced inputs. The highest investment of household incomes into aquaculture was observed in Group C, possibly because no support was available for these farmers. Overall, a more evolutionary pathway as described by Brummett and Williams (2000) and practiced by Groups B and C in this study, was found to be most successful in this study. Generally, the introduction of fish farming should have built more on natural resource constraints and the local knowledge base as suggested by Hishamunda and Ridler, 2006, Brummett and Williams, 2000, and Coche *et al.*, 1994 to make aquaculture development sustainable in the long-term.

Trainings on how to increase pond productivities without subsidies (e.g. through the application of more cost-effective farming practices) are crucial for farmers in the study area. Methods for processing and storing agricultural by-products for their subsequent use in aquaculture should be promoted.

7.1.4 Other Aspects

Other considerations for livelihood improvements, which are not explicitly incorporated in the DFID (1999) definition, but in the context of this study became obvious, are dealt with in this section.

Environmental Conservation

This study shows that some fish farmers gave up fishing in Lake Victoria to start farming fish. Aquaculture could hence help to replenish reduced fish stocks in the lake; indirectly securing employment opportunities and animal protein availability for lakeside communities in the future through improved capture fisheries. With supporting aquaculture development the GoK hence has a promising chance avoiding the aggravation of environmental problems in Lake Victoria and hopefully even enhancing the situation. More research, however needs to be done on the fishing- and aquaculture relationship since many of the fish farms visited in this study were located quite far inland, and are hence rather unlikely to represent former capture fishing households.

Empowering Underprivileged Groups – Women and Young People

Aquaculture, since it is an activity with many different stakeholders, can provide employment also to women and young people. This study, however, mainly incorporated male and quite old farmers. However, because on many farms aquaculture represented an added activity to the other farming activities, additional workers were needed. This possibly gave employment opportunities to the farmers' families. By supporting aquaculture development the GoK may hence also have provided incomes to underprivileged groups, i.e. women and young people, as established by Hino (2011), and Jagger and Pender (2001). In order to further assess the roles of these groups more research needs to be done incorporating additional groups of stakeholders.

Changes in other Livelihood Parameters

Changes in certain other livelihood parameters that indicate increased well-being; i.e. increased healthcare, the increased possession of household assets and the increased ability to pay schooling fees were also chosen in this study to shed light on livelihood changes of the fish farmers in the study area.

Overall, livelihood situations of the fish farmers in terms of the above-stated livelihood parameters improved with commence of fish farming. Profits from aquaculture may have enabled farmers from Group A to initiate these improvements. However, the also rather favourable situations of Groups B and C cannot be explained with income creation by aquaculture. I suspect here that farmers may have tried to impress me when answering these rather personal questions about their well-being.

7.2 Future Challenges and Opportunities

In order to help fish farmers increase production and hence increase aquaculture profits to improve livelihoods, their problems need to be taken care of. Financial problems were mentioned primarily by most farmers. Farmers in Group C, probably due to the lack of financial support, had the most severe financial problems. Financial problems of farmers in Group A may have arisen from the fact that these farmers hardly used any cost-effective farming techniques, increasing their aquaculture related expenditures with decreasing subsidies. Trainings about integrated farming techniques may help alleviate financial problems on the farms. However, some farmers may have exaggerated financial issues in the hope of receiving more support.

Many of the other problems mentioned, e.g. seepage problems, predation problems and security issues, could be taken care of by building better ponds, the use of fences and nets against predators and the employment of security staff. This, however, calls for trainings and/or the availability of more capital. It is important to build a solid base of knowledge to eventually achieve self-sufficiency of aquaculture since support is temporary. This should have been a priority from the start of the ESP, especially as Ahmed (2009) identifies trainings as low-cost methods to increase fish farming productivity. Trainings through the ESP were offered in the study area, but not sufficiently attended by the farmers. This may be due to insufficient advertisement or due to training-locations not easily accessible for fish farmers. Minimizing these constraints could raise the training-attendance of fish farmers, helping to educate them about sustainable fish farming practices. However, the fact that almost twice as many farmers who started aquaculture on their own initiative attended trainings may also show that farmers in this group had a higher interest in learning about fish farming than farmers who were imposed from outside. This is supported by ALCOM (1994). Also, out of all groups, the need for trainings in the future was mostly realized by farmers from Group B, and least by farmers from Group A. A possible reason could be that farmers in Group A were not aware of problems, due to their lacking aquaculture experience. Local farm supervision by trained cooperative members who attentively point out problems to inexperienced fish farmers could be one way to alleviate the situation. Increasing aquaculture profits could be achieved by improving the marketing of the fish through improved availability of storage and cooling facilities. Also, even though Alal (2012) stressed that market availability in Kenya's Lake Victoria region is not a problem, access to the markets was often complicated for the farmers in the study area. Improving road infrastructure would possibly help to alleviate this problem. The respondents were aware of these shortcomings. Frequently stated were 'better market access' and 'availability of storage and cooling facilities' as support needed in the future.

Most farmers were planning on expanding their fish farming businesses and financing these actions through farm profits. However, only 32.8% % of ponds in Group A were constructed without support from the ESP, i.e. only on these farms expansion had already taken place. Since ESP support is ending, financing aquaculture by aquaculture profits may even be impossible for farmers in Group A, if no increase in profits takes place. Alarming is the large number of fish farmers that did not know how to finance their ponds in the future. A small number of farmers stated their plan of future aquaculture financing as being loans. However, this study shows that only a total of seven respondents ever applied for a loan. Low levels of credit use by fish farmers in Kenya were also observed by Quagrainie *et al.* (2010). This may have to do with non-sufficient knowledge about available loans or simply the fear of applying for a loan. More advertising activities need to be undertaken in order to promote potential future support programmes, and also loans available to the fish farmers, to boost aquaculture production. Such advertisement should be done through extension officers, promotional activities and also the media. These were sources of information found to be well-perceived by the respondents of this study.

7.3 Conclusions

In conclusion, this study shows that livelihoods of ESP supported farmers in Kenya's Lake Victoria region have indeed improved in terms of increased protein consumptions. However, observed improvements are mainly indirect, possibly through the generation of income from aquaculture. Since fish pond productivities of ESP supported fish farmers are exceptionally low, profits were possibly only recorded because aquaculture inputs were, at least partially, subsidized over the years. Efforts hence need to be made to increase the productivity of fish ponds in the study area, securing the continuation of aquaculture after ESP subsidies have completely stopped. Governmental aquaculture subsidies helped fish farmers in the short-term, i.e. through income generation and increased protein accessibility, but it failed to teach farmers how to achieve self-sustainable aquaculture without the help of subsidies. One way of achieving higher pond productivities, and hence self-sustainable aquaculture practices, is the promotion of sustainable and integrated aquaculture-agriculture farming practices, allowing for the use of locally available and cost-effective aquaculture inputs. This fish farming technology was, however, not widely used by ESP supported farmers. The risk is high that if pond productivities are not increased, aquaculture practices may be discontinued having negative consequences on the farmers' livelihoods.

7.4 Recommendations

The following recommendations, based on the outcomes of this study, should be noted in order to successfully continue aquaculture in western Kenya to help improve livelihoods:

I) Fish farmers should be educated about integrated aquaculture systems to make fish farming more sustainable and cost-effective.

II) The perception of farmed fish needs to be improved among rural communities.

III) Farmers should be taught how to produce their own high-quality fish feed from local and easily available ingredients.

IV) Local feed mills and local hatcheries should be promoted to reduce transport costs for important fish farm inputs and high mortality rates of fingerlings.

V) Further encourage fish farmers to be members of fish farming groups and cooperatives to improve communication amongst fish farmers which may prove to be helpful in problem solving.

VI) Train cooperative members to be able to supervise and train other farmers in the area, especially on predator control tools, achievement of farm security and integrated aquaculture.

VII) Improved publication of relevant aquaculture development project results and improvements through appropriate media in order to attract the interest of rural people, governmental and non-governmental organizations and funding agencies.

VIII) Testing of the suitability of the area and community setting before promoting aquaculture projects in order to avoid the building of ponds in unsuitable areas, i.e. areas where land and water availability are scarce.

IX) The development of a suitable model for fish marketing mechanisms is necessary. This includes certain infrastructural facilities such as the availability of storage and cooling facilities and an improved road network.

X) Educate fish farmers on the use of loans and instruct commercial agricultural lenders to invest in the aquaculture enterprise.

XI) More large-scale intensive fish farming systems need to be developed to keep up with continuously increasing needs for fish.

XII) The model for large-scale commercial aquaculture systems in Kenya needs to be critically assessed in terms of equity and (environmental) sustainability in order to avoid social disruption and environmental degradation. Environmental regulations need to be monitored.

XIII) Promote local participation and investments in wider research and knowledge.

XIV) The reliance of fish farmers on natural water resources needs to be alleviated, e.g. through the construction of boreholes, to secure water supply during droughts.

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Appendix A – Research Questionnaire

Respondent name: *Name of interviewer:*
Respondent phone: *Interviewer phone:*
Date: *Village/County/Province:*

(1) General information – Farm characteristics & Demographics

1.1. What is your age? ....**1.2.** What is your gender? ( ) Male ( ) Female

1.3. What is your highest level of education?
( ) Illiterate ( ) Primary ( ) Secondary ( ) Tertiary

1.4. What is your link to aquaculture?
( ) Owner ( ) Labourer ( ) Other: ....

1.5. What is your household size (including you)? ......

1.6. How much extended family do you have? ....

1.7. Number of paid employees? ....

1.8. What year did you start fish farming? ....

1.9. Did you start fish farming with ESP? ( ) Yes ( ) No

1.10. Do you own or rent the land you use for fish farming? ( ) Owned ( ) Rented ( ) Other: ....

1.11. Describe the fish farming activity!

(a) Number of ponds ....

(b) What size are the ponds (m^2)? ....

(c) What fish do you farm? ( ) Tilapia ( ) Catfish ( ) Both

(d) Culture system: ( ) Monoculture ( ) Polyculture ( ) Both
( ) Monosex ( ) Polysex ( ) Both

(e) Source of water ( ) Well ( ) River ( ) Groundwater ( ) Lake ( ) Other: ....

(f) Do you re-use the pond water? ( ) Yes ( ) No

(g) What do you feed the fish with? .... **(h)** What fertilizer do you use? ....

1.12. What is the main problem you experience concerning fish farming? ....

1.13. Have ( ) Flooding or ( ) Drought influenced your fish farming activity?

1.14. Are you a member of a fish farming group/cooperative? ( ) Yes ( ) No

1.15. Do you keep records? ( ) Yes ( ) No

1.16. Please fill in the table!

Access to...	How far from the farm?
Fingerlings	km
Fertilizer	km
Fish feed	km
Help for pond construction	km
Education/training	km
Closest market	km

1.17. What type of transport do you have access to?
( ) Public ( ) Bike/walk ( ) Own motorized vehicle ( ) Other: ....

(2) Support mechanisms used
2.1. What sources of support do/did you receive?
( ) ESP ponds (number: ....) ( ) ESP feed ( ) Other: ....
( ) ESP trainings (number: ....) ( ) ESP fingerlings
2.2. *If farmer receives ESP support:* What is his/her source of information?
( ) Promotional activities ( ) Extension officers ( ) Other farmers ( ) Media ( ) Other: ....
2.3. *If the farmer does not receive ESP support*, why not? ....
2.4. Have you ever applied for a loan? ( ) Yes ( ) No
2.5. Was it successful? ( ) Yes ( ) No

(3) Farm wealth
3.1. Time between stocking of pond and re-stocking of pond *(= length of cycle*): ..... months
3.2. What are your sources of income (1 = most important, 5 = least important)?
1: .... 3: .... 5: ....
2: .... 4: ....
3.3. Income from aquaculture per cycle? KES..........
3.4. Is aquaculture an additional source of income? ( ) Yes ( ) No
3.5. *If no* – which former activity was replaced by aquaculture? ....
3.6. Income from this former activity? KES/year ....
3.7. Aquaculture related expenditures (1 = most important, 3 = least important)
1: .... KES/cycle: ....
2: .... KES/cycle: ....
3: .... KES/cycle: ....
3.8. Size of last fish harvest? Kg ....
3.9. What are you mainly using the harvested fish for?
( ) Sold on market ( ) given to relatives/neighbours/payment-in-kind
( ) Home consumption ( ) Other: ....
3.10. What are you mainly using your income for?
( ) Investment in aquaculture ( ) Schooling fees
( ) Personal ( ) Other: ....

(4) Livelihood changes
4.1. What types of protein do you and your family consume? Indicate changes!

Type of protein	**Before aquaculture (times per week)**	**Now**
Meat		More/less/same
Fish from market		More/less/same
Omena		More/less/same
Beans		More/less/same

4.2. Livelihood quality. Indicate changes!

Livelihood quality	Situation 'now' compared to 'before aquaculture'
Diet diversity	Better/worse/same
Healthcare	Better/worse/same
Payment of schooling fees	Better/worse/same
Possession of household assets	Better/worse/same

(5) Future perspectives

5.1. What are your plans for aquaculture operations in the next 5 years?
( ) Continue at current level ( ) Expand ( ) Reduce
( ) Discontinue ( ) Undecided ( ) Other: ....
5.2. What support do you need in the future? ....
5.3. How are you planning on financing aquaculture in the future?
( ) Fish farm profits ( ) Subsidies ( ) Other: ....
( ) Loan ( ) Don't know

Appendix B – Cover Letter

Survey of Fish Farming Households in the Lake Victoria Region, Kenya

(Europe – University Centre of the Westfjords – Iceland)

As a graduate student of the University of Akureyri in Iceland I am conducting a study on tilapia aquaculture in Kenya; in particular in understanding the situation of tilapia farming households in your area. Your participation in this study will be very useful in generating valuable insights. I would like to assure you that all responses at the individual level will be kept strictly confidential. None of your responses will be quoted or disseminated to another person or organization to safeguard your identity.

Following are my research questions:

(1) How effective has the Kenyan government's Economic Stimulus Programme been for chosen Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*) farmers in western Kenya to improve livelihoods in terms of improved well-being and reduced vulnerability through *(a)* increased income creation, *(b)* changes in protein consumption, and the *(c)* sustainable use of natural resources?

(2) What is the long-term potential of small-scale Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*) aquaculture in chosen farms in western Kenya *(a)* with or *(b)* without the support of the Kenyan government's Economic Stimulus Programme?

Háskólasetur Vestfjarða
University Centre of the Westfjords